An exploration of some factors which inhibit females from entering Engineering and Physical Science vocational areas from the Hull and East Yorkshire Local Education Authorities.

being a Thesis submitted for the degree of Doctor of Philosophy

in the University of Hull

by

Antony Edward Delaine BEd(Hons)
University of Huddersfield,
Fellow (formerly Graduate) of the
Royal Society of Chemistry.

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ABSTRACT.

The following thesis examines why many engineering and physical science vocational areas remain dominated by male candidates, and whether this trend is reversible. National figures support the fact that female school students currently out perform male students in almost all academic areas. It could therefore be anticipated that female students would have the pick of university, college, and training opportunities. However, female candidates remain reluctant to enter many science and engineering vocations, despite efforts to attract them. Figures provided by the Engineering Council (1995) show current female participation at around 15%, a figure confirmed by one of Britain`s largest employers with a site in East Yorkshire.

As females occupy about half the places at all educational establishments, the question must be asked, why is there a great reluctance for females to enter engineering and physical science professions. If one assumes that these chosen fields of study are not chosen at random, then whatever the reason for the decision, it is likely to be made during, or even before school years. To try to find the reason for these choices, this research thesis examines the decisions made by females at various stages of their time at school. Examination of ideas, beliefs, pressures, and selections in the 9 to 16 age group have been covered. The results of a literature review were then compared to the research findings.

Are females aware of the opportunities that exist, or are they aware and have decided better opportunities lie elsewhere? The research reveals some of the reasons why there appears little motivation for female students to enter engineering and physical science vocational areas. The research also generates some conclusions which may provide a framework for producing future equality in these vocational fields.

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GLOSSARY

A	Answer
A-level	Advanced Level
AS-level	Advanced Supplementary Level
BA(QTS)	Batchelor of Arts with Qualified Teacher Status
BP	British Petroleum
CBI	Confederation of British Industry
CDT	Craft Design Technology
C & G	City and Guilds
CWSET	Committee on Women in Science, Engineering and Technology
DfEE	Department for Education and Employment
DTI	Department of Trade and Industry
EPA	Expressive Performing Arts
FE	Further Education
GCE	General Certificate of Education
GCSE	General Certificate of Secondary Education
CEG	Careers Education and Guidance
HE	Higher Education
HETA	Humberside Engineering Training Association
HMSO	Her Majesty's Stationery Office
ITT	Initial Teacher Training
LEA	Local Education Authority
LEC	Local Enterprise Companies
N/A	No figures available
OFSTED	Office for Standards in Education
OST	Office of Science and Technology
PGCE	Post Graduate Certificate in Education
PSE	Personal Social Education
Q	Question
RAF	Royal Air Force
RSA	Royal Society of Arts
SAR	Social Analysis and Research
SE	Science and Engineering
SET	Science Engineering and Technology
SMEs	Small to Medium Employers (less than 250 employees)
TEC	Training and Enterprise Council
TPS	Teacher Placement Service
UK	United Kingdom
WISE	Women into Science and Engineering

CHAPTER 1

INTRODUCTION.

In recent years there have been several investigations of the relationship of gender to examination results and vocation selection, and the Rising Tide report (1994) recorded the establishment in 1993 of the Committee on Women in Science, Engineering and Technology to make greater use of the talents of females in these specific vocational areas.

Grant (1994) highlighted the fact that female school students out perform male students in almost all academic areas. It could therefore be anticipated that female students would have the pick of University, College, and Training opportunities. It is somewhat surprising that female candidates are remaining reluctant to enter some science and many engineering vocations, despite the great efforts taken to attract them.

Personal involvement with a large British based International Company has revealed that its engineering and science training programme aimed at the 16-20 year age group, attracts only 10-15% of the total applications from female students. Considerable effort has been spent in areas such as local publicity and active school links to attract more female applicants, but the percentage remains little changed overall. This figure is matched almost exactly by information supplied by the Engineering Council (1995). In 1950 only 0.5% of engineering students attending universities in the UK were female. In 1984 this had risen to 8%, and by 1995 it had risen to 15-16%

Some Facts About Women (1995), supplied by the Equal Opportunities Commission, revealed that females made up 51% of the population and 45% of all occupational groups in Great Britain. Bearing this in mind, the Table 1 below shows the number of students in Further Education and Higher Education in Great Britain in 1993/4.

Table 1 - Students in Education 1993/4

Area	**Females**		**Males**	
	Number (1,000s)	**% of Line Total**	**Number (1,000s)**	**% of Line Total**
Further Education				
All students	1,261.6	57.0	953.4	43.0
Physical sciences	0.6	26.1	1.7	73.9
Engineering/Technology	16.3	8.2	183.6	91.8
Higher Education				
All students	385.7	49.4	395.6	50.6
Physical sciences	8.3	37.4	13.9	62.6
Engineering/Technology	9.4	10.8	77.5	89.2
University				
All students	152.6	47.0	171.8	53.0
Physical sciences	8.5	31.4	18.6	68.6
Engineering/Technology	4.8	13.9	29.7	86.1

Figures supplied by the Equal Opportunities Commission (1995).

As females occupy about half the places at all educational establishments, the question must be asked, why is there a great reluctance for females to enter engineering and some science professions. If one assumes that these chosen fields of study are not chosen at random, then whatever the reason for the decision, it must clearly be made during, or even before school years. The following research examines the decisions and choices made by females at various stages of their time at school. Examination of ideas, beliefs, pressures, and selections made by the 9 to 16 age group have been covered. To explain why there exists gender bias in these areas a considerable literature review of related areas has been performed. The information gathered considers;

1) Education and women, and specifically science education, of the nineteenth and twentieth centuries.

2) Basic child development theory including the works of Piaget and Erikson.

3) Theses from related research, and results of the WISE (Women into Science and Engineering) Campaign (1984-95), together with other associated literature.

4) The results of a series of interviews with individuals who are directly affected by the reluctance of females to enter science and engineering professions, or are in positions which can significantly influence the current situation.

Are females aware of the opportunities that exist, or are they aware and have decided better opportunities lie elsewhere? The results of the literary review linked to the thesis research conducted with students have been compared in the discussion section (chapter 5) using the methodology described in chapter 3. From this reasons are revealed as to why there appears little motivation for female students to enter engineering and physical science vocational areas, and conclusions reached to provide a framework for achieving future equality in these occupational fields.

CHAPTER 2

LITERATURE REVIEW.

2.1 - INTRODUCTION TO THE LITERATURE REVIEW.

As this section of the dissertation is one of the most lengthy of the study, it is important to establish some logical progression. To establish this, the work of Cooper (1989) has been used to form the framework. Cooper subdivided literature review methodology into five stages. Stage one is called the problem formulation stage. All research work must commence with a careful review of the research problem. In performing the research all variables must be defined together with a rationale for relating the variables to each other. A topic is generally considered suitable for review provided it has created appreciable interest within a discipline, either because it of broad conceptual calibre or because it is surrounded by intense research activity. The ability of the researcher to make sense of many related but not identical theories to be studied is paramount to the research programme.

Stage two is the data collection stage. The target population covering all elements and including all individuals and groups the researcher wishes to represent, must be identified. Primary research conducted by the researcher may be a major impact on the research, but other researchers may have significant contributions to make. These can be identified by computer searches, journals, and books, and a thorough method of data collection must be identified and implemented.

The third stage is data evaluation and involves making judgements on what data should or should not be included. It is necessary for the researcher to ensure that data selection is relevant to the study and the analysis of outcomes must be sustained by the evidence.

Stage four covers analysis and interpretation involving the synthesis of the separate data points collected during the research into a unified statement about the research itself. This involves the identification of systematic patterns from chance fluctuations. The final stage is the presentation stage. The accumulated knowledge must now be translated into a document describing the project task and associated implications.

As this research follows a scientific path, trustworthy accounts of past research form a necessary condition for orderly knowledge building. Time constraints placed restrictions on the breadth and depth of the review performed but with such importance placed on this part of the overall research, an orderly and considerable search has been conducted. As this section was completed prior to the author`s personal research, the contents provided many of the reference points and hence prime areas of the research performed and recorded subsequently. The data collected, recorded and evaluated in this section assisted in the precise problem formation, subsequent analysis and interpretation, and ultimate presentation.

With these aims in mind, the following records the valid topics uncovered during the literary review for this research.

One further point is noted at this stage. This chapter includes data supplied by many sources and especially the Department for Education and Employment. In many cases the figures supplied were up to two years old due to the delay in attaining, analysing and publishing data. Figures included were the most current available, as at 1995, when this section was compiled. In some cases data initially recorded was subsequently replaced by more current data, although the subsequent data had not fundamentally altered from that initially recorded.

2.2 - THESIS VALIDITY.

Before embarking on this chosen project it was necessary to ensure that the selected topic had not previously been researched. This task was performed in two ways, firstly by contacting educational researchers in the UK, and secondly by a dissertations abstract sweep.

Educational Researchers Comments.

The first point of contact was the Engineering Council. Dr John Williamson indicated that this topic had not been the subject of previous research, nor was there any current research of which he was aware. Dr Williamson suggested contacting Christine Brown of the University of East Anglia, and Professor Alan Smithers and Dr Pamela Robinson then of the University of Manchester to gain a further insight of potential researchers in this area. Contact with both Christine Brown and Dr Pamela Robinson revealed this area had not been researched , nor was undergoing current research, but would tie well to previously researched areas involving female students at primary school entry and at university level. Both showed great interest in the outcomes of the research and how these outcomes could complement their own research.

Dissertations Abstracts Sweep.

A comprehensive sweep of all dissertation abstracts available revealed only one related thesis. Silver-Miller (1992) had investigated the factors influencing females toward undergraduate college majors in mathematics, science, engineering and technology, a study performed in the United States of America. The research considered that significant factors influencing the selection of mathematics and science for study at college and university level may occur at a fairly early age, and that parents and teachers played a significant role in this choice. The chosen sample consisted of female students in their junior or senior year of mathematics, science or technology study at selected South Dakota Universities.

Results were based on 126 questionnaires (65% returns) which revealed teachers having the greatest influence, fathers next, and encouragement as the most frequent method of influence. The survey also revealed that females who majored in mathematics or science fields were most often the first born in their families. Whilst this is of significance to the chosen field of this research project, it is different in many respects. To correct the apparent female/male imbalance, as much attention must be paid to students not choosing a science and engineering vocation, as to those who do. This is clearly not the case in this study. The quoted study was also performed at a time considerably after selections influencing future vocations were made, i.e. looking back with hindsight, and not at the time these selections were actually made. The view of a now committed scientist may be significantly coloured, and not reflect fully the true reasons a commitment to this type of career was made, or the timing of the major factors influencing selections.

Following these surveys, the chosen study area appeared a valid research area. As such a comprehensive literature review was subsequently performed, and all items valid to this research area recorded. The literature review of relevant subject matter helped formulate both problem and hypothesis, and also determined the research methodology used by the author. The review subsequently assisted the analysis and interpretation of the results obtained from the research.

2.3 - RANGE OF RESEARCH.

This thesis is titled "An exploration of some factors which inhibit females from entering Engineering and Physical Science vocational areas from the Hull and East Yorkshire Local Education Authorities". Whilst most of this title is self explanatory, the areas of engineering and physical science need to be defined.

Indexes to the Standard Industrial Classification of economic activities (1992) covers engineering within two numerical classification groups. Group 74.20 covers architectural and engineering activities and related technical consultancy, whilst group 74.30 covers technical testing and analysis.

Physical sciences are more difficult to classify being covered by many manufacturing sections from 23.10, manufacture of coke oven products to section 25.11 manufacture of rubber tyres and tubes. Other areas covered include the manufacture of chemicals, fertilisers, plastics, agro-chemicals, paints, inks, pharmaceuticals, soaps, and oils.

Classified areas of hospital activities 85.11, medical practise activities 85.12, dental practise activities 85.13, other human health activities 85.14, and veterinary activities 85.20 are not considered as physical sciences, and are not included in the initial hypothesis. The reason for their exclusion is shown below.

A question in the CVCP Parliamentary Review (1998) promoted the publication of two tables in the CVCP Bulletin (1998). Extracts from one of these tables is shown in table 2.1.

Table 2.1 - Percent applicants for full time first degree, HND, and DipHE courses in Science in the UK 1994 to 1997.

Subject	1994		1995		1996		1997	
	Male	Female	Male	Female	Male	Female	Male	Female
Biolog. Sciences	39	61	37	63	36	64	35	65
Phys/Chemistry	67	33	66	34	66	34	67	33
Medicine	50	50	51	49	50	50	49	51
Engineering	89	11	89	11	88	12	87	13
Other Sciences	54	46	53	47	54	46	55	45
Total	60	40	59	41	58	42	58	42

As the table shows females are in the majority for biological sciences, have attained equality for medicine, and almost achieved equality in other sciences. They make up only one third of the applicants for physical sciences places and only 13% of the applicants for engineering places.

The Department of Trade and Industry (1998) in its Science Engineering and Technology (SET) Statistics sections its science , engineering and technology subjects into 11 areas.

These areas are;

1) Medicine and Dentistry

2) Subjects Allied to Medicine

3) Biological Sciences

4) Veterinary Science

5) Agriculture and Related Subjects

6) Physical Sciences

7) Mathematical Sciences

8) Computer Science

9) Engineering and Technology

10) Architecture, Building and Planning

11) Social, Economic, and Political Studies.

The same SET statistics further define engineering and physical sciences to include the areas of information technology, materials, chemistry, mathematics, physics, clean technology, innovative manufacturing, design and integrated production, control and instrumentation, electrical engineering, mechanical engineering, marine technology, process engineering, general engineering, engineering for manufacturing, and engineering for infrastructure.

These documents will form the basis for assignment of data into the areas of engineering and physical sciences and explains why these two specific areas were selected for research.

2.4 - EDUCATION, SCIENCE AND WOMEN.

There has been a struggle for sexual equality throughout the nineteenth and twentieth centuries in terms of both educational provision and career opportunities. Whilst some changes were swiftly introduced, others took decades to achieve. Bryant (1979) uses an observation from the novel "Ruth" by Mrs Gaskell.

> "The daily life into which people are born, and into which they are absorbed before they are well aware, forms the chains which only one in a hundred has moral strength enough to despise, and to break, when the right time comes."

This quotation is clearly representative of the struggle for female educational emancipation in the nineteenth and twentieth century, and the following section examines the educational changes, particularly with regards to science education and the specific involvement of females. It examines some of the "chain breakages" and the females who possessed the moral strength to cause them. The section reveals some of the reasons for the science and engineering professions becoming, and remaining a male dominated area.

Education and Women in the Nineteenth and Twentieth Centuries.

In the early to mid nineteenth century, most of the population of England only had access to elementary education. It was co-educationally based with equal access to males and females. Up to 1870 attendance of educational institutions, which were mainly owned and operated by the Church, was voluntary. This changed with the Elementary Education Act 1870. Maclure (1986) records details of the 1870 Act where two of the main provisions were to provide a 50% state grant to "voluntary" schools and the compulsory attendance (with exceptions) for children of ages 5 to 13. Attendance appears to have been for both males and females, with attendance problems appearing to be greater for males than females. These attendance problems were often associated with the use of child labour in certain activities performed around this time.

In the mid nineteenth century there was very little opportunity for further recognised educational progression for females beyond the elementary stage. The place for the woman was considered to be in the home looking after children, but things were about to change. Around the mid nineteenth century there was an imbalance between the genders. Diseases of the earlier nineteenth century had killed more males than females, so even if all females wanted to marry and raise children they were unable to do so. This created a situation where many females sought new roles often with a greater requirement for access to education and entry to the professions, such as medicine, dominated completely by males.

Access to education beyond elementary standard was limited to girls of upper and middle class status who could attend boarding schools, but here curriculums were restricted to the likes of music, languages and hand crafts. Only males were allowed to attend Grammar Schools and then directly enter or matriculate to Universities. A series of events which were to provide the educational equality for females, and major events are highlighted next.

Rowold (1996) recorded that in 1850 and 1854 Frances Buss and Dorothea Beale opened secondary schools for girls, the North London Collegiate School and the Cheltenham Ladies` College. Both offered more academically oriented curricula than conventional girls` schools.

Bryant (1979) records that in 1868 the Taunton Commission reported that schools for girls should be established to replicate the provision provided for boys by Grammar Schools. During the next ten years, many such establishments were formed, being termed Girls High Schools. Despite such initiatives, there continued to remain problems for females to gain access to and certification from higher educational establishments. The Governesses` Benevolent Institution had been established in 1843 to provide higher education to governesses who had retired or were "resting" between engagements. Shortly after this in 1848 Queen`s College for women was established in Harley Street, London. This was more of a secondary school than a college and was open to females above the age of twelve, but in 1849 The Ladies` College , Bedford Square, London was established.

Although the University of London issued degrees nationwide from 1851, it was not until 1878 that degrees were issued to women. Women could attend the courses, take the exams, but were not given degrees until 1878. The main reason postulated, although never confirmed, was that if females could pass university courses, then the courses were too easy.

Bryant (1979) records that colleges were established for women at both Cambridge (Hitchin, 1869) and Oxford (Newnham, 1871). Despite the fact that the University of London had issued degrees to women from 1878, degrees were not issued to women until 1919 at Oxford and until 1921 at Cambridge. The difference in allowing female graduation so much later from Oxford and Cambridge is attributed to the religious influences exerted in the governing bodies of these centres. The difficulty for females to obtain a professional qualification can be highlighted by the case of Elizabeth Garrett, who became the first qualified female physician to practise in England. Her degree had to be obtained from the University of Paris, where discrimination by gender was lower than in the United Kingdom at that time.

With such discrimination against females until well into the twentieth century, it is hardly surprising that males dominated the professions. Why then should certain professions currently show a far lower gender imbalance than science and engineering? An examination of the provision of science and technical education may provide the answer.

The Growing Need for Technical Education in the Nineteenth Century.

Cotsgrove (1958) recorded that the technical education system of that time (1958) still retained in all too many respects, the form given to it by the nineteenth century. He questioned whether the system that existed at that time could be flexible enough to meet the changing social needs. His question resulted from research which examined educational developments over the previous 150 years, and some of these areas are now examined.

Although there was a growing interest in science from the seventeenth century onwards, there appeared to be little scientific and technical instruction before 1824. Religious and philanthropic motives predominated in the limited working class education for both children and adults at this time, and continued to do so for much of the nineteenth century. The period 1824-1851 saw the rise and fall of the Mechanics` Institutes, aimed at making their members efficient industrially. By 1851 technical instruction had emerged along with the value, in an industrial society, of a wide diffusion of useful knowledge.

Brookes (1988) examines the period 1850 to 1900 in some detail. The Crystal Palace Exhibition of 1851 illustrated a buoyant industrial spirit, backed up by material prosperity, high industrial production and flourishing foreign trade. This was in fact the case as in 1870 the foreign trade of the United Kingdom was more than twice that of France, Germany and Italy together. However, by the 1867 International Exhibition in Paris, indications of the United Kingdom`s declining world position, especially in areas of new technologies, were obvious. Cardwell (1957) recorded that,

> "Our engineers and chemists ascribed our failure to the systems of technical education developed in European countries for the masters and managers of industry."

This decline can be confirmed by the fact that towards the end of the nineteenth century modern industrial growth in chemicals, electrical engineering and machine tools were firmly based in Germany, the United States and France. Between the period of 1870 and 1900, the position of the United Kingdom had slipped from technological leader to that of a bit part player in an increasing global market.

