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Machinery of Dominance

Women, Men, and Technical Know-how

with a foreword by Ruth Schwartz Cowan

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Introduction

Popular sayings are often close to the mark. None less so, however, than the one that goes: 'the hand that rocks the cradle rules the world'. The world is really ruled by people who left the cradle to others and instead invested their time and energy in amassing and deploying wealth and skills 'out there' in the economic world. Since long before the industrial revolution, a good deal of wealth has taken the form of tools, equipment and machinery, and a good many of the abilities needed to make more wealth and to generate more power have been technological skills. This book is about technological competence, who has it, what authority it confers and what connection it has with ruling the world and rocking the cradle.

Technology is a medium of power. At the simplest level the lever or the pulley adds power to the arm. The thumbscrew, the battering ram and the nuclear arsenal amplify the physical strength of the state. Owning tools, equipment and machinery and putting other people to work on them, uniting the two great forces of production, has been the primary source of economic power. The person who possesses special knowledge and competence with technology has always had a valuable asset, whether to put to use autonomously or to place at the service of an employer. 'Know-how' about making or using matter but also over people. Those who do not have it must depend on those who do to achieve their ends: to win a war, social production, in the factory for instance, the authority of know-how over the instruments of labour, the machinery, is extended to authority over the worker. The engineer who

knows about the mechanisms of the assembly line governs the movements not only of materials but of human beings.

Technology has an inescapable bond with wealth. Even simple tools are no use without the resources to acquire land or materials on which to use them. Larger-scale technologies, such as those of warfare, irrigation or construction, depend on massive economic surpluses to be effective. The engineer has always needed a patron. Once capitalist industrial production developed, the skilled technologist was obliged to turn to the manufacturer if he wanted a chance to exchange his skill for a living. Since the advent of twentieth-century corporate capitalism, the 'technological innovator' has often been a team in the employ of a giant firm, since it takes a multinational to launch a major new product or process onto the market.

As technologies change and displace each other, there is disturbance among the technically skilled strata. Some gain and some lose position; some help push others down. The relationship of the person who has the relatively powerful attribute of technological competence to the person or organization with the absolutely powerful attribute of wealth has always been a negotiated one, highly ambiguous. The place of technology and technological skills in class struggle has been an important theme in economic history.

Technology, however, plays a part in a second set of power relations that is often overlooked. Among the haves and have-nots of technological competence, women and men are unevenly represented. When the United Nations reported in 1980 that 'women constitute half the world's population, perform nearly two-thirds of its work-hours, receive one-tenth of the world's income and own less than one hundredth of the world's property' they might well have added that women possess an all-but-invisible fraction of its technological know-how and technical jobs. (They might also have noted that just such a tiny proportion of the world's cradles are rocked by men.) The technical competence that men as a sex possess and women as a sex lack is an extension of the physical domination of women by men. It also has, as we shall see, extensive effects

in differential earnings and social authority.

It is common sense to suppose that technology, as a medium of power, will be developed and used in any system of dominance to further the interests of those who are on top. As women, then, we have to consider technology from, at the very least, the perspectives of both class and sex, two systems of power that bear heavily on us. Only very recently have women begun to aspire to technical training and work. In a sense, this book responds to that aspiration, assessing the scale and nature of our undertaking. Women's project of learning technical skills is clearly fraught with contradiction. If technology is a historical aspect of male power, can women participate in it at all without becoming 'honorary men'? If it is an aspect of class domination, how can women engage in it without lending a hand to exploitation? Can women, however, do without this knowledge?

The particular context within which technology is considered in this book is the *sexual division of labour*, the way work is divided up between women and men. That means we are not immediately concerned with military technology, nor with technologies of contraception, genetics or housework, although these have significant effects on women. The technologies in question here are those used in paid work. They are, broadly speaking, *technologies of production*.

Within this context of production the focus is not a narrow one, on 'the engineer' alone, but includes all those that deal with the technology. It is only in their relationships that we can trace the divisions of class and sex. This supposes an interest in owners, inventors and managers of technology; in professional and academic engineers, technician engineers and craft workers - mechanics, fitters, turners (who also often call themselves 'engineers'). We have to include semi-skilled and unskilled workers assembling machinery and operating it. Drawing on recent instances of technological change in the workplace, we will see how, though occupations themselves may have been transformed, the relations of technology continue. A sexual division of labour in and around technology persists and survives.

Chapter 1 begins with a discussion of the sexual division of labour itself. Segregation of occupation by sex is an enduring feature of economic life and, along with male supremacy, seems to occur to a varying degree in all known contemporary societies. Technological competence is a factor in sex-segregation, women clustering in jobs that require little or none, men spreading across a wider range of occupations which include those that call for technical training. There is nothing 'natural' about this affinity of men to technology. It has, like gender difference itself, been developed in a social process over a long historical period in conjunction with the growth of hierarchical systems of power. Men controlled the technological knowledge that governed the instruments of labour and the work processes of other men and of all women. With the rise of capitalism, an economic system based on continual advances in technology, men were thrown into perennial conflict with capital and with each other over the possession of technological competence and the power to use it. Women were actively excluded from technological knowledge, acted upon by the technology and not interactive with it.

In the ensuing three chapters I examine some contemporary labour processes in detail and trace the effect on them of electronic technology and the way sexual divisions change but survive through a period of economic crisis and technical transformation. In Chapter 2 I look at the clothing industry and in particular at two clothing firms. One is still using conventional methods of producing patterns with pencil and paper, cutting cloth with simple portable electric tools. The second firm has brought the computer to the pattern room, where the grading of patterns and the preparation of lays of pattern parts is now carried out at a video screen. The cloth is cut, with dramatic increases in productivity, by a computer-driven knife. This is a classic story of the dispossession of the traditional male craft producer and the scrapping of the simple tools over which he, not a company engineer, had effective control. In his place have been installed two new kinds of employee: a semi-skilled operator, characteristically female; and a system technologist (male), on whose know-how depends

the management of the new equipment and the new labour processes.

Chapter 3 looks at the reorganization of warehouses in mail order firms, those houses that sell their goods to the public by means of a printed catalogue. I look at one warehouse that uses the time-honoured hand method of order filling, and then survey the technological developments sweeping through more advanced firms in the sector, including one particular company that has taken the step of moving goods instead of people. Here again the computer (in this case associated with materials-handling equipment) can be seen bringing about a restructuring of the labour force. Many workers are made redundant while the remainder become more productive and more disciplined. Again, women and men play different parts in the drama: men do the jobs that require technical skill or physical competence and which afford a degree of physical mobility. They are to be found managing, maintaining and repairing the machinery on which the women work. Women are confined to less mobile, unskilled, low-paid and non-technical jobs.

The third technology, described in Chapter 4, lies outside the business world, within the X-ray departments of National Health Service hospitals. One hospital looked at has only conventional X-ray equipment, the other has acquired, additionally, a powerful new diagnostic tool, the computed tomography scanner. In contrast to the two previous studies, situated among skilled and unskilled manual workers, this one is located among professionals and para-professionals in the male-dominated hierarchy of medicine. Here the staff of the X-ray department is mainly female, and this study proves, if such proof were called for, that women are quite capable of gaining technological knowledge and practical technical skills and are keen to do so. There is still, however, a group in the hospital with greater technical authority than they: the scientists and technicians of the medical physics department. The more senior and technology-oriented members of the physics team are male. Like the manufacturers of the new equipment, physicists and doctors fail to share the radiographer's priority of keeping a high level of technical skill in the practice of

radiography. They often distinguish technological ability from the quality needed for patient care, linking men with the former, women with the latter.

One industry plays a key part in the cyclical transformation of the forces of production: the engineering industry. This is where the machinery and equipment set to work in other industries actually originate. Though these capital goods firms too are subject to competition and some go to the wall in times of crisis, certain sectors of engineering are bound by their nature to thrive on technological change. So I followed the three computer-based technologies 'upstream' to find out how women are faring in firms involved in producing and disseminating the 'new technology'. Chapter 5 looks at the technical labour processes and the division of labour in a large engineering firm producing X-ray equipment; in two import agencies marketing computer clothing systems; in a consultancy advising on warehouse innovations, and in an engineering workshop making electrically controlled mechanical equipment for warehouses. This is the heartland of technological skills. The firms employ technically qualified managers, professional engineers in design and development, many technician engineers in maintenance, installation and repair, and craft engineers, along with less skilled workers, in production. Here we can see technological segregation by sex painfully spread out to view. The technologists, with few exceptions, are men. Women play the support role of office secretary to the professional engineers and, in production, they are the base-line, least-skilled, lowest-paid assembly hands.

The consistent theme unfolding here is this: women are to be found in great numbers *operating* machinery, and some operating jobs are more skill-demanding than others. But women continue to be rarities in those occupations that involve knowing about what goes on inside the machine. The electronic revolution is making little difference. The flexible, transferable skills of engineering are still the property of males. With few exceptions, the designer and developer of the new systems, the people who market and sell, install, manage and service

machinery, are men. Women may push the buttons but they may not meddle with the works.

