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Women Engineers in Britain, 1945-2000

Thesis submitted for a PhD

History

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ABSTRACT

Women Engineers in Britain, 1945-2000

This thesis looks at the work of women engineers in the period 1945-2000. Its central focus is the impact gender had on the likelihood of a woman making such a career choice, on the training to become an engineer and on women's lived experiences in the work place. It discusses the impact of the equality legislation and considers the effect that the characterisation of engineering as a male profession had on the numbers of women in engineering and on their treatment.

The thesis approaches these subjects through a study of the experiences of a group of women engineers. Their life histories are set against the social and economic changes that occurred over the period. It encompasses both women who were engineers at the beginning of the period and those from later generations. The use of oral history allows a rounded picture of the changing experiences of women engineers, their career expectations and the degree of success that they achieved.

The thesis argues that the history of women engineers has been largely ignored. While their experiences have paralleled that of women in other careers, the continued overwhelming dominance of the profession by men has resulted in a number of assumptions regarding discrimination and harassment that remain unproven. It demonstrates that the social stereotyping of engineering discourages many women from considering the career, thus perpetuating both gender inequality and the myth that women are unwelcome in the career.

Acknowledgements

I wish to thank staff at the following archives for their help: The Institute of Electrical Engineers, The Institute of Civil Engineers, The Institute of Mechanical Engineers, The Institute of Engineering Designers and the Modern Records Centre at the University of Warwick. I would also like to thank the companies who made company archives or other information available to me, particularly GEC at Cheltenham, and Westland Helicopters Ltd. at Yeovil. My thanks also go to the various unions who allowed me access to their archives. I am grateful to all the women engineers who helped me with the oral history and to the other people, men and women, who offered their recollections and opinions, particularly those who offered me access to unpublished material.

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Introduction

Research Aims

Engineering attracts very few women and there is no simple explanation for this. This thesis addresses the question of why so few women become engineers by focusing on different areas to those examined in the past. There is currently no history of women engineers in the post-war period and this thesis gives women engineers agency over the way their history is related. While much of the existing work presents women engineers in ways that support particular preconceptions, this history allows the destabilising of public perceptions of engineering and the unsettling of some current theories regarding the treatment and experiences of women engineers.

While historians have studied many areas of women's lives, the subject of women in engineering since the Second World War is one that has only recently been examined. As a woman engineer and a member of the Women's Engineering Society (WES), it was with interest that I read the biography of Jane Gardiner, reviewed by the Society in 1993.¹ When searching for other books about women engineers I could find a few biographies and some excellent histories about women before and during the Second World War, but nothing that examined the modern period. On discovering a pocket of work among the books written by social scientists, I came to the conclusion that these works were either written to encourage girls into engineering - in which case they blamed society in general for assuming engineering was unsuitable for girls - or that they adopted a radical feminist stance towards technology, denigrating it as militaristic and male dominated.

The first type of material was inclined to minimise the problems girls could face in an attempt to encourage them to become engineers. As a woman engineer I have been involved in some of the efforts to encourage girls to consider careers in engineering, but such efforts have generally failed. While the percentage of female university students

¹ Jane Gardiner, *Memoirs of a Woman Engineer*, Sussex, The Book Guild Ltd, 1990.

studying engineering and technology has increased dramatically, from just 0.12 percent in 1965/66 to 14.3 percent in 1997/98, there are far fewer women studying for engineering than other professions.² The statistics for Medicine, Dentistry and Health show that the percentage of female graduates has increased from 31 percent in 1965/66 to 49 percent today. Although in the teaching profession, which was dominated by women in 1965/66 with 71 percent of teachers being female, the trend is now reversing with women making up just 53 percent of all teachers in 1999.³ Employers consider that, with the predicted shortfall in engineers, it is vital that young people of both sexes be encouraged to consider whether a career in engineering might be suitable for them, yet the number of women engineers remains consistently low.

The feminist literature of the 1980s, on the other hand, seemed problematic by being set against the engineering profession. Writers such as Cynthia Cockburn and Dot Griffiths highlighted the point that technology was portrayed as totally masculine, too involved with the machinery of war, and entirely an instrument of the paternalistic and capitalistic western civilisation.⁴ While accepting that the early condemnation of the 'maleness' of technology was justified, I disagreed with their conclusions about the treatment of women engineers and believed these to be based on incorrect assumptions. While more recent feminist works have modified this stance, attempts to explain why so few women choose engineering continue to range from blaming the 'macho' image of technology in schools to a belief that women engineers must sacrifice some of their femininity to succeed.⁵ By chronicling the experiences of women engineers over the post-war period this thesis will highlight the areas where public attitudes regarding engineering

2 Statistics taken from Statbase on www.statistics.gov.uk on 3/1/2001

3 Ibid.

4 Cynthia Cockburn, *The Machinery of Dominance*, London, Pluto Press, 1985, and Dot Griffiths 'The Exclusion of Women from Technology' in Wendy Faulkner and Erik Arnold (eds) *Smothered by Invention*, London, Pluto Press, 1985, for example.

5 Judy Wajcman, *Feminism Confronts Technology*, Cambridge, Polity Press, 1991, Flis Henwood, 'Engineering Difference. Discourses on Gender, Sexuality and Work in a College of Technology' in *Gender & Education*, Vol. 10, Issue 1, March 1998 and Wendy Faulkner, 'The Technology Question in Feminism: A View From Feminist Technology Studies' in *Women's Studies International Forum*, Vol. 24, No.1, 2001, for example.

as a career, bolstered by assumptions about the treatment of women engineers, perpetuated the misconceptions which still exist.

Periodisation, Approach and Theory

When first conceived, this thesis was to examine the period from 1955 to 1975, however it was later decided to extend the period from 1945 to 2000. The time span covers the cultural changes following the Second World War and encompasses the equality legislation of 1975, details of which are given later. By extending the period up to 2000 the thesis includes an entire generation of women born since the equality legislation has been in place. Women who might be expected to have very different attitudes and expectations from the women who grew up in the 1950s.

I am an engineer, inevitably this has led to complications as, although I have used my own experiences to highlight certain points, clearly indicated in the text, I have tried to minimise the influence my personal narrative has on the thesis. My own experiences of the difficulties encountered on choosing the career in the sixties encouraged my interest in careers advice to girls who express an interest in the career today. My enjoyment of an interesting and rewarding career has influenced my reactions to some of the literature produced, particularly that of some feminist writers in the 1980s. By adopting the personal narrative approach I shall be looking at women as individuals, not as a generic group, and my own experiences as a woman engineer offer me the opportunity of access to women who would not normally feature in the more formal lists of women engineers. While this personal experience offers particular challenges, as I have to attempt to put it to one side so that my own experiences do not colour the conclusions drawn, it does offer the advantage of common ground with the women interviewed. These interviews and the questionnaire responses provide a unique chance for women engineers to talk about what it was actually like to work in engineering over the period 1945 to 2000. Their attitudes and opinions will

be presented as they were given, and the conclusions drawn will take note of how prevalent certain attitudes were amongst the women engineers, while recognising that their memories will be influenced by subsequent events. The stories they tell follow a familiar pattern of career breaks to bring up children, the impact of which will be shown to be one of the greatest changes over time.

Methodology and Sources

There are four central themes to this thesis: why did society see engineering as male; why did the various campaigns fail to change this; why did some women become engineers against the general trend; and how did women get on in engineering compared to women in other careers? These four themes are inextricably linked, as any change in one will impact on the others. Thus to affect a change in the numbers of women becoming engineers, changes were necessary in how society as a whole viewed engineering. In turn, such changes inevitably had an impact on how women engineers were treated by their employers and by their male colleagues. These four themes will be examined in the light of two main points: society's lack of knowledge about engineering, and the feminist assumptions that the gendering of technology had implications for the way women engineers were treated. The contribution of this work will be to offer a historical perspective of the changes that affected women engineers from 1945 to 2000.

The published works are not only referred to as secondary sources, but also form primary sources when they are used to demonstrate attitudes prevalent at the time of publication. In addition, the thesis is based on the documentation of the various institutes involved with engineering: the Institute of Mechanical Engineers (IMechE), the Institute of Electrical Engineers (IEE), the Institute of Civil Engineers (ICE) and the Institute of Engineering Designers (IED), where council minutes and committee reports were examined along with published reports and journals. Research was also done in the

archives of WES, which included ephemera regarding women engineers, newspaper cuttings and the collected archives of many retired or deceased women engineers. Research was also undertaken at the Modern Records Centre at the University of Warwick, where I had access to the documentation of the main engineering unions, DATA/TASS/AUEW, ASTMS, APEX, and also to the documentation of the various engineering employers' federations.

Initially the thesis was not going to include any oral history, a questionnaire was circulated to some members of WES instead. A list was made of the members who would have been working in the 1960s and 50 names were chosen at random. These women were requested to complete the questionnaire shown in Appendix 1. Forty-six replies were received. The questionnaire covered topics such as family background, why the women chose to become engineers, their education and training, and subsequent career progression. Space was allocated for them to add any comments regarding women engineers that they wished to make. When the time frame of the thesis was expanded more women engineers, known to me or my colleagues at work, were also asked to complete the questionnaires. A request was also made through various engineering magazines for brief memoirs of male engineers who remembered working or training with women engineers. All the responses are summarised in Appendix 1.

As the responses to the questionnaires came in, I was fortunate in being offered various other sources. Some women sent me newspaper cuttings, one woman offered me the workbooks she had kept from her training with the WRNS (Women's Royal Naval Service). Another woman who had left engineering to lecture at a university allowed me access to an oral history exercise some of her students had completed in 1988 into the history of WES. A friend who had done a short project using oral history in 1994 offered a useful piece of comparative work, this involved interviews with teachers on the subject of returning to work while their children were young. All these have been used to provide some background information against which to set the data gained from the questionnaires

and interviews. All the raw data for this thesis will be stored in the WES archives once the thesis is completed.

With the expanded time frame I also decided to include a limited amount of oral history. While interviewing women from various branches of engineering would have provided an interesting cross section of experiences, the influences of the variety of employers, geographic locations, and types of engineering practiced would have made any comparison of experience problematic. By interviewing women from one company these differences were removed and a comparison of experiences over time became more realistic. Unlike the questionnaires which included a number of women who had left engineering, although retaining enough interest in the career to remain members of WES, the interviewees were all women who chose to remain in the career. This inevitably means they are biased towards the career and their responses reflect this.

Working in an aerospace company allowed me access to other women engineers employed there. The company is typical of most aerospace or defence companies in its attitude towards women engineers. I have worked in 4 other aerospace or defence companies, and friends from other companies in this discipline agree that attitudes are similar throughout the sector. As was stated above, other engineering disciplines may have different attitudes towards women engineers which would have prompted different responses. Twelve interviews were conducted with a selection of women who have worked as engineers for Westland Helicopters Limited (WHL) at some time in their lives. They were chosen, from women engineers previously unknown to me, to give a picture from the 1950s to the present day, and some attempt was made to cover most of the areas in which engineers work, although this was not entirely possible. No representative of a production engineer could be found, and while many of the women interviewed had started in the materials laboratory, none still worked there. The interviews were generally conducted at work, with the exception of the three retired engineers who were interviewed in their homes. A tape recorder was used in all cases except that of the software engineer.

Due to pressure of work she was interviewed in the canteen at lunch-time where a taped interview was not possible. In this case the interview, which was quite short, was written up immediately afterwards from notes made during the interview. Pseudonyms are used throughout, but where I am expressing my own opinions or relating my own experiences this is clearly stated. The interviewees had completed the questionnaire mentioned above, and now completed a second, more personal questionnaire (see Appendix 2.) The interviews covered a basic set of subjects that were discussed with each interviewee. These encompassed family background, the reaction of family and friends to their choice of career, and the reactions of people they meet both socially and through work to their status as women engineers. The other subjects covered included topics such as discrimination, harassment and their opinions about feminism; how they felt about engineering as a career for women and whether they would encourage girls to choose the career. The interviewees were allowed to take authority for the interviews and were only prompted when necessary. The older women had generally thought about what they wanted to say and spoke with little encouragement, while the younger ones preferred to be asked questions to which they responded in as much or as little detail as they felt comfortable with. Once again this data, both tapes and transcripts will be deposited in the WES archives.

Much has been written about the advantages and pitfalls of oral history. Trevor Lumiss stresses that one difficulty of oral history is the problem of 'omission and suppression.'⁶ This point is particularly applicable to this thesis as most of the interviews were conducted at work. Although the narrators were all assured that, as the thesis was not sponsored by the company, they could feel free to say whatever they wished, it would be unrealistic to suppose that in interviews conducted at work, about work, all of them would do so. Kristina Minster warned that British and American women are unused to public speaking and would revert to the style expected of them, claiming:

The general public appearance of women as full-time wage earners at all levels of organisations and in all kinds of work, as full-time entrepreneurs and business owners, graduate students, students in professional schools, and holders of political office is so recent that it has had little effect upon the way women speak. Changes in gender presentation lag far behind societal changes.⁷

While feminist historians are concerned about the problems inherent in interpreting oral history, pointing out that the misplaced belief 'that gender united women more powerfully than race and class divided them' has led to misunderstandings,⁸ I am fortunate in that my direct link with the narrators helps to overcome some of these problems. However, such a link can also add to the difficulties of interpreting the responses. A shared background makes it easy to assume that the narrator holds the same opinions as the interviewer. Also the narrators do not bother to explain some points, knowing that they will be understood because of this shared background. Since the thesis is not aimed at people with an engineering background, some effort had to be made to cover this ground in a way that could be interpreted by those outside the industry.

Rhonda Williams suggested that oral history can fail when the 'performance' side of it is omitted. She points out that gestures, intonations and body language all play a part in our understanding of verbal communication.⁹ As Paul Thompson commented, all data needs interpretation. Social statistics, letters, newspaper reports etc. are all 'subject to social pressures from the context in which they are obtained.'¹⁰ The interpretation of the interviews had to incorporate the things that were not 'said'. The interpretation of the body language of the narrator is something that cannot be conveyed in a simple transcript of the interview, so notes were made of any 'impressions' given to aid in using the transcripts truthfully. Video was not possible as cameras are not allowed in Westland Helicopters for security reasons.

6 Trevor Lumiss, 'Structure and Validity in Oral Evidence.' In Robert Perks and Alistair Thomson (eds.) *The Oral History Reader*, London, Routledge, 1998, p.274.

7 Kristina Minster, 'A Feminist Frame for the Oral History Interview' in S. Berger, S.Gluck & D.Patai (eds.) *Women's Words*, London, Routledge, 1991, p.29.

8 S. Berger, S.Gluck & D.Patai, (eds), *Women's Words*, London, Routledge, 1991, p.2.

9 Rhonda Williams, 'I Am a Keeper of Information: History-Telling and Voice' in *Oral History Review*, Vol. 28, Issue 1, Winter/Spring 2001, p. 41.

Structure of Thesis

The first two chapters of the thesis provide the historical background regarding women's working lives and the engineering profession. The thesis starts with a brief history of women engineers and WES, followed by an assessment of the opportunities for women to become engineers presented by the Second World War and how their status was affected by the return to peace. Based on a large amount of available secondary literature on the history of women and women's work after the Second World War, the first chapter examines how the social changes that followed the Second World War led to two and a half decades of uncertainty for working women as their role was manipulated by the predominantly male culture. The demand for equality that gained momentum in the 1960s and 1970s was not new, but now the impetus was great enough for action and by 1975 the legislation was in place. The changes that followed the legislation had particular impact on women's working lives, and although the average wage for women was still well below that for men, the opening up of careers for the more educated woman could have led to more women becoming engineers. All these cultural changes are assessed with particular reference to women engineers, while offering a comparison between them and other career women. The chapter concludes by considering the equality legislation of the 1970s, particularly its influence on career women and how the pattern of their working life changed.

Chapter Two examines the engineering profession. Although engineering changed rapidly after the war, these changes went largely unseen by the public, who retained an image of noisy dirty factories, and associated engineers with 'men in greasy boiler suits'. Such an image was totally contradictory to the stereotype of the ideal woman, and of female work, and so engineering was seen as unsuitable for girls. The longstanding academic tradition in Britain's universities led to a lack of appreciation of the more

10 Paul Thompson, *The Voice of the Past*, Oxford, Oxford University Press, 1978, p.124.

practical approach required by engineering. However, by the 1960s the employers and the professional engineering institutes were failing to get enough recruits, and the recruits they were getting were not from the top level of graduates. Two strategies were considered, firstly to improve the image of engineering and secondly to encourage girls to consider the career. Unfortunately neither strategy had significant success, the reasons for this are examined by analysing the actions suggested and how effectively they were implemented while making allowances for the changing employment in the engineering industry in post-war Britain. Comparison is made between the numbers of women and men and how this ratio compares to the numbers of women engineers in other countries. The attitudes of employers, both supportive and discriminatory are examined, as is the way the trade unions and the professional institutes treated women engineers, both prior to and following the equality legislation of the 1970s.

The thesis then considers the public reactions to women engineers, and their experiences. Chapter Three focuses on the attitude of the feminist movement towards technology and the impact this had on women's attitudes. The large body of feminist sociological work establishing the gendering of technology is examined and comparisons are made between the world of technology and other business institutions to assess whether levels of patriarchal or militaristic control were greater within technology, and if such control was influential in women's attitudes towards engineering. Women engineers are frequently assumed to be different from other women, this difference is seldom defined. The chapter will examine the various ways in which such difference is commented on and offer the opinions of women engineers regarding such differences. It will also consider feminist charges that women engineers ignore or trivialise discrimination and harassment in an attempt to minimise such difference.

Chapter Four examines the changes in education, careers advice and training over the period. It considers the effect levels of education had on girls who wanted to become engineers and how this changed. The careers advice offered by schools, the youth

employment service and industry prior to equality legislation is compared to the advice available since then. The role of WES is considered, establishing how its history has affected the careers advice given. The input of WES to Women Into Science and Technology (WISE), Science, Engineering and Technology (SET) and similar initiatives will be assessed. The chapter examines the successes and failures of these initiatives to establish why they had no major impact on the numbers of women becoming engineers. An analysis of the influences on career choice offers insights into why women consistently prefer other careers to engineering. This is followed by a brief analysis of the training necessary to become an engineer, the various routes and how access to these has changed since the equality legislation of the 1970s. This establishes the effect class had on which routes were open to a woman and also looks at the way the changing emphasis on examination results and the increasing numbers of university places have affected the training for the profession. This chapter outlines how women were treated during training before the equality legislation, and how much this changed once the legislation was in place. It reflects on the gender inequalities that still exist in Britain's universities and what impact this has on female engineering students, and on the feminist academics attitudes towards harassment and discrimination. The chapter concludes with an assessment of both how and why women engineers entered the profession.

Chapter Five examines women engineers as individuals. A brief description of the work undertaken by engineers offers opportunities for assessing how different women need to be from the accepted norm to enjoy the work. How much impact the equality legislation had on women engineers is assessed from the point of view of the women themselves, provided by oral history evidence. By locating the life histories within a core structure of the changes in one company since the end of the war, as seen through the eyes of women engineers employed there, it is possible to highlight areas where they share common experiences and those where an experience is unique to an individual. The histories demonstrate how a woman's expectations have changed over the years and also how her

expectations can colour her reactions to a situation. The emphasis is on women as individuals, and it will be shown that the campaigns to encourage more women into engineering frequently founder on the tendency to treat women as an homogenous group.

Throughout the thesis the changes over time are noted. In most cases, the changes for women engineers reflect the changes that all working women experienced during the second half of the twentieth century, particularly in relation to motherhood. In certain respects, women engineers have fared better than other career women; with few women entering the career it will be shown that those who did choose engineering seldom encountered the prejudice that an influx of women entrants, following the equality legislation, engendered in some other careers. However, it will be demonstrated that the reverse situation applied during training. While access to training became easier, the 'macho' culture continued to prevail, making this a difficult time for many women engineers. The thesis will establish that, while cultural changes resulted in women being expected to have careers by the end of the century, social stereotypes and the status and image of engineering still affected whether the career was considered suitable.

In conclusion, by providing a history of women engineers in the post-war period, the thesis establishes what caused engineering to be perceived as a male career by society at large. It explains why the various campaigns to encourage women into engineering had only limited success, and why some women became engineers against the general trend. It offers a comparison between women in engineering and in other careers, and relates the experience of female engineers to those of women in other professions. By giving women engineers agency over the way their history is related, it avoids depicting them as either unwitting victims of discrimination, or as women who willingly sacrifice their femininity to further their careers. This unsettles some current theories regarding the treatment and experiences of women engineers. This thesis shows that women engineers are no more (and no less) different to other career women than male engineers are to other men. There are no easy answers and no quick fixes to the under-representation of women in

engineering. By examining the experiences of women who have chosen to become engineers from an historical perspective, rather than from a sociological stance, some of the myths can be dispelled and some of the more extreme claims made about engineering, and women's roles within it, can be put into perspective.

Why So Few Women Choose Engineering?

The history of women and work gives insights into the changing nature of women's employment between 1945 and 2000. The social changes over this time resulted in most women wanting to work, but now women are expected to work, even after having children and in spite of more than a decade of high unemployment from the mid-1980s to the late 1990s. These changes can be followed in any of the numerous books on the subject, such as those by Ross Davies, Lindsay Mackie and Patty Pattullo or Rosemary Crompton.¹¹ Their research shows how women's careers are constrained by social pressures, firstly in the limiting of choice by traditional ideas of what is suitable, and secondly by the limiting of promotion due to career breaks to have children. The research also shows that most women who do not train for a career are still largely confined to the low status, low paid jobs traditionally seen as women's work. Jane Lewis argues that the outcome of this is a shift away from the traditional difference in prosperity and expectation between men and women to one between successful professional women and teenage unmarried mothers.¹² However, the fact remains that even the successful professional woman is unlikely to be an engineer.

An editorial in *The Engineer* on 27 April 2001 pointed out that in a decade's time, when 'the demographic bulge of engineers aged 45-plus' begin to retire, the profession will

¹¹ Ross Davies, *Women and Work*, London, Arrow Books, 1975; Lindsay Mackie and Patty Patullo, *Women at Work*, London, Tavistock Publications, 1977; Rosemary Crompton, *Women and Work in Modern Britain*, Oxford, Oxford University Press, 1997.

¹² Jane Lewis, *Women in Britain Since 1945*, Oxford, Blackwell, 1992, p.10.

be hit by a shortage of recruits worse than any seen before.¹³ Shortages of engineers are frequently predicted, but the trend away from an unfashionable and undervalued career in Britain seems set to bring about the 'more or less permanent shortage of technically qualified staff' predicted in the article. The spring of 2001 saw the initial issue of *SET News*, another step in the government's efforts to recruit women into Science, Engineering and Technology. As has already been said, these efforts generally fail; this may have been due to the simplistic nature of such efforts. While sociologists, such as Peggy Newton, seek to identify the 'differences' in women who chose engineering as a career,¹⁴ feminists like Cynthia Cockburn consider it was the 'maleness' of technology that repelled women,¹⁵ and career advisors suggest that until a 'feminine' career model is devised women will continue to be ill advised regarding technical careers.¹⁶

The current shortage of engineers and the question of how women can be encouraged to fill the gap is a major concern of both educationalists and the professional institutes. The WISE and SET campaign literature ignores the cultural factors and concentrates on offering girls the necessary help and advice at an early enough stage in their schooling so that they can make an informed choice about a career in engineering. By ignoring the fact that the current social climate not only sees engineering as a lower status career than others, but also as a 'male' career, this literature does little to address the underlying problems. The feminist precept that engineering is a male dominated career and that changes to the entire structure of the profession are needed before women will enter it in any numbers dominates the educationalist literature. Two recent articles on women in technology in Scotland demonstrate this. The earlier article, from 1998, comments that:

The recruitment problem in Science and Technology is not confined to women;

13 Paul Carslake, 'Editorial', *The Engineer*, 27 April 2001, p.3.

14 Peggy Newton, 'Becoming a Female Engineer: Sex Role Self Concept and Sex Role Attitudes in Occupational Choice.' Unpublished PhD Thesis, Kent University, 1986.

15 Cockburn, *Machinery of Dominance*, particularly Chapters 6 and 8.

16 Jenny Brimrose, 'Girls and Women: Challenges for Careers Guidance Practice.' In *The British Journal of Guidance and Counselling*, Vol. 29, No.1, 2001.

it is much more general and a cause of concern across the United Kingdom, but it is clear that women experience particular obstacles and barriers in their pursuit of studies and employment in SET.¹⁷

The comment is made that, while the problem of low participation is related to 'wider historical and cultural factors' the article is only concerned with access to higher education. In the examination of feminist epistemologies and pedagogy that follow, the article concludes that women's achievements in SET are consistently ignored or trivialised. The article also points out that the effect of the low numbers of women lecturers in Science and Technology subjects results in 'the fostering of a hard, competitive, and relatively unsupportive climate in order to "weed out" unsuitable students'.¹⁸ It suggests that this in itself would deter many women from choosing SET subjects. This is a point taken up in the second article, from 2000, which examines the likelihood of success of the various campaigns aimed at schoolgirls. This article studies the effect of schools as well as higher education on girls' attitudes to Science and Technology and takes note of the effect that society's view of these subjects being 'male' still have on such attitudes.¹⁹ The article concludes that the problem needs 'tackling on all fronts' and that the solution will not be short-term. It points out that, as gender equality is not monitored in Science and Technology subjects, there is a tendency for such equality to be perceived as less important. The article suggests that unless this attitude is changed, the long-term goal of a more balanced gender distribution within engineering, leading to a change in the male dominated ethic from within, is unlikely to be achieved.

Julia Evetts examined why women chose engineering as a career. In contrast to the research done for this thesis, Evetts's sample were all from one company and did not include any older women, there was only one whom she assessed as being in mid-career, the others were all recently qualified. However, as her research was concerned with the

¹⁷ Angela Roger, Catherine Cronin, Jill Duffield, Maureen Cooper & Sheila Watt, 'Winning Women in Science, Engineering and Technology in Higher Education in Scotland', in *Design News*, Vol. 53, Issue 24, 21/12/1998, p.22.

¹⁸ *Ibid*, p.48.

educational experiences that influenced the women this was perhaps not of great significance. She points out that:

First experiences of engineering and of industry had been an important clarification of career directions. They had enjoyed and related to what they perceived as engineering work. It was relevant and important. They had come to realise that the cultural image of engineering was outdated, stereotyped and wrong. Engineering was about solving problems, about devising procedures and processes, about testing and coming up with results. There was absolutely no reason, in these women's view, to accept the cultural association of engineering as men's work.²⁰

Her article emphasised the need for schools to keep subject choices open for as long as possible. When girls do not know what they want to do the cultural perception of what is women's work can result in restricting their options to choose engineering at a later date. She found that most of the women in her survey had 'chosen engineering related courses despite, rather than because of, schools' advice.'²¹ Such sociological studies of a current problem largely have no equivalent in historians' examination of the history of women engineers.

Historiography

There has been a large amount of sociological work published regarding women and technology, and a good deal of it examines women engineers. However, until recently, none of this work looked at the history of women engineers or examined changes over time. The history of women engineers in post-war Britain, while not totally neglected, is only sparsely covered by the current literature. Books such as *Ingenious Women*, by Deborah Jaffé,²² which examines the patents granted to women since 1637 address this problem, but much remains to be done. There are some biographical studies examining the

19 Angela Roger & Jill Duffield, 'Factors Underlying Persistent Gendered Option Choices in School Science and Technology in Scotland', in *Gender and Education*, September 2000, Vol. 12, Issue 3, p.367.

20 Julia Evetts, 'Women in Engineering: Educational Concomitants of a Non-traditional Career Choice' in *Gender and Education*, Vol. 5, Issue 2, 1993, p.175.

21 Ibid, p175.

22 Deborah Jaffé, *Ingenious Women*, Thrupp, Sutton Publishing Ltd, 2003.

lives of women engineers, such as Jane Gardiner and Caroline Haslett,²³ and the period prior to this has been examined in a number of excellent works, not least that of Clare Wightman. There are also the works of the social scientists as surveyed above. These were generally written to advance theories about education or career development, and while valuable in demonstrating contemporary attitudes, they do not present a rounded picture of the history of women engineers and their experiences.

Among the books on women and work, Clare Wightman's study *More Than Munitions* is an analysis of women working in engineering up to 1950 and shows how women were restricted in their opportunities by wartime regulations on the dilution of skills.²⁴ She demonstrates that issues of women's employment are complex, and that to give too much weight to any particular ideology, whether capitalistic or paternalistic, neglects much of historical relevance. She shows that the relationship between working women and the trade union movement has not always been presented in a way that takes account of women's priorities. It is clear that, contrary to popular belief, women were quite prepared to take industrial action, but only when they considered it necessary. Wightman shows that women would even take action against their own unions, if those unions considered the demands of male workers to be more important than those women might make. Her study is a valuable forerunner to this thesis, but it is not concerned with women at technician level or above, and ends in 1950, whereas this investigation will consider female engineers from 1945 to 2000.

One writer, whose work parallels this thesis, is Clara Greed. Her study of women who choose to become surveyors shows that they face many similar problems to women who become engineers.²⁵ Greed points out that only a certain type of woman is attracted to surveying, and it should not be assumed that she is likely to be a feminist. However, she

²³ Jane Gardiner, *Memoirs of a Woman Engineer*. R. Messenger, *The Doors of Opportunity: a Biography of Dame Caroline Haslett*, London, Femina, 1967.

²⁴ Clare Wightman, *More than Munitions, Women, Work and the Engineering Industries 1900-1950*, London, Longman, 1999.

points out that the male perception of the women surveyor's future career was totally different to that of the women themselves. Women were still, typically, seen as helpers in the work and career progression of others, 'not as people who will have careers themselves.'²⁶ This attitude is not apparent in engineering, in spite of the highly patriarchal nature of technology.

There are many histories of Britain's engineering industry by writers such as Trevor Williams, George Bassalla and George Bugliarello.²⁷ The history of women in the latter half of the twentieth century is also well documented, but there is no single text that deals with both subjects. The more general histories of women have obvious relevance since the changes that affect women in general also affect female engineers. No history of any aspect of women's lives can be written without a thorough understanding of the social and economic changes that have affected all British women in the twentieth century. However, as Jane Lewis comments, one of the difficulties with women's history since the Second World War is deciding exactly how much has changed.²⁸ Writers such as Sheila Rowbotham, Elizabeth Wilson and Sue Bruley conclude in their various books on women in the latter half of the twentieth century that the main area of change is concerned with the amount of freedom women have.²⁹ Women now have the same legal freedom as men; they are free to make their own choices about when, or if, to have children; and they are free to choose their own careers. However, there is a degree of illusion about these freedoms. Social pressures still ensure that women continue to bear the main responsibility for housework and child-care, although they are now expected to undertake paid work as well. The conflict of interests such pressures generate can result in women being forced by

25 Clara Greed, 'Women Surveyors: Constructing Careers', in Julia Evetts (ed), *Women and Careers: Themes and Issues in Advanced Industrial Societies*, London, Longman, 1994.

26 Ibid, p.146.

27 George Bassalla, *The Evolution of Technology*, Cambridge, Cambridge University Press, 1988; George Bugliarello and Dean Doner, (eds), *The History and Philosophy of Technology*, Illinois, University of Illinois Press, 1979; and Trevor Williams, *A Short History of Twentieth Century Technology*, London, Clarendon Press, 1982.

28 Lewis, *Women in Britain*, p.10.

circumstances to put their careers 'on hold' while their children are young. This causes them a degree of downward occupational mobility. Shirley Dex's study of working women confirmed that their subsequent employment recovery was highly dependent on their original status.³⁰ Again, such work, while relevant to this thesis, does not address the history of women engineers who are such a small group that they fail to feature prominently in any of the histories of working women.

Terms and Definitions

There are certain terms that I have used throughout the thesis that require some explanation.

Engineer, Technician/Technologist

The problem with the title 'engineer' is that, unlike continental Europe, Britain has never developed specialist titles for the various engineering professionals. Indeed, the specialist job titles that used to exist for many technician jobs have largely fallen into disuse as companies have preferred to rationalise their wage structures by uniting all such jobs under the generic term 'engineer'. There are 43 Institutions represented by the Engineering Council and each of these covers an entirely different discipline. Each discipline encompasses a wide variety of jobs at many levels. While those at the top level are following an engineering profession, it can be argued that many of those below this are simply following a career. This makes the task of comparing women engineers with those in other professions difficult, as there is little point comparing a woman in a lower level technician job with a highly qualified professional woman in any career. Throughout the thesis, where career comparisons are made, this has been considered and attempts have

29 Sheila Rowbotham, *A Century of Women*, London, Viking, 1997; Elizabeth Wilson, *Only Halfway to Paradise*, London, Tavistock Press, 1980; and Sue Bruley, *Women in Britain Since 1900*, Basingstoke, Macmillan Press, 1999, are examples.

30 Shirley Dex, *Women's Occupational Mobility, A Lifetime Perspective*, London, Macmillan Press, 1987, p.123.

been made to keep comparisons to broadly similar levels of training and employment, using Routh's classification of Engineers (Professional) as Class 1A, along with Accountants, Architects, Lawyers and Medical practitioners, Draughtsmen and other technicians he categorises as Class 1B, the same group as Teachers,³¹

Many people have tried to define what is meant by the term 'engineer'. This problem of definition is addressed in this thesis, particularly on pages 148,161 and 174, but the definitions I am using are as follows. The term 'engineer' is used as a generic term for anybody employed in the industry doing a technical job. It does not cover 'skilled' workers and it does not include managers who no longer have any technical input in their job. For this thesis engineers are then split into 'Technologists' and 'Technicians'. This is done purely on the basis of the training that a person has undergone, since once they start work the difference is seldom noticeable. A 'Technologist' is an engineer who attended university or polytechnic on a full-time or sandwich course and attained a degree or Higher National Certificate before becoming a graduate apprentice. This means that they intended to become an engineer, and many became members of an engineering institute, although lack of such membership does not take them out of the technologist bracket. 'Technicians' are the bulk of the engineers who trained by doing apprenticeships and day-release courses. As will be seen, both the style of training and the work subsequently done by technicians and technologists has changed over the years, and many who started out as technicians finished their careers in jobs that would be recognised by the professional institutes as technologist positions. Another point to be borne in mind throughout the thesis is that very few engineers actually join the relevant professional institute, although this is gradually changing with the current emphasis on qualifications for all careers making registration not only more advantageous, but also easier for newer recruits to the profession.

³¹ Guy Routh, *Occupation and Pay in Great Britain 1906-79*, London, Macmillan Press, 1965, (2nd Ed.) 1980, p.222. He only mentions Draughtsmen, I have included all technicians at this level to reflect normal industry practice.

Class, Working/Middle/Professional

Class is another term which requires definition. Although engineers are seldom mentioned in lists of typical jobs given in class tables, the Registrar General's Index of Social Class would place most engineers in social class A or B. The difficulty of defining class resulted in W.G. Runciman³² dividing Britain into seven classes. He retains the terms 'upper'; 'middle' and 'lower' adding descriptive terms to distinguish these further. In his grouping engineers would be placed in class 2, 3 or 4, his upper-middle, middle-middle or lower-middle class. Most of the women contacted for this thesis would fit into these categories, but their parents came from a much wider range, only classes 1 and 7, the upper class and the under-class, being excluded. His definitions are the ones I have used in this thesis.

However, the subjective definitions of class used by the women interviewed are more complex and have changed over time. In the 1950s there were still marked differences between the lower middle class and the skilled working-class. Across the post-war period this difference became blurred and many of the younger women preferred to describe themselves as 'professional' rather than middle or working class. Women from traditional working-class families had no problem defining the class of their parents, although the definition of their own class became more difficult. They could see the improvements in their own lifestyle compared to that of their parents in a way less obvious to women from middle-class homes. These women shared a tendency to equate the need to work with being working class. The effect of class on the women in this thesis is only clearly relevant at the beginning of their careers, and even that has dwindled over time. In the 1950s and 1960s, those from middle-class backgrounds had more opportunity to go to university than those from working class backgrounds. As the class distinctions became less noticeable in the later part of the century, class was supposedly less of an obstacle to going to university, although apprenticeships were still more popular among those from

working class backgrounds. This may have been due to the knowledge of the necessity to get 'hands-on' training at some point, and the worry of not being able to get such training at a later date, leaving the female graduate with no route to a career in engineering.

Equality Legislation

The equality legislation is mentioned frequently throughout this thesis and refers to the Equal Pay Act of 1970 and the Sex Discrimination Act of 1975. The Equal Pay Act came into force on 29 December 1975, giving industry five years to allow gradual implementation. This act was described as 'an Act to prevent discrimination, as regards terms and conditions of employment, between men and women.'³³ The loose wording of subsection 5, regarding work considered the equivalent of any done by men, led to many women being effectively denied equal pay. This was not the case for women engineers, both technicians and technologists were doing jobs that were obviously covered by the act. This meant that by the time the act came into force women engineers had every right to expect equal pay. The act did not address the subject of equal opportunity, this was covered by the Sex Discrimination Act of 1975 which was intended to take the issue of equality further, by 'promoting equality of opportunity between men and women generally.'³⁴ While certain 'special cases' were exempt from the act, the main effect on women engineers was to remove barriers to training and to open up opportunities for promotion. The drive to get the legislation passed is examined in Chapter One, and its effects on various aspects of women engineers working lives are assessed throughout the thesis. Further legislation followed; in 1980 women were given equal entitlement to most social security benefits; in 1984 the right to equal pay for work of equal value modified some of the inconsistencies that had resulted from the original Equal Pay Act. In 1990 married women were taxed independently, in 1993 maternity rights were extended and

32 W.G. Runciman, 'How Many Classes Are There in Contemporary British Society?' in *Sociology*, Vol. 4, No. 3, 1990.

33 *The Equal Pay Act 1970*, London, H.M.S.O. 1970

enhanced, and in 1995 arrangements were made for equalisation of state pension age and equal treatment for occupational pensions.

Discrimination

The issue of sexual discrimination is an emotive one, where one person sees bias, another will accept that decisions may go against a woman as well as in her favour. Attitudes have changed over time, prior to the equality legislation obvious cases of prejudice or unfair treatment were often accepted as 'normal behaviour' and this attitude did not always change immediately the law was passed. Women continued to accept treatment that lessened their opportunities, often excusing it on the grounds that men were only 'protecting' them, or that it was 'natural' for a man to assume a woman was less ambitious. With the changing attitudes towards women and their careers came a change of attitude towards the treatment women would tolerate at work. This was accompanied by a realisation that accepting men's behaviour was prompted by 'good intentions' could cost women valuable experience that would prevent them achieving their full potential. Although the law gave women the necessary backing to fight discrimination, they continued to suffer the problems inherent in their greater responsibilities for caring for a family.

These concerns are relevant to all women, whatever career they choose. For the purposes of this thesis, I have accepted the term discrimination in the loose sense that the women engineers used it, which was to describe unfair treatment that they felt was due solely to their gender. This omits the problems arising from being in a minority, such as feeling the need to prove themselves better than men. None of them saw this as discriminatory behaviour; they considered this to be a normal reaction to any minority group. Once again, comparisons with other careers are difficult, due to the varied types and levels of work that are undertaken by engineers. There are differences of degree in

sexual discrimination. In some careers 'feminisation' has resulted in an insidious downgrading of pay and status, leading to an apparent equality between the sexes that still discriminates against women and contributes to the gender pay differential that continues to exist.

Summary

This thesis examines why engineering has never attracted women. It focuses on the experiences of women engineers and, by placing such experiences within the wider historical framework offers a view of the career that differs from existing work. It suggests ways in which both training and careers advice have failed to provide women with equal opportunities of access to the career, while demonstrating that women who do enter the profession are well treated. It demonstrates that, until the profession and the industry itself do more to change public perceptions of engineering, recruitment to the profession will remain problematic, particularly among women.

Chapter 1

The Double Shift: Women and Work

Introduction

There have been women engineers for as long as engineering has existed as a career. In the past they have mainly been shadowy figures described as ‘helpers’ of their husbands, brothers or fathers, women such as Ada Lovelace who helped Charles Babbage, inventor and constructor of the first computing machine for example. In this chapter a brief history of some of these women and of the early pioneers among qualified women engineers leads on to the founding of WES. An examination of the work of women engineers during the Second World War will be followed by an analysis of the way in which their status was affected by the return to peace. This chapter also investigates how notions of appropriate female behaviour and role changed after the war, particularly in relation to women’s employment. From 1945 onwards the improvements in education, housing and health care that took priority in the plans of the post-war governments led to great social changes, particularly in the lives of women. Such changes were not always easy for women to deal with. As girls they were encouraged to do well at school, yet as women they were expected to give up their independence when they married. They became a useful pool of reserve labour, yet were harangued about leaving their children when they returned to work. Divorce became more acceptable yet men were still assumed to be the wage earners.¹ The idea of a ‘family wage’, fought for by the unions immediately following the war, left many women struggling on low salaries. As late as 1973 Roger Lumley stated that although women made up 46 percent of white collar workers, the unions were ‘unattractive to women members. There is still prejudice in some areas against permitting women to discuss anything but their own problems’,² demonstrating

¹ Applications for Divorce rose steadily from 25,689 in 1959 to 60,134 in 1969. *Annual Abstract of Statistics 1970, No 107*, London, H.M.S.O., Table 84, p.84.

² Roger Lumley *White Collar Unionism in Britain*, London, Methuen & Co. 1973, p.36.

that women were only considered a reserve labour force by the unions as well as the employers.

The contradictory messages that were being given to women, combined with the growing political and social awareness that characterised the post-war decades, created a fertile climate for the women's liberation movement. The stereotypical image of women was changing, but the clash between the stereotype and the reality of women's lives and capabilities became a major topic for feminists, as they tried to change the image and role forced on women by their gender. The equality legislation that came into force in the 1970s was more acceptable to the general public, partly because of the publicity that the feminists generated during the 1960s. The effect of the legislation on women engineers will be considered here in general terms. While the original legislation did not go as far as feminists wanted, subsequent legislation and the gradual change in attitudes following women's greater participation in the work place resulted in women getting fairer treatment at work. However, cases of discrimination and harassment continued to be brought against men who failed to realise that behaviour that was still tolerated, and sometimes even welcomed, in a social environment was inappropriate in the work place.

Early Women Engineers in Britain

While the shadowy figures of the women who assisted their men-folk with various aspects of engineering largely remain hidden from history, some women are recorded. An early example of such women is Elizabeth Bell, who was granted a patent in 1803 for 'An artificial method of sweeping chimnies and of constructing them in such a manner as to lessen danger and inconvenience from fire and smoke'.³ In 1857 a 17 year-old girl, Henrietta Vansittart, described as a propeller specialist, accompanied her father on board

³ Featured in *Ingenious Women* by Deborah Jaffè, Thrupp, Sutton Publishing ltd. 2003., Pat GB2702/2703, Elizabeth Bell, Hampstead

HMS Bullfinch to assist in the trials of his patent propeller; while in 1910 Elsie Verity took her first step to becoming a motor engineer when, on her sixteenth birthday, she collected a new car from London and drove it to Manchester for her father.⁴

The outbreak of the First World War gave some women the opportunity to train as engineers. The National Union of Women Workers fought to soften the rigid application of the government's agreement with the Amalgamated Society of Engineers and similar organisations that stipulated women would be forced to relinquish such jobs when the men returned. They had limited success and a special Engineering Committee was set up to work towards equal opportunities for women in engineering and allied industries. Claudia Parsons, who had taken over the running of her husband's engineering firm during the war, and her daughter Rachael, also a qualified engineer, set up WES in 1919.⁵ Rachel Parsons became the first President of the society, followed by her mother. Caroline Haslett (later Dame Haslett) became the first secretary for the society, she was an engineer who had worked for the Cochrane Boiler Co. during the war and went on to become the Director of the Electrical Association for Women. She was also the first woman to serve on the board of the British Electrical Authority. WES collated information on the training facilities available to women and helped those women who were forced out of jobs to find new opportunities within engineering. In 1919 the WES published the first issue of their quarterly journal, *The Woman Engineer*, which has appeared without fail ever since. In the early days this was the only place where women engineers could publish their research and work. Membership grew slowly during the twenties; many members were not themselves engineers, but were women who were interested in engineering and hoped the Society might encourage employers to consider women.

In 1919 a widely felt need to prevent the exploitation of women had resulted in regulations which forbade the employment of women between 10pm and 5am. This

⁴ *Celebrating Women in Engineering*, London, WES, 2002, p7 & p9.

⁵ Claudia was the wife of Sir Charles Parsons, a renowned turbine engineer and she was one of the first women to take an engineering diploma at Loughborough, starting in 1919.

effectively prevented women from doing any of the engineering jobs which required shift work. By 1934, at the representation of WES, there was an agreement that such severe restrictions were no longer desirable and they were modified to take account of systems of shift work and to permit certain categories of managers and technical staff to do night work. This followed an incident when a factory inspector found a girl apprentice working the night shift in a power station. The power station was one of a number in the West Country built by an electrical engineering firm established by Miss Margaret Partridge, a founder member of WES. Her firm had undertaken the running and maintenance of the power stations after they were built and had a number of girls among their apprentices. WES pointed out that the 1919 convention would prevent women from taking apprenticeships. They won their point and, when the subject was raised again in 1959, the amendment was retained on their recommendation.

By 1932 WES had sufficient members to set up an aeronautical section that ultimately became the British Women Pilots Association. (Amy Johnson was president of WES from 1935 to 1937.) With the advent of the Second World War women were again urged back to work and WES tried to ensure that those who had the talent, and the desire to do so, could train as engineers. In 1935 the society had a membership of 111, this rose to 250 with the influx of women into engineering with the Second World War.⁶ With the end of the Second World War, many women once again returned to their traditional place as homemakers. However, unlike the situation at the end of the First World War, this time both the social changes that took place, and the need to keep Britain's industry competitive enabled women to retain some of the 'equal rights' they had been accorded in wartime. WES became active in careers advice and was consulted by the government on the problems of encouraging women into science and technology.

⁶ Cicely Thompson, *The Women's Engineering Society, 1919 to Present Day*, London, The Women's Engineering Society, 1989.

Women Engineers in Wartime Britain

During the Second World War women had been encouraged into industry in greater numbers than had ever been seen before. Many women engineers served with distinction during the Second World War, for example, female pilots undertook the task of delivering new aircraft to the airfields, often with no instructions on how to handle the planes and minimum directions as to where they were going.⁷ Victoria Drummond, who had qualified as a Marine Engineer in 1918, was awarded the MBE and the Lloyds Medal for bravery at sea for single-handedly keeping the engines of her ship running during a German bomber attack,⁸ while Constance Tipper solved the problems of the 'Liberty Ships' sinking in heavy seas due to material fatigue.⁹ Both Verena Holmes (President of WES from 1931 to 1932) and Margaret Partridge (President of the WES from 1944 to 1945) became Technical Officers of the Ministry of Labour. Government scholarships were made available for women to take degrees in mathematics, science and engineering, and engineering training became available to women at professional, technician and craft levels. Caroline Haslett (President of WES 1931 to 1932) was appointed 'Advisor to the Ministry of Labour' to give advice on the call-up of women into munitions work and, with her help and encouragement, the capabilities of women to do more technical jobs was realised. In a lecture given to the Institute of Electrical Engineers in 1941 she suggested that:

It is the opinion of the author that the engineering industry offers an exceptional opportunity for those who enter it. No one wishes to take advantage of the times, but women would appreciate an acknowledgement of their part in obtaining victory and what better acknowledgement than the permission to share in the joys and sorrows of an honourable career and help to use their real ability in the building of the new world.¹⁰

The important part played by women at the craft levels of engineering has been well

⁷ Details of the work of the Air Transport Auxiliary can be found in Lettice Curtis, *Forgotten Pilots*, London, Nelson & Saunders Ltd, 1971.

⁸ *Celebrating Women in Engineering*, p.10.

⁹ *Ibid.* p.11.

¹⁰ Caroline Haslett, 'Women in War Time Engineering.' Transcript of a Lecture at the Institute Of Electrical Engineers on 27/9/1941, p.6. Information held in WES archives at the Institute of Electrical Engineers, Ref. NAEST 33/10.8.

documented in recent years, particularly by Clare Wightman's book *More Than Munitions*.¹¹ However, women also made a contribution at the higher levels of engineering. The actual numbers are difficult to assess since no records were kept that listed women technologists, but by 1951 the census gave the figures as 87 Civil engineers, 111 Mechanical engineers and 195 Electrical engineers. These would have been the women who had qualified as technologists and registered with the relevant professional institution. Alongside these were 12,251 draughtswomen, other technicians not being listed.¹² Since these figures apply after most of the female wartime workers had withdrawn from the labour market, it is reasonable to conclude that the numbers of women engineers during the war would have been higher.

Such women had made a valuable contribution to the war effort and to the post-war reconstruction of Britain's industry. With memories of the way women's gains in the work place had been rapidly lost following the First World War, Haslett commented in a radio broadcast in 1945 that:

Women in engineering have been perhaps the greatest factor in Britain's war production. Now that problems of resettlement are beginning to loom large it is important that women be allowed to play as important a part in establishing the peace as they have done in bringing the world out of the chaos of war. Their ability in almost all spheres of activity is undisputed but vigilance must be exercised to ensure that their potential contribution is not neglected.¹³

While women were not to lose all the opportunities that they had gained at the end of the war, the hope that women would continue to enjoy careers in engineering proved unfounded for many, particularly at the lower levels of engineering. When women left work to have children, many discovered that they were not welcomed back when they tried to return, as Penny Summerfield's article 'They Didn't Want Women Back In That Job!'

11 Clare Wightman, *More than Munitions, Women, Work and the Engineering Industries 1900-1950*, London, Longman, 1999.

12 *Census 1951, England & Wales, Occupational Tables*, London, H.M.S.O. 1956, Table 1, p.17.