As Cardwell (1957) records, it became increasingly apparent around this period (1850 - 1890) that one of the main reason for Britain lagging behind developments in many other countries was its education system. This was very noticeable in the areas of the new technologies, but the United Kingdom governments of the time were still unwilling to take control for both provision and funding. A choice was clear, fall further behind industrial competitors and accept declining prosperity, or do something to halt the decline.

Cardwell (1957) records that the period 1851 to 1882 saw a major development in further education with the growth of evening classes in the principles of science. This was stimulated by the payment of state grants, after 1859, on the results of examinations of the Science and Art Department. In 1880 the Livery Companies of London established the City and Guilds of London Institute (C & G) which took over the technological examinations of the Royal Society of Arts (RSA), and in 1881 the Finsbury Technical College opened, becoming the first of its kind for technological studies. This was accompanied by an increase in science teaching at universities, e.g. King`s and University Colleges, London, and Owen`s College, Manchester.

The Technical Instruction Act of 1889 provided increased state aid for scientific and technical education, and supplemented by "whisky money" (money raised by a tax on alcohol), more and more provincial technical schools and colleges were established.

Once established, centres for technical and scientific education would grow as their importance was to grow throughout the twentieth century. Their development was to be directed predominantly by central government throughout this period.

The entry of women to both education programmes and "professions" was still strictly limited even though the provision of technical education was to undergo such rapid development. Examination of both developments and apparent exclusions may shed light on the current male/female gender bias in engineering and science professions.

Changes in the Provision of Science and Technical Education in the Nineteenth and Twentieth Centuries.

Cardwell (1957) records that the rise of science has been clearly influenced by religious institutions, which until the latter part of the nineteenth century had almost total control over educational establishments, industry and commerce. Theories on the social motivation of science are often related to society becoming increasingly aware of the industrial and social importance of science in what was an increasingly liberal democratic state. Increasingly liberal it may have been, but there was little or no place for women in religious, industrial or commercial organisations in the early nineteenth century. If science and technology was driven from these areas, it is little wonder that these new areas did little to encourage female involvement, and perhaps offers the greatest indication for the lack of gender equivalence and opportunity which still exists in the late twentieth century.

This section examines in detail some of the historically significant events which have continued to support this discrepancy, although one could argue they should have contributed to removal of the gender imbalance totally decades ago.

Roderick and Stephens (1972) record that in the 1850s there was a growing realisation among a minority that England was in danger of losing her industrial supremacy. In 1852 the Government created the Department of Practical Art in order to reform the Schools of Industrial Design, and the following year a Science Division was added. It was the creation of this Government department which enabled central funds to be made available for technical education, and provided the impetus for technical education to develop in the latter half of the nineteenth century. As stated previously, the education available to the majority of females in the middle of the nineteenth century consisted of no more than elementary education to the masses, and female studies above this level were restricted to the middle to upper class females who could afford the fees to take advantage of such limited provisions. There was little opportunity for females to become involved with any technical profession.

The records of the Liverpool Literary and Philosophical Society recorded by Roderick and Stephens (1972) make interesting reading. The aim of this society, and many similar societies around the country formed in the early nineteenth century, was to arouse and stimulate the minds of its middle and upper class members, by a series of lectures and organised events. Around mid century, science began to play take an ever increasing role in the organised activities. In 1857 the president of the Society stated,

> "Liverpool has done little for science, though science has done much for Liverpool".

However, it was not until 1862 that science provision started to appear as significant entries in the Society records. Around the same time the "gentlemen" of the society permitted women to attend some of the Society`s functions. The society passed a bye-law providing admission of ladies to the meetings on certain occasions, to be fixed by the Council. Although science and technology was to play an increasing role in such urban societies, females did not appear to have a part to play in such developments.

Roderick and Stephens (1972) make reference to an early example of female participation in technical subjects. With the introduction of adult education around the country in the 1860s, the possibilities of instruction of females to the encouragement of meteorology was included in the provision. This corresponded to the approaches by the Royal Society and the Board of Trade to establish a meteorological station in the 1860s. One only has to watch a television weather forecast to observe the level of female participation in this area. The question must be asked, has a long standing female involvement from the infancy of the profession helped to remove "barriers" to female participation?

Cardwell (1957) examines technical education in England in the period 1868-1890, and particularly some of the arguments that raged at that time. All the quotations are from males, and a quotation from T H Huxley from a Rectorial Address to Aberdeen

University in 1874 emphasises this. In his address he agreed that,

"Written examinations tell us nothing about man`s powers as an investigator".

It appears that at this time there was no consideration of women`s powers, or in many cases no belief that they may possess any.

One could have expected that a new century and a major war (1914-18) would have caused a major change in female advancement within science and technological disciplines with such high male fatalities across the class barrier. Cardwell (1957) stated that this war broke the continuity of science education and as a result it developed in new directions. This may well have been fuelled by the removal of traditional markets, such as Germany, for the supply of certain technical equipment, but resulted in technical expansion in many areas. To fulfil these new requirements. a Privy Council for Scientific and Industrial Research was formed in 1915. It identified a need for an increased supply of trained researchers, which would consist predominantly of Honours Graduates.

Cardwell (1957) indicated that at this time the annual output of 1st and 2nd Class Honours students in mathematics, science and technology was running at 530 per year. At the same time a number of men formed the "Committee on the Neglect of Science". This committee demanded a wider diffusion of science among the populace and its major recommendation was to stop the specialisation before boys leave school. Once again there was no proposals for gender equality despite the continued fatalities of many males in the current conflict. Science was seen as a continuing male domain.

Cardwell`s book "The Organisation of Science in England" (1957) covers the period 1800 to the post World War I period. It is quite clear from the text that there was no significant female contribution to the development of science and technology. Similarly no movements to redress the gender balance were considered worthy of inclusion. This fact can be confirmed by the work of Cotsgrove (1958). Figures given for students entering higher education at technical colleges and universities in the period 1910 to 1929 are for males only. It is only after World War II, that figures for females were considered worthy of inclusion. Figures for the period 1949 record female involvement, and subsequent records show a gradual increase to 1955.

The figures reveal that male students entering universities from grammar schools outnumbered females in the ratio of 3:1, and whilst the number of boys entering university from technical schools (established nationally in the early twentieth century) showed a continuing increase, there was no indication of any progression of female students from the same technical establishments. However, as the percentages of students entering further education are similar for males and females, one could conclude that the emphasis on technical progression was still very much male dominated in 1955.

Cotsgrove (1958) did indicate a slight movement of student numbers away from arts education towards technical education and postulated two potential driving forces. Firstly growing demand for scientific and technical staff since 1945, and secondly the resulting increased rewards of such occupations in terms of pay and prestige.

Figures supplied by the Engineering Council (1995) would suggest that female involvement in engineering has shown a gradual increase. In 1950 only 0.5% of engineering students attending universities in the UK were female. In 1984 this had risen to 8%, and by 1995 stood at 15-16%. This may indicate a dramatic correction of the imbalance shown in 1950, but compared to certain other professions, such as the legal profession (the work of Wilkinson [1994] is examined later in this literature review), gender equality appeared far more difficult to attain.

It would appear that nineteenth century "gentlemen" did little to encourage female participation in science and technical professions, and this situation continued well into the twentieth century. Although there has been some advancement towards gender equality in the latter part of twentieth century, there is still a long way to go in the twenty first century if true equality is to be attained.

2.5 - CHILD DEVELOPMENT.

The main purpose of examining child development was to reveal any explanations amongst the many theories and studies performed regarding the development of children, that could explain the current gender bias in engineering and science careers. The field of child development covers the development of both genders with age. In certain cases development is considered to be complete by adolescence, in other cases the development is considered to be continuous throughout a lifetime. In the introduction, figures were quoted showing there has been a gradual increase in the numbers of females entering science and engineering careers. This number is still low (15%) compared to the same number of males (85%) embarking on these careers. What could be the basic influences on this apparent anomaly? To try to answer this problem, the works of two child development theories were examined, those of Piaget and Erikson.

Piaget`s theory is classed as a cognitive theory. Lloyd and Mayes (1987) describe cognitive development not as a steady accretion of skills, but as a stage theory with a series of sudden leaps. Development proceeds by way of a series of qualitative changes, often referred to as stages. One stage grows out of another, and in some instances may be considered a reconstruction of earlier knowledge, but the result is a new way of looking at things. One of the prime contributors to such development is the child`s own active contribution to cognitive growth. This action-based growth termed by Lloyd and Mayes (1987) as constructivist, is considered to occur in an invariant order. The development is completed by an inter-actionist approach where growth is dependent on the person`s environment.

Psychoanalytical theory, into which category Erikson`s work falls, was developed by Freud. It is termed a dynamic theory of emotional development which sought to explain the causes of various kinds of psycho-pathology and offer treatments for their cure. Processes that brought unconscious motives, thoughts and feelings to consciousness, or which prevented this from happening were central to its aims. Bee (1992) describes the psychoanalysis theory as a method of explaining human behaviour by understanding the underlying processes of the mind and personality. Development is governed by conscious and unconscious processes, the latter being present at birth, the former develop with time.

By comparison of the two theories, similarities and differences start to emerge. Cognitive theory indicates that study groups should exhibit shared patterns of development. Psychoanalytical theory emphasises the importance of both shared and individual differences. Although both indicate qualitative developmental change, psychoanalytical theory views this change in stages whilst cognitive theory sees it as mainly sequential, but with some stages. Psychoanalytical development can be driven by unconscious processes e.g. dreams and fantasies, whilst cognitive development is driven by the likes of logic and morals. There are similarities between the two basic theories, but also significant differences. Aspects of these theories are now examined in detail to examine if they suggest any reasons why child development may depend upon gender.

Wadsworth (1989) quotes from the work of Piaget, stating Piaget described his basic theory as follows. Piaget`s cognitive theory suggests there are four periods of development. Period one covers the time from birth to two years and is termed the sensory-motor period. During this time a baby is gaining experience through senses, and absorbs these experiences into patterns of behaviour. Period two is the pre-conceptual/intuitive period and spans the age 2 to 7. This period covers acceptance of language and the building up of ideas and notions into basic concepts. Period three is the concrete operational period from age 7 to 11 and allows concept development into classification and serialisation. Finally period four lasts from 11 to 15 when most people become able to reason abstractly and hypothesize by applying logical reasoning.

Wadsworth (1989) records that in his later years Piaget revised his theory and stated that his initial stages were only guidelines for initial postulation, and it was always the intention of himself and supportive co-researchers to expand on these stages and the age ranges they covered. Wadsworth (1989) also states that Piaget never claimed that the course of development outlined in his theory was the only possible one.

Erikson examined Freud`s theory of psychosexual stages and developed his own theory based on psycho-social stages. As with the theory of Piaget it is subdivided into stages, and the stages recorded by Erikson are recorded by Bee (1992) and shown in table 2.2.

Table 2.2 - Erikson`s stages of psycho-social development.

Age	Stage
0 to 1	Trust versus mistrust
2 to 3	Autonomy versus shame, doubt
4 to 5	Initiative versus guilt
6 to 12	Industry versus inferiority
13 to 18	Identity versus role confusion
19 to 25	Intimacy versus isolation
26 to 40	Generativity versus stagnation
41+	Ego integrity versus despair

Freud`s research was almost entirely based on a study of adults. The childhood development of these adults was then researched. Birch and Malim (1988) write that Erikson developed Freud`s theory from a study of children and adults, and his psycho-dynamic approach to play is characterised in the use of play therapy to treat disturbed children. Erikson`s initial theory had a similar basis to Piaget`s regarding stages, but listed eight stages from birth to middle age. The stages appear precise, but are flexible in application and cover the development of both children and adults.

A fundamental part of the two theories are the developmental stages. Piaget`s first stage covers development reflex actions, mainly movements. Subsequent stages involves basic classification and symbols, language development, hypothesis formation and organisational skills development. The majority of the skills developed are governed by child environment, and although personal thought contributes to the overall development, external forces will a major motivator. Erikson tends to emphasise internal considerations. Even from the birth the child is building an internal file of who/what can and cannot be trusted. Then the child enters areas such as shame, guilt, inferiority, confusion, intimacy and isolation, stagnation, and finally despair. Although these are a simplification of terms, they all relate to internal feelings, which may or may not be the result of external actions.

These two theories promote considerable discussion which has been limited to meet the precise needs of this research. The work of Piaget states that basic notions are formed in the 2 to 7 age range. Here acceptance of language and the building of ideas and notions form the prime area of focus. If we consider a child`s own contribution to this stage, it will depend greatly on the environment. Young females are unlikely to be exposed to the engineering and physical science based learning environment that males of a similar age experience. This idea is complemented by the work of Erikson. In the 6 to 12 year age group he considers industry to inferiority. Erikson suggests that a child`s involvement with a subject promotes a contentment with it, whilst exclusion may lead to feeling of inferiority in this area. If the environmental differences mentioned earlier are considered both consciously and unconsciously by the children, then science and engineering may well be imprinted as a no go area for many female children because they are excluded from involvement in these areas.

A combination of the two theories of cognitive and psychoanalytical development would suggest that the main age range for the building of notions and ideas were 2 to 12. However in England and Wales, GCSE selection, which is probably most indicative of adolescent career selection, does not occur until the age of 14. This is probably the first point at which a child must apply these conscious or unconscious ideas. As a result, to successfully perform this research it was necessary to access children at a time decisions were being made which would influence their career choice period. For the purpose of the study it was decided to choose children from secondary schools at the 13-14 age group, who were about to make their GCSE choices. At the same time children from "feeder" primary schools in the 9 to 11 age group were included in the study to try to identify at what stage physical science and engineering were identified as a likely or unlikely career path. Group activities, questionnaires, and subsequent data analysis were identical for all groups of students.

This specific area of research and the application of child development theory provide possible reasons for the differences in male and female development relevant to this research. The theories will be applied in the discussion section of this study.

2.6 - SCIENCE EDUCATION AND SCHOOLS.

This section examines recent research relating academic achievement and gender in schools. Work of various individuals has been examined before linking via the common theme of the thesis hypothesis.

Young People and Their Attitudes to School.

As this study has examined the ideas and beliefs of students at primary and secondary school, an understanding of their attitudes to school was of significant importance, to assess whether ideas or beliefs held were generalised or subject specific.

The following examines the work of Barber (1994). Keele University established a database in 1993/4 which recorded the attitudes of 7000-8000 young people to all aspects of secondary school. The findings examined students perception of school, and were quite alarming proposing many questions.

Firstly in spite of the problems uncovered, 88% of pupils were usually happy at school. Other statistical analysis revealed 70% said they worked as hard as they can, 90% believed school work was important, 70% got on well with most teachers.

However a specific question revealed that only 50% of students viewed themselves and the school as friends, 25% as distant relatives, 10% as strangers, and 6% as enemies. Further examination revealed that as many as 17% of year 10 (14-15 year olds) would truant, rising to 20% by year 11 with the highest figures predominantly from urban schools. As all figures resulted from questionnaires handed out in school time, one can conclude that the actual figures were higher than recorded, as many truants would not be present to complete questionnaires. A general lack of motivation was indicated for 40-50% of all secondary students with 70% of students stating they counted the minutes to the end of lessons. It was also recorded that 50% of pupils made fun of students who worked hard.

When age and gender were addressed, important differences were observed. The study revealed that most year 7 (age 11) students start secondary school life in a highly motivated and positive fashion. However the number of students maintaining this feeling dropped by about five percent of the initial group size per year, only being reversed in year 11 (age 15), the GCSE year, where some increase in motivation levels were recorded. The study also revealed an expanding gap in terms of achievement between girls and boys at the 16 age group. In subjects where females have been traditionally strong e.g English, modern languages, and history, the gap between boys and girls was widening. In subjects where boys were considered traditionally strong, e.g science and mathematics, DfEE Statistical Tables (1997) showed that girls took the lead in 1993 and 1995 respectively.

Hymas and Cohen (1994) stated that in 1994 boys outnumbered girls by two to one in Britain`s schools for children with learning difficulties. The same article recorded that at age 16, 46% of girls will attain five or more GCSEs, but only 37% of boys. Similarly at age 18, 16% of girls will gain three or more "A" levels, but only 14% of boys.

The Keele study reveals that although there was a common slippage in motivation, girls were consistently more positive, better motivated, better at getting on with teachers, better behaved, and achieving higher grades than boys. This was despite the fact that boys recorded higher perceptions of parental support with their school work than girls. Equally surprising was that more boys than girls consider themselves able or very able, and more girls than boys consider themselves below average. The study clearly suggested the reverse.

There were several conclusions which can be reached from the study. Firstly, the study does not reflect falling standards. From 1955 to 1994, the percentage of students obtaining higher grades at GCSE has risen from 15% to 50%. Similarly students entering higher education have increased from 3% to 30%. Secondly the motivation figures varied dramatically from school to school, so clearly acceptance of the figures should not mean little can be done about them. There must be a way to unlock and maintain potential. The third and final conclusion is that girls are now consistently outperforming boys in all aspects of measurable secondary school. If this is the case the question which must be asked is that in terms of equal opportunities, exactly which gender requires most assistance? This question will not be answered by this study!

A second question, which will be addressed is that if girls are now outperforming boys at GCSE level in both science and mathematics, why do so few females wish to follow a career in engineering and physical sciences? This measure of student ability would suggest females would probably be more likely to be successful than males in these professions.

Gender, Primary Schools and the National Curriculum.

Olney (1999) noted that to ensure girls are not left behind in what was termed "the Technical Revolution" girls must be encouraged to participate equally with boys in all technical subject areas. Ross and Browne (1993) also noted this, and the importance of promotion of equal opportunities for girls in the areas of maths, science and technology in primary schools. Tutchell (1992) stated that the concept of a curriculum which all primary children experience will render all equal opportunities.

The following section examines these ideas and is derived predominantly from the work of Smithers and Zientek (1991) who researched sexual stereotyping in primary schools.

Smithers and Zientek (1991) were commissioned by the National Association of Schoolmasters Union of Women Teachers and the Engineering Council. Smithers and Zientek provided this independent report which was aimed at encouraging the development of equal opportunities policies to help counter narrow stereotyped views and attitudes of pupils in primary school classrooms. The introduction of the national curriculum was viewed as an ideal time to try to rectify some of the problems associated with sexual stereotyped attitudes.

The study was based on the fact that anthropological studies across a wide variety of societies show men tend to take on one set of tasks and women another. There are basic reasons for this e.g. hunting being a male domain and child rearing a female domain in certain societies, but it should not be used as an excuse for people to be written off from something they may enjoy, purely on the grounds of prejudice in whatever form this may take. The report stated that,

> "Despite extensive investigation, no biological or social factor has been identified why so few females go into physical sciences and engineering".

It was considered that this was the result of "old scripts" being played out. These scripts, although pervasive, are capable of change. As one of the fundamental purposes of education is to challenge young people so they can discover who they are and what they like doing, schools have the opportunity to change these scripts.

One of the first areas examined was that of gender stereotyping. An experiment was conducted in a number of primary schools in England and Wales. Twenty cards, depicting activities, were shown to 259 boys and 247 girls aged five. The students were asked to attach another card indicating if the activities was suitable for men only, women and men, or women only. The results showed that both boys and girls identified these activities in the same way, with fifteen of the activities shown for one sex only. Some examples are shown in table 2.3.

Table 2.3 - Activities of men and women.