The advantages to men of this sexual division of labour give them every reason to strive to perpetuate it. What of employers, however? While I encountered some prejudiced attitudes among employers, several managers said their main problem was a shortage of appropriate skills. They would be willing to employ good technologists of either sex. Women, they said, were just not coming forward. Chapter 6 therefore looks behind the notion of 'equal opportunity' to some of the cultural processes that go on in the technological workplace and help to explain women's reluctance to enter it. From men's own words it is possible to see how they ascribe high value to technology and technological work and how they identify their masculinity with their skills and careers. They relate to each other through competing over or sharing their manly competences, meanwhile relegating women to a different, lower, domestic sphere. Technology enters into our sexual identity: femininity is incompatible with technological competence; to feel technically competent is to feel manly. The gendering of men and women into 'masculine' and 'feminine' is a cultural process of immense power. People suffer for disregarding its dictates. It is, besides, not only people who get gendered but also occupations.

In Chapter 7 we hear what women have to say about their jobs, their commitment to work and their appetite for the technical competence that few get a chance to acquire. We also get a sense of their understanding that for a woman to cross into male work is to transgress gender rules and to invite penalties. It involves abandoning women's traditional values and concerns. Unlike women, men relate to the responsibilities of 'home' from a position of relative autonomy. They choose to give priority to earning and to work, leaving domestic responsibility to women. In this way they compete with women for training and in the labour market on unequal terms. In addition, women and men talk here about the way a sexual division of labour in technology exists in the home as well as at work: while women are occupied with cooking, cleaning and child care, it is almost exclusively men who do maintenance

work on house or vehicles. At this intimate scale it is possible to see that the grasp men have of technology and tools impedes women from gaining competence.

Finally, in Chapter 8, some conclusions are drawn as to why technologies may change but sex inequalities remain. Two factors emerge as helping men maintain their separation from women and their control of technological occupations. One is the active gendering of jobs and people. The second is the continual creation of sub-divisions in work processes, and levels in workplace hierarchies, into which men can move in order to keep their distance from women.

I discuss practical steps that can be taken to help women get technical skills and in particular the kinds of employment practices trade unions can press for and ways they too could usefully change. But we have to acknowledge women's reluctance to take up technical careers. It does not spring from inadequacy or lack of interest but from a keen perception of the costs involved: isolation, discomfort, harassment and, often, wasted time and energy. To equalize the presence of women with that of men in technological qualification and work we need not a few hundred more but tens of thousands of women at professional level, hundreds of thousands at craft and technician level. If the majority of women are refusing to follow the pioneers, turning their faces the other way, it is not surprising. Technology and the relations of technical work have to change before most women will choose to engage with them.

Some women have found a way forward, meanwhile, in organizing autonomously to get technical training for women in circumstances free of men. If this book has a single urgent message it is a plea for more commitment of support to women-only projects. There is, however, only one way of getting fully above and beyond the contradictions and legitimately encouraging women to abandon their boycott of technology. This is the long-term project of dismantling gender, both of people and of occupations. Gender difference, like apartheid, has always meant separate development for inequality. When women's and men's lives are no longer complementary but

similar, then women will share in technical skills and an unaccustomed hand will share in the rocking of the cradle too. What the cradle symbolizes, the human factor in human life, has to replace power as the purpose of production and technology.

1. Technology, production and power

It is a fact known to the youngest school child that women and men 'do different jobs'. A sexual division of labour is one of the most marked and persistent of the patterns that characterize human society everywhere. In Britain, men and women cluster in different industries. For example, while women are only 14.8 per cent of the labour force in the industrial group called the 'mechanical engineering industry', they are 70.3 per cent of the labour force in 'footwear and clothing'.¹ Within any one industry of course there will be people doing many different kinds of job. So a large proportion of that female 14.8 per cent in 'mechanical engineering' is in fact doing traditional women's work in the offices and canteens of engineering firms. The closer we look the more differences we find between what women do and what men do. Using 'occupational' in place of 'industrial' statistics – what we actually work at rather than the type of firm we work in – we find that 76.7 per cent of the clerical labour force is women. On the other hand, only 4.8 per cent of people in processing, making and repairing jobs in connection with metal or electrical products are women.²

Women are clustered into relatively few occupations. Of women manual workers, 85 per cent work in three broad occupational groups: catering, cleaning, hairdressing and other personal services; painting, repetitive assembling, product inspecting, packaging and similar occupations; and making and repairing jobs (excluding those in metal and electrical work). Of women non-manual workers, no less than 91 per cent are to be found within three categories: selling; clerical jobs; and professional and related work in education, welfare and health services.³

Men, by contrast, are engaged in a far wider range of activities and there are few from which they are entirely absent. More importantly, they monopolize the higher ranks of most. It is useful to distinguish 'horizontal' segregation of occupations, whereby men and women engage in different *kinds* of work, from 'vertical' segregation, whereby the sexes attain different *levels* of seniority in their occupations. The statistics show that men occupy a disproportionate number of higher-grade positions and women are concentrated in the lower grades of the rather limited range of work they do.⁴

Studies of individual industries or firms show that when one gets down to workplace level the divisions between women and men are yet more pronounced. An occupational category such as 'warehouse hand' is likely to conceal a situation in which heavy work like pushing goods around is done by men, sedentary work like checking delivery notes is done by women. In particular, sex divisions nearly always break cleanly along the line of skill. Jobs formally classified as skilled are done by men. Women are found in jobs that are considered unskilled and semi-skilled.⁵

A recent British survey involving over 3,000 women obtained an even closer look at segregation by sex. Working women reported in 63 per cent of cases that they worked in 'women-only' jobs. The occupational segregation was higher still if the professions and office work were weeded out. For instance, of semi-skilled factory workers no less than 73 per cent were working only with women in their particular job. Even more of men's work is exclusively male. Of the smaller number of husbands interviewed in this same survey, 81 per cent of those working with other people worked only with men, and 98 per cent had male supervisors.⁶

Surprisingly, there has been little lessening of occupational segregation by sex during this century. Catherine Hakim used a number of different measures to find out whether a change had occurred between 1901 and 1971. She found that the proportion of occupations without any women workers at all was relatively constant at around 9 per cent between 1901 and 1961, but an improvement had been detectable by 1971, as a few women

pioneers penetrated male fields in the forward-looking decade of the 1960s. The proportion of all occupations in which women were at least as well represented as men in the labour force as a whole, however, remained virtually constant over the 70-year period, at the low level of 25 per cent of the total. Typically male occupations remained at a fairly constant high level of 73 per cent of all occupations listed. The proportion of occupations in which women were greatly over-represented (at 70 per cent or more of the workforce) actually *increased* slightly, from 9 per cent to 12 per cent. In addition, Hakim's data indicated a trend towards greater vertical segregation over the period. Men, not women, were climbing. She summarized: 'Occupational concentration and occupational segregation have remained relatively unchanged in Britain over seven decades.'⁷

It seems that the phenomenon of sex segregation is not limited to Britain. Reports from the USA⁸ and European countries⁹ show a similar situation. In Third World countries, though the actual occupations done by women and by men may vary widely, the existence of a clear sexual division of labour of some kind characterizes them all.¹⁰ Even in the USSR, where the ideology of the 1917 Revolution and the shortage of skilled labour in the period that followed gave a boost to women's entry into non-traditional work, the return of a measure of normalcy was accompanied by an increase in occupational segregation by sex. Though more women than in Britain are scientists, engineers and technicians, they tend to be in the lower-ranking branches and grades of the fields in which they work. The 1970 census in the USSR showed that men were not taking their place alongside women in traditionally female jobs. Ninety-eight per cent of nurses and nursery school personnel, 99 per cent of stenographers and 91 per cent of catering employees were female.¹¹

Divided by technology

Technology has an important position in this widespread sexual division of labour. Technological knowledge at the

professional level, and technological know-how at the practical level, are sharp differentiators of men and women. Taking occupational categories, for instance: in 1983 in Britain, women were only 8.6 per cent of the professionals in science, engineering and technology, and 4.8 per cent of the labour force who process, make and repair metal and electrical goods.¹² The former figures show a slight gain (of 1.5 per cent) since 1975, the latter a slight fall (1.1 per cent).