13 Caroline Haslett, Broadcast for BBC Radio in 1945. Transcript held in the WES archives at the Institute of Electrical Engineers, Ref. NAEST 33/11.3.

suggests.¹⁴ Some women were faced with blatant discrimination, this was the experience of Bella Keyzer who had trained and worked as a welder during the war. She was told that she could not keep the job when peace returned and it took her until 1975 and the sex equality legislation before she was allowed to do the job again.¹⁵ Women who had trained as engineers rarely faced such discrimination. Four of the women interviewed for this thesis had been working as engineers during the war and another seven had begun their training. None of them had been forced to resign at the end of the war, or knew of anyone who had, and none found difficulty returning to full time work after having children. However, there was some resistance among both professional engineers and employers as Braybon and Summerfield suggest when they reported the arguments that raged in the columns of *The Engineer* on the admission of the first female to the Institution of Mechanical Engineers as a full member in 1944.

Correspondents repeated arguments, which the same journal had hurled against women in the engineering shops in the First World War, addressing them now to women aspiring to become professional engineers. The world of engineering was unsuitable for women because they would be exposed to bad language and long hours of standing (by implication it did not now matter that working-class women put up with these things daily in the workshops). Moreover women might undercut the male professional engineer and compete with him for jobs.¹⁶

As Armytage pointed out, 'the Second World War accelerated the process of transforming Britain into an engineering state' and the shortage of engineers in the decades that followed ensured that any good engineer (even a female one) could find employment.¹⁷ Women who had proved themselves capable generally found that their employers were happy to keep them; indeed, many of these women were highly valued by their employers. For example, one interviewee was employed by a firm of civil engineers

14 Penny Summerfield, 'They Didn't Want Women Back In That Job! The Second World War and the Construction of Gendered Work Histories' in *Labour History Review*, Vol. 63. No.1, Spring, 1998, pp.83-103.

15 Angela Holdsworth, *Out of the Dolls House*, London, BBC Books, 1988, p.82.

16 Gail Braybon & Penny Summerfield, *Out of the Cage: Women's Experiences in Two World Wars*. London, Pandora Press, 1987, p.174.

17 W.H.G. Armytage, *A Social History of Engineering*, London, Faber & Faber, 1961, p.306.

in Scotland and was offered a partnership once the war was over.¹⁸ Another interviewee who rose rapidly in her profession after the war was employed as an engineer with an electricity company. She had studied mathematics at Cambridge and had expected to be employed as a mathematician, but when she arrived at her new job the work was that of an engineer, many of the men who had previously done such work no longer being available.¹⁹ Another mathematics graduate from Cambridge had done a vacation job at an electrical company and she returned to work there full time once she had graduated.²⁰ She remembered that ‘there were 13,000 people there and three women graduate engineers’. She worked on airborne radio equipment and when asked how the war had affected her career admitted that:

It made my career. If it hadn't been for the war I doubt very much that I'd have become an engineer. In those days, a woman going into engineering was.... You see, until Beryl (Baroness Platt) came up a year behind me, she was one of the first ones to get an engineering bursary.²¹

Baroness Platt had studied engineering rather than mathematics. She remembered being sent a letter by the government at the time that she was considering her options for university, telling her she could do more for the war effort if she studied one of six suggested subjects in preference to mathematics.²² (Such suggestions were often made to students, of either sex, as the government tried to ensure its technicians were trained in desperately needed disciplines.) One of these subjects was aeronautics, which she chose, but when she arrived at university she found she was reading Mechanical Sciences. There were five women studying engineering at Cambridge in 1941 where previously only nine women had ever studied it. Baroness Platt went on to work for Hawker Aircraft and after the war joined the research department of BEA working on air safety. Like most women

¹⁸ Questionnaire source, see Appendix 1.02.

¹⁹ C. Chamberlain, R. Skoletsky and L. Stanton, ‘An Oral History of the Women’s Engineering Society’ A report submitted in partial fulfilment of the interactive qualifying project to meet the degree requirements of the Worcester Polytechnic Institute, 13/5/1988. Transcripts of interviews are held in the Society Archives at the Institute of Electrical Engineers, London, p.258.

²⁰ Ibid. p. 166.

²¹ Ibid. p. 171.

²² Ibid. p. 83.

engineers, she considered herself a 'normal' woman and was content to put her family first. In a similar manner to other women of her generation, she married and gave up work in 1949, but she entered local government part time when her children were young and later served on a number of bodies including the Equal Opportunities Commission.

As a child Maria Watkins, who completed one of the questionnaires, was fascinated by a wireless, and when her father could not explain how it worked she decided she wanted to become an engineer.²³ After some dispute with her parents, they agreed she could study engineering and, although the family was Polish, it was decided she should do so in Scotland. She duly arrived in Edinburgh in 1939, speaking very little English, to find that, after the initial surprise her arrival provoked, most of her instructors were helpful and her fellow students friendly. She married one of her fellow students, and when they qualified he was conscripted into the RAF, while she was sent to work for an electrical power company in London. After the war, like Baroness Platt, she left work to have children and, once they were old enough to be left and she wanted to return to work, she decided to give up engineering and turned to teaching, believing that it was an easier career to fit around family commitments.

Another woman had attended the local high school where she was taught all the basic subjects but remembers that 'science was botany/nature study and subsequently biology.'²⁴ She was sent to a boarding school when she was 13 where physics was taught 'but only by the cookery teacher, and the mathematics teacher had forgotten any she ever knew.' When she returned to the high school a few years later she had private coaching in maths and passed the entrance examination for Newnham College Cambridge to study mathematics. She remembers her father could not afford to send her to Cambridge but in 1941 the government had decided that it must train more engineers and radio specialists to win the war. They asked for maths and physics so she 'lied about the physics as she had the maths' and she got a bursary. She remembered that at Cambridge in those days students

²³ Ibid p.69, and Questionnaire history source, see Appendix 1.14.

studied all branches of engineering and a three-year course was crammed into two years.²⁵

At the end of the second year, in spite of having expressed a preference for civil engineering, she was sent to Rolls Royce to do mechanical engineering and was taken on as a graduate apprentice at £3 a week (the same rate as the men). Here she was given four weeks in the apprentice training school to get some practical experience and then worked in the stress department. Her impression was that women were not really wanted in the technical areas, no matter how good individual women proved to be, 'it was not seen as suitable.'²⁶ Only two of the 63 women who completed questionnaires commented on this, all the others saying that colleagues were friendly and helpful, but inevitably some women were to come into contact with men who were prejudiced against women in engineering.

As is clearly shown in Clare Wightman's book *More Than Munitions*, the majority of women were only trained to do the skilled and semi-skilled manual jobs similar to those done in the First World War, but some women were trained to do technical work.²⁷ In her talk on 'Women in War Time Engineering' in 1941, Haslett had pointed out that:

Government training centres were established to rehabilitate men long unemployed and to fit them for work where demand for labour exceeded supply. In the first stages women were only accepted for unskilled training. The pressure of events however has been too great for the maintenance of such an attitude. As more and more men are transferred from industry to the armed forces the demand for greater skill among women has increased.²⁸

Some of the women who completed questionnaires for this thesis benefited from the war to train as engineers, but did not actually start work until the war had finished. Four of these studied at university, three others undertook less academic training. The first of these was given the opportunity to train with the electricity generating company that her father had worked for before the war.²⁹ She was allowed to attend college on a day-release scheme and had no problems with either the instructors or her fellow students in spite of being the

24 Jane Gardiner, *Memoirs of a Woman Engineer* Lewes, The Book Guild Ltd. 1990.

25 Women were awarded the 'title of a degree' and were not given degrees at Cambridge until 1948 although Oxford had awarded degrees to women since 1920.

26 Questionnaire source, see Appendix 1.14.

27 Wightman, *More than Munitions*.

28 Haslett, 'Women in Wartime Engineering' transcript, p.4.

29 Questionnaire source, see Appendix 1.41.

first girl ever to study for HNC in electrical engineering at the college. The other two women started their working lives in the drawing office.³⁰ Both were encouraged to undertake day release training and neither recalled any problems with discrimination. However at this time women did not expect equality and the concept of discrimination was not one that many women considered. Coupled with the recent experiences of wartime life, when women had proved capable of doing many jobs, an apparently more egalitarian climate existed in the late 1940s. The women who studied at university also said there was no discrimination during their training, one had been in the WRNS during the war and was recommended to study engineering by her senior officer.³¹ She took advantage of the Further Education and Training grant offered by the government to anyone whose training had been interrupted by the war and went to university in 1946. She found most of the students were ex-servicemen who did not think of engineering as being unsuitable for a woman, a common reaction while memories of the war were fresh. This was in contradiction to the 'official assumption' that Braybon and Summerfield suggest existed:

The official assumption was that servicewomen could not expect to use their special technical skills in civilian jobs and should think in terms of entering university or training for one of the women's occupations, like teaching, nursing or clerical work.³²

This attitude was to influence women's careers as time passed. One of the women engineers explained it in a comment attached to her questionnaire, 'It was only in the 50s and 60s that everyone went backwards.'³³ As memories of women's achievements during the war faded, men again took control of the work place and most women were relegated to the subsidiary roles that were considered suitable. The next section examines what this meant for women in general and women engineers in particular.

30 Questionnaire source, see Appendix 1.13 & 1.40.

31 Questionnaire source, see Appendix 1.17.

32 Braybon & Summerfield, *Out of The Cage*, p.266.

33 Questionnaire source, see Appendix 1.12.

The Return to Peace

Alec Cairncross stated that between 1945 and 1950 'most of the two million women workers who had taken paid jobs in war time withdrew from the labour market.'³⁴ His statement offers no reasons why these women gave up paid work; he is not concerned with what these women might have felt about giving up their independence to return to the home and family environment with which they were supposed to be satisfied. While not all work was pleasant or desirable, and some women were perfectly happy with the role of housewife, it was not one that appealed to all women. When Caroline Haslett appeared on television in 1951, she summed up a report on women out at work saying:

Not all married women want to be housewives but we must agree that for many women the most important job will always be in the home. I believe that women's contribution should be equal and certainly in technical jobs it must be. Equality in work must of course mean equality of pay. Best contribution can be made from men and women working in partnership. But this means equal remuneration, equal opportunities in education and training facilities and most of all removal of prejudice enabling women to get to the top of the tree.³⁵

Her comments highlighted a belief that many women shared. Having been forced into a new lifestyle by the years of war, they could see no reason to return to the subservient position society had forced them into in the pre-war years. In the collection *Wartime Women* there are many quotes regarding women continuing to work once the war finished.³⁶ While there was some disagreement regarding mothers working, all those quoted were in favour of women continuing in their careers. It was to take twenty-five years before legislation gave women the right to equal opportunity and remuneration, yet the numbers of working women continued to increase. Although the baby boom played a part in women withdrawing from the labour market and many women wanted to stay at home, not all women felt this way. Bruley points out that 'by 1950 the longer term trends of women's employments had reasserted themselves', this trend being for more women to

34 Alec Cairncross, *The British Economy Since 1945*, London, Blackwell, 1992, p.60.

35 Caroline Haslett on BBC TV in 1951, summing up a report on women out at work, copy held in the WES Archives at the Institute of Electrical Engineers, London, Ref. NAEST 33/11.3.

36 Dorothy Sheridan (ed) *Wartime Women: A Mass-Observation Anthology, 1937-45*, London, Phoenix Press, 2000, pp.215- 226

work after marriage.³⁷

Some professional women fought against the tendency to push women into 'acceptable' careers. At the first post-war conference of the International Federation of Business and Professional Women it was suggested that women had a large part to play in rebuilding the western world following the war. The federation suggested that 'it is from the ranks of trained women that women qualified to make such a contribution must be drawn.'³⁸ The conference also suggested that such rebuilding would result in a shortage of labour and it was hoped that this would offer women the opportunity to continue in technical careers. In her draft of Caroline Haslett's biography Mrs Worth said:

It was universally acknowledged that men who had been called up were to get their jobs back when they returned to civil life after the war. Would there be room for women who had entered industry to remain in it if they wished? To this C.H. answered that there would always be a large number of women to whom domestic life appealed far more than industry and the amount of reconstruction after the war suggested that a boom period would follow when industry would not only be able to absorb large numbers of women workers but would need them desperately.³⁹

In 1947 the predicted labour shortage arose. On 1 June 1947, the BBC broadcast a plea by G.A. Isaacs MP, Minister of Labour and National Service, in which he announced 'We need women back at work.'⁴⁰ This marked the start of an advertising campaign to get women back into paid employment, although it was emphasised that this was a temporary requirement and that they were 'not asking women to do the jobs normally done by men.' Haslett was active in the campaign and her notes suggest that the women who might respond best to the call would be 'first young unmarried girls and then there are the older women who did such a magnificent job during the war.'⁴¹ The campaign showed that, in spite of the generally accepted attitude that a woman's place was at home, there was an

37 Sue Bruley, *Women in Britain Since 1900*, London, Macmillan, 1999, p.121.

38 First post-war conference of the International Federation of Business and Professional Women Paris, 1947. Copy held in The WES Archives at the Institute of Electrical Engineers, London, Ref. NAEST 33/10.8.

39 Mrs. R. Worth, typed draft of book 'My Sister.' Copy held in The WES Archives at the Institute of Electrical Engineers, London, Ref. NAEST 33/19.7.

40 Broadcast by G.A. Isaacs, MP. Minister of Labour and National Service, on Sunday 1st June 1947. Copy held in The WES Archives at the Institute of Electrical Engineers, London, Ref. NAEST 33/11.6.

41 Typed campaign notes, Copy held in The WES Archives at the Institute of Electrical Engineers, London, Ref. NAEST 33/11.6.

obvious need for women to work if industry was to recover and remain competitive, although women were still regarded as a 'reserve labour force' with the inevitable undervaluing of their contribution. As they were expected to take less interest in their career than their home, so they were expected to be content with less in terms of pay, training or opportunity for promotion. Summerfield found that between the 1950s and 1970s:

Repeated government reports and policy documents, as well as more popular writing, declared that 'women's work' did not demand skill or strength, it required the existence of 'feminine' characteristics such as dexterity or maternal qualities, and it was located in woman-employing niches in industry, services or professions.⁴²

This perpetuated the social attitudes that placed women firmly in subservient positions to men in the work place. Women could only rise to the top in careers that reflected their 'feminine' qualities of caring, such as teaching or nursing. In the medical profession those who chose to become doctors rather than nurses, or who opted for the more 'technical' areas such as radiography, found the glass ceiling almost impossible to crack, while teaching remained a profession where men were distinctly over represented at the higher levels.

The changes in attitudes towards women and work, briefly mentioned above and examined in more detail in the next section, reflected more general changes in society. The linking by advertisers of products with ideas and images which were seen as commendable acted as a reinforcement of the status quo: as early as 1946 Viola Klein had commented on the advertising industry's inclination to appeal to a woman's desire to 'please men by her looks and charm' and this stereotypical portrayal of women continued for some time.⁴³ Women were constantly being encouraged to look better, have a cleaner home, cleaner washing, everything shining with polish; the inference was that anything less was failure. Most housewives spent between 60 and 70 hours a week on housework in

42 Summerfield, 'They Didn't Want Women Back in That Job', p.86.

43 Viola Klein, *Britain's Married Women Workers*, London, Routledge & Keegan Paul, 1965, p.33.

spite of the labour-saving devices they increasingly owned.⁴⁴ The spread of labour-saving gadgets for the home, coupled with the lack of domestic servants for the middle classes and a better financial position for most of the working class, resulted in a generation of women who could realistically be termed 'housewife'. The term itself was descriptive not only of what a woman was expected to be interested in, but also what she was to be bound by, namely her house and family. The rapid growth of the advertising industry at that time encouraged the belief in the 'perfect' housewife. The advent of television advertising in 1955 transferred the main weight of advertising to this media. In 1960 the Pilkington committee found:

Since they sell goods by holding up certain attitudes as admirable, it seems obvious that they are at the same time and to some degree 'selling' the attitudes also. Although there is no compelling statistical or quantitative proof of this, failing such proof the responsible course must be to assume that the attitudes and values which act as vehicles for the sale of goods are themselves also being 'sold'.⁴⁵

By the 1960s, the female stereotype was beginning to change. The results of a survey conducted in Sheffield in 1963 had revealed that:

Some girls are tending towards more independence in their dealings with men, and that they will not be content to sign over their lives to their husbands on marriage.⁴⁶

Marwick suggests that this demonstrated that the self-confidence resulting from the teenage revolution was the cause of profound change.⁴⁷ This explanation fails to take into account that few women were conscious of any major change in their own lives. Rather, while some had a little more freedom or confidence than their predecessors, many were still limited by what society expected of them. The changes that did occur were not entirely due to an increase in self-confidence among the young, any more than the sexual revolution of the 1960s and 1970s can be written off, as Hobsbawm suggests, as being:

Made possible by anti-biotics, which appeared to remove the major risks from sexual promiscuity by making venereal diseases easily curable, and by the

44 Ibid. p.16.

45 Pilkington, Cmnd 1753, *Report on Broadcasting 1960*, London, HMSO, 1962, p.80.

46 M.P. Carter, *Education, Employment & Leisure*, Harmondsworth, Penguin, 1963, p.155.

47 Arthur Marwick, *The Sixties*, Oxford, Oxford University Press, 1998, p.79.

birth-control pill which became widely available in the sixties.⁴⁸

Certainly greater self-confidence and more sexual freedom were important factors in how and why the stereotype of women was modified, but as with so many social changes, the number of factors and their varied effects on different women are complex. The way women were portrayed in the media, and in how they saw themselves, both stemming from and leading to changes in the way they behaved had many causes. From the early sixties onwards, the media and advertisements were reflecting women's attitudes, looks and behaviour. Advertisers had new ways to attract consumers, either depicting a young married couple with emphasis on the 'partnership' of marriage or using the attractiveness of the female body as an attention grabber in an ever more blatantly sexual manner. Women were being allowed a new role, but it was still under the control of men. In her study of women's magazines, Carolyn Faulder found they contained numerous articles on the theme of 'how to get your man and keep him.'⁴⁹ The portrayal of women as young, trendy and fashion conscious or as sophisticated, elegant and self-assured was the positive stereotype, while the negative one was supplied by the narcissistic woman or the savage seductress. Faulder maintained:

In the stories in magazines and women's fiction, women play supportive roles or are the victims. Girls who have careers either give them up to get married or are portrayed as villainous, aggressive, or threatening to a happy marriage.⁵⁰

This was in contrast to the attitudes expressed in the articles which often included advice on choosing careers or featured women in unusual jobs. It was also contrary to the approach of earlier magazines, Penny Tinkler found that, prior to 1950, although attitudes to work expressed by magazines varied along class lines, careers were promoted as a good thing for the middle class girl.⁵¹ While she was expected and encouraged to marry, the acceptance that a career would supply her with an interest outside of her home once her

48 Eric, Hobsbawm, *Age of Extremes 1941-1991*, London, Abacus, 1995, p.270.

49 Carolyn Faulder, 'Women's Magazines' in J. King & M. Stott (eds), *Is This Your Life*, London, Quartet, 1977, pp.173-194.

50 Ibid.

51 Penny Tinkler, *Constructing Girlhood*, Taylor and Francis, London, 1995, p.114.

children were grown, was offered as a good reason for training.

While the subjects a girl studied and the career she chose were assumed to be relatively unimportant, the way a girl looked and dressed was considered of great importance to her chances of marriage. The way women dress is a reflection of the way they live. The Victorian woman in her restrictive corsets and huge petticoats was expected to do very little (a working class woman's clothes were far less restrictive), while the modern woman in her business suit or jeans is as unhampered by her clothing as her male colleague. Until the early sixties, fashion was still dictated by the *haute couture* of Paris. Models like Fiona Campbell Walker typified the well-bred style that was copied by ordinary women buying clothes through the chain stores.⁵² The style was aimed at married women, young celebrities such as Jackie Kennedy being role models with the acceptable face of womanhood being 'nice' clothes and minimal makeup. The normal dress for a girl when she left school was little different to her mother's, reinforcing prevailing attitudes and stereotypes by allowing little scope for individual expression. The gradual introduction of 'blue-jeans' worn by teenagers of both sexes was slow to take hold: in 1959 a home shopping catalogue offered no jeans at all for women, and only one pair by 1963.⁵³ One woman engineer who trained in the late 1950s explained that she had to 'behave like a lady and work like an engineer.' When asked for clarification of how a lady behaved she said it was not acceptable for her to wear trousers, in spite of working on large electrical switchgear where trousers would have been sensible.⁵⁴

The desire for marriage and a family led girls to behave in a way they thought would be attractive to men: in the Crowther report it is pointed out that during the last year or two of the school course:

There can be no doubt that at this stage boys' thoughts turn most often to a career and only secondly to marriage and the family; and that the converse

52 Holdsworth, *Out of the Dolls House*, p.171.

53 Grattan's Home Shopping Catalogues, held in the archives of the Castle Museum, York.

54 Chamberlain et. al. 'An Oral history of the Women's Engineering Society,' p.61.

obtains with girls.⁵⁵

This was seen as a perfectly natural aim for girls of all abilities; even the most intelligent girls were still encouraged to see marriage and children as their prime role in life. A woman was expected to channel her abilities into ensuring and enhancing her husband's success. Women did not consider their own careers to be as important as their husband's and expected to give up work to bring up children. If the husband's job required a move across country a wife would give up her own career to accompany him. In the Reith Lectures of 1962, G.M. Carstairs commented on the conflict, suggesting:

Society has not yet abandoned the Victorian ideal of the fully-domesticated mother and wife, destined to find her satisfaction only through service for others. Because of this lingering concept, remorselessly perpetrated by all women's magazines, women are still made to feel guilty if they seek for themselves satisfactions which come from the fulfilment of their own particular talents and potentialities.⁵⁶

The social changes between 1945 and the 1960s all impacted on women and work; the growth of the consumer society and the freedom that girls were beginning to experience all reflected on the importance, or lack of it, that they placed on their careers, as will be examined next.

Women and Work

By the 1950s, many women returned to work after having children, either part-time or full-time, leading to the pattern of working life for women normally being a comparatively short period prior to the birth of their first child, during which they would undertake any training required for their chosen career, followed by a break while their children were very young, then a return to work for the longer part of their working life. This pattern, demonstrated in Myrdal and Klein's *Women's Two Roles*⁵⁷, was one reason why many

⁵⁵ Crowther, 15 - 18; *Report of the Central Advisory Council for Education – England*, Vol.1. Report, London, HMSO, 1959, p. 34.

⁵⁶ G.M. Carstairs, *This Island Now. The BBC Reith Lectures 1962*, London, Hogarth Press, 1963, p.76.

⁵⁷ Myrdal, Alva & Klein, Viola, *Women's Two Roles*, London, Routledge & Keegan Paul, 1962.

women preferred careers where less effort would have to be made to keep abreast of developments or to retrain when they returned to work. The *Robbins Report on Higher Education* suggested that ‘adequate financial arrangements should be made to enable married women to take refresher courses,’ but this was slow to materialise.⁵⁸ Clerical and secretarial jobs generally required only a short refresher course and teaching was another career for which a woman could be quickly retrained. The chronic shortage of teachers following the Second World War resulted in a call for married women to return to teaching, in spite of the teaching unions failure to universally welcome this. In 1960 the National Association of Schoolmasters expressed:

grave concern at the increasing numbers of unqualified teachers now entering the schools of this country, and asks the minister of education to announce a date, after which only properly trained, qualified and registered teachers will be permitted to teach children who are in compulsory attendance at school.⁵⁹

Yet in March that year the University of Cambridge ran a course to encourage ‘married women and others who are trained scientists - to take up or return to teaching in schools.’⁶⁰

One girl, who was training to be an engineer, explained when interviewed by Seear et. al.:

She thought it possible that once she had children she would go into teaching because she believed that after even a few years away from her work she would be too out of date to catch up in engineering.⁶¹

Summerfield pointed out that ‘women were not expelled from paid work after the war.

They were drawn into it along lines which followed the pre-war pattern.’⁶² She supported

this view with stories such as Felicity Snow’s who, having trained as an air mechanic

during the war, found her career marginalised by peace-time attitudes. It is also supported

by the figures below:

An industrial analysis in June 1957 showed that 30,000 of the total of 160,000 (women in employment) were in distribution, 23,000 in catering trades, 18,000

58 Robbins, Cmnd 2154. *The Robbins Report On Higher Education*, London, HMSO, 1963, par. 515, p.168.

59 The National Association of Schoolmasters, Minutes of 38th Annual Conference, Hastings, 19-22 April 1960. Copy held at the Modern Records Centre, University of Warwick, Ref.MSS38A/1/2/1/109.

60 ‘Physics and Chemistry in Schools’ course held at Maddingly Hall, Cambridge, 14th to 21st March 1960. Copy of prospectus held in the Modern Record Centre, University of Warwick. Ref. MSS27/25/44-59.

61 N. Seear, V. Roberts & J. Brock, *A Career for Women in Industry*, London, Oliver & Boyd Ltd. 1964, p.27.

62 Penny Summerfield, *Women Workers in the Second World War. Production and Patriarchy in Conflict*. Routledge, London, 1989. p.187.

in clothing, 15,000 in textiles, 10,000 in professional services and 8,000 in engineering. An occupational analysis at the same date showed that 16,000 vacancies for women were for clerks & typists.⁶³

Of the 8,000 in engineering, few would have been in skilled work, most would be doing the repetitive unskilled or semi-skilled jobs that had been decreed 'women's work.'

The sexual stereotyping of boys and girls begins in early childhood, but in the immediate aftermath of the war this was not thought important. Although social changes meant the stereotype was beginning to change most girls accepted the traditional vision of their future as wife and mother, happily playing with dolls and other 'girls' toys'. Girls were brought up to consider themselves less important than boys. Claire Langhamer found that girls regularly had less leisure time than their brothers, being expected to perform household chores that males were generally exempt from.⁶⁴ A girl was certainly less likely to be encouraged to think of a career since it was assumed that she would marry, thus the toys given to a girl were those that reinforced her role as 'carer', being mainly dolls, nurse outfits and miniature copies of the household utensils that her mother used. A boy's toys also reinforced the role he was expected to fulfil, the 'macho' image being promoted by toy guns, cowboy outfits or by toy cars. One of the 'boy's toys' that encouraged some boys to go into engineering was the 'Meccano Set'. This compendium of wheels, pulleys and struts encouraged children to build models, but it was only advertised as being for boys.⁶⁵ Carter remarks that the comment 'his Meccano set kept him quiet for hours' was scant evidence of why a boy should become an engineer, but such toys certainly helped to develop an understanding of mechanical engineering, while reinforcing gender stereotypes.⁶⁶ Many of the women engineers interviewed for this thesis admitted to being interested in how things worked when they were children, one of them said that playing

63 'The Employment Of Women & Girls In Great Britain Since The War', *Ministry of Labour Gazette*, March 1958.

64 Claire Langhamer, *Women's Leisure in England, 1920-60*, Manchester, Manchester University Press, 2000.

65 Grattan's Home Shopping Catalogues, held in the archives of the Castle Museum, York.

66 Michael Carter, *Into Work*, Harmondsworth, Pelican Books, 1966, p.91.

with her brother's Meccano set started her interest in engineering.⁶⁷ If a girl had a family that encouraged such curiosity there was more chance of her thinking about a career in engineering. However, this was not the normal reaction. In their survey on women in industry Nancy Seear et. al. found 'there is undoubtedly a hesitancy about accepting science as suitable for girls - a certain lack of conviction that science, compared to other subjects is really important for girls.'⁶⁸

The accepted social attitudes in the early 1950s, largely based on male middle-class values, had quickly reverted to the pre-war belief that 'a woman's place is in the home', but among the lower classes many women always had and continued to work both before and after marriage. Elizabeth Roberts concluded:

Working women's perceptions were that whereas it was acceptable – indeed desirable – to earn money on their own account, it was not 'right' to have a job which demanded long hours of work and the taking of responsibilities which would leave them too tired, both physically and emotionally, to care 'properly' for their families.⁶⁹

The additional money not only enabled them more quickly to acquire items from the new range of consumer goods being produced, it also gave them a certain amount of independence, although among the working classes careers were not generally approved of. While every secondary-modern school leaver could expect a visit from the Youth Employment Officer the advice was not always encouraging.⁷⁰ May Hobbs remembered the officer telling her not to think of making a career out of anything because she would 'only give it up to get married and have kids.'⁷¹ Such advice followed the general expectation that a woman's life would revolve around her family and anything else would be of secondary importance. Women who did have careers were expected to work in the caring professions, such as teaching or medicine, and engineering was not considered suitable for women. In 1945 the Electrical Association for Women announced 'today the

67 Questionnaire source, see Appendix. 1.25.

68 Seear, et al *A Career for Women in Industry*, p.24.

69 Elizabeth Roberts, *Women and Families: An Oral History, 1940-1970*, Oxford, Blackwell Publishers Ltd, 1995, p. 235.

70 H. Heginbotham, *The Youth Employment Service*, London, Methuen, 1951, p.132.

following careers are now open to women: Mains engineer, heating and ventilating engineer, BBC engineer, communications engineer,⁷² but the change in social attitudes towards women and technical careers resulted in the numbers of women technologists dropping from 393 in 1951 to 270 in 1961.⁷³ Fifteen of the eighteen women engineers interviewed who were working in the sixties had to take a career break to bring up children. Of these nine eventually returned to work in engineering but six did not; three of these retrained as teachers. Many of the women admitted to lowering their ambitions, feeling that their families must take priority and so accepting that they would not progress as far as they might have done in their careers. Part-time work was the answer for some women while their children were young, but this was not always available. One woman engineer who completed the questionnaire was forced to retire in 1959 when she started a family. She would have returned to the part-time job that her boss offered her, but was prevented by the union who withheld their approval.⁷⁴

When a woman married, the state acknowledged her lesser status by offering her the choice of paying a reduced National Insurance contribution. Many women chose this, even though it meant they had no entitlement to any benefits of their own. For women who chose to continue paying the full contribution their lesser status was reflected in the benefits they could claim. In December 1960 the government announced an increase in benefits to:

Unemployment or Sickness Benefit:

57/6d (£2.88p) for a single person

+ 35/0d (£1.75p) for a dependent wife

or 39/0d (£1.95p) for a married woman who continued her contributions.

Retirement Pension:

71 May Hobbs, *Born to Struggle*, London, Quartet, 1973, p.28.

72 Elsie Edwards, 'The Electrical Association for Women Point of View on Post-war Reconstruction Interim Report', 1945, p.15. Copy held in The WES Archives at the Institute of Electrical Engineers, London, Ref. NAESt 33/10.8

57/6d (£2.88p) for a single person

+ 35/0d (£1.75p) for a dependent wife

or 35/0d (£1.75p) for a married woman who continued her contributions.⁷⁵

In spite of legal changes to the status of women that ensured that by the 1960s single women were treated much the same as men, once a woman married she became financially a 'non-person'. Her tax was dealt with by her husband, he was entitled to anything she saved, and she could not keep her savings secret since he had to declare them for tax purposes. The system was based on the assumption that a married woman was the responsibility of her husband. Those women who did not marry, while supposedly free to take on mortgages or other loans, usually had to have a man to stand guarantee for such transactions, as society did not accept the idea of an independent woman. The income tax allowances in 1960 were £140 per annum single allowance; £40 personal allowance and £240 married man's allowance. A wife's earned income allowance was £140 maximum.⁷⁶ This meant that while she received the same basic allowance as when she was single, a married woman could no longer claim any personal allowance for which she may previously have been eligible. Her husband now claimed the married woman's allowance, and he received the benefit on his salary. Once again the assumption was that married women only worked for 'pin-money' and they were financially dependent on their husbands.

Although many men had been killed during the war, the 'lost generation' of the First World War was not repeated in the Second World War and marriage continued to be the accepted aim in life for women. In 1960 there were 393,598 marriages (15 per 1000 of the population): of these, 72 percent of the brides and 53 percent of the grooms were under

⁷³ *Census 1951, England and Wales, Occupational Tables, Table 1 p17. & Census 1961, England and Wales, Occupational Tables, Table 1 p6. H.M.S.O., London 1963*

⁷⁴ Questionnaire source, see Appendix. 1.17.

⁷⁵ *Keesings Contemporary Archives, Benefits Increase, December 24-31 1960, London, Keesings, 1961.*

⁷⁶ *Annual Abstract of Statistics 1970, Central Statistical Office, London, HMSO, p.314.*

twenty-four years of age.⁷⁷ This led many girls to feel that they had to marry while still young, as there would be fewer chances later in life. In the same year there were 532,840 births, 63 percent of which were to mothers in their twenties. The tendency to marry and have children was one factor frequently given by employers as an excuse for not training women; they felt that the investment would be wasted, as the woman would give up work before the company had retrieved its cost. That many women would choose to return to work once their children were old enough, if given the opportunity, was overlooked. The fact that many women found the restricted life of a mother and housewife unsatisfactory was shown in surveys done at the time. Social research was beginning to examine women in greater detail than previously. While earlier surveys had looked at problems, such as poor living conditions or the lack of health care, which affected women, the late fifties and early sixties research looked at all aspects of women's lives. Surveys such as *The Captive Wife* by Hannah Gavron; *Women, Work and Age* by F le Gros Clark; *Married Women Workers* by P. Jephcott and *Women's Two Roles* by Alva Myrdal and Viola Klein all looked at the reasons why women did or did not work, and the effect working had on their lives and family relationships. Most surveys discovered women to be unhappy with the role society expected of them but, since few women at that time had any organisation through which they could voice a protest, their dissatisfaction was only beginning to be noticed. The conflict and stress that their changing role was forcing on women was summed up by Hannah Gavron as follows:

Our society tends to respond to women for what they are rather than what they do. But this does not really become apparent until adult life, for, as has been suggested, socialising processes both inside the family and more particularly in the school, allow and even stimulate some degree of orientation towards achievement. Girls are encouraged to do well at school in much the same way as are boys. So from the very beginning girls learn to develop aspects of their role which conflict directly with the base on which their role rests.⁷⁸

Such conflicting ambitions caused a *Sunday Times* correspondent to ask in 1963 'Do today's women know what they want? They abandon a career in favour of marriage and

⁷⁷ *Annual Abstract of Statistics 1970*. Table 23. p.22.

children, and once having achieved both they don't seem to be able to wait to get back to work.'⁷⁹ The question ignored the financial imperative some women had for working. One couple, featured in *The English Marriage*, saw the husband's wage drop from £35 a week to just £13 due to ill health, making the wife's wage critical.⁸⁰

The lack of mental stimulation imposed upon a woman by her role as mother was a major reason for many women preferring to work. Unfortunately not all husbands appreciated this and many felt it a reflection on their own capabilities as 'breadwinner' if their wives returned to work. This added to the conviction that men did not want a woman to be financially independent. Most girls believed that men preferred 'helpless' women and thought that a girl should not do anything to undermine a man's sense of his superiority, as this would be unattractive. In 1962 Margaret Mead argued that there was constant pressure on girls to play down their achievements and discipline their ambition.⁸¹ The belief in the superiority of men was clearly shown when the Head of BBC's Women's Programmes, Doris Stevens said no women would appear as compères because 'men make better compères and women viewers accept a man much more uncritically than their own sex.'⁸² Society as a whole only expected women to operate machines, following step-by-step instructions, one instruction book for a washing machine even going so far as to illustrate how to plug the appliance into the mains.⁸³ Many women were perfectly happy with this situation, never wanting to know how things worked; some would not change a fuse or put on a plug, seeing these as 'technical' things that needed a man. Such attitudes perpetuated the belief that women were not mechanically minded and that engineering was 'unnatural' for a girl.

In spite of the belief, prevalent until the 1970s, that a woman should remain at home

78 Gavron, *The Captive Wife*, p.145.

79 Ibid. p.144.

80 Drusilla Beyfus, *The English Marriage*, Harmondsworth, Penguin Books, 1968, p.109.

81 Margaret Mead, *Male and Female*, London, Gollanz, 1962, p.320.

82 Maureen Hill (ed), *Women in the Twentieth Century, Extracts from the Daily Mail*, London, Chapmans, 1991, p.1961.

83 Operating instructions for a Servis washing machine circa 1960, copy held in the archives of the Castle Museum, York.

to care for her children, many mothers did work. A professional woman who gave up her career for this reason in the late fifties remembers being told 'it is our duty to stay at home.'⁸⁴ In 1957, Judith Hubback had conducted a study on *Wives Who Went To College* looking at the situation of 1500 British graduate women. She commented that:

It would be disastrous if the present desire to protect children from emotional instability were to lead to a new campaign on the lines of 'a woman's place is in the home.' That slogan is in need of reinterpretation, but not of restatement.⁸⁵

The rise of juvenile crime in the early sixties was often blamed on working mothers.⁸⁶ One London magistrate, Basil Henriques, went as far as to suggest legislation to restrict the hours that mothers of school age children were allowed to work.⁸⁷ The lack of any form of maternity leave effectively prevented most women from returning to work within five years of having a child, but those who had someone to care for the child still faced opposition to continuing their careers. In 1963 a private member's motion was sponsored by Lord Balniel to 'regulate the employment of women for reward during the period following childbirth'. The motion was opposed as a serious infringement of the rights of women. Miss Pierotti, chairman of the Status of Women Committee, was quoted as saying 'women are adults, able to make their own decisions. They should not be treated as mentally incompetent children.'⁸⁸

The guilt about returning to work was made worse for women who suffered from disappointed expectations; not all women found motherhood to be as enjoyable as they expected. 'A small, pink, ugly baby who does nothing but vomit and crap is not a very attractive prospect' was how one mother defined it.⁸⁹ Even those who enjoyed motherhood had problems. Hannah Gavron found that 75 percent of mothers at home with young children would have preferred to be working since they found being at home 'terribly

84 Holdsworth, *Out of the Dolls House*, p.125.

85 Judith Hubback, *Wives Who Went To College*, London, Heinemann, 1957, p.155.

86 Of 182,217 indictable offences in England and Wales in 1961, 64,284 were committed by youngsters under the age of 17. Taken from the *Annual Abstract of Statistics No 102 1965*, London, H.M.S.O., 1965, Tables 62 & 63, pp.66,67.

87 Holdsworth, *Out of the Dolls House*, p. 126.

88 *The Times*, 25th March 1963.

boring.’⁹⁰ While Viola Klein found that ‘running a home efficiently is no longer considered the creative job it was, but is felt to be ‘a waste of time.’⁹¹ Joan Bakewell, a television interviewer who was fortunate in her ability to combine a career and a family said:

The suburbs are full of housewives settled with children after having a secretarial career and who thought it would be wonderful having two cars, clubs and coffee mornings. But there is a great neurosis among women who find that this life is not enough and the fun is over.⁹²

Geoffrey Gorer pointed out in 1955 that while marriage was changing, the expectations that men had of their wives was not matched by the expectations women had of their husbands.⁹³ The idea of a companionate marriage was widely mooted in the post-war period, but this did not imply an equal partnership. As Janet Finch and Penny Summerfield commented regarding the immediate post-war period

The new expectations were heaped on wives, who were to be more comradely, and might be permitted to have outside interests, but were also to be better mothers of larger families, better sexual partners and better homemakers. They were only to take on paid work if they could do so without either making their children psychotic or neurotic, or detracting from their domestic duties.⁹⁴

In 1969 Jenny Swidells, an engineering undergraduate commented:

I get terribly inflamed when people say to me 'of course you'll get married'; probably I will, but does this mean I'm going to be contained within four walls for the rest of my life?⁹⁵

Sentiments such as this reflected the growing sense among young women that they deserved the opportunity to have both a career and a family. This was to become slightly easier in 1975 when they were given the right to maternity leave, but that right alone failed to address the greatest problem that all working mothers faced, that of secure child-care, or to ease the double burden of running a home while coping with a career. In 1967 a report

89 Beyfus, *The English Marriage*, p.72.

90 Gavron, *The Captive Wife*, p.115.

91 Klein, *Britain's Married Women Workers*, p.17.

92 Beyfus, *The English Marriage*, p.151.

93 Geoffrey Gorer, *Exploring English Character*, London, Cresset Press, 1955, p 125-129.

94 Janet Finch and Penny Summerfield, 'Social Reconstruction and Companionate Marriage' in *Marriage, Domestic life and Social Change* David Clark (ed.) London, Routledge, 1991, p 30.

highlighted the problems women were facing in all careers, particularly the need to interrupt their career to have children, which left them lagging behind men who suffered no such restrictions and suggested that 'the social processes by which the changes involved in introducing more women into senior jobs take place are likely to proceed in part spontaneously and in part by deliberate decision.'⁹⁶ This was a clear indication that the long promised equality legislation was finally gaining momentum. By 1969 a report examining the role of women in engineering pointed out:

While women have certainly established their competence throughout the professional engineering field, there is clearly a built-in or unconscious prejudice against them.⁹⁷

This report went on to admit that women were generally only welcomed in certain areas, and suggested that this had nothing to do with ability, but was because they were areas where the women are less likely to be 'put in authority over men.'⁹⁸ Such reports provided input to the equality legislation that was radically to change women's opportunities in the last quarter of the twentieth century.

As the working wife became more accepted, particularly from the 1970s onwards, Young and Wilmott found that many of the working wives they interviewed had a sense of pressure, in spite of their husband's help at home.⁹⁹ This was because women were still expected to see to the smooth running of the home and family. Many men were reluctant to do much about the house, but Young and Wilmott found that by 1970 only 14 percent were offering no help, and that 70 percent would help in many ways, 'doing more than just the washing-up'.¹⁰⁰ A truly equal division of labour within the home, even a dual career home, remained very unusual.

95 Jenny Swidells quoted in *Women in Engineering 1969, Report of A Working Party*, London, Engineering And Applied Science Forum, 1969, p.34. Copy held in the archives at the Institute Of Electrical Engineers, Ref. NAEST92a/7.13.

96 *Women and Top Jobs an Interim Report*. P.E.P. Report 17/6/67. p70.

97 'Report of Working Party on the Role of Women in Engineering.' in *Proceedings of the Institute of Civil Engineers*. Vol.48 Jan-April 1971, Referring to a working party report of January 1969, p.344.

98 *Ibid.* p.344. General conclusions: 8. Appendix 1.

99 Michael Young and Peter Wilmott, *The Symmetrical Family*, London, Routledge and Keegan Paul, 1973, p.115.

100 Young & Wilmott, *The Symmetrical Family*, p.93.

The man's wage was considered the important one and with no legal recourse to equal pay this remained the situation in most households. Like other working women, many women engineers were only paid between 60 percent and 80 percent of the man's rate, although some companies did not set separate scales for women but offered them 'the rate for the job'. Another disadvantage that women suffered and some women engineers commented on, was that they were not allowed to join company pension schemes until a later starting age than a man. This supports Viola Klein's findings. She reported the minimum age of admission to pension schemes varying between twenty-one and forty for women.¹⁰¹ One woman engineer who was about to retire when interviewed highlighted the problem.¹⁰² Not having being allowed to join the pension scheme until she was twenty-five, while men joined at twenty-one, she had four years less service and contributions than a man. Since the pension assumed a possible working life of 45 years, this shortage of contributions reduced her pension by 1/11. She was paid only 80 percent of a man's salary for the first eight years that she was in the scheme and her contributions were therefore less, so her final pension was considerably less than a man's with the same length of service. It would take time and legislation to change these inequalities in the workplace. In 1975 the legislation was in place, but much more time was needed to achieve anything approaching equality.

The Effects of Equality Legislation on Working Women

During the war Caroline Haslett had been a staunch champion of a woman's right to be treated in the same way as a man. Her sister commented 'she was wise enough not to ask for equal pay for men and women, as if there were two classes of workers; she fought for the 'rate for the job' an important distinction.'¹⁰³ For many years after the war the

101 Klein, *Britain's Married Women Workers*, p.126.

102 Oral history source, see Appendix. 1.4. & Appendix 2

103 Mrs R Worth, Draft of book 'My Sister' Chapter 15 p204.

simplistic rhetoric that insisted women only worked for 'pin money' and assumed that a man should earn a family wage continued to be bandied about by those who believed women belonged in the home. Employers were happy to endorse the argument which gave them no reason to increase their wage bills and the campaigners for equal pay were faced with a multitude of excuses why it should not be a legal requirement. Fears that the increased costs of equal pay for women would make British industry even less competitive were used to delay legislation and, with the average weekly wage for a man in 1960 standing at £14.17p and for a woman at only £7.58p, these fears seemed justified. The unions, as has been shown, paid lip-service to the idea of equal pay but did little to force the issue, being more concerned with maintaining the wages of their male members. Barbara Switzer, the first woman to hold a senior post in her union, joined the union DATA in 1959 when she was 18. She remembered:

Like a lot of people I did not know how the union worked. I wanted to put a motion about equal pay to the union's annual conference. A pal of mine, another female apprentice, seconded it and I sent it off to the general secretary. He quite rightly wrote back and said he'd passed the correspondence to the branch, and would I like to attend.

I went and dutifully stood outside. The branch council meeting was still on, and I only went in after a man who arrived late told me it was all right to go inside. I sat at this table of men, probably all over 40, and listened intently. My piece of correspondence was announced, noted, and without giving me any opportunity to comment, the meeting carried on!¹⁰⁴

After this experience she stopped attending union branch meetings. Most women, and many men, never attended, restricting their interest in the union directly to their place of work. Switzer was made of sterner stuff however, and later she attended a women's sub-committee weekend school on equal pay. 'The general president of the union and two other male officials attended - there were no female officials in the union!'¹⁰⁵ The union, under pressure from women like Switzer, slowly began to recognise some of the problems women faced. Although Maria Vetch remembered that:

They would glibly say 'aye' whenever a resolution on the subject was put to a conference, and then do nothing. And afterwards the men would laugh about it

¹⁰⁴ Ibid. p.6.

¹⁰⁵ Ibid. p.6.

among themselves.¹⁰⁶

After the Second World War, the Treaty of Rome (1957) committed the governments of Europe to agree, in principle, that women should have equal pay for equal work.

However getting the government to ratify this agreement was more difficult until both major political parties agreed to apply to join the EEC (European Economic Community).

This ensured that legislation would eventually have to be put in place. Early in 1966 Dame Joan Vickers asked when the convention would be ratified and received the reply that

Her Majesty's Government is unable to ratify either convention at present because, in the matter of equal pay, the present position in the UK is not fully in accordance with the detailed requirements of these instruments.¹⁰⁷

By the summer of that year, continual pressure forced the government to hold meetings with the TUC and the CBI to consider the question in more detail although with the proviso that 'economic circumstances must affect the timing of any action to implement equal pay.'¹⁰⁸ The proviso meant that by the end of 1967 no action had been taken in spite of numerous demands from male and female MP's that the legislation be introduced.¹⁰⁹

The following year a major dispute within the engineering industry put additional pressure on the government. The engineering industry had minimum wage rates, most men were paid considerably more than the rates stipulated, while the majority of women were paid close to the minimum. In 1968 the unions fought to get the minimum rate raised considerably. While this would apparently have little effect on the wage bill for men, it would cost the employers dearly to pay women the increase. The cost was compounded by the fact that many companies had an agreed a differential rate between men and women. This differential would thus ensure that men were also given a substantial increase, simply because women's rates had been so low.¹¹⁰

The government finally introduced the Equal Pay Act of 1970, although this was

¹⁰⁶ *The Times*, 3 September 1969.

¹⁰⁷ Hansard Vol. 729, London, H.M.S.O. Col.141-142, 26 May 1966

¹⁰⁸ Ibid. Vol.732 Col 348, 29 July 1966

¹⁰⁹ Ibid. Vol.756 Col.625 14 December 1967 & Vol, 756 Col. 893 18 December 1967 for example.

¹¹⁰ Ibid. Vol. 770. Col.888 21 October 1968, Mrs Castle's comments on the engineering industry dispute.

not to come into force until 29 December 1975, giving industry five years to allow gradual implementation. It was described as ‘an Act to prevent discrimination, as regards terms and conditions of employment, between men and women.’¹¹¹ The loose wording of subsection 5, regarding work considered the equivalent of any done by men, led to many women being effectively denied equal pay. However, this was not the case for women engineers, both technicians and technologists were doing jobs that were obviously covered by the act. This meant that by the time the act came into force, in December 1975, women engineers had every right to expect equal pay. The act did not address the subject of equal opportunity, this was covered by the Sex Discrimination Act of 1975 which was intended to take the issue of equality further, by ‘promoting equality of opportunity between men and women generally.’¹¹² While certain ‘special cases’ were exempt from the act, the main effect on women engineers was to remove barriers to training and to open up opportunities for promotion. Compared to other careers, women engineers suffered little discrimination, what did exist tended to be the ‘unthinking’ discrimination caused by a protective attitude taken by men towards the women they worked with. Women engineers recognised that they were being penalised by such attitudes, but also accepted that the men concerned were not deliberately discriminating against them.

Once the equality legislation had been passed, there was no great increase in the numbers of women becoming engineers. By 1995/6 women made up 52 percent of newly qualified solicitors and nearly forty percent of newly qualified chartered accountants.¹¹³ In contrast, women made up only six percent of newly qualified engineers that year.¹¹⁴ This was in spite of almost two decades of equal opportunity and in the face of social changes that meant most women accepted that they would work for most of their adult life.

111 *The Equal Pay Act 1970*, London, H.M.S.O. 1970

112 *The Sex Discrimination Act 1975*, London, HMSO, 1975.