Activity	Men only (%)		Women only (%)	
	Boys	Girls	Boys	Girls
Car repairs	95.8	88.7	1.5	5.7
Scientist	72.6	65.6	9.3	9.7
Doctor	48.6	46.2	14.3	15.8
Proposing Marriage	40.2	45.7	29.7	30.8
Typist	27.4	21.1	35.1	39.3
Hairdresser	6.6	2.8	67.6	69.6
Washing clothes	3.1	3.2	84.9	86.2

When the student`s teachers were asked their response to these findings, they ranged from

> "I wasn`t aware of their attitudes. The children do not display stereotyped attitudes in the classroom situation",

to

> "We expected more or less the results we had".

Neither could be considered constructive. The situation became worse when the awareness of teachers to sex-typing was examined further. Thirty percent said it was news to them, with the following comment recorded.

> "I have never been aware in all my years in teaching of this situation arising within a 5-6 age group. Boys and girls naturally enjoy the classroom activities regardless of what the activity is".

Requesting comments from the seventy percent of teachers who had encountered sex typing, most said it was because boys and girls tend to be drawn to different things. Boys tended to enjoy aggressive games at playtime, and during free choice lessons head straight for the Lego. It was also noted that boys seem to know more about science than girls at this age. Girls tended to enjoy painting, drawing and writing stories. Although only seventy percent of teachers recorded they had encountered sex typing, eighty four percent stated they took positive steps to achieve a balance. One must clearly question why the extra fourteen percent thought this justified if they had never encountered it? Interventions included encouragement of girls to build models, and praise of their efforts. Boys would be encouraged to enter what was termed "home corner" entering some of the activities and games usually performed by girls only. These interventions aimed at evening the activities were recorded as generally ending in failure, as once freedom of choice was restored sex typing almost immediately returned.

Although the report stated there was some evidence of enjoyment in role reversal such as girls playing robbers in cops and robbers games, boys making tea in "home games", it was felt that the sex link was operating below the level of consciousness. It was considered that schools, although trying their best, exerted little influence in regard of sex typing or its removal. As the interventions were applied for only a short period of time it would appear likely that children would naturally rely on stronger instincts when the interventions were removed, and return to type. This point was not covered by the researchers and perhaps perseverance or a more uniform continuous intervention would have been worthy of attempting and recording. This section did conclude that there was no evidence revealed to provide a good reason why girls should not choose and enjoy the sciences.

Teachers were asked to comment on the introduction of the national curriculum, and how this may affect sex typing. Most teachers saw a major advantage in the fact that neither pupils nor teachers would be able to opt out of their least favourite areas. In this case activities were less likely to be sex stereotyped with all students having equality of access to subjects. However even at the early stages of the introduction of the National Curriculum, teachers felt they were working in "sub-optimal" conditions. A lack of time and investment meant that benefits, such as ending sex stereotyping, were unlikely to be achieved. Increases in non-contact time, for planning and tutoring, and lower class sizes were felt paramount to successful introduction, but these were in opposition to the views of government and managing bodies. As such the objectives of the National Curriculum were unlikely to be achieved.

Areas of concern raised by the survey respondents (sample size 194) regarding the implementation of the National Curriculum were too much change too quickly (70%), workload (39%), assessment (30%), and resources (19%). Lower levels of concern were in service provision (13%), too much emphasis on attainment targets (8%), class sizes too large (4%), and undervaluing of reading (3%). It is somewhat surprising that the last two items should be considered so low in levels of importance by teachers, when current pressure by educational reformists and the British Press (an area covered later in this review) suggest these are two of the most important areas which require to be addressed.

The report ended by making ten recommendations to remove gender stereo-typing in schools.

1) The majority of teachers, particularly younger ones, were aware of gender stereotyping, and willing to apply interventions. However not all seemed aware of just how over simplified and exaggerated the views of children really are. Teachers need to be made aware of the extent and pervasiveness of gender stereotyping among young children.

2) Through their awareness, teachers can awaken their pupils to the fact that they do not have to accept their lots as given. Boys do not have to be girls, or girls boys, and people should not write themselves off from things unnecessarily, e.g. because of sex stereotyping which may be prevalent around them. Girls should be encouraged to fully involve themselves in the science and technology curricula.

3) There is some irony in one of the most sex-linked occupations, teaching young children, being responsible for getting it across to children that occupations need not be sex linked i.e. what children are hearing is different from what they are seeing. Attempts should thus be made to attract more men into teaching in infant schools.

This however may not be easy to achieve. Halpin (31-07-1996) comments that male teachers are being scared from the classroom by fears of false child abuse accusations. Since 1986 the figures for males teaching in primary schools has fallen by 10%, whilst the number of women teachers has risen by the same amount. This decline is also occurring in secondary schools where the percentage of male teachers has now fallen below 50% for the first time.

Halpin (31-07-96) also quotes John Andrew (General Secretary of the Teaching Union) who stated that school budgets also promoted this situation. Schools are offering more part-time and short-term contract work. These usually attract more women than men.

4) The balance of qualifications in infants schools does raise questions about how well science and technology is going to be taught. It would appear essential that more people with good science qualifications be attracted into teaching the youngest children.

5) As the National Curriculum has been prepared with equal opportunities in mind, it must be kept under scrutiny to avoid any advantage going unwittingly to one sex or to the other.

6) Introduction of the National Curriculum has placed great pressure on teachers, which has been exacerbated by chronic under-funding resulting in larger class sizes and increased teaching loads. A campaign for a better deal for education must continue.

7) A particular feature of infants school teaching is the lack of non-contact time.

More than two thirds of the teachers surveyed said they had no non-contact time at all. The working day of teachers of young children should be reviewed with the aim of introducing non-contact time for teachers to plan and develop teaching strategies.

8) Young children require individual attention, it is thus crucial that infant classes should not exceed 25 students, and preferably be no more than 20.

9) Arising from (8) above, it could also be recommended that more ancillary help be made available for early-years teachers.

10) In seeking to improve education, the current in-service provision be evaluated to identify what improvements can be made.

The report finished by stating that improvements recommended would provide a better chance of reducing gender stereotyping. It was essential for the opportunities of young people and the prosperity of the nation that the necessary investment be made.

The survey revealed that 67% of the 218 teacher surveyed had over ten years teaching experience, and 97% more than two years experience. Of the 218 teachers surveyed, 210 were female and this suggested that as the sample had been drawn at random, 96% of infant and primary school teachers were female. This seemed somewhat extreme so figures produced by Department for Education and

Employment are examined later in table 2.8 to see if this is representative of the primary school teaching population.

Changes in the provision and examination of Science at GCSE level.

The figures used in this section were supplied by the Department for Education and Employment. They cover GCSE entries and results for the period 1988/89 to 1993/4. The provision of science education in secondary schools has changed significantly over the past decade. In 1988/9 the emphasis was on teaching science subjects in specific areas and table 2.4 highlights this.

Table 2.4 - Students (1,000s) attempting Science GCSEs 1988/9.

Subject	Boys	Girls	Total	%Girls of total
Single/Double Science	70.6	71.5	142.1	50.2
Physics	138.9	58.0	196.9	29.5
Chemistry	99.8	79.2	179.0	44.2
Biological Sciences	81.9	135.1	217.0	62.2
Other Sciences	23.8	20.5	44.3	46.3
Total	415.0	364.3	779.3	

These figures are now compared to year 1993/4 shown in table 2.5..

Table 2.5 - Students (1,000s) attempting Science GCSEs 1993/4.

Subject	Boys	Girls	Total	%Girls of total
Single Science	28.6	32.0	60.6	52.8
Double Science	190.7	190.2	380.9	49.9
Physics	23.2	12.2	35.4	34.5
Chemistry	22.7	13.1	35.8	36.6
Biological Sciences	22.3	14.9	37.2	40.1
Other Sciences	5.1	2.5	7.6	32.9
Total	292.6	264.9	557.5	

Comparing the two tables the following points can be made. Firstly the national curriculum has a compulsory science requirement. This requirement has seen a move towards combined science awards, away from individual sciences. This move will almost certainly account for the apparent lower overall figure in total science subjects. Secondly, as science subjects are now compulsory, one would expect the 1993/4 figures for single and dual science entry to be fairly even with regards to gender, and this is the case. Thirdly, from the 1993/4 figures, where greater freedom of choice exists in the areas of individual sciences (chemistry, physics, and biology) 62.3% of the candidates are male. This may indicate that female students wish to be involved with the smaller amount of science subjects than males and possibly more than they would like, being forced to study some options by the National Curriculum.

There are 9 modular sections in the National Curriculum Syllabuses for Single and Double Modular Science Awards for the Southern Examining Group (1997).

S1 Processes of Life which is biology based.

S2 Reproduction and Inheritance which is biology based.

3 Ecosystems which is mainly biology based.

4 Earth and Space which is physics/geology based.

S5 Materials which is chemistry based.

6 Chemical Change which is chemistry based.

S7 Electricity and Magnetism which is physics based.

8 Light and Sound which is physics based.

S9 Forces and Energy which is physics based.

Note - the S indicates Single Award, all 9 modules must be studied for Double Award.

Although arguments could be put forward to support physics and biology as the major constituent of either single or double award programmes, there is a fairly even distribution of chemistry, physics and biology in the awards. Students taking these awards **must** study all three science areas so no science area can be omitted as is possible where separate science subject options are available. (Table 2.5 indicates that where a choice of subjects are available, biology is slightly more popular with females than chemistry and physics, and table 2.1 would tend to confirm this preference.)

Regardless of whether females would choose science options, their performance in science subjects is every bit a match for that of the males, as table 2.6 demonstrates.

Table 2.6 - Students (1000s) achieving Science GCSE A to C grades 1993/4.

Subject	Boys	Girls	Total	%Girls of total
Single Science	3.6	6.0	9.6	62.5
Double Science	88.0	88.5	176.5	50.2
Physics	19.0	9.8	28.8	34.0
Chemistry	18.2	10.9	29.1	37.5
Biological Sciences	18.2	12.3	30.5	40.3
Other Sciences	2.1	1.2	3.3	36.4
Total	149.1	128.7	277.8	

If the final percentage column is now compared to the 1993/4 figures for the number of students attempting the subjects shown in table 2.5, then in all areas bar one, the percentage success rate of females examined, is greater than their percent of entry. For single science it is 62.5/52.8 (success/entry), double science 50.2/49.9, physics

34.0/34.5, chemistry 37.5/36.6, biology 40.3/40.1, and other sciences 36.4/32.9. Although some of the figures are very close, it would be difficult to conclude anything other than the fact that females are outperforming males in science subjects at GCSE level. It may also indicate that brighter girls choose a single science option compared to double science or separate science options.

Progression to A/AS levels.

The figures used in this section were supplied by the Department for Education and Employment and cover the period 1991/92 to 1993/4. The figures are somewhat complicated by the fact that students may take these examinations at either schools or Further Education (FE) colleges. The following figures cover both possibilities.

Table 2.7 - Female students (1,000s) attempting science A/AS-level.

Subject	Venue	1991/2	1992/3	1993/4
Biology	School	17.6	14.2	15.3
	Further Education	6.6	10.4	10.8
	Total	24.2	24.6	26.1
Chemistry	School	11.2	9.1	9.6
	Further Education	2.8	4.8	4.9
	Total	14.0	13.9	14.5
Physics	School	5.9	4.8	4.4
	Further Education	1.3	2.0	1.9
	Total	7.2	6.8	6.3

Whilst there is some increase in the number of students taking biology, and a much smaller increase in the number of students taking chemistry, there is a marked decrease in the number of students taking physics. This would indicate that the increased performance of female students in science subject is not encouraging female students to pursue physical sciences as a likely career option.

Halpin (1996) recorded the continued decline of interest in A level science subjects. Whilst the overall number of A levels taken increased from 725,992 in 1995 to 739,163 in 1996, this increase was not reflected in science subjects. In biology the figures were virtually stagnant increasing from 51,848 to 51,894. In chemistry the figures fell from 42,280 to 40,455 and in physics it fell from 34,767 to 32,801. The figures recorded were not available on a gender basis.

None of the conclusions which can be drawn from this section suggest reasons why boys and not girls continue to dominate physical science and engineering professions, when in terms of basic skills, girls appear more able than equivalent boys. It does appear to support the theory that for some reason girls are "switched off" to sciences long before GCSE selections are made. The National Curriculum at GCSE level appears to be forcing females to study a subject of little interest until they can follow “chosen” subjects at a higher level.

Gender Differences and GCSE Results.

Department for Education and Employment statistics (1994) show that until 1986, the number of students attaining five or more passes at O-level was fairly constant at around 25% of boys and 25% of girls. Since 1988 when GCSEs were introduced the difference in attainment of 5 passes has increased steadily for both groups, but far greater for girls. The 1994 pass rates were 38% for boys and 48% for girls, and this gap appears to be growing. This section examines why this difference has developed and if anything be done to improve the performance of boys.

The following study was performed by the Centre for Successful Schools, Keele University (1994). The study was performed on GCSE results gained by girls and boys at five Hampshire schools in 1992 and 1993. The results obtained build on the observations from a pupil survey performed at the same schools in Spring 1992. The introduction to the study listed brief comments by some of the schools on the recorded GCSE results. School A was pleased with 50.8% of students obtaining 5 or more GCSEs of grade A-C, girls outperforming boys by 15%. School B had 60% of students with 5 or more GCSEs at grade A-C. Normally they would expect 60% girls, 40% boys, as in previous experience, but in this case it was almost equal. School C confirmed the results of school A with their total results improving, girls doing extremely well, boys performance, by comparison, weakly.

An examination of the reasons for the differences revealed several potential causes. School A concentrated efforts on year 10 and 11 (age 15 to 16) as they considered the school was particularly good at satisfying the needs of both sexes in earlier years, but then "loses it" in year 10 and 11. School B had been aware of this problem for some time, so specifically channelled a great deal of effort in preventing this discrepancy occurring. School C had themselves tried to quantify this performance difference by looking at the performance of students prior to entry to year 10, testing ability in term one of year 10, and finally comparing GCSE results obtained in year 11. The results were somewhat confusing. For 1993 GCSE students, boys and girls were consistent from entry, through testing, to GCSE attainment. For 1994, whilst on entry and in GCSE performance girls outperformed boys, the initial survey showed equality.

Follow up interviews and discussions in the schools revealed further information. Differences were identified and recorded for some pupils in year 4 (age 9). Initial discussions looked at a possible genetic link, but this was rejected by all groups, including students, teachers, and researchers. Environment and upbringing differences did produce more favourable support. The Centre for Successful Schools/Keele University study (1994) considers that baby boys are often more treasured by parents than baby girls, and so arrive at school expecting a large slice of the attention cake. With increasing class sizes, teacher time is rationalised evenly, so boys "play up" to gain more attention. This is supported by the work of school B who openly admit to giving boys more attention than girls.

The question which was frequently raised was why do students enter secondary school so motivated, and yet quickly become disenchanted with lessons. One reason given was teaching methodology. Talk and chalk become progressively less acceptable with age. Visual learning methods became far more acceptable, and effective. Another reason identified was that of maintaining motivation. Girls appear to need reinforcement much less frequently. There appears a brittleness to the male ego which makes them far more likely than girls to switch off and stay switched off. Discussion revealed that it was felt teachers, male and females, favoured girls, possibly in line with the school's generalised expectations. If this is correct, stereotypes of "naughty boy" and "virtuous girl" were being reinforced and there may have to be a conscious effort to reverse this trend.

From this several conclusions can be drawn. Firstly the differences in gender differences can be observed from year 7 onwards, and in some cases even earlier. Secondly this difference is not inevitable, and thirdly there are clear differences in the way girls and boys develop, and school policy should take this into account in strategic planning.

Ethnic Differences and Science Education for Girls.

Grant (1994) recorded that education theorists have tentatively suggested that the parents of ethnic minority children, aware of what is stacked against them by a racist society, place greater value on educational achievement as a way to success than the parents of white children who may, in the past, have regarded jobs as guaranteed. They may similarly be more responsive to children following educational paths, and ultimately careers, in areas which can lessen the effect of potential discrimination.

Solomon (1996) was a little more specific, examining the area of science being more popular with Asian girls than it is with similarly placed non-Asian girls. One of the conclusions from her work was that Asian girls seemed keener than non-Asians in getting jobs in all categories except those which depended on knowledge of current affairs (television and journalism). Asian girls were significantly more likely to say science was their favourite subject. This potential area for female advancement in science areas is currently limited by the fact that many Asian girls have difficulty in obtaining family permission to stay at school for A-levels. Many parents wish their daughters to follow family traditions and marry early.

This area has been addressed by Solomon (1996) with the production of educational material and a video. The latter to be taken home and watched by daughter, father and mother and is available in both Urdu and Bengali versions with English subtitles. The stars of the video are Asian parents who have themselves not had the opportunity of education in this country, but want the very best for their daughters. Initial response to this programme has been stated as promising and must be an area worthy of further consideration when examining steps to further the participation of females in engineering and science careers.

Co-educational versus Single-Sex Schooling.

Single-sex education was greatly reduced in England and Wales with the reorganisation to comprehensive schooling in the 1960s. The numbers of schools has fallen from almost 3,000 in 1960 to a few hundred in 1996. Single sex schools survive mainly as grammar schools in local education authorities which did not implement the 1965 Labour Party directive to change to comprehensive education, and independent schools. The following is a study of the data available which compares the results of students in co-educational schools with those in single sex schools. Conclusions are respectful of the fact that many single-sex schools are selective of the quality of students they will admit, and so one may expect their level of performance to be greater than that of co-educational main stream schools.

This was an error in the work of Thomas, Pan and Goldstein (1994). Their research suggested that single sex schooling has an impact on girls GCSE attainment. As single-sex versus co-educational results was the only data used, the findings were undermined when considerations such as parental background and entry ability were considered. Steedman (1983) examined the performance of 14,000 children born in March 1958. The parents of pupils at single sex schools were evenly split between manual and non manual professions, but at co-educational schools this was 30% non-manual, 70% manual. Smithers and Robinson (1995) also concluded that what at first sight appears to be improved performance at single sex schools is in fact mainly due to differences in intake, particularly ability and social class.

To try to limit the study a little, relative performance in science and mathematics, which has been extensively investigated, was examined. For many years males have performed better than females at GCSE level, and it has been considered an area of male domination, although DfEE statistics from 1993 and 1995 have shown this to no longer be the case. Recent studies (e.g. Halpin 1996) have revealed that for all schools there has been a gradual fall in the percent of students selecting A-level mathematics and sciences. The fall has been lowest for girls at independent schools where there is a high proportion of single-sex schools. However three boys for every two girls choose science and mathematics options at A-level.

Kelly, Whyte, and Smart (1984) and Smith (1987) examined the performances at co-educational schools where boys and girls have been separated to prevent male domination and allow girls to reach their potential. A gradual fall in selection of these subjects by all A-level students since these studies were performed make their results inconclusive. Smithers and Collings (1981) suggest that the choice of mathematics or science at A-level is purely down to ability. At both co-educational and single sex schools, 30-35% of the most able students select these subjects, whilst this falls to 10-15% of the less able students. The figures quoted suggests the choice of subject is dependent on ability rather than which type of school is attended. It makes no reference to the fact that although females appear more able than males, more males than females select science and mathematics options at A-level.

West and Hunter (1993) surveyed parental views on schools. Parents of children at co-educational schools felt that the mixing of the sexes was good preparation for later life. On the other hand, parents of girls at single sex schools felt they had a chance to develop in areas of self confidence and sex-stereotyping subjects.

The confusion generated does not clear with the article "Standards Stumble" in the Times Educational Supplement (Aug 25th 1995). Here the results of a study by Dr

Lindsay Paterson are used to support the argument that there is no evidence that girls at single sex schools do better at GCSEs than girls at co-educational schools. The same article quotes recent research performed by Leicester University which shows single sex schools do induce girls to adopt a more positive approach to mathematics and science, at least in the junior years.