More detailed information is obtainable from the statistics of education and training. These, besides, are a better pointer to the future. Again, a difference is observable between the educational levels. Girls and boys start out on their different routes while still at school. If we take maths, physics, computer studies and technical drawing as indicators of future technological career choices, we find females already disadvantaged at 16 years of age. At GCE O-level, for instance, though the percentages have been slowly rising since 1970, girls still had only 43.6 per cent of the passes in maths, 27.9 per cent in physics, 27.3 per cent in the relatively new subject of computer studies, and 4.6 per cent in technical drawing in 1983. The disadvantage is confirmed and deepened by 18 years of age. At A-level these percentages fall to 31.1, 21.0, 19.6 and 2.9 per cent respectively.¹³

If we move up the age range to vocational training, we find in 1982-3 women representing only a negligible 1 per cent of those entering for the craft engineering exams of the City and Guilds of London Institute, the body officially responsible for qualifying craft workers.¹⁴ The situation is hardly better on the courses leading to the somewhat higher level of engineering technician exams, which are certified by the Business and Technical Education Council: a little over 2 per cent of those entering were women in 1982-3.¹⁵ Among students of English polytechnics enrolling on advanced 'engineering and technology' courses in 1983 there were 720 full-time female students to 7,125 male (9.2 per cent). Against 1,172 female 'sandwich' students there were 17,917 males (6.1 per cent), and only 419 young women were getting day release to attend these courses as against 10,798 young men (3.7 per cent).¹⁶ Finally, among

full-time university undergraduates in 'engineering and technology', women represented 9.1 per cent in 1983. This proportion had, however, doubled since 1975.¹⁷ The picture is of an overwhelmingly male field of work into which a few women pioneers are making their way. It is a little easier for those who make it over the A-level threshold and can follow the professional route, unremittingly hard for those young women who must take the manual, vocational route. At all levels, while the pioneers have a little more female company each year, pioneers they remain.

The effect on women as people and as workers of their exclusion from the skills needed to govern the technologies of production will gradually become clear in the course of this book. One point is worth making here, however. It is costing women money. The Equal Pay Act of 1970, operational in 1975, promised to bring women's pay up to the level of men's. Yet while women's average gross hourly earnings as a proportion of men's were boosted, partly by the new legislation, from 63 per cent to 75 per cent between 1970 and 1977, they then slipped and stood at 73.5 per cent in 1984.¹⁸ If we consider average gross weekly earnings, which include the fact that men have access to more overtime possibilities than women, we find that women's pay packets look even thinner. They earned 54.5 per cent of what men earned in 1974 and had only crept up to 65.8 per cent of men's weekly earnings by 1984.¹⁹

It is by now widely accepted that the reason the Equal Pay legislation of the 1970s failed to achieve equal pay for women is that the majority of women are segregated into fields of employment in which they are unable to compare themselves with men for purposes of grading and pay.²⁰ Skilled manual work pays more than unskilled; professional jobs pay more than office work. In technology, as in other fields, women are not on the career paths that offer pay and prospects. In the engineering industry, for example, of a total of 2.3 million employed in 1982, 22 per cent, or around half a million, were women. Yet their share of the industry's wage bill was certainly not proportional to their numbers, since 45 per cent were in relatively low-paid operator jobs and almost all the remainder

in equally ill-rewarded clerical work. Only 2.5 per cent of the women working in the engineering industry were in managerial, scientific, technological or technician occupations.²¹ It is the men in the industry who earn the skilled wages and the professional salaries. And the same technological division of labour by sex, with the same pecuniary effects, applies outside as within the engineering industry proper.

Men's appropriation of technology

To understand the different relation the sexes have to technology today we need to recognize the relevance of technology to power and to the emergence of power systems in the past. Despite the stereotype of the stone-age cave man dragging 'his' woman along by the hair and wielding a club (technology?) in his free hand, the evidence of archaeology does not point to any 'natural' distance between women and technology.²² Today, when explaining the emergence of human societies, the emphasis has shifted from *Man The Hunter* to *Woman The Gatherer*.²³ It is suggested that females, not males, were the first technologists. Under pressure of nutritional stress, caring for both self and young, females are the more likely sex to have invented the digging stick, the carrying sling or bag, the reaping knife and sickle, pestles and pounders, methods of winnowing, washing, detoxifying and preserving food.²⁴ It is well established that women were the first horticulturalists, purposefully growing selected plants in and around their settlements.²⁵ They may well have invented and used the hoe, spade, shovel and scratch-plough.²⁶ Whether hunting animals (large or small), or herding, gardening and farming, a simple division of labour may have occurred. We need not suppose, however, that it gave one sex a marked monopoly of technological skills.²⁷

As human societies have developed, in different parts of the world at different times, they have tended to pass through broadly similar phases. Often these are designated by archaeologists according to the material of the dominant technology: stone age, bronze age, iron age. Associated with the technologies are successive stages in social organization. Women appear to

have been central to the organization of social life until the late neolithic age. As the neolithic ceded to the bronze age, however, in many cultures of which a record exists it is possible to see a shift towards male dominance. A relatively egalitarian and peaceful community of woman-centred kinship clans gave way to an increasingly centralized society divided into hierarchical classes, based on agriculture, warfare and slavery. As this occurred, it seems, women were actively subjugated by men, excluded from many crafts and trades and displaced from their positions of political and religious authority.²⁸ The rise of class society is associated with a shift to patrilineality (determining descent through the male blood line) and to patrilocality (a wife moving to the domain of her husband's family on marriage).²⁹ It is also associated with an increasing division of labour, the emergence of specific crafts and trades.

In particular the new occupations surrounding metallurgy were highly significant. The importance of metals and of the skills of smelter, founder and smith to the military and agricultural exploits of rulers and ruling classes can be in no doubt. It seems that in male-dominated societies these occupations are seen as male. Technological skills are a source of power and where men were in possession of all other vehicles of power, from state organization to marriage, it would have been surprising to find women in possession of mechanical powers. The 'mighty five' devices – lever, wedge, screw, wheel and inclined plane – that made it possible to move mountains and build pyramids were the technical armoury of men.

It was not in the cradles of 'civilization', however, but in the western extremities of Europe that technology would explode in the eighteenth and nineteenth centuries AD, and it is of interest to trace the technological division of labour by sex as it progressed there. As the use of iron was rapidly expanded in the eighth and ninth centuries,³⁰ it is clear that women's role in production, though of prime importance then as it has continued to be ever since ('two-thirds of the world's work hours'), was nonetheless confined to particular activities associated with domestic consumption. Apart from food preparation and child care, women were responsible for

'spinning, dyeing, weaving, tending the garden, raising livestock and... cultivating land'.³² It was men who were the goldsmith, weapon-smith and blacksmith, 'making ploughshare and coulter, goad and fish-hook, awl and needle', and the carpenter, 'responsible not only for various tools and utensils but for houses and ships'.³³

In the later Middle Ages again we find rural women involved with 'dairy work, gardening, food preparation and the textile crafts of carding, slubbing, spinning and weaving', while their male equivalents 'worked the land, reared livestock, repaired hedges, ditches and tools'.³⁴ Among these tools were more and more made of iron. Iron was rapidly becoming the basis of the dominant technology. 'It is the consensus among historians of agriculture that the mediaeval peasantry used an amount of iron which would have seemed inconceivable to any earlier rural population and that the smithy became integral to every village'.³⁵ And there were few trades more associated with manliness than that of smith.

The towns, which grew rapidly in importance in the thirteenth and fourteenth centuries, were the centres of specialized handicrafts. Under the authority of the feudal state, the craft and merchant guilds laid down the rules by which apprentices might be recruited and trained and business carried on. The guilds covered certain skilled techniques producing goods for consumption, such as printing. But they also included those that produced tools and implements: carpenter, wright and various kinds of smith. The guilds were male in character.³⁶ Women engaged extensively in economic life in the towns, but mainly in sex-specific areas that had by long tradition been female. They were domestic servants, washerwomen, bakers, brewers and inn-keepers, roles that were extensions into trade of the concerns of domestic life: food, drink and textiles, goods and services for domestic consumption.

The sexual division of labour was not absolutely total at this period, however. Women appear listed alongside men as engaging in certain kinds of production (shoe making for instance) and in certain fields of commerce (as drapers, chandlers and even ironmongers). The pattern that we have

seen to exist today, however, whereby women cluster in a few occupations and men spread across many, is evident in the Middle Ages. Poll tax returns for Oxford in 1380, for instance, mention six trades followed by women, six in which both women and men were employed, and no fewer than 81 that were followed exclusively by men. Alice Clark concluded from her study of mediaeval trades that, though women followed some skilled and semi-skilled occupations, 'no traces can be found of any organisation existing' within them.³⁷ Certainly women were not considered a threat to male occupational rights. A statute of Edward III expressly exempted women from the ordinance that men should not follow more than a single craft. 'But the intent of the King and his Council,' it reads, 'is that Women, that is to say Brewers, Bakers, Carders and Spinners and Workers as well of Wool as of Linen Cloth and of Silk, Brawdesters and Breakers of Wool and all other that do use and work all Handy Works may freely use and work as they have done before this time . . .'.³⁸

The role of the guilds extended beyond an immediate trade to social organization within the town. A woman therefore might be a member of a guild without actually plying its trade. A daughter might take up right of patrimony in her father's guild for the civic advantages it afforded. Some are known to have become apprenticed to a master in his guild so as to work as a domestic servant to his wife. Widows frequently inherited their husbands' enterprises. Widows are therefore sometimes named even as farriers and smiths. An exceptional woman might have broken the convention to carry out this work herself, but a commoner practice was for a widow to manage the business while hired journeymen and apprentices carried out the skilled practical aspects of the work.