113 Suzanne Franks, *Having None of It: Women, Men and the Future of Work*, London, Granta Books, 1999, p17.

114 Data from the National Statistics web site <http://www.hesa.ac.uk> on 10/10/02.

Changing Patterns of Women's Work

The pattern of women's working lives was changing, as women benefited from a range of legislation introduced during the 1970s. The right to maternity leave encouraged some women to return to work more quickly after having a child, while the rapidly rising numbers of single mothers, either divorced or unmarried, gave many women no choice but to return to work. The growth in home ownership and the rising consumer market meant that for many couples the wife's wage became an essential part of their budget, no longer 'pin money.' Between 1975 and 1996 the participation of women in the work force increased from 60 to 71 percent of women of working age.¹¹⁵ At the same time there was a change in attitude towards planning a family, many women were waiting until they had become established in their careers before having their first child. By the early 1990s women were more likely to give birth in their early thirties than in their early twenties.¹¹⁶ The decision not have children at all was also increasing, only 13 percent of women born in 1947 had not had a child by age forty compared to a predicted 22 percent of those born in 1969.¹¹⁷

Such changes were not always reflected in a more equitable division of labour within the home. While it has been established that a wife in full time employment gets more help at home from her partner than one in part-time work, the division of domestic labour and responsibilities is seldom equal.¹¹⁸ Ruth Carter and Gill Kirkup examined the way women engineers dealt with this problem. They found that the women in their survey always remained responsible for running the home and family. They might employ nannies or housekeepers, but it then became the woman's job to ensure these employees carried out their duties properly. Carter and Kirkup also found that 'the woman herself and

¹¹⁵ Briefing Paper, *The Labour Market*, Manchester, The EOC, 1997.

¹¹⁶ J. Craig, 'Population Review: (9) Summary of Issues,' 1997 *Population Trends*, Vol. 88. pp 5-12.

¹¹⁷ *Population Trends*, 1996, Vol.85. p1-2.

her immediate family made few allowances for the effect of her professional work on her private responsibilities.¹¹⁹ Later surveys found the situation slow to change, and this may be one reason that many professional women are choosing to remain single, and sometimes childless. As Sue Bruley suggested, 'to professional women, motherhood is a threat to status and hard-won financial and personal independence.'¹²⁰

The careers women chose also broadened after the equality legislation, although female 'firsts' demonstrated the slow progress of equality, even for the intelligent and well educated woman who benefited far more than her less privileged counterpart. Margaret Thatcher was the first female Prime Minister in 1979, but by 1997, in spite of doubling their numbers, women made up only eighteen percent of MP's. 1995 saw the first woman Chief Constable and the first female fighter pilot, and the Civil Service had their first female Commissioner in 1993.¹²¹ However, while women entered most careers in growing numbers, they continued to be concentrated in the lower levels, a trend that will be examined in Chapter Three. The numbers of women choosing careers in engineering continued to be low. By 2000 sixty-four percent of teaching professionals and thirty-two percent of legal professionals were female, only six percent of engineers and technologists were. Similarly, while ninety percent of nurses and seventy-six percent of social workers were female, only nine percent of draughtspersons/surveyors were. Such figures ensured that the various initiatives to encourage women into SET careers would continue.

Summary

Women who had become engineers before, during or just after the war found their careers were enhanced by the necessity for firms to accept women in positions normally

118 This subject is dealt with in Rosemary Crompton, *Women and Work in Modern Britain*, Oxford, Oxford University press, 1997, Sue Bruley, *Women in Britain Since 1900*, and Jane Pilcher, *Women in Contemporary Britain*, London, Routledge, 1999, for example.

119 Ruth Carter and Gill Kirkup, *Women in Engineering, A Good Place to Be?* Basingstoke, Macmillan Press, 1990, p.100.

occupied by men. Most experienced little or no discrimination and, in general, were not forced out when the men returned from the services, unlike many women in skilled or semi-skilled engineering work. This was partly due to the growth in the engineering sector following the war, when Britain's engineering industry expanded greatly. Training was also easier for women to get in the immediate aftermath of the war, although personal reasons removed many women from the work force. However, as the years passed, society as a whole reverted to the pre-war belief that a woman should put her family before her career, and it became more difficult for women to enter careers that were not seen as 'suitable' for a woman. Women continued to be employed mainly in unskilled or semi-skilled jobs, or in the service or clerical sector. The International Labour Organisation continued to campaign for better opportunities for women, but it was to a largely unresponsive government, while employers continued to offer less to women.

The advent of equality legislation meant that traditional views could no longer relegate women to the periphery of the world of work. However, as Shirley Dex commented, while attitudes continued to move away from the traditional view of the importance of women's work, 'women's behaviour in the home seems still to fit in with the traditional view of gender roles.'¹²² Janet Finch and David Morgan pointed out that the 'New Man' was seldom seen,¹²³ which meant that women who wanted a career and a family had to accept that the double commitment would result in a far greater workload, and its associated stresses, than a man would have to endure. As has been shown, girls who wanted careers continued to be guided towards 'suitable' careers, such as teaching or medicine. The shortage of teachers and the expansion of careers for women in the business sector, coupled with an increase in the variety of technical jobs within the health sector, all combined to give women a wider variety of careers to choose from. At the same time, the

120 Sue Bruley, *Women in Britain*, p.175.

121 Jane Pilcher, *Women in Contemporary Britain*, pp. 14-15.

122 Shirley Dex, *Women's Attitudes Towards Work*, London, Macmillan Press, 1988, p.42.

123 Janet Finch and David Morgan, 'Marriage in the 1980s' in *Marriage, Domestic Life and Social Change* David Clark (ed.) London, Routledge, 1991, p 65

lack of information for women about careers in engineering, and society's reversion to the pre-war desire to keep women separate from 'hard' or 'dirty' work resulted in a general acceptance of the idea that engineering was unsuitable as a career for women. This remained the case in spite of the changing circumstances of women's lives in the last two decades of the twentieth century.

It has been shown that public attitude towards engineering largely considered it an unsuitable career for women. In Chapter Two the image of engineering as a noisy and dirty job, an image which was still largely influenced by what people had seen during the war, will be examined. The industry made little attempt to change the view that engineers worked in factories, doing hard physical work, resulting in a decline in the numbers studying engineering at university. While this caused some concern, as company employed engineers were generally trained from amongst the most promising apprentices, only sporadic and uncoordinated attempts were made to change the public image of engineering until the latter part of the century.

Chapter 2

'Prejudice and Sheer Ignorance' - The Public Image of Engineering

In the previous chapter it was shown that, once the necessity of employing women in all spheres disappeared with the end of the war, engineering was generally assumed to be unsuitable for women. This chapter will show how Britain's academic tradition contributed to making engineering an unpopular choice of career for the brightest students, both male and female. In Britain, engineering as a career suffered from a low status image, and some possible reasons for this will be examined.

In 1956 Mr. I .J. Pitman, MP for Bath, had suggested that 'technical education is "non-U", whereas academic education is "U". Technical education is "servants-hall" if not scullery, whereas academic education is "drawing-room" or "upstairs".'¹ Such attitudes were adopted throughout society. They started at the top where out of twenty members of the Cabinet only one had a science degree, and continued down through all levels of society. Industry, while deploring this attitude, did little to change it. Employers usually trained engineers from amongst their brighter apprentices; the few graduate apprenticeships offered were generally perceived as being 'fast-track' to management positions. How much this situation changed over the decades will be examined.

The second half of the twentieth century saw fluctuations in Britain's engineering industry which led to changes in the numbers employed, and of the perceived importance of the industry to the country. In the late 1950s 35 percent of Britain's working population was employed in manufacturing.² In the 1960s many engineers were dissatisfied and joined the brain drain away from Britain in search for better pay and more recognition of the essential job they were doing. Economic factors led to a decline in the industry and employment in manufacturing fell from 30 percent in the late 1970s, to just 16 percent by

¹ *Hansard*, Vol. 554. 21st June 1956, London, HMSO, 1957, Column 1698.

² *Annual Abstract Of Statistics 1962*, London, HMSO, 1962, Table 13, p.12.

the turn of the century.³ In spite of this there were continual fears about a shortage of trained engineers and various efforts were made to counteract this shortage.

Engineering was late in establishing an overall authority for the career. The Council of Engineering Institutions was not formed until 1962, by which time the individual institutes were not prepared to give up their power to decide who should be recognised at each level, and the Council's attempts to reconcile the different disciplines did little to convince the many unregistered engineers to join an institute. Since membership was not a prerequisite for employment the majority of engineers never joined a professional institute. It will be shown that the professional institutes, while acknowledging that there were a great many technicians doing good work, never decided exactly how to integrate these engineers into the existing hierarchy. One training officer at Westland Helicopters remembered their attitude was 'elitist, they weren't interested in anybody except "chartered" engineers.'⁴

In 1964 Nancy Seear asked, since industry was short of good men, 'why, then, does industry not employ more "good women"?'⁵ Some companies did as she had suggested even before the equality legislation of the 1970s. These companies will be compared to those that refused to employ women in technical grades. The equality legislation of the 1970s made such attitudes illegal, but even so some individuals remained unconvinced about women's abilities. The gradual change in employers' attitudes over the 1980s and 1990s will be examined and contrasted with the attitudes of engineers, male and female, towards their employers.

This chapter will demonstrate that the enormous changes in Britain's engineering industry since the Second World War have not been accompanied by a similar change in the perception of engineering among the general public. While some attitudes have

3 The Jobs People Do. <http://www.statistics.gov.uk>. 31 July 2002.

4 Comment made while giving information on apprentice training, a note regarding this can be found with the other original data used for the thesis in the WES archives.

5 N. Seear, S. Roberts & J. Brock, *A Career for Women in Industry?* London, Oliver & Boyd, 1964, p.61.

changed, this has been more a result of changes in attitudes towards women than in changes in the knowledge that the public have of the work done by an engineer.

The Low Status of the Engineer in Britain

In the decades following the Second World War, Britain, unlike the rest of Europe, failed to recognise engineering as a high status career, indeed an engineer was seldom recognised as a professional; to the general public the term engineer was as likely to be applied to the mechanic who repaired their car as it was to the designer of the car. A quotation at the start of Nevil Shute's novel, *Trustee from the Toolroom* reads: 'An engineer is a man who can do for five bob what any bloody fool can do for a quid.'⁶ This summed up how many people saw engineers. The term had become more of a description than a title and was used in a casual way to describe almost anyone working with machinery, perpetuating the belief that engineering was 'dirty' or 'manual' work. Jackson and Marsden in *Education and the Working Classes* mentioned the difficulty of defining the term. They point out that the description of a father as an 'engineer' could 'point to a parent who was director of an engineering plant earning £3000 pa or it could mean a semi-skilled mechanic earning £8 a week.'⁷ This was in contrast to attitudes to engineering on mainland Europe, where the career was more highly regarded. In part this was due to the differences in the training undertaken by engineers. While Britain relied heavily on the apprentice system for training, with few engineers going to university, on the continent where industrialisation had started later, technical education establishments were seen as equal to universities. In France state engineering schools had demanded long years of academic study, particularly mathematics since the 1790s.⁸ By 1829 these Ecole Polytechnique were joined by the Ecole Centrale des Arts et Manufactures which were

6 Nevil Shute, *Trustee From the Toolroom*, London, Heinemann, 1960.

7 B. Jackson & D. Marsden, *Education and the Working Classes*, London, Ark Paperbacks, 1962, p.217.

8 Stephen Crawford, *Technical Workers in Advanced Societies*, Cambridge University Press, 1989, p.52.

intended to offer a more practical training, although these also concentrated on the more theoretical aspects of engineering. Such a background gave engineers social standing and although the majority of French technicians in the nineteenth century were trained at the technical high schools, by the twentieth century these schools had progressed so that engineers trained this way were also registered. Germany became industrialised later than France, but by the beginning of the First World War they had 60,000 qualified engineers compared to 40,000 in France and just 15,000 in Britain.⁹ Goran Ahlström suggested that in Britain ‘engineering and/or technology was considered a socially unsatisfactory career’ largely due to the assumption that the arts and humanities subjects were more worthy of study.¹⁰ Throughout the second half of the twentieth century engineers continued to be perceived as unqualified and thus of less value than other professionals. Correlli Barnett suggested that the British belief in ‘the practical man, taught on the job’ lay at the root of the lack of status of British Engineering. He contrasts British technical education with that of the rest of Europe and with America and concludes:

In the light, therefore, of Britain’s entire educational and industrial history since the mid-nineteenth century, who should be surprised that British society’s image of the engineer is of a narrow nuts-and-bolts tradesman with cultural interests limited to football and brown ale?¹¹

The academic tradition in Britain’s secondary schools was based on the ‘classical and literary curriculum of the ancient grammar schools.’¹² J.T. Young pointed out that its exclusion of vocational subjects was one reason why engineering struggled to get the top level recruits it needed.¹³ He commented that technology suffered from the feeling that there was something ‘inherently unworthy or even vulgar in learning the practices of industry or trade and that this type of instruction suffers from narrowness and a fundamental indignity of purpose.’¹⁴ The ‘narrowness’ was one result of the need to focus

9 Goran Ahlstrom, *The Engineer and Industrial Growth*, Croom Helm, London, 1982, p.13.

10 Ibid. p.101.

11 Correlli Barnett, ‘Image And Status’, in *Engineering First*, Issue No.3. 1997, p.4

12 J.T. Young, *Technicians Today and Tomorrow*, London, Pitman & Sons, 1965, p.11.

13 Ibid. p.11.

14 Ibid. p.11.

closely on a rapidly expanding subject but, as Anne Marie Wolpe demonstrated, this was also often assumed because of the tendency among male engineering students to have decided on their subject of study at a relatively early age.¹⁵ Engineering students were often totally absorbed in their own subject, with little interest in any other. This summed up the attitude expressed by the General Secretary of the Engineer's Guild Mr. J.G. Orr who, when talking about the decline in engineering influence asked 'Can it be the absence of a higher standard of education in the humanities and the social sciences amongst entrants to the profession?'¹⁶

However, the academic tradition did not prevent science getting recruits of the highest calibre, it was only engineering that suffered this. In 1961 a government report suggested that the recruitment and training situation was under control, although it admitted that 'a slight shortage of technologists will be balanced by a slight surplus of scientists.'¹⁷ This highlighted the tendency for technology and science to be treated as a single discipline by government, a trend that still persists. By 1963 the Institute of Mechanical Engineers reported that senior members of all the major engineering institutions were alarmed at the profession 'not getting its fair share of the best brains.'¹⁸ The following spring an editorial in *The Technologist* suggested that in Britain there was

an unhappy ambivalence of attitude towards technology: on the one hand, a recognition of the economic importance of continuous technical innovation, whilst on the other its relegation to a position of inferiority both to pure science and to financial and commercial activity.¹⁹

Such statements blaming the 'crisis in technology' on society's attitudes towards engineering were supported by the findings of other reports, such as that on industrial training, which concluded:

Science attracts not only more students but also the better quality for in 1961-62 some 30 percent of undergraduates in science had 3 or more A levels with

¹⁵ Anne Marie Wolpe, 'Factors Affecting the Choice of Engineering as a Profession Among Women.' Unpublished MSc Dissertation, University of Bradford, 1972, p.116.

¹⁶ *The Times*, 13th November, 1961.

¹⁷ Cmnd 1490, *Report on the Long-Term Demand For Scientific Manpower*, London, HMSO, 1961, p.20.

¹⁸ Professional Engineering Institutes Presidents Meeting, 24/4/1963. Copy of minutes held in the archives at the Institute of Mechanical Engineers, London.

¹⁹ *The Technologist*. Vol.1. 1964, p.6.

60 percent marks or more and only 11 percent in technology had the same qualifications.²⁰

It adds as an aside that 'very few girls were attracted to applied science'. Wolpe pointed out that while Lord Jackson, in his lecture at the Institute of Civil Engineers in 1964 specifically included women when he discussed the nature of under-graduate courses he made no suggestions as to how women could be included in any of his ways of overcoming the manpower shortages.²¹

He took it as given that the proposed changes and remedies would apply equally to women. This error is repeated many times when the question of women as a potential reserve labour force is discussed.²²

In 1965 a memorandum from the WES on increasing the number of women engineers and technologists claimed that only 0.1 percent of professional engineers in Britain were women compared with 2 percent in France and 10 percent in Norway. The memorandum went on to suggest two main reasons, firstly ignorance and prejudice, and secondly the failure to ensure that girls got an adequate basic education.²³ A Press Report issued in 1966 had admitted that the demand for qualified engineers was 'unlikely to be met,' it went on to suggest that the 'widespread belief that academic research is the only respectable outcome of a scientific education must be changed.'²⁴ However, as Viola Klein pointed out:

At a time when the more traditionally female professions clamour for recruits and compete with each other for the historical pool of qualified women it is perhaps not surprising that the number of women prepared to take the risk of having to fight for equal status in a profession that for whatever reasons so far has been male identified is relatively small.²⁵

20 Cmnd 1892, *Industrial Training, Government Proposals*, London, HMSO, 1962, p.22.

21 Lord Jackson of Burnley. 'The Problems of Engineering and Scientific Manpower and Their Implications' The Graham Clarke Lecture, Institute of Civil Engineers, London, 1964. Copy held at the Institute of Civil Engineers, London.

22 Wolpe, Unpublished M.Sc. Thesis, p.15.

23 Memorandum from WES, June 1965. Copy held in the Modern Record Centre at the University of Warwick, Ref. MSS200/C/3/EDU/11/1.

24 'The Supply & Demand for Engineers, Technologists & Scientists.' Joint press notice by Dept. of Education & Science and the Ministry of Technology, 11/10/66. Information held in The Modern Record Centre, University of Warwick, Ref. MSS271/T/6/1-10.

25 Viola Klein, 'Demand for Professional Manpower' in *The British Journal of Sociology*, June 1966, Vol.17(2), p.189.

The failure to attract women to engineering compounded the problem; engineering was not a career that appealed to the majority of the brightest students. Although the suggestion was made that girls be recruited, no action was taken since it was a common assumption that 'the universities cannot be expected to accept girls for engineering courses unless they are the very best.'²⁶

This blatant discrimination was ignored when reasons why women were not coming forward were discussed. In 1968 Hardwich suggested:

Women are too bound by social prejudice and the peacetime social climate is so against the employment of women as professional engineers that in truth the girls do not come forward. The unfavourable social climate is based on an appalling ignorance of the meaning and content of engineering, ignorance so abysmal as to have nurtured the belief that engineering is unsuitable for women and women are quite unsuited to engineering.²⁷

While such ignorance was certainly one factor, neither the universities nor the professional engineering institutes made any attempt to convince women that engineering was an option they should consider. The associated demand that they be better qualified than male students was another reason for women not to pursue the career. While the equality legislation removed this barrier, with a wider range of careers open to them the information they had about careers in engineering was still failing to attract girls.

In 1961 only 5.45 percent of 18 year old boys and 2.73 percent of 18 year old girls were still in any type of full time education, by 1980 these figures had risen to 11.6 percent of boys and 9.24 percent of girls.²⁸ By 1990 the number of undergraduate course entrants had risen to 19 percent, and by 2000 to 38 percent of the 18-year-old population. However, of these fewer were choosing to study engineering, just 5.5 percent in 2000 as opposed to 10.4 percent in 1990. In 1997 a common set of performance indicators offered the first opportunity for a true comparison of the 'drop-out' rates. This showed that

26 D.C. Johnson 'The Possibilities for Women Graduates' in *Careers for Girls in Engineering*, London, Women's Engineering Society, 1968, p.2.

27 Isabel Hardwich, 'Why There Are So Few Women Engineers In Industry Today.' Talk given at University of Warwick 25/3/1968. Copy held at the Institute Of Electrical Engineers Archives Ref. NAEST92a/2.8.

28 *Annual Abstract of Statistics No.107*, Central Statistical Office, London, HMSO, Table 109, p.100.

engineering suffered a 12 percent higher 'drop-out' rate than any other subject, demonstrating that engineering still failed to get its 'fair share of the best brains.'²⁹

The Fluctuations of British Industry

Britain's post-war prosperity was largely due to her engineering industry. In spite of failing to grow as quickly as her European neighbours Britain still had a 16.5 percent share of world trade in manufactured goods in 1960.³⁰ The British engineering industry grew at the average rate of 2.7 percent per annum during the 1950s and engineering accounted for 35 percent of Britain's gross national product and nearly half of the United Kingdom's total exports.³¹ Engineering exports accounted for a larger share of total exports in 1961 than they did in 1950, leading many people to assume that the British engineering industry would retain its leading place in world trade. However, while exports had increased, world trade had increased at a faster rate and the declining percentage was spread over a wide range of goods that included many of Britain's traditionally important products. There were exceptions to this trend; diesel and aerospace engines, and also gas, water and steam turbines had all increased their share of world trade, as had the aircraft industry. The automotive industry had maintained its share of car exports and increased its share of trade in lorries and tractors, but Britain's share of world trade in the newest technologies, which were the fastest growing, was smaller than either the USA or Germany. This reflected the worries of the Federation of British Industry who issued a press statement in 1960 in which they admitted that the steadily rising trend of previous years had continued 'at a slackened pace'. The statement goes on to suggest, 'exports have not risen to the extent necessary to support our high level of domestic activity.'³² This or

29 *Digest of Engineering Statistics 2002*, London, The Engineering Council, 2002, Section 4

30 Alec Cairncross, *The British Economy Since 1945*, Oxford, Blackwell, 1992. p.120.

31 *Annual Abstract Of Statistics 1970*, London, HMSO, 1971, Table 304, p.285.

32 Federation of British Industries Press Statement 14/10/1960. Copy held at the Modern Record Centre, University of Warwick. Ref. MSS200/B/3/3/264 Pt.2.

similar messages were to be repeated at yearly intervals when the Federation issued their report on the state of British industry.

The numbers of male employees in the shipbuilding industry fell from 249,000 in June 1959 to 228,100 in December 1960, a drop of almost 1 percent. Over the same period the electrical industries saw an increase of 1 percent of male and 1.15 percent of female employees while the aircraft industry saw a rise of 0.8 percent of men and 1.1 percent of women.³³ The numbers of women being employed was increasing in all areas, even in the shipbuilding industry, but this was due to the rise in clerical jobs, now considered 'women's work'. While, as the previous chapter has established, women's working lives changed after the war, with more of them in employment, the majority of these jobs were for clerks and typists, as was shown in an article in the *Ministry of Labour Gazette*.³⁴ In 1960 there were 1,948 newly qualified electrical engineers and 3,499 newly qualified mechanical engineers entering the employment market; by 1963 the figures were 2,242 electrical engineers and 3,584 mechanical engineers, a 15 percent increase in the electrical field while the mechanical field only increased by 0.25 percent.³⁵ This was due partly to the growing interest among new recruits in the 'modern technologies' and partly to the decrease in the more traditional 'heavy engineering'.

In 1961 the government report on the *Long-Term Demand for Scientific Manpower* concluded:

The overall supply and demand for qualified manpower will not be very much out of balance at the end of the first five years of the decade 1960/70. If anything a slight shortage of technologists will be balanced by a slight surplus of scientists: any possible divergence of supply and demand comes into the second five years.³⁶

The problem inherent in such a statement was that, assuming the predictions were correct; a surplus scientist could not simply be used to fill a vacancy for a technologist. The two

³³ *Annual Abstract Of Statistics 1970*. Table 14, p.15

³⁴ *Ministry Of Labour Gazette*, March 1958. Copy held at the Modern Record Centre, University of Warwick. Ref. MSS292/134/3.

³⁵ *Statistics of Scientists and Technologists*, Central Statistical Office, London, HMSO, 1963. Table 23. p.12.

careers were not necessarily interchangeable. A few individuals did move from science to technology or vice-versa, but they were generally highly trained experts whose years of experience allowed them to make the transition. The report also suggested that the problem of recruitment was due to the attitude of society:

In British eyes other professions such as medicine, the law, university teaching and scientific research have a higher social prestige than engineering, and, indeed, on available information, are more lucrative.³⁷

In 1961 Mr. Henry Benson, Education & Training Secretary for the Federation of British Industry sent a memorandum to Sir Hugh Beaver in which he talked about reasons why the economy was not growing as fast as it should.³⁸ He listed twelve management problems, among which was the shortage of technicians.

In the *Report of a Committee Appointed to Consider the Present Standing of Mechanical Engineering Design*, published in 1963, a warning was given that Britain was losing ground in its traditionally strong engineering areas 'probably because the design of these products is failing to satisfy the customer.'³⁹ The situation was worsened by the attitude of engineers towards employment in Britain. Salaries were failing to keep pace with those of skilled men and the low status of engineering in Britain led many to look abroad. Many suggestions were put forward to improve the situation, including the need to train more engineers. This was highlighted in the report by the statement:

It is important to know whether the design resources upon which production and trade depend are adequate to sustain the higher rate of growth in the economy as a whole which the nation is now seeking to achieve.⁴⁰

To emphasise the importance of training these people was just one of the remedies proposed by the report.

36 Cmnd 1490, Par 75, p.20.

37 *Engineering Design, Report Of A Committee Appointed By The Council For Scientific And Industrial Research To Consider The Present Standing Of Mechanical Engineering Design*, Department of Scientific and Industrial Research, London, HMSO 1963, p.41

38 Memorandum Ref. 19/4. Copy held at the Modern Record Centre, University of Warwick. Ref. MSS200/F/1/2.

39 *Engineering Design*, Par 17. p.9.

40 *Ibid.* Par 13. p.8.

While industry acknowledged the importance of recruiting and training engineers, it failed to do anything to retain those it already had. Many engineers became dissatisfied, some moved into management jobs, others changed companies to improve their salary; some took this a step further and went abroad. This had always been an acceptable move, as the exchange of trained personnel between countries was considered a healthy way of broadening the experience and attitudes of the work force. However, as dissatisfaction with management grew within the profession more engineers went to work abroad, particularly in America, where they got the wages and status they felt they deserved. In 1963 the Royal Society undertook a small study that found twelve percent of Britain's annual PhD output was leaving the country.⁴¹ While these were mainly research scientists, the appeal of better wages and more recognition of the importance of their work encouraged many technologists and technicians to follow suit, and the situation continued to escalate. The government finally examined the problem of the so called 'brain drain' in 1967 and concluded that:

1. There is a serious brain drain of young engineers, technologists and scientists from the UK
2. The right solution is to create more challenging opportunities, particularly in industry, for talented people. This will require, as an element, a high and sustainable level of industrial investment
3. It will also require greater recognition that the source of national wealth is industry, and that new ideas create wealth only if commercially exploited.⁴²

Accepting that the 'movement of scientists and technologists is an old and traditional phenomenon,'⁴³ nevertheless the disparity shown by the 1964 figure which demonstrated that 1,097 of the 2,669 European engineers who immigrated into America were British implies a greater degree of dissatisfaction among British engineers than their continental colleagues.⁴⁴ While governments and economists were concerned about whether the brain

41 *The Emigration Of Scientists From The UK*, London, The Royal Society, 1963.

42 Cmnd 3417, *The Brain Drain*, Committee Of Manpower Resources For Science And Technology, London, HMSO, 1967, Summary Of Conclusions And Recommendations.

43 G. Beijer, 'Brain Drain as a Burden, a Stimulus and a Challenge to European Integration.' In F. Bechhofer ed. *Population Growth and the Brain Drain*, Edinburgh, University Press, 1969, p.4.

44 *Ibid.* p.25.

drain was important economically; at an individual level the decision to work in another country was likely to be based on what was offered. 'Making Sure There's no Place Like Home' pointed out that while there were enough positions and good careers available for graduates in Britain, the onus to find work was placed on them.⁴⁵ By contrast, in America an approach was made to each individual graduate by an interested company. Women do not feature in the literature at all, the assumption was either that all professionals were male, or that women professionals were no different from men, and did not need to be considered separately. It is probable that, if women were considered in the research, they would be assumed to be tied to Britain by family commitments and so less likely to go abroad.

In 1965 Guy Routh classified engineering as a 'higher profession', along with medicine, the law, and the church among others.⁴⁶ However, he showed that in 1955-56 while a doctor might expect to earn £2,370 per annum, an engineer could only expect to earn £1,497. This undervaluing of engineers was one reason why the industry failed to attract the 'best brains.' Similarly in 1967 the trade union DATA pointed out that the differentials between a skilled man and a draughtsman had been reduced to an all time low, with the skilled man able to earn £1,165 while a draughtsman could only earn £1,295.⁴⁷ The following year the National Development Office examined the problem of the persistently high levels of overtime and concluded that in some cases it was because 'the wage paid for the standard working week may be unrealistic in relation to earnings.'⁴⁸ In their investigation into the problem Stannic and Pym found:

It has been observed during many relevant enquiries that highly qualified personnel often take a 'dim' view of management. Much criticism is focused on the lack of technical knowledge among management, the preponderance of politics, and the emphasis on the commercial rather than the scientific aspects

45 A & K Gebbie, 'Making Sure There's No Place Like Home,' in *New Scientist Vol 32* (1966) 503-23.

46 Guy Routh, *Occupation And Pay In Great Britain 1906-70*, Macmillan, 2nd edition, 1980, pp.13, 17, 67 & 69. (First Edition 1965.)

47 'Summary Of Response To National Board For Prices And Incomes In Regard To Design Staff & The Problem Of Changing Differentials', 1967, Copy held in The Modern Record Centre, University of Warwick. Ref. MSS101/DA/3/1 DATA.

48 *Better Use Of Labour In The Firm*, London, National Economic Development Office, 1968.

of work.⁴⁹

Such dissatisfactions continued to be voiced, but with the inevitable reduction of Britain's engineering industry as it became less competitive, many engineers, like other employees, put job security ahead of any other problems.

In June 1970 the Conservative party won the general election. Their campaign concentrated on the 'cost of living' since inflation had been increasing rapidly under the Labour government. Political economist Michael Nevin outlined the Conservative response as follows:

The Heath government laid down guidelines for the level of public sector pay settlements in the form of the "N-I" policy. The notion behind this policy was that each pay award in the public sector should be 1 percent lower than the previous one so that pay rises would be gradually brought down....set [ting] an example of wage restraint to the private sector.⁵⁰

This was difficult for the public sector workers to accept. Prices continued to rise and the private sector workers refused to go along with the suggestion that they accept what was effectively a cut in pay. In 1972 the NUM (National Union of Miners) called for strike action which managed to break the 'N-I' pay policy. In 1973 international events caused an oil shortage, threatening fuel rationing in Britain for the first time since the Second World War, and when the NUM once again called a strike over pay, the government took the unprecedented step of instituting a three-day working week. The emergency measures meant that every home and employer (apart from hospitals and other emergency services) had its power supply cut off at preset times and the TV companies stopped broadcasting at 10.30pm. These restrictions had an enormous impact on hourly paid workers who lost money. Accompanied as it was by a four-fold increase in the price of petrol with the inevitable increase in price of most products, the country was in deep trouble. An election was called in February 1974 which returned the Labour party to power but without an overall majority. In less than eight months a second election was called at which their

49 Vladimir Stannic & Denis Pym, *Brains Down The Drain - The Misuse Of Highly Qualified Manpower*, ANBAR Monograph No.12, 1968.

50 Michael Nevin, *The Age of Illusions*, London, Victor Gollancz, 1983, pp.59-60.

situation improved enough to be a workable majority. However, in 1974 inflation reached 28 percent and wage rises averaged 26.4 percent, such a situation could not continue unchecked, and Denis Healey's budget of 1975 abandoned the commitment to full employment. He admitted that the measures required to get inflation under control would cause unemployment, but it was hoped that this would only be short term. While the unions had grudgingly accepted that inflation had to be controlled, the loss of jobs hit employees hard, and the failure of many bosses to suffer the wage restraints imposed on their workers led ultimately to the 'winter of discontent' and the 1979 election. By now many people were also disillusioned with the unions who were accused of 'holding the country to ransom' because of their power to overturn government decisions by taking strike action. When Margaret Thatcher became the first female prime minister of Britain with the success of the Conservative party in the election of 1979, she promised to deal with the economic problems that had plagued Britain.⁵¹ Britain's engineering industry shrank over the following decades as economic policies combined with the growth of multi-national corporations to cause the percentage employed to drop by 16.2 percent between 1978 and 1981.⁵² In 1978 there were 4,929,000 men and 2,197,000 women employed in the manufacturing industries, this had dropped to a low of 2,942,000 men and 1,370,000 women by 1993 and had only climbed to 3,058,000 men by 2000 although the numbers of women employed had continued to drop, being only 1,171,000.⁵³ In spite of this, output went up by 42 percent between 1981 and 2002.⁵⁴ The majority of the jobs lost between the late 1970s and the early 1990s were not those of engineers, but as with the earlier decimation of British industry, there were redundancies among engineers in spite of the employers' belief that there was a shortage. As early as 1969 Richardson had pointed

51 For a more detailed analysis of events see any of the economic or political histories of Britain, such as Correlli Barnett, *The Verdict of Peace*, Basingstoke, Macmillan Press, 2002, Brian Spittles, *Britain Since 1960*, Basingstoke, Macmillan Press, 1995, or Cairncross, *The British Economy Since 1945*, each of which has a very distinct ideological framework.

52 *The Census of Employment*, Office for National statistics, London, HMSO, 1985.

53 Work Force Jobs by Industry, Office for National Statistics, <http://www.statistics.gov.uk>. November 2002.

54 Facts About the Engineering Profession, Engineering Council, <http://www.engc.org.uk>. August 2002.

out that:

The professional engineer who cannot secure a post as a professional engineer does not usually become an unemployment statistic. More likely he becomes a technician, i.e. the skill becomes unemployed, but not the person.⁵⁵

Such a person would probably be able to find work, particularly if they were prepared to move to another area, although such a move might be difficult for a married woman engineer.

The Professional Engineering Institutes

The need for the professional institutes was explained by Armytage as follows:

The 'engineering point of view' in British affairs is exhaled partly through the Parliamentary and Scientific Committee (a loosely knit body constituted in 1932), partly through the Royal Society and partly through the four senior institutions of Civil, Mechanical, Electrical and Chemical Engineers.⁵⁶

These four main engineering institutes were autonomous organisations, each with its own rules and entry requirements and, although all had accepted women members since the 1920s, little was done by them to encourage women into the profession until after the equality legislation of the mid 1970s. In 1961 there were four new female admissions to student membership of the Institute of Mechanical Engineers, bringing the total number of women members to 28 out of a total of 54,713 members.⁵⁷ That was the first year in which the institute listed the numbers of women members separately; unfortunately the separate listing of women members ceased in 1964. In 1962 an article in *Target* stated, 'fewer than 400 women belonged to an appropriate professional body.'⁵⁸ It pointed out that although the Women's Engineering Society had 255 female members, the Institute of Electrical Engineers had only 77 and the Institute of Mechanical Engineers a mere 37. Those figures

55 V.A. Richardson, 'A Measurement Of Demand For Professional Engineers' in *British Journal of Industrial Relations*, Vol. 17, No.1, March 1969, pp. 53-70.

56 Armytage, *A Social History of Engineering*, p.328.

57 *Journal of the Institute of Mechanical Engineers*, 1961 Vol. 175, p.369.

58 'Women Engineers In A Man's World' in *Target*, July/August 1962,

followed the national trend; it was estimated that in 1958 only one in 1000 Britain's engineers were women.⁵⁹

In 1960 WES published the results of a comparative study between the attitudes of Britain and the USSR to women in engineering.⁶⁰ This found that while there was more equality of schooling and more access to opportunity in the USSR, the real advantage that the Russian women had over their British counterparts was that the social acceptability of women being engineers was far greater. The press response to the report was to ask 'how would you like a woman boss (at work of course)?' The article that followed dismissed the idea of women becoming accepted as engineers because 'men would not take orders from women in this country as happily as they did over there.'⁶¹ Such responses reflected the attitude of society and, while those who wanted to encourage girls to enter engineering were demanding a change in attitudes, little action was taken towards this end by WES or any the professional engineering institutes. Government committees on matters relating to the Engineering Profession frequently consulted the professional institutes. In 1961 a memorandum from the councils of the Institute of Mechanical Engineers, the Institute of Civil Engineers and the Institute of Electrical Engineers was sent to the Committee of Higher Education in which the following appeared:

Question (vii):

Are there special difficulties in the higher education of women and is full use made of this potential supply of students and their possible contribution to the stock of highly qualified people?

Answer:

(Ignoring the known deficiencies in science teaching in some schools) Other countries have shown that women can be employed effectively in engineering in a professional capacity. However the number of women seeking to enter the engineering profession in this country is very small. Our present corporate membership comprises only 9 women in civil engineering, 10 in mechanical engineering and 37 in electrical engineering. The reasons why so few women seek to become engineers are associated with traditional

59 'Report on the Results of a Survey of the Employment of Women Scientists And Engineers' the TUC Education Committee 12/4/1960. The survey was carried out in 1958 for the Ministry of Labour by Social Surveys Dept. of the Central Office of Information. Copy of report held at the Modern Record Centre, University of Warwick. Ref. MSS292/134/3.

60 L.S. Soultter, & R. Winslade, *Women Engineers in the USSR*, London, WES, 1960.

61 *Daily Express*, 11 October 1960.

social attitudes, of parents and of the girls themselves; there could probably be some prejudice to overcome in industry. There are some difficulties arising from statutory requirements and the control of labour.⁶²

That answer was typical of much of the correspondence of the Institutes at the time: women were not deliberately excluded; rather they excluded themselves from the profession and simply were not numerous enough in the profession to be considered. That was accepted as perfectly natural: women engineers were still seen as very unusual and rather odd. Many men were extremely supportive of the women engineers they came in contact with, but few would have considered encouraging more women to enter the profession, in spite of the expected deficit of trained professionals. As has already been shown, in the face of the growing shortage of technicians and technologists some companies made efforts to recruit women, but the Industrial Training Report of 1962 found 'very few girls were attracted to applied science.'⁶³ This was in contrast to Russia, for example, where over 30percent of engineers were women compared to barely 1percent in England.⁶⁴ By 1969, a press notice reported the comments of Mrs. Shirley Williams, Minister of State for Education and Science, who commented:

it was probably easier for the rich man to get through the eye of the proverbial needle than it is for a girl in Britain to become an engineer....there are no sensible reasons for this extraordinary situation. We need more technologists & engineers. We need more teachers who can teach the applied sciences, for our shortage is growing more serious day by day.....in France 1 engineer in 28 is a woman, in Syria 1 in 14, in Norway & Turkey 1 in 10, in Russia 1 in 3, in Britain 1 in 500!⁶⁵

This demonstrated that, whatever the reasons were for Britain's failure to attract women into engineering, they were social rather than biological. Differences in male and female brain patterns might have accounted for fewer women than men being attracted to engineering but were unlikely to explain the variation from 33 percent down to 0.2 percent. Rather this was due to the other, social aspects already mentioned.

62 Memorandum from the Three Councils to the Committee of Higher Education 1961. Copy Held at the Institute Of Mechanical Engineers, London, Ref. (P)378.62.

63 Cmnd 1892, p.22.

64 *Daily Telegraph and Morning Post*, February 21 1962, article by Elizabeth Prosser.

65 Press notice Engineering for Girls 5/3/69. Copy held in WES archives, Ref. NAESt 92a/1.2.3

As technology moved at an ever increasing pace, and engineering failed to recruit enough young people, the distinction between the technician and the professional engineer became largely academic. While the difference between a technologist and a technician exercised the writers of various reports on training and recruitment, the engineering industry seldom saw a need to differentiate between the two. The major engineering institutions controlled the use of the titles chartered or incorporated engineer, but employers seldom required such titles for working engineers. Within industry, while chartered engineers were employed, neither the membership of an institution nor the qualifications required by them were prerequisites for employment at any level within most companies. For women who had achieved Chartered status, this could be an advantage as they were frequently competing for jobs with less qualified men. Women technicians who had not got the qualifications required by the institutes were not so lucky, they had to compete with men on 'equal terms' which, prior to the equality legislation, frequently meant very unequal terms. The leaders of the main professional institutes formed the Council of Engineering Institutions in 1962 to represent the joint interests of all engineers. Unfortunately, in an attempt to remedy the low status of engineers the institutes largely abandoned any interest in, or control over, the technician grades. Comments such as 'the Institution of Mechanical Engineers should give greater weight to the professional content of work than to the number of staff controlled' highlighted the tendency of the institutions to consider themselves as only being for the top level of the profession.⁶⁶ The majority of engineers did not come into this bracket; obviously if to become a member, an engineer had to show they were controlling staff, then those staff could not apply to become members themselves. A Department of Scientific and Industrial Research report recommended:

The Engineering Institutions Joint Council should consider the introduction of a new category of membership to cater for engineering technicians including draughtsmen, and should discuss with the Institution of Engineering Designers

⁶⁶ *The Present Standing of Mechanical Engineering Design*, p.42.

the possibility of some form of affiliation.⁶⁷

However, such pleas were not acted upon and the Institutions continued to ignore a large proportion of Britain's engineers.

Teaching was the only other profession that suffered from similar problems, having always accepted teachers from a variety of backgrounds. Although a standard had been set, the career was forced to recruit a number of 'unqualified' teachers during and immediately following the Second World War. This prompted a call from the National Association of Schoolmasters to say:

This conference expresses grave concern at the increasing numbers of unqualified teachers now entering the schools of this country, and asks the minister of education to announce a date, after which only properly trained, qualified and registered teachers will be permitted to teach children who are in compulsory attendance at school.⁶⁸

While the situation could not be immediately resolved, the rapid expansion of teacher training colleges ensured that qualified teachers soon replaced those unqualified ones who were re-titled teaching assistants. The dilution of the teaching profession had resulted in a corresponding drop in the level of salary. In 1962 a report on salaries claimed the life earnings of men between 30 & 65 were as follows:

Consultants (Medical)	£117,000
NHS Doctors	£71,000
Dentists	£70,000
Accountants	£71,000
Graduates in Industry	£84,000
Solicitors	£88,000
Surveyors	£63,000
Graduates in Teaching	£40,000 ⁶⁹

From these figures it can be seen that graduates in industry were likely to be better paid than some other professionals. However, such graduates were more likely to be in management roles than in those of technologist or technician. The union DATA showed

⁶⁷ Ibid. p.42.

⁶⁸ Minutes of 38th Annual Conference of the National Association of Schoolmasters, Hastings, 19-22nd. April 1960. Copy held in the Modern Record Centre, University of Warwick. Ref. MSS38A/1/2/1/109.

⁶⁹ Quote from A Royal Commission for Doctors and Dentists Remuneration, in a report on salaries to be presented to the 40th Annual Conference of the National Association of Schoolmasters, Plymouth, 1962. Copy held in the Modern Record Centre at the University of Warwick, Ref. MSS38A/1/2/1/115.

that in 1964 a draughtsman would have earned 'about thirteen pounds a week' which equated to approximately £30,000 in a lifetime.⁷⁰

In spite of their failure to register most technicians, the engineering institutes performed a valuable service. They enforced minimum standards of academic and practical experience for the various grades of engineer that they did recognise. As has been shown, they conducted training schemes, offered careers advice and were the point of contact for anyone seeking information about engineering. With the granting of a royal charter to the Council of Engineering Institutions in 1965 it was hoped that more engineers would join an appropriate institution. However, while the Council continued to expand the numbers of institutions it covered, the institutions themselves failed to make any significant impact on the percentage of engineers who were members.⁷¹

By 1969 the Institute of Civil Engineers had compiled a report on the Role of Women in Engineering which stated:

There is no doubt that, in many branches of engineering, interesting, intellectual, creative and well-paid work can be done just as well by women as by men and there is a wide range of career opportunities.⁷²

This was a sample of what was to come. As the idea of encouraging women into the profession, prompted by the publicity given to the women's rights movements and adopted by industry as a way of overcoming the shortage of engineers, took hold the institutes all changed their attitudes. Unfortunately, however, the combination of social attitudes, the reduction of the engineering industry and the opening of other careers all combined to restrict the numbers of women choosing engineering as a career. In 1975 an article appeared, light-heartedly describing the bevy of beauties that were the civil engineering

70 Memorandum from John Forrester, Divisional Organiser to the General Secretary of the Association of Engineering & Shipbuilding Draughtsmen. 11/2/64 Ref. JF/DW/HO. Regarding a wage claim by the Union. Copy held in the Modern Record Centre at University of Warwick. Ref. MSS101/DA/3/3/1.

71 There were 14 institutions that were constituent members of the council of engineering institutions in 1966. By 1995 when the new college structure for the engineering council was proposed, there were 43 institutions.

72 'Are Women Engineers Needed?' Working Party on the Role of Women in Engineering. Institute of Civil Engineers Archives. File 3/Wre /69. dated 29/5/69.

students at Leeds University; there were 37 on the course.⁷³ Three years later the writer published a follow-up article in which he admitted that his previous article had been condemned as patronising and offensive by some women. One of the students that he re-interviewed commented:

Sometimes at meetings I am assumed to be a secretary by those not in the know...the trouble is, one is not just an engineer, one is always a woman engineer.⁷⁴

In the 1990s, the Engineering Council launched SARTOR (Standards and Routes to Registration) and set out to discover what employers needed and to relate it to what the various institutions were supplying. By the end of the century it was found that the three streams of engineers (chartered, incorporated or technician) that formed the basis of the membership were in the opposite proportion to that required. There were approximately four times as many chartered as incorporated engineers and three times as many incorporated engineers as engineering technicians. In supporting the employers' view it was explained that:

While there is a continuing need for engineering innovation in terms of new products, systems and processes, a lot of present-day competitiveness is derived from improvements in working practices, manufacturing efficiencies and better logistics.⁷⁵

These proportions did not reflect engineering employment and were almost certainly due to the failure of technicians to apply for membership, a situation that the Engineering Council was beginning to address through its policy of continuing professional development. However, few technicians regarded the Eng Tech grade as anything but the first rung on the ladder to Chartered status. As has already been shown, not all engineers joined an institution. By 1990 it was reported that only about one third of Britain's engineers were members of a professional institution.⁷⁶ Another report demonstrated that, while the Engineering Council had a total of 279,338 members, only 1,456 (0.5 percent) were

73 R.J. Barfoot, 'A Bevy of Engineers' in *Concrete*, December 1975.

74 R.J. Barfoot, 'Apologies to a Bevy of Engineers' in *Concrete*, October 1978.

75 SARTOR, *A Guide For Employers*, iss.7, The Engineering Council, London, 2000 p.26.

76 *Digest of Engineering Statistics*, Par.8.7.

women. These women were not evenly spread over the age ranges, the percentage of women under 34 was 2.11 percent, those between 35 and 44 made up 0.61 percent while those over 45 were just 0.13 percent.⁷⁷

Employers and Women Engineers

A survey on Women and Engineering, conducted in 1958, concentrated on the Manchester area and included Metropolitan-Vickers. As has been shown, this company had a positive approach to employing women as engineers, although it denied making any special recruitment efforts to attract them. The survey concluded:

On the whole engineering companies in the Manchester area are unlikely to employ women as professional engineers so long as equally well qualified men are available. A few companies which are willing to accept women have been unable to find any. Six of the larger establishments do employ women, one of these having done so for over forty years. Women who make the grade are just as competent and reliable as their men colleagues. Their tendency to leave work on marriage however sometimes causes an employer to refuse training even when there is no bias against employment of the trained.⁷⁸

This survey included an analysis of local job adverts in which it found that only 14 vacancies for engineers specified that the vacancy was for a man or a woman, 825 were non-specific and 793 restricted the vacancy to men. A similar breakdown of the adverts for technician vacancies showed 59 to be open to both sexes, 870 to be unspecified and 366 to be restricted to men. The evidence that more technician level vacancies were unrestricted reflected the fact that women did not often rise above this level. These findings confirmed Isabel Hardwich's comments on the government's recommendation that employers increase the numbers of women in technical jobs, when she said:

Since this suggestion was made neither have girls besieged the factory gates nor has industry obviously attempted to recruit girls. Advertisement after advertisement still holds out glittering hopes specifically to boys and young

⁷⁷ 'Women In The Professions', a report compiled by the United Kingdom Inter-Professional Group Working Party on Women's Issues, June 1990, London, The Law Society, 1990 p.36.

⁷⁸ 'Women In Engineering', Manchester, The Manchester College of Science and Technology, May 1958. Copy of typed conclusions sheet held in the Women's Engineering Society archives at the Institute of Electrical Engineers, London, Ref. NAEST 92A/2.1.

men.⁷⁹

In 1958 the Women's Engineering Society booklet *Training & Opportunities for Women in Engineering* suggested that employers were 'willing to consider the employment of women engineers.'⁸⁰ A statement that was qualified by the caveat:

The posts that can be occupied by the professional engineer vary with the different branches of the industry. There are two, however, that permeate all branches, and these, moreover, are ones at which women frequently do very well and where they encounter the minimum of opposition and prejudice. These posts are in Design and Research.⁸¹

Many of the women engineers who completed questionnaires worked in those areas, certainly when first employed, and none felt they had encountered prejudice. One commented that her sex was only a disadvantage because men saw her as an attractive woman. 'When young, sex was always the problem. Men were interested in you as a female, rather than as a colleague.'⁸² While some would interpret this as discrimination, she found it to be more of an advantage than a problem to her. Apart from that aspect, most women found little prejudice among colleagues once they were working; the problems were more likely to be in getting suitable employment, as some employers were less inclined to give a female the chance to prove herself if a man was available for the job.

In 1959 the government carried out a *Survey of the Employment of Women Scientists and Engineers*. By 1960 the TUC circulated a report on the survey; they found that the three main disadvantages to employing women in these posts stated by employers were:

1. Women leave jobs because of domestic commitments
2. Women have difficulty exerting authority over male personnel
3. Conditions, which are rough, dirty and physically hard are not suitable for women.⁸³

When challenged on those points, the 13 percent of companies in the survey who

79 Isabel Hardwich, 'Opportunities For Girls In Industry' Paper delivered to the 6th Annual Conference of The British Association for Commercial and Industrial Education. 1957. Copy held in Women's Engineering Society archives at the Institute of Electrical Engineers, London, Ref. NAEST 92A/7.3.