The only conclusion which can be drawn is that performances at both O-level and A-level is not influenced by a choice of single sex or co-educational schooling. The major effects appear to be those of ability and to a lesser extent social background. The only influence that single sex schools seem to exert in the fields of science and mathematics is that the fall in these options selected at A-level appear lowest at single sex girls schools. There was once again a wealth of evidence to support the theory that girls are continually outperforming boys throughout their secondary school careers. There was equal evidence to suggest that if the driving force in selecting science and mathematics at A-level is ability, girls should be dominating entries to physical science and engineering professions, something they are clearly not achieving.

Analysis of Teachers in Nursery, Primary, and Secondary Schools.

The following information has been extracted from a range of statistical bulletins produced by the Department for Education and Employment. The Department for Education and Employment (March 1993) produced a detailed listing of full-time teachers in maintained nursery, primary and secondary schools. At this time 376,711 a total of 9,263 deputy heads were female. It would appear once again that the female equality in the number of teachers in secondary education was not reflected in the attainment of senior teaching positions. A further point worthy of note was the number of graduate teachers. In nursery/primary schools 48.8% of male teachers were graduates, whilst only 40.9% of females were. In secondary education 71.05% of males were graduates, whilst 63.45% of females were graduates. Whilst being a graduate may not make someone a good teacher, it does perhaps imply a potentially greater depth of knowledge in certain areas.

These figures promote two questions. Why was there a higher percentage of male teachers who were graduates than female teachers, and why was there a higher percentage of graduate teachers in secondary than primary education? The answer to the first question may be historical with females still catching up men in attaining higher education qualifications. The answer to the second may lie within the school budget, but encouraging more graduates to enter teacher training to teach primary school rather than secondary school children may redress this imbalance, an area examined in the next section.

The Department of Education statistical Bulletin (May 1994), examined the curriculum provision in Maintained Secondary Schools in England. It showed that between 1987/8 and 1991/2 at key Stage 3 and Key Stage 4, there had been a decrease in the number of students studying the subjects of biology, chemistry and physics, and an increase in the number of students studying combined sciences. These can be studied as either a single or double award. This appeared to be a fairly full-time teachers were recorded in these establishments. Table 2.8 shows these figures, with all columns showing the number of teachers in each area.

Table 2.8 - Gender and status of teachers 1993.

Area	Male		Female	
	Graduates	Total	Graduates	Total
Nursery/Primary	16,214	33,254	60,113	146,825
Secondary	70,464	99,166	61,847	97,466
Total	96,678	132,420	121,960	244,291

These figures revealed some alarming facts. Firstly it could be seen that females were by far the largest percentage of nursery and primary school full-time teachers, 81.5%. With such a bias in terms of female teachers, it was somewhat surprising that in a total of 21,202 head teachers, 10,661 (50.3%) were female. In terms of deputy heads, in a total of 18,470, only 12,526 (67.8%) were female. The latter figures were nearer the 81.5% of female teachers overall, but asks the question that if females make up the majority of nursery and primary teachers, why is this majority not reflected in the senior positions? Could the stereotyping observed here, equally be reflected in the teaching and career preparation of female students?

Secondary education appeared far more even with regards to the gender of its teachers, in this case 49.6% were female. Examining the senior positions, in terms of head teachers 1,027 (21.8%) of a total of 4,716 were female, whilst 3,111 (33.6%) of standard method adopted by most comprehensive schools as a way of "conforming" to the requirements of the National Curriculum. However not all schools responded in the same way.

Table 2.9 - Distribution (%) of students taking science options at GCSEs 1993/4.

Students aged 15/16	Single Award	Double Award	3 Separate Sciences
Boys Comprehensive	11	86	2
Boys Grammar	2	69	29
Boys Self Governing	10	85	5
Girls Comprehensive	12	86	2
Girls Grammar	6	77	17
Girls Self Governing	11	86	3

Table 2.9 shows that at comprehensive and self governing schools there was little difference between the genders in the selection of science programmes. Grammar schools for boys and girls showed an increased participation in separate science programmes, although boys showed a greater participation than girls with a higher percentage choosing the 3 - science option.

Was there evidence that teaching by staff without higher qualifications in science subjects does not promote interest in these subjects? Table 2.10 was extracted from the Department of Education (March 1993) Statistical Bulletin, and represent the number of full-time teachers in maintained nursery, primary and secondary schools in

March 1993.

Table 2.10 - First subject of degrees taken by teachers 1993.

Subject	Nursery and Primary		Secondary	
	Male	Female	Male	Female
Education	6,611	22,685	14,036	14,601
Maths	392	1,544	5,034	3,615
Physics	88	93	3,367	888
Chemistry	141	258	4,368	1,642
Biology	458	1,982	3,984	3,715
Other Sciences	646	1,365	6,164	1,853
Other Social Sciences	1,475	5,685	3,172	4,176
English	851	7,000	4,622	8,166
Other Arts Subjects	2,657	8,196	8,540	7,066
Total	16,199	59,957	70,438	61,811

Is it possible for students to be effectively taught in areas such as physics with only 181 members of primary staff sufficiently interested to study the subject at degree level? This question becomes more relevant after examination of table 2.11 extracted from the Department of Education Statistical Bulletin, December 1993. This table lists the percentage tuition in the subject provided by teachers without a post A level qualification in it.

Table 2.11 - Percentage subject tuition provided by teachers without a post A-level qualification in subject.

Subject	% in 1992
Mathematics	11
Biology	17
Chemistry	8
General Science	57
Other Science	48
Craft Design Technology	37
Other Technology	94
English	14
Music	5

Initial observance of the list suggested that sciences such as biology and chemistry were well taught by teachers with relevant qualification. However, as most science is taught as combined or general science, then the high figures for these subjects and technology indicates many students may not be being taught science by a teacher with a higher science qualification. This raised the question that if these figures were so obvious, were the government trying to rectify the situation through the teacher training programme. The answer appeared to be yes, but the following figures suggest the plans appear far from satisfactory.

The figures used in Table 2.12 come from the Department of Education Statistical Bulletin, September 1995. The table shows recruitment to initial teacher training courses from 1992/93 to 1994/95, and the intake targets for 1995/6 to 1997/8.

Table 2.12 - Teacher training recruitment and proposed intake 1992/8.

Area	1992/3	1993/4	1994/5	1995/6	1996/7	1997/8	% change 1992-8
Primary	18,364	17,976	15,087	13,350	11,950	11,950	-34.9
Under Graduate	12,109	11,487	9,447	N/A	N/A	N/A	-22.0*
Post Graduate	6,255	6,489	5,640	N/A	N/A	N/A	-9.8*
Secondary	13,616	15,239	16,407	18,000	19,000	20,000	+46.9
Under Graduate	3,380	3,158	2,966	N/A	N/A	N/A	-12.2*
Post Graduate	10,236	12,081	13,442	N/A	N/A	N/A	+31.3*
Subject Area							
Maths	1,787	2,013	2,050	2,380	2,500	2,675	+49.7
English	1,473	1,635	1,933	1,920	2,025	2,225	+51.1
Science	2,269	2,729	3,074	3,590	3,875	4,095	+80.5
Languages	1,456	1,798	1,936	2,235	2,400	2,510	+72.4
Technology	2,355	2,376	2,249	2,455	2,465	2,510	+6.6
History	633	809	979	845	855	875	+38.2
Geography	520	637	686	745	810	895	+72.1
Physical Education	1,204	1,165	1,378	1,310	1,320	1,320	+10.0
Art	629	759	805	880	940	980	+55.8
Music	459	500	526	635	715	715	+55.8
Religious Education	371	388	465	540	595	700	+88.7
Other	460	412	326	465	500	500	+8.7
Total	31,980	33,215	31,494	31,350	30,950	31,950	-0.1

*These figures are for 1992 to 1995 only.

N/A indicates no figures available when the table was released in September 1995.

Table 2.12 revealed that although there was little change planned in the number of teachers recruited, there was a change in emphasis from primary to secondary training. It could also be seen that although there was to be an increase in science teachers recruited, there was a significantly lower increase in those teaching technology. The figures did not reveal from which specific area the science teachers were be to recruited, or be expected to teach.

The report also noted a minor shift towards training graduates to become primary teachers, but the majority of those undergoing teacher training remained undergraduates.

Teaching and Teacher Training.

Do children at school receive teaching that allows them to develop and advance to any occupation which offers them the opportunity to fulfil their desires and expectations? A series of articles by Turner (1996) questioned the basic teaching philosophies and methodologies currently in use in the UK. Turner quotes Dr Eric Anderson, formerly a headmaster of Eton and now Rector of Lincoln College, Oxford who stated,

> "Most of us would be dead if we trained our doctors as we train our teachers".

His comments were based on what he considered the continuing use of,

"Failed and discredited ideas of the sixties".

Anderson was quoting from his time at Eton when approximately half the number of teachers hired had been to training college and half had not. The half that had not were considered by far the better teachers.

The article continued that recent Conservative Party Education Secretaries had commented that far too many teachers emerged from colleges and universities stuffed with half-baked, politically correct and utterly impractical theories, but very little notion of how to teach the basics of reading, writing and arithmetic. Considering the Conservative Party had formed the UK government from 1979 to 1997 one clearly must ask why they still complained about something they had done little to alter. This was a question which did appear to have an answer with recent complaints in Whitehall resulting in applying greater pressure to the Office for Standards in Education (OFSTED) to produce tougher reports on teacher training establishments. The 1996 OFSTED report on the Department of Teaching and Education at Lancaster University was noted as one of the first inspections to be covered by new tougher guidelines.

The following quotes from a report produced by the Office for Standards in Education (1996). This report was on the Department of Teaching and Education at Lancaster University, and covers the inspections on 19 - 22 June 1995, and 13-16 November 1995. This inspection was part of the 1995/6 programme of inspection of all providers of primary Initial Teacher Training (ITT) in England. The inspection examined initial teacher training for both primary and secondary phases. At the time of inspection there were 52 students on the Post Graduate Certification in Education (PGCE) and 778 students on the four-year Honours degree with Qualified Teacher Status [BA(QTS)]. The latter programme prepared students to teach in the 3 - 12 age range. Within this students opted to focus on early years (age 3 - 8) or later years (8 - 12). The PGCE prepared students for the 3 - 11 age range, and students were able to specialise in early years (3 - 8) with an optional nursery focus, or later years (7 - 11).

A team of five inspectors made two visits to observe training sessions at the University on visit one, and observed 19 undergraduate students teaching English and mathematics in 16 schools on the second visit. Although other items were inspected, the inspection focussed mainly on the training received by and the final teaching competencies of the undergraduate students. Their main findings were recorded as follows.

The quality of training for the teaching of English was unsatisfactory. In the undergraduates course, there was too little linkage between the training based in the Department for Teaching and Educational Studies and the students` classroom experience. Students were not adequately prepared to teach reading. In several lessons, the standard of teaching and quality of pupils` learning was unsatisfactory. A high proportion of students were not competent in teaching reading and many had significant weaknesses when assessing and recording pupils` progress.

The quality of training for the teaching of mathematics was unsatisfactory. The undergraduates course provided inadequate coverage of many elements of primary mathematics. Insufficient attention was given to identifying and rectifying gaps in the students` personal knowledge of mathematics. The time allocated to the training in arithmetic was too short. The standard of teaching among students following the later years training was generally sound or better, but in the lessons taught by students who were following the early years training, the standard varied widely from good to unsatisfactory. Overall, a significant number of students lacked an adequate knowledge and understanding of mathematics, and did not possess the required competence to teach arithmetic.

The report also found the quality of training in assessment, recording and reporting, and quality assurance arrangements unsatisfactory. The report stated that in both BA(QTS) and the PGCE courses, the content of training generally focussed on the requirements of the National Curriculum. If so many problems exist in English and mathematics, what problems will exist in the teaching of science and technology?

Some interesting figures were provided regarding the students. On the BA(QTS) programme, of 778 students 83% were female and 87% were in the 18 - 20 year age group. For the PGCE where there were initially 58 students, 88% were female and 76% were in the 21 - 25 age range. As could be clearly seen, females were by far the gender majority undergoing training at Lancaster University. What was also clear was that the majority of students at BA(QTS) appeared to follow a school - teacher training - school route, and the PGCE students appeared to follow mainly a school -

university - teacher training - school route. For most teachers, including those teaching science, some industrial/commercial experience may have given a broader base to assist in both teaching and preparing students to enter careers other than teaching.

Turner (1996) had spoken to three recently qualified teachers in their twenties to early thirties. Two were graduates who had taken a one year teacher training course, and one had taken a four year course to become a primary school teacher. No actual names were quoted for fear that their comments may limit employment possibilities, but the "names allocated" would suggest all three were females, although this may not have been the case.

They commented that lots of teacher training time was spent on various teaching methodologies, but emphasis was placed on certain areas with very little emphasis on whole-class teaching, whole class teaching being the main style used in Japan, Taiwan and Germany. The feeling was that this method of teaching historically produced a higher level of class performance whilst continuing to support the growth of students of all levels of ability. Turner`s articles commented that current teaching methodology was loaded against the whole class method as the teacher using it is,

> "Spouting off and not connecting with the children".

Allowing children to work freely in small groups with teachers providing inputs to individuals or small groups was preferred and encouraged. This did not appear to consider that children in small groups may be talking about anything other than the subject in hand. Turner in fact observed a science lesson for trainee teachers using the collaborative group learning method. Teachers admitted that only 75-80% of their group talk was related to the lesson subject. What is the likely percentage for young children with lower concentration or motivation levels? A move away from collaborative learning to whole class teaching supporting setting and not mixed ability teaching appeared to be gaining support. Many educational establishments which had to achieve improved standards have done so by using these methods.

Exactly what steps to improve teaching and classroom learning should be taken? Turner (1996) has suggested several options, but primarily for teachers to move away from the facilitator role occupied in collaborative learning, and take a more authoritative position in whole class learning. Turner (1996) suggested that reasons for this may be based on the results of teaching practices adopted in the 1960s and 1970s. Items such as grammar, spelling and multiplication tables were replaced with creative writing and creative mathematics, under the rubic of investigative mathematics. Education became more about values not skills, attitudes rather than mere results, social engineering not the acquisition of knowledge. This entire ideology was based on theory, having no track record of success in producing better educated children. In fact the only figures available, from the United States, suggested that the method would not produce the expected results and could well lead to a lowering of overall standards.

Turner`s article (1996) postulated eight points as guidelines for improved teaching/learning practices in schools.

1) A drastic overhaul of the teacher-training institutions so that ideologies enthroned there can no longer undermine existing reforms and common sense. A move to training teachers within the best school environments may be the preferred option, but more practical training via current training institutions may be the best current option.

2) All schools to be grant maintained, so that none of the finances available are siphoned off by local education authorities. Small primary schools may need to organise themselves into clusters to gain maximum benefit from such a move.

3) Launch a national reading programme to meet the crisis of widespread under achievement. A simplification of the National Curriculum at primary schools would allow more time to be spent on basic skills of literacy and numeracy.

4) All schools must take note of teaching experiments, and where results justify changes, they should be implemented and assessed.

5) It is important to realise that by 13 or 14, children need different types of education. A one scheme for all approach is no longer acceptable.

6) Reduction of class sizes, particularly in the early years, is essential.

7) The salary of teachers should be substantially improved both to reward the faithful who have soldiered on through a welter of badly conceived change, and to attract a higher quality of applicant into the profession.

8) The £55 million pounds spent on educational research each year should be better directed. The money should be directed at research which will produce better educated children.

The aim of these changes was to re-establish the fact that schools are there to offer a rigorous, challenging and effective education for children, and that social engineering has no part whatsoever in the process.

The learning methodologies applied and teacher backgrounds covered in this section could have an effect on the related performance of students, particularly females in science areas. A change in the selection and direction of science teachers may also be worthy of investment to try to make science and technology lessons more interesting and influential on vocational selection. The need to attract more science teachers to primary education is fairly clear. The information covered in this section will be considered in greater depth in chapter 5 - discussion.

2.7 - CAREER PERCEPTIONS AND DECISION MAKING AMONGST YOUNG PEOPLE IN SCHOOLS AND COLLEGES.

The following section examines the research performed by Foskett and Hemsley-Brown (1997) of the Centre for Research in Education Marketing, School of Education, University of Southampton.

The project examined the perceptions and knowledge of specific careers held by pupils age 10, 15 and 17 and the influence of those perceptions on choices and education pathways. A sample group of 410 pupils/students in two localities in the West Midlands and South-East England were involved via focus groups and questionnaires.

The report recorded that young peoples perceptions are highly individual and are the products of images of jobs they see for themselves (contracted images), those passed from parents and friends (delegated images), and those from the media (derived images). As many jobs are *invisible* to young people, they may have no percieved image of them at all.

In terms of Careers Education and Guidance (CEG), many young people ignore careers already rejected or unfamiliar reinforced by an information on demand approach with students only told about careers they ask about. Engineering recruitment was specifically mentioned in this context. Foskett and Hemsley-Brown (1997) considered a need for engineering recruitment to focus on working with primary age pupils and with teachers on presenting lifestyle perceptions of engineers.

The report noted that younger students perceptions of engineering were biased towards the low skilled manual, vocational training end of the spectrum of jobs within engineering. Therefore, when comparisons were made with engineering and their own choice of occupation a number of well established misconceptions about the use of the word engineering were exposed. Project questionnaires revealed that there were potential scientists, physicists, research scientists, building designers, computer (software) designers, car designers, boat engineers and sound technicians who genuinely did not think of themselves as engineers.

The report also noted that 11.2% of respondents said they were interested in the possibility of an engineering career, 18.8% of the boys and 5.3% of the girls. The main reason for choosing engineering was that respondents were interested in engineering or had a role model who was working as an engineer. This role model was typically a father although one mother was recorded in this category

The question “what is engineering?” brought a range of responses. One focus group of middle class boarding school boys saw engineering as being well paid attractive work. Girls at a selective school in the South of England described engineering as a science related graduate occupation whilst girls in an equivalent school in the West Midlands admitted that they did not know what engineering was. The report quoted the work of Bronzi, Mason, Tarris and Zaki (1995) who stated “most people simply do not know what [...] engineering is. Worse those who think they do, have negative and incorrect images of the field."

The report by Foskett and Hemsley-Brown (1997) recorded the reasons for members of their sample group not choosing an engineering career. These reasons are recorded in table 2.13.

Table 2.13 - Reasons for students/pupils not choosing an Engineering career

Reason for not choosing an Engineering career	**Percentage**
Not interested*	27.1
Dirty Work	12.7
Might do it	11.2
Anti-science	11.2
Too difficult	7.3
Dislike cars	6.4
What is it?	4.6
Working with hands	3.4
Low paid	2.4
Factory	2.2
Well Paid	2.0
Too creative	2.0
Health risks	1.7
Man`s job	1.5
No patience	1.5
No reason	1.0
Aiming higher	0.7
Outdoor work	0.5
Too easy	0.5

*32.0% of girls compared to 21% of boys gave not interested as their reason for not choosing an engineering career.

The importance of role models and the media were highlighted by Foskett and Hemsley-Brown (1997). Role models are important because of their lifestyle based on job security, income and status, and therefore they tend to be family and friends. The youngest pupils in the survey based their description of an engineer on the only fictional character they could identify, a car mechanic in a soap opera. In most cases the young people taking part in the survey believed that the career they had chosen was of higher status than engineering, that engineering was not to be well paid, or offer similar opportunities to reach the top. Girls were more concerned with status and image, boys with pay.