Tools that make tools

In this account of early divisions of labour we can distinguish certain skills which were of special significance in production and which yielded, as a consequence, greater influence to those who possessed them than was yielded by ordinary productive

abilities. They are the skills that were required for making tools, implements and weapons. In other words, *they involved competence in the production or adaptation of other producers' instruments of labour*. Eventually we will see these skills evolve into those that make machinery and later still into those that build computer systems.

Why should these abilities afford greater power than others; than the knowledge needed to nurture children, for instance, or to weave cloth or plough the land? The answer is, first, related to systems of class power. Those who own the means of production, whether slave-owning emperors, land-owning feudal nobles or factory-owning capitalists, depend for the making of their wealth on a yoking in tandem of labour and tools, labour and machinery. They may be expected therefore to pay well, in cash or food, freedom or status, for the skills they need to effect this linkage and continually to improve its productivity. Other talents could, in another world, have been valued more highly. But from the onset of male-dominated class-structured societies, the priority has been supremacy in a struggle for ownership and control of disposable surpluses. That priority has forced the development of technology in a certain direction. The forcing-house has often been warfare.

Secondly, however, those who possessed these skills had a source of power over everyone who did not. Such men rendered other people dependent on them for the maintenance of their own environment and instruments of labour. They were in a position to impede or enhance, direct or redirect other producers' labour processes. They acquired a degree of authority among other men of those classes who worked manually. It will be clear also that the skills enhanced men's power over women. Not only were women firmly subordinated to men in the patriarchal family, but they were also dependent on them for certain important practical processes of everyday life. The technological skills, defined as male property, were therefore both a cause and an effect of male supremacy.

Meanwhile, technological knowledge was evolving. By the early fourteenth century Europe had made considerable progress towards substituting water and wind power for

human labour in apparatus of many different kinds. Applications of the new sources of power were advancing in step: the cam in the eleventh and twelfth centuries; the spring and treadle in the thirteenth; complex forms of gearing in the fourteenth. In the fifteenth century the crank, connecting-rod and governor were coming into widespread use, aiding the very significant step of converting reciprocating to continuous rotary motion. By the sixteenth century, 'Europe was equipped not only with sources of power far more diversified than those known to any previous culture, but also with an arsenal of technical means for grasping, guiding and utilizing such energies which was immeasurably more varied and skilful than any people of the past had possessed or than was known to any contemporary society.'³⁹

The history of invention represents the inventors of antiquity, the Middle Ages and the Renaissance as invariably male. A hefty and comprehensive 'history of the machine' published in 1979 encompasses technological development from the Cro-Magnon anvil to the space rocket. Among approximately 450 men named in connection with invention in this book there is one woman, Ada Lady Lovelace, mathematician.⁴⁰ The question of what part women did or did not play in technological invention is a knotty one. Women have almost always been 'hidden from history' when the historians were men. Autumn Stanley's work reaffirms women's creativeness.⁴¹ She suggests that we should be sceptical of the male historians of technology and look for the hidden women. We should, besides, give greater emphasis to the activities to which women notably *have* contributed their ideas: preparing food, healing, making garments, caring for children. After all, the significance ascribed to any productive practice has been largely a male choice.

Stanley proposes that 'all else being equal' we may assume that those who work in a process invent the tools by which it is carried on.⁴² While this is likely to be true for very early periods of human history, it is to miss a crucial characteristic of subsequent patriarchal and class societies. Women were systematically excluded from all sources of power, including

the technologies that held sway over their own female areas of production. The development of textile technology, for instance, has been a male not a female project. The following discussion by Lynn White Jr of the technology of the spinning wheel makes clear how differentiated were the considerations of *mechanics* from the consideration of spinning thread:

The spinning wheel is mechanically interesting not only because it is the first instance of the belt transmission of power and a notably early example of the flywheel principle, but because it focussed attention upon the problem of producing and controlling the various rates of speed in different moving parts of the same machine. One turn of the great wheel sent the spindle twirling many times; but not content with this, by c.1480 craftsmen (my italics) had developed a U-shaped flyer rotating around the spindle and permitting the operations of both spinning and winding the thread on a bobbin to proceed simultaneously. To accomplish this, spindle and flyer had to rotate at different speeds, each driven by a separate belt from the large wheel, which, of course, revolved at a third speed. Finally, by 1524, the crank, connecting-rod and treadle had been added to the spinning wheel.⁴³

Was White being sexist in assuming that these developments originated with men? I think not. Leonardo da Vinci is credited with the invention of the flyer for the spindle in 1490. Johann Jürgen, a woodcarver of Brunswick, invented a partly automatic spinning wheel employing a flyer around 1530.⁴⁴ The way of thinking that would have enabled such innovations arose not in the main from the spinning of thread but from a familiarity with other kinds of apparatus and technique. The matter of differential speeds, for instance, was being explored in clock-making at this time; the notion of the flywheel and the transmission belt were used in the developing of grinding mills. Technological knowledge is essentially a *transferable* knowledge, profitably carried from one kind of production to another. It is a field of its own. We will see this in the

contemporary studies that follow: computer-aided design and cutting systems built for use with metals are adapted for use with cloth; a robot developed for use in the car industry stimulates developments that will solve management problems in warehousing. Men move from industry to industry carrying know-how across the boundaries of firm and sector. Then, as now, it was men and not women who had mobility (intellectual, occupational and physical mobility) and the overview it afforded. Later of course it would be other men – Hargreave, Arkwright, Crompton, Kay – who would adapt the domestic textile apparatus for factory and mechanized use.

What is at issue here is not women's inventiveness. There is no doubt that women have the ability to be as imaginative and innovative as men. Women have frequently 'had ideas' for the improvement of tools and machinery with which they worked. They have seldom had the craft skills to effect in wood or metal the improvements they conceived. Besides, despite the frequent adulation by historians of male inventors, technological development is not in reality a series of brainwaves. A materialist understanding of history gives the personal less significance than the social. In tracing technological change, therefore, the focus needs to be 'not upon individuals, however heroic, but upon a collective, social process in which the institutional and economic environments play major roles'.⁴⁵ The social process of technological development has been overwhelmingly a male process. It is women's lack of social and economic power that holds them 'down' to the role of producer of goods for immediate consumption. Since the bronze age, women have worked *for* men, whether the man was head of household, slave-owner or feudal lord. It is clear that they also produced by *means of* man-made technologies. They were subject to that particular form of material control that comes of men as a sex having appropriated the role of tool-maker to the world.

Machines that make machines

The departure that was about to change the world dramatically for both women and men, however, was not a technical

invention. It was capitalism: an entirely new set of social relationships that would find the organizational means to bring science and technology together and harness them for production. During the sixteenth and seventeenth centuries the peasant economy of the countryside and the craft economy of the towns, both essentially home-based domestic forms of production, changed their character. From among the yeoman farmers and the guild masters emerged a new stratum of large-scale producers. The merchant class also grew in number and in influence. Wealth, accumulated through trade in England and overseas, sought new ways of making more wealth. Independent craft production gave way to 'manufacture' as merchants became entrepreneurs, no longer simply buying from but actively employing the producers.

At first the new capitalist class 'put out' the material to scattered producers to work on in their homes, and in this way the domestic system continued for a while within the new mode of production. Much of women's production continued to be carried on under the authority of father or husband. Eventually, however, entrepreneurs saw advantage in gathering producers into workshops and factories where an employer could enjoy economies of scale and supervise production more closely.

As the restraints of the guild system were shrugged off, the new class of employers found it possible and profitable to introduce a sub-division of the work process. Merchandise that had once been produced by a single craftsman undertaking all the varied parts of the process was now the product of a series of manual workers, each of whom repeated a part of the task over and over again with a single tool. Some of the detail tasks were more skill-demanding than others. The workforce could be differentiated: some remained relatively skilled and costly, but others could now be less skilled, and a new cheap category of entirely unskilled 'hands' was called into play. Often these were women or children, many of whom were drawn from the surplus population thrown off the land by the agrarian revolution.

A significant change began to occur in the relationship between producers and 'their' technologies. The craftsman had owned his own tools. This included the tools owned by those

men who made the tools that other producers used. The craftsman guarded the 'mystery' of how to use them. As Marx put it, 'the labourer and his means of production remained closely united, like the snail with its shell'.⁴⁶ Now the snail had to be prised from its shell if capitalism was to fulfil its potential: in the new factories the employer owned the instruments of labour and put the worker to work on them. For many artisans who had once purchased materials with their own money, worked with their own tools and sold to their own customers, the change was historic. Now what they sold, all they had to sell, was their labour power.