80 V. Holmes & L.S. Souther, *Training & Opportunities For Women In Engineering*, London, Womens Engineering Society, 1958. p.3.

81 Ibid. p.37.

82 Questionnaire source, see Appendix 1.16.

83 TUC Report held in the Modern Record Centre, University of Warwick. Ref. MSS292/134/3.

employed women as engineers or scientists admitted that the turnover of female staff was not actually different to that of male staff. In fact all companies agreed that turnover was not considered important and they also admitted that the second point had not proved to be true. No comment was made regarding the third point although, as women were often employed in unskilled or semiskilled positions on the factory floor, the point would appear to be unfounded. Very few engineers actually worked in noisy or dirty conditions because although the factory floor might be all those things, engineers generally worked in offices. Those might be drawing offices, or production offices (engineers' work might involve using computers, which were becoming more available from the early 1960s) or it might involve statistical analysis (they might be designing new products, new plant layouts, or designing new processes to make products). Some development engineers might work in small workshops where they could build and test prototypes, but the majority of engineers only visited the 'shop floor' to deal with problems or to oversee a particular operation. They would be called in when problems arose but were seldom based in the factory. Nursing, considered an 'acceptable' career for women, was often far more physically demanding. Lifting patients often caused nurses to suffer bad backs, and dealing with the bodily functions of patients exposed them to far 'dirtier' conditions than the oil of a factory floor. The excuses given by employers were specious, employers in all sectors, not just engineering, saw no point in upsetting their mainly male work force unless there were direct benefits to the company. When they did accept a woman in any male dominated environment, they happily publicised themselves as 'forward thinking' while doing little to encourage other women into the work place.

The government survey had found that there was a fairly general opinion among employers that women should not become engineers because the conditions were unsuitable; but employers admitted that women were particularly good at detail work and for testing or analysis work. Of the firms in the survey 28 percent favoured employing women, 54 percent would employ women with only minor reservations and only 10

percent were actually opposed to employing women. However, only 13 percent of the firms were actually employing women, due to a lack of women applicants. Of the firms employing women, 60 percent paid men higher rates for the same job and 74 percent admitted that women only had limited promotion prospects.⁸⁴ The TUC Education Committee issued a memorandum, accompanying their 1960 report on the government survey, which summed up the prevailing attitude:

From the economic standpoint a woman scientist is not considered to be as good an investment as a male scientist is, and unless she is exceptionally able, men will be given preference over her.⁸⁵

Women engineers are not mentioned in the survey which covered 758 companies employing a total of 15,972 male engineers and scientists. 370 female scientists but only eight female engineers were employed by these companies, so the failure to mention women engineers is perhaps understandable. However the findings were no doubt as applicable to women engineers as to women scientists. Further findings of the report showed that 62 percent of the firms in the survey who were looking to recruit engineers or scientists, were only looking for men. Of the firms not currently recruiting, 43 percent confirmed that they would not employ women. Promotion prospects were also found to be limited for women. Although 74 percent of the firms in the survey said promotion was available, many qualified this by the proviso that they would have to be 'very exceptional women'. While this demonstrates that there was some discrimination prior to the equality legislation this was true of all careers at the time. The exceptions were the teaching and the Civil Service, both of which offered equal pay but neither of which made any attempt to offer equal opportunities.

The varied attitude towards employing women engineers was demonstrated by the GPO. In spite of being part of the civil service which had phased in equal pay for women

⁸⁴ *Survey Of The Employment Of Women Scientists And Engineers*, Central Office of Information, London, HMSO 1960.

⁸⁵ Copy of memorandum Ref. Cpd Mm dated 29/3/60 held in the Modern Record Centre, University of Warwick. Ref. MSS292/134/3.

between 1955 and 1961, there was no rule regarding equality of opportunity. A query had arisen about the GPO's refusal to recruit girls as student apprentices. Miss Wey, honorary secretary of the 'Status of Women Committee', had failed to get more than a promise 'to consider a review of the policy.'⁸⁶ The Women's Engineering Society was then involved to collect information which could be presented to such a review, should it take place. In August of 1960 Mr. Martin of the GPO finally responded to the Women's Engineering Society's letter of May 1960. In his reply he explains:

Generally speaking, I doubt whether any of the normal duties of Executive Engineers in the Post Office would be beyond the physical capabilities of women but, of course, an Executive Engineer must be conversant with the work of his subordinates and capable of taking an active part in every aspect of it in case of necessity. For this reason the Student Apprentices, like other trainees for Post Office Engineering posts, will have to perform arduous duties some of which we have regarded as unsuitable for women. Examples of such work are:

1. Work on pole routes using, on occasion, the bosun's chair.
2. Manhandling poles and pole jacks on pole route construction.
3. Maintenance on poles during conditions of snow, ice or very cold winds.
4. Excavations of buried cable joints (not in joint boxes or manholes).⁸⁷

The Women's Engineering Society then sent out a circular asking for their members' response to Mr. Martin's explanation. Eight replies were received, only one of which expressed approval of Mr. Martin's attitude:

The idea of British women doing such arduous work is extraordinary. For girl apprentices to do this during the physically formative years is against the laws of Nature.⁸⁸

The other responses, as well as giving examples of girls doing exactly the tasks described, and doing them well, expressed a variety of opinions ranging from 'An Apprentice - girl or boy - is still growing and should not be put on heavy labouring jobs,' to 'In her late teens and early twenties, a girl is as strong and active as any young male' and a reminder that:

The trenches for the complete relaying of electric cables at a large ship-repairing dock were dug entirely by women during the war. The old cables

⁸⁶ Letter from Mrs Wey. Copies of this correspondence are held in The Women's Engineering Society Archives at the Institute of Electrical Engineers, London. Ref. NAEST 92A/3.2.1(i)

⁸⁷ Letter from Mr Meyer dated 13/8/1960. Copies of this correspondence are held in The Women's Engineering Society Archives at the Institute of Electrical Engineers, London. Ref. NAEST 92A/3.2.1(i)

⁸⁸ Response to questionnaire circulated by WES. Copies of this correspondence are held in The Women's Engineering Society Archives at the Institute of Electrical Engineers, London. Ref. NAEST 92A/3.2.1(i)

were also dug up by the women.⁸⁹

Armed with this information the Women's Engineering Society again contacted Mr. Martin, and made the following points:

From your letter it would seem that the real objection of the GPO to accepting a girl as a student apprentice is not that she could not become an executive engineer. It is rather that she would be

1. Unable to perform certain duties normally required of a student apprentice and
2. A bad financial risk.

The letter then summarised the response to their circular and continued:

In response to 2. In our present society the rare girl who wants to undertake a student apprenticeship does so because she is excessively interested. The view that she is a bad financial risk is not held by national or private industries i.e. CEGB, National Area Electricity Boards and AEI. It is not held by all civil service departments, Ministry of Supply apprenticeships are open to girls.⁹⁰

By August 1961 the GPO responded that:

The fundamental objection to recruiting girls as student apprentices is that as our staffing policy at present stands the executive engineer grade in the Post Office is not staffed by women due in large measure to the nature of the training to which recruits to the grade have to undergo.⁹¹

Once again, a circular argument was used; the GPO would not train girls because they had no women engineers: this was because they would not allow girls to train.

In contrast to this were companies such as AEI (formerly Metropolitan Vickers). AEI had employed its first woman engineer in 1915 and continued to recruit both qualified women engineers and girls who wished to train for any branch of technician or technologist work. In her 1961 paper on Women Professional Engineers in AEI, Mrs. Hardwich outlined:

Today there are thirteen girls on sandwich engineering courses, six on drawing office courses and three on day-release courses, making a total of twenty-two girls in training. In addition several enthusiastic girl school-leavers who are working as assistants in engineering design offices but who are not apprenticed are being allowed the privilege of day-release to study for the National

⁸⁹ Ibid.

⁹⁰ Letter from WES to Mr. Martin, dated 24/5/1961. Copies of this correspondence are held in The Women's Engineering Society Archives At The Institute Of Electrical Engineers, London. Ref. NAEST 92A/3.2.1(i)

⁹¹ Letter from Mr. Martin to WES, dated 9/8/1961. Copies of this correspondence are held in The Women's Engineering Society Archives at the Institute of Electrical Engineers, London. Ref. NAEST 92A/3.2.6

Certificate in Engineering.

The trainees far outnumber the women now employed as professional engineers, although these cover between them a large part of AEI activities. They include a motor designer; a rolling mill designer; a transformer designer; a gear development engineer; a telephone contracts engineer; an x-ray research engineer and the section leader of the Magnetic Materials Laboratory at Harlow. A woman senior engineer with much experience of power station construction works with the Nuclear Power Group which handles the nuclear energy engineering side of AEI. There are also several semi-professionals working as technical writers, draughtswomen and engineering laboratory assistants.⁹²

From that it became clear that women could indeed be found in all branches of engineering. AEI were one of the more advanced companies regarding the employment of women engineers, possibly due to their geographic location in an area where competition for good engineers was intense. However, they were not unique. English Electric Ltd also campaigned to attract girls into their engineering departments as did most of the aircraft companies. Many small companies would train girls who approached them, although few of these actively encouraged girls to consider the career.

A survey, carried out by Liverpool University in 1962, was concerned with the employment of women engineering graduates in industry. The survey admitted to being biased, in that it chose to approach companies 'which might be expected to view the employment of women graduates favourably.' These were companies such as AEI who had a reputation for employing women, and those in the newer electronics industries who had no long tradition of all male work forces. The findings confirmed that most opportunities for women were in research, computer programming and design; but they also found some employers prepared to consider women for all aspects of engineering. Regarding career prospects the results showed that the majority of firms said they could offer women engineers comparable jobs and career prospects up to the age of 30. Somewhat fewer firms would be prepared to offer this beyond that age, and less than half the firms in the survey were definitely prepared to re-employ women who took a career

⁹² 'Women Professional Engineers In British AEI.' Draft of paper to be given by Mrs. Isabel Hardwich. Copy held in Women's Engineering Society Archives at the Institute Of Electrical Engineers London, Ref. NAEST 92A/2.3

break to bring up children. The report concluded:

Although in some cases there was an indication of prejudice in engineering against women, firms were in general ready to co-operate in the recruitment of women graduate engineers. The demand is likely to be greatest from the newer and expanding industries, such as companies specialising in the production of electronic equipment e.g. telecommunication, automatic control equipment and computers. Most of the posts available are likely to be in research, design and development or in service functions such as computer programming or library and information work. However the 'pioneering type' wishing to work in some other field of activity, is likely to be able to do so, if she is persistent.⁹³

The survey findings regarding career prospects after the age of 30 highlight the fact that women were at a permanent disadvantage. Either they had children, in which case they were unsuitable for promotion, since it was assumed that they would 'naturally' put their children before their career; or they did not have children. In this case, despite anything they might say to the contrary, they would be expected to become mothers at some point, so promoting them was considered pointless. As with all career women, once a woman was over forty and had proved that she was not intending to leave to have children, she was generally so far behind the men of her age that she was considered unsuitable for promotion anyway.

The comment made by Seear, that girls were not interested in fighting prejudice, was echoed in a comment attached to the questionnaire completed by Dr. Dorothy Fisher:

It was a time when we were very busy trying to push open doors that were barred to women. I felt this was not always realistic, unless there was a press of women waiting to push the doors wide. I recall that Lord Bowden gave a speech to the jubilee lunch of Women's Engineering Society at Manchester. He claimed that the greatest barrier to women's advancement was 'other women' who, perhaps unconsciously, resented women getting into traditionally male strongholds and in countless ways made women who did so feel that they were not quite real women.⁹⁴

She summed up the attitude of many women engineers when she said 'I think I would have got further had I been a man, but I was never conscious of overt discrimination.'⁹⁵ In spite of most women engineers claiming that they encountered no direct prejudice at work, sex

93 'Enquiry Concerning The Employment Of Women Graduates In Industry', The University Of Liverpool, Copy held in the Women's Engineering Society Archives at the Institute Of Electrical Engineers, London, Ref. NAEST 92A/7.1

94 Questionnaire source, see Appendix. 1.30.

discrimination did exist. All the women engineers interviewed for this thesis commented on the fact that they felt they would be seen as representative of their sex. They believed that, if they failed, the company would brand all women engineers as failures; if they succeeded, the company just might give another woman a chance. Such feelings are common to women in any situation where they are in a minority, women in most careers have commented on this, but with the continuing small numbers of women choosing engineering as a career, the situation has continued for far longer than in most other careers. The difficulty is that such feelings are impossible to quantify or verify, however, if a woman felt this it put more pressure on her to succeed in her career. One woman engineer who was interviewed commented that:

When a woman engineer makes a statement on something I think its probably going to be true because she will have spent the time making sure she has got her facts right, whereas men, I think, will often be wrong because they have the macho 'man engineer, I know' attitude.⁹⁶

The tendency to ensure they were right before committing themselves to a statement may have resulted from the belief that any mistakes would be noticed more because of their gender. It certainly put more pressure on women who felt this way, but it had the effect of making them better engineers, a situation that finally resulted in women engineers outstripping their male colleagues in the 2001 survey considered later.

By 1971, with the legislation for equal pay in place, the Engineering Employers Federation admitted:

Where women are employed on jobs which are personally satisfying, their turnover and absenteeism is usually less marked, especially in the later age groups, than is generally believed.⁹⁷

Findings such as this, the implementation of the equal opportunities legislation and the continuing shortage of engineers all combined to encourage employers to take on women

95 Questionnaire source, see Appendix 1.30.

96 Oral history source, see Appendix 1.45 and Appendix 2.

97 *Equal Pay, A Further Paper Of Guidance With Particular Reference To Job Evaluation*, July 1971. Engineering Employers Federation, Copy held in Modern Record Centre, University of Warwick. Ref. MSS193/1. Implementation In Engineering Par.4.4. p.8.

engineers. It has already been shown that while discrimination existed, many companies had not actually refused to employ women, but few women came forward. This continued, in spite of the various initiatives aimed at encouraging women into engineering.⁹⁸ By the turn of the twentieth century, those that did choose to become engineers could reap the benefit of their commitment. A 2001 survey of engineering salaries showed that only those women engineers between the ages of 25 and 29 were earning the same average salary as men. The rest were earning more, a situation explained by one woman in the following terms:

Any woman who has gone through a male-dominated engineering course develops a certain amount of confidence. That helps her later on.⁹⁹

At the same time the Engineering Council found that ‘pay for professional engineers compares very favourably with that of other professions.’¹⁰⁰ In 1991 the situation of women employed by a city council in the Midlands that had a workforce that was 49 percent female was examined. The women only held 14 percent of the senior posts, and 80 percent of the lowest grade posts.¹⁰¹ The survey found a similar situation existed in banking, where ‘nearly one third of all men are working in managerial posts, whilst less than 2 percent of women do so.’¹⁰² Yet women were still failing to choose engineering as a career. Young woman of the year 2000 winner Rachael Beconsall believed that this was due partly to schools not encouraging girls to consider the career, but was mainly due to the image of engineering as a ‘very dirty, shopfloor, mechanical type of job.’¹⁰³ Clearly, while the engineering industry had changed, the public perception of it had failed to keep pace.

98 These subjects are dealt with in the following chapters.

99 Michelle Richmond, Senior project manager at Ubinetics, quoted in ‘Women set pay Agenda’ in *The Engineer*, 4 January 2002, p.10.

100 *Facts About the Engineering Profession*.

101 Susan Halford, Mike Savage & Anne Witz, *Gender Careers and Organisations*. MacMillan Press, Basingstoke, 1997, p.39.

102 *Ibid.* p.46.

The Public Perception of an Engineer

The events of the Second World War had introduced many people to the work done in factories, either from direct experience, or from cinema footage of the factories. This was not particularly good publicity for engineering as a career, since the work featured was generally that done by skilled workers. It can be interesting to watch a piece of metal being transformed on a lathe, the mental exercise required to decide which metal is most suitable and to establish the ultimate shape required for the particular component, taking into account the stresses and strains that it will undergo in use, is less visually exciting. Thus the work of an engineer was generally overlooked entirely or depicted by a quick glimpse of a drawing board and a shot of a brief discussion. With the return to peace Britain's factories, run-down from the lack of maintenance necessitated by the war years, struggled to remain competitive in a world market, leaving little time or money for modernisation, or the publicity that would change the image still carried by the general public. Although there had been an exhibition 'Britain Can Make It' in 1946 to generate interest in good design and to show the world that Britain was still producing high quality goods, this and the Festival of Britain in 1951 were more concerned with the aesthetic side of design.¹⁰⁴ While the BBC in its accompanying programme commented that 'designing something means more than just drawing a picture of what it is to look like; it also means thinking about how it is to be made and making sure it will do its job properly'¹⁰⁵ this was one of the few references to any of the aspects of engineering. The tendency to link engineering with the process of manufacturing, and then ignore both was to continue, as will be shown later. As the shortages of post-war Britain disappeared, consumer spending took off and conditions within the factories improved. Wages were higher and people from all walks of life spent more, particularly on their homes and the new electrical goods

103 Helen Beasley, 'How to Attract Women' in *The Engineer*, 4 February 2000, p.15.

104 'Britain Can Make It Exhibition' in the Victoria and Albert Museum, London in 1946 and 'Festival of Britain Exhibition, 1951.

105 Becky E. Conekin, *The Autobiography of a Nation: the 1951 Festival of Britain*, Manchester University press, Manchester, 2003 p.50.

that filled them. The Festival of Britain had been successful in promoting interest in the many new products in the 'modern style' favoured by its designers.¹⁰⁶ While science and technology were getting more publicity in the mid-1960s, this was mainly focused on scientific breakthroughs or on the artefacts produced by 'new technologies' such as the non-stick coating for saucepans that was developed from work done for the American space project. The publicity generated by America and Russia's race to conquer space meant people came to accept as reality things that once would have been science fiction, such as a man walking on the Moon.

The complexities of science and technology were not suitable for the sort of general presentation given by the media and were often oversimplified in the interests of brevity. One frequently used way to achieve this brevity was to ignore the process of production. This meant that while the public now had more information about what science and technology could achieve, the work done by engineers in producing usable artefacts from the 'breakthroughs' was as little understood as ever. In his lecture 'Humanity and Technology' Hugh Clausen commented:

So little attention has, in fact been given to the industrial arts - of which engineering is one - in the past that the idea is quite widely spread, even among people who should know better, from business executives to university Dons, that there really *is* nothing in them. Nothing at any rate to which they themselves need pay any attention.¹⁰⁷

Yet this very lack of attention to engineering encouraged the acceptance of it as an everyday activity. Hilary and Stephen Rose argued that technology that comes within 'our everyday experience' is more readily accepted than that which relies on a 'cogent grasp' of the scientific procedures.¹⁰⁸ In a country where by 1968 one in four people had a telephone, 15 million had TVs and 11 million had cars, experience of science and technology was more common than ever before.¹⁰⁹

106 Ibid. p.51

107 Hugh Clausen, 'Humanity & Technology' Lecture and discussion 7th November 1966 Society of Engineers reprinted in the Journal of the Society of Engineers Vol.LVII No.4. 1966, p184.

108 Hilary & Steven Rose, *Science and Society*, Harmondsworth, Pelican Books, 1969, p.255.

109 Alan F. Sillitoe, *Britain in Figures*, Harmondsworth, Pelican Books, 1971.

In their 1964 study on Design in Engineering Education, de Malherbe and Solomon claimed that 'the goal of the engineer is to utilise knowledge of the physical world for social benefit. In order to achieve this aim he designs and builds physical objects.'¹¹⁰ However, few looked at the work that engineers were doing and saw it as the important and satisfying job it could be. Nancy Seear found ignorance of the work that was available to be one reason why engineering was considered unsuitable for women. Among the girls in her research there were those who were taking degrees but had delayed deciding on a career. 'Many of these girls were not against working in industry; few of them, however, knew much, if anything about the possibilities.'¹¹¹ In practice, the list of jobs performed by engineers is long, but with many tasks being given different names by the various branches of engineering, and some engineering companies using their own titles for the tasks, such a list would convey little of the work performed. Jobs in Design and Drawing Offices, work on stress and weights calculations, evaluation of research results and the planning and control of production processes were all areas where engineers worked in clean quiet offices. Civil engineers worked 'on-site' for much of the time once a job was in the construction phase, but before this stage was reached time would have been spent in the office on design, planning and costing. The Defence industry and the Aerospace industry both had need for large teams of designers and specialists to perform stress and other calculations before any metal was cut. It is interesting to note that in the 1950s, prior to the widespread use of computers in engineering, women were employed as 'computers' in the aerospace industry. Their job was to carry out the involved mathematical computations which were later to be done electronically. Once a product came 'off the drawing board', design modifications, process planning and many other specialist areas would have an input. Engineers in all these departments worked in offices; they would

110 M.C. De Malherbe & P.J.B. Solomon, 'Design in Engineering Education - A Preliminary Study' sponsored by Clayton Grant 1964. Copy held in the Library of the Institute of Mechanical Engineers, London Ref. (N)(p)378.62.

111 Seear et al., *A Career for Women in Industry*, p.33.

have to visit the factory from time to time, but such visits would be to view work done by others, not to operate the machinery themselves.

The lack of information about this range of jobs, coupled with the memories of noisy, dirty, war-time factories contributed to Seear's comment: 'The preferences given for some jobs and the reasons against others often showed a considerable amount of prejudice and lack of information.'¹¹² One of the conclusions she reached was:

The outstanding fact that emerged from this study was the lack of knowledge among girls, their parents and their advisers, of work in industry - both in engineering and in other industrial openings. Prejudice and sheer ignorance are widespread and can only be dispelled if responsible people in industry take new and imaginative action to give precise information about industrial openings.¹¹³

This situation continued to affect recruits of both sexes. In 1967 *The Sun* suggested: 'ask any bright group of boys and girls what they want to be when they grow up, few children will think of engineering.'¹¹⁴ In 1970 *The Times* claimed:

Ask Mr. or Mrs. Average Citizen about engineering and engineers, and the chances are getting less that their answers will be conjured up from images of men in dirty overalls with a spanner in one hand and a cup of tea in the other, or of the backroom boys (no girls) working on obscure problems slightly out of touch with reality.¹¹⁵

However, little evidence existed that this was the case. By 1980 Sir Montague Finniston in *Engineering Our Future. Report of the Inquiry into the Engineering Profession* pointed out that Britain was failing effectively to harness its creative talent.¹¹⁶ In 1988 *Manpower 2000* reported that 'Engineering is associated with manual and skilled work rather than professional people.'¹¹⁷ This was reiterated in 1995 when a group of engineering students concluded that the Finniston report 'is still relevant today'.¹¹⁸ This study found that while the ideas of what the work of engineers involved improved as children got older, in the 11-

112 Ibid. p.33.

113 Ibid. p.45.

114 *The Sun*, 3 February 1967.

115 *The Times*, 29 September 1970.

116 Sir Montague Finniston, Cmnd. 7794

117 *Manpower 2000*, London, HMSO 1988.

118 'The Birth of an Engineer', Unpublished Master of Engineering Multi-disciplinary Project Report. University of Southampton, 1995/1996.

12 year old group, there was a failure to associate the design and technology subjects they were taught with engineering. Their study concluded that:

Whilst it was pleasing to the team that adults and some sixth form pupils have an accurate idea of what Engineering involves, we considered that by this stage, important decisions may have already been made which limit the individual from the study of Engineering - for example not doing Maths or Physics A-level, or equivalent.¹¹⁹

Thus it can be seen that the public perception of engineering as a career, while changing slightly, has remained largely ill-informed. In 1998 a further study of the attitudes of secondary school children towards engineering found that while one in seven would consider working in engineering, 55 percent of males and 61 percent of females still believed it would be a dirty working environment and 31 percent of males and 50 percent of females thought it would be boring.¹²⁰ The Engineering Council even concluded in its report that young people may 'be less informed about engineering than they were in the 1970s.'¹²¹

Summary

The low status of engineering as a career in Britain was shown to be partly the result of the academic tradition within the universities. Engineering was an unpopular choice for the brightest students, both male and female. The additional demand that women have better qualifications than men before being accepted to study was another reason why few women chose the career. While this discrimination changed after the equality legislation of the 1970s, engineering continued to attract fewer students, particularly females, than other subjects.

It was demonstrated that the decline of Britain's engineering industry resulted in fewer job opportunities, yet there continued to be a shortage of qualified engineers. The

¹¹⁹ Ibid. p.83.

¹²⁰ *Views of Engineering as a Career*, London, MORI/EMTA, 1998.

¹²¹ *Digest of Engineering Statistics 2002*, Summary.

dissatisfaction with the career that led to the brain drain of the 1960s and 70s compounded this and although efforts were made to counteract this, these did not include any attempt to make the career attractive to women. It was shown that since membership of a professional institution was not a prerequisite for employment, the engineering institutions failed to represent the many unregistered engineers, concentrating instead on the chartered engineer level. While they did not discriminate against women, once again no efforts were made to attract them into the career. As with employers, once the equality legislation was in place, only the discriminatory practices changed, efforts to improve recruitment concentrated on men. The fact that women would need to be attracted to the career by different methods failed to be appreciated.

It was shown that prior to the equality legislation, while some companies actively recruited women engineers, others refused to employ women in technical grades. This reflected the public perception that engineering was unsuitable for women, although it was shown that such an opinion could not be substantiated. The lack of publicity given to engineering made it difficult to change public perceptions of the career. While the equality legislation improved the access of women to the career, it did nothing to change public perception. As late as 1988, *Manpower 2000* found 'the image of Science and Engineering in the media is generally poor. Technology is often presented but its link with Engineering is rarely mentioned.'¹²² As long as engineering failed to be given publicity, the public view of it as 'dirty' or 'boring' continued to deter many young people, of both sexes, from considering it as a career.

The publicity given to women who broke into 'male' careers during the 1960s and 1970s encouraged other women to follow them. Engineering did not benefit from this. Women had been practising engineers for many years, and thus there was no chance to publicise 'the first', nor any requirement for a feminist outcry against the refusal to allow women to practise. The feminist writers concentrated on the patriarchal nature of

¹²² *Manpower 2000*.

technology with its indifference to women's opinions and its overwhelmingly military use. Such publicity did nothing to enhance the image of the profession. The impact this had on women engineers will be examined in the next Chapter.

Chapter 3

The Machinery of Dominance

Introduction

This chapter will examine some aspects of feminism that had an impact on women in engineering, using the feminist literature concerning women and technology. It has already been shown that men were generally assumed to have an affinity with technology that women lacked, and that this was reinforced by the way in which goods were marketed. The feminist movement highlighted this as one of the key ways in which women were having technology forced upon them rather than being involved with it. The literature on this will be reviewed, demonstrating how technology was seen as gendered, and the ways in which some aspects have changed since the 1970s, while others have not.

The early feminist literature offered various reasons for the gendering of technology. The military aspect of technology was highly publicised by feminists and that technology, and therefore engineering, was a patriarchal institution was a major tenet of the feminist literature. It will be argued that all western institutions were, and indeed still are, patriarchal, but this did not prevent the feminist movement from fighting for women's rights to join them. This chapter will demonstrate that, in the 1980s, the feminist concern regarding the gendering of technology resulted in engineering being presented in a different manner. Women who chose to become engineers were considered to be different to other women, and some even accused them of 'selling out' their 'sisters'.¹

It will be shown that the public response to the feminist movement has always been more influenced by the media than by anything the movement actually does. Changing attitudes to feminism, however, do not mirror the changing attitudes to women engineers and this will be examined. Women who do choose engineering are frequently described as 'different' by society at large, as well as by feminists. What this difference is assumed to

¹ Ruth Carter and Gill Kirkup, *Women in Engineering, A Good Place To Be?* Basingstoke, Macmillan, 1990, p.171.

be will be traced through feminist writing and through sociological reports. The reactions of women engineers to the suggestion of their difference will be assessed and this will lead on to the subjects of harassment and discrimination. These are emotive areas where some feminists have accused women engineers of refusing to acknowledge what is happening, while women engineers accuse feminists of being unrealistic. Feminist attitudes towards sex discrimination and harassment will be examined and compared to those held by women engineers in an attempt to reconcile the differences between the approach of WISE and similar organisations and those of some feminists.² That WISE offered girls advice on how to 'cope with' situations was anathema to the more extreme feminists who believed this was pandering to unacceptable male behaviour. Engineering was not unique in suffering this and similar behaviour was evident from men towards women in all careers, as will be shown. It will be suggested that the degree of discrimination and harassment prevalent within academic circles may have had undue influence on how feminists viewed the engineering profession.

The Construction of Technology as Gendered

It was shown in previous chapters that in the 1970s society saw engineering as male. With the growing influence of the feminist movement and the introduction of the equality legislation in the mid 1970s it might have been expected that this attitude would change, but there was little evidence of this until the emergence of the communications revolution of the 1990s, which will be examined later. In October 2001 the Equal Opportunities Commission published its research findings on *Young People and Sex Stereotyping*.³ The attitudes reported showed a definite trend towards a more egalitarian view of working life, with an acceptance that all careers were open to either sex, yet the occupations that boys

² WISE (Women Into Science and Technology) was a campaign launched by the Equal Opportunities Commission in conjunction with the Engineering Council in 1984.

³ *Young People and Sex Stereotyping*, Equal Opportunities commission, Manchester, 2001,

and girls expected to follow remained stubbornly close to the old stereotype with engineering only being mentioned by boys. A telling comment made by a 12 year old girl was ‘there are some things that women are better at, like making beds, things like that, men are better at fixing the car.’⁴

Although the advent of the women’s liberation movement in the 1960s and 70s had encouraged women to see and understand how they were being discriminated against, the movement quickly split into smaller groups, each pursuing their own agendas. As Caine pointed out, the term ‘feminism’, while suggesting unity, was used once the movement had been disrupted by the differences in political outlook and sexual orientation.⁵ Such differences were often used by the media to pour scorn on ‘feminist’ attitudes. By only publicising the most extreme views they discouraged many women from finding out what less militant feminists might be arguing for. This rejection of feminism remained despite the changes in women’s lives. Flis Henwood found an ambivalence towards feminism when she conducted her survey in 1998⁶ and one of the younger women interviewed for this thesis assured me that feminism was outdated now, as women could do whatever they wanted. When questioned about the wage gap that still exists, she pointed out that it was up to the unions to fight this, not just women.⁷ In 2003 Cynthia Cockburn admitted that ‘feminism is a word that a lot of women, even activist women, feel uncomfortable with.’⁸ Such comments confirm the findings of Melanie Howard and Sue Tibballs who conducted research for the EOC in 2003 regarding public opinion about equality. They point out that people ‘understand, talk about and tackle these issues (social inequality) in a very different way from “equality professionals” – those promoting equality’⁹ The research discovered that ‘most people – men and women – are sceptical about the claim that women as a sex

4 Ibid.

5 Barbara Caine, *English Feminism, 1780-1980*. Oxford, Oxford University Press, 1997, p.264.

6 Flis Henwood, ‘Engineering Difference. Discourses on Gender, Sexuality and Work in a College of Technology’ in *Gender & Education*, Vol. 10, Issue 1, March 1998.

7 Oral history source, see Appendix 1.57, and Appendix 2.

8 Cynthia Cockburn, *Why Feminist Anti-militarism?* Department of Sociology, City University, London, 1 March 2003. This article is based on a talk given by the author at the Annual General Meeting of the Women’s International League for Peace and Freedom, Nantwich.

9 Melanie Howard and Sue Tibballs, *Talking Equality*, the Future Foundation, 2003, p.7.

are unequal.’¹⁰ In this they echo Rosalind Coward when she asserted that feminism had become one of the most influential movements in twentieth century Britain. According to Coward:

Feminism has been a dramatically successful social movement. It has utterly changed what women can expect from, or do with, their lives. It has also transformed what men expect from sharing their lives with women and how they will behave towards them. Children growing up now simply take for granted feminism’s messages about sexual equality and justice when only thirty years ago such messages were opposed as extremist and threatening to the social order.¹¹

None of the women engineers interviewed were prepared to call themselves feminists although all believed in the equality of women. The term feminist had become debased in the eyes of the general public, whose information about feminism comes from the media. By only publicising the most extreme feminist comments and continually linking the term with behaviour that is depicted as ‘anti-men’ or later with the fringe exponents of ‘political correctness’ the media made the title feminist one which many women rejected.

Although some changes had occurred in attitudes and in the way technology was presented to the public, the central idea of a technological world inimical to women remained. For many years this was reinforced by the way in which technology was ‘sold’ to the public. When Cockburn wrote her influential work on technology in 1985 she asserted that:

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.¹²

While feminists tried to put forward the point that technology was not unnatural for women, the general public were still inclined to believe that women did not understand it, and as more technology entered the domestic arena this became obvious in the way that products were marketed. Technology aimed at men, such as televisions or stereos were

10 Ibid. p.29

11 Rosalind Coward, *Sacred Cows*, London, Harper Collins, 1999, p.1.

12 Cynthia Cockburn, *Machinery of Dominance*, London, Pluto Press, 1985, p.9.

marketed using as much technical jargon as possible, while domestic products aimed at women were marketed by emphasising how much they would improve the woman's life. This was to be achieved either by taking away some of the 'labour' she had to put into running a home; or by improving her production of food or cleanliness for her family.

Transport was one area where the gendered approach to technology was particularly noticeable, cars and motorbikes traditionally being the province of men, women generally being passengers. While many men serviced their own cars, indeed made a hobby out of 'tinkering' with a car, women were assumed to be, and frequently were, put off such activities by the necessity to get 'dirty and oily.' Although more women were learning to drive they were seldom encouraged to understand the engine of a car. In 1954 *House and Garden* ran a car advertisement aimed at women, suggesting that 'woman's intuition' was the best guide a woman could use in choosing a car. Other points the woman was asked to notice were the placing of the rear door handles out of reach of the children and the fact that she could:

Choose [her] favourite colour for upholstery and coachwork from the exciting schemes devised by Mrs. Kay Petre, Austin colour adviser and famous racing motorist.¹³

Mrs. Kay Petre may have been a famous racing motorist, but for marketing purposes her input to the design of the Austin Seven could not be more than the colour schemes. In his examination of the car in British society, Sean O'Connell concluded that in the process of marketing cars as masculine technology, women became associated with the 'frivolous' matters of comfort and aesthetics. He explained how cars quickly became a male icon, and how slow this was to change.

By the mid-1960s only 13 percent of women held a driving licence, in comparison with 56 percent of men. By the 1990s the gap has narrowed, but there are still significant differences within specific age groups.¹⁴

Although a third of all new car sales in 1995 were to female buyers, many women still found that car showrooms were 'intimidating places to visit' and some women resented

13 Ann Shearer, *Woman, Her Changing Image*, Wellingborough, Thorsons Publishing Group, 1987, p.55.

14 Sean O'Connell, *The Car and British Society*, Manchester, Manchester University Press, 1998, p.220.

salesmen who 'still think women buy cars because of their colour'.¹⁵ This was a point made by some of the women engineers interviewed. One commented on the tendency of salesmen to assume that she would not understand the more technical details and admitted:

It's quite entertaining actually...things like cars, it happens as well, when they talk to your husband and ignore you. Umm, no, I don't tend to get annoyed. I just think up a really technical question to ask them and then they get very shocked and it's quite upsetting for them. (Laughs) I don't tend to let things like that worry me, I don't think it does you any good if you do.¹⁶

O'Connell went on to point out that the myth of the woman as a bad driver still persists, in spite of the fact that statistics show a female driver is less likely to be involved in an accident.¹⁷ The car probably highlights most clearly the conflict between the male desire to own and control technology, and women's insistence on being allowed access to it.

If the marketing of cars was gendered, so too was the marketing of white goods. Judy Wajcman pointed out as late as 1991 that 'domestic appliances 'belong' in the kitchen, along with the women, and communication technology such as the television are found in the 'family room'.¹⁸ Susan Ormrod did a study showing how the marketing of the household microwave changed according to its targeted consumer. Originally aimed at single men, for heating up prepared foods, it was marketed as a 'brown good' with the selling points designed to appeal to those knowledgeable about hi-fi rather than cooking, it was then redesigned as a 'white good', with more cooking facilities to 'suit women' and marketed as such.¹⁹ Advertising, which is inextricably linked with marketing, reinforces the attitudes it reflects; this meant that the continual gendering of technology reinforced society's attitude that women did not understand it.

While the percentage of family expenditure on Leisure Goods and Services, many of which would be technological in nature, rose from 10.2 in 1976 to 13.3 in 1990 and 18.4 in

¹⁵ *The Times*, 6 July 1996.

¹⁶ Oral history source, see Appendix 1.47 and Appendix 2

¹⁷ O'Connell, *The Car and British Society*, p.221.

¹⁸ Judy Wajcman, *Feminism Confronts Technology*, Cambridge, Polity Press, 1991, p.107.

¹⁹ Susan Ormrod, 'Lets Nuke the Dinner' in Cynthia Cockburn and Ruth Fürst Dulic (eds), *Bringing Technology Home: Gender and Technology in a Changing Europe*, Buckingham, Open University Press, 1994, pp. 42-58.

2002/3,²⁰ for many years there was little apparent change in the way technology was sold. It was not until the recent spread of communication technology in the form of internet access and mobile phones that a less gendered technique in marketing was adopted. For the first time, a technology was acknowledged as being equally relevant to both sexes and was marketed as such. A recent marketing report described a consumer trend by asking executives to remember when families argued over access to these items.²¹ The report went on to explain that IT manufacturers could benefit from 'marketing previously scarce technological products as bundled commodities and bringing them within reach of all members of a family'²² thus demonstrating that both sexes of the 'entire family' were now seen as a marketing target. However this did not indicate that the marketing was right for women. In 2004 Mia Kim, editor of Popgadget, welcomed the recognition that technology companies were giving to women, but was unhappy about what such companies thought women wanted.

Their solution is to do things like add mirrors to cell phones, make things pink, instead of really dealing with the issue of not marketing to women and not having media or retail outlets that are women friendly.²³

Such comments demonstrate that while the target market had changed the stereotype of what females were expected to respond to remained unrealistic. One result of the slowly increasing percentage of women engineers was the emergence of the Volvo Concept Car. This was the first car designed by an all women team, and although it was not designed specifically for women it has many features that male designers had not considered, such as removable seat covers. Lena Ekelund, engineer and leader of the all-women team, suggested the technology industry needed to look beyond preconceptions. They should be focusing on making user-friendly products and using technologies and functionality that

20 Family Expenditure Survey and Expenditure and Food Survey, Office for National Statistics; www.statistics.gov.uk. 31 July 2002.

21 'Feudless Families' A description of an emerging consumer trend that was featured in an unspecified issue of TRENDWATCHING.COM's free monthly newsletter which was accessed in August 2005.

22 Ibid.

23 BBC News Online Science and Technology. Newswatch, Tuning the Wireless: A Man's Role in the 1950s. 11 October 2004.

improved the users' life, rather than gadgetry for its own sake.²⁴

Feminist Approaches to Technology

In 1985 two key feminist books were published regarding women and technology, these were *The Machinery of Dominance* by Cynthia Cockburn and *Smothered by Invention*, a collection of essays edited by Wendy Faulkner and Erik Arnold. The books highlighted the way in which technology was being used to perpetuate women's subservient position. Cockburn expounded the view that 'technology is a medium of power' and pointed out that '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.'²⁵ Her work argued that although male engineers were controlled by capitalism this was also a male system. She claimed:

With the rise of capitalism, an economic system based on continual advances in technology, men were thrown into perennial conflict 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.²⁶

She insisted that this was a conscious act on the part of men, wanting to keep technology for themselves, and pointed out that women, excluded from 'tough physical engineering work' by its masculinity, were also excluded from 'cerebral, professional engineering' by 'associating masculinity with rationality and the intellect, femininity with the irrational and the body.'²⁷ In *Smothered by Invention*, the way that technology was controlled by men with little regard to the needs of women was clearly demonstrated.²⁸ The book examined technology as a body of knowledge and found that few women were involved in the design stages. It then looked at the impact of some technologies that women were likely to use

24 Newswatch, 11 October 2004.

25 Cockburn, *Machinery of Dominance*, p.7.

26 Ibid. p.9.

27 Ibid. p.235.

28 Wendy Faulkner and Erik Arnold, eds. *Smothered By Invention, Technology in Women's Lives*, London, Pluto Press, 1985.

and showed how they were imposed upon women, rather than being chosen by them. In her essay 'The Exclusion of Women from Technology', Dot Griffiths pointed out that the exclusion started with the development of Britain's industrial age and had continued ever since.²⁹ She highlighted the fact that at school, girls were more likely to drop out of subjects that had a 'male' image, while for those who did take such subjects and went on to study engineering at university, four fifths had been discouraged from taking such a step, thus perpetuating the male image.³⁰ This and the subsequent essays all confirmed the feminist view of a technological world that deliberately excluded women.

Later feminist writers were less critical of the industry, in 1991 Wacjman examined the subject and found that while the link between technology and masculinity was seen as self-evident, in fact it was a very complex issue. She argued that there was a tendency to think of technology in terms of masculine objects, such as cars, rather than feminine ones such as washing machines, although both are artefacts of technology.³¹ She claimed this was a cultural matter rather than an inherent gendering of technology. Wacjman pointed out that the strong link between technology and masculinity pervades all classes, from the shop floor where physical toughness and mechanical skills formed part of the measure of a man's status, to engineers, where technical knowledge conferred power as well as status.

However as she pointed out

That the technological enterprise has developed as a distinctly masculine realm may be largely a reflection of the male domination of all powerful public institutions rather than something specific to the male spirit.³²

In 2001 Faulkner demonstrated that technology continued to be considered male, pointing to the classic case of adolescent boys bonding with their fathers while taking cars apart.³³ She suggested that cultural images of technology were strongly associated with hegemonic masculinity, although she admitted that in practice there was a huge mismatch between

29 Dot Griffiths, 'The Exclusion of Women from Technology' in *Ibid.* p.54.

30 *Ibid.* p.67

31 Wacjman, *Feminism Confronts Technology*, p.137.

32 Wacjman, *Feminism Confronts Technology*, p.140.

33 Wendy Faulkner, 'The Technology Question in Feminism' in *Women's Studies International Forum*, Vol 24, No.1. 2001. p.89.

image and reality.³⁴ She argued that until it was accepted that technology was not gender neutral, as was generally assumed, there was little chance of changing the masculine image it possessed in the public mind.

Feminists did not only decry the patriarchal nature of technology, they pointed out that the whole western civilisation was founded on patriarchal institutions. Many theories were put forward to explain how and why society had developed in this way and why it was not changed by women's suffrage or subsequent equality legislation.³⁵ In respect to feminists of the 1970s Sheila Rowbotham noted 'a tension which has afflicted many radical movements, oscillating between making a separate culture and demanding access to the mainstream.'³⁶ This split in views regarding what feminism means was analysed by Cockburn in 2003 as having three main streams; firstly the women who use it to describe an essentialist theory of women's natural, biological difference from and superiority over men; secondly women whose aim is to get equal by competing successfully with men, which she calls liberal feminism; and thirdly, what she describes as radical feminism, women who see gender oppression as the primary source of oppression.³⁷ While all three theories have their uses in different applications, she suggests that liberal feminism is a personal goal feminism that does not address the underlying problems of a culture that damages both men and women. This is the position from which, in the 1980s, Ruth Carter and Gill Kirkup suggested that women engineers had 'sold out.'³⁸ However, I would argue that the individualist approach taken by every woman when making a career choice is no more a sell out for a woman engineer than for any other career. The need, or desire, to change the patriarchal nature of western society is unlikely to be a major influence on most women's choice of career.

34 Ibid.p90.

35 P. Abbot & C. Wallace, *An Introduction to Sociology: Feminist Perspectives*, London, Routledge, 1996; S. Walby, *Theorising Patriarchy*, Oxford, Blackwell, 1990, and *Gender Transformations*, London, Routledge, 1997; M. Barrett, *Women's Oppression Today*, London, Verso, 1988; R.W. Connell, *Gender and Power*, Cambridge, Polity Press, 1987; and *Masculinities*, Cambridge, Polity Press, 1995, for example

36 Sheila Rowbotham, *A Century of Women*, London, Viking, 1997, p.399.

37 Cockburn, *Why Feminist Anti-militarism?*

38 Carter and Kirkup, *Women in Engineering*, p.171.

One area of concern to feminists was that dealing with the development of weapons. Many people, men and women, were concerned about the proliferation of weapons, from the 'Ban the Bomb' campaign which started in 1958 to the hippy movement of the 1970s with its 'love and peace' slogans, there was worry about the worsening relations between America and the communist countries throughout the world. In 1981 a group of women decided to establish a 'peace camp' outside the American military base at Greenham Common to draw attention to the march from South Wales to Greenham to protest against the siting of American Cruise missiles on British territory. The camp began as a predominantly white middle-class feminist movement but, as the political awareness of the women grew, so did the camp, and it encompassed women from all classes, ethnic backgrounds and sexualities. While the press were largely sympathetic to the aims of the peace camp, much publicity was given to the lesbian nature of some of the women, and public reaction was often coloured by this and many thought the women should return home rather than live in the squalor that pervaded the camp. The camp remained for the next 19 years, closing on 5 September 2000. During its existence thousands of women visited it, and it brought the subject of militarism to the forefront of many women's thoughts. However, the assumption that all women agreed with all feminist opinions regarding weapons was as erroneous as any generalisation. As Cockburn recently pointed out regarding women's anti-militarism groups:

There's a short answer to 'why women', which is also dangerous one. And that is to say 'it's in women's nature to be peacemakers, we're naturally empathetic and caring, it's in the genes, it has something to do with childbearing'. The reason this is a dangerous notion is, first, that evidence continually belies it: for every woman in the peace movement, there's another who's cheering on the troops. To expect women to be naturally unaggressive is a recipe for disappointment.³⁹

The acceptance that women were not a homogenous group, all of whom were anti-militaristic was not evident in some of the feminist research into why women failed to choose engineering as a career. It was often suggested that the military uses of technology

39 Cockburn, *Why Feminist Anti-militarism?*

would repel women, without considering the many non-military uses that benefited everybody, and might be expected to attract women.

In her exposé of the under-representation of women in technology, Dot Griffiths argued that ‘technology is about control.’⁴⁰ As has been shown, some early feminist works on technology concentrated on the way in which women were excluded from it. Their explanation for this was mainly concerned with the belief that men had no intention of giving up any of the power they held over women and, since technology equated to power, they would naturally not want women to have any share of it. In 1985 Cockburn suggested that it was not technology that was ‘out of control’, as many saw it at the time, ‘but capitalism and men.’⁴¹ She advocated a dismantling of the entire gendering system within society, but admitted this would be an enormous undertaking. Her work pointed out that under the existing system both women and men who chose to enter careers that were usually associated with the opposite sex were either masculinized, in the case of women, or portrayed as effeminate in the case of men. Neither of these outcomes was desirable, and since men were the dominant sex women suffered more under the system than men. She also wanted to find a ‘feminist’ technology that would include the many labour saving devices invented by women over the years to lighten their everyday work, she denounced the militarist or ecologically damaging nature of much of technology and suggested that while women needed to understand and become competent with technology, they needed to do so without ‘becoming accessories to exploitation.’⁴²

By 1991 Wajcman suggested that all theories of technology, including a feminist one, were incomplete, as they each ignored one or more facets of the subject. She disagreed with the feminists who ‘adopt an essentialist position that seeks to base a new technology on a fixed and universal set of women’s values.’⁴³ She pointed out that the history of technology was an area where women have been largely ignored and suggested

40 Griffiths, ‘The Exclusion of Women from Technology’ p.60.

41 Cockburn, *Machinery of Dominance*, p.255.

42 Ibid. p.254.

43 Wajcman, *Feminism Confronts Technology*, p.163.

that women's alienation from technology was caused by the 'historical and cultural construction of technology as masculine.'⁴⁴ Wajcman agreed that men's monopoly of technology and women's lack of technological skills were giving men an unfair share of power in western life.⁴⁵ Her book raised a number of interesting concepts about who controlled technology since, while technical expertise conferred power on men, it was only one source of power, and could not override other factors, such as class.⁴⁶

Twentieth century technology is a construct of the patriarchal nature of western society but it also provides the civilised lifestyle that society demands. The desire to overturn the inequalities within society led some early feminists to over-emphasise the masculine nature of technology. By insisting that women were excluded by technology's 'male dominated' attitudes, these feminists reinforced Jane Lewis's comment that 'women's achievements in SET are consistently ignored or trivialised.'⁴⁷ Early feminists called for a reassessment of technology that recognised that everyday artefacts, many almost certainly developed by women, such as a baby's feeding bottle, are part of technology. I believe that this is an example of such trivialisation, since, while such artefacts can be construed as technology, men will see no value in them. As Margaret Lowe Benson pointed out 'areas of male expertise are defined by them as the only legitimate areas of concern; women's whole realm is dismissed as unworthy of serious notice.'⁴⁸ This statement highlights one of the problems that women have regarding technology, men and women do not communicate as equals. Benson suggests that 'men may explain a technological matter to women but they do not discuss it with them.'⁴⁹ Unless women have enough knowledge to generate such a discussion they will continue to be ignored. Gender inequalities exist and, since men will not relinquish their position of

44 Ibid. p.22.

45 Ibid. p.iix.

46 Ibid. p.145.

47 Jane Lewis, *Women in Britain Since 1945*, Oxford, Blackwell, 1992, p.10.

48 Margaret Lowe Benson, 'Women's Voices/Men's Voices: Technology as Language' in Gill Kirkup & Laurie Smith Keller (eds.) *Inventing Women, Science, Technology and Gender*, Cambridge, Polity Press, 1998, p.39.

49 Ibid, p.40.

superiority willingly, it is only by gaining knowledge in male areas of expertise that women can overcome such inequalities.