The summary recorded that older pupils believed a career in engineering requires good qualifications in maths, physics and science and is accessed via a university degree in engineering. Those most likely to consider engineering as a career are middle class boys in years 10 and 11, and those least likely working class girls in year 6.

It was considered insufficient to change the perceptions of only those who may become engineers but of the public at large and especially all young people at an early age. If this does not occur then many young people will be too shy to admit they wish to do a job which their peers perceive as manual labour with low status. The teacher role, especially in primary schools, may be critical in achieving this change.

2.8 - EQUAL OPPORTUNITIES.

If female students are to be encouraged to take a greater percentage of the vocational positions available in the areas of engineering and physical sciences then one must ask if equal opportunities for males and females do actually exist? The following examines the promotion and implementation of equal opportunities and also acts as a bridging section between the research involving schools, and that involving employers.

Equal Opportunities in Schools.

In March 1996 the Equal Opportunities Commission produced a research report entitled "Educational Reforms and Gender Equality in Schools" which covered this topic in some detail. The report stated that most schools and Local Education Authorities (LEAs) have specialist equal opportunities policies which include gender, and they tend to concentrate on curriculum practice and employment concerns rather than on pupil or student performance or on parents. The growth in grant maintained schools, who have decided to "opt-out" of LEA control, has seen a shift in the responsibility for equal opportunities away from LEAs and towards individual schools.

This in itself may not be a bad thing as the Equal Opportunities Commission recorded that fewer than one fifth of primary and secondary schools in England and Wales reported receiving support on equal opportunities issues from the LEA. Of these schools, 70 per cent claimed not to have had LEA provided equal opportunities training for senior managers, classroom teachers or careers teachers. As most schools reported a increased activity and positive outcomes on promoting equal opportunities, especially in secondary schools, one can only assume that forces other than LEAs were responsible for these changes. If this was not the case, one must clearly question the statement itself!

The report stated that equal opportunities policy making has, to some extent, adapted to become part of the new main stream culture of schools. Pupils perceptions of gender issues were seen as more open and sensitive to changing cultural expectations and/or changes in the labour market. Nevertheless, occupational choices for both sexes appeared to remain conventional and stereotyped. If this is so, what prevents the awareness becoming transmitted to measurable change in removing sexual stereotyping in career selection?

Schools and LEAs were found to be shaped largely by the culture of male management (in the staffing, and chairs of governing bodies). There was little evidence of strong parental concern for gender issues or of initiatives to involve governors or parents in equality work. Although initiatives on equal opportunities have been developed in certain LEAs and schools, most have been "in house" and do not appear to have been widely publicised or discussed.

The report concluded that cultural, demographic and labour market changes have influenced the way students and teachers think about the schooling of girls and boys.

In the competitive climate of the 1990s, female students were proving attractive to schools in preference to low achieving poorly behaved boys. The report did not record any specific information regarding schools removing stereotyping from the areas of science study, or encouraging female students to select science and engineering career options. The research revealed a mixed picture of beneficial procedures and policies, but overall, no infrastructure for the delivery of equal opportunities on a wider and more systematic basis. This situation must be rectified to provide genuinely better opportunities for future generations of both female and male citizens.

Equal Opportunities in Employment.

Whilst females have achieved equality or even become the majority in some professions, equality in physical science and engineering professions remain male dominated. This is supported by the Engineering Council figures (1995). The section records some of the interventions made to try to promote equality in these vocational areas, along with their limited success.

The Daily Mail (12th January 1995) reported on the 1994 Young Woman of the Engineer Award. This award was established in 1978 to raise the profile of women in the industry and is sponsored by the Institution and Electronics and Electrical Incorporated Engineers. They list only 200 female members in a total membership of 28,000 worldwide, i.e. less than 1% of total membership. The winner was 28 year old Hayley Gladstone, who had been responsible for major contracts such as modernising communications on the Beijing subway system. She was about to fly to Hongkong to manage a similar contract for the rail extension to the new airport. The comments of both the winner, and runner-up Emma Croucher were rather illuminating.

Hayley Gladstone told her careers teacher at school she wanted to be an engineer. The teacher responded that she did not stand a chance, the teacher`s image of an engineer being someone having grease behind the fingernails. Hayley Gladstone stated,

> "A lot of engineering work is now computer-based, and I would advise young girls not to be put off by the old image. I have not found being a woman is a barrier to progressing, but the reality does not seem to be getting through to the schools. I recently spoke to a class of 13 year olds who were amazed that I was an engineer!"

Emma Croucher stated,

> "It certainly helped going to an all girls school. There was no perception that boys should lean towards sciences and girls towards arts".

The image problem of associating women and engineering was also covered by Meikle (1995) in the Guardian Education. Emma Croucher is again quoted in this article. She stated,

> "Because women are engineers, they are thought to be hairy or undesirable, but it is just a job, like being a nurse or a journalist. Women engineers need to be addressed as normal."

Interventions such as the Engineering Employers Federation`s encouragement of engineers who have been made redundant to consider a second career teaching their skills to young people, is one option. However as there are many reasons for someone being made redundant, this may not prove the most successful of alternatives.

An article by Irwin (1994) in the Times Educational Supplement looked at women scientists. Only 2 per cent of professorships in science, engineering, and technology were held by women. It quotes from a report "The Rising Tide" that only 16 per cent of full-time academics in science and technology subjects were female. It showed that of the 35,000 extra places in higher education in science between 1988 and 1991, the majority have been taken up by men. The report called for a target of a quarter of public appointments and senior positions to be held by qualified women by the year 2000. Its main recommendation was for a development unit to be set up to deal with the needs of women in science and publicise best practice in encouraging women into science. The unit would help to set up databases and networks of women in science and technology, working towards a national database. It would run an experimental careers advisory service and try to get media attention for women in science. Suitable mentors would be found for female undergraduates.

Irwin (1994) quoted Dr Lane, a zoologist at Cambridge University, who stated,

> "One of women`s big problems is isolation. We need role models for girls to aspire to. They don`t believe us when we say they can go into science".

It is quite clear that steps are needed to encourage more women to enter science and engineering professions.

2.9 - WOMEN INTO SCIENCE AND ENGINEERING.

The Engineering Council are currently operating a Women into Science and Engineering (WISE) Campaign under the current management of Marie-Noelle Barton. It was launched in 1984 by both the Engineering Council and the Equal Opportunities Commission. The main objective was and continues to be to help change the attitudes of young people, parents, teachers and the general public to the value of engineering and its suitability as a career open equally to both men and women. A series of videos, booklets, linked to awards, courses and visits are used as initiatives in the campaign. The campaign claims the results of seeing female students on higher education programmes rise to 15% in 1995 as a major success, but there is still some way to go to reach equality. Some of the campaign methodology and outcomes are now considered.

The four main booklets produced are for parents, staff of primary schools, staff of schools and colleges, and staff in higher education.

Engineering Equals - A Guide for Parents.

The booklet is used to try to explain to parents how the early development of children can have a lasting effect on their choice of career. It quotes from the work of Solomon and Lee (1992) which recorded that for the group of 3 to 5 year olds studied at nurseries, boys dominated the use of technological toys. This appeared to result from the difference in toys and play offered to males and females at home. It confirms the work of Cash (1992) and suggests that parents should offer support equally to boys and girls or an unconscious discrimination against science and engineering may be placed in the minds of girls from a very early age. If a boy or girl demonstrates an inquiring investigative mind, then this should be supported, gender should not be an issue in these circumstances. In this way a female will feel that science and technology are suitable for girls as well as boys.

Six steps were proposed in helping females extend scientific and technological experience. These stages are equipment (scientific toys), experiences (doing rather than watching), entitlement (equal attention and support of girls and boys), encouragement (confidence building), esteem (feeling proud of achievements), and finally examples (female role models). Parental contribution can be in the form of toys or visits to exhibitions and museums. Support must be continuous from early childhood until leaving school, and even when entering a profession. This may be difficult if neither parent has any experience of science or engineering themselves, but help is never very far away.

Engineering Equals - A Guide to Staff in Primary and Secondary Schools.

Science programmes suitable for primary schools have been available for many years. Brown (1989) measured involvement at Primary school level and found that males often dominated these sessions. He concluded that girls participation at this level is crucial if they are to develop as scientists or engineers of the future. Key factors to encourage participation are material selection and experience of investigative techniques. Boys and girls should have access to the same materials and receive equal investigative experience. Equipment should not be segregated as suitable for girls or suitable for boys.

In some cases girls may need positive discrimination. Girls may need more time to gain experience of things boys are already familiar with. Teachers must be aware of the current status and requirements for technical jobs in the UK, and that preconceived ideology means girls may need more time to talk over ideas with teachers. They will certainly need encouragement and reward for successful achievement. Teachers must be aware of peer group pressures at school and at home. Encouragement of working in teams, possibly via whole class teaching (covered earlier in this chapter under the sub-section teaching and teacher training) whether single or mixed sex is important in developing understanding for the future. By operating a team philosophy with pupils, other teachers, and parents, results may be substantially improved. In such mould breaking situations the use of role models is extremely important as success often breeds success. This can be enhanced by a high level of female involvement in the teaching of sciences to female or mixed groups.

Wise Essay Competition - Analysis of Essays.

In 1994, to mark the tenth anniversary of WISE, the Engineering Council and the Office of Science and Technology sponsored an essay competition for females aged 14 to 18 in secondary schools in the UK. The essay topic was "Discuss why the

United Kingdom needs more women engineers, and how to attract more girls and women into science and engineering" and over 800 essays were received.

The essays raised some key issues but exact percentages for the items recorded in this paragraph were neither recorded or available. Many of the essays expressed the need for more female engineers to provide more originality, a different viewpoint, a more caring approach and greater humanity. A few mentioned better understanding of environmental issues, and most regarded women as having a unique and invaluable contribution to make. Many pointed out that females were at least as good as males in critical subjects such as mathematics, chemistry, and physics, others suggested greater involvement of females was likely to lead to increased profitability. The following twelve key areas were identified when considering how to attract more females into science and engineering. The figure in brackets indicates the percentage of essays including this area.

Teachers (56%) were not considered to teach technology and science in an exciting manner likely to capture the attention of females. Males were often given more encouragement than females, even regarding requests to help set up equipment. A lack of women teachers of science and technology, and teaching the subject in an uninspiring way was matched by complaints of lack of practical support to many lessons. Talks by female engineers and scientists linked to practical projects and visits to local engineering companies were requested.

Secondary schools (52%) were not able to correct for the comparative lack of understanding of engineering, often acquired by boys from toys, with which girls left primary school. Constant encouragement during well prepared, challenging lessons was seen as a way of overcoming a lack of self-confidence in science and technology studies. Males appeared to have an innate interest in the subject, but females required meaningful presentation to promote involvement.

Women into Science (51%) and many associated programmes were mentioned. Changes in strategies were suggested and are covered later.

Image and media (48%) created the picture that an engineer is a male carrying a spanner. The alternative view was provided by some parents, relatives and friends. Soaps and other television programmes were blamed for this image, and can only be rectified by more responsible coverage.

Primary schools (47%) could assist development of initial interest by operating a unisex approach to toys. This may encourage female awareness of engineering principles which can be capitalised on later.

Careers advise/information (47%) was criticised as being ill-informed on current opportunities for young women in this field.

Engineering companies (43%) were viewed as male dominated with little interest in the provisions for the needs of female engineers. More favoured approaches in other countries were mentioned. Students recommended that company literature should not quote the "token woman" but should demonstrate a proper provision was made to attract women to roles of previous male dominance. Promotion prospects and career development as well as childcare and career breaks were items which required to be addressed.

Role models (39%) appeared in short supply. The first role model is often the subject teacher, thus more females were again requested.

Influence of peers (32%) indicated the apprehension young women felt to entering male dominated territory. Teasing and stereotyped jokes were liable to "put many females off" these areas. A quiet life being preferred, meeting the expectations of parents and boyfriends.

Toys and early age (30%) were considered a major influence. Unisex science and engineering games, particularly board-games involving parents and brothers, were considered beneficial.

Women themselves (30%) were not considered the major obstacle. Male dominance and a profession not moving with the times was a far greater problem.

There appeared little direct reference made for further **Government (12%)** action, those covering this area wanted the Government to encourage firms to become more positive in their approach to attracting women. This was in the national interest as a more balanced workforce was likely to make the engineering industry more internationally competitive.

From these finding came several suggestions for reviewing the WISE campaign.

1) Development of a family game "Scientists and Engineers".

2) Encouragement for the production of more unisex toys.

3) Mount a campaign to educate parents and teachers about the need to help young girls to consider science and technology as a career.

4) Promote more imaginative teaching of science and technology in both mixed and single sex schools. An award for the most outstanding female technology teacher of the year was suggested.

5) Provide more role models e.g. more female Neighbourhood Engineers could become involved with assisting secondary school projects.

6) Publications targeted at girls in years 10 and 11.

2.10 - NARROWING THE GENDER GAP IN ENGINEERING AND PHYSICAL SCIENCE VOCATIONAL AREAS.

Section 2.8 in this literature review examined whether equal opportunities exist for females in physical science and engineering vocational areas. This section examines a broader area of vocations, recording where significant moves to gender equality have been achieved and where further movement is still desirable.

A topic which has undergone, and is undergoing much research is the increasing number female professionals and managers. This section examines some of this research in general terms, and especially in respect of the science and engineering sectors.

Eichenbaum and Orbach (1992) examined the historical, social and psychological demands on women. Social pressures have historically led to women deferring to others, predominantly males, resulting in the feeling of becoming a shadow. Psycho-analysis moving from a Freudian base to Humanistic or Gestalt theories have allowed people to get in touch with their feelings, encourage individuals to act on their own behalf, and demystify the process of psychological change. As a result women feel they have changed a lot, but society has not changed as quickly. This has given support to the feminist movement described by Lovelace and White (1996) as women who feel strongly about sexism against women and having a range of beliefs and ways of regarding women`s rights.

Wilkinson (1994) postulates reasons for the movement to gender equality, and equally postulates reasons restricting attainment of this equality. The first and main driving force for attaining gender equality was a change in the national culture and female employment aspirations. Historically a cornerstone of the UK economy has been female acceptance of part-time jobs, usually associated with low pay and for which demand changes dramatically. Oakley (1981) noted that more than half the employed females in the UK worked in three service industries, these being distributive trades (shops, mail order, warehouses), professional and scientific (typists, secretaries, teachers and nurses), and miscellaneous services (laundries, catering, dry cleaning). The second reason, which may also be considered a constraint, there was a high negative reaction by males to accepting females in employment regions which are historically "male domains". This has, and still often results in female discrimination, for no other justifiable reason than "it`s always been a man`s job." Women are no longer prepared to accept such discrimination and view its removal as an actively pursued achievable goal. The third reason was the generation gap. It is estimated that currently there are seven million males and females in the 18-34 age group. This is the group both driving and expecting a change to equality. However fewer than one in twenty members of political parties are aged under 25, and nearly half the 18-25 year olds did not vote in the 1992 general election. Wilkinson (1994) recorded that if this age group expects change, how can it be obtained if decision making is in the hands of a much older generation, hardly aware of demands of this younger group, and certainly less able to understand and react to them.

Values of British Women.

Wilkinson (1994) recorded that although females were still more attached than men to the family and authority, there were clear signs of a movement away from rigid moral codes and puritanical values. Working females with higher education and committed to careers had higher self-esteem than non-working females and were becoming more escapist, more international, more inclined to take risks and be hedonistic. They were far more at ease with complexity than women without jobs, and by past comparisons they were far less concerned about financial security.

These changing values could be related to several factors. The "feminisation" of attitudes played a major role. Another factor was the medical technology which allows females to assume total control of reproductive functions. A changing culture has allowed for dominant female roles to develop in media situations such as television programmes and cinema roles. Here females such as Helen Mirren (Prime Suspect), Sigourney Weaver (Alien movies) have taken lead dominant roles which only 10-15 years ago would have been considered male roles.

Wilkinson (1994) quotes figures which revealed that in the 16 to 64 year age range, female working participation has risen from 53% in 1973 to 65% in 1991, whilst male participation has fallen from 93% to 86%. The sharpest increase was in female graduates, where 54% of newly qualified solicitors and 37% of new intake chartered accountants were female. Females accounted for 38% of what were considered professional jobs, but female earnings were estimated at only 79% that of males in

1991.

The Training Statistics (1993) published by the department of Employment show that in the period 1984 to 1992 females have moved into the lead regarding job related training. In 1984 9.7% of males compared to 8.5% of females received job related training. In 1992 this had become 14.4% of males and 14.7% of females. This demonstrates that in an increasing female labour market females are likely to demand and receive at least as much job specific training as males.

Changes in Employer's Requirements.

Changes in the requirements of almost all employers have been dramatic in the last 20 years. Shifts in technology, industry structure, organisation, and location have been some of the most noticeable. The Labour Market and Skill Trends (1995/6 and 1996/7) produced by the Department for Education and Employment suggest an annual employment growth of 0.6% and 0.8% respectively and quote the need for a highly motivated and qualified and flexible workforce. Employers will require more flexible and skilful workforces, attributes often more associated with females than males. Jobs requiring physical strength, the one major advantage possessed by males, remain in major decline.

One of the key issues of the Humberside TEC Economic Review (1998) stated that the workforce is changing, with fast growth in female participation and the employment profile, whilst set to grow overall, shows shifts to part-time and self-employment Some companies may see flexibility and the option of part-time working as a way of reducing potential redundancies and at the same time enhancing their image as a family friendly employer. This opens more possibilities for females who wish to continue their career, but at the same time continue in a traditional role as a family raiser.

The same change has isolated unskilled males in many regions. Many have had to re-evaluate their roles and apply for the service sector jobs, previously seen as "women`s work" (Oakley 1981). Some have accepted part time vacancies to allow greater child rearing involvement, allowing the female in the partnership to assume the position of primary "bread-winner".

The Pace of Change.

Wilkinson (1994) recorded that one of the main concerns of females in attaining equality was the gap between rhetoric and delivery. In terms of equality of pay and attaining top management positions equality was still a long way off, but in other fields such as financial services, females have already made major gains. Many females still considered there to be a mismatch between the culture of high female aspirations and institutions that are failing to deliver. Employer`s moves towards equality seemed to be curtailed at every recession, equality being one of the first items to suffer in the cutbacks. Eurostat (1993) showed that the UK had a higher drop out rate for women with children from the labour market than any other EU country.

The Institute of Directors (1992) performed a survey of women directors which revealed the following. Over 70% felt women do not have equal opportunities in the workplace, with male attitudes (37%) cited as the most common problem. However 90% rejected quotas, and 70% rejected targets as a method of reaching equality. The Institute of Management (1994) have produced a report titled "Management Development to the Millennium" based on research conducted by both questionnaire and interviews of current members. A section of this report "Today`s Male Managers Face Extinction" referred to many male managers as dinosaurs having problems ahead of them in adjusting to meet current and future needs. The report stated that female managers were far more receptive to “change” and more likely to support initiatives proposed by their team members than male managers.

In future managers will no longer be considered the "Boss", but a team leader. The team will not necessarily be in the same building, town or even country. The Institute of Management (1994) also noted that female attributes of team working, consensus management, negotiating, interpersonal skills, and the ability to handle several projects at once, appeared to make them more ideal as a modern manager. Females were considered the most able in terms of basic management requirements for the next century. Basic management requirements including skills such as strategic planning, responding to management change, total quality management, verbal communication, coaching others, and delegating responsibility were equally applicable to males and females. It was the attributes which females appear to possess in more abundance than males which were likely to see them dominating this field, although their was no supporting evidence in the report that proved females demonstrated these skills more effectively than males.