So, as the capitalist initiative (which was also, it must be noted, a masculine initiative) drew into existence this new class of wage workers, unknown in the feudal world, men of the two classes were drawn into endemic conflict. Capital might own the instruments of production but working men alone had the craft know-how to use them. How and by whom, for how long and for what reward, the tools and techniques were to be used became the basis of the struggle that has been the prime mover of history in the intervening 200 or 300 years.

The process, however, had a long way yet to go. Technology would not only set in opposition the interests of the employing class and the working class. It would also be instrumental in forming the new working class as a stratified and divided one. As the general-purpose tools of the craftsmen were put to use in a sub-divided production process, the tools too were altered – simplified and multiplied – to suit the new detail tasks.⁴⁷ Simple tools, combined and associated with a power source and a transmitting mechanism, resulted in a machine. The machine was soon associated with others in a factory system that itself had the characteristics of a machine. The groundwork was laid for vast new possibilities of accumulation for the owner of the new mechanical means of production.

Machinery offered men as a sex opportunities that were not open to women. Already certain technologies of which men had exclusive tenure had a special significance in production; now they took on an amplified importance. Those who had traditionally worked the materials from which tools were made

would now adapt their skills to the new machine age. What capital needed in place of smiths and wrights were 'mechanics' and 'engineers'. It was only men, inevitably, who had the tradition, the confidence and in many cases also the transferable skills to make the leap. It was therefore exclusively men who became the maintenance mechanics and the production engineers in the new factories, governing capital's new forces of production.

Marx singled out these key employees in the new 'manufacture'. He noted the essential division between the operators, who are actually employed on the machines, and their unskilled attendants. But, he wrote, in addition a historically new worker appears, a 'class of persons, whose occupation it is to look after the whole of the machinery and repair it from time to time; such as engineers, mechanics, joiners etc. This is a superior class of workmen, some of them scientifically educated, others brought up to a trade; it is distinct from the factory operative class and merely aggregated to it. This division of labour is purely technical.⁴⁸ These technical men were the one category of worker whose earning power was not reduced by the introduction of machinery.⁴⁹ If one mechanic, together with a handful of unskilled, low-paid machine operators, can put out of work many craftsmen, capital could (and as we shall see later still can) afford to pay the technical newcomer relatively well.

The old-style smith and wright, new-style mechanic and engineer, however, were also to play another part in production history. Machinery was crippled in its complete development so long as machine-building itself remained a handicraft affair. As Marx noted: 'The expansion of industries carried on by means of machinery, and the invasion by machinery of fresh branches of production, were dependent on the growth of a class of workmen who, owing to the almost artistic nature of their employment, could increase their numbers only gradually and not by leaps and bounds.'⁵⁰ Besides, because of the increasing size of the prime movers and the use of iron and steel - as Marx put it 'a more refractory material', huge masses of which had now 'to be forged, to be welded, to be cut, to be

bored and to be shaped' - it was inevitable that machines had to be invented with which to build machines.⁵¹

Skills, however, were still needed to design, develop and build these machines that were to make machines to do the work of men and women. While one kind of skilled man, therefore, had become the mechanic and engineer of the 'downstream' processes of what Marx called Department II, where they supervised the machines that produced the means of consumption, his brother now moved 'upstream' to become the mechanic and engineer of Department I, the influential machine-building or capital goods industry producing the means of production for others.⁵² We will see men of these two categories in the story ahead, for Chapters 2-4 in a sense deal with Department II, where services and goods are produced for consumption, while Chapter 5 looks at some of the inheritors of the capital goods industries of Department I.

The struggle over technical skills

The Combination Acts, which had outlawed collective organization by workers, were repealed in 1824-5. After this, journeymen from many of the male crafts formed trade unions. At first there existed a variety of societies, local or regional in scope, representing millwrights, machinists and other categories of technical skill. The strongest of these was the Steam Engine Makers, founded in 1826, and later known as the 'Old Mechanics'. In 1851, many of the smaller societies joined together to form a new union, the Amalgamated Society of Engineers, Machinists, Smiths, Millwrights and Pattern-Makers. It was an exclusive, skilled union, characterized by high membership subscriptions and generous benefits, and it became a model for other skilled unions. Not all metal-workers belonged to it: the Old Mechanics among other societies kept apart; later the United Pattern-Makers, a highly elite section, would break away. But the ASE nonetheless quickly became one of the largest unions in the country and had a membership of 72,000 by 1891.⁵³

Meanwhile the scope of the industry itself was expanding to

encompass different kinds of metal-work: the heavy sectors of ship and locomotive building, the machine tool industry and eventually lighter sectors producing consumer goods such as bicycles. In the 1870s the employers organized themselves into the Iron Trades Employers' Association, the better to fight back against the unions. The employers, by repeated cycles of technological innovation, attempted to deskill the work of the engineering industry and divest themselves of dependence on the craft engineers. The skilled workers of the ASE and other engineering unions on the contrary struggled to maintain craft regulation of work, including an agreed ratio of apprentices to journeymen, and to prevent the employers fragmenting the labour process and using unskilled handymen on the machines.⁵⁴

Pattern-making foundry work, blacksmiths' work and boiler-making all saw the appearance of minor labour-saving devices; but the most fundamental and rapid changes were taking place in the machine shop, which with its fitters and turners, was the heart of the Engineers' empire. About 1890 came the capstan and turret lathe, the vertical, horizontal and later the universal milling machine, the external and surface grinder, the vertical borer, and the radial drill. Work on these specialist machines did not require the all-round competence of the craftsman and many of the men put onto them, at wage rates below craft standards, had neither served an apprenticeship nor picked up a broad experience on the shop floor.⁵⁵

Instrumental in bringing about this sub-division of work and the deskilling of craft engineers was a new breed of formally educated professional engineers. Civil engineers – men like Isambard Kingdom Brunel – had already achieved status and acclaim as architects of the era of canal, road and rail. Now, towards the end of the nineteenth century, the new high-status industrial engineer was interposing himself between the mechanic and the employer in science-based manufacture. Entire new industries such as electrical and chemical engineering grew up, which had no craft basis. In these the engineer was not

only key employee but also often manager.⁵⁶

The engineering employers were in perpetual struggle with the craft engineering unions and took the offensive in a nationwide lockout in 1897. Bitterness lay in the fact that while the capitalist and the skilled men needed each other, they did not need each other equally. As David Noble points out, technological innovation was often achieved by their combined efforts. The skilled man saw in new scientific knowledge about the nature of the material world the basis for new or refined methods of production; the capitalist recognized the potential for enhancing profitability. Often, 'these two visions took shape as one in a single mind: the capitalist was frequently an inventor of sorts, while the inventive craftsman shared not a little of the entrepreneurial spirit of the capitalist.'⁵⁷ The difference was that the capitalist would readily turn the skilled man's own inventions against him, with the help of other brands of engineer.

From this history it will be clear that the technically knowledgeable and skilled fraternity is by no means simply a 'superior class of workman', as Marx put it. It is varied, it is hierarchically stratified and its component parts are continually shifting in relative status. Technological skills are forced by capital to adapt and change. They do not only act on others' skills, they are also acted upon. The skilled men respond by demarcating and defending areas of competence. As a result the unions at one moment join forces, at another split apart. Some categories of technical men are always ahead of 'the state of the art', and consequently in demand. Some are running to keep up, fearful of technological redundancy, the obsolescence of their knowledge, the demise of the process they are accustomed to work at. The challenge for all of them is to keep abreast of technology, maintain marketable skills and retain a governing role over the machinery on which other people produce, at the point both of its manufacture and of its application. Those technologists who succeed, 'do well' by themselves. Their role develops more and more from control of machinery to control of labour processes and so to control of people:

They are entrusted not only with planning the labour process and with keeping production up to pre-established technical standards, but also, and mainly, with maintaining the hierarchical structure of the labour force and with perpetuating capitalist social relations, that is with keeping the producers separated (alienated) from the product of their collective labour and from the production process.⁵⁸

The advent of powered machinery was, then, profoundly contradictory for men as a sex. On the one hand many men could view it only with hatred. It was the enemy. It enabled capital to dispense with the skills of the skilled man and the muscle power of the labourer. On the other hand, mechanical skills were the property of men as a sex, much as machinery itself was the property of the dominant class. Men's power over women could only be enhanced by advances in technology.

The vested interests of men with technical skills led them into an ambiguous class position. Technological change can be seen as class warfare. 'It would be possible to write quite a history of the inventions, made since 1830, for the sole purpose of supplying capital with weapons against the revolts of the working class,' wrote Marx.⁵⁹ And who designs and uses those weapons in class struggle if not the mechanics and engineers? Some are working-class men. Others are drawn from the ranks of the bourgeoisie. Either way they play an equivocal role in the struggle between the workforce and the employer. David Noble noted that, 'As those charged with supervision of the industrial labour force, engineers found labor organisations difficult and disagreeable, and as professionals, they viewed unions as a measure of mediocrity.'⁶⁰ So, whether they were members of elite unions, whether they were non-unionized and actively anti-union, the technologists' close identification with the machinery and those that owned it was always in danger of standing between them and other workers. Women workers, whether in industries producing consumer goods or, as increasingly occurred in the twentieth century, in the capital goods industries, were always among the 'others'. Men's power over women continued to exert itself, in this way and in others,

within the changing relations of capitalism.