The Woman Engineer as Different

As has been said, women who become engineers were seen as different by society at large. They were stepping outside the accepted sex stereotype and choosing a job that was unusual, even if it was not necessarily considered unsuitable anymore. They were learning about technology. The difference between women engineers and other career women was the subject of research by Peggy Newton, who examined the degree of femininity (measured by the Bem Sex Role Inventory and the MAFERR Inventory of Feminine Values) exhibited by a group of girls who chose to enter a technician-training scheme.⁵⁰ She compared them with girls in training schemes for business management and nursery nursing, and established that while those training to be nursery nurses showed most feminine characteristics, there was little difference between the other two groups. Newton found that most research suggested female engineers regarded themselves as highly feminine and had strongly feminine interests, but that there was nonetheless a popular feeling that a woman must be 'very tough and masculine to survive as an engineer.'⁵¹

In the late 1980s, Carter and Kirkup conducted a comparative study of the working lives of women engineers in Britain and America.⁵² Their aims were twofold: to provide a specialist study of women engineers for feminists and teachers of women's studies courses, and to describe the experiences of women engineers for engineering educators who were contributing to their development. The study took the same stance towards technology as

50 Peggy Newton, 'Who Becomes an Engineer? Social Psychological Antecedents of a Non-traditional Career Choice' in Anne Spencer & David Podmore (eds.) *In a Man's World*, London, Tavistock Publications, 1987, p.182.

51 Ibid. p.49.

52 Carter and Kirkup, *Women in Engineering*.

Cockburn's work of 1985, and also assumed that there was something in the feminine gender that could not survive without the support of other women. Carter and Kirkup concluded that women should be encouraged into engineering, but they sounded a note of caution regarding the stress that women 'must' suffer in such a male dominated profession. This assumption is not supported by the women engineers interviewed.⁵³ None of the engineers interviewed for this thesis found the lack of female colleagues a problem. The engineering profession is certainly dominated by men, but many women are employed by the industry in clerical positions so that a woman is unlikely to have no female companionship should she need it. Indeed the only woman who made any comment about working without female companionship was a teacher who had taken a holiday job with a small company while she was training. She was employed as a secretary and, as the only female there, she hated it.⁵⁴ The younger female engineers were generally employed by companies who were large enough to employ more than one woman engineer, so it had never occurred to them that there would be a problem. Carter and Kirkup suggested that the women engineers they interviewed all had 'a very strong sense of identity as individuals, rather than members of a category "women".'⁵⁵ There is an impression that they do not consider such individuality normal for women, as they go on to point out that while engineers are 'new women' at work, their home life is much more conservative. While there is no comparison given to other career women, I would suggest that, in respect of individuality, women engineers are probably similar to many women with careers.

Henwood examined the WISE literature and suggested that the desire to combine 'the needs of industry with some notion of equal opportunities for women' had led them to 'ignore the real problem for women in engineering' which she saw as 'continuous informal

53 Ibid. p. 147-152

54 Oral history source, see Appendix 2

55 Carter and Kirkup, *Women in Engineering*, p.152.

discrimination and prejudice.’⁵⁶ Henwood accused WISE of suggesting that women should be offered help to cope with the problem rather than demanding an inquiry that might lead to claims for a change in the work place environment. In her opinion this attempt to make women appear ‘the same as men’ effectively silenced any chance women had to complain since such complaints would highlight their difference. She went on to argue that women who enter male dominated areas of work are seen as deeply threatening to men’s sense of superiority. Her suggestion was that:

We need to understand more about the relationship between gender, sexuality and work and the ways in which both gender and (hetero) sexuality are produced through the construction of difference at work. Only by exploring these relationships more systematically can we begin to understand how and why any radical or transformatory potential of equal opportunities initiatives such as WISE is constantly undermined.⁵⁷

In a later article Henwood criticises the tendency of research into women in engineering to focus on the women themselves, seeking to understand how far and in what ways such women are different from other women. She commented that this has the effect of supporting the notion that the baseline for women are those in traditional ‘women’s work’ and thus women engineers are the exception that prove the rule that women are not suited to engineering.⁵⁸ Her assertion that women reject the notion of being ‘different’ because it is too easily associated with ‘less’ can be applied to the desire not to be different from male engineers, or not to be different from other women.

The one explicit area of difference between women engineers and other women is that women engineers have a knowledge and understanding of technology. In their search for explanations of the behaviour of women engineers this is generally ignored by sociologists who are more concerned about why some women have chosen to acquire this knowledge. Having learned to understand and discuss technology on an equal footing with men, women engineers frequently develop a relationship with the men they work with that

56 Flis Henwood, ‘ WISE Choices? Understanding Occupational Decision-Making in a Climate of Equal Opportunities for Women in Science and Technology’ in *Gender and Education*, Vol. 8, Issue 2, June 1996, pp 199-225.

57 Ibid.p.210.

58 Henwood, ‘Engineering Difference’, pp.35-50.

transcends gender considerations. As one woman who was interviewed put it 'I am an engineer, not a woman engineer.'⁵⁹ This explains some of the dichotomies found by the research mentioned above. Once it becomes possible to ignore gender, then other reasons can be found for inequalities in treatment. A promotion may have been given to man rather than a woman, or vice versa, because they were actually more suited to the position. However, such a gender balance is easily upset. There are men who refuse to ignore the fact that a colleague is female and make inappropriate remarks, or abuse a position of power to restrict a woman's promotions. Women engineers are too often aware that their behaviour, both professional and personal, is highly visible because they are a minority. However, some women engineers are prepared to balance such problems by using their femininity to gain an advantage when a situation arises, gender problems are never one-sided.

Although engineering remained a male dominated profession to a greater extent than almost any other, the amount of discrimination and harassment reported by women engineers was extremely low. One respondent to the questionnaire believed that it was prejudice against women from the top level of management that prevented her career progressing in the Health Service.⁶⁰ That may well have been the case: in *Women in Top Jobs* it was found that 'open-mindedness about senior women seemed in the last resort to depend on the character traits of the men interviewed rather than on their age or seniority.'⁶¹ It also found that 'even senior men who were particularly well disposed towards women felt that the ability of women to organise or exercise managerial functions decreased as the size of the unit grew.'⁶² The book summed up one of the main problems women had when trying to get promotion, which it described as a 'vicious circle' and explained thus:

59 Oral history source, see Appendix 1.27 & Appendix 2.

60 Questionnaire source, see Appendix 1.13.

61 *Women in Top Jobs*. Political & Economic Planning Council, London, George Allen & Unwin, 1971. p.40.

62 *Ibid.* p.43.

If women do not show initiative in actively seeking promotion, they are overlooked, because initiative is a desirable quality in senior management. However, women who have agitated for better prospects or promotion or more equal treatment are branded, only too often it appears, as troublemakers.⁶³

It is often pointed out that there are very few women in senior positions within engineering companies. This is largely due to the circumstances of women's lives, rather than discrimination. Younger women may well reach much higher positions, partly as they no longer have to sacrifice their careers to have children, but also because women are now encouraged to be ambitious in their careers. However, not all women engineers want to take senior roles, many engineers, both male and female, prefer to do an interesting job, at a reasonable wage, rather than a more senior one where the extra money is offset by not only more responsibility, but also very often by a less technical and more managerial role. This was the case with a number of the women who responded to the questionnaire or were interviewed, particularly Linda, who commented that her ambitions changed dramatically after having children⁶⁴.

In her investigation of female surveyors, Clara Greed found that:

Unfortunately the male perception of the women's future careers is often poles apart from that of the women themselves. Women are still, typically, seen as helpers in the work and career progression of others, not as people who will have careers themselves.⁶⁵

This did not appear to be the case for the women engineers interviewed. The younger women certainly assumed they were entitled to careers in their own right, and the older women, hopeful of this at the start of their careers, had seldom been disappointed. Henwood's assertion, referred to earlier, that men find women who encroach on their areas of expertise threatening does not appear to be upheld by women who have been interviewed, either by her, by Carter and Kirkup or by myself. While they suggest this is because women engineers refuse to acknowledge the problem, it may also be that male engineers find the women less threatening because they are in such a minority.

63 Ibid. p.43.

64 Questionnaire source, see Appendix 1.13

65 Clara Greed, 'Women Surveyors: Constructing Careers' in Julia Evetts (ed.) *Women and Careers: Themes and Issues in Advanced Industrial Societies*. London, Longman, 1994, p.152.

The younger women (those born after 1970) who were interviewed were more aware of sexual harassment and more inclined to comment on it. The older women, having come into engineering when women had no legal rights to equal opportunity, accepted that they were interlopers in a male environment and did not expect special treatment. In fact they were generally treated in a civil manner although they had to accept the presence of pin-up calendars and the occasional swear word. Many of the men adopted a protective role towards them, apologising if they thought they might have offended them in any way, and generally helping wherever they could. Such protectiveness could prevent women from gaining the experience necessary to promote their careers, as men assumed they would not want to undertake some duties such as travelling alone. An ambitious woman, such as Elizabeth Laverick,⁶⁶ would soon make it clear that she was not prepared to be treated this way and the problem would be solved. Today women would rightly condemn this behaviour as condescending and discriminatory, but the women affected by it realised that it arose from the best of intentions. Few men today will feel protective towards the women they work with, seeing them as competitors for jobs and promotion. The younger women also expect to be treated as equals in the office and while some men use this as an excuse to be as rude to them as they are to other men, the only incident of harassment commented on was by Evelyn, who found it offensive when a comment was made about her bending over in a tight skirt. While she acknowledged that the comment may have been intended as a compliment, she did not like it. Many women feel that such comments are inappropriate in the work place, and John commented that 'most men don't make personal remarks to women any more, they are too scared, you never know how it will be taken.'⁶⁷ Although it must be remembered that not all women share this attitude, Janet recalled in her early days at NGL she had the reputation of 'the Longest Legs in the Factory' and was proud of it, while many of the older women regretted the passing of the flirting and jokes that enlivened work in their early days in the drawing office.

⁶⁶ Questionnaire source, see Appendix 1.13

⁶⁷ Oral history source, see Appendix 2.

Among the general public, the engineering profession is often assumed to be rife with discrimination, while the problem is rarely considered regarding a career in teaching. Immediately following the Second World War, the changes in education meant that there was a shortage of teachers. Teaching has always been seen as a particularly suitable career for women, combining as it does both caring for children and the nurturing of their abilities, qualities that are considered particularly feminine. In an attempt to encourage many more women into the career women teachers were granted 'equal pay' in April 1955, long before other career women were guaranteed it by the equality legislation of the 1970s. However, women teachers have always been concentrated in the lower echelons of the career. The career suffers from the belief that women are unsuited to management positions, one woman recalling being told in 1973 that 'the headmaster wouldn't even consider appointing a woman to this post.'⁶⁸ The situation has changed little despite the equality legislation of the 1970s making overt discrimination illegal. In 1994 Mac an Ghail found that 'the power of masculinity' operated to 'marginalize and exclude women' in schools.⁶⁹ The different levels of discrimination are highlighted by the fact that while 1.7 percent of the cases brought before the EOC in 1977 were brought by professionals in Science, Engineering and Technology and just 0.3 percent by professionals in Education, by 1980 the situation was reversed, just 4.4 percent being from SET while 26.4 percent were from professionals in Education. In 2001 Marianne Coleman found:

There is a continuing and high level of discrimination faced by women who aspire to senior management in education, the discrimination being fuelled by stereotypes that include the identification of women with their domestic role.⁷⁰

She points out that while the proportions of men and women teachers in the secondary sector are roughly equal, men are three times more likely to achieve secondary headships. Academics suffer similarly. In higher education in 1993 eleven of the thirteen Principals

68 Marianne Coleman, 'Achievement Against the Odds: The Female Secondary Head-Teachers in England and Wales' in *School Leadership and Management*, Vol. 21, No.1, 2001, pp75-100.

69 M. Mac An Ghail, *The Making of Men: Masculinities, Sexualities and Schooling*, Buckinghamshire, Open University Press, 1994, p.29.

70 Marianne Coleman, 'Achievement Against the Odds.'

of new universities were men, and at both principal and senior level of lecturers' men outnumbered women by at least three to one. Not until one drops to basic lecturer scales do the numbers approach similarity.⁷¹ In the Health sphere women were also concentrated in the lower echelons, making up 87 percent of nursing staff and 75 percent of secretaries and clerical workers in 1997.⁷² Yet in 2001 a survey found that in every age group except those over 50, a woman engineer's average salary was 11.9 percent higher than a man of the same age in the same position. When the comparison was made at what age each promotion was achieved, women were being promoted faster than men.⁷³ Discrimination, far from being more prevalent in engineering than elsewhere, seems in fact to occur less frequently than the common misconception suggests.

The issue of sexual harassment is another area where engineering is often expected to have a worse record than teaching, yet 'gender joking' was shown by Cunnison to be used to maintain power relationships among male and female teachers.⁷⁴ Coleman found female head-teachers referred to suffering bullying treatment, and at least one school where female teachers had to undergo a humiliating 'right of passage.'⁷⁵ By 2002 it was reported that women graduates were often less able to cope with institutional sexism than their mothers or grandmothers had been. One woman, not an engineer, compared her life at university with her life at work; she found university 'inspiring' saying she had been told to 'reach for the skies.' Once at work, however, she found 'the egalitarianism I had experienced at college did not exist in the work place. It was all a bit of a shock.'⁷⁶ In contrast, women engineers found more sexism while they were training; one woman observed that 'this is due to the "less mature" state of the male colleagues encountered during the early stages of a female engineer's career.'⁷⁷ She went on to say that once in the

71 Gina Wisker, *Empowering Women in Higher Education*, London, Kogan Page, 1996, p.77.

72 Jane Pilcher, *Women in Contemporary Britain*, London, Routledge, 1999, p.36.

73 2001 Annual Survey of Engineering Salaries. *The Engineer* Vol.4. Jan.2001 p.10.

74 S. Cunnison, 'Gender joking' in S. Acker (ed), *Teachers Gender and Careers*, Lewes, Falmer Press, 1989.

75 Marianne Coleman, 'Achievement Against the Odds.'

76 *The Times* 8 June 2002. 'University and Life Experience.'

77 *The Engineer* Vol 4. Jan.2002. p.12.

business environment sexism was rarely encountered, in this she reflected the views of most of the women engineers interviewed.

Summary

This chapter has shown how the public perception of engineering as a male environment was slow to change. The gendering of technology resulted in the public equating engineering with 'male' objects, such as cars or weapons, forgetting that 'female' objects such as household appliances also required engineering. Such attitudes were reinforced by the way articles were sold to the public, and while this was modified with regard to information technology, other marketing was been slow to follow suit. The changes that have taken place have not yet had time to influence the numbers of women considering a career in engineering. The lack of demand from women for concerted action to increase their opportunities within the career allowed the academic work of feminists in the 1980s to develop along lines that many women engineers believed to be unrealistic, with some feminists demanding a rejection of the existing patriarchal structure of western society, while others accused women engineers of failing to admit to the discrimination they were being subjected to.

It was demonstrated that, while women engineers were often assumed to be different, either from male engineers or from other women, this difference is only verifiable regarding the knowledge they have of technology. One aspect of difference that was commented on was their supposed acceptance of discrimination and harassment. While obvious discrimination in promotion or wages and blatant sexual harassment will be acknowledged by anyone, the less clear cut instances are open to debate. While some women may find swearing offensive, others use the words themselves, similarly with pin-up calendars or sexual innuendo. It was shown that in this instance the views of women

engineers differed from those of some feminist writers who assumed that all women share the same standards.

The feminist response to the under-representation of women in engineering has generally been to see this as a justification of their arguments regarding the maleness of technology. The next chapter will examine the changing availability and style of career advice, and the reasons women engineers gave for choosing the career. Certainly all the women had been recipients of surprised comments on their choice of career, but few of the comments had come from people with a realistic picture of what an engineer did. If 'dirty and noisy' are masculine traits then engineering does indeed have a masculine image, but one that is more due to ignorance than to any patriarchal plot to keep women out.

Chapter 4

An Unsuitable Job for a Woman – Becoming an Engineer

Introduction

This chapter will examine the changing influences on a girl's choice of a gender atypical career. An assessment will be made of the effect schooling had on her chances of becoming an engineer and what impact the equality legislation had on this. A survey of the changes in careers advice available to girls who decided to become engineers will be followed by an assessment of the impact WES had, both on careers advice and on the formation and execution of the WISE initiative. The chapter will then assess the training to become an engineer, and will examine the effect gender had on both the academic and practical training available to women.

The reasoning behind career choice is influenced by a large number of factors, and those that influenced the choice of engineering by the women engineers interviewed for this thesis will be considered. The suggestions regarding the different careers advice requirements of women compared to men will be examined, and the way gender stereotypes restrict the range of careers women choose will be established by an analysis of the numbers of women engineers compared to more typically female careers.

Prior to the equality legislation of the 1970s, many schools failed to teach the physical sciences to girls. Mathematics was often only taught to a minimum standard that left women ill-equipped to undertake the subsequent training for a career in engineering. While this situation was greatly improved after the legislation, problems still arose as gender stereotypes continued to effect the way such subjects were presented and taught. It will be shown that the failure to demonstrate the relevance of technical subjects frequently restricted the access of girls to future training.

After the Second World War careers advice was not always available and for many young people the choice was guided largely by their parents. By the early 1960s, however,

more formal careers advice was available to most youngsters from a variety of sources. Schools, the Youth Employment Executive, engineering companies and the professional institutions all supplied information to those who asked about a career in engineering. Until the 1980s the prime source of advice for girls about careers in engineering was the WES. How its history affected the advice it gave will be analysed here. The later work done by other bodies, assisted by the WES, in helping to set up and run the various initiatives aimed at encouraging girls into engineering will also be examined. By the early 1980s engineering was still suffering from a lack of recruits and the WISE campaign (see Chapter Three) was set up by the EOC to give women the information necessary to decide whether to choose a career in science or engineering. Its successes or failures and various later initiatives will be analysed.

This chapter will show how the training necessary to become an engineer varied over the period and will analyse how much influence gender had on the training received. As has already been mentioned, the history of technical training in Britain had left the profession with a less academic tradition than that favoured by continental Europe. Malcolm Gregory has pointed out that for many years the pathway to becoming an engineer was by indenture or apprenticeship.

The aspiring engineer worked in company with other engineers both in the design office and in the field; he [sic!] absorbed engineering attitude by personal contact, and acquired proficiency in design and construction or manufacturing methods by imitation under guidance, supplemented by learning, well-tryed practical rules.¹

After the Second World War the apprentice system expanded to include a varying amount of academic study. The training undertaken by graduate engineers incorporated a period of apprenticeship, either after getting a degree or on a 'sandwich' course that incorporated it between periods of study. As late as 1966 roughly two thirds of all chartered engineers in a Ministry of Technology study were still non-graduates.² These engineers would have studied at night-school or on day-release while doing their apprenticeship, but at all levels

¹ Malcolm S. Gregory, *History and Development of Engineering*, Longman, 1971, p.150.

women had problems being accepted, particularly for the practical side of an apprenticeship. While the problems of being accepted to do an engineering course at college, or for an apprenticeship, were significantly reduced by the equality legislation of the 1970s, women continued to suffer from discrimination and harassment due to the 'macho' attitude adopted by many training establishments.

Gender Atypical Career Choice.

Sandra Harding concluded that waiting for change from within the engineering industry was pointless as there were too few women to effect such change.³ Until such change happened women would not choose the career in greater numbers, therefore a radical rethink was required. Time has proven that she was right on this point, however the predicted shortage of engineers and the widening of girls interests and access to science teaching following the equality legislation has led to the 'conservative' WISE literature encouraging a steady, albeit slow, increase in the numbers of women becoming engineers. This in turn makes the career more socially acceptable and again contributes to an increase in numbers.

While careers advisors have acknowledged since the 1960s that girls had different needs from boys, little changed in practice. H.S. Farmer pointed out that 'it has been accepted that career theories do not provide professionals with realistic frameworks for effective practice with girls and women.'⁴ However, since the 1980s there have been new career development theories for girls and women. Examples are Gottfredson's theory of 'circumscription and compromise', Hackett and Betz's 'career self-efficacy theory' and the feminist careers counselling theory that seeks to emphasise the limiting structures within

2 *The Survey of Professional Engineers 1966*, The Ministry of Technology HMSO, 1967.

3 Sandra Harding, *The Science Question in Feminism*, New York, Cornell University Press, 1987.

4 H.S. Farmer, 'Women's Motivation Related to Mastery, Career Salience, and Career Aspiration: A Multivariate Model Focusing on the Effects of Sex Role Socialization.' In *Journal of Career Assessment*, Vol. 2. 1997, p.355.

which girls and women live. These theories offer some new ways of assessing girls' choices of careers, but all highlight the limitations society puts on women by assigning gender roles that disqualify them from certain careers. Jenny Brimrose's work agrees that the failure to encourage women into engineering might be due to the nature of careers guidance currently offered.⁵ She comments that careers guidance for many years assumed that the career behaviour and development of women was the same as men's, and 'now we know better'.⁶ She points out that 'more than two decades after equal opportunities the position of women in labour market shows a depressing resistance to change.'⁷ Careers guidance has been based on both differential and development psychology, but these followed studies of men. Many careers guidance experts argue that these theories ignore sex, race and other minority groups. In 1996 Hakim argued that the inadequacy of occupational guidance in schools was one reason why women remained concentrated in low status jobs and suggested that women chose between two polarised lifestyles, a commitment either to work or to family. Hallett & Gilbert disagree, saying their findings showed that women today do not see this as an either or choice.⁸ Some have a conventional pattern where the female takes the major share of household duties and her career is less important, or the partnership is a role sharing one where both partners share in home and both pursue careers. The responses of the interviewees suggest that the second pattern is the one most often adopted by women engineers, indeed the one most 'career' women would adopt. Brimrose concluded that as the aim of careers guidance is to meet the needs of the client and 'this can only be achieved if their real needs are understood.' All such theories must take account of diversity in all its forms, including gender, class, race and sexual orientation.⁹ However, since career choice was not based

5 Jenny Brimrose, 'Girls and Women: Challenges for Careers Guidance Practice.' In *The British Journal of Guidance and Counselling*, Vol. 29, No.1, 2001. p.88.

6 Ibid. p.88

7 C. Hakim, *Key Issues in Women's Work*, London, Athlone Press, 1996. p.215.

8 M.B. Hallett and L.A. Gilbert, 'Variables Differentiating University Women Considering Role-sharing and Conventional Dual-career Marriages' in *Journal of Vocational Behaviour*, Vol.50, No.3, pp.308-322.

9 Brimrose, 'Girls and Women'. p.88.

solely on the availability of information, or the success of role models, the aim of official bodies to increase the numbers of women in engineering largely failed.

Angela Roberts suggested the problem of encouraging girls to consider engineering 'does not only concern higher education but is linked to wider historical and cultural factors.'¹⁰ Julia Evetts pointed out that career choices are not determined by background factors and other circumstance 'although these constrain choice.'¹¹ The women engineers interviewed for this thesis appeared to be more influenced by background factors since many of them said that the convenience of a job close to home was a major influence in their choice of an engineering career. Comparatively few of those interviewed actually set out to become engineers without some previous experience or family influence, such as fathers or brothers who encouraged their interest and directed their initial entry into the profession. This confirmed Anne Marie Wolpe's finding that family influence played a large, if unacknowledged role in attracting girls towards engineering.¹²

The sixty three women interviewed for this thesis gave various reasons for choosing engineering. These reasons showed little change over time, although immediately following the Second World War more women commented on wanting to do something to help rebuild the world, but generally the reasons fell into one of four categories. These could be summarised as:

- 1 An interest in how things worked
- 2 Family influence
- 3 A liking for mathematics or physics
- 4 Chance

However, when the numbers giving each reason are compared over time the change

10 Angela Roger, Catherine Cronin, Jill Duffield, Maureen Cooper & Sheila Watt, 'Winning Women in Science, Engineering and Technology' in *European Education*, Winter 98/99 Vol.30, Iss. 4, pp. 82-101.

11 Julia Evetts, 'Women in Engineering: Educational Concomitants of a Non-traditional Career Choice.' In *Gender and Education*, Vol5, Issue 2. 1993. pp. 167-179.

12 Anne Marie Wolpe, 'Factors Affecting the Choice of Engineering as a Profession Among Women.' Unpublished MSc Dissertation, University of Bradford, 1972, p.118.

becomes apparent. While an interest in how things worked showed a steady increase as the reason, in the 1950s fewer women gave an interest in maths or physics as a reason and more became engineers by chance. Family influence was the reason that changed most, it was given by around 30 percent of those becoming engineers from pre-1950 to the end of the 1960s, but this dropped to 18 percent of those in the 1970s and only 9 percent of those since 1980.

The two main factors, mentioned by most of the women interviewed, were an interest in maths or physics, and the knowledge that they were not interested in any of the traditionally female careers that they were being offered by their schools. The first factor led a number of the women to study either subject at university, and then enter engineering, because the opportunity to put their ability into practice appealed enough to overcome the negative image of engineering. The second factor was still being quoted by women who had left school as late as 1989, some 14 years after the equality legislation that was supposed to have opened all careers to women had come into effect. This demonstrated the importance of the various initiatives to encourage girls to consider the career mentioned previously.

In spite of many initiatives to encourage women into the career, the percentage of women who became engineers remained low. While exact statistics are difficult to obtain, partly due to the inexact definition of who is an engineer, in 1986 the Engineering Industries training board suggested that women made up 4.6 percent of Scientists and Technologists (once again combining these two separate areas as one) and 2.9 percent of Technicians and Draughtspersons.¹³ In 2001 the EOC released evidence that while younger women's qualifications had increased to a similar level to men's, women's participation in engineering was lower than in any other professional group. Women made up just six percent of engineers and technologists. They accounted for 64 percent of

¹³ Engineering Industries Training Board *Occupations of Women Employed in the British Engineering Industry 1986*. London, EITB, 1987

teaching professionals, 32 percent of Legal professionals and 30 percent of business and financial professionals. At technician level, women made up nine percent of draughtspersons, while they accounted for 76 percent of social welfare professionals and 87 percent of health associate professionals.¹⁴ The percentages change when further broken down, age having significant effect on level of achievement as might be expected. Thus it is clear that, while the percentages had increased, the career remained one that very few women chose.

Education and its Effect on Becoming an Engineer

In 1958 the Labour Party issued its Policy for Education in which it explained the tripartite system of education thus:

Grammar Schools claim to cater for the more advanced academic studies; from them, it is hoped, will come the members of learned professions, and the holders of responsible posts in industry and public administration. Technical Schools are intended to produce craftsmen or the more skilled technicians, and the occasional advanced technologist. Modern Schools are intended for the rest.¹⁵

From such a summary of the existing school structure it would appear that even a boy might have had difficulty becoming an engineer if he was only one of 'the rest'. The most he could have hoped for was to become a skilled operative, or possibly a craftsman. Girls suffered an added difficulty due to the poor standard of science and mathematics taught in most girls' schools, many schools continued to fail to teach girls physics, assuming that biology was the only science that interested them. Frequently the teaching of mathematics was also to a lower standard. For example, my own school omitted to teach differential calculus although it was part of the 'O' level syllabus, assuming that girls would have no

14 *Women and Men in Britain, Professional Occupations*, Equal Opportunities Commission, Manchester, 2001.

15 The Labour Party, *Learning to Live: A Policy for Education from Nursery School to University*, London, 1958, pp.25, 26.

need of higher level mathematics.¹⁶ The numbers of girls passing mathematics at 'A' level in 1959 was just 2,828 compared with 20,093 boys, the figures for physics were 2,220 girls and 16,701 boys, while for technical drawing the figures were 846 boys and just two girls.¹⁷ Many of the women who completed questionnaires for this thesis had problems at the start of their training due to this lack of basic education. One remembered she had nearly failed 'A' level mathematics because her teacher 'left us to study on our own a lot,'¹⁸ while another said she felt at a disadvantage because she had not studied technical drawing.¹⁹

In 1963 the Report *Half Our Future* looked into the education of pupils of average and below average ability between the ages of 13 and 16. Since the tripartite education system was in operation in most areas of Britain at the time, that meant mainly secondary modern school pupils. The report followed the accepted wisdom that technology was for boys, not girls. Some remarks were made about girls needing to understand modern technology within the home; but the findings showed that boys got more teaching in science and mathematics, and that technical drawing was only taught to boys.²⁰ The report also showed that while both sexes had craft lessons, those for boys were designed to encourage marketable skills, while for girls the emphasis was on house-craft and childcare.²¹ Similar attitudes towards girls and technology pervaded many of the technical and grammar schools; Nancy Seear's findings confirmed that women frequently suffered from a lower standard of teaching in science and mathematics. Evidence from the Ministry of Education disclosed 'differences ranging from 44.5 percent to 0 percent between schools'; this compounded the discrimination against girls studying technical subjects.²²

16 Questionnaire source, see Appendix 1.64.

17 Copy of draft speech held in WES Archives at the Institute Of Electrical Engineers London. Ref. NAEST92A/2.7.

18 Questionnaire source, see Appendix. 1.8.

19 Questionnaire source, see Appendix. 1.11.

20 Newsome, *Half Our Future: Report of the Central Advisory Council for Education - England*, HMSO, 1963 p.239.

21 Ibid. p.237.

22 N. Seear, V. Roberts & J. Brock, *A Career for Women in Industry*, London, Oliver & Boyd Ltd. 1964, p.10.

The issue of encouraging girls to consider careers in industry led to arguments. Industry blamed the schools for not encouraging girls, but schools did not always get the backing needed. The headmistress of one school wrote to *The Times Educational Supplement* to express her frustration at trying to find industrial placements for girls, a task that she found impossible:

We now feel thoroughly disheartened at the prospects for girls and shall certainly not feel we can recommend this course of action (i.e., trying to place them in engineering) for the future, although both we ourselves and the universities would like girls to have the opportunity of industrial experience before embarking upon an academic course. There may, of course, be firms out there who practice privately what they preach publicly, but we have yet to hear of them.²³

G.B. Harrison, Director of the Schools Council Project Technology, quoted this letter at a conference the project held at the University of Warwick.²⁴ He agreed that the problem was 'only too frequent', but suggested that it should not be given publicity as it might deter schools from trying to get girls into industry. He was of the opinion that there should be no difference made between boys and girls when teaching technology, rather he wanted schools to see technology not as a separate subject, but one that was an integral part of many subjects. He described this as the 'philosophy of the application of knowledge to assist mankind,' but his attitude was never adopted.²⁵

After the equality legislation of 1975 the availability of technical subjects to girls remained patchy, a number of cases were brought before the Equal Opportunities Commission to allow individual girls to study technical subjects. As late as 1982, at one school the parent of a second form pupil complained that she was refused permission to continue her study of technical subjects because it was the schools practice to segregate pupils by sex into either home economics or technical subjects after the first year.²⁶ In 1970 only 0.4 percent of those studying technical drawing were female, by 1981 this figure

23 *The Times Educational Supplement*, 21 March 1968.

24 Conference on Science and Technology for Girls, hosted by the Schools Council Project Technology at University of Warwick 25-26 March, 1968.

25 Ibid.

26 *EOC, 7th Annual Report*, London, HMSO, 1982, p.16.

was 4.3 percent. Similarly physics increased from 6.2 percent to 18.3 percent, while mathematics increased from 35.6 percent to 48.1 percent.²⁷ Some effort was made to encourage girls to choose science and technology subjects, but when the WISE campaign was launched in 1984 the EOC found that the education sector was limited in its support due to budget restriction.²⁸ Courses for girls, such as those run by the EITB and later WISE, were aimed at correcting popular misconceptions about the engineering industry, but the numbers on such schemes were tiny, increasing from 300 in 1976/77 to 1000 in 1980/81. The report on the scheme in 1984 concluded that girls needed 'positive encouragement to consider a career in engineering' and that they were 'ignorant of career opportunities.'²⁹ In the early years, the majority of cases brought before the Equal Opportunities Commission that had a bearing on women engineers concerned the opportunity to study science and technology subjects at school. In 1978 the commission 'received many complaints about discrimination in the provision of curricular options.'³⁰ The situation improved, though only slowly, by 1982 the commission found that while girls were still under-represented in science and technology subjects, the numbers of girls gaining an O level in Physics had doubled during the previous ten years. This led to the hope that 'the importance of a qualification in physical science at 16, for girls as well as boys is recognized.'³¹

The driving force behind the WISE campaign was the encouragement of girls to study science and technology, although the provision of the information necessary to dispel the ignorance of scientific and technical career opportunities was added once the campaign was underway. Initiated in 1984 the campaign highlighted the effort needed to make good the poor quality of mathematics and science still being taught in some girls' schools.

While improvements in teaching did happen, girls continued to take less interest in these

27 *Girls and Technical Engineering*. London, EITB, 1984.

28 *EOC, 9th Annual Report*, London, HMSO, 1984, p.16.

29 *Girls and Technical Engineering*.

30 *EOC, 3rd Annual Report*, London, HMSO, 1978, p.20.

31 *EOC, 7th Annual Report*, p.19.

subjects. The problem was recently examined by Warrington and Younger who found that girls were actually put off physics by the attitudes of male teachers who 'preferred to talk to the boys.'³² The shortage of female science and mathematics teachers made the situation self-perpetuating, a lack of female role models meaning few girls would choose to study these subjects. Many researchers showed that boys heavily influenced the classroom ambience.³³ Pam Harker exposed one result of this when she found that fewer girls in Leeds studied science subjects in co-educational schools than in single sex schools.³⁴ She suggested that curricular reform had made science more interesting to boys than girls because 'the observational and descriptive aspects of science are now stressed less than the manipulative aspects'.³⁵

Careers Advice for Girls

In 1957 the Careers Magazine *Opportunity* carried nine articles about careers for boys in industry.³⁶ They only suggested three careers for girls, the first two being ophthalmic optician and interior or jewellery designer. The third was an article by Mrs. Hardwich, recommending engineering for girls. Most magazines often offered advice on careers; a typical page carried information about joining the Fleet Air Arm for a reader's son, about becoming a Home Advisor with the Gas Board for a reader's daughter, and about secretarial work or working for the BBC for other readers.³⁷ Articles such as these and suggestions from school or family members were often the only sources of information on careers that were considered by working-class girls. Girls from middle-class homes

32 Molly Warrington & Michael Younger, 'The Other Side of the Gender Gap' in *Gender and Education*, December 2000, Vol. 12 Issue 4, p.496.

33 A. Kelly 'Gender Differences in Teacher-pupil Interactions: a Meta-analytic Review,' in *Research in Education*, No.39, 1988. M. Lafrance 'School for Scandal: Different Educational Experiences for Females and Males, in *Gender and Education*, No.3, 1991. J. Swann *Girls, Boys and Language*, Oxford, Blackwell, 1992. M. Younger, M. Warrington and J. Williams, 'The Gender Gap and Classroom Interactions: Reality and Rhetoric?' in *British Journal of Sociology of Education*, No.20. 1999, for example.

34 Pam Harker 'A Suitable Case For Treatment' in *Industry Education View*, No. 4, Summer 1980, p.19.

35 *Ibid.* p.19.

36 *Opportunity, The Magazine for Youth Entering Industry*, Vol.4, No.2, April 1957.

were frequently encouraged to have careers, but could face strong opposition when they wanted an 'unsuitable' career. A number of women engineers interviewed said their parents initially had reservations about their choice of career, not liking the thought of their daughter in a 'factory'. Seear et.al. found that middle-class parents were 'said to be less averse than working-class parents to the idea of their girls having anything to do with industry', but also noted that:

A general aversion to industrial, applied science, traditionally male work, was expressed by the majority of sixth form girls who were interviewed. Those who were proposing to take up scientific work had in mind careers in which girls were already acceptable, chief of which were: medicine, including nursing and medical auxiliary; laboratory work; work in the computing field; research.³⁸

Working-class girls, who were now able to take advantage of their better education to have a career, came mainly from what Michael Carter describes as 'home centred aspiring families' in which the mother seldom worked after marriage since her role was to care for her home and family.³⁹ He pointed out that:

Before marriage, the chances are that the wives worked in offices or as shop assistants - neither they nor their parents would have considered factory or warehouse work suitable.⁴⁰

Girls from such homes were breaking with tradition since a 'career' implied a return to work after marriage; to go further and choose engineering was likely to meet opposition since such 'parents think in terms of 'good' jobs for the boys and 'nice' jobs for the girls.'⁴¹ Added to that attitude was the fact that such a girl's father may well have had experience of life in a factory and did not want his daughter to have similar experiences. Many girls from working class families never thought about having a career. Even those who attended grammar schools were more likely to leave before the sixth form in order to start work.⁴² Early leaving was less of a problem for working class boys who left before

37 *Woman and Home*, July 1961, p.6. Copy held in the Archives of the Castle Museum, York.

38 Seear et al., *A Career for Women in Industry*, p.27.

39 Michael Carter, *Into Work*, Harmondsworth, Penguin Books, 1966, p.41.

40 Ibid. p.41.

41 Ibid. p.45.

42 Ibid. p.20.

the sixth form, since they frequently took up apprenticeships, thus continuing their education while working. Many of these boys went on to become competent technicians, as will be shown in the next chapter, but a similar route was not generally considered to be suitable for girls. The importance of marriage has already been stressed and few girls thought about the years after their children were grown up even though most would later return to work. Hayes and Hopson made the point that:

Girls who assume that they will not be resuming work when they have completed their family will not give serious consideration to the need for long-term career planning.⁴³

Many of the women interviewed spoke of being pushed towards favoured careers by their school. These were normally teaching or nursing, with banking, the civil service or social work also being acceptable to most schools. Such pressure may have deterred some girls from taking up engineering but others simply persevered and obtained the necessary information from other sources. Some schools were very helpful when a girl expressed an interest in engineering; mixed sex schools had an obvious advantage in that they usually had all the information available since many boys would be expected to be interested in becoming engineers. Even some single sex girls' schools were pleased to encourage a girl when she expressed a preference for engineering as her choice of career. One took the trouble to arrange for a pupil to attend technical drawing classes at a nearby boys' school, since the subject was not taught in her own school.⁴⁴ The women engineers who completed questionnaires for this thesis had varying reactions from their schools to choosing engineering as a career, some had been actively helped, but a few had been discouraged, one commented that her school disapproved of girls having any connection with 'trade', they should only be academic.⁴⁵ In her 1972 thesis, Wolpe pointed out that women suffered a lack of 'vocational awareness' about scientific careers compared to men,

43 J.Hayes & B. Hopson *Careers Guidance: The Role of the School in Vocational Development*, London, Heinemann Educational Books, 1972, p.21.

44 Questionnaire source, see Appendix 1.21

45 Questionnaire source, see Appendix 1.10

her sample had ‘overwhelmingly’ denied being influenced by their schools towards a career in engineering, with some forty-six percent being actively discouraged.⁴⁶ The comments she recorded were similar to the ones offered by those who completed questionnaires, ‘the headmistress thought I was not able to carry heavy machinery. She was more concerned with producing a ‘young lady’ than with letting someone follow their interests.’⁴⁷ Or the comment that the school ‘didn’t know what to advise and discouraged me, they liked ‘their girls’ to go into teaching, nursing and banking’.⁴⁸

During the 1950s and 60s a number of reports were commissioned by the government to gain an understanding of what was needed within education to ensure a continuing supply of suitably qualified labour. The fears that Britain would not have enough engineers to remain competitive in world trade was always present and in 1956 the chairman of the committee that produced the white paper on scientific and technical education, Mr. R. M. Weeks pointed out that the reserve of talent among young people that was not being developed was ‘greater among the girls than the boys.’⁴⁹ He went on to suggest that, as the ambition to marry would continue to be important to girls:

Progress in recruiting more girls and women for courses in technical colleges depends on their recognition that further education will help and not hinder the prospects of a happy married life.⁵⁰

In 1958 the Carr report, *Training for Skill; Recruitment and Training of Young Workers in Industry* emphasised the need to encourage more youngsters to train as technologists and technicians and the Youth Employment Executive issued a booklet in response to this.⁵¹ The thirty-six-page booklet has only one page on ‘Opportunities for Girls’ on which it expresses a hope:

46 Wolpe, Unpublished MSc Dissertation, p.119.

47 Ibid. p.119.

48 Questionnaire source, see Appendix 1.7

49 Cmnd. 9703, *White Paper for The Development of Scientific and Technological Education*. H.M.S.O., 1956, .par. 91, p.21.

50 Ibid par. 91, p.21.

51 Carr, *Training for Skill; Recruitment and Training of Young Workers in Industry*, National Joint Advisory Council, Ministry of Labour, London, HMSO, 1957.

That employers will not discourage suitable girls who wish to be trained under apprenticeship or similar arrangements purely because it has been traditional to train boys.⁵²

In 1959 the report '*15 to 18*' stressed the need for educators to realise that the trend towards earlier marriage and childbearing left girls with more opportunities to return to a career later in life. It was suggested that there were a number of careers open to girls that involved some further education but not to degree standard, these were careers such as teaching, nursing, commerce and secretarial work. The implication was that these careers were suitable and should be enough to satisfy girls. Disparity of opportunity was ignored. While 210,000 boys were taking industrial courses of higher education as part-time students, only 4000 girls were doing the same.⁵³ 36 percent of boys got apprenticeships, but only six percent of girls were offered apprenticeships, most of which were in the clothing industry.⁵⁴ Such discrepancies were explained by the comment that:

A girl has a much shorter expectation of uninterrupted working life than a boy. It is this fact rather than the nature of the work she does or any deliberate sex discrimination, that explains how unlikely she is to get part-time day release.⁵⁵

The whole report emphasised the necessity of training more engineers, technologists, technicians, craftsmen and operatives if Britain's engineering industry was to remain competitive, yet it did not follow up Mr Weeks' suggestion that girls should consider these options. In this the report reflected society's attitudes, the attitudes that were also prevalent within most girls' schools. Such reports provided the background information behind the Industrial Training Act of 1964, which was supposed to 'ensure a good supply of properly trained men and women in industry.'⁵⁶ By 1967 the Secretary of State for Education and Science was asked 'what plans were being made to increase the total numbers of girls training to become engineers and scientists?' to which he replied 'all the

52 *Training for Skill*, London, HMSO, The Youth Employment Service, 1958. p.28.

53 Crowther, *15 - 18; Report of the Central Advisory Council for Education - England*, Vol.1. Report, London, HMSO, 1959, pp. 322,323.

54 *Ibid.* p.338.

55 *Ibid.* p.338.

56 Engineering Training Board Bulletin ETB24, February 1965, copy held in the Modern Record Centre, University of Warwick, Ref. MSS44/TBN101/3.

work in hand applies to girls equally with boys'. The response to this was a further question:

Does not there still exist in the country the feeling that science and engineering are not for girls, and is not there a good deal of wasted ability and talent as a result?⁵⁷

The Secretary of State for Education and Science, Mr Goronwy Roberts, agreed and admitted that 'a good deal needs to be done to prove among others to employers, that girls have a capacity for engineering and technology.'⁵⁸ Unfortunately this acknowledgement of girls' capabilities did not lead to any comprehensive action to change attitudes.

The Youth Employment Service was publicised as offering vocational guidance for all school leavers, but in the early 1960s this was not a realistic possibility. As Hayes and Hobson pointed out, there was a shortage of Youth Employment Officers, they were not all properly trained and many schools failed to give them enough time, or to supply the necessary information for the officers to provide genuine help to school leavers.⁵⁹ The service did produce information booklets, but as the majority of women were not expected to have careers, less attention was paid to their needs. In 1959 a series of booklets on the choice of careers issued by the Central Youth Employment Executive listed 101 titles, only two of them specifically for girls, *Engineering Work for Girls* and *HM Forces, The Women's Services*.⁶⁰ Of the remaining 99 some 41 would probably have been deemed unsuitable for girls. In practice most of the women who were prepared to train for a career chose between teaching, commerce and nursing.⁶¹ All were areas where women were nominally accepted on equal terms although, due to family commitments, women seldom reached positions of responsibility. Nursing was an exception, there men were in the minority and a female hierarchy had developed.

57 *Hansard*, Vol. 751, Col. 942, 27th July 1967, London, HMSO, 1967.

58 *Ibid.*

59 Hayes & Hopson, *Careers Guidance*. p.2.

60 *Choice of Careers*, Central Youth Employment Executive, Ministry of Labour & Central Office of Information, London, HMSO, 1959.

61 Cmnd. 9703. Par. 91 p.21.

The Youth Employment Service was part of the Ministry of Labour and National Service and was segregated into Boys' Officers and Girls' Officers whose functions were to 'know all about careers. [The officers] are willing to answer enquiries and send printed information.'⁶² None of the women interviewed for this thesis had been given information on engineering by the Youth Employment Executive, possibly because they would have seen the Girls' Officers who would not have considered engineering to be a suitable career. My own experience was of being seen by the boys' officer because the girl's officer had gone sick. He saw me in her room because that was where all the information on careers for girls was kept. When I expressed a desire to become a draughtsman, he returned to his own room for the information.⁶³ Many girls who wanted a career had decided what they wanted to do long before reaching an age at which they were offered advice. Much of the early careers advice was aimed at ensuring potential recruits knew the qualifications and training they would need for any particular career. The choice of career was left to the person concerned, who often had little knowledge of the options available. Veness conducted a study in 1962, which claimed that girls were generally lacking in ambition; secondary modern girls were at the lowest point on the scale of ambition with grammar school girls above them. Secondary modern boys came just above grammar school girls, but even they were seen as lacking any real ambition.⁶⁴

The shortage of recruits to the engineering profession forced some companies to target girls. Metropolitan Vickers ran an Easter vacation course for 40 boys and girls in 1957, aimed at giving them a clear idea of what working in engineering was like.⁶⁵ Other companies, such as British Railways and the Electricity Board ran similar schemes 'but these are normally for older boys who are prospective apprentices' Carter concluded in

62 *The Work of the Careers Mistress in the Secondary School*, London, The Association of Assistant Mistresses in Secondary Schools, 1960, p.6.

63 Questionnaire source, see Appendix 1.64.

64 Thelma Veness, *School Leavers - Their Aspirations and Expectations*, London, Methuen, 1962.

65 *The Woman Engineer*, Vol. 8, No.5. Summer, 1957, p.5.

1966.⁶⁶ One company, English Electric issued a careers leaflet in the early 1960s that suggested:

Perhaps one of your brothers is now a graduate or student apprentice with us. Among the graduates we have recruited a small but steady stream of young women engineers, physicists, mathematicians, chemists. Now we are thinking of recruiting the grammar school sixth form girl. There is no reason to suppose that girls are any less academically capable than boys. For industrial jobs they may even be more suitable, notably in laboratory work. The only thing is, how can we get girls to consider so unexpected a career as engineering?⁶⁷

The booklet admitted that people thought of engineering as 'dirty, noisy and strenuous, a matter of manual skill and strength, a trade not a profession.' It introduced girls to the ideas of design, planning, research and the other areas of engineering to which they could be recruited.⁶⁸ Other firms did not go so far as to produce booklets, but still viewed the idea of training women favourably.

The Professional Engineering Institutions all issued booklets on careers in engineering and while none of them excluded women, there was little effort to encourage women into the profession in the years following the Second World War. It was assumed that the few women who did want to become engineers were exceptions and would be treated as such. By 1960 only the booklet published by the IEE actually mentioned girls taking up the career.⁶⁹ The IMechE tried to promote an interest in engineering among school children in 1964 in conjunction with the BBC. The sub-committee charged with this initiative suggested that 'in view of the envisaged expansion of higher education still more of the abler boys should be attracted into mechanical engineering.'⁷⁰ From such comments it becomes clear that, while not deliberately excluding women, no attempt was being made to include them. Efforts at recruiting young people into the profession continued to be aimed at boys intending to become technologists, as was shown by the

⁶⁶ Carter, *Into Work*, p.76.

⁶⁷ English Electric careers leaflet 'Think About Engineering' p.3. Copy held in WES Archives at the Institute of Electrical Engineers, London Ref. NAEST 92/5.5.

⁶⁸ *Ibid.*

⁶⁹ *The Chartered Electrical Engineer*, London, The Institute of Electrical Engineers, 1960.

⁷⁰ Council Minutes 18/3/64, Promotion of Interest in Mechanical Engineering Sub-committee. Copy held in the IMechE archives, London.

decision concerning the career film sponsored by the IMechE. The film was aimed at 'young people who are choosing their career' and was to 'concentrate on presenting the life of a chartered mechanical engineer mid 20 to mid 30 years old,' inevitably, at that time, he was shown as a man.⁷¹ By 1969 the predicted shortage of engineers forced a change in attitude and the ICE commissioned a report into *The Role of Women in Engineering* that concluded 'the number of women in engineering in Britain is pathetically small, i.e. out of 42,500 members of ICE only 60 are women.'⁷² The report went on to say that the failure to encourage women was 'a waste of talent which Britain cannot afford' and blamed the failure on 'ignorance and the shortcomings of our educational system.' The IEE were also attempting to encourage women. In 1969 they produced a careers film documenting the work of Anne James, who started as junior in the office of an oil company and did day release to become an engineer.⁷³ This was followed a year later by another film showing five women in the different disciplines of Electrical, Electronic, Civil and Mechanical engineering in an attempt to encourage girls to consider the career.⁷⁴

The Women's Engineering Society and WISE

One of the women who completed the questionnaire for this thesis remembers being taken by her mother to a WES conference in 1957. This was what made her decide to become an engineer.⁷⁵ The topic of the conference was 'Careers for Girls in Engineering'

71 Education Committee Report Ref. E/18/67 dated 9/3/67. Copy held in the Institute Of Mechanical Engineers Archives, London.

72 'Report of a Working Party on the Role of Women in Engineering,' in Proceedings of the Institute of Civil Engineers, Vol.48 Jan-April 1971, p.344.