These management skills are as applicable in physical science and engineering management as any other areas, but if gender equality is not attained in these professions may not its management and ultimate growth be impaired?

The Centre for Policy Alternatives (1990) recorded that many females in the USA preferred to set up their own small businesses rather than try to overcome male prejudices in employment areas. In 1990 32% of small businesses were female owned, and the same survey predicted 50% by 2000. The Institute of Management (1994) supported these findings with similar growth patterns recorded in the UK. These results suggest that females are fed-up of waiting for change, so are leading it to bypass existing restrictive policy. It would appear that the pressures of running one`s own business are far preferable to trying to alter existing work-place culture.

How can the Pace of Change towards Gender Equality in the areas of Physical Science and Engineering be Accelerated?

Harding (1986) stated that historically the vocational dominance of males in many SET areas is often recorded as being located in women themselves, particularly their socialisation, their aspirations and values. The broader questions of whether and in what way science and its institutions could be reshaped to accommodate women are seldom asked.

Kirkup and Keller (1992) state that a better technology should be disseminated and made available to women, and women should be able to come to control this major influence on their lives. Wajcman (1996) states that in developing a theory of the character of technology, we are inevitably in danger of either adopting an essentialist position that sees technology as inherently patriarchal, or losing sight of the structure of gender relations through an overemphasis on the historical variability of the categories of "women" and "technology". This appears to suggest that to progress to gender equality in the areas of physical science and engineering then the historical relationship of genders to these vocational areas must be side stepped.

Wilkinson (1994) comments that the older group of feminists tend to view male resistance to gender employment equality simply as "bloody-mindedness". Watson (1987) terms male resistance to the attainment of equality in some vocational areas as males looking after male interests. From whichever position one observes this point, there has to be a some support for the theory of male resistance to females attaining gender equality in certain vocational areas, but it is by no means the only restriction to equality. So what hurdles must be overcome to speed the change?

A survey by the Guardian (1991) revealed that 58% of 1,100 females surveyed felt there was discrimination in the workplace. However only 9% viewed feminism favourably, and only 13% belonged to women's groups. The survey researcher commented that this may reflect the modern change to inner-directedness and autonomy. Basically people want to be free to make choices, and are prepared to carry the consequences of these choices. Choice though, often rests on infrastructures of support and if these do not exist in certain vocational areas, other areas will be selected. These findings suggest that political initiatives are not required to provide the driving force. However, as the government is the highest profile body in the country, gender equality of Members of Parliament and governmental committees would certainly provide encouragement to both females and direction for other prospective employers.

Far greater impetus can be given by employers actively providing the environment to attract female employees, especially in professional and management positions. High profile items such as childcare, nursery provision and after school activities would scream "we want female employees". Employers should move to cultivate a more balanced working environment. Reduced emphasis on long hours should be replaced by more emphasis on the quality of output, more imaginative support services, improved flexibility, and in many areas encouragement of working from home. In all cases policies need to become gender-neutral as institutions reflect the gender, ethnic, and age make-up of the population.

2.11 - GOVERNMENTAL CONCERN.

The previous section postulates that political interventions are not required to promote gender equality in the workplace. This does not suggest that governments should not encourage greater female involvement in areas dominated by males. This section examines the Conservative governmental philosophies regarding the encouragement of more females into the areas of Science, Engineering and

Technology (SET), and also briefly looks at some of the proposals of the Labour Party who formed a new government in May 1997.

The Rising Tide.

In March 1993 the Committee on Women in Science, Engineering and Technology was established by the Rt Hon William Waldegrave MP, and meetings chaired by Dr Jean Balfour. The Committee`s task was to prepare a report identifying actions to further science, engineering and technology by making greater use of the talents of women, and at the same time enable women to realise their potential. To further this aim, a working group was established to produce an independent report, and meetings of this group were chaired by Dr Nancy Lane. A report entitled "The Rising Tide" (1994) detailed the result of the discussion of the issues raised by the Committee and Working Group, and this section covers some of the major points raised by this document.

The Rising Tide - The Potential To Be Realised.

The White Paper, Realising Our Potential: A Strategy for Science, Engineering and Technology (1993), acknowledged that women are the country`s biggest single most under-valued and therefore under-used resource. It also recorded that by the year 2000, 23.5 million women aged over 16 years of age will represent 46% of the available labour force. Throughout the 20th century progress has been made in attracting women to the SET professions, but it has been very slow. Consequently there has been a rising tide of awareness that the loss of ability and skills caused by gender bias is neither acceptable nor in the national interest. Recruiting and retaining women scientists and engineers at all levels of employment will increase the pool of talent in these areas, and create a workforce with a greater diversity of skills.

The report raised three principal questions which needed to be considered. Firstly, how can we ensure more girls become sufficiently interested in science, engineering and technology to choose to study these subjects at school, college and university? Secondly, how can careers in science and engineering be made more accessible and attractive to women, and result in their skills and expertise being used more effectively? Thirdly, how can it be ensured that more women are represented on, and chair, boards and bodies responsible for developing and managing policy in these areas?

The report produced a series of recommendations which are summarised next. The Committee suggest these recommendations should be taken forward by a Development Unit, established under the auspices of the Office of Science and Technology, for an initial three year period.

In the area of **Education**, the Committee recommended that Government Education Departments and education and training establishments ensure the initial and in-service training of teachers on equal opportunities issues including guidance on means of maintaining the interest of girls as well as boys in all science subjects. A further recommendation was for the Office for Standards in Education (OFSTED) to routinely review the status and effectiveness of equal opportunities policies in schools. The advantages of a broader curriculum in encouraging more young people to study science beyond the age of 16, was also considered to be beneficial.

In the area of **Employment**, the Committee recommended that equal opportunities policies should be a recognised part of an organisation`s or company`s strategy. The implementation of these policies should be monitored in Annual Reports. "Investors in People" and "Opportunity 2000" schemes should build on these initiatives to address the specific needs of women in these employment areas. The Office of Science and Technology Development Unit should initiate a series of pilot studies to identify and disseminate information on the economic and other benefits of existing women friendly management practises in science and engineering areas. Encouraging more flexibility e.g. funding returner schemes for women in science and engineering areas and a more flexible approach to research funding to allow for family commitments, could also help attract women to these areas. EMTA Matters (1999) noted that Daphne Jackson had set up a trust to help female scientists and engineers return to their careers after a break.

Other recommendations included establishing databases and networks of women scientists and engineers qualified for appointment to boards, committees or public appointments. From these a target for 25% of all public appointments and senior positions in science and engineering to be secured by qualified women by the year 2000 could be achieved.

The Rising Tide - The Present Position.

The introduction of the Education Reform Act (1988) requires the students of all maintained schools in England and Wales to follow the National Curriculum. In respect to science subjects, students have the following options. At GCSE level, students must opt for either single science, double science, or all three separate sciences. Single and double science being referred to as "balanced science" courses.

By 1992, the number of boys and girls with at least one science subject pass A-C grade at GCSE had reached equality. In the same year fewer girls than boys obtained an A-level in mathematics and chemistry and significantly fewer A-levels in physics and technology. More girls than boys obtained A-level biology. A-level success rates are shown in table 2.14.

Table 2.14 - Science A-level success rate by gender 1992.

Subject	Boys		Girls	
	Candidates	**%Success**	**Candidates**	**%Success**
Technology	6,152	77.7	1,528	82.1
Physics	23,520	80.4	6,680	82.0
Chemistry	17,926	82.3	12,634	82.2
Mathematics	31,525	77.2	16,972	78.3
Biology	12,506	80.6	20,149	79.3
English	20,062	85.9	44,859	87.6

In terms of entry to Higher Education, in 1991 just under half the entrants were women. In the subjects of engineering and technology only 13.7% were female. Employment figures show a similar trend. Whilst women outnumber men as laboratory technicians (57%), they occupy only 2-6% of traditional engineering positions, 11-12% in electronic planning and control, 20% chemical science and 33% biological science.

A study of the number of men and women appointed to Councils and Boards performed by Public Bodies 1992 (HMSO 1993), showed that in science and engineering related fields only 118 out of 917 are female. Gregg and Machin (1993) record that out of 1,370 Chief Executives of Britain's quoted companies in 1992, only 5 were women.

The Rising Tide - The Way Forward.

As modern society depends increasingly on technical competence and innovation, the need to attract more young people, both males and females, to science and engineering is evident. There is generally a need to include a greater participation by women. To achieve these aims all children need to acquire basic technical skills and some understanding of science. Science and engineering are often still perceived as "masculine" producing stereotyped career viewpoints.

Some research studies suggest that girls perform better in science in single sex schools, however evidence is variable. More work is needed on presentation and teaching methods, and the content of courses to ensure that girls and boys are well taught in science, mathematics and technology and have an equal opportunity to consider science and engineering as a career option. With science and mathematics as core subjects and technology a compulsory subject in the national curriculum, there is a hope that the number of 16 year olds choosing to study science and engineering may increase.

Technology is a key theme of the curriculum for 5-14 year olds in Scotland. The report stated that considerable improvements in the quality and quantity of science teaching has created a greater interest and participation level and should feed through to a more sustained uptake of science subjects at higher level. The report also stated that there is evidence to suggest that girls respond better to broad courses incorporating some elements of science rather than to very narrowly specialised science on its own. There was no record of exactly what this evidence was.

Equal opportunities should be given higher status in both schools and teacher training. OFSTED should continually review and report on this subject.

The Rising Tide - Teaching of Science, Engineering and Technology in Schools.

Science, engineering and technology are inherently exciting and challenging subjects. It is particularly important that children of an early age are introduced to these subjects in a manner which captures their imagination and counteracts traditional stereotyping. Committed enthusiastic teachers setting high academic standards and showing personal interest in science and the future development of their pupils are required to both maintain interest in these subjects and encourage students to pursue careers in these areas. The presence of high calibre women in senior positions in schools is also valuable because they can influence school policy and provide role models. Greater use of information technology in the interactive mode could help in development, by accommodating different learning styles.

In **nursery schools** the use of learning materials which are not gender typed was recommended by the Committee in Science, Engineering and Technology. The provision of publicly funded nursery education, which compares unfavourably with other EC member states, should be improved and expanded. In **primary schools** the recent inclusion of science as a core subject for primary schools children was viewed as a positive step. However, there are few primary school teachers who are science graduates, and this is a matter of concern. In Scotland a large proportion of women primary school teachers do have a science qualification and a significant number also have science-based degrees. From 1st Sept 1998 all new entrants to primary school teaching programmes must have a grade C or above in a science subject at GCSE level.

In **secondary schools** children between the age of 14 and 16 decide whether to continue their education and in which areas such as A-levels and NVQs. These choices have far reaching effects on their careers. Children, and girls in particular need sound information and guidance at this stage, and work experience (2 weeks) can play a significant part in this. Greater contact with scientists and engineers, of both sexes would be beneficial.

Training and Enterprise Councils (TECs), Local Enterprise Companies (LECs) could play a greater role in enabling girls to visit employers whose activities are science or engineering based. Careers advice offered at schools should emphasise the importance of science, engineering and technology, and avoid gender stereotyping. The system of guidance in Scottish schools is subject to more focussed professional control. Teacher Placement Service (TPS) has been successful in organising exchange placements for teachers and people from industry, and this should be encouraged especially in the science and engineering areas.

The Committee on Women in Science, Engineering and Technology also considered current A-levels to be too limited and divisive. As science and engineering careers require 2, 3, or 4 science subjects to be followed, too few young people, particularly girls, are choosing sufficient science to continue the subject at higher education. Clearly encouragement of more young people to study science beyond 16 is necessary. In higher education, pressures on females attending science and engineering programmes which often only have small female minorities, can be great. Greater attention must be paid to this minority to reduce undue pressures.

The SPRINGBOARD programme, which is a self development training programme to help women identify and develop their strengths and abilities, has proved useful in education as well as in industry and professional life. The use of women scientists and engineers as mentors in many areas should be encouraged. In Further Education, craft and technician courses show a serious imbalance between men and women. Gender stereotyping and experiences of isolation may present serious problems which caused concern to the Committee on Women in Science, Engineering and Technology.

The Rising Tide - Helping Women Stay in Science, Engineering and Technological Employment.

Good management practices which maximise the skills and potential of women, as well as men, benefit employers and employees alike. As such equal opportunities must be part of an organisation's strategy. Leadership of such a policy should be from the top and included in Annual Reports. Employers should include their women scientists, engineers and technologists more prominently in their promotional and recruitment procedures. Flexible working patterns may be needed to attract and retain women in science and engineering areas. Attempts must be made to reduce the isolation female employees often encounter when entering these areas.

Child care difficulties could be addressed more effectively. Companies may offset the cost of childcare facilities against corporation tax. The government should provide more publicly-funded and locally-available childcare services. Claims for childcare costs should be allowed against employees income tax, and this was considered a key action which would make a positive long-term impact on the issue. Arrangements for "keeping in touch" during career breaks are essential in science and engineering fields. Improved retraining and updating facilities are required with associated funding, both public and private. Career development plans should include provision for appropriate training for men and women and inclusion in high profile projects and senior level meetings. Placing women in pivotal positions was considered crucial.

The Rising Tide - Regional Career Choices.

To improve the number of women entering science and engineering professions, career advice should be provided locally by relevant professionals. Most career advice is aimed at 16 to 19 year olds, and there is little career advice for women in the fields of science and engineering. Such a service, driven from the Department of Employment, should be available to women, advising them on realistic career choices. This may be advanced by the development of an "Association for Women in Science" who could help establish a network of groups to support this service.

The Rising Tide - A Higher Public Profile for Women in Science, Engineering and Technology.

The image and status of scientists, engineers, and technologists are strongly influenced by the media. Women scientists, engineers and technologists should have a higher, more positive public profile so that their achievements are more widely recognised. This is particularly important for the perception of children in this area. Major employers and Government Departments can play a key role in such developments. To this aim the Office of Science and Technology should further develop its strategy for promoting public awareness, by maintaining contact with media outlets.

Government Response to the Report, The Rising Tide: Women in Science, Engineering and Technology.

The Conservative Government (1994) produced a response to the report which stated,

> " The Government is committed to equality of Opportunity between the sexes."

The responses to the recommendations were in fifteen points.

1) A Development Unit should be established under the auspices of the Office of Science and Technology (OST), for an initial three year period to take forward those recommendations which would benefit from action and coordination by a dedicated unit.

2) The Council for Science and Technology should be invited to consider the report.

3) Government Education Departments and education training establishments should ensure the initial and in-service training of teachers on equal opportunities issues include guidance on means of maintaining the interest of girls as well as boys in all science subjects.

4) The Office for Standards in Education (OFSTED) should routinely review the status and effectiveness of equal opportunities policies in schools.

5) When reviewing post-GCSE courses in England, Ireland and Wales, the Department for Education and Employment, The Department of Education for Northern Ireland and the Welsh Office Education Department should consider the advantages of a broader curriculum in encouraging more young people, particularly girls, to continue to study science beyond the age of 16, taking note of the Scottish experience.

6) Equal opportunities policies should be a recognised part of the organisation`s or company`s strategy. The implementation of these policies should be monitored and reported in Annual Reports.

7) The OST Development Unit should work with "Investors in People" and "Opportunity 2000" to build on these initiatives to address the specific needs of women in Science, Engineering and Technology (SET).

8) The OST Development Unit should initiate a series of pilot studies to identify and disseminate information on the economic and other benefits of existing women friendly management practices in SET.

9) The Government should allow child care costs to be claimed against employees' income tax, where both parents or a single parent in single parent families, are working. In addition, the Government should increase the provision of publicly-funded child care services.

10) The Department of Employment should facilitate national support and funding for successful returners schemes for women in SET, to help secure the future of these schemes and enable greater numbers of potential women returners to take advantage of this type of training.

11) Funding bodies should make research funding arrangements for principal investigators and research fellows more flexible so that potential award holders are not disadvantaged if their mobility or availability for full-time work is restricted by family commitments. The Government's Annual Forward Look of Science and Technology should provide information on the extent to which the Research Councils are addressing this issue.

12) The Office of Science and Technology Unit, in consultation with the Department of Employment, should examine the provision of a regional careers development advisory service in science, engineering and technology, building where possible on existing regional schemes and networks.

13) Employers and professional institutions should set up and maintain their own databases and networks of women scientists and engineers qualified for appointment to their boards and committees, or for nominations to public appointments. A central catalogue of databases should be held by the OST, and updated annually, to disseminate this information.

14) Government Departments and other employers should set targets specifically for all public appointments and senior positions in SET, including chairmanships, of at least 25% qualified women, by no later than the year 2000.

15) The OST should develop its strategy for promoting public awareness and maintaining contact with media outlets, and should encourage coverage of the contribution women make to SET.

The response concluded that through the establishment of the Development Unit in the Office of Science and Technology, and through the action of other departments and agencies, it will seek to ensure that the momentum already stimulated by these organisations is developed and further progress made.

Towards a Learning Society.

David Blunkett (1996) stated that to sustain economic opportunity and prosperity in a global economy, including key sectors such as engineering, Britain needs to use the talents of its workforce to the full. To meet the needs of the technological and knowledge based revolution of the 21st century requires equipping men and women to cope with the enormous economic and social change to meet the needs of that area around us. The Labour Party recognised that government, employers and employees all have their role to play. Government's responsibility started when people were young and learning, even in the primary years.

If elected to power in 1997, Labour would launch a new initiative in partnership with the private sector to bring the provision of education and training into line with the competitive demands of the 21st century. This would be termed the University for Industry. The aim, although ambitious, was to create a learning culture under which everyone would enjoy a lifetime entitlement to learning, something that would be shared across industry and services, including engineering.

2.12 - SUMMARY.

The literature review suggests there are many items which must be examined to understand the gender imbalance in the engineering and physical science professions. These areas promote many questions, some of which are now summarised.

1) The professions of physical science and engineering seem to have developed into a male dominated domain. Whilst this was true of many professions until the mid 20th century, physical science and engineering retain a male domination not apparent in many other professions. Wilkinson (1994) records that 54% of newly qualified solicitors are female graduates. Clearly this promotes the question, why do the areas of physical sciences and engineering remain dominated by males?

2) The work of both Piaget and Erickson indicate the importance the environment in which a child "grows up" can play in the development of that child. This is equally emphasised by the work of Silver-Miller (1992) in the roles that teachers and fathers have played in encouraging females to major in science and engineering subjects. Foskett and Hemsley (1997) also cover the areas of role models and the effect they can have on a child selecting engineering as a possible career. There are clearly avenues where parents, teachers, and the media can influence the development of all children. How can these resources be best utilised to bring gender equality to engineering and physical science vocational areas?

3) Educational developments such as the introduction of the National Curriculum, covered by Smithers and Zientek (1991) in section 2.6 and under the Rising Tide report in section 2.11, should have produced the impetus to reduce the gender imbalance in science and engineering areas. Table 2.1 has shown that this objective has yet to be attained. Why has the objective not been attained, and how can it be attained in the future?

4) If the aim for equal opportunities had been successful, why do females hold between 2-6% of engineering posts in the UK engineering industry, and why does this situation not cause higher concern?

5) Are the many initiatives which have been suggested to increase the number of females entering the engineering and science profession likely to achieve their objective of narrowing the gender gap?

6) What does the government really feel about this imbalance, and are its suggestions for overcoming it likely to produce the required results?

In an attempt to understand this topic in more detail, and answer some if not all of these questions, a specific research methodology has been produced.

CHAPTER 3

METHODOLOGY.

3.1 - INTRODUCTION.