Women's relationship to the machine

The preferential place that men have carved for themselves in production has survived from the earliest days and through several revolutions in economic organization. Perhaps most striking of all, men maintained their unique grasp of technological skills when capitalism exploded apart the ownership of the instruments of production from the skills they entailed and unleashed an unprecedented epoch of technological development. We now have a kind of genealogy for the maintenance technician, the systems technologist, technical manager and professional engineer as we will encounter them in the 'new technology' workplaces of the 1980s.

We also have the beginnings of a similar genealogy for the women 'operators' we are going to encounter. We know that women have continuously contributed a large proportion of total production and that a very sizeable part of that has been in food and clothing, whether for immediate consumption or for sale. In addition, of course, women have been the ones to perform almost all the 'reproductive' tasks associated with child care and housekeeping that are not normally classed as work.

Women were also employed, particularly when single, in the heaviest types of manual labour, were exploited as domestic servants, as 'servants in husbandry' working in the fields, and even carrying coal, washing lead and breaking ore in the mines. More women were forced into labouring (or pauperism) as the break-up of the old feudal relationships dispossessed the least secure. Female cottagers who had scratched a living from vegetable patch and grazing rights on the commons were made landless by the enclosure movement that 'rationalized' the land into large-scale farms. More and more of the women working as independent or family producers in towns lost their livelihood as competition from outwork and factory work organized on capitalist lines in the rural areas destroyed urban craft production. At first many women, like men, became outworkers in their own homes. As industrialization advanced they followed

the work to the factories. Women were unpractised in craft organization and many had the docility that results from subordination within the home. The new class of male employers could benefit by this – in a sense they stole a march on men of the working class.⁶¹

The effect of the industrial revolution and the special uses of women, as perceived by the new captains of industry, were contradictory for women themselves. Some results were clearly adverse. Women and children were terribly exploited and abused in the frenzy of capitalist production. Industrial methods wiped out women's small businesses – bleaching and brewing, for instance. Women's types of production were brought more firmly under the sway of a male principle. Making clothing, food and drink, for instance, as it was socialized and mechanized, became more institutionally subject to men's special knowledge of machinery than women's domestic production had been subject to individual men's knowledge of tools.

As industrialization increased and more and more women were drawn into work, a powerful adaptation of the old ideology of 'a woman's place' evolved to ensure that women's relationship to work and earning was no more than provisional. A basic theme of this ideology was the assumption that woman's proper role was that of wife and mother. 'Remaining in the home was central to the maintenance of a woman's sexual purity and respectability.' The theme of this ideal Victorian lady, says Sarah Eisenstein, 'developed in some complexity and with uneasy insistence, in the early nineteenth century, in literature, popular magazines, religious tracts and public debate'.⁶² As she points out, these were middle-class ideas that had little real relevance to the situation of working-class women, yet 'they informed the ideology of the period so thoroughly that they dominated prevailing attitudes towards working women and shaped the terms in which those women interpreted their own experience'.⁶³ Women, as a consequence, worked but could not aspire to the great achievements dreamed of by many Victorian men.

More positively, however, the development of a female

industrial labour force did bring practical opportunities for women to evade both this gender ideology and the more material aspects of male dominance. First, it meant coming out of the enclosed sphere of the patriarchal family into the more public sphere of the patriarchal firm. This is not so simple a move as it sounds. The feudal and the early capitalist domestic system of manufacture had made the home a far from private place. In a sense the home became truly a private sphere only once production had left it. The constitution of 'home and work', the 'private and public' as we know them was in many ways a cultural artefact of the industrial revolution. The more significant factor was that an increasing number of husbands and fathers lost some of their control over their daughters and wives, as they came to depend in part on an income earned by these womenfolk in the domain of another man.

Second, many women started to earn an independent wage. Though often enough it was quickly subsumed into household income for the disposition of the head of the household, nonetheless it increasingly gave some women independent means. The population of women was greater than that of men throughout the nineteenth century, and the surplus increased from 1851 to 1901.⁶⁴ Not all women would be able to marry and many would be widowed. By 1911, 54 per cent of single women would be working for a wage.⁶⁵

Writing in 1915, and looking back over the previous century, Elizabeth Leigh Hutchins concluded:

the working woman does not appear to me to be sliding downwards... rather is she painfully, though perhaps for the most part unconsciously, working her way upwards out of more or less servile conditions of poverty and ignorance into a relatively civilised state, existing at present in a merely rudimentary form. She has attained at least to the position of earning her own living and controlling her own earnings, such as they are. She has statutory rights against her employer, and a certain measure of administrative protection in enforcing them. The right to a living wage, fair conditions of work, and a voice in the collective control over industry

are not yet fully recognised, but are being claimed more and more articulately and can less and less be silenced and put aside . . . Among much that is sad, tragic and disgraceful in the industrial exploitation of women, there is emerging this fact, fraught with deepest consolation: the woman herself is beginning to think.⁶⁶

The third change was that women were not only following their own traditional kinds of work into the factories. They were also diversifying their roles in production. Though they were found in their greatest numbers in the spinning and weaving mills, and in jam-making, confectionery and other forms of large-scale food production, soon they were also producing other kinds of commodity. Even in the early 'domestic' years of capitalist production women had begun to do 'unskilled', heavy and dirty work in metallurgy, making nails, nuts, bolts, screws, buckles, locks, bits and stirrups. Defoe wrote of the West Midlands area in 1769 that 'every Farm has one Forge or more',⁶⁷ and these forges were producing not for farm consumption but for capitalists. When these 'small iron trades' began to be organized into a factory system, women followed. In 1841 the number of women in the Birmingham district employed in metal manufacture was estimated at 10,000. Twenty-five years later there were 2,050 females returned as employed in Birmingham pen-works and others were employed in the light chain trade, in lacquering brass, and making files and pins.⁶⁸

Women, then, were spreading into new spheres of production as production industrialized. What now became significant, however, was the particular role they played *within* these new industries. Women clustered within three types of occupation. Hutchins noted, from visits to non-textile factories early in this century, 'that men and women are usually doing, not the same, but different kinds of work and that the work done by women seems to fall roughly into three classes'.⁶⁹ Her first class was 'rough hard work preparing and collecting the material, or transporting it from one part of the factory to another'. A second was finishing and preparing goods for sale: examining,

folding, wrapping and packing. It is the third group of jobs, however, that is the most interesting for us. They are the routine production jobs on machines that we shall see women doing in the 1980s. This work is 'done on machines with or without power, and this includes a whole host of employments and an endless variety of problems. Machine tending, press-work, stamp-work, metal-cutting, printing, various processes of brasswork, pen-making, machine ironing in laundries, the making of hollow-ware or tin pots and buckets of various kinds.' Hutchins did not of course note that the mechanics who kept these machines going were *not* women. It could be taken as given that those jobs belonged to men.

The response of male workers

The final significant effect of the industrial revolution on women was that it threw them, in many cases, into direct competition with men for work. Some of the new machine-based occupations of the late eighteenth and early nineteenth centuries, while they demanded great stamina, no longer called for sheer muscle. Employers could and often did replace men with women and children. Whereas the craft guilds had been organized mainly in exclusion of other men – the exclusion of women being more or less taken for granted – the skilled trade unions were obliged to direct their energies to keeping women out. Men could do little to prevent capital engaging women to work in the new industries. Men's efforts therefore had to be geared to segregating women and maintaining sexual divisions *within* the factory. Consciously and actively, male workers hedged women into unskilled and low-paid occupations. In printing, for instance, the male compositors and machine-minders confined women to book-binding and other print-finishing operations where they were severely exploited by employers.

It is the most damning indictment of skilled working-class men and their unions that they excluded women from membership and prevented them gaining competences that could have secured them a decent living. Virginia Penny wrote in 1869 that women's lot would be greatly improved if only women might

enter the trades and professions monopolized by men. 'Apprentice ten thousand women to watchmakers,' she said. 'Put some thousands in the electric telegraph offices all over the country; educate one thousand lecturers for mechanics' institutes . . . then the distressed needlewoman will vanish, the decayed gentlewoman and broken-down governesses cease to exist.'⁷⁰ Men were not misled in perceiving women as a weapon in employers' hands by which their own wages could be kept down. Where they were misled was in their response. Instead of helping women to acquire skills and to organize their strength, they weakened women (and in the long run the entire working class) by continuing to exploit women domestically and helping the employer to exploit them as a secondary labour market. Not only were women barred from men's areas of skill but women's particular skills came to be universally undervalued in comparison: undervalued and underpaid. 'There is no reason, save custom and lack of organisation, why a nursery-maid should be paid less than a coal-miner. He is not one whit more capable of taking her place than she is of taking his,' wrote Elizabeth Hutchins.⁷¹

So great a gulf had men in earlier centuries fixed between women and technology, however, that the ASE was not obliged to see women as a threat to the engineer throughout the nineteenth century. The kinds of semi-skilled work brought into being by the mechanization of engineering (in the main, machining metal) were not seen by employers as appropriate areas in which to try to substitute women for men. The stratum of 'handymen' infiltrated by the employer into engineering works was just that: men. The Victorian and Edwardian women's movements did not include in their demands technical skills for women. It was not until the First World War, when they were brought into munitions and other heavy industries to release men for the Front, that women began to approach the masculine sphere of technical skill and consequently to be feared for the first time as 'dilutees'.