73 Film 'Profile of an Engineer' Cat. No.Uk2663 1969, Institute Of Electrical Engineers Archives, Ref. NAEST 92/9.4.

74 Film 'The Engineer Is A Woman' Cat. No.Uk1883 1970. Institute Of Electrical Engineers Archives, Ref. NAEST 92/9.4.

75 Questionnaire source, see Appendix 1.6.

and the speakers were four women who had progressed in their careers.⁷⁶ The importance of role models to girls who were interested in engineering is difficult to gauge. Some of the interviewees had never had a female role model and did not feel the need of one. Others were full of praise for the women who encouraged them; the knowledge that other women had succeeded in engineering careers gave them the confidence to continue themselves. Many of these role models were members of the Women's' Engineering Society, one in particular who was praised by many women engineers was Mrs. Isabel Hardwich of Metropolitan Vickers Ltd. Manchester. She had been a postgraduate apprentice there and had become their Supervisor of Women; this gave her responsibility for recruiting female technical staff and overseeing their training. In a paper written in 1957 on 'Women Professional Engineers in British AEI' she claimed that more than a third of all women chartered electrical engineers in Britain had connections with AEI.⁷⁷ Since 1923 a total of 230 women had benefited from full time training with the company, 155 of whom were still employed in engineering. The encouragement from such a company was very useful to girls who lived close to Manchester; girls in other areas were not necessarily so fortunate.

The WES booklet of 1958 gave girls a great deal of information on the types of work and training available; the problems of getting accepted were made clear, but not allowed to dominate. In the introduction it said:

It would be misleading to pretend that entry to the profession is as easy for girls as it is for boys. On the other hand there is now no reason why a girl with talent and determination should not embark on an engineering career with every prospect of success. She is advised, however, to equip herself fully with formal qualifications.⁷⁸

76 Prospectus for Conference on Careers for Girls in Engineering, naming; Miss J.D. Targett, Assistant Section Leader in the Wind Tunnel Department at Vickers Armstrong Aircraft Ltd.; Mrs R. West, Electronic Development Engineer at GEC; Miss Mary Fergusson, a partner in the firm of Blyth & Blyth Consulting Engineers; and Miss W. Haskett, Head of the Mathematical Physics Section at English Electric. Held at The Modern Record Centre, University of Warwick, Ref. MSS292/134/3

77 Typed draft of paper held in the WES Archives at the Institute of Electrical Engineers, London, Ref. NAEST 92A/7.3

78 V. Holmes, & L.S. Soultter, *Training and Opportunities for Women in Engineering*, London, The WES, 1958. Introduction.

The society, being the prime source of information on a career in engineering for women, was realistic about the problems girls would face. The booklet suggested that 'Engineering is not the right profession for one who expects her way to be made easy, for the work of an engineer consists largely in overcoming difficulties.'⁷⁹ The comment is made that entry is easier in some branches of engineering than in others, electrical, electronic and aeronautics are quoted as being more ready to accept women, although why this should be so was not explained, a point that will be examined later. Girls were warned that there was still prejudice against putting women in control of large numbers of men and that this might limit a woman's career prospects.

One highly qualified woman engineer, Dr. Dorothy Fisher, who worked at Metropolitan Vickers, found herself getting involved with careers advice in the early 1960s. She was a member of WES and used her contacts with the society in conjunction with her experiences at Metropolitan Vickers. She remembered the girls were anxious about working with 'all those rough men.' She reassured them that they would not find this a problem since she said the shop floor workers she had contact with were all 'natural gentlemen' in their dealings with her. She felt that a girl's natural interest in the social content of engineering as applied to everyday life should make engineering a more attractive career than pure physics. As she had started as a physicist at a research station before becoming an engineer she could offer advice on both careers, but recalled that she had to emphasise that:

Being an engineer did not necessarily involve spending one's days on ones' back under some machinery with an oily rag and a spanner sticking out of one's pocket.⁸⁰

In 1967 WES were involved with an 'Engineers Day' at the Science museum in London designed to encourage young people of both sexes to consider careers in engineering. The Ministry of Technology declared the day 'a great success' with 180,000

⁷⁹ Ibid. Introduction.

⁸⁰ Questionnaire source, see Appendix 1.30.

visitors, 2,570 of whom attended a variety of talks. Of these 175 attended a talk on 'Women in Engineering' and 55 attended a film and talk 'Living with Technology' by Elizabeth Laverick.⁸¹ Such exhibitions and other efforts continued to promote the career among girls and with the changes following the equality legislation WES continued its work, although some felt that such an organisation was unnecessary 'since most of the barriers to women becoming engineers have been cast down.'⁸² One article, having made this point, went on to admit that 'the numbers of women going into engineering is still small and women are regarded as something of a novelty when they do.'⁸³

While WES supported all women engineers and offered advice to women in all fields of engineering, there was a predominance of electrical engineers among the founding members of the Society. Later the aeronautical engineering field was also well represented, but few women from other disciplines took leading roles in the society. The prevalence of engineers from the electrical and aeronautical disciplines within the WES may have given rise to the belief that women were more suited to work in these areas and that they were less biased against women engineers. However, many women chose other disciplines and succeeded. Mary Fergusson was advised not to choose civil engineering, but persevered anyway and proved that the Society could be wrong.⁸⁴ Other women also chose civil engineering and found little prejudice, similarly fields such as Heating and Ventilation attracted women like Jane Gardiner.⁸⁵ Mechanical engineering also boasted a number of women, the IMechE having 28 women members in 1961.⁸⁶ One member of the WES summed up the attitude of the society at that time, recalling being seen as an oddity when she went to meetings in the 1960s since she was a mechanical engineer, not electrical or aeronautical.⁸⁷ Such an attitude did not survive the equality legislation of the 1970s,

81 Report on Success of Engineers Day at Science Museum. Copy held in Modern Record Centre, University of Warwick, MSS200/C/3/EDU/11/7.

82 Elaine Williams, 'Man Is Still Ruling The Engineering Roost' in *The Engineer*, 26 April 1979, p.30/31.

83 Ibid. p.30

84 Questionnaire source, see Appendix 1.02.

85 Jane Gardiner, *Memoirs of a Woman Engineer*, Lewes, The Book Guild Ltd., 1990

86 Institute of Mechanical Engineers Journal, 1961 Vol. 175, p.369.

87 Questionnaire source, see Appendix 1.03.

although among women engineers as well as men there are those who believe that some tasks are 'difficult or even impossible for the female sex.'⁸⁸

After the equality legislation of the 1970s, WES concentrated on providing comprehensive careers information for girls. As was mentioned earlier, by 1983 the Equal Opportunities Commission was concerned that girls were still not getting a fair deal in technical and science education. With the support of the Standing Conference on School Science and Technology and the Annual Conference of the Association for Science Education an initiative was launched to publicise the need for girls to study these subjects. During the planning of the campaign by the Equal Opportunities Commission and the Engineering Council it became clear that there was a requirement for more and better careers advice for girls and women. The WISE (Women Into Science and Engineering) Campaign was set up with a wide agenda, the effort to attract more girls into science and engineering was seen as requiring attention to each of the following areas: tertiary education, youth training and careers guidance, post experience and continuing education and in career progression.⁸⁹ In the first area, that of tertiary education, it was suggested that courses similar to the Insight courses run by the EITB should be made widely available, the lack of science and maths education should be addressed, along with a comment that financial support should be available for any mature women wishing to resume their education. It was also pointed out that academic staff needed to be aware of the problems women faced when in a minority along with a suggestion that the number of women lecturers 'must be increased, by removing age discrimination and by offering part-time posts.'⁹⁰ The importance of communication skills to a technical career was stressed along with the comment that girls' abilities in this skill must be recognised. The subject of youth training and careers guidance gave rise to comments on the narrowness of the contemporary training schemes that often limited the options open to girls and the lack of

⁸⁸ Questionnaire source, see Appendix 1.06.

⁸⁹ EOC draft document for the WISE campaign, p.130. Copy held in the Fawcett Library.

⁹⁰ Ibid. p.131

knowledge about engineering careers evident among many advisors from both the Youth Employment Executive and schools was deplored. The EOC found that while there was a universal endorsement of the aims of WISE, the amount of support from schools was limited, many being unable to organise or sponsor projects. One of the outcomes of this was the creation of the WISE Vehicle programme. This was co-ordinated by the engineering council and involved many engineering companies who sponsored the conversion of the vehicles into effective mobile classrooms, offering the chance for schoolgirls to use various technologies. The vehicles proved to be extremely successful and continued to be run until spring 2003, alongside a number of joint initiatives with the Engineering Employers Federation and the various education establishments.⁹¹

The other main problem that quickly became obvious was the lack of suitable careers information for girls who were interested in engineering. An EOC report on the WISE campaign admitted that, while the Commission was not a careers advice service it was:

Forced to adopt this role because there was no one else whom the girls felt they could approach for support and advice. It is significant that so many girls felt unable to approach those people whose job it is to produce advice – careers teachers, advisers and representatives from further education / higher education and industry.⁹²

In her study in 1971 Wolpe found that 75 percent of boys who chose engineering as a career had done so by the time they were 16. The majority of the girls in her study had not reached this decision until after they had sat their 'A' level exams (generally aged 18), she also found that some 46 percent of the women had been actively discouraged from pursuing such a career by their school.⁹³ 15 years later Peggy Newton's findings repeated this, she commented that:

Unlike male engineers, most women make the choice of engineering relatively late in their school careers. They choose engineering out of an interest in mathematics and see engineering as having a greater social value than male engineers.⁹⁴

91 By this time the vehicles, some of which were twenty years old, were considered too costly to run. Also the access of SET subjects to school girls was much better.

92 EOC, *9th Annual Report*, p.16.

93 Wolpe, Unpublished MSc Dissertation, p.118.

94 Ibid. p.62.

Newton also found that teachers and careers advisors were unlikely to suggest engineering as a career, but were 'very likely to discourage women from engineering and to suggest that it is a job which is unsuitable for a woman.'⁹⁵ Julia Evetts discovered the same when she conducted her research in 1993. She added that some women chose engineering against the advice of their school, although individual teachers, generally with some experience of industry, acted as mentors to encourage some girls to take it up.⁹⁶ This problem was to set the tone for much of the literature produced by the WISE campaign as it aimed to solve the problem. In the 1990s the WISE campaign was joined by SET (Science, Engineering and Technology), a government initiative aimed at encouraging men and women to consider careers in these areas. Women in SET sought to encourage girls to study technical subjects and pursue careers in science, engineering or technology.

The WISE campaign offered girls comprehensive information about careers in engineering, along with clear guidance on where to seek more detailed advice and succeeded in giving teachers, parents and girls' themselves some idea of the opportunities engineering offers. Work by both Evetts and Flis Henwood supported the fact that advice became available to girls from a wide variety of sources.⁹⁷ However, in spite of the availability of this advice, few girls or women undertook the training necessary for a career in engineering.

Academic Training

Training to become an engineer in Britain incorporated two disciplines, the

95 P.D. Newton. 'Becoming a Female Engineer: Sex Role Self Concept and Sex Role Attitudes in Occupational Choice.' Unpublished PhD Thesis. University of Kent, 1986, p.44.

96 Evetts, 'Women in Engineering' p.167.

97 Julia Evetts, 'Women In Engineering,' and Flis Henwood 'Wise Choices? Understanding Occupational Decision-making in a Climate of Equal Opportunities for Women in Science and Technology' in *Gender and Education*, June 96 Vol.8, Iss.2, pp199-225, for example.

academic and the practical. A technologist would require more academic training, to degree level, while a technician generally had less, sometimes as little as a single subject at ONC or BTec level, taken at night school in the local technical college. Apprenticeships ensured that alongside this academic study, the practical aspects of engineering were studied, particular emphasis being placed on those relevant to the company that sponsored the apprentice. Prior to the equality legislation, as Dame Mary Smeeton pointed out in 1964:

There is no formal barrier to girl apprentices but even the official guide to engineering openings for girls carries a warning that very few firms will accept them.⁹⁸

In Britain technical education started early with part-time courses being held in trade schools and business or union institutes from the middle of the nineteenth century.⁹⁹ Most technicians were trained on the job, although this generally included day-release at a local technical college. The Engineering Industries Training Board showed a total of 2,506,430 males, employed in the engineering industry at the end of May 1959. The figure for females was 803,270, thus females made up 32 percent of the labour force but only 0.05 percent were studying at all, showing how small a percentage of female workers were being trained. The survey went on to say:

Boys training to be technicians usually serve a five-year apprenticeship and are sometimes known as student or engineer apprentices. They are normally given a wider but less intensive practical training than craft apprentices and more stress is laid on technical education.¹⁰⁰

The figures for students enrolled in part-time day courses on 23 October 1959 showed that 19,105 men were studying for Higher National Certificate and only 68 women, a mere 0.35 percent. For Ordinary National Certificate the figures were 59,238 men and 425 women, slightly better, but still only 0.7 percent.¹⁰¹

98 Dame Mary Smeeton DBE MA, *Some Trends in the Employment of Women*, The Inaugural Dame Caroline Haslett Memorial Lecture. Delivered to the WES 11th March 1964, London. Copy held in WES Archives at the Institute Of Electrical Engineers London.

99 G.A.N. Lowndes, *The Silent Social Revolution*, Oxford University Press, 2nd Edition, 1969, p.150.

100 *Recruitment and Training of Young Persons in the Engineering Industry*, Engineering Employers Federation, London, 1962, p.6.

101 Ibid. Table 62, p.213.

The Report '*Education in 1959*', suggested: 'Looking forward to 1961, the council found good reason to believe that the total output (of scientists and technologists) would by then be about 18,450, and that the technical college contribution would by then be over 9,000.'¹⁰² The type of qualification would be Ordinary or Higher National Certificate or Ordinary or Higher National Diploma, and in 1962 the comment was made that 'although most technician apprentices probably still study by day release the use of block release and sandwich courses is growing.'¹⁰³ In 1963 a question was raised in a letter to a newspaper, asking why the local engineering course was only open to boys. The reply said the lack of response from girls led the authority to modify their entry requirements for the courses to exclude girls, and went on to add: 'If any requests were received from girls for entry to such course the authority would no doubt give further consideration to the matter.'¹⁰⁴ The tendency to put the onus on girls to push their way onto such courses highlights one reason why so few girls became engineers. Social attitudes decreed it was unsuitable, many companies would not recruit them and to be told, when enquiring, that a course was not open to them could well be the end of their aspirations. The Engineering Employers Federation report gave predicted figures for November 1963, showing 20,231 studying for Higher National Certificate and 33,870 studying for Ordinary National Certificate on day release. Once again, no information was given about how many of these were girls, but a further breakdown of students under 18 released by their employers to study engineering subjects gave an average at 30.2 percent of all boys employed but only 7.1 percent of girls.¹⁰⁵

Male attitudes towards women on the shop floor made it unlikely that a girl would be considered for a craft apprenticeship. Some girls were offered technologist

102 Cmnd 1088, *Education in 1959*, Report of the Ministry of Education and Statistics for England and Wales. London, HMSO, 1960, p.37.

103 Ibid. p.7.

104 'Ystrad Mynach College Of Further Education - The Engineering Course Is Only Open To Boys', cutting from unidentified newspaper dated 15/1/1963. Reply from E. Stephens, Director Of Education, Glamorgan County Council. Copy held in WES Archives at the Institute of Electrical Engineers, London Ref. NAESt 92a/3.4.2.

105 *Recruitment and Training of Young Persons in the Engineering Industry*, Table IV.

apprenticeships, although the previously mentioned difference in the education for girls could present difficulties in getting the necessary starting qualifications, particularly since colleges and employers frequently demanded better qualifications from a girl before they would accept her. With the advent of equality legislation women were given access to all apprenticeships, allowing them equal access to training, and colleges could no longer refuse to take them. From the 1990s there was also a widening demarcation between craft and technologist apprenticeships. The reduction of the numbers of engineering companies, most of whom now offered fewer apprenticeships, and the growth in the numbers attending university, students were expected to decide before they started training whether they were going to become engineers or craftsmen.

Following the Second World War, a student who wished to become a chartered engineer was expected to get a degree in engineering from a university. This would require the student to get 'placements' in industry during long vacations to gain the necessary practical experience. Once qualified an employer would take them on as a graduate apprentice to increase their practical experience, before they were accepted as an engineer. However, Britain desperately needed qualified engineers and in the 1950s, the National Advisory Council for Industry and Commerce had developed the block release, or sandwich, course, on which the student attended college for only two years out of the five spent training. Diplomas were generally awarded by colleges of advanced technology (CATS) that had been established in 1956 to provide a wider based, more commercially useful training to supplement the highly academic and mainly arts based education offered by the universities. G. Lowndes stated:

In the mid 1950s more than three-quarters of the students who obtained professional qualifications through colleges of technology did so by part-time study only. The important engineering group (4,000 in 1955 and about 5,500 in 1957) outnumbered the university-trained engineers by two to one and probably five out of six of these had qualified by attending part-time courses.¹⁰⁶

106 Lowndes, *The Silent Social Revolution*, p.340.

By 1960 nine CATS were operational, their syllabuses had been planned in collaboration with industry to ensure that what was taught was relevant to the needs of the country.¹⁰⁷ The establishment of CATS and the introduction of the Diploma of Technology gave much more opportunity for technical training. Figures for the *New Supply of Qualified Manpower* show that in 1960 3,423 students were employed upon getting their first degree in engineering and technology while just 179 students getting their Diploma in Technology were newly employed in 1960.¹⁰⁸ By 1963 the Engineering Industry Training Board could state that 4,938 students were studying for the Diploma in Technology on sandwich courses in England and Wales. A further 4,079 were studying for the Higher National Diploma on sandwich courses with 105 studying full time. The Ordinary National Diploma had 540 sandwich students and 1,789 full time students.¹⁰⁹ In 1960 the first woman was awarded a Diploma in Technology, she was 24-year-old Miss Shirley Wallis, employed at the Royal Aircraft Establishment, Farnborough.¹¹⁰ The following year another woman employed there, Mrs. Maureen Jones, was also awarded a Diploma in Technology, which she had studied on a sandwich course.¹¹¹ In 1962 the first woman to be awarded the Electrical Engineering Diploma was a Miss Judith Gardiner, aged 22.¹¹²

The overall numbers of students that took engineering and technology courses at university also increased, although slowly, at the start of the 1960s, going from 13,597 in 1960/61 to 14,942 in 1963/64.¹¹³ Fewer girls went on to study anything at university, 7,194 girls against 20,823 boys in 1960, a ratio of 1:3.¹¹⁴ Many more boys went on to do technology and engineering courses; the ratio of girls to boys doing technology courses was only 1:250. Of all the women engineers who completed questionnaires only three

107 Cmnd 1088, p.36.

108 *Statistics of Science & Technology*, Dept. of Engineering & Science, Ministry of Technology. London, HMSO, 1970, Table 23, p.50.

109 Engineering Industry Training Board, 'Training in the Engineering Industry', Paper T.C.3, Dec. 1964, Table 4. Copy held in the Modern Record Centre, University of Warwick Ref. MSS44/TBN102/1.

110 *The Woman Engineer*, Vol. 18, No.16, Spring 1960.

111 Questionnaire source, see Appendix. 1.3.

112 *Daily Telegraph & Morning Post*, Feb. 21st 1962, article by Elizabeth Prosser.

113 *Statistics of Science & Technology*, Table 39, p.96.

114 *Annual Abstract of Statistics 1961*, Central Statistical Office, London, HMSO, 1962, Table 121, p.112.

were studying engineering at university in the early 1960s; the first, who studied mechanical sciences at Cambridge University, was on a scholarship from the Central Electricity Generating Board.¹¹⁵ She remembered the boys on her course as being curious about her but friendly and protective once they got to know her. She had problems with the vacation placements she was to undertake with the CEGB to gain practical experience since, as a woman, she was not allowed to work night shifts. She had been fortunate in that both her parents were engineers and so she had a good engineering background; although they discouraged her ambitions until convinced she was really determined. She was also lucky in her school, it was one that had a good standard of mathematics and science teaching; this school accepted her ambition and allowed her to attend a local technical college on a part-time basis during her final two terms to make good any deficiencies in her education. The second woman who was at university in the early 1960s studied physics at London University, and remembered that her lecturers had tried to persuade her to stay on and do research as they thought work in industry was a waste of talent.¹¹⁶ The last of the women was less fortunate, she remembered, 'I felt very isolated, even lonely, as the only girl in a class of 60 students - I was not very extrovert so I missed out on collaboration.'¹¹⁷ That was a problem some women faced when entering a male dominated environment, and one that feminist writers were to make much of.

One woman engineer who completed the questionnaire was employed at Metropolitan Vickers.¹¹⁸ She had eight 'O' levels when she started to study at Salford College of Advanced Technology in 1959; but her achievement of coming first in her class for HNC did not change the attitude of Mr. W.P. Baker, the principal, who felt it was a mistake to encourage women to study engineering. That led to a correspondence between him and Isabel Hardwich that prompted a letter from her in 1961 commenting sarcastically:

115 Questionnaire source, see Appendix. 1.6.

116 Questionnaire source, see Appendix. 1.8.

117 Questionnaire source, see Appendix 1.22.

Everyone knows that girls are not interested in engineering and that they couldn't do it if they tried as the mathematics would be beyond their poor brains. Even when they do get a paper qualification, they aren't any use because they won't get dirty, they can't be put in charge of men, and anyway they always get married and forget all about engineering!¹¹⁹

That letter parodied the attitude of many at the time and showed the frustration felt by a woman who knew what girls could achieve. As an engineer herself Hardwich felt she was better situated to understand what was involved in the career than a college principal. In her position as Supervisor of Women at Metropolitan Vickers she was able to demonstrate that training was no more wasted on a girl than it was on a boy. Fortunately the woman concerned cannot have come into contact with Mr. Baker, since she found her time at Salford CAT very enjoyable and commented that her instructors were supportive and treated her as the equal of the boys. She added that as she was bright they could not 'talk down to me'. Another woman was not so lucky. She started doing a Diploma in Technology but found her lack of technical drawing and her lower standard in mathematics and science made the course very difficult.¹²⁰ She changed to an O.N.C. course and only returned to get her Diploma in Technology after completing the lower level course. She remembered the boys on her course had varied reactions to a girl student; some ignored her; others tried to date her and she ended up marrying one of them.

Another woman did a Diploma of Technology on a sandwich course at Bristol CAT.¹²¹ Like the last woman, she found herself at a disadvantage compared to the boys, due to her lack of practical experience. She found their reaction to her was one of amusement or indifference but she did not face any open hostility. She still has fond memories of a professor who gave her a lot of help and encouragement during her apprenticeship, even going so far as to encourage her to make spare parts for her car in the practical classes, rather than tools she would never need. She admitted that some

118 Questionnaire source, see Appendix. 1.10.

119 Copies of this correspondence are held in the WES Archives at the Institute Of Electrical Engineers London, Ref. NAEST 92A/2.6

120 Questionnaire source, see Appendix. 1.11.

121 Questionnaire source, see Appendix. 1.9.

apprentice supervisors could be difficult, but the amount of discrimination a woman faced was entirely dependent on her individual contacts. One woman found herself elected spokes-person for her group and remembered her lecturers as 'interested in my ambitions, very helpful and in some instances allowing an added perk'.¹²² Very few of the women interviewed faced open hostility although all admitted to coping with a certain amount of disbelief in their abilities.

In 1965 the changes to Britain's higher education system, prompted by proposals of the Robbins committee were announced.¹²³ The proposals were modified allowing for two types of higher education, i.e. universities and polytechnics; the latter were to be created out of the better technical colleges and the colleges of advanced technology. Polytechnics were supposed to be the equal of a university, but concentrating on technology and vocational training rather than the purely academic training offered by universities. Universities would continue to offer engineering degree courses, but the diplomas offered in the polytechnics would supplement these. A typical sandwich course was that proposed by the Enfield College of Technology, this was to lead to a BSc or a BSc (Hon) and comprised an initial three-week spell at college followed by supervised work in a relevant industry. This was to be followed by another, longer, period at college during which:

The student will be required to spend part of his summer vacation in reading and in writing a minor project report. It is also intended that students shall have this single opportunity during their four-year course of taking a longer vacation and will be encouraged to travel.¹²⁴

The entire course lasted four years and involved full time attendance at college during term time and full time work in industry during the vacations from college. Many companies would also require the graduate to do another year as a graduate apprentice to gain more practical experience before considering them an engineer. Such a long-term commitment to training meant many companies refused to consider girls, since it was assumed they

122 Questionnaire source, see Appendix 1.3.

123 Cmnd 2154, *Robbins Report On Higher Education*, London, H.M.S.O., 1962

124 Proposal for a Course at Enfield College Of Technology. Submitted to The Council For National Academic Awards in May 1965. Copy held at The Institute Of Engineering Designers, Westbury Wiltshire.

would get married and so the training would be wasted.

In 1965 it was stated that the target of 218,000 university places was within the capabilities of the existing academic institutions.¹²⁵ Not all academics welcomed an expansion of the university system. R.D. Anderson commented that 'during the grammar school era, the function of the universities was seen as producing an elite of 'leaders' from a limited pool of ability' and expanding the numbers of places would simply dilute this elite pool.¹²⁶ Others foresaw that the dual system of degrees and diplomas would result in the existing tendency to place more worth on academic subjects than applied science becoming even more prevalent. However, the idea that technology was not as valid a field of study as the more academic subjects, mentioned in Chapter Two, was beginning to change. At the Second International Conference of Women Engineers in 1967, Dr. Jackson claimed:

Concern about the dichotomy between humanities and sciences and about over-specialisation within the sciences and engineering has already given rise to changes and new developments in education, both in schools and universities.¹²⁷

Yet attempts to get women to take engineering courses were failing. By 1968 only 0.326 percent of students on engineering courses were women.¹²⁸ The common belief that men had a natural affinity with technology which women did not possess was felt to be sufficient justification for demanding better qualifications from women, before giving them the opportunity to train. In her survey in 1971 Wolpe found:

Of the total of men students only sixteen percent scored between nine and fifteen, as compared with fifty five percent of women in the same groups. These findings are similar to those reported in an empirical study carried out in the United States. Women engineering students were 'intellectually' outstanding.¹²⁹

Thus although the 'best' men were failing to take up engineering degrees, women who

125 Cmnd 2846, *University Grants Committee Annual Survey 1964-65*, London, HMSO, 1965, p.5.

126 R.D. Anderson, *Universities and Elites in Britain Since 1800*, London, Macmillan, 1992, p.62.

127 *The Woman Professional Engineer*, discussion at the Second International Conference of Women Engineers, held in Cambridge, 1-9th July 1967.

128 *Annual Abstract of Statistics No. 107*, Table 122, London. H.M.S.O., p.113

129 Wolpe, Unpublished MSc Dissertation, p.98.

wanted to take applied science faced a different problem, and Wolpe concluded that there was a basis for

suggesting that universities discriminate in the recruitment of women engineering students by demanding better 'A' level grades in physics, mathematics and chemistry, than they expect from male students.¹³⁰

The universities also practised another form of discrimination by limiting the places available for women on the courses offered. One of the women who completed the questionnaire remembered 'they would not accept me at one university because they had already filled the two places they allocated to girls on the course.'¹³¹ This was not unique to engineering courses, Nickie Charles pointed out that 'in the late 1960s many medical and veterinary schools used quotas to restrict the numbers of women entrants.'¹³²

Following the equality legislation such blatant discrimination came to an end. It was replaced by a more insidious form of discrimination as some male tutors belittled and alienated female students. Many feminists conducted studies proving this, Henwood quoted an example of a male tutor who was furious at a request that pin-up calendars no longer be displayed. She points out that he assumed equality for women meant they had to accept the same conditions as men, rather than men changing to accept women on equal terms.¹³³ Dot Griffiths had commented on similar instances of discrimination and found that female students suffered from a lack of assumed background knowledge and a feeling of isolation.¹³⁴ In 1984, an EOC report based on the findings of the WISE initiative pointed out that lecturers needed to be aware of the special needs of women students, but such needs were largely ignored. Efforts to combat this were hampered by the shortage of women lecturers in engineering subjects, in 1993/4 the ratio of male to female lecturers in UK universities was 8:1, for professors in the same discipline it was 96:1.¹³⁵ In 2002 a report from the Athena project commented that 'it is in everyday practices such as

130 Ibid. p.72.

131 Questionnaire source, see Appendix 1.35.

132 Nickie Charles, *Feminism, the State and Social Policy*, Basingstoke, Macmillan Press, 2000, p. 80.

133 Henwood, 'WISE Choices?' p.207.

bullying, stalling, sabotage, manipulation and spite that gendered power relations in academia are maintained.’¹³⁶ One way suggested to overcome such problems was mentoring. While its effect on women engineers will be examined in Chapter Five, it also helped female academic staff in SET disciplines, ‘forming the Project Team brought together women within the Institute who had previously only passed in the corridor.’¹³⁷ This way of reducing the feelings of isolation among women in minority groups may ultimately have the desired effect of increasing the numbers of female lecturers. However, by 2005 the EOC was still reporting that ‘the respondents suggested that some of their lecturers found it difficult to understand why women want to train in non-traditional areas, which resulted in low expectations of their capabilities’ and ‘some of the students experienced overt negative and discriminatory comments from male lecturers.’¹³⁸

Practical Training

While most technicians were offered apprenticeships prior to the equality legislation, as has been shown, it could be difficult for a girl to get an engineering apprenticeship. In 1951 one woman engineer who completed the questionnaire had been given an apprenticeship although, even this soon after the end of the war, she was not expected to do the two and a half years that the boys did in the machine shop.¹³⁹ She found this an advantage as she did only a short spell there and was then seconded to various other departments which apprentices did not usually get the chance to experience. Removing

134 Dot Griffiths, ‘The Exclusion of Women from Technology’ in Wendy Faulkner and Erik Arnold, (eds.) *Smothered By Invention, Technology in Women’s Lives*, London, Pluto Press, 1985. p.67,

135 *Universities’ Statistical Record, University Statistics 1993-1994*, Vol.1:Students and Staff, 1995

136 Diane Bebbington, Athena Project Equality Challenge Unit, ‘Women in Science, Engineering and Technology: A Review of the Issues’ in *Higher Education Quarterly* Vol.56, No 4. October 2002, pp. 360-375. In 1999 the Athena project was launched, this was given the specific task of improving the retention and advancement of women scientists in higher education employment.

137 *Mentoring Women in SET*, Bolton Institute, Athena Project Report 1. ref.

www.bolton.ac.uk/technology/news/mentor

138 Angela Dale, Norris Jackson & Nicky Hill, *Women in Non-traditional Training and Employment*, Occupational segregation Working Paper Series No. 26, Institute for Employment Studies. London, EOC.2005. p.22

139 Questionnaire source, see Appendix. 1.31.

women from the shop floor was a sign of the way many employers would treat girls in the future; the title 'Trainee', or 'Technical Assistant', was given to most girls, to differentiate the fact that they would not receive the same practical training as boys. Only two other women who completed questionnaires had actually been taken on as apprentices in the 1950s. When the first did her apprenticeship she found 'the lecturers and instructors were usually impartial, which I appreciated, though they did tell me that, with a girl in the group, the boys worked much harder.'¹⁴⁰ The other woman also did exactly the same work as the boys and thoroughly enjoyed her time on the shop floor.¹⁴¹ In a paper presented to the 6th Annual Conference of the British Association for Commercial and Industrial Education in 1957, Mrs Hardwich stated that in most electrical and aeronautical companies a girl could 'partake in all the standard student and pre-graduate apprentice training schemes already open to boys'.¹⁴² At the same time a small company making electrical switchgear in the West Country had two girl apprentices out of a total of ten.¹⁴³ Other companies took on girls in junior technical posts such as tracers or technical clerks and allowed them to train if they showed the necessary aptitude, although they often refused to allow girls to be given apprenticeships and kept them segregated from the boys.

In 1958, ten percent of firms who were members of the Engineering Employers Federation ran technician apprentice schemes. By 1961 that had risen to 15.4 percent employing a total of 9,097 technician apprentices between them.¹⁴⁴ Most of these were between the ages of 17 and 20, the most usual entry qualification being GCE 'O' levels in one or more subjects. A memorandum from the General Secretary of the Confederation of Shipbuilders and Engineering Unions to representatives of the National Joint Body for the Recruitment and Training of Juveniles for the Engineering Industry expressed 'the need to revive in many areas the local apprentice training committees'. In the report of the ensuing

140 Questionnaire source, see Appendix. 1.7.

141 Questionnaire source, see Appendix. 1.31.

142 Typed draft of paper held in The WES Archives at the Institute of Electrical Engineers, London, Ref. NAEST 92A/2.5.

143 Information supplied by a male engineer doing his apprenticeship at the company in the 1950s.

meeting the point was made that:

Girls should not be discouraged from taking up apprenticeships, industries should see what can be done to make this possible.

Response: the sub-committee is not against this proposal, and it is understood that there are a few girl apprentices in the engineering industry.¹⁴⁵

The economics of taking on apprentices are difficult to assess, as the value of a well-trained workforce cannot be easily calculated. In spite of the lower rates paid to apprentices during the 1960s, a boy apprentice being paid approximately a quarter of the average male wage, the costs of allowing time off for training had to be taken into account.¹⁴⁶ Some firms ran their own training schools, 369 firms in 1961, but even so the wastage of apprentices leaving before completing their training was 36 percent.¹⁴⁷ That may have accounted in some measure for the gradual erosion of apprenticeships in this country. The Engineering Employers Federation booklet on the employment of apprentices showed that in 1961 there were 351,823 skilled men and 75,361 apprentices in 78.9 percent of the firms in the Federation. The ratio of apprentices to skilled men by size of company showed that large companies, those employing 2000 skilled men and over, had a lower ratio of apprentices at 1:8 than smaller companies. Firms with less than 20 skilled men had a ratio of 1:3.¹⁴⁸ However, as most of the firms not included in the survey were smaller ones, the implication being that while some small companies had a good apprentice ratio, others may have not bothered with apprentices at all.

The British Employers Federation and the Trades Union Congress had established the Industrial Training Council in 1958 to encourage and control training. Most apprentices were on 'craft' apprenticeships and many firms were still filling 'technician' vacancies by promoting craft apprentices who were prepared to continue their studies, or by finding a suitable job for a 'student engineer' who did not meet the requirements for a

144 *Recruitment and Training of Young Persons in the Engineering Industry*, p.21.

145 Memorandum from H.G. Barrett 4/7/1961 and point 23 in minutes of meeting, copy held in the Modern Record Centre, University of Warwick Ref. MSS44/TBN 23/7.

146 *Annual Abstract of Statistics 1962*, Central Statistical Office. London, HMSO, 1962, Table 152, p.128.

147 *Recruitment and Training of Young Persons in the Engineering Industry*, p.1.

148 *Ibid*, pp.14-15.

'technologist'. In 1961 the Engineering Employers Federation reported 7,178 'technician' apprentices in 379 firms were being trained for 41 different occupations.¹⁴⁹ The apprenticeships were mainly offered in the light engineering and electrical fields; 193 of the 379 firms covered being in these. Geographically London and Birmingham offered more apprenticeships, 152 of the 379 firms being in these areas.

Girl apprentices were taken on by only 39 of the firms in the survey and were being trained for only 12 of the 41 occupations.¹⁵⁰ The one occupation that differed from the ones open to boys was the position of Laboratory Assistant. That, like tracers, was an example of a level only applicable to women that was classed as above craft level but below technician. The number of girls doing technician apprenticeships was a mere 0.01 percent of the total number of technician apprentices covered by the survey. The section on girl apprentices comprises the figures given above, but the text is short and is quoted in full below.

The number of firms employing Girl Apprentices in the 1961 survey shows an increase of over one-third more than the number in 1958. The number of Girl Apprentices employed has increased by nearly 60 percent. However the number of employers and employees is still too small to allow of any valid comparative analysis.¹⁵¹

The survey estimated that in 1963 the total number of boys doing apprenticeships was 22,889, the number of girls was 136.¹⁵² There had been a decline of apprenticeships over the years and the Ministry of Labour statistics quoted by the Engineering Industries Training Board showed:

A steady increase in the number and proportion of apprentices recruited up to 1961 but there was a falling-off in 1962 and an even more pronounced one in 1963.¹⁵³

That was in direct contradiction to the government's expressed desire for greater training. In December 1964 the Engineering Industry Training Board issued a paper on Training in

149 Ibid, p.9.

150 Ibid, p.11.

151 Ibid, p.22.

152 Ibid, p.11.

153 'Training in the Engineering Industry', Paper T.C.3, par. 18. p.7.

the Engineering Industry covering the period 1959-1963. It established that there were:

Four main levels of entry to the engineering industry - as trainee operator, as craft apprentice, as technician apprentice and as graduate apprentice. Ideally all involve both technical education and practical works training, though in varying proportions.¹⁵⁴

Many girls were given training which approximated an apprenticeship but omitted the practical training that boys underwent as this was considered unsuitable. Occasionally girls were encouraged to undertake extra practical work to ensure they were as good as, if not better than, the boys who were also being trained, although one woman found a problem during workshop practice, because she was not heavy enough to operate some of the older machines that needed brute strength.¹⁵⁵ Like so many facets of any career, once a girl got a position within a company what she made of it was very dependent on the circumstances and personalities involved. One woman taken on as a trainee remembered, 'men loved to explain things.'¹⁵⁶ She was allowed to do exactly the same work as the boy apprentices, although she could not be classed as an apprentice. Another was a 'technical assistant' and received a 'thorough training throughout the shop floor and every department of the company.'¹⁵⁷ One man remembered the girls he trained with all had a better standard of education than he had.¹⁵⁸ He admits that in spite of their obvious intelligence and capabilities, and the fact that the company that trained him encouraged girls to take up engineering work, their options would be limited. They could become either a Tracer in the Design Office or, if they completed a five-year apprenticeship and gained a minimum of Ordinary National Certificate they might be offered a position as a Junior Draughtsperson. Their other option would be as a technical clerk in the progress or planning office or possibly in the buying department. He was training alongside two girl apprentices when he first started with the company. He remembers that they were already

154 Ibid, p.2.

155 Questionnaire source, see Appendix 1.58.

156 Questionnaire source, see Appendix. 1.1.

157 Questionnaire source, see Appendix. 1.25.

158 Oral history source, see Appendix. 2.

well ahead of him academically but that they were not allowed to undertake the more 'manual' parts of the apprenticeship that a boy did. This had a limiting effect on what they would eventually be qualified to do.

The position of Tracer was one that was only open to women, it was recognised as a skilled job, but originally carried no technical input. Women would trace an engineer's drawings onto a waxed linen using ink. This was a necessary stage, since the engineers could produce and modify the drawings more quickly on paper using pencil. However these paper drawings could not be reproduced until they had been traced and it was from these tracings that 'blueprints' were made. As reproduction technology advanced, the necessity for drawings to be traced was diminished and some tracers began to undertake work that was of a more technical nature. This led to difficulties as the union DATA, which represented tracers, sought to get agreement to a new training scheme that recognised their true work. The EEF response was:

the training scheme you propose, the skills, knowledge and techniques, go far beyond those required by a tracer. Indeed, any girl who did acquire such knowledge & skill would be quite different from a tracer. Many of the girls who have the ability to complete successfully such a training scheme would, in fact, have the ability to become draughtswomen.¹⁵⁹

When the union claimed that it was based on the work tracers were actually doing, the talks broke down with vague promises to allow the technician training sub committee to examine the problem. The problem appeared to be that neither the employers nor the union expected the women concerned to be capable of becoming draughtswomen. As time went on the position of tracer ceased to exist. The women who were capable became draughtswomen, those who were not were pushed out. One woman who completed the questionnaire had started work as a tracer in 1957 and was encouraged to study on day release.¹⁶⁰ She achieved her H.N.C. but found college stressful as she was the only girl and there were no facilities for female students. This was a problem many women were to

¹⁵⁹ Proceedings in conference between EEF & DATA London Tuesday 1st.Nov.1966, Par.4b. copy held at the Modern Records Centre, University of Warwick. Ref MSS101/DA/1/4/252.

¹⁶⁰ Questionnaire source, see Appendix. 1.20.

encounter, for example Erith Technical College erected a new block for O.N.C. and H.N.C. students in the early 1960s but they failed to install any ladies lavatories, presumably because girls were not expected to take these courses.¹⁶¹ The tracer mentioned found that in spite of her qualifications, her sex made her less likely to be considered for promotions, and she was gradually sidetracked into minor positions. When she gave up work to have children she took the decision not to return to engineering; she is now a secretary.

Discrimination in training was theoretically ended by the equality legislation of the 1970s. Training, including full apprenticeships was now available to girls but, as Newton found girls were being put off engineering by social attitudes and that:

The girl who considers engineering usually meets with mixed reactions from family, friends and teachers. She is often encouraged to 'keep her options open' and asked whether she is certain about her career choice.¹⁶²

The few girls who did persevere and undertake apprenticeships had to face similar problems to those who trained as technologists. Jill was an example, she remembered that boys she had got on well with at school suddenly would not talk to her at the training school, she was the only girl and felt very isolated. The problem was made worse by a group of boys who would make 'vulgar remarks about whether I was having my period'.¹⁶³ Eventually Jill approached one of the lecturers to say she wanted to quit because of the problem. He said that she would be silly give up at that point as she had only two months to go before finishing. He did not offer to speak to the boys concerned, obviously feeling it was up to Jill to cope with the problem, she had chosen to come into a 'man's' world and must accept the consequences, an attitude that Henwood noted among many of the lecturers in her study.¹⁶⁴ Jill recalled that most of the lecturers were non-committal about girls in engineering, 'as long as you did the work they were OK.' Once Jill returned to her home town and started working in the main factory, her situation improved, generally she

161 Questionnaire source, see Appendix 1.64.

162 Newton. Unpublished PhD Thesis. p.54.

163 Oral history source, see Appendix 1.59 & Appendix 2.

164 Flis Henwood, *Engineering Difference: Discourses on Gender, Sexuality and Work in a College of Technology*, in *Gender and Education*, March 1998, Vol.10, Iss.1, p.41.

found 'most people accepted you if you could do the job'. When asked about such problems, the apprentice training officer at the factory commented that 'the girls need to be given a lot of encouragement while they are at college.'¹⁶⁵ He would not give any specific details, but pointed out that many of the girls improved tremendously once they got into the work environment and away from that of college. Once again, because male lecturers predominate in engineering disciplines, particularly in the more practical, craft orientated ones, many girls suffer from low self confidence, and as a recent EOC report pointed out 'the absence of female lecturers and role models added to the isolation of being the only female student.' The same report suggested that 'the provision of women only positive action training was instrumental to the success of many women in non-traditional skill areas.'¹⁶⁶ While such extreme measures can be unpopular, if female lecturers are not available and men will not change their attitudes towards female students, these measures may be the only solution until the ratio of female to male lecturers can be improved.

Becoming an Engineer Later in Life

Many women engineers do not pursue the career immediately upon leaving school. They take up the career for a variety of reasons, and in a variety of ways. The first route that will be examined is that of the women's services. After the Second World War ex-service men and women had the opportunity to go to university. While Braybon and Summerfield suggested that:

The official assumption was that servicewomen could not expect to use their special technical skills in civilian jobs and should think in terms of entering university or training for one of the women's occupations, like teaching, nursing or clerical work.¹⁶⁷

165 Comment made during discussion on apprentices, copy held with original data for the thesis in the WES archives

166 Dale et.al. *Women in Non-traditional Training and Employment*. p.22

167 Gail Braybon & Penny Summerfield. *Out of The Cage: Women's Experiences in Two World Wars*, London, Pandora Press , 1987, p.266.

Some women did train as engineers. One woman who completed the questionnaire had been in the WRNS during the Second World War and her divisional officer suggested she take advantage of the government's further education and training grant to do a degree in Electrical Engineering.¹⁶⁸ Being more mature she had few problems adapting to college life, which included many ex-service personnel at the time. As time passed opportunities to train as an engineer with the services became less publicised, but they were still available. Joining the Armed Forces would obviously not appeal to all girls but was a way for some to become engineers. A girl could take a commission in the WRAC for permanent employment with the Royal Electrical and Mechanical Engineers. One such woman was Major Bunty Sergeant who was featured in an article in *The Daily Mirror* in 1968 where she is described as being 'in charge of 200 civilian fitters, blacksmiths and welders.'¹⁶⁹ The qualifications necessary were an engineering degree acceptable to the Institutions of Mechanical or Electrical Engineers as satisfying sections A and B of their Associate Membership Examinations. In effect, if a girl had done her engineering degree, but was unable to get a graduate apprenticeship in industry to gain the practical experience she required, she could apply to the WRAC. Alternatively, if she wanted to join with only 'O' levels she could train as a 'mechanic' in a number of disciplines and would be helped to attend evening classes at a technical college to gain qualifications. Success in those classes could lead to promotion to Sergeant or Warrant Officer Class 1. The WRAF had two levels for Other Ranks, 'Technician' at Corporal, Senior, Chief and Master level or the lower grade of 'Aircraftwoman' at 5 ranks up to Junior Technician, but these, like the mechanics in the WRAC, were not professional engineers. The WRAF would take women with a degree or with HNC in Electrical or Mechanical Engineering for commissions and such women would work on the servicing and repair of aircraft and guided weapons or on research, design and development.

168 Questionnaire source, see Appendix. 1.17.

169 *The Daily Mirror*, 14 February 1968.

The WRNS had fewer opportunities for women to reach professional engineer status because the only commission offering technical training and responsibilities was in the Air Radio Branch, but this seldom led to anything beyond Second Officer level. They did offer Air Mechanic training to female ratings with 'O' levels. The double standard which universities operated with regard to female students was not unique; it operated throughout most of British Industry and was also operated by the WRNS in the 1960s. One woman who completed the questionnaire remembers that a Wren had to have four 'O' level passes, including mathematics, science and English, before being allowed to train as an aircraft fitter (the equivalent to technician level in industry).¹⁷⁰ The male ratings were not required to have any qualifications before starting the course. This meant that, since they were taught alongside each other, doing the same academic and practical classes, the women were always coming top of the class in the academic subjects and frequently in the practical ones. Her workbooks show that during the ten week practical course subjects such as piston engines, helicopters, gas turbines, oxygen, aircraft acquaintance, non-destructive testing, fuel systems, cabin conditioning and wheels, tyres and brakes were studied.¹⁷¹ In addition to this two half days were spent in academic work such as mathematics and science. Her workbook shows that she did exceptionally well. She remembers that the male ratings invariably got lower marks than the WRNS, partly because the girls were determined to prove themselves, while the ratings had nothing to gain by working too hard. The other reason the WRNS achieved better results was their better academic background; this gave them an advantage which more than offset any practical experience the male ratings had. Working on cars and other 'male' hobbies, while familiarising the ratings with the use of some tools, bore little resemblance to the detailed knowledge required to strip an aero engine.

170 Questionnaire source, see Appendix. 1.42.

171 Work books belonging to the student in question are stored with the other original data for this thesis in the WES archives.

Once the male and female services were combined in 1992, women were able to undertake the same training as men for engineering roles. While women were not allowed on the frontline, since most engineering was seen as a support activity there was little reason to restrict the training offered. One woman who took advantage of this expressed gratitude at the quality and depth of the training the services supplied, although she never took her commission.¹⁷² She described her departure as a 'mutual decision', brought about by her desire to work in a hands-on way in engineering and her dislike of being expected to leave this to others and to concentrate on the management skills required of an officer.

Some women became engineers because they were in the right place to profit from the opportunities offered. As has been shown, by the mid-1960s tracers were often doing much of the work previously done by junior draughtsmen. A talented woman who was prepared to study, often in her own time, would eventually be recognised as a draughtswoman. For a woman to work in the drawing office was generally more acceptable and some women became engineers by first becoming proficient draughtsmen in another discipline, such as architecture, rather than by starting as tracers. As was the case with tracers, these women would have to prove themselves capable at the lowest (technician) level of drawing office work, that of a 'detailer'. This was a level that some draughtsman, male and female, remained at. Others went on to become designers and would be considered technologists.

Other routes into engineering included that taken by women who were technical clerks with a good grasp of mathematics. In the early 1960s many women were employed as 'computers' and were required to undertake the many mathematical computations necessitated by the development work done in the aeronautical and defence industries. Women who understood not only the mathematics they were doing but also the reasons behind their calculations were sometimes allowed to become development engineers. In general that only happened after the woman had amassed enough experience to become

¹⁷² Oral history source, see Appendix 1.58. & Appendix 2

capable of teaching the newer, usually male, recruits how to do the job, leaving the firm with little option but to admit the woman was performing the functions of an engineer. One such woman worked at WHL. She started in 1954 and initially was only offered the training necessary to do her job. She, and another girl who was taken on at the same time, was lucky in being put under the guidance of a man who encouraged them to learn all they could about the aircraft. He sent them into the flight shed to talk to the engineers to find out what the problems were with the aircraft, and when they were not too busy he sent them around the factory to get to know how the various parts of the aircraft were made. As Mary described it:

The work was pioneering, we were all learning as we went along, I had a book beside me showing me how to do wave form analysis, and that's how we did it, all by hand.¹⁷³

When the two girls asked if they could be apprentices like the boys and go to college, they were told definitely not. However, they persevered and it was agreed that they could go to college, but it would have to be entirely in their own time. This meant that they would have to attend night school three nights a week, as well as working the full 40-hour week that was standard then. When they turned up at their first night-school class it was to find an elderly gentleman taking the class who told them 'I don't think you ladies are in the right class, this is engineering.' They had to show him their names on his register to convince him they were serious, but once that was sorted out the two girls sailed through the course, mainly because they had already done their 'O' levels, which most of the boys had not.