Anderson and Ricci (1993) state that width and diversity of levels are hallmarks of Social Science, which ranges from details of personal and family life to social developments at world level. To understand contemporary society, it moves outwards in geographical space and backwards in time, and also down to details of particular situations and processes.

To examine the questions the thesis asked, the investigation required working closely with selected student groups in various locations, including one group of students from a single sex school. By encouraging all students to become co-researchers, good written and verbal communications were maintained with all students during the research period. The students were encouraged to provide all outcomes by wherever possible asking open questions. By answering student`s questions directly, and without offering more information than was required, students were not led to provide specific answers.

3.2 - SAMPLING, VALIDITY AND RELIABILITY.

Clegg (1994) provides some basic definitions to assist sample selection and data interpretation. If we consider the large pool of information which we wish to examine, we can refer to this as the population. From the population we draw a small portion which we study and this is referred to as the sample. The skill with which a sample, and its size, is selected will determine just how accurately statements about the population from which it is drawn can be made.

A critical examination or evaluation of the qualities or abilities of a person or thing is the Oxford Dictionary (1984) definition of a test, and a test may be used to produce data for researchers. A reliable test is one in which the scores obtained by subjects are known to be consistent, and unlikely to change because of factors which are not connected with the test procedures. A valid test is one which measures what it is supposed to measure, and not something else.

The Oxford Dictionary (1984) defines a sample as a small separated part, showing the quality of the whole. To ensure that the selected sample produced both a reliable and valid test, the following schools provided the samples.

1) One secondary school from an inner city area.

2) One secondary school from a suburban area.

3) A single sex (female) secondary school.

4) Primary schools which act as feeders to 1, 2, & 3.

Groups of students in the age range 9 to 15 were selected from these schools. Students of a younger age were not expected to be fully aware of the vocational areas available to them, but older students were already involved in selections to prepare for a chosen vocation. The main area of research investigated the factors affecting vocational selection around the time the selections were actually being made.

3.3 - QUALITATIVE AND QUANTITATIVE ENQUIRY METHODS.

Bell (1993) has produced a brief description to provide an understanding of the differences between quantitative and qualitative analysis. Quantitative researchers collect facts and study the relationship of one set of facts to another. They measure, using scientific techniques that are likely to produce quantified, and if possible, generalisable conclusions. Researchers adopting a qualitative perspective are more concerned to understand individuals` perceptions of the world. They seek insight rather than statistical analysis. They doubt whether social "facts" exist and question whether a "scientific" approach can be used when dealing with human beings. Yet there are times when qualitative researchers draw on quantitative techniques, and vice versa. It was the intention of this researcher to collect both qualitative and quantitative data.

There are several different enquiry methods which a researcher can use and some are covered briefly.

Case Studies.

Dixon, Bouma, and Atkinson (1987) state that a case study can answer the question "What is going on?". In a case study, a single case (hence the name) is studied for a period of time and the results recorded. A case study may be one person, one group, one family, one town, or any individual item. This is one of the case study`s limitations because in studying one item to the exclusion of all others, a biassed conclusion may be reached merely reflecting the performance of one item and not representative of the total population.

The terms exploratory study or observation study may also be applied to case studies in which a specific or non-specific hypothesis is tested. In the latter case, research data may be provided to produce specific objectives or a hypothesis.

The proposed investigation is a case study and will be treated accordingly.

Interviews and Questionnaires.

Dixon, Bouma, and Atkinson (1987) state that in an interview, the researcher asks the respondent questions, using an interview schedule. A questionnaire is used when the respondent reads and answers the questions separately from the interviewer.

Both the interview schedule and questionnaire are techniques for measuring variables which involve asking people questions. Questions used can be open where the respondent produces their own answer, or closed where a respondent has to select from a series of possible responses offered. A questionnaire will be structured, but an interview can be structured, semi-structured, or open depending on the technique and questions selected in the interview schedule.

A questionnaire must be designed to produce valid and reliable data. Interview schedules must be designed with sensitivity if delicate topics are to be covered. Both must be non-discriminating and care must be taken that selected questions do not lead to a predetermined conclusion. The questionnaire (Appendix 1) was produced to include both open and closed questions. It was designed to avoid boxes, and be no longer than three sides. The former demonstrates that individuals were not being forced into pre-determined groups, the latter to produce an objective response before boredom set in. The subsequent interview guide for students (Appendix 2) contained open questions which allowed students to expand answers provided in the questionnaire.

The questionnaire was issued to groups of students (precise numbers recorded in chapter 4) following a brief introduction to its purpose. Students then completed the questionnaire and returned it. This ensured a high percentage of returns. The questionnaire produced both quantitative and qualitative data, the latter being expanded by subsequent semi-structured interview. Candidates (precise numbers shown in chapter 4) for semi-structured interview were selected from the students completing the questionnaire. By examination of the questionnaire answers, areas were explored in greater depth and expanded by use of open questions which allowed confirmation of ideas, and some measurable conformity to back up the initial quantitative data.

Murphy and Torrance (1988) state that experienced interviewers are aware of many pitfalls, especially in semi-structured or depth interviews, where the information outcome of the interaction depends not only on the language, content and order of the interview but also on subtle non-verbal cues, silences and practical organisation. Should full transcripts always be used, if not how much data is reported, what level of uncodeable or unsortable data is tolerable, and what basis is used for filtering the data, are questions which must be addressed and stated during all data collection, analysis and reporting. The investigation may then be expanded or supplementary interviews performed following examination of the initial data.

3.4 - GENERATING THEORY FROM DATA.

McNeil (1989) states that all social research takes time, but a study based on a particular observation usually requires at least two years. Researchers will usually spend six months to two years "in the field", and long periods of time analysing the data generated and writing the report. It is thus of great importance that the overall research plan includes details of the sample selected and how theory is to be generated from data. All research will start with a hypothesis, from which the research plan is devised. An initial sample will be drawn which will test this hypothesis. From the initial sample, the researcher may "funnel in" on a smaller sample for detailed interview or case study analysis. Data collected during the whole research should provide direction, and ultimately support to the hypothesis or theory generated.

A pilot study of the techniques to be used can show that examination techniques are being interpreted in the correct manner, and that they produce the standard of results the researcher is looking for without leading the sample group to a pre-selected conclusion. The researcher must then ensure the selected sample group is representative of the total population. In this research the sample selected was chosen to represent the female students who could enter physical science or engineering vocations from the Hull and East Yorkshire Local Education Authorities

Examination of data must produce valid, reliable results, and the researcher must be aware of the randomness factor, trying to ensure that data is truly representative and not selected for a particular aim or purpose. It is important that significant data directly related to the hypothesis only is reported. There is no need to include every piece of information collected as this will only confuse and may even prevent a conclusion being reached.

Initial analysis of the data will produce quantitative data. Preliminary analysis will be univariate analysis (variations of a single aspect), e.g. age or school. This will then quickly be followed by bivariate analysis (variations of more than one aspect), linking sections initially investigated as univariate data together, to find areas which provide reasons to explain the initial hypothesis. Data analysed from the single sex school was of particular significance as it may indicate the effect the removal of male students has on the promotion of engineering and science areas to an all female student group.

3.5 - ACTION PLAN.

The action plan was performed in several stages listed below.

1) **Literature review** - Although a considerable review was performed prior to commencement of this project, the review was updated continually as the project developed where relevant material was either uncovered or recently published. Initial review was completed by mid 1996.

2) **Training opportunities** - an investigation of the training opportunities (Modern Apprenticeships) available to school leavers in the Hull and East Yorkshire areas.

3) **Initial group selection** - To comply with initial planning, three initial groups at three secondary schools were selected at random by the school contact for initial discussion, followed by completion of a questionnaire. The three schools were;

a) Amy Johnson School - an inner city school, situated in Hull.

b) Newland School - a single sex all female school, situated in Hull.

c) Wolfreton School - a suburban school, situated in Willerby and Kirkella, East Yorkshire.

All students contacted were in year 9 (age 14 years), the year at which GCSE selections were undertaken. Initial meetings took place in the Spring term of 1996. A description of all schools is shown in Appendix 3, and their location on the map (Appendix 4).

Before commencing the main research, a pilot study was conducted. This involved a group of seven students from the Sir Henry Cooper School, Hull. The students were involved in general discussions on the topic, and completed a sample questionnaire. The findings from this pilot study were used to produce the final discussion notes and questionnaire to be used in the main research project. Again a description of the school and its location are shown in Appendices 3 and 4.

4) **Feeder schools** - to examine if the same feelings were held by students prior to entering these schools, one feeder primary school for each of the above schools were selected. Students from these schools were selected at random by the Head Teacher for initial discussion, followed by completion of a similar questionnaire. The three schools were;

a) Wheeler Street School, Hull.

b) Bricknell Primary School, Hull.

c) Carr Lane Primary School, Willerby.

All students contacted were in years 5 and 6 (age 9 to 11 years), the two final years before transfer to secondary schools. Initial meetings took place in Spring or Summer terms 1996. A description of all schools and their locations are shown in Appendices 3 and 4.

5) **Questionnaire Data Examination, Interview Selection** - From examination of the data revealed by the questionnaires certain areas were shown to require a more detailed examination. To perform this examination samples of students representative of all the views recorded on the initial questionnaire were selected from each group for semi-structured interview. These interviews were held in two periods. As some of the students in the feeder (primary) schools may not transfer to the secondary schools in the survey, it was important to interview the chosen students before the end of the year. The interviews with the feeder schools were held in the summer term of the 1995/6 year. As a similar problem did not exist at the secondary schools, students here were interviewed in the autumn term of the 1996/7 year. As all interviews were conducted within a 6 month time period, this time difference

was unlikely to have had any effect on the results obtained.

6) Once all data from the interviews had been examined and early conclusions formed, these conclusions were discussed with the following;

a) A representative of the Engineering Council. This involved examination of the path the Council may wish to follow to encourage greater female participation.

b) Representative of the Confederation of British Industry (CBI). This involved a similar examination to that performed with the Engineering Council, but with greater emphasis on employer/workplace participation.

c) Representatives of the Department for Education and Employment. This examined what steps the Government currently employ in terms of educational initiatives to encourage more females to enter engineering and physical science vocations.

d) A representative from a Technology Enhancement Programme to discover the current level of female participation in engineering and physical science vocations, and to indicate the future direction required to achieve increased female participation.

e) Representatives of the Development Unit for Women in Science, Engineering and Technology (SET) at the Department of Trade and Industry. Once again current Government initiatives aimed at rectifying the gender imbalance in these areas were examined.

All interviews listed above were concluded by the end of 1997.

7) Once the data produced from the previous research had been examined a questionnaire was to be sent to large and small to medium employers in engineering and physical science sectors in the Hull and East Riding of Yorkshire areas.

Once all research was complete all data collected was reviewed and the thesis completed for submission and approval in August 1999.

3.6 - SUMMARY.

The action plan for the research topic examined the hypothesis stated by selection of a representative population sample, from which valid and reliable data was obtained and examined.

Initially the research topic was introduced to selected sample groups, and was followed with a simple questionnaire (Appendix 1) involving both fixed choice and open questions. The questionnaire was in turn followed by semi-structured interviews (Appendix 2) with a smaller sample selected from the original sample group. Analysis of the data generated provided the basis for investigational development and direction.

The investigation covered a four year period and produced solutions to the questions generated by the original hypothesis. Data generated showed what actions need to be taken to address and correct this current imbalance.

CHAPTER 4

RESULTS.

4.1 - INTRODUCTION.

This section records the findings of the research performed by the author. All findings are recorded, in both qualitative and quantitative forms where available and relevant. The initial contact time allowed for each group varied greatly from school to school, and person to person. As the initial objectives at each school was to explain the purpose of the research to each student, and ensure every student present completed a questionnaire, these tasks were given priority and the discussion periods were expanded and contracted to maximise use of the remaining time.

At the school pupil interview stage an approximate time was allowed for each interview and these times were adjusted to meet the ability and responses of each individual. Interviews performed with companies, organisations, and representatives of educational establishments were again initially set times but these were allowed to vary depending on the items raised and responses obtained at each interview. At no time were discussions terminated because of any time restraints at any group session or interview. The following sections are a representation of the discussion and relevant answers to questions raised at the various sessions.

4.2 - ENGINEERING/SCIENCE TRAINERS.

To investigate if females were reluctant to apply for positions in science and engineering training, three local trainers were contacted. The Humberside Engineering Training Association (HETA)of Hull, and Crownship Technical (Hull) provide engineering training to young people in the 16 to 20 year age group for many companies in the Humberside area. British Petroleum (BP) Chemicals, Hull operate their own Quartz training programme for young people in the 16 to 20 year age group and include engineering, operational, and science trainees. The three companies supplied the following information.

Humberside Engineering Training Association.

The figures supplied cover the 1990s, and although averaged, are remarkably similar each year. The places available can be divided into skills areas these being 40% mechanical engineering, 40% fabrication and welding, and 20% electrical/electronic engineering.

1) Training places available each year - 80

2) Number of female applicants - 5 or 6

3) Number of male applicants - 450

4) Number of females offered training places each year - 2 or 3

Although the positions were advertised via local media only approximately 1% of applicants were female, but 50% of female applicants were offered training places despite the fact that there are 6 applicants for every position. This suggests that there was a great opportunity for female applicants to obtain a far greater number of the available places, if only there were more female applicants.

Crownship Technical.

The figures supplied covered the years 1994/5 and 1995/6. In each year approximately 120 applications were received for 10 training places. Only two applicants from female candidates were received in this period, and neither applicant was considered suitable. To try to attract more females onto the training programmes, Crownship approached the Hull College to try to contact potential female trainees. Following discussions with the only two females on a full-time GNVQ engineering programme, both were offered and accepted training places with Crownship Technical.

Once again, although the positions were advertised via local media less than 1% of applicants were female. Even with this low number of applicants 10% of the training places have been secured by female candidates and the female candidates selected have been successful, and continued on the training programme. This demonstrates that the females applying for these training positions have at least equal, if not greater, ability to secure and retain training places in these areas.

The only restriction on females attaining a far greater number of training places was the reluctance of females to apply for these places. The positive recruitment methods adopted by Crownship do not appear to have made any alterations to the overall number of female applicants for training places.

British Petroleum (BP) Chemicals.

BP Chemicals had operated the Quartz Training Programme for 16 to 20 year olds for six years at the time this data was provided. They have offered training places to Engineering Apprentices (electrical, instrumentation, and mechanical), Technical Process Operators, and Science Trainees (analytical and research laboratories) since 1991 via the Quartz programme. Table 4.1 shows the number of applicants for the positions each year from 1991 to 1996.

Table 4.1 - Application for Quartz training places 1991/6.

Year	Males		Females		Total Number
	Number	%	Number	%	
1991	347	92	32	8	379
1992	186	90	20	10	206
1993	195	91	20	9	215
1994	166	89	20	11	186
1995	245	82	55	18	300
1996	205	92	17	8	222

The 1995 figures included applications for the Quartz Administration roles available in this year. Hence a significantly higher number of total female applicants were obtained in 1995 than in other years. With the exception of 1995 when these administrative positions were available, the percentage of female applicants per year was remarkably consistent at 8 - 11%. In terms of actual trainees offered places, table 4.2 shows the numbers in terms of areas and genders.

Table 4.2 - Places taken by Quartz trainees 1991/6.

Year	Process		Laboratory		Engineering		Total	
	Male	Female	Male	Female	Male	Female	Male	Female
1991	5	1	5	1	9	0	19	2
1992	6	0	1	1	6	0	13	1
1993	4	1	3	2	4	0	11	3
1994	6	0	0	3	3	0	9	3
1995*	6	0	2	1	4	0	12	1
1996	6	0	1	1	6	0	13	1

* In 1995 two administrative trainees were recruited, both females.

Over this six year period 88 trainees have been recruited, 77 males and 11 females. The percentage females recruited (excluding administrators) was 12.5%, slightly above the 8 - 11% of applicants, but no engineering trainees had been recruited. The reason given for this was that very few females have expressed any interest in an engineering career. The few who did, had not met the required programme entry standard or matched the male applicants at the selection procedure.

BP Chemicals have links with five local secondary schools in Hull and The East Riding of Yorkshire. They have tried to encourage more female participation in the scheme and a paragraph from their advertising stated,

> "BP Chemicals is an equal opportunities employer and we actively encourage applications from females, who are currently under represented on our Quartz Programme".

The information supplied and subsequent discussions would suggest that considerable effort has been put into their recruitment strategy to attract a higher percentage of female applicants. Publicising the successes of female role models from earlier years has not resulted in an increase in applicants from females for the positions available. To meet targets for a gender balance in both applicants and trainees alternative methods must be tried to alter a currently stagnant position.

Discussion with Trainers.

Discussion with these trainers revealed the following information. There had certainly been occasions when an employer had requested a female student be selected for training. One could even sense this may have initially been a "token female" to avoid discriminatory accusations. The females selected in all cases had demonstrated abilities which matched or exceeded those of the "average" male. As a result the desire to employ a higher percentage of females was the future objective in all cases. This desire remains unachievable as the number of female applicants have remained relatively small when compared to the number of males. Despite this desire to employ more females, accepting females who do not meet entry requirements is likely to result in situations hardly beneficial to trainees, employers, or ultimately the cause of gender equality in the professions. All trainers felt that the only solution to this situation was to see a gender balance in terms of applications as this would lead to a likely balance in trainees.

4.3 - PILOT STUDY.

To test the initial group session scheme of work and questionnaire, a pilot study was performed with a group of seven female students from the Sir Henry Cooper School, Hull. The results were obtained from a session lasting just over one hour. The session involved a group discussion after which a questionnaire was completed by each student individually. The session was then completed by a short discussion before the students had to return to their next lesson.

Initial Discussion.

The initial discussions were prompted by the pre-prepared introduction sheet explaining what was about to happen and the reasons for it. From the discussion, the following points were revealed.

Q - Who do you think perform best at schools girls or boys?

The answer was unanimous, girls.

Q - Why do you think this is so?

The answer fell into two areas. Firstly boys "mess about" and secondly girls were more mature than boys at this age, and put in more effort.

Q - Have you made up your mind which career you would like to follow?

The group split here, five stating yes and two as yet undecided. Of the former group, three wanted to become carers, one a physiotherapist, and one a nurse. The two undecided members thought they would like to work in the leisure industry.

Q - How did you decide which career you wished to follow?

Four students replied it was as a result of information supplied by a family member or friend. Two students stated it was as a result of work experience. One stated it was as a result of current school work.

Q - When do you feel you made a decision about which career you would like to follow?

Six of the seven students stated they had made their decision during the last year, only one stated the decision had been made some time ago.

Q - Why do you think that none of you have chosen a career in science and engineering?

Several answers for this were given in which the group was in agreement as a whole. The first was that they found science subjects complicated and often boring. The subjects appeared to require a lot of manual skills at which they might not be good. The other item mentioned was the teachers. These were mainly male and did not promote science or engineering as careers to which females should aspire. All present would like to have seen more female role models from these professions who may well have influenced a change in career choice.

At this stage the students were given the questionnaire. The relevance of each question was explained to the students, and they were completed in approximately fifteen minutes.

Questionnaire Results.

Age and Ethnic Background.

The group consisted of seven white females aged 15 to 16.

Occupations of Close Relatives.

Figures recorded in table 4.3 show those relatives forming a close part of the families at the time of the session.

Table 4.3 - Occupations of relatives to students at Sir Henry Cooper School (n = 7 students).