The *Labour Gazette* in 1917 estimated that one out of three working women was replacing a man.⁷² Women went into a number of industries besides munitions:

They planed, moulded, mortised and dovetailed in sawmills; drove trucks in flour and oil and cake mills; made upholstery and tyre tubes; bottled beer and manufactured furniture; worked in cement factories, foundries and tanneries, in jute mills and wool mills; broke limestone and loaded bricks in steel works and worked as riveters in shipbuilding yards. They could be found in car factories, in quarrying and surface mining and brickmaking . . . only underground mining, stevedoring and steel and iron smelting were still all male.⁷³

Women, says this author, shattered the myth that they were incapable of skilled work.

A serious challenge was made to male exclusiveness in the ASE by the radical shop stewards' movement of the war and post-war years. Progressiveness on the woman question was a logical position for the shop stewards, whose aim was to turn the ASE from a craft union into an all-grades industrial union.⁷⁴ Nonetheless, the pledge the government had given the union to lay off dilutees at the end of the war was honoured. Many thousands of women were ejected from their jobs. High unemployment among women resulted, made worse by the slump of 1920.

The ASE became the Amalgamated Engineering Union in 1922, but still did not admit women members. Meanwhile women's role in the engineering industry expanded fast in the inter-war years, as they became the characteristic semi-skilled assembly-line labour force in the industries producing the new electrical consumer goods.⁷⁵ In the Second World War women again replaced men in many engineering jobs, both unskilled and skilled. This time the situation for the traditionalist men in the union was past saving. Women were, with bad grace on the part of many members, finally accepted into the union on 1 January 1943. The women's section had 139,000 members by 1944.⁷⁶

Acceptance into the union, however, did not mean that those women who had acceded to skilled jobs in the war were able to consider them theirs for keeps. After the war, women were once

more expected to retire gracefully to domestic life, and for the most part they did so. Those who stayed were reduced to unskilled or semi-skilled work. Women found themselves addressed by an intense ideology of 'femininity' and 'domesticity'. The media, advertising, fiction and film all ludicrously reinforced gender differences, flying in the face of women's lived experiences. The ideology identified men with work and earning, women with home and caring. To associate women with technological competence now seemed as ridiculous as it had ever seemed.

Yet the situation of women was to change once again in the 1950s and 60s as the economic boom caused a demand for their labour and women themselves, even married women now, began to aspire to independence, work and careers in greater numbers than ever before. By the time the recession of the late 1970s hit the British economy, women had grown to be 42 per cent of the labour force.⁷⁷ Statements by Conservative ministers to the effect that women were expected to do the decent thing and return home, leaving the shrinking supply of jobs to men, were this time ignored by women. Women's consciousness had changed radically since the post-war period and this had influenced 'public opinion' more generally. Supportive legislation of the early 1970s had strengthened women's hand. This time they held on to work, though it was often part-time and low-paid. While the number of male employees in employment fell by 14 per cent between 1971 and 1983, the number of women rose by 7 per cent. The recession, and its handling by the government, has caused a dramatic increase in unemployment during the 1980s, but women have experienced it less acutely than men to date.⁷⁸

The way out of the recession for British capital, fervently promoted by a monetarist government, is by shedding labour, reducing the wages of the remainder and investing in super-productive new electronic technology. In such a situation, with men objectively weakened in the labour market, employers indifferent to or even positive towards employing women, and women themselves showing a new confidence in their right to work, we might expect to see women entering technical training

and skilled occupations in new technology in equal numbers with men. If, as will become apparent, this is not happening, it should alert us to ask more penetrating questions about how male dominance is renegotiated and how the sexual division of labour continues to be reproduced over time.

Notes and references

Chapter 1

- 1 Department of Employment, *New Earnings Survey*, 1983, Part E, Table 135. Figures relate to Great Britain and show women as a percentage of the occupational and industrial labour forces.
- 2 *ibid.*
- 3 *ibid.*
- 4 Catherine Hakim, *Occupational Segregation*, Report No.9, Department of Employment, 1979.
- 5 See, for instance, Angela Coyle, 'Sex and skill in the clothing industry' in Jackie West (ed), *Work, Women and the Labour Market*, Routledge & Kegan Paul, 1982; Ruth Cavendish, *Women on the Line*, Routledge & Kegan Paul, 1982; Anna Pollert, *Girls, Wives, Factory Lives*, Macmillan, 1981; and Sallie Westwood, *All Day Every Day*, Pluto Press, 1984.
- 6 Jean Martin and Cerdwyn Roberts, *Women and Employment: A Lifetime Perspective*, Department of Employment and Office of Population Censuses and Surveys, HMSO, 1984, pp.27-8.
- 7 Catherine Hakim, *op.cit.*, p.43.
- 8 Edward Gross, 'Plus ça change? . . . The sexual structure of occupations over time', *Social Problems*, 16, Fall, 1968.
- 9 Organization for Economic Co-operation and Development, *Women and Employment: Policies for Equal Opportunities*, Paris, 1980.
- 10 Esther Boserup, *Women's Role in Economic Development*, George Allen & Unwin, 1971.
- 11 G.W. Lapidus, 'Occupational segregation and public policy: a comparative analysis of American and Soviet patterns', in M. Blaxall and B. Reagan (eds), *Women and the Workplace: The Implications of Occupational Segregation*, University of Chicago Press, 1976. See also Michael Paul Sacks, *Women's Work in Soviet Russia: Continuity in the Midst of Change*, Praeger, USA, 1976.

- 12 Department of Employment, *op.cit.*, 1983 and 1975.
- 13 Department of Education and Science, *Statistics of Education and Statistics of School Leavers*, 1970-83, cited in Equal Opportunities Commission, *9th Annual Report*, 1984. Figures relate to England and Wales, summer examinations.
- 14 Figures obtained from City and Guilds of London Institute during 1984.
- 15 Figures obtained from the Business and Technical Education Council during 1984.
- 16 Department of Education and Science, *Statistics of Education: Further Education*, November 1981, table 22, and the Welsh Office. Figures relate to England and Wales and are cited in Equal Opportunities Commission, *op.cit.*
- 17 Statistics published by the Department of Education and Science (*Statistics of Education: Universities*) and the University Grants Committee (*University Statistics*) and cited in Equal Opportunities Commission, *op.cit.*
- 18 Department of Employment, *New Earnings Survey*, 1970-84, Part A, Tables 10 and 11.
- 19 *ibid.*
- 20 M.W. Snell, P. Glucklich and M. Povall, *Equal Pay and Opportunities*, Department of Employment, Research Paper No.20, 1981.
- 21 Engineering Industry Training Board, *Women in Engineering*, Occasional Paper No.11, 1984, tables 2.1 and 2.2.
- 22 The stereotype cave-man reflects scientific theories as they were developed, almost entirely by men, in the patriarchal and ethnocentric societies of western Europe in the nineteenth and early twentieth century. It has been pointed out that it would not be surprising if these men had looked for and found a replica of themselves in pre-history. Nancy Makepeace Tanner suggests that these scientists in effect produced a modern 'origin myth' (*On Becoming Human*, Cambridge University Press, USA 1981, p.3). The effect of male bias among anthropologists on the study of societies in early stages of development is demonstrated by Ruby Rohrlich-Leavitt, Barbara Sykes and Elizabeth Weatherford in 'Aboriginal women: male and female anthropological perspectives', in Rayna R. Reiter (ed), *Toward an Anthropology of Women*, Monthly Review Press, 1975.
- 23 See, for instance, Sally Slocum, 'Woman the gatherer', in Rayna R. Reiter (ed), *op.cit.*
- 24 Nancy Makepeace Tanner and Adrienne Zihlman, 'Woman in