Such ad hoc ways of becoming a technician continued. In 1975 Grace moved into a new area on her marriage, her husband being employed as an engineer by a local aerospace company. Unable to get a job in her previous profession of hospital laboratory technician and needing to work, she took her husband's advice and applied to the Weights department. She was taken on for a three-month trial period to see if she could cope with

173 Oral history source, see Appendix 1.21 and Appendix 2.

the work and stayed for 26 years.¹⁷⁴ Pauline's engineering career at the same company followed a different pattern.¹⁷⁵ On leaving school in 1984 she had been employed in the accounts department. Initially she enjoyed the work, but once computers were introduced she found it became too mundane. Her husband, who was an engineer with the company, suggested she transfer into the materials laboratory as a technical assistant. She did so and then made the move into project engineering, discovering an affinity for the career that led her to study and qualify.

Economic changes had led to the decimation of Britain's manufacturing industries and although the engineering companies that remained were streamlined and competitive, the stigma of the years of failure remained in the public mind. This, coupled with the wide variety of careers open to women once the equality legislation came into effect, meant that few women considered a career in engineering. Helen had no intention of becoming an engineer, but her experience was typical of the 1980s.¹⁷⁶ She had done a degree in physics and started to look for work in 1982, by this time unemployment figures in Britain were approaching three million and, as she expressed it, 'we all applied for hundreds of jobs.' Westland Helicopters offered her a job as a software engineer and she took it, she enjoyed the work and went on to become a principal engineer running a department. This positive initial experience of engineering was another factor that influenced women to become engineers. All except one of the women interviewed had enjoyed their careers, they would never have stayed in engineering if they had not. This reflected Evetts' findings. She pointed out that the women in her group 'spoke very positively of their first experiences of engineering and of industry.'¹⁷⁷ However, as such experiences generally took place after the choice to enter industry had already been made, it would not have influenced the initial choice, although it certainly influenced women to continue, or even to start studying

174 Oral history source, see Appendix 1.61 & Appendix 2.

175 Oral history source, see Appendix 1.57 & Appendix 2.

176 Oral history source, see Appendix 1.62 & Appendix 2.

177 Julia Evetts 'Women in Engineering' p177.

to become qualified engineers. An example of this was Evelyn, who joined WHL in 1988.¹⁷⁸ She had tried training as a hairdresser when she left school, but had given that up for a variety of unskilled jobs. After she married, her father-in-law, who worked at Westland Helicopters, suggested she apply for a position as a technical assistant there. Evelyn was offered work in the Materials Laboratory, preparing test pieces for examination. She enjoyed the work and soon got involved in the more technical aspects of the job; she progressed well and was given day-release to do HNC at the local technical college. She describes her boss of that time as 'rather old-fashioned', although he never tried to stop her, even though she dropped out of college for a year because her marriage broke up while she was studying. When she approached him again, asking if he would allow her to re-take the year she had spoilt, he agreed and she has continued to study, either at college or in house ever since. She had no problems at college, suggesting the fact that she was ten years older than the rest of the class, and always top of it, earned her 'a lot of respect from the lecturers.' Her age difference made her better able to deal with any problems from her fellow students. As she expressed it 'they weren't allowed to give me problems.' She said that there was a mutual respect between them and she became good friends with some of them, still meeting for lunch occasionally. This offers a very different picture of college life from many other examples.

Summary

Surveys into why women chose non-traditional gender careers undertaken in the 1990s offered a variety of reasons, from the desire to be in a high status career to a subconscious desire to do something 'directly associated with both masculinity and power.'¹⁷⁹ Faulkner points out that male engineers share a devotion to their careers in

¹⁷⁸ Oral history source, see Appendix 1.45 & Appendix 2

¹⁷⁹ Flis Henwood, *Engineering Difference*. P.36.

terms of 'tinkering' that goes far beyond the needs of the job.¹⁸⁰ She asserts that females do not share this desire to 'tinker' and suggests that this lack is one reason why few women are attracted to the career. My own research suggests that many women who become engineers did enjoy tinkering with things as children and this is one of the things that lead them to consider a career in engineering.

The social upheavals that followed the Second World War eventually resulted in a more favourable climate towards women taking up careers for which they previously would have been considered unsuitable, such as banking or the more technical jobs within the health service such as radiography and laboratory technicians. This did not happen with regards to women engineers. The continuing need for more teachers, the opening up of other careers for women and the lack of information about engineering careers combined to offset the more positive aspects of the change in women's position at work. Britain continued to have fewer female engineers than any other European country, possibly due to the lower status of engineering commented on in Chapter Two.

While the situation improved slightly following the equality legislation, the increase in women engineers was so low that it prompted initiatives such as WISE, which addressed the problem of giving girls access to information about the career. While the information that was provided offended some feminists by offering suggestions about how girls should 'cope with' sexism, it failed to have a significant effect on the numbers becoming engineers. Girls were simply not asking about the career.¹⁸¹ In spite of the reservations of feminists regarding the WISE and other similar campaigns, and the subsequent evidence that providing information on the career was not enough to get more women into the profession, such information was essential.

Training to be an engineer was fraught with many difficulties for women in the post-war period. If they decided to study at university it was not always easy to get the

180 Wendy Faulkner, 'The Power And The Pleasure? A Research Agenda For 'Making Gender Stick' To Engineers.' In *Science, Technology and Human Values*, Winter 2000, Vol.25. issue 1.p.92.

181 Henwood 'WISE Choices?'

necessary practical training, equally they were seldom given the opportunity of apprenticeships. The attempts to make engineering courses more popular showed some success among boys, but girls remained indifferent. While the equality legislation improved girls' access to training, it did nothing to improve the more insidious problems of discrimination and harassment that they suffered during training. While by the end of the twentieth century it can be said that both the access to and the actual training necessary to become an engineer were genuinely equal for the sexes, it has been shown that the quality of such training was often poorer for women due to the lack of female tutors. The difficulties facing girls were as likely to have their roots in society's continuing belief that technology was not a girls' subject, as in the failure of some tutors and young male students to accept that the 'macho' culture some of them adopted on leaving school was unacceptable to women.

It was shown that some women became engineers later in life. The military services continued to offer training to both men and women, but for technologists such training was university based and stressed the 'man-management' skills necessary for an officer.¹⁸² The informal or unstructured path into engineering continued to be the route taken by a number of women who had not considered engineering as a likely career until experience gave them the opportunity to assess what it offered. It was shown that they generally coped well with the subsequent training, being less affected by the harassment and discrimination mentioned above. The current commitment of most engineering companies to 'life-long-learning,' to enable engineers to keep abreast of rapidly changing technology ensures that engineers continue to study throughout their working lives. The experiences of women engineers while at work, whether they encountered harassment or discrimination, and how their careers progressed is the basis for the next chapter.

182 Oral history source, see Appendix. 1.58. & Appendix 2.

Chapter 5

A Dying Career? Changes in the Employment of Engineers

Introduction

While it is impossible for an outsider fully to understand the work done by any professional, most of the public have some idea of what is involved in being a teacher, doctor, lawyer, or any other profession. The social reaction that engineering was unsuitable for women was largely caused by the public's ideas about what an engineer did, which often had little basis in fact. The work done by engineers, like every career, has changed over the post-war period, particularly with the widespread use of computers; indeed this has introduced an entirely new field of engineering into the career. While, as has been shown, the public's attitude towards engineering modified slightly over the period of the thesis, there is still a great deal of confusion about what an engineer does. The reasons why this confusion persists will be examined and an assessment made of the tasks undertaken by engineers.

This chapter examines the actual experiences of some of the women engineers interviewed. It locates the life history approach within a core structure of the changes in one company since the end of the war, as seen through the eyes of women engineers employed there. This highlights areas where they share common experiences and those where an experience is unique to an individual. It demonstrates how a woman's expectations have changed over the years and also how these expectations can colour her reactions to a situation. The changing attitudes of both unions and male colleagues over the years will also be examined, both before and after the equality legislation of 1975. The emphasis is on women as individuals, and it will be argued that the campaigns to encourage more women into engineering frequently foundered on the tendency to treat women as a homogenous group. This chapter highlights the fact that women engineers have enjoyed their careers, but it also explores the areas where problems did exist. Women

engineers have been accused of trivialising such problems, how true such accusations are will be examined.

What Does an Engineer Do?

The problem of defining exactly who was an engineer, and whether they should be classed as a technician or a technologist, has been mentioned before. The government's White Paper for *The Development of Scientific and Technological Education* of 1956 started out by defining technologists and technicians and it is worth quoting these definitions in full.

A professional engineer is competent by virtue of his fundamental education and training to apply the scientific method and outlook to the analysis and solution of engineering problems. He is able to assume personal responsibility for the development and application of engineering science and knowledge, notably in research, designing, construction, manufacturing, superintending, managing and in the education of the engineer. His work is predominantly intellectual and varied, and not of a routine mental or physical character. It requires the exercise of original thought and judgement and the ability to supervise the technical and administrative work of others.

An engineering technician is one who can apply in a responsible manner proven techniques which are commonly understood by those who are expert in a branch of engineering or those techniques specially prescribed by professional engineers; working on design and development of engineering plant and structures; erecting and commissioning of engineering equipment and structures; engineering drawings; estimating; inspecting and testing engineering construction and equipment; use of surveying instruments; operating maintaining and repairing engineering machinery; plant and engineering services and locating defects therein.¹

The above definitions, apart from totally excluding women, appear to be comprehensive but they were not the definitions used by the employers, the professional institutes or the public. The employers would have considered the technologist described above to be a specialist engineer, often combining this role with that of a manager. The technicians, also specialising in different fields, would have been originally described by job titles such as draughtsman, estimator, maintenance engineer, and so on. More recently, many companies

¹ Cmnd 9703: White Paper for the Development of Scientific and Technological Education. London, HMSO 1956, p.2.

have simply described all those doing these jobs as engineers and split them into grades according to expertise and responsibility. As Hyde commented:

Just as it is true that many academically qualified engineers do not go on to practise, it is also true that the gaps are often filled by very capable people who have found themselves doing the job apparently without the need of a professional qualification. At best they are able to offer a mixed portfolio of craft certificates and 'O' levels, but nevertheless still enjoy the respect of their colleagues, employers and those who answer to them. They are likely to be trusted with major projects, substantial budgets and high level decision making.²

Thus the engineering profession is a confused rag-bag of qualified and unqualified personnel from a wide variety of disciplines, each of which will have its unique hierarchy of specialists. While the general public is vaguely aware of the technologist described above, the immediate reaction to the term engineer is more likely to conjure up a picture of the technicians mentioned at the end of the list, namely 'operating, maintaining and repairing engineering machinery; plant and engineering services and locating defects therein.'³ This is where the vision of the engineer as a man in a boiler suit clutching an oily rag comes from.

It was shown in Chapters One and Two that most engineers spent the majority of their time in offices and, while the public's attitudes to engineering did change, there was still a failure to associate technology with engineering, or to consider engineering to be a profession. The social climate of the 1960s was one that encouraged an interest in anything to do with new technology, with the space race and the 'white heat of technology' frequently being featured by the media. Television programmes such as *Tomorrow's World*, which began in 1965, showcased many products that were to become part of everyday life.⁴ 'Inventors' were the stars, 'Scientists' were credited with discoveries, but the engineer was seldom mentioned. The IMechE were trying to get publicity for engineering at the time, but found the BBC reluctant to televise their 1965 Leonardo da

² Frank Hyde, 'NANPEAN, An Alternative Way to Vocational Training' in *The Engineering Designer*, May/June 1995, p.20.

³ Cmnd 9703: p.2.

⁴ 'Tomorrow's World,' BBC Television programme, first broadcast in 1965 and still running in 2002.

Vinci lecture. The institute had to be content with an item about the lecture in the newsreel.⁵ The fact that 55 percent of males and 61 percent of females still believed it would be a dirty working environment in 1998 demonstrates how little progress had been made in changing the image of engineering.⁶ Following the success of the TV drama *Silent Witness* featuring a female forensic pathologist, UKRC (United Kingdom Radiological Congress) director, Annette Williams, commented:

TV is a powerful medium. If current trends continue, by the age of eighteen the average child will have spent more time watching TV than any other activity except sleep. And after leaving school, for the overwhelming majority of people in Britain, science is experienced almost wholly through television and broadcast media.⁷

The comment was made in a report produced by the Public Awareness of Science and Engineering (PAWS) Drama Fund, and was the outcome of a meeting held in November 2004 which brought TV dramatists, script writers and producers together with science, engineering and technology professionals to forge a better understanding of how science and engineering can inspire new and popular television drama. The report makes twelve recommendations, from short-term measures to make role models more visible and accessible to writers, to longer term measures to improve the status and perception of science and engineering in society at large. The third recommendation was to ‘explore the cultural background to how science and technology is perceived, by UK television in particular and society in general.’ If such an exploration can be successfully completed and action is taken on the other recommendations then the public image of engineering might become closer to the reality of the profession. What effect this may have on the percentage of women considering the career is impossible to predict.

5 Institute of Mechanical Engineers, Council Minutes 27/1/65, Promotion of Interest in Mechanical Engineering Sub Committee.

6 Views of Engineering as a Career, London, MORI/EMTA, 1998.

Women's Experiences in Post-war Britain

Mention has already been made of several women engineers who proved that it was possible to succeed in spite of their sex long before equality legislation. Mary Fergusson had become a partner in a firm of consulting engineers in 1945 and in 1957 she became the first woman Fellow (then referred to as a Full Member) of the ICE. The report about her achievements that appeared in a local newspaper is reproduced below.

WOMAN PIONEER FROM EDINBURGH

First to be Senior Civil Engineer

Miss Mary Fergusson of 318 Lanark Road, Edinburgh, is the first woman to become a full member of the Institution of Civil Engineers. Miss Fergusson, for the last seven years a partner in the Scottish firm of consulting engineers, Messrs Blyth & Blyth is a Bachelor of Science of Edinburgh University. The institution, which was founded in 1817, has at present four other women on the roll as against five for the Institution of Mechanical Engineers of whom only one is a full member, and 28 for the Institution of Electrical Engineers, none of whom are full members. Civil engineering has been considered essentially a man's profession probably because of the conditions of life on engineering sites and the fact that only male labour is employed on construction. An official of the institution said Miss Fergusson has proved that women can be as capable as men in the field of civil engineering. She has been personally responsible for the design and construction of over £2 million worth of engineering works, including reinforced concrete bridges, steel framed buildings, and the well known River Leven Purification Scheme, which was completed in 1952. In the light of Miss Fergusson's achievements many senior members of the profession have revised their attitudes towards women entrants. Russia is known to be admitting an increasing number of women to the profession.⁸

Mary continued to do the work required of a civil engineer until she retired in 1978. She offered the opinion that, in her experience, having a 'mentor' such as she had in the two original partners who gave her a chance, was more important than any role model. The importance of mentors has recently been acknowledged by a number of engineering organisations. While mentors do not have to be female, efforts are being made to ensure that young women engineers have access to experienced women engineers to fulfil this role and to act as role models when necessary, a subject that will be examined later.

Other success stories are those of Dr. Elizabeth Laverick and Isabel Hardwich. Dr. Laverick worked in the Radio Research Laboratory of Elliott Automation Radio Systems.

7 The PAWS Women into TV Drama Project. www.setwomenresource.org.uk

8 *The Scotsman*, 17 January 1957.

By 1960 she had been promoted to manager of the laboratory. The laboratory incorporated both microwave and mechanical engineering departments with its own drawing office and workshops. She said that she felt being a woman was an advantage in that people noticed her more than they would a man, and she considered this was 'OK as long as you're doing a good job.'⁹ Isabel Hardwich was a woman engineer who worked for Metropolitan Vickers, a company that has already been mentioned as encouraging women to choose engineering as a career. After a successful engineering career she ultimately became responsible for the recruitment, training and general overseeing of their women engineers. She left AEI when it was taken over by GEC in 1969 and became Chief Clerk to the Open University in Manchester until she retired ten years later.¹⁰

Dr. Dorothy Fisher also worked at Metropolitan Vickers; she had worked as a physicist for many years before moving into engineering in 1957. She recalls that after joining WES she became involved with careers advice. Women engineers were often asked to do this in an attempt to supply girls with role models, although Dr. Fisher remembered that:

I found they were inclined to be a little anxious about working among 'all those rough men' in a factory - and was delighted to reassure them that the shop floor workers whom I met were natural gentlemen in their dealings with the professional women who came among them.¹¹

She says that she felt that the efforts put into pushing open doors for women was wasted at that time as there was no great rush of women waiting to take up the opportunities.

However, she does make one point about the problems that women engineers caused by not fitting into the system dictated by society.

In the 60s your status in a factory was judged by where you ate. When I joined Metro-Vic. there was a middle management mess, but because there had not previously been any women in that category it was men only. There was a senior staff canteen for secretaries etc. but they said we did not belong there, as

⁹ Laverick left industry in 1971 at which stage she was a Technical Director within Marconi Avionics Systems Ltd. Questionnaire source, see Appendix 1.18.

¹⁰ Hardwich was also a part time lecturer at Salford Royal Technical College (now University of Salford) and at Manchester College of Technology (now UMIST). Information available from the Women's Engineering Society Archives held at the Institute Of Electrical Engineers London. Ref. NAEST92a.

¹¹ Questionnaire source, see Appendix 1.30.

we were engineers! Isabel Hardwick and I ended up eating in the ordinary staff canteen.¹²

The first quote highlights the effect that class was still having during the 1960s. Only a middle-class girl would think of 'all those rough men', a working-class girl would know that these men were likely to be the fathers of her friends, or even her own relations.

Working class girls might have been more intimidated by the secretaries in the senior staff canteen mentioned in the second quote. As was shown in earlier chapters, class still had a major influence on career choice at this time, and while class issues had little direct impact once a woman engineer was at work, they could effect her reactions to some situations.

The changing nature of the British class system is demonstrated by the responses to the question asked at the interviews regarding class. This was answered easily by women who grew up before the 1970s, but the younger women generally had much more difficulty deciding which class their parents belonged to, demonstrating that, for them at least, class was much more fluid than it had been.

The secretaries in the second quote, who refused to allow Isabel and Dorothy to eat in their canteen, because they were engineers, emphasise a point that other interviewees made, often there was more prejudice from other women at work than from the men. Comments on this were made by almost all the women interviewed, from those working in the 1950s up to and including the younger women. While the numbers of women who resent others stepping outside the gender stereotype appears to be falling, there remain a few who will demonstrate such resentment whenever they meet women who threaten their concept of what a 'woman' should do. This is an area that is ignored by studies into discrimination and harassment, possibly because such women seldom have much power. However their attitudes can influence others and increase the pressure on a woman engineer who is facing problems.

In common with other career women not all women engineers succeeded. One woman who completed the questionnaire pointed out that:

¹² Questionnaire source, see Appendix 1.30.

the sixties was a bad time for newcomers. 1939-45 women could do ANYTHING, but things reverted in the 1950s and 60s unless you were well established. I don't think attitudes changed until the 1980s.¹³

While major areas of discrimination prior to equality legislation were regarding pay and access to training and promotion, another problem for working women at this time was the lack of any right to maternity leave, and engineering was no different. Replying to the question regarding the effect gender had on her career one woman who completed the questionnaire responded 'nearly put an end to it, because in 1958 you were given your cards, not maternity leave, on the arrival of your first child.'¹⁴ Less obvious discrimination also forced women out, one woman who started work in 1957 as a tracer and subsequently trained as an engineer found herself gradually sidelined.¹⁵ She recalled her main problem was being unable to keep to a structured career path, as she had to go where she was offered jobs. After a seven year break to bring up children she became a technical secretary.

The women engineers at WHL suffered in similar ways, while the company had no overall policy of either discrimination against women engineers, nor of trying to encourage them, individual managers were free to operate under their individual preferences. The company was very busy in the post-war period, undertaking its first major helicopter design. It did not have any women engineers employed at senior levels, instead it followed the trend common in many companies, of employing women as technicians in areas it felt were appropriate for them.¹⁶ Because these women invariably gave up work when they had children, while there was no discrimination preventing women from reaching the higher grades, there was an assumption that they were unlikely to get that far. Two such women were Mary and Joan. Mary had started work in the Vibration Test Department when she was 17, shortly after it was set up and as she describes it she 'grew with the

¹³ Questionnaire source, see Appendix 1.12.

¹⁴ Questionnaire source, see Appendix 1.19.

¹⁵ Questionnaire source, see Appendix 1.20.

¹⁶ Questionnaire source, see Appendix 3.

job'.¹⁷ As the aircraft got more complicated the work was already familiar. She remembered that a big job, such as measuring the vibration of the helicopter blades so that the Stress Department could confirm their calculations, could take a year to do. The first machine to help with the analysis was not brought into the office until 1964, the same year that Mary left to have her son. She had worked at WHL since she was a young girl, working in an area where she would meet many men, she met her husband. He was the Chief Flight Test Engineer and they married in 1961.

In 1957 Joan had started working at WHL as a tracer.¹⁸ The tracing office was situated away from the main factory, and it was here that the tracers, all women, would work. Occasionally there would be drawings that could not be allowed 'off-site' and then a tracer would be sent into the relevant office to do her work. Joan did this a few times and, about 15 months after she joined the company she was invited to work in the Weights Department. She was offered the chance to study at technical college, but like Mary she could not be an apprentice. 'They just couldn't let us work in the shops' she remembered. The Weights Department has the task of calculating the weight of parts from the drawings and of checking that the total weight of the helicopter was within that specified, both theoretically and actually, they also calculate the centre of gravity of the helicopter, so that it stays in balance. Joan says she was 'in at the deep end' in the office, doing calculations on everything and going over to the shops to weigh components gave variety to the job, although in her early days she was always accompanied on such visits, the workshops not being considered a suitable place to send a young girl on her own. She recalls there were about a dozen engineers in the office including two older ladies who had worked there during the war, as far as she can remember these women (although only paid 75 percent of the male salary) were on similar grades to the men and there was no discrimination regarding promotions. She recalled that there was great concern about dress.

When I first started women weren't allowed to wear trousers, only skirts.

¹⁷ Oral history source, see Appendix 1.21 & Appendix 2.

¹⁸ Oral history source, see Appendix 1.04 & Appendix 2.

When we went to weigh the aircraft down in the shops then we had overalls to put on, but we weren't allowed to wear trousers in the technical office. Even the men weren't allowed to wear bright colours, I remember someone coming in a red shirt, and they were sent home.¹⁹

Her comment reflects that of the woman quoted in Chapter One. Like Mary, Joan met her husband at work and they were married in 1963, she left work in 1967 to have her first child. The Weights Department was very busy and her boss had suggested that she could return part time after the baby was born, a practice becoming more common by the mid 1960s. Joan was considering this until the union stepped in and said they could not agree to it.

As was shown in earlier chapters, a common problem at the time, as the drive towards sex equality gained momentum, was that unions often fought against anything they saw as undermining a man's job. Their fear of devaluing such jobs prevented them from supporting women members' rights. In 1951 the TUC (Trades Union Congress) had started to collect information for the compilation of a history of women in the Trade Union movement. The AEU (Amalgamated Engineering Union) said it had no historical material regarding women.²⁰ The historical booklet was published in May 1955 to coincide with the 25th Annual Conference of Unions Catering for Women Workers and commented that in the 1890s 'in contrast to the more exclusive craft unions, the general labour unions showed a willingness to include women worker in their ranks.'²¹ This may have been due to the greater numbers of women employed in other trades, but was more likely due to the need to protect the jobs of the members of craft unions. However, in spite of the slow start with regard to allowing women to join the engineering unions, they were admitted to membership of the AEUW from 1 January 1943 and by May that year 64,000 women had joined, although by 1955 this had dropped to 52,480, the explanation given for its drop

19 Oral history source, see Appendix 1.04 & Appendix 2.

20 Copy of TUC Circular dated 6/12/51. Copy held in the Modern Record Centre, University of Warwick. Ref. MSS292/60.3/1.

21 *Women in the Trade Union Movement*, London, TUC, 1955, p.51 Copy held at the Modern Record Centre, University of Warwick. Ref. MSS292/60.3/1.

being that it was due to the end of war work.²² The unions in general had not made great efforts to recruit women: in 1960 male union density (actual membership as a percentage of potential membership) was 54.2 percent, but female union density was only 25.4 percent. By 1963 this figure had increased to 26.2 percent, but many union members were slow to change their attitude to equality issues. As Soldon commented:

Within unions women were either discriminated against or they deferred to men as far as leadership positions were concerned. Possessing only token representation on the TUC General Council, and with the WAC relegated to the status of an advisory body, women were effectively still under male control.²³

While technicians could belong to various craft unions, as they progressed in their career many dropped such membership in favour of a staff association or membership of a professional institute. For technicians in the design office this was less likely. The union DATA was, according to Eric Wigham,

a well run, well disciplined organisation. Because draughtsmen come mainly from shop floor apprentices, they inherit craft traditions more than most white-collar associations.²⁴

The union represented not only draughtsmen and women, but also tracers.²⁵ In 1960 DATA started to fight for better pay for tracers. Unfortunately, the union failed to take notice of the plight of most draughtswomen, many of whom were also members of DATA; they continued to be paid only 75 percent of the man's rate. That meant that, in 1960, a draughtsman's minimum wage at age 21 was £11/0/1d (£11.00p), whilst a draughtswoman received £8/5/0d (£8.25p). A tracer's minimum wage, at age 19 was £6/7/6d (£6.38p); thus a draughtswoman was being paid only 0.3 percent more than a tracer, for her extra

22 Ibid. p.52.

23 Norbert C Soldon, *Women in British Trade Unions 1874-1976*, Gill & Macmillan, Dublin, 1978, p.184.

24 Eric Wigham, *The Power to Manage*, London, Macmillan, 1972, p.247.

25 DATA was later amalgamated with the AEUW, when it became TASS. As it grew in size and influence, it took over many other unions representing other technicians and, while it eventually spread into non-engineering staff areas and became the Managerial, Scientific and Financial Union, it retained its close links with the AEUW, which it finally re-amalgamated with to become AMICUS in 2001.

training and two years more experience. Barbara Switzer, Assistant General Secretary to the union M.S.F. until 1997, commented when recounting her early experiences:

For the whole length of my apprenticeship, and on its completion, I was paid the same rate as the males. However, at 21½ years, the men's pay was increased to the 21-year-old rate but not mine, as I discovered to my horror. We had gone through exactly the same training and passed the same exams! That was the first time I experienced direct discrimination in pay. I boldly raised this with management but was told bluntly that it didn't apply to women! This was in 1962. Then we had nationally negotiated union minimum rates for draughtsmen and tracers. But draughtswomen only got 75 percent.²⁶

As was shown in Chapter One, such discrimination was evident in many careers, while teachers had the right to equal pay in 1955, and civil servants in 1962, most women had to wait until the equality legislation of the seventies. In 1964 a union questionnaire established that equal pay for equal work was offered to women by the Civil Service, the Atomic Energy Commission, and British Railways, but not to female draughtsmen and technicians.²⁷

One woman who started work as a graduate apprentice in 1968 after doing a mechanical engineering course at U.M.I.S.T. chose engineering to impress her father.²⁸ She admits this was not a good reason for choosing the career and it took her many years to admit her mistake. She was a Design Engineer until 1979 when she finally gave up engineering to become a teacher. She recalled 'I never had trouble getting a job but felt I was taken as a novelty. I was never given responsibility and was sometimes moved sideways.' She suggested this may have been because her dissatisfaction with the work was obvious and commented 'I still love the Physics and Maths side of Design Engineering but now I teach it to 'A' level and I find my industrial experience a great help.' The problems she encountered were also experienced by women who enjoyed their careers, many of whom subsequently became successful once the equality legislation was in place.

Most women engineers from this time comment that their male colleagues were

²⁶ Barbara Switzer, 'And Then', in *M.S.F. Women Today*. December 1997, p.6.

²⁷ Executive Committee Agenda item no.7 26/8/64. Summary of replies received to questionnaires sent to affiliated unions on 27th July 1964. Ref EC/6T/37 N.F.P.W Copy held at Modern Records Centre, University of Warwick, Ref MSS239/1/9/1.

'protective.' They accepted that this arose from a genuine desire to prevent them being distressed by behaviour that men assumed women found offensive. This included the assumption that women were troubled by travelling alone, so women were seldom sent abroad on business. The effect of such behaviour was to limit a woman's experience, thus making her less eligible for promotions. Because the women realised that such behaviour was prompted by a genuine concern for their welfare, they often accepted such discrimination without complaint, as Mary said 'I don't think it ever entered my head that I was being hard done by.'²⁹

The Years of Change

As was shown in Chapter Two, between the late sixties and the early eighties there were many changes in the engineering industry, not only those relating to equality. The power struggle between the unions and the government meant that women who thought of entering the engineering profession at this time had not only to contend with the social changes caused by the equality legislation, but also with continual references to industrial unrest. While the NUM was the most notorious, many of the engineering unions were similarly militant, and frequently featured in TV news articles. Despite a steadily increasing number of small companies closing down and growing unemployment, employers continued to fear a shortage of trained engineers. As was shown in Chapter Four this meant that in some areas companies actively encouraged women to become engineers. One such company convinced a female spectrographic analyst to join an engineering team.³⁰ She found her boss and her colleagues to be very supportive, except for one foreman who 'really couldn't work for a woman', he moved to another department and they remained friends. She became the first woman council member of the

28 Questionnaire source, see Appendix. 1.35.

29 Oral history source, see Appendix 1.21 & Appendix 2.

30 Questionnaire source, see Appendix 1.15.

Chelmsford Engineering Society and also presented papers at the IEE and IERE and at other conferences on her specialist area of engineering, that of Microwaves - Millimetre Magnetons. She never joined a professional institution, being an example of the valued engineers that Frank Hyde mentioned. Her comment 'I was accepted on equal terms as part of that team. I certainly didn't have to fight my way' echoes many of the women in engineering at this time. In 1974 one of the women who completed the questionnaire started work in aeronautical engineering.³¹ She started her career as a Project Supervisor and eventually became a Business Development Manager. She admits to using her sex as an advantage, pointing out, as Elizabeth Laverick had earlier, that 'you get remembered.' She also echoed Laverick's comment regarding other women, commenting that 'the wives of senior managers perceive you as a threat to their husband's career.'

Throughout the 1970s WHL remained buoyant. While it had suffered some industrial unrest, the rural setting with its corresponding lack of other engineering employers ensured that the unions were less militant. Women continued to be employed as technicians and, following the equality legislation they were encouraged to train for more senior positions. The company recognised the problems women had combining a career and a family and did what they could to facilitate this. In 1970 Mary returned to work part-time, this came about because her husband told her how under-staffed the Vibration Test department was and started bringing her work she could do at home.³² She was paid by the hour and when her son was six she returned to the office, going in for three mornings a week. She never went in during the school holidays, returning to the system of her husband bringing her work home, so that their son was never left. Gradually her hours at work increased until she was working five mornings each week. In 1979 when her husband died, the company did everything she asked to facilitate her returning to full time work. She was allowed to finish at three pm each day so that she was home before her 14

31 Questionnaire source, see Appendix 1.37.

32 Oral history source, see Appendix 1.21 & Appendix 2.

year old son. There was no flexitime agreement in place at the time, but the company, when approached by a manager with a request to change the rules for a female employee, always tried to be helpful. On her return to full-time work she had finally been given the same title as the men, Vibration Test Engineer. She recalled that it usually caused some embarrassed laughter when she was asked what job she did at social occasions.

By 1973 the Weights Department was desperate for staff. Joan now had two children, and while out shopping she met her old boss.³³ He asked if she would come back to work and she agreed, but only if she could go back part time, and have the school holidays at home. Once again the company readily agreed, and she returned to work. By this time the wages paid to men and women engineers in the company had been brought in line. Although she worked part time she was paid the same hourly rate for the hours she worked and promotion continued to be offered at a rate commensurate with her capabilities. In 1975 Grace came to work in the Weights Department, she had not intended to become an engineer, but when she moved to the West Country after she married she could not find work in her own field (she had trained as a technician in a hospital pathology department).³⁴ Her husband, who was employed at WHL as a Stress Engineer, suggested she try working in the Weights Department and this is where her engineering career started. With her experience of working with women and her lack of engineering background, her comments regarding attitudes to women engineers were interesting,

I've generally found most of the chaps I've encountered have always been very helpful and courteous and it hasn't really been too much of a problem. Previously I was in mostly a female environment and there sometimes can be a little bit of cattiness or bitchiness in the background.

None of the women interviewed said they had suffered discrimination at this time although, as was shown earlier, discrimination was so much part of a woman's life before 1975, that for years many women accepted injustice without a thought.

It was shown in Chapter One that this was an era when women in all careers were

³³ Oral history source, see Appendix 1.04 & Appendix 2.

³⁴ Oral history source see Appendix 1.61. & Appendix 2.

beginning to reap the benefits of the equality legislation. Salaries were brought in line with men's, maternity leave became a right, and opportunities for training and promotion were opening up. Women engineers were no different but, while many men accepted the situation, not all were capable of change. The former spectrographic analyst mentioned above was fortunate that the foreman who could not accept a woman moved to another department. Other women tolerated innuendo and harassment from men who were convinced that women should not be engineers. On being interviewed for a job in 1980, at the age of 31, I was told there was plenty of work to keep me employed for the next three years by which time 'you will have left to have kids anyway.'³⁵ Such behaviour was not unique to engineering; women in all careers were generally tolerant of all but the most extreme forms of discrimination, accepting that attitudes do not change overnight because legislation says they must.

Experiences Following Equality Legislation

In 1985 Dot Griffiths decried the attitudes towards female students of engineering at Imperial College, University of London. This was substantiated by one woman who completed the questionnaire who, when asked about the attitude of her instructors while studying there, recalled that it was 'very poor, girls were given the same tutors each year, tutoring, welfare and careers advice for girls seemed to be reserved for those at the end of their careers.'³⁶ Griffiths allowed her experience of the discrimination and harassment she saw to colour her judgement of the companies that were sponsoring the female students at Imperial College, commenting:

My guess is that while most large companies are now sufficiently concerned about their public image to want to recruit a few women engineers, traditional prejudices intervene when it comes to their promotion.³⁷

35 Questionnaire source, see Appendix 1.63.

36 Questionnaire source, see Appendix 1.37.

37 Dot Griffiths, 'The Exclusion of Women from Technology' in Wendy Faulkner & Erik Arnold (eds.) *Smothered by Invention: Technology in Women's Lives*, London, Pluto Press, 1985, p.69

With the sex discrimination rampant among teaching professionals, Griffiths had little reason to think otherwise, but unfortunately her 'guess' about engineering companies became accepted as fact by many other feminists. Cynthia Cockburn also believed this, although her insistence that women were deliberately excluded from the career in the 1980s was somewhat undermined by her own admission that one of the companies she studied had 500 applications for the post of Test Engineer, only one was female and she was hired.³⁸ As was shown in Chapter Three, the feminist assumption that engineering was rife with sex discrimination remained unchallenged.

Undoubtedly the engineering industry was guilty of discrimination. In 1981 complaints about job evaluation procedures highlighted that the industry was giving a 'high weighting of factors such as experience and physical strength against a low weighting of mental and visual factors' that penalised women workers.³⁹ There were also complaints about spurious 'responsibility' or 'flexibility' payments being given to men to restore the old differentials after job evaluation schemes had resulted in the upgrading of women's work. These problems were applicable to women on the shop floor and in some clerical jobs, they seldom affected women engineers. However, such behaviour on the part of the employers doubtless influenced the feminist lobby when they decried the industry as riddled with sex-discrimination. The industry was also suffering the effects of Monetarism, and of the domestic and economic problems besetting Britain at the time. Margaret Thatcher's government implemented policies to break the union stranglehold and an economic policy which, among other things, decimated the engineering industry. Continuous publicity about the closure of engineering companies and battles with unions (particularly the NUM in 1984) left Britain's engineering industry with serious recruitment problems. That the engineering workforce had rallied to the cause in 1982 to ensure that arms and equipment were available for the Falklands War, and again in 1991 for the first

38 Cynthia Cockburn, *Machinery of Dominance*, London, Pluto, 1985, Chapter 5 ref.5 p.267

39 EOC, 6th Annual Report, London, HMSO, 1981, p. 9.

Gulf War, may have gained the industry a little publicity, but did little to improve the situation. The high unemployment that resulted from monetarism enabled the industry to gain some recruits, but as unemployment dropped in the 1990s the shortage of recruits to the career became noticeable.

As was shown, the implementation of the equality legislation gave the unions difficulties as their stated support for equal pay was in conflict with their desire to protect the wages of their male members. Sue Bruley commented that 'where women were attempting to organise and make collective demands of employers, trade union officials were often unhelpful.'⁴⁰ This echoed Clare Wightman's findings regarding women and the unions during the Second World War. Women had different priorities to men, and while men outnumbered women in the trade unions, men's business would dominate. While the various unions began to change after the equality legislation, Bruley pointed out that 'in the 1980s there is still plenty of evidence of male-orientated trade unions' undervaluing of women's skills and abilities.'⁴¹ However, by the 1990s the unions had largely adapted to the changes, women were now accepted as an integral part of the working population and when a new training scheme for full time union organisers was launched by the TUC in 1998, two thirds of their first intake were young women.⁴²

The most noticeable change in public attitudes towards engineering was between the conclusions of the Finniston Report of 1980 and those of the more recent surveys. These suggest that engineering is no longer seen as a man's career. Women continue to be under-represented in the career, but this is now due to their belief that it will be a boring career in a dirty environment, with only a third believing that it was a job mainly for men.⁴³ A large-scale quantitative project was undertaken early in 2000. While this report, like many others, does not separate engineering from science and technology, the findings

40 Sue Bruley, *Women in Britain Since 1900*, Basingstoke, Macmillan Press, 1999, p.167.

41 Bruley, *Women in Britain*, p.168.

42 S. Milne, 'After the Brothers Here's Sister' *The Guardian*, 14 March 1998, pp.2-3.

43 *Digest of Engineering Statistics 2002*, Section 1. See <http://www.engc.org.uk>.

indicate that public impressions of professional engineering among adults are favourable, but there was a clear divergence of opinion between the adult group and the younger group, with the latter being much less positive.⁴⁴

Women continued to work as engineers, the numbers slowly increasing as attitudes towards women and careers changed. Dolores Byrne had read Physics at Queens University Belfast, and after getting her PhD she joined the government's Defence Evaluation Research Agency in 1980.⁴⁵ She worked in various engineering disciplines, being promoted with each change and, after taking a MBA, became Director of the Air Systems Sector in 1998. When Sarah Bicknell left school in 1989 she had felt able to announce her intention of becoming an engineer without expecting any adverse reactions.⁴⁶ She went to university and studied Mechanical Engineering and recalled that one lecturer went out of his way to rearrange the groups so that she and the only other girl were in the same group. She became a Manufacturing Engineer in 1994 and has progressed to being Materials and Processes engineer, commenting 'I don't think sex has much impact on your career – there are advantages and disadvantages to being female in a male environment but they tend to even themselves out.' This attitude is echoed by most of the women who completed the questionnaire who started work in the 1990s, one commented:

My first job was in a 99 percent male environment, I used my sex to my own advantage in terms of interpersonal skills in managing teams – a calming influence to diffuse situations etc. The only other female in the area provided a great role model for me – I picked up many tips on handling people and earning respect. I felt that some of the older guys looked on me kind of like their own daughters in that the age difference was right and their kids could be in jobs like mine. I found certain situations difficult – like giving instructions to the main trade contractors before overhauls. Telling a group of 40 scaffolders how to climb a ladder most safely was quite tough! In my current job there are about 20 women out of the 120 in the office. The environment is such that it really makes no difference being female. The management ethos simply doesn't allow it – and it's great to feel equal in all areas.⁴⁷

Similarly positive comments were made by the engineers employed at WHL.

44 *British Attitude to Science, Engineering and Technology Survey*, The Welcome Trust, 2000.

45 *Celebrating Women in Engineering*, London, WES, 2002. p.5.

46 Questionnaire source, see Appendix 1.48.

47 Questionnaire source, see Appendix 1.54.

Throughout this time both Mary and Joan were still working there. Mary's son left home 2 years after her husband's death and, as she expressed it:

Then I was really into it, back at work, I got more and more involved with production aircraft. That was really my sole job. In those days, well, - today we clear eleven aircraft in a year, - well I've cleared eleven aircraft in a month. Worked Saturdays and Sundays as well to do it, that's what we did.⁴⁸

By now although there was much less being done manually in the department, data analysis machines were becoming more sophisticated, but there was still a lot of direct contact with the aircraft. One machine, used for tracking the tail rotor, had to be watched from the aircraft test pad. This meant being out in all weathers, be it rain, snow or hot sunshine. Mary remembers coming back into the office and all the men (who had not had to go out) fussing over her asking if she was all right. 'But I wouldn't have changed it a bit. I loved every minute of my job.' Mary retired in 2001, Joan in 2000. Both Joan and Mary were fortunate in being offered hours to suit their home circumstances, and being allowed to change these hours when it suited them. This may have been due in part to the location of WHL, which restricts the pool of labour from which it can recruit. However, both women had proved themselves capable engineers and their supervisors were happy to get them back.

In 1989 Sarah Perry had joined WHL as an apprentice, encouraged by her older brother who was already there.⁴⁹ Her comments about college reflect what has already been said. The boys gradually accepted her, although some tried to embarrass her with sexual comments and gestures but her response was 'I gave as good as I got. I did not want them to have that sort of power over me.' Sarah did not have problems with her tutors, except one who tried to make her give up and stay at home because this suited his religious beliefs. Her comments on the difference being female made to her career were 'No matter how you try to fit in, your work / character / attitude is always more noticeable than a man's. I don't think I have been pushed as hard as a boy because they expect me to have

⁴⁸ Oral history source, see Appendix 1.21 and Appendix 2.

⁴⁹ Questionnaire source, see Appendix 1.43.

children.’ She did in fact give up work in 1999 to have her first child and did not return to engineering. Most of the younger women engineers at WHL made more positive comments, although one did say that she ‘felt throughout my schooling and in my working life I’ve had to prove myself to be 150 percent better than them [men] to be considered equal – but once they’ve accepted that we are equal then there’s not a problem.’⁵⁰ This belief that women have to prove themselves better is one that is still prevalent in all careers. While men might reasonably argue that everyone has to prove their capabilities, and that women are not treated differently to men, women obviously feel this is not the case. Similarly problems with male lecturers were still being commented on, one interviewee saying ‘most treated us the same as the boys. With some I felt I had to prove a point, they were waiting for us to make silly mistakes. They tended to ask the girls more questions than the boys.’⁵¹ Such attitudes on the part of lecturers would emphasise the feeling of needing to prove oneself.

One of the few women to comment on discrimination had been an apprentice at WHL from 1985 to 1990.⁵² She then decided to go to university to get a degree. When she had achieved this, in 1994, she was offered a job by a company in the Midlands where she found there were more women engineers employed. However, she was sent to work in the materials laboratory where her manager ‘tried to get me a pay cut because he thought I was paid too much as a woman.’ The man was one of the ‘old school’ who believed women only worked for pin money. When he left she complained about only being given menial tasks and having made no progress in her career, but his successor ‘was no better.’ She never made a formal complaint, but she did transfer to the technology department, where she remembered ‘the head of technology was really good and supportive.’ However, the work she was doing was moved to another department where the manager

⁵⁰ Questionnaire source, see Appendix 1.53.

⁵¹ Questionnaire source, see Appendix 1.46.

⁵² Oral history source, see Appendix 1.59. & Appendix 2.

also 'had the same attitude on women that most of my other bosses had.' Once again she did not complain, choosing instead to leave that company and return to WHL.

While women engineers at the end of the twentieth century have different attitudes to those held by their predecessors, growing up with the right to equality has not automatically given them the self confidence to overcome problems. While some women gain strength from fighting prejudice, others find it debilitating. Finding ways to solve the problems women in SET suffer was the aim of a project set up in 1999. This project was designed to supply women in SET with female mentors and to establish how helpful such mentoring was. All women staff, postgraduates and final year undergraduates at the Bolton Institute were invited to become mentees. Mentors were women with successful careers in SET, in industry or academia, all were external to the Bolton Institute. The project started with 16 pairs; it was explained to the mentees what they could expect and training was given to the mentors. Careful matching between mentor and mentee resulted in very positive feedback. It was established that mentoring was important where women were an isolated minority, comments ranged from 'it was good to talk to someone in a similar field who was one step ahead of me in their career' to:

The project has been a huge help to me and I have been able to see how my mentor has achieved success in her job- how she copes with some situations at work and also how she fits this together with having a family. I think it has also shown me a human side to a person who would perhaps otherwise have appeared to be a long way from me.⁵³

There was an unexpected benefit in a reduced feeling of isolation among the mentors. The success of the project was such that the Athena Development Programme continued to extend it to offer all women in SET, who choose to register, to become either mentor or mentee. While this is a slow process, by offering the opportunity for women engineers to develop their own networks, problems may be less traumatic when they do arise.

⁵³ Mentoring Women in Set, The Bolton Institute Project, supported by the 1999 Athena Development Programme. www.bolton.ac.uk/technology/news/mentor.

Summary

The changes in women's working lives that were explored in Chapter One have been mirrored by the changes demonstrated in this chapter. Company attitudes towards women engineers varied, largely influenced by their ability to get the recruits needed. The equality legislation, while improving the pay of many women engineers, had its greatest impact in the entitlement to maternity leave. As with other careers, this impact would have been greater still had it been accompanied by a wider availability of child care provision. However, engineering companies that wanted to keep trained women engineers were able to offer flexitime or part time working. This was not as easy in other careers where a direct interface with the general public, such as medicine, teaching, or the law, meant times could not necessarily be changed to suit the woman concerned.

At first the unions made little effort to recruit women, being more concerned with ensuring men's jobs were not devalued. This led to a dichotomy of attitudes as they supported the idea of equal pay while fighting to preserve the 'family wage.' A combination of the equality legislation and the decline of union power under the Thatcher governments forced them to accept that women's issues were important, and the unions began to treat women's issues seriously. Similarly the professional institutes did not take any measures to encourage women into the profession until the equality legislation combined with a shortage of recruits forced them to take action. From then on the professional institutes actively sought to change the image of engineering. They did this by showing female students and engineers whenever possible in the careers literature that they produced.⁵⁴ However, as happened with the WISE initiative to encourage girls into engineering, without a change in the way society as a whole viewed the profession the action had little effect on the numbers of girls considering the career.

While some feminists continued to complain about the male domination of industry the level of discrimination and harassment they assumed to exist is not supported by the

⁵⁴ See 'Engineering as a Career' leaflet from the Council of Engineering Institutions for example.

interviewees. While women engineers comment on problems during training, and admit to feeling the need to 'prove themselves', only two out of sixty-three stated they had been the victim of discrimination at work. Other women made comments about believing they would have done better had they been a man, or that having children had changed their ambitions, and one mentioned the 'Glass Ceiling,' but none made specific complaints about discrimination. The women employed at WHL made no such complaints, the only discrimination commented on was age discrimination, as young 'graduate engineers' became more prevalent from the mid 1990s. While individual companies suffered slumps and periods of high turnover, which impacted on recruitment and promotion, none appeared to discriminate against women solely on the grounds of their sex. The instances of discrimination that were mentioned were perpetrated by an individual, rather than being a company policy, although such companies needed to give clear guidance that such discrimination would not be tolerated. All of the woman interviewed, both from WHL and from the wider field of engineering, believed that engineering was a good career for a woman. It has been shown that companies will often offer flexitime or part time working if necessary to keep good engineers, and Chapter Three demonstrated that many women engineers are now overtaking men in terms of pay and promotion.

Thus women engineers appear to have more in common with other career women than is generally believed. They normally work in clean conditions, dealing with other specialists, solving problems, and interacting with their male colleagues on an equal footing. While this was not always the case, other careers were no better. It has been shown that the differences that have been suggested between women engineers and other professional women are a product of the public lack of knowledge regarding the work done by engineers. The situation has changed little over the second half of the twentieth century but, if the TV programmes suggested by PAWS can be made reality, a true vision of what an engineer does may finally reach the public.

Conclusions

By adopting a methodology which takes the agency of individual women seriously, this thesis has begun the work of documenting the input of women into technology in the second half of the twentieth century. Since women make up such a small percentage of engineers their presence has, hitherto, been easily overlooked, this in turn has perpetuated a common assumption that engineering is not, and has never been, a career for women. This thesis has shown that popular misconceptions regarding the career have changed comparatively little over time, many still associating the world of engineering with the 'boiler suit and oily rag' of the mechanic. While changing social mores regarding women and work have ostensibly allowed women the freedom to choose any career, social stereotypes continue to limit these choices and engineering is one of the professions that suffers in this way.

There are many influences on career choice and there is no simple answer to why engineering has consistently failed to attract women. Nonetheless, this thesis has demonstrated that while technology remains gendered, and the career of an engineer is presented to the public in a way that appeals to men, rather than emphasising the aspects of it that would appeal to women, the situation is unlikely to change. The engineering employers are keen to encourage women into the profession to help fill the apparently perennial shortfall of technicians and technologists, but their efforts have had little effect. The Equal Opportunities Commission continues to report that career choice is influenced by gender stereotypes which are preventing women from achieving economic parity with men. This thesis has shown that until steps are taken to change the way engineering is presented to the public, particularly women, recruitment will remain a problem.

Recent reports on engineering wages show that women engineers are now overtaking men in terms of pay and promotion prospects demonstrating that, contrary to the findings of many sociological works, discrimination is rarely an issue within the

profession. This thesis has shown that, by concentrating on attitudes within the academic world, sociologists have highlighted the one area within engineering where a woman is likely to meet harassment and discrimination. Their demands for a change of attitude regarding the way technology subjects are taught, at all levels, are fully justified.

However, by concentrating on these areas, rather than the everyday experiences of women working as engineers, they project a level of discrimination and harassment at work that is not supported by the findings of this thesis.

Putting the post-war experiences of women engineers at its centre, this thesis has addressed four central themes: why has society seen engineering as male; why have various campaigns failed to change this; why did some women become engineers against the general trend; and how did women succeed in engineering compared to women in other careers? The first two chapters demonstrated that, while both women's working lives and Britain's engineering industry saw changes in the second half of the twentieth century, these changes had little impact on how the engineering profession was perceived. Routh classed Professional Engineers with Accountants, Architects, Lawyers and Medical practitioners; and Draughtsmen were considered a similar level to Teachers, but while most others careers in his list were getting women entrants in growing numbers, engineering remained an unpopular choice for women.¹

The many social changes that occurred during the time frame of the thesis gave all women not only the right to equal pay and opportunity, but also the expectation of having a career. Although many women worked prior to the equality legislation, they were expected to relegate their career to second place when they married. This curbed the ambition of many women but, once the equality legislation was in place, attitudes changed rapidly. Within a generation, women were expected to have careers and to be as ambitious as men. However, this was not accompanied by a similar change in domestic responsibilities, and running the home largely remained the woman's responsibility.

¹ Guy Routh, *Occupation and Pay in Great Britain 1906-79*, London, Macmillan Press, 1965, (2nd Ed.) 1980, p.222. By inference this is a split between technologists, as professional engineers and technicians.

Arguments regarding the advisability of leaving children, to return to work, raged in the 1950s and 60s. By the end of the century the working mother was accepted as normal, with many employers offering crèche facilities, or help with nursery costs, to encourage women back to work as quickly as possible. Such changes affected all women, but while the numbers entering most careers rose, engineering failed to benefit from this, attracting a smaller proportion of women than other careers. This was partly due to the failure of the profession to market itself in a way that would appeal to women. For such a varied career, covering a multitude of disciplines and levels, this was an almost impossible undertaking. It was shown that when individual companies made efforts to attract women they often succeeded. Changes in the way engineering was viewed by society failed to keep pace with what was happening in the industry, and while engineering was no longer considered an unsuitable career for women, with little knowledge of what an engineer did, many assumed it would be dirty or uninteresting.

Chapter Three addressed the issues raised by some feminist writers regarding the male dominance of technology. It was established that early claims regarding the gendering of technology were accurate, and this has had an impact on women's attitudes towards the career. Little change has been achieved in this, although recent advances in I.T. are having an impact on how some technology is marketed. Over the long-term such changes may result in technology ultimately becoming gender neutral. Similarly, claims regarding the degree of harassment and discrimination that women faced during training for the career find support in this thesis. Much needs to be done before any semblance of equality is achieved, either for female tutors in technology subjects, or for female students. However, the assumption by some feminist writers that such discrimination and harassment continued in the work place has not been supported by my research.

The reports on wages and promotion, the dearth of cases being taken to the Equal Opportunities Commission, and the experiences of the women engineers interviewed, all demonstrate that the engineering profession has an enviable record regarding

discrimination and harassment. When it is suggested that women engineers ignore or trivialise discrimination and harassment, it implies that women engineers are either insensitive, or are colluding in their own mistreatment out of a misplaced wish to be 'one of the boys.' While this thesis acknowledges that many women engineers do make allowances for men, regarding behaviour that some individuals find offensive, such as the presence of pin-up calendars or swearing in the office, not all women find these things offensive. Today many women swear and women as well as men display pin-up calendars. The older women engineers interviewed said they missed the joking and flirting that used to lighten a day at work; men no longer feel that such behaviour is allowable. As one man commented 'you never know how it will be taken.'²

Feminist writing emphasises the point that men resent and fear women encroaching on their work areas. This thesis has not found this to be the case in engineering, possibly because women are in such a minority that they do not appear as a threat. The ability to weather the problems, apparent both on choosing the career and during the training, stands women in good stead, once a woman has overcome such problems and is working in the more congenial atmosphere apparent in most engineering companies, her career blossoms. Women engineers are noticeable at work because of their minority status, while this increases pressure on women to perform well; it also provides a showcase for their achievements that has contributed to their recent overtaking of men in terms of salary and promotion. The thesis has shown that this is a legacy of the work done by earlier women engineers. Such women, initially lacking any legal right to equality, worked diligently, knowing they would be held representative of their sex, and were recognised as capable engineers in their own fields, at whatever level they ultimately achieved. All the women interviewed acknowledged that the career offered enjoyable, challenging and varied work, and said they would recommend girls to consider the career.

² Oral history source, see Appendix 2.

This thesis has been particularly concerned with the way technology was presented, both when marketed and when taught in schools, and has assessed how this affected career choice. That the presentation was designed to appeal to the male character is clearly shown. The expression 'toys for the boys' sums up much of the desire to tinker with things that is at the forefront of the male interest in engineering. This showed little change over time, and the fact that engineering is about solving real problems, a more appealing aspect for many women, is seldom highlighted when technology is presented as a possible career. The thesis has established the effect levels of education had on girls who wanted to become engineers and how this changed between 1945 and 2000. It demonstrates that, while in the earlier period schools frequently failed to give girls the necessary basic education required for an engineering career, girls themselves would take steps to overcome this if they decided to become engineers. Once the equality legislation was in place, there were a number of cases brought which highlighted the fact that some schools were still assuming girls did not need education in the physical sciences or higher mathematics. The thesis confirms that, while this situation has changed, there is still evidence that girls are not encouraged to take technology subjects, and that sexual stereotyping is still widespread.

The changing availability and styles of careers advice offered have also been examined and it has been established that a new approach to advice for girls and women is now being developed which takes into account the difference in their career path compared to men. However, there has been no associated change in the way technology careers are marketed. While surveys into why women chose non-traditional gender careers undertaken in the 1990s offer a variety of reasons, this thesis demonstrates that sociologists place the emphasis on factors which differ from those given by women engineers, and there have been few attempts to explain how technology should be marketed if it is to attract women.

In examining the training necessary to become an engineer it has been shown that prior to the equality legislation women often suffered difficulties of access to training due to discrimination. No evidence was found of subsequent discrimination or harassment once a woman was on a course. However as this was during a time when some women accepted such things as normal, even though wrong, this may explain why no comments were made regarding it. While the equality legislation improved women's access to training, it did nothing to improve the more insidious problems of discrimination and harassment that they suffered during training. As has been shown, this harassment was a major cause of the feminist assumption that engineering was rife with such behaviour, since it was so prevalent in colleges and universities where the training took place. However, I have suggested that this culture is one that exists within academia rather than within industry. This is one explanation of the dichotomy between the expectations of the feminists conducting surveys and the responses of the women engineers. A further explanation may be found in the gender balance that many women engineers enjoy at work. When women can discuss technological problems in language that both genders accept, rather than the dominant male discourse where men 'explain' technical matters to them, a climate of mutual respect can develop. This not only improves the way in which men treat their female colleagues, but also enables women to be more tolerant of the occasional failure of men to adhere to the ideal behaviour that women desire. Although some women engineers admit to using the fact that men enjoy explaining things as a way to diffuse difficult situations.

The final chapter foregrounded the life histories of women engineers themselves. It explored change over time and showed how changes in women's lives and in Britain's engineering industry effected the careers of women engineers. The chapter explored the supposed 'difference' of women engineers, a difference that is seldom defined although often commented on. The only difference evident in this thesis is that of making a choice that defies gender stereotypes. While this is also true of women in other fields, due to the

engineering industries failure to address the problem of the image of an engineering career, it is more noticeable in this career than in most.

In the 1950s and 1960s engineering was seen as dirty or heavy work. Technology was masculine, women were not expected to understand it and this, combined with poor science and maths teaching in schools, emphasised the difference of those who became engineers. The women who worked in engineering at this time commented on the protective attitude that many of their colleagues adopted towards them. While this had the effect of depriving them of some opportunities, the women concerned did not see it as discrimination, they accepted it as natural. Women engineers were rare, but once they had shown that they were capable of doing their job they were generally accepted. It was shown that, if they had the ambition, they could overcome any discrimination to reach the highest levels in the industry. Once the equality legislation of the seventies assured women access to all careers the low number of women in engineering was expected to change. When this did not happen various initiatives were instigated, but once again the masculinity of the way engineering was presented prevented such initiatives from having any major impact. The opening of other careers, the low status of engineering and the persistent belief that it was a dirty job conspired to keep women away from the career. Women who did become engineers continued to be accepted in the work place. Some met discrimination, but this was usually from an individual rather than the result of company policies. However, with the changing social mores they suffered more harassment when training. The growth of the aggressive 'macho' culture removed any vestige of the protective instinct, and although few women made official complaints, many of the younger women contacted for this thesis mentioned the problem. The women who had problems generally preferred to deal with it themselves, acknowledging that dealing with difficult men was something they would almost certainly have to do at some point in their career.

This thesis has highlighted the need for more research into the history of women engineers. While it is accepted public knowledge that women worked in engineering during both World Wars, this is often assumed to be only at the shop floor level. More research is needed into the early history of women engineers and to establish how many women engineers there have been at various times, and in what engineering disciplines they worked. There is also a need for more research into the question of how women see discrimination and harassment. The area is currently dominated by feminist works which do not appear to reflect the attitudes of women working in industry. This echoes the comment in the recent report commissioned by the EOC which pointed out that the public do not see equality in the same terms as equality professionals do.³

This thesis has shown that, contrary to popular belief, there have been professional women engineers for many years. Their history parallels that of most career women of the twentieth century, except for the cloak of invisibility that has surrounded them. Attempts have been made to raise the profile of women engineers but, while these succeed within the profession, the general public remain largely uninformed and women engineers continue to be considered different. Throughout the time-span of the thesis women engineers have been shown, working, achieving success at various levels, and retiring. They have been recorded as marrying, having children and coping with all the stresses that every career woman suffers. The career has been shown to be one that can be a rewarding and fulfilling one for women at all levels. However, until women stop allowing outdated gender stereotypes to limit the range of careers available to them, the achievement of real equality at work will remain elusive.

³ Melanie Howard & Sue Tibballs, *Talking Equality, What Men and Women Think about Equality in Britain Today*. The Future Foundation. www.futurefoundation.net EOC 2003.

GLOSSARY OF ABBREVIATIONS

AEI	Amalgamated Engineering Industries
AEUW	Amalgamated Union of Engineering Workers
AEU	Amalgamated Engineering Union
APEX	Association of Professional and Executive Staff
ASTMS	Association of Scientific, Technical and Managerial Staffs
BEA	British European Airways
CAT	College of Advanced Technology
CBI	Confederation of British Industry
CEGB	Central Electricity Generating Board
DATA	Draughtsmen and Allied Technicians Association
DTI	Department of Trade and Industry
EEF	Engineering Employers Federation
EITB	Engineering Industries Training Board
EOC	Equal Opportunities Commission
GCE	General Certificate of Education
GEC	General Electric Company
GPO	General Post Office
HNC	Higher National Certificate
ICE	Institute of Civil Engineers
IED	Institute of Engineering Designers
IEE	Institute of Electrical Engineers
IERE	Institute of Electronic and Radiographic Engineers
ILO	International Labour Office
IMechE	Institute of Mechanical Engineers
IT	Information Technology
MSF	Manufacturing, Scientific and Finance Union

NUM	National Union of Miners
ONC	Ordinary National Certificate
OND	Ordinary National Diploma
PAWS	Public Awareness of Science and Engineering
RAF	Royal Air Force
SARTOR	Standards and Routes to Registration
SET	Science, Engineering and Technology
TASS	Technical, Administrative & Supervisory Section
TUC	Trades Union Congress
UKRC	United Kingdom Radiological Congress
WAC	Women's Advisory Committee
WES	Women's Engineering Society
WHL	Westland Helicopters Limited
WISE	Women Into Science and Technology
WRAC	Women's Royal Army Corps
WRAF	Women's Royal Air Force
WRNS	Women's Royal Naval Service

Appendix 1

The Questionnaire

SECTION 1: WHY ENGINEERING?

- 1.1 What sparked your interest in engineering?
- 1.2 Why did you become an engineer?
- 1.3 What did your family think about you becoming an engineer, were they supportive?
- 1.4 What did your friends think about you becoming an engineer?
- 1.5 Did you get any comments, help or advice from anyone else?

SECTION 2: SCHOOL / TRAINING.

- 2.1 Type of School
- 2.2 Single Sex or Mixed
- 2.3 Age on Leaving School
- 2.4 Qualifications on Leaving
- 2.5 Year of Leaving
- 2.6 Location of School
- 2.7 Did you go to University?
- 2.7.1 Which?
- 2.7.2 What did you study?
- 2.8 What training did you have?
- 2.9 Location
- 2.10 What Qualifications did you get?
- 2.11 Did you have any particular problems?
- 2.12 What re-action from the boys?
- 2.13 Were there any other girls on the course?
- 2.14 What was the attitude of your instructors?

SECTION 3: CAREER ADVICE & HELP.

- 3.1 Who gave you advice on becoming an engineer?
- 3.2 What was re-action of your school
- 3.3 Did you get any encouragement from your school?
- 3.4 Did you get encouragement from any other organisation?
- 3.5 Did you get encouragement from any individual?

SECTION 4: YOUR JOB.

- 4.1 When did you start work?
- 4.2 What was your job title?
- 4.3 Location?
- 4.4 What branch of engineering?
- 4.5 Were you a member of an Institute?
- 4.6 Were you a member during the 1960s
- 4.7 Your job profile in the 1960s
- 4.8 What is your job title now?
- 4.9 How do you feel your sex has affected your career?

APP.NO.	D.O.B.	Work	Type of Engineering	Job Now/Last	Working Level
1,01	1945	1961	Building Services	Technical Sales Engineer	Technician Level
1,02	1914	1936	Civil	Partner, Civil Engineer, retired 1978	Technologist Level
1,03	1938	1961	Mechanical	Engineering Advisor	Technologist Level
1,04	1942	1958	Aeronautical	Principal Weights Engineer	Technician Level
1,05	1935	1957	Electronic Research	Principal Research Engineer	Technologist Level
1,06	1943	1965	Power Generation	Lecturer	Technologist Level
1,07	1943	1966	Electrical	Tutor	Technician Level
1,08	1944	1965	Applied Electronics	Physics teacher	Technician Level
1,09	1943	1967	Pipelines & Terminals	Project Engineer	Technologist Level
1,10	1943	1960	Electrical	Training Consultant	Technician Level
1,11	1940	1962	Air Conditioning	Customer Support Manager	Technologist Level
1,12	1930	1949	Water supply & Sewerage	Engineer, retired 1988	Technologist Level
1,13	1926	1949	Heating & Ventilating	Principal Asst. Engineer	Technician Level
1,14	1919	1941	Electrical Power	University Lecturer	Technologist Level
1,15	1942	1971	Microwave	Spectrographic Analyst	Technologist Level
1,16	1936	1957	Aeronautical	Engineer grade 2	Technician Level
1,17	1923	1950	Electrical	Test engineer	Technologist Level
1,18	1925	1946	Electrical	Deputy Sec. I.E.E.	Technologist Level
1,19	1928	1951	Electronics	Senior Micro Specialist	Technician Level
1,20	1940	1957	Electro-mechanical	Secretary	Technician Level
1,21	1937	1953	Aeronautical	Senior Vibration Test Engineer	Technician Level
1,22	1945	1966	Mechanical	F.E. Lecturer	Technologist Level
1,23	1926	1944	Electro-Mechanical	Lecturer, retired 1980	Technician Level
1,24	1918	1946	Journalist	Plant Editor on Surveyor	Technician Level
1,25	1925	1961	Electrical	Senior Engineer (1981)	Technician Level
1,26	1948	1968	Computing	Resource Manager	Technologist Level
1,27	1947	1965	Mechanical	Senior Engineer	Technician Level
1,28	1931	1959	Medical Equipment	Senior Technician	Technician Level
1,29	1950	1968	Chemical	Maths Teacher	Technologist Level
1,30	1913	1957	Metallurgy	Editor	Technologist Level
1,31	1935	1952	Scientific Instrument m/f	Engineer	Technician Level
1,32	1941	1962	Heavy electrical	Asst. General sec. to MSF	Technician Level
1,33	1929	1952	Aerodynamics	Teacher	Technologist Level
1,34	1946	1968	Light assy/manufacture	Design engineer 1979	Technician Level
1,35	1950	1974	Aeronautical	Business dev. Manager	Technician Level
1,36	1949	1967	Aeronautical	Systems Analyst	Technician Level
1,37	1948	1969	Electrical	Programme Manager	Technologist Level
1,38	1954	1975	Civil Engineering	Control Manager	Technologist Level
1,39	1943	1962	Aeronautical	Applications Engineer	Technician Level
1,40	1925	1940	Electro-mechanical	Draughtsperson	Technician Level
1,41	1925	1942	Electrical	Senior Programmer	Technician Level
1,42	1950	1967	Aeronautical	left engineering in 1970	Technician Level
1,43	1975	1991	Aeronautical	Electrical Design Engineer	Technician Level
1,44	1966	1985	Electronics	Lecturer in Engineering	Technician Level
1,45	1968	1995	Materials	Structural Design Engineer	Technician Level
1,46	1974	1995	Mechanical	Structural Design Engineer	Technician Level
1,47	1973	1991	Mechanical	Stress Analyst	Technician Level
1,48	1971	1994	Mechanical	Materials & Process Engineer	Technician Level
1,49	1976	1999	Avionics	Flight Controls Engineer	Technician Level

1,50	1972	1992	Mechanical	Project Manager	Technologist Level
1,51	1973	1997	Chemistry	Advanced Technologist	Technologist Level
1,52	1971	1989	Mechanical	Stress Engineer	Technician Level
1,53	1971	1989	Mechanical	Customer training Manager	Technician Level
1,54	1974	1996	Mechanical	Plant Technical Engineer	Technologist Level
1,55	1959	1977	Avionics	Business Group Manager	Technologist Level
1,56	1946	1962	Mechanical	Lecturer in Art History	Technician Level
1,57	1968	1991	Mechanical	Project Engineer	Technician Level
1,58	1968	1992	Mechanical	Development Engineer	Technologist Level
1,59	1969	1985	Mechanical	Cost Analysis Engineer	Technologist Level
1,60	1960	1976	Mechanical	Design Engineer	Technician Level
1,61	1951	1975	Applied Biology	Mass Properties Engineer	Technician Level
1,62	1959	1982	Physics	Principal Software Engineer	Technologist Level
1,63	1949	1965	Aerospace	Senior Design Engineer	Technician Level

An analysis of some of the answers provides the following data:

SECTION 1: WHY ENGINEERING?

34 of the interviewees commented on being interested in how things worked
18 of the interviewees commented on family influence
7 of the interviewees commented on not being interested in the careers their school offered
18 of the interviewees became engineers by chance.
(There are more than 63 responses as these answers are from questions 1.1 & 1.2 combined)

45 of the interviewees found their family was supportive of their decision

18 of the interviewees had friends who thought them 'odd' to choose engineering

SECTION 2: SCHOOL / TRAINING

13 of the interviewees had attended Comprehensive Schools
4 of the interviewees had attended Secondary Modern Schools
32 of the interviewees had attended Grammar Schools
14 of the interviewees had attended Other Schools

31 of the interviewees had attended Single Sex Schools

32 of the interviewees had attended Mixed Schools

37 of the interviewees were graduates

12 of the interviewees commented on problems during training, of these
4 were concerned with the attitudes of the students/lecturers
8 were concerned about a lack of prior training in science/maths/technical drawing subjects

SECTION 3: CAREER ADVICE & HELP

12 of the interviewees had found their schools encouraging about their career choice
12 of the interviewees got advice about starting the career from family members
10 of the interviewees got advice about starting the career from Careers Advice Literature
6 of the interviewees got advice about starting the career from WES

SECTION 4: YOUR JOB.

2 of the interviewees were never engineers, one is a scientific journalist, one a mathematician

3 of the interviewees are/were Chemical Engineers

6 of the interviewees are/were Computer Engineers

2 of the interviewees are/were Civil Engineers

5 of the interviewees are/were Building Services Engineers

5 of the interviewees are/were Manufacturing Engineers

16 of the interviewees are/were Mechanical Engineers

19 of the interviewees are/were Aerospace Engineers

21 of the interviewees are/were Electrical/Electronics Engineers

The total is more than 63 due to engineers changing jobs

30 of the interviewees are members of the relevant professional institution

14 of the interviewees left engineering to do other work

10 of these became teachers/lecturers

The description of Technologist/Technician gives an approximation of the level at which the respondent was working when they completed the questionnaire or when they last worked in engineering.

The interviewees covered the full range of ages,

4 were born before 1920

9 were born in the 1920s

7 were born in the 1930s

20 were born in the 1940s

7 were born in the 1950s

6 were born in the 1960s

10 were born after 1970

In addition there are 5 letters from male engineers with comments regarding women they worked with.

Appendix 2

The additional questionnaire completed by the women engineers interviewed is followed by the tabulated responses to it. This is followed by brief notes about the interviews. The full transcripts of the interviews, including those of interviews conducted with two male engineers and two female teachers and the original tapes will be deposited at the WES archives, held at The Institute of Electrical Engineers, London, with the exception of the interview with Ann who refused permission for the tape to be made available.

The Questionnaire

Full Name & Address:

Contact telephone number:

Date of Birth:

Who influenced your choice of engineering as a career?

What was your Father's occupation?

What was your Mother's occupation?

How many siblings, older or younger than you?

What occupations did they choose?

What class would you describe your parents as?

What class would you describe your self as?

Where were you living as a teenager / when you started work?

Are you Married or in a long-term relationship?

If so when did you marry/start living together?

What is your partner's occupation?

Did you have a previous marriage/relationship? If so please give the Years it started & finished and your previous partner's occupation?

Do you have children?

Children's sex and date(s) of birth?

Name	App. 1	D.o.B.	Status		Partners Occupation	Children
Chris	1.47	27.12.72	Married	1996	Teacher	No
Evelyn	1.45	24.07.68	Divorced	1987/1990	Labourer	No
Emma	1.27	31.08.48	Partner	1983	Design Engineer	No
Pauline	1.57	28.03.68	Married	1994	Systems Engineer	Girl 2000
Sue	1.58	12.05.68	Single			No
Rose	1.39	21.06.43	Divorced Married	1966/1985 1985	Aeronautical Engineer Electrician	Boy 1969 Girl 1971
Ann	1.16	14.03.36	Divorced Widowed	1953/1980 1979/1998	Engineer Engineer	No
Linda	1.6	17.04.61	Married	1982	Design Engineer	Boy 1991 Boy 1995
Mary	1.21	22.07.36	Widowed	1961/1979	Chief Flight Test Engineer	Boy 1964
Jill	1.59	20.07.69	Divorced Partner	1997/2000 2000	Retail Aircraft Manager	Boy 1998
Grace	1.61	06.03.51	Married	1973	Stress Engineer	No
Joan	1.04	26.02.42	Married	1963	Aircraft Engineer	Girl 1968 Boy 1970
Helen	1.62	7.10.58	Partner	1983	Systems Engineer	No

Name	Father's Occupation	Mother's Occ.	Siblings	Occupation
Chris	Chartered Engineer	Teacher	Older Brother Older Sister Younger Brother	Chemical Engineer Medical Physics Civil Engineer
Evelyn	Capstan Lathe Operator	Housewife	Younger Brother	Capstan Lathe Operator
Emma	Scrap Merchant	Home Help	Younger Sister Younger Sister Younger Brother	Librarian Sales Rep. Retail
Pauline	Draughtsman	Housewife	Younger Brother	Builder
Sue	Lecturer in Mech. Eng.	Library Assistant	Younger Sister	Chartered Accountant
Rose	Armed Forces/ Prison warder	Housewife	Younger Sister Younger Sister	Administrator Secretary
Ann	Musician	Shop Assistant	Younger Brother	Engineer
Linda	Banking	Banking	Younger Brother	Chef then Driving Instructor
Mary	Car Mechanic	Housewife	Younger Sister Younger Sister	Drs Receptionist Wrens
Jill	Chief Draughtsman	Housewife	Younger Sister	Graphic Designer
Grace	Doctor	Housewife	Younger Brother Younger Brother Younger Brother Younger Sister	Navy/Electrician Bio Med.Engineer Systems Analyst Company Secretary
Joan	Aircraft Engineer	Shop Assistant	Younger Sister Younger Sister Younger Brother Younger Brother	Hairdresser Various Aircraft Engineer Aircraft Engineer
Helen	Dock Worker	Secretary	None	

Name	Parents Class	Own Class	Home location
Chris Technologist Level	Middle	Professional	Liverpool
Evelyn Technician Level	Working	Middle	Somerset
Emma Technologist Level	Working	Working	West Yorkshire
Pauline Technician Level	no response	no response	Yeovil
Sue Technologist Level	middle	middle	Cornwall
Rose Technician Level	Working	Professional	Yorkshire
Ann Technician Level	Working	Middle	Luton
Linda Technician Level	Middle	Middle	Somerset
Mary Technologist Level	Working	Middle	Dorset
Jill Technologist Level	Working	Middle	Yeovil
Grace Technician Level	Middle	Middle	Berkshire
Joan Technician Level	Working	Working	Yeovil
Helen Technologist Level	Working	Professional	Southampton

Chris (ref App. 1. 47)

4 July 2001, Lynx Conference Room, WHL, lunch time.

Chris seemed perfectly at ease, the only point that caused her confusion was that of class, she considers herself working class, but after some discussion agreed that her parents were middle class. She is in her early thirties and has been married for 5 years, she has no children.

Evelyn (ref App. 1. 45)

11 July 2001, Lynx Conference Room, WHL, lunch time.

Evelyn considers herself definitely middle class, although her parents were working class. She is an extremely attractive woman in her early thirties, she married at age 19 but divorced three years later. She has no children and was not in a steady relationship at the time of the interview.

Emma (ref App. 1. 27)

18 July 2001, Emma's Office, WHL, lunch time.

Emma was very busy and there were a number of interruptions during the interview, but we covered most things in spite of the interview being terminated abruptly by an important phone call. Emma is in her early fifties and has been in a long-term relationship for eighteen years, she has no children.

Pauline (ref App. 1. 57)

30 July 2001, Lynx Design Conference Room , WHL, lunch time.

Pauline works 3 days a week and does not want the fact that she is part time to affect how others see her performance. She is in her early thirties, has been married for eleven years

and has an eight-month-old baby daughter. She would not answer the question about class, saying this was no longer relevant.

Sue (ref App. 1. 58)

2 August 2001, SMTE Conference Room , WHL, lunch time.

Sue was very relaxed about being interviewed, she is in her early thirties, enjoys travel and meeting people. She is not in any relationship. After the interview, while walking back to work, she added a comment about the 'military' aspect of technology. She pointed out that some people had asked her how she felt about working on 'war machines', ignoring the amount of peacekeeping and rescue work done by military helicopters. She remarked that the same people said nothing about this when she was in the services and took her turn on guard duty with a loaded sub-machine gun.

Rose (ref App. 1. 39)

6 August 2001, Lynx Conference Room, WHL, lunch time.

Rose has strong feelings that the company is not making the best use of its employees, particularly the older ones and this coloured her responses. She was well prepared for the interview and had typed out a brief history of her working life. She is approaching retirement age and has been married for twenty years. She first married when she was twenty three and had two children, she divorced after nineteen years to marry her present husband.

Ann (ref App. 1. 16)

6 August 2001, Ann's Home, 7.00 pm.

Ann chatted quite happily about her experiences as an engineer, but made some disparaging comments about people she had worked with. She refused permission for her

tape or transcript to be deposited for future access, but was happy to be quoted provided I did not give her real name. She is an active widow, having lost her second husband shortly after retiring. This marriage had lasted seventeen years. She had initially married at age seventeen, but the marriage failed after twenty-seven years. She has no children.

Linda (ref App. 1. 60)

18 September 2001, Lynx Conference Room, WHL, lunch time.

Linda was happy to be interviewed but not very interested in the project. This meant that I had to do quite a lot of prompting. With the extra pressure on every-one at work due to the events in America, this was not a particularly good interview. She is forty, has been married for nineteen years and has two sons, aged ten and seven.

Mary (ref App. 1. 21)

18 September 2001, Mary's Home, 8.00 pm.

Mary happily talked with little prompting from me about her life working for WHL. Having been widowed in 1979 after eighteen years of marriage, she probably put more into her career than many women, in spite of having a son who was only 14 at that time. She is having difficulty coming to terms with her retirement, which started at the end of April 2001, missing both the company and the challenge of her career.

Jill (ref App. 1. 59)

9 October 2001, European Conference Room, WHL, lunch time.

Jill has had a lot of bad experiences with men, including a rift with her father during his divorce and a messy divorce herself, this may have influenced how she re-acts to men. She had a son in 1998 and married his father eighteen months later. The marriage failed when

she moved back to the West Country in 2000, leaving her husband in Birmingham. Both parties started new relationships and she divorced in June 2001.

Grace (ref App. 1. 61)

23 October 2001, Lynx Design Conference Room, WHL, lunch time.

Grace talked quite happily with little prompting. She had originally trained as a lab technician working in hospitals, when she married at age twenty-two she moved to the West Country but could not get a job. After some months of unemployment she started work at WHL. She is now fifty, still married and has no children.

Joan (ref App. 1. 04)

17 November 2001, Joan's Home, 8.00 pm.

Joan had only recently retired, she talked more easily about her earlier working life, having little to say about recent events. She worked in the same department for all her time at WHL and progressed to become a principal engineer before retiring. She married in the early sixties and had two children.

Helen (ref App. 1. 62)

14 November 2001, the Canteen, WHL, lunch time.

Helen was happy to do the interview but had very little to say. She only became an engineer because the job was available and, in spite of saying she enjoys her work, and having progressed to a principal engineer, she seemed mildly disappointed not to have moved into management. She needed a lot of prompting and the interview was very short. It was not taped due to background noise, notes were made at the time and written up immediately after. She is in her early forties and has been in a long term relationship for eighteen years. She has no children.

Appendix 3

Westland Helicopters Ltd.

A Brief History of the Company

Britain's only helicopter manufacturer is located in the Somerset. This location has resulted in an employer who has to suffer both the drawbacks and the benefits of a restricted pool of labour. Without the large and skilled workforce available to employers in the more industrialised areas of the country, Westland Helicopters developed a 'family' attitude to its workforce. Frequently entire families are employed in various positions around the factory and very often parents introduce their offspring into the firm. With the changing fortunes of the engineering industry and the advanced technology employed in the design, development and production of the modern helicopter bringing more specialists in from outside the area, this family atmosphere has become less noticeable. However, as the only large employer in the town, Westland Helicopters remains a major force in the local economy, influencing not only the jobs likely to be considered by young people growing up in the area, but also the subjects taught at the local technical college.

At the turn of the century Yeovil was a market town; it was a centre for the gloving industry and the only significant engineering activity in the area was a company that produced oil engines providing power for agricultural purposes and light industry. These engines proved so successful that, by the outbreak of war in 1914, the company was looking for a suitable site for a new foundry near the railway. In addition to the foundry, some 75 acres of farmland was purchased in order to build a garden village to house the expected increase in the workforce. With the outbreak of war there was an immediate appeal from the government for companies to turn their attention to armament manufacture and this was the start of Westland Aircraft as an aircraft manufacturer. The two world wars established Westland Helicopters as a major part of Britain's aerospace industry. There had been a brief excursion into Rotary winged aircraft in 1936, when Westland Aircraft

constructed two autogyro designs and with the return to peace in 1945 the board of Westland Aircraft decided that the company future lay with this totally different form of flying machine, the helicopter.

The first practical helicopters had appeared towards the end of the war in Germany and USA, one of the most successful American designers being Sikorsky. In 1946 Westland Aircraft had negotiated a long-term agreement to build Sikorsky designs under licence, but they also made the bold policy decision to specialise in helicopter designs for the future. In 1960 the British aircraft industry underwent a major re-organisation. Over twenty aircraft manufacturers were competing for a few orders and the government of the time made it clear that it could no longer support this situation. The result was a period of re-organisation where many of the companies combined to form two major aircraft manufacturing groups (The British Aircraft Corporation and the Hawker Siddeley Group), neither of which retained any interest in rotorcraft. Because of its success in the helicopter business, Westland Aircraft was well placed to take the lead for rotary winged aircraft. They acquired Bristol Helicopters, Fairey Aviation and Saunders-Roe to become Westland Helicopters, Britain's sole helicopter company. The British forces' requirement for a range of new helicopters was met by collaboration with the French company, Aerospatiale to produce three new designs, Westland Helicopters took design leadership for the Lynx, while Aerospatiale were responsible for Puma and Gazelle. Both companies took part in the development and manufacture of all three aircraft. The 'Anglo-French Helicopter Package Deal' represented a major step in the development of Westland Helicopters within the European aircraft industry. There followed a period of unprecedented prosperity for Westland Helicopters, the Lynx was a great success, setting a new high standard for small ship operations with Westland Helicopters becoming the world leader in this field.

The mid 1980s saw Westland Helicopters in the national press, the Lynx took the world absolute speed record for helicopters, which still stands, (400.87kph / 249.1 mph)

using the new composite rotor blades, and the prototype EH101 flew for the first time.

However the press were more interested in the political row that was sparked by Westland Helicopters' need to find a partner to provide financial stability until the EH101 was in production. Westland Helicopters favoured a link with Sikorsky but the then Secretary of State for Defence, Michael Heseltine, preferred a European option although this would have effectively ended Westland Helicopters position as a major helicopter design company. The link with Sikorsky went ahead and Westland Helicopters survived. The partnership was needed because the company was making considerable investment in composite blade technology and the design of the EH101 as a replacement for the Sea King. Westland Helicopters had already entered an agreement with the Italian company Agusta, to collaborate in the design, development and production of this new large helicopter. The EH101 is a multi-role helicopter designed to meet naval, military utility and civil requirements and in 1991 the Ministry of Defence placed an order for 44 for the Royal Navy.

The engineering company GKN had been a major shareholder in the Westland Helicopters Group since 1987 and was one of the Group's strongest supporters. Sikorsky's parent company, United Technologies, was the other significant shareholder and in 1994 it decided to sell its holding. GKN bought the UTC shares and launched a successful take-over bid for Westland Helicopters. Re-named GKN Westland Helicopters in 1995, the substantial financial muscle of GKN enabled the company to bid successfully for the contract for EH101's for the RAF and the contract to supply the Army Air Corps with the new Apache helicopter. In 1998 GKN and Finmeccanica announced that they were starting negotiations to create a joint venture company by combining their respective helicopter companies, Westland Helicopters and Agusta. Those negotiations were successfully concluded in July 2000. The company Agusta Westland Helicopters became the second largest Helicopter Company in the world, with a turnover of more than US\$2

Billion and a workforce of some 10,000 people. The Westland Helicopters factory employs over 5,000 people on its original site in Yeovil, where it undertakes the design, development, build and test flights of the three helicopters currently in production. The company also operates a pilot training programme, teaching pilots from the armed forces of Britain and many other countries how to fly helicopters.

A wholly owned subsidiary company, Normalair had been set up in 1952 to concentrate on environmental control systems for aircraft. This activity originated in work done during the Second World War when the Welkin high altitude fighter was developed. The requirement to operate at altitudes of 40,000 feet or more called for cabin pressurisation, and it was from this pioneering work that the independent company was developed. The company shared the site and its staff belonged to the same pension fund as the Westland Helicopters employees, although the company had its own board of directors and management team. In 1967 Westland Helicopters sold 48 percent of its ownership to the American Company Garrett, renaming the company Normalair Garrett Ltd (NGL). This had little impact on the employees who continued to move between jobs in Westland Helicopters and NGL when they wanted to. In 1993 Westland Helicopters finally relinquished their holding in NGL and the company became entirely separate.

The Company and Women Engineers

Westland Helicopters, like most factories had a large female work force during the war, although figures are no longer available. However some older employees remember individual women in engineering areas, particularly in the weights and stress offices, although these women have been impossible to trace. The company has never refused to employ women as engineers, leaving the decision about whether they were suitable to the individual office managers. Before the equality legislation was passed this led to some

discrimination when the manager concerned did not believe women suitable for the task to be performed, but in general women were accepted. Once the equality legislation was in place, girls as well as boys were recruited as apprentices from the local schools and, while few girls responded to the opportunity those that did proved highly successful, frequently taking the prize for apprentice of the year.

The only historic figures available were for the subsidiary company NGL, these showed that in the 1970's 1.75 percent, or 5 of the 285 apprentices taken on were female. In the 1980's 300 apprentices were taken on, 10 of whom were female, a rise to 3.3 percent, while during the 1990's only 142 apprentices were taken on, 9 of whom were female, rising again to 6.3 percent.¹ Apprentice figures from Westland Helicopters were only available from 1996; they are given below.

1996	23 boys	1 girl (4.3 percent)
1997	21 boys	1 girl (4.75 percent)
1998	27 boys	1 girl (3.75 percent)
1999	20 boys	1 girl (5 percent)
2000	28 boys	0 girls
2001	15 boys	0 girls
2002	16 boys	2 girls (12.5 percent)

The training advisor commented that they were 'just not getting any female applicants.' He blamed the situation on the attitude of society that still equated engineering with dirty or heavy work.²

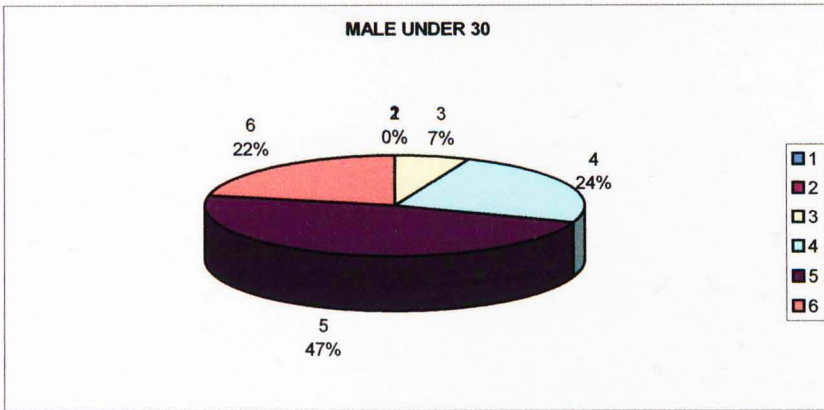
Currently approximately 7½ percent of the engineers employed at Westland Helicopters are women; the engineers are split into 6 grades, E1 being the lowest grade, followed by E2. Once an engineer has gained experience and takes on responsibility it is possible to progress to Senior Engineer (SE) and then Principal Engineer (PE), above this come two managerial engineering grades of Deputy Chief and Chief Engineer. There are 693 people in the engineering group, of whom 674 are engineers; of these 51 are women. 9

¹ Data supplied by NGL training department in Sept. 2002

² Comment made when supplying the data in Sept. 2002.

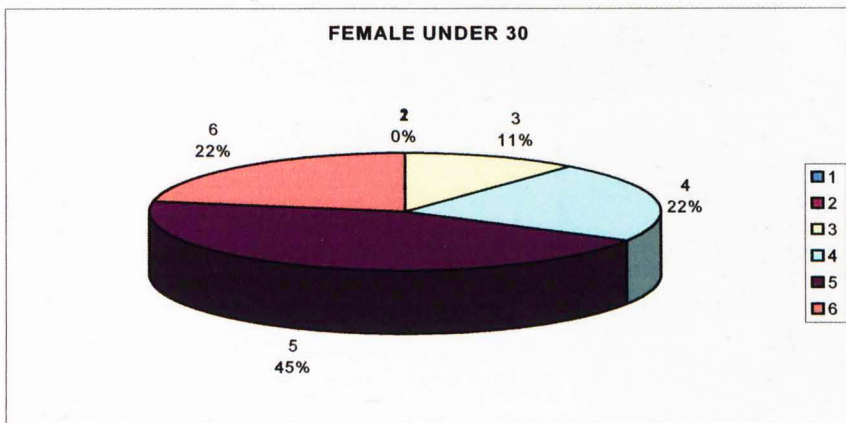
of these women were interviewed, (17.½ percent). Only in the highest grade, Chief Engineer, of whom there are 48, are women totally absent. When the age ranges are split up however a more detailed picture emerges. This is shown in the charts below.

(Note, the key to all the charts is the same as that given on the first pair)



GRADE

- 1 = Male Chief Engineer
- 2 = Male Deputy Chief
- 3 = Male Principal Engineer
- 4 = Male Senior Engineer
- 5 = Male E2
- 6 = Male E1

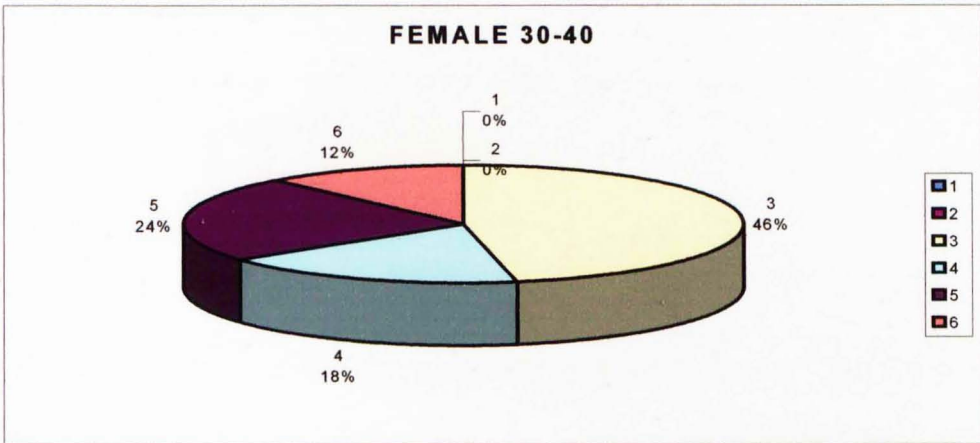
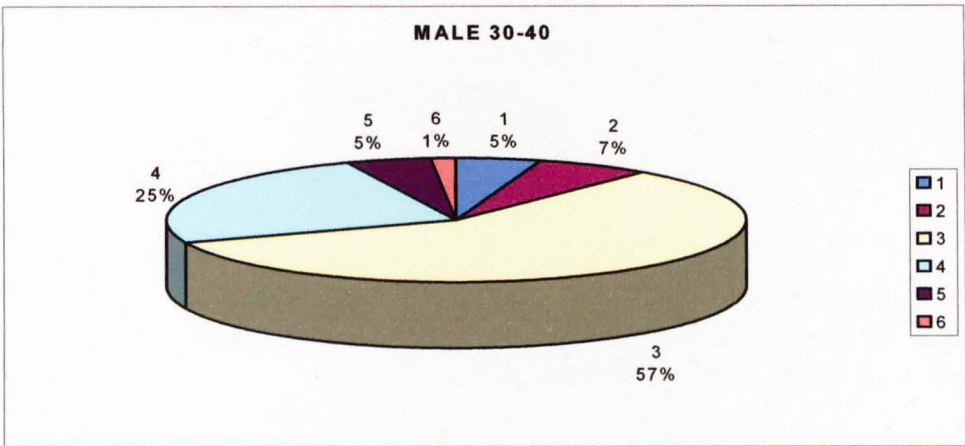


GRADE

- 1 = Female Chief Engineer
- 2 = Female Deputy Chief Engineer
- 3 = Female Principal Engineer
- 4 = Female Senior Engineer
- 5 = Female E2
- 6 = Female E1

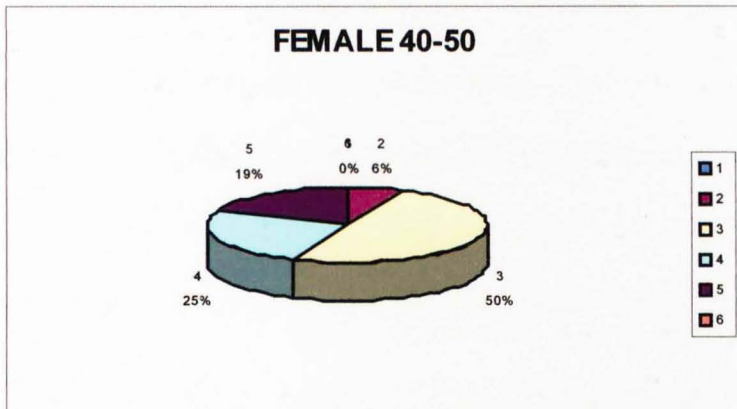
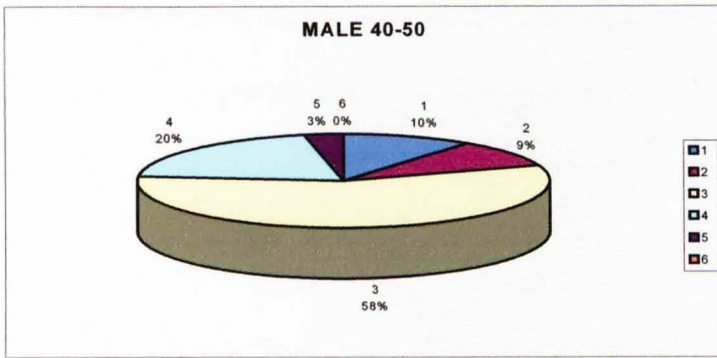
The spread across the grades in the under 30 age group is not noticeably sexually biased.

The age range of 30- 40 comprises 231 engineers, 17 of whom are women, just over 7 percent. The majority of these engineers are in the two middle grades, some sexual bias is visible, but as this is the age range during which many women leave work to bring up children, the bias is not unexpected.



Once the age range goes over 40 the percentage of women might have been expected to fall since these women would not have had the full benefit of the equality legislation of the 1970's. However between the ages of 41 and 50 there are 210 engineers of which 16 are women, retaining the 7½ percent proportion. The spread across the grades is now beginning to show some sexual bias. Although the overall percentage of women engineers remains similar, they are now beginning to be concentrated in the lower grades. Over the age of 50 there are only 2 women engineers, both on SE grade, the percentages of men on each grade is shown below. ³

³ All information supplied by Westland Helicopters Ltd in December 2001.



The grading structure shown above may not give a true picture of the company attitude to female pay as it has been in place for many years and is becoming unworkable. Many anomalies exist within the structure, caused by some departments finding it difficult to recruit specialist staff. A new structure is in the process of being agreed between management and unions that will remove some of the anomalies, such as the preponderance of principal engineers in some departments.

The company tries to operate family friendly policies with flexitime working for all engineers and, while there is no crèche facility at work, part-time work is generally available if requested. There is a strong union representing the engineers and while disputes do occur these seldom lead to industrial action. As with many engineering companies overtime is worked on an almost permanent basis by many staff, leading to an erosion of the benefits to families from the flexitime. However the company can be considered among the more progressive of employers in many of its attitudes, particularly

with regard to its training programmes. It is committed to life-long learning and has a training school where staff can study not only subjects to enhance their careers, which are studied during working hours, but also a range of subjects for their own interest that they can study after work.

The Engineering Process

To those not familiar with the work done by an aerospace company the process of engineering may require some explanation. There are many jobs performed by engineers, and within Westland Helicopters women can be found in most of them. The particular requirements of the aerospace industry require an extremely well controlled and documented system to be operated at all times. Within Westland Helicopters this has resulted in an engineering process that remains based upon the same route as that followed in the 1950's, although it has expanded and developed over the years with the growing sophistication of aircraft systems. This route can be simplified to the following stages:

1. The Specification Stage
2. The Design Stage
3. Stress Engineering
4. Aerodynamics & Weights Engineering
5. Production Engineering
6. Prototype & Development Testing

As the aircraft is designed and its life cycle develops so changes will be specified, either to suit another customer's needs or to stay ahead in a competitive market. Each of these changes or 'upgrades' will pass through all of the above stages before implementation, so the cycle continues.

The specification will be agreed between the customer and the marketing department, but obviously there has to be close liaison between the marketing department and the design engineers to ensure that the specification can be met. This will result in a number of schemes being produced to prove to the customer that what is being specified is possible. Some marketing personnel have an engineering background and one woman engineer, who chose to transfer into marketing, said that she found the challenges involved and the opportunity of travelling and meeting new people, compensated for moving away from the direct involvement with engineering that she previously enjoyed. The design stage is where engineers from all disciplines will be consulted to ensure that the optimum design is produced. Frequently the conflicting requirements of the other disciplines will result in the designer having to decide on a compromise that offers something to all areas rather than the best for one. There are a number of women design engineers within Westland Helicopters and this is an area where women can often find their ability to forge compromises among a group of disparate people advantageous. The design task itself is split into various areas of expertise, computer software, structure, power plant, transmission, flying controls, hydraulics and fuel systems, instrumentation and many more. Once a design has been agreed many engineers in the design office will work on it concurrently, producing detailed drawings of the necessary parts, in consultation with the relevant specialist areas, and the stress department. This ensures that the parts will withstand the strains placed on them in flight. On completion the drawings will be signed by the specialist, approving the design; the stress department, agreeing the safety; and the aircraft designer who oversees the entire aircraft.

The drawings will then be released to the Aerodynamics & Weights Engineering teams for them to carry out the necessary calculations. This is another area where women engineers have traditionally been employed, their attention to detail being an essential part of the job. The Production Engineering team will then oversee the manufacture of the parts

and the build of the prototype aircraft. In this area there are few women engineers, none would have been employed prior to the equality legislation, and although a few are now employed in this work, it is not an area that attracts many women. Once the aircraft is built it is the turn of the test engineers, many of whom are women, to design and carry out the necessary tests to assess the performance, whether it is meeting the specification and where it can be improved. This is work that frequently involves travelling to inhospitable areas. 'Hot and High Trials' and 'Cold Trials' can involve staying for weeks at a time in uncomfortable surroundings, while the aircraft is flown under demanding conditions.

This is obviously an extremely simplified version of the engineering process, a helicopter is a very intricate piece of machinery, and has many parts. Each of these will have been the subject of careful consideration before selection, every part needing to meet a minimum strength and maximum weight requirement before being acceptable. However it will enable the descriptions of working at Westland Helicopters to be placed in context.

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