- evolution: innovation and selection in human origins'. *Signs*, Vol.1, No.3, Spring 1976; and Nancy M. Tanner, *op.cit.*
- 25 M. Kay Martin and Barbara Voorhies, *Female of the Species*, Cambridge University Press, USA, 1975.
- 26 Autumn Stanley, 'Daughters of Isis, daughters of Demeter: when women reaped and sowed', *Women's Studies International Quarterly*, Vol.4, No.3, 1981.
- 27 Eleanor Burke Leacock illustrates this point by reference to the sex-egalitarian gathering and hunting community of the Montagnais-Naskapi of Canada in the period immediately preceding their conversion to Christianity by Jesuit missionaries (*Myths of Male Dominance*, Monthly Review Press, 1981).
- 28 Çatal Huyuk, a settlement of c.6000 BC, represents the transition from neolithic village to bronze-age town. James Mellaart's excavations revealed a society based on cattle breeding and irrigation agriculture, supplemented by gathering, hunting and fishing. (James Mellaart, *Çatal Huyuk: A Neolithic Town in Anatolia*, McGraw-Hill, USA, 1967.) House design and burial arrangements, evidence of female deities and female priests, lead to the conclusion that women were socially pre-eminent at Çatal Huyuk (Ruby Rohrlich-Leavitt, 'State formation in Sumer and the subjugation of women', *Feminist Studies*, 6, No.1, Spring 1980).
- 29 A well-authenticated instance of this, explicit in epic poetry, laws and codes, occurred in the Middle East between the fourth and second millennia BC (Ruby Rohrlich-Leavitt *op.cit.*). The process was theorized by Frederick Engels in the nineteenth century in *Origin of the Family, Private Property and the State*, Pathfinder Press, 1972. A material Factor that may have enabled men to subjugate women is proposed by Autumn Stanley. Drawing on evidence from foraging societies that have adopted a sedentary agricultural existence and a grain-based diet, she suggests that this change precipitates an increase in body-fat, earlier puberty in women and regular ovulation, all tending to a dramatic increase in fertility. It could have been excessive childbearing that, in neolithic agricultural communities, first put women at a physical and economic disadvantage relative to men (Autumn Stanley, *op.cit.*).
- 30 Whether fully matriarchal societies ever existed is doubtful. There is, however, evidence of matrilineal and matrilocal societies which would certainly have ensured a centrality for women, and also of societies existing in the more recent past in which the sexes were very much more equal than our own (see Eleanor Burke Leacock, *op.cit.*) In place of 'patriarchy', therefore, as a time-less trans-

historical expression, it is helpful to use the concept of a 'sex/gender system', as proposed by Gayle Rubin ('The traffic in women', in Rayna R. Reiter (ed), *op.cit.* p.159). This enables us to conceptualize changes over historical periods in the relative power of men and women as sexes, variations in the 'set of arrangements by which a society transforms biological sexuality into products of human activity and in which these transformed sexual needs are satisfied'.

- 31 See Lynn White Jr, *Medieval Technology and Social Change*, Oxford University Press, 1962, who suggests that the iron age proper began for Europe in the ninth century AD, p.40.
- 32 Suzanne Fonay Wemple, *Women in Frankish Society: Marriage and the Cloister 500-900 AD*, University of Pennsylvania Press, USA, 1981, p.70.
- 33 Dorothy Whitelock, *The Beginnings of English Society*, Penguin Books, 1952, p.106.
- 34 Miranda Chatto and Jane Lewis, 'Introduction' to Alice Clark, *Working Life of Women in the Seventeenth Century*, Routledge & Kegan Paul, 1982, p.xxiv. Originally published 1919. Chatto and Lewis are referring to rural life in the pre-capitalist period.
- 35 Lynn White Jr, *op.cit.*, p.41.
- 36 B. Wilkinson, *The Later Middle Ages in England 1216-1485 AD*, Longman, 1969; M.M. Postan, *The Medieval Economy and Society*, Penguin Books, 1975.
- 37 This and other information in this and the succeeding paragraph is drawn from Alice Clark, *op.cit.* In Chapter V she traces the position of women in craft and trade in the fourteenth to sixteenth centuries, pp.150-70.
- 38 Quoted by B.L. Hutchins, *Women in Modern Industry*, E.P. Publishing Ltd., 1978, p.38. First published 1915.
- 39 Lynn White Jr, *op.cit.*, p.128
- 40 Sigvard Strandh, *A History of the Machine*, A.&W. Publishers Inc., USA, 1979.
- 41 Autumn Stanley, 'Women hold up two-thirds of the sky: notes for a revised history of technology', in Joan Rothschild (ed), *Machina Ex Dea: Feminist Perspectives on Technology*, Pergamon Press, USA, 1983. Autumn Stanley's research on women inventors will be published in 1986 under the title, *Mothers of Invention*.
- 42 Autumn Stanley, 'Daughters of Isis, daughters of Demeter: when women reaped and sowed', *op.cit.*
- 43 Lynn White Jr, *op.cit.*, p.119.
- 44 Lewis Mumford, *Technics and Civilisation*, Routledge & Kegan

- Paul, 1934, p.144. The electrification of kitchen equipment, which began in the last decade of the nineteenth century, was the work of electrical engineers not housewives.
- 45 Nathan Rosenberg, *Inside the Black Box: Technology and Economics*, Cambridge University Press, 1982, p.35.
- 46 Karl Marx, *Capital*, Vol.1, Lawrence & Wishart, 1954, p.339. First published 1887. Much of the account of the development of industrial capitalism in this chapter is drawn from Chapters XIII-XV of this volume of *Capital*.
- 47 *ibid.* p.323
- 48 *ibid.* p.396
- 49 *ibid.* p.331
- 50 *ibid.* p.361
- 51 *ibid.* p.362-3
- 52 *ibid.* p.399. 'The total production of society may be divided into two major departments . . .
I Means of Production - commodities having a form in which they must, or at least may, pass into productive consumption.
II Articles of Consumption - commodities having a form in which they pass into . . . individual consumption.'
- 53 Henry Pelling, *A History of British Trade Unionism*, Macmillan, 1976. See also, for a history of the Amalgamated Society of Engineers, James Barrington Jefferys, *The Story of the Engineers 1800-1945*, Lawrence & Wishart, 1946.
- 54 Jonathan Zeitlin, 'Craft control and the division of labour: engineers and compositors in Britain 1890-1930', *Cambridge Journal of Economics*, No.3, 1979.
- 55 H.A. Clegg, Alan Fox and A.F. Thompson, *A History of British Trade Unions since 1869*, Vol.1, Oxford, 1964, p.138.
- 56 David Noble, *America by Design: Science, Technology and the Rise of Corporate Capitalism*, Oxford University Press, 1979, p.5. First published by Knopf, USA, 1977.
- 57 *ibid.*
- 58 André Gorz, 'Technology, technicians and class struggle' in André Gorz (ed), *The Division of Labour*, Harvester Press, 1976, p.169.
- 59 Karl Marx, *op.cit.*, p.411.
- 60 David Noble, *op.cit.*, p.41.
- 61 Painstaking accounts of women's work in the industrial revolution can be found in Ivy Pinchbeck, *Women Workers and the Industrial Revolution 1750-1850*, Virago Press, 1981, first published 1930; B.L. Hutchins, *Women in Modern Industry*, E.P. Publishing Ltd., 1978, first published 1915; Wanda F. Neff, *Victorian Working*

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- 63 *ibid.*
- 64 B.L. Hutchins, *op.cit.*, p.75.
- 65 *ibid.*, p.90.
- 66 *ibid.*, p.xviii.
- 67 Daniel Defoe, *Tour*, 1796, cited in Ivy Pinchbeck, *op.cit.*, p.272.
- 68 B.L. Hutchins, *op.cit.*, p.62-3.
- 69 *ibid.*, p.66-7.
- 70 A book by Miss Virginia Penny entitled *Think and Act*, 1869, cited in Annie Nathan Meyer, *Woman's Work in America*, Arno Press, USA, 1972, p.286. First published 1891.
- 71 B.L. Hutchins, *op.cit.*, p.201.
- 72 Gayle Braybon, *Women Workers in the First World War*, Croom Helm, 1981, p.46.
- 73 Norbert C. Soden, *Women in British Trade Unions 1874-1976*, Gill and Macmillan, 1978, p.102.
- 74 James Hinton, *The First Shop Stewards Movement*, George Allen & Unwin, 1981; and Edmund and Ruth Frow, *Engineering Struggles*, Working Class Movement Library, 1982.
- 75 Miriam Gluckman, 'Women and the "new industries": changes in class relations in the 1930s', paper to the Economic and Social Research Council seminar on Gender and Stratification, University of Norwich, July 1984.
- 76 Norbert C. Soden, *op.cit.*, p.152-3.
- 77 *Employment Gazette* figures, published in Equal Opportunities Commission *Annual Report* 1983, table 3.3.
- 78 *ibid.*
- 79 *ibid.*, fig.3.3.
- ## Chapter 2
- 1 *Census of Production 1981*, published 1983, PA 453, 'Clothing, hats and gloves'.
- 2 *Bulletin of Textile and Clothing Statistics*, Department of Trade and Industry, May 1984.
- 3 For an exploration of the international scope of the textile industry