Relative	Blue Collar	White Collar	House-person	Unemployed
Father	4	0	0	0
Mother	1	0	4	1
Brothers	2	0	0	2
Sisters	0	1	0	2

<u>Chosen Career.</u>

Q - What do you think your chosen career (future job) will be? Please state why you have made this selection.

Table 4.4 - Career choices of students at Sir Henry Cooper School (n = 7).

Career	Number of Students
Caring	3
Leisure	2
Nursing	1
Physiotherapy	1

Q - If you have not chosen a science or engineering career, please state why you do not feel a science or engineering career is for you.

The words boring, complicated, too hard for me, were the main ones used in this section. References to not liking science lessons at school, finding them amongst the most boring and poorly delivered were common. A comment was recorded that there had been no real discussion at home or school regarding these professions and no investigation of possible entry to these professions performed by the students. Subsequent discussions were now unlikely to influence selected career options.

Which Groups Have an Effect on Career Selection.

Q - From the following groups, please indicate which three have had the greatest effect on your career selection. Select and number in importance from 1 to 3.

To quantitatively analyse the data attained from this question, each category chosen as selection 1 has been awarded three points in the table 4.5, those chosen as selection 2 two points, and those chosen 3 one point. Where joint selections have occurred, the points awarded have been divided evenly.

Table 4.5 - Career influences on students at Sir Henry Cooper School.

Category	Points Awarded
Careers Service	7
Employers	3*
Friends	10
Media	0
Father	4.5
Mother	9.5
Other Relative	7
Teachers	0

* Two of the points awarded here were for work experience.

Current and Future Studies.

Q - What examinations do you expect to take whilst at school?

GCSEs in English language, English literature, art, geography, mathematics, single science, French, graphics/craft design technology (CDT), drama, expressive performing arts (EPA), textiles, and history were recorded. English, mathematics and science were common to all selections. GNVQs at foundation level and in some cases intermediate level ware being studied by all seven students. Three students were studying leisure and tourism, four health and community care. It was subsequently revealed that the students studying GNVQs had done so at the expense of two GCSEs. These were one option subject and a reduction to single science award from dual science.

Q - After leaving school, do you intend to continue with studies e.g. at college or university. If your answer is yes, in which areas or courses will you study?

All students intended to continue with their studies on leaving school. All stated they felt they would continue on a GNVQ advanced programme, and one felt she may take A-levels.

Subsequent Discussion.

Following the completion of the questionnaire, there was a short discussion around the following two questions.

Q 1 - What skills do you feel your chosen careers will require?

The initial answers consisted of good exam grades, relevant experience, personality, attitude, punctuality, respectability and confidence. When asked to look a little deeper at the question the areas of being a good communicator and listener, being good with ones hands, voice control and computer skills were given.

Q 2 - Would the same or different skills be required for a career in engineering or science?

The feeling of the group was that the same skills would apply.

Changes to Subsequent Sessions.

From this pilot study two slight alterations were made to the questionnaire before it was to be used again. Firstly in the section listing the occupation of close relatives, a space was already allocated to Father, Mother, Brother and Sister. A further space was allocated for another relative or friend. Secondly in the section listing the greatest effect on career selection, a space was allocated to work experience. Although it was subsequently revealed that work experience took place at the end of year 10 (summer term), and may therefore not have occurred with other groups of co-researchers, the relevant importance of work experience in career selection made it worthy of inclusion in future questionnaires.

The students were asked if the discussion period had influenced any of the answers given on the questionnaire. The students stated that it had not influenced them to change any answers but had helped them focus on some areas. The discussion period had seemed a little long to it was divided in subsequent sessions. Sessions were to commence with some questions to promote discussion with an approximate time allowance of 20 minutes. The questionnaire was then be introduced and completed in an approximate time of 20 minutes. The final 20 minutes was then to be taken up with the "subsequent discussion".

4.4 - WOLFRETON LOWER SCHOOL.

Wolfreton School has two sites, a lower and upper school. Students attend the lower school until age 14 (year 9) and then transfer to the upper school. The student group consisted of all the female students, present that day, from two co-educational mixed ability tutor groups, 23 students in all. The groups were chosen totally at random by the school contact and not because of gender, ability, or subject preference.

Initial Discussion.

As the time allocated was only 30 minutes, the session consisted mainly of a brief explanation of the research project, and questionnaire completion. The following points were revealed from the short discussion period with 23 students.

Q - Who do you think perform best at schools girls or boys?

The answer was unanimous, girls.

Q - Why do you think this is so?

The answer fell into two areas. Firstly boys "fool about". Secondly girls also like to have fun and enjoy themselves, but "being more mature than boys" knew when to play and when to work. They wanted to complete their work effectively, and this took precedence over other matters.

Q - Have you made up your mind which career you would like to follow?

As the two tutor groups had just completed selection of their chosen GCSEs, it could be considered that this task had been performed on the basis of reasonably firm ideas on future careers. This appeared not to be the case as only seven of the students had selected a preferred career. These were physiotherapy, general practitioners, clothes design, teaching (primary school), law, accountancy, and the Army. One student did add that although she had not selected a career, her choice would be influenced by the financial rewards available.

At this stage the students were given the questionnaire. The relevance of each question was explained to the students, and they were completed in approximately fifteen minutes.

Questionnaire Results.

Age and Ethnic Background.

All students were between 13 and 14 years of age. In terms of ethnic background, 20 were White, one was Asian, and two students did not select an ethnic group.

Occupations of Close Relatives.

Table 4.6 recorded details of those relatives who formed a close part of the families at the time of the session. The "Other" section allowed the profession of a close relative or friend of the family to be stated.

Table 4.6 - Occupations of relatives to students at Wolfreton School.

Relative	Blue Collar	White Collar	House-person	Unemployed
Father	8	14	0	0
Mother	11	8	4	0
Brother	3	2	0	0
Sister	3	4	0	0
Other	11	12	0	0

Chosen Career.

Q - What do you think your chosen career (future job) will be? Please state why you have made this selection.

All students, bar one, identified a likely career path although the majority of students had previously stated they had not selected a career path. Some students offered two options, in this case both have been recorded.

Table 4.7 - Career choices of students at Wolfreton School.

Career	Number of Students
Accountancy	2
Clothes Design	1
Dentistry	1
Doctor	1
Hairdressing/Beautician	2
Journalism	1
Law	4
Nurse/Midwifery	2
Physiotherapy	1
Police	1
Retail Management	1
Teaching (Primary)	2
Travel/Tourism	2
Veterinary Work	2
Working with Children	1
Uncertain	1

Although there is a scientific input required by some of these professions (mainly biology), none could be considered truly physical science or engineering based.

Q - If you have not chosen a science or engineering career, please state why you do not feel a science or engineering career is for you.

Table 4.8 - Reasons for Wolfreton School students not choosing a career in science or engineering (n = 23 students).

Reason	**Number of Students**
Am not good at science	1
Boring/unenjoyable	13
Dirty job	1
Not a preferred career	4
More for males	1
No answer given	3

Several group members felt to pursue a science or engineering profession an individual had to be very good at science subjects.

Which Groups Have an Effect on Career Selection.

Q - From the following groups, please indicate which three have had the greatest effect on your career selection. Select and number in importance from 1 to 3.

To quantitatively analyse the data attained from this question, each category chosen as selection 1 has been awarded three points in the table 4.9, those chosen as selection 2 two points, and those chosen 3 one point. Where joint selections have occurred, the points awarded have been divided evenly.

Table 4.9 - Career influences on students at Wolfreton School.

Category	Points awarded
Careers Service	13
Employers	1
Work Experience	4
Friends	5
Media	10
Father	34.5
Mother	38.5
Other Relative	19
Teachers	13

Current and Future Studies.

Q - What examinations do you expect to take whilst at school?

The following table shows the popularity of GCSE subjects amongst the selected group. The group were all aware that English, mathematics, science and one language subject were compulsory. The popularity of a subject is identified in table 4.10 by the number of students listing the subject as being taken at GCSE level. Grade 1 was to be taken by more than 75% of the students, grade 2 by 50% to 75%, grade 3 by 25% to 50%, and grade 4 by 10% to 25%.

Table 4.10 - GCSE subject popularity at Wolfreton School.

Subject	Popularity
English	1
Mathematics	1
Science	1
French	1
History	3
Geography	3
Textiles	3
Graphics/Media	3
Art	4
Business Studies	4
Child Development	4

There were mentions for German, music, economics, drama, physical education, and food technology.

Most students expecting to enter the sixth form remained undecided on there likely choice of A-levels. The responses obtained are shown in table 4.11.

Table 4.11 - A-level choices of Wolfreton School students.

A-level Subject	Number of Students
English	4
Mathematics	6
French	2
History	3
Economics	2
Biology	2
Physics	1

Q - After leaving school, do you intend to continue with studies e.g. at college or university. If your answer is yes, in which areas or courses will you study?

Table 4.12 - Higher Education destinations of Wolfreton School students, (n = 23 students).

Selected Option	Number of Students
University	14
College	5
Don`t know yet	2
Will not go further	1
No response	1

Of the 14 students selecting the university option, four students wished to study science related subjects these being chemistry, general sciences, medical studies and physiotherapy. The two most popular subjects were business studies (3 students) and law (2 students). Of the five students wishing to attend colleges, only one student selected a programme with any scientific content (nursing).

Subsequent Discussion.

There was no time available for further discussion at this session.

4.5 - NEWLAND SCHOOL FOR GIRLS.

Initial Discussion.

A time of one hour ten minutes was allowed for this session. As a result considerable discussion both before and following completion of the questionnaire was possible. The group consisted of all the members of one class from year 9 (13 to 14 years of age) present on the day, 25 students in all.

Q - Who do you think perform best at schools girls or boys?

The answer was unanimous, girls.

Q - Why do you think this is so?

There were several answers to this question. Firstly the whole group felt that girls were more mature than boys of similar age, and boys tended to "mess about" more than girls. One girl responded that perhaps girls thought about things more than boys with the group as a whole seeming to agree to this comment. A group of three girls felt that it was perhaps the interests of boys and girls that made girls respond to school work more than boys. Expansion of this topic lead to the activities of boys and girls. The boys like to play football, fight and generally make a lot of noise, the latter not in an attempt to establish a communications base. On the other hand girls like to communicate, learn, discuss. Some enjoyed play/games, but not to the same extent of males of a similar age.

Q - Have you made up your mind which career you would like to follow?

An initial show of hands suggested approximately half the class had decided on a future career, and half had not. When asked to name these careers, eight were named. These were law, journalism, drama, the Police Force, veterinary work, medical/surgery, criminal psychology, and social work.

At this stage, the questionnaire was issued to the group and approximately 15 minutes allowed for its completion.

Questionnaire Results.

Age and Ethnic Background.

The group consisted of 23 White, 1 Black and 1 Asian female students.

Occupations of Close Relatives.

Table 4.13 records selections for those relatives who formed a close part of the families at the time of the session. The "Other" section allowed the profession of a close relative or friend of the family to be stated.

Table 4.13 - Occupations of relatives to students at Newland School for Girls.

Relative	Blue Collar	White Collar	House-person	Unemployed
Father	9	3	0	6
Mother	4	5	16	0
Brothers	5	0	0	0
Sisters	1	2	0	0
Others	11	6	0	0

Chosen Career.

Q - What do you think your chosen career (future job) will be? Please state why you have made this selection.

All students identified a likely career path although half of the students had previously stated they had not selected a career path. Some students offered two options, in this case both have been recorded. Table 4.14 records these selections.

Table 4.14 - Career choices of students at Newland School for Girls.

Career	Number of Students
Chef	2
Criminal Psychologist	1
Doctor	2
Entertainer	2
Journalism	1
Law	1
Leisure	1
Nurse/Midwifery/Paramedic	4
Office/Secretarial	3
Police	2
Social Work	1
Teaching (Biology/Science)	1
Veterinary Work	4
Working with Children	3

Only one student selected a career that may be considered physical science or engineering related, this being science teaching.

Q - If you have not chosen a science or engineering career, please state why you do not feel a science or engineering career is for you.

Table 4.15 - Reasons for Newland School for Girls students not choosing a career in science or engineering (n = 25 students).

Reason	Number of Students
Am not good at science	2
Boring/Unenjoyable	8
Dirty job	2
Not a preferred career	4
More for males	2
No answer given	7

The high "no answers given" may be due to the fact that some girls had indicated a choice of a science career, or because never having considered a science or engineering career they could not effectively suggest reasons why they had not chosen one. A group of three students had commented that to pursue a science or engineering career an individual had to be very good at science subjects. When asked how good they were they responded good, but not good enough.

Which Groups Have an Effect on Career Selection.

Q - From the following groups, please indicate which three have had the greatest effect on your career selection. Select and number in importance from 1 to 3.

To quantitatively analyse the data attained from this question, each category chosen as selection 1 has been awarded three points in table 4.16, those chosen as selection 2 two points, and those chosen 3 one point. Where joint selections have occurred, the points awarded have been divided evenly.

Table 4.16 - Career influences on students at Newland School for Girls.

Category	Points Awarded
Careers Service	12
Employers	3
Work Experience	11
Friends	15
Media	16.5
Father	17.5
Mother	38
Other Relatives	17
Teachers	13

Not all students identified three category areas.

Current and Future Studies.

Q - What examinations do you expect to take whilst at school?

Table 4.17 shows the popularity of GCSE subjects amongst the selected group. The group were aware that English, mathematics, science and a language were compulsory subjects. The popularity of a subject is identified by the number of students listing the subject as being taken at GCSE level. Grade 1 was to be taken by more than 75% of the students, grade 2 by 50% to 75%, grade 3 by 25% to 50%, and grade 4 by 10% to 25%.

Table 4.17 - GCSE subject popularity at Newland School for Girls.

Subject	Popularity
English	1
Mathematics	1
Science	1
French	1
History	3
Geography	4
Graphics/Media	4
Art and Technology	3
Expressive Art	4
Business Studies	4
Information Technology	4
German	4

There were mentions for child development, food technology, music, physical education, textiles, and word processing.

Few students indicated that they wished to take A-levels. The responses obtained are shown in table 4.18.

Table 4.18 - A-level choices of students at Newland School for Girls.

A-level Subject	Number of Students
English	5
Mathematics	3
Science (non-specific)	3
History	1
Music	1
Media Studies	1

Q - After leaving school, do you intend to continue with studies e.g. at college or university. If your answer is yes, in which areas or courses will you study?

Table 4.19 - Higher Education destinations of Newland School for Girls students (n = 25 students).

Selected Option	Number of Students
University	4
College	16
Drama School	2
Will not go further	2
No response	1

Although table 4.14 shows 4 students interested in veterinary work, only two students indicated likely study at a higher level(1 university, 1 college), and only 1 (college) student wished to study other science subjects. Law was the most popular subject for prospective university students, with 2 students selecting this area.

Subsequent Discussion.

Following the completion of the questionnaire, there was a short discussion followed by a group activity. The activity involved the class being divided into two groups. One group listed the skills they felt they would need for their chosen professions (non scientific/engineering based). The other group were asked to imagine they were going to be scientists and engineers. They were asked to list all skills they felt scientists and engineers would need. In both cases the students were requested to consider their responses to the questionnaire whilst completing the task. The results were written on flip chart paper and compared and discussed at the end of the activity. Table 4.20 records the lists obtained.

Table 4.20 - Skills requirements indicated by Newland School for Girls students.

Scientists/Engineers	Non-Scientists/Engineers
Approachable/patient	Approachable/friendly
Good communicator	Good communicator
	Honest/trustworthy
Physical abilities/skills	Physical abilities/skills
Qualifications	Qualifications/knowledge

The group looking at skill requirements of scientists and engineers tended to expand dramatically in the area of knowledge. This covered chemistry, physics, biology, information technology, mathematics, graphics, and technology. Skills in welding, joining and mechanics were added to this section.

The group looking at the skill requirements of non-scientists and engineers did not record such depth of knowledge requirements. This indicates for this group that scientific and engineering vocations appear to require a far greater initial depth of knowledge than the other professions considered. This concept may well have a negative influence on the choice of science and engineering as career options.

4.6 - AMY JOHNSON SCHOOL.

Initial Discussion.

A time of one hour ten minutes was allowed for this session. As a result considerable discussion both before and following completion of the questionnaire was possible. The group consisted of all the female members of two tutor groups from year 9 (13 to 14 years of age) present on the day, 25 students in all.

Q - Who do you think perform best at schools girls or boys?

The answer was unanimous, girls.

Q - Why do you think this is so?

There were several answers to this question. Firstly the whole group felt that girls were more mature than boys of similar age, and boys tended to "mess about" more than girls. The group felt that it was perhaps the interests of boys and girls that made them react differently to school work. Expansion of this topic lead to the activities of boys and girls. The boys like to play football, fight and "show off" to try to impress both their male friends and any girls present. Girls of the same age were more mature and as a result had a better attitude to school work than boys of the same age. Girls concentrated more effectively than males in class, and had developed better attitudes and personalities which resulted in better communication and learning skills.

Q - Have you made up your mind which career you would like to follow?

When asked to name likely careers, the following list was provided. Careers listed were law, writing, the Police Force, the Fire Brigade, veterinary work or working with animals, medical service (doctor/nurse/physiotherapist), counselling, child care, teaching (art), modelling, plumbing, mechanical engineering, manual factory work, and operating a party agency.

At this stage, the questionnaire was issued to the group and approximately 15 minutes allowed for its completion.

Questionnaire Results.

Age and Ethnic Background.

The group consisted of 21 White, 2 Black and 2 Asian female students.

Occupations of Close Relatives.

Figures are recorded in table 4.21 for those relatives who formed a close part of families at the time of the session. The "Other" section allowed the profession of a close relative or friend of the family to be stated.

Table 4.21 - Occupation of relatives to students at Amy Johnson School.

Relative	Blue Collar	White Collar	House-person	Unemployed
Father	18	4	0	2
Mother	12	2	9	0
Brothers	0	0	0	0
Sisters	3	0	0	0
Others	3	1	0	0

Chosen Career.

Q - What do you think your chosen career (future job) will be? Please state why you have made this selection.

All students except one identified a likely career path. Some students offered two options, in which case both were recorded in table 4.22.

Table 4.22 - Career choices of students at Amy Johnson School.

Career	Number of Students
Architect	1
Armed Forces (RAF)	2
Banking	1
Chef	1
Computers	1
Doctor	1
Engineering	1
Hairdressing	1
Law	2
Leisure	1
Nurse/Midwifery/Paramedics	2
Manual Work	1
Marine Biologist	4
Office/Secretarial	4
Social Work	1
Teaching (Art/Primary)	3
Tourism	2
Veterinary Work	4
Working with Children	4

Only two student selected a physical science or engineering career, these being architecture and general engineering. The student selecting computing was interested in office based operations.

Q - If you have not chosen a science or engineering career, please state why you do not feel a science or engineering career is for you.

Table 4.23 - Reasons for Amy Johnson students not choosing a career in science or engineering (n = 25 students).

Reason	Number of Students
Am not good at science	0
Boring/Unenjoyable	11
Dirty job	0
Not a preferred career	6
More for males	1
No answer given	7

The high "no answers given" may be due to the fact that some girls had indicated a choice of a science career, or because never having considered a science or engineering career they could not effectively suggest reasons why they had not chosen one. Four students had commented that to pursue a science or engineering career an individual had to be very good at science subjects. When asked how good they were they responded good, but not good enough.

Which Groups Have an Effect on Career Selection.

Q - From the following groups, please indicate which three have had the greatest effect on your career selection. Select and number in importance from 1 to 3.

To quantitatively analyse the data attained from this question each category chosen as selection 1 has been awarded three points in table 4.24, those chosen as selection 2 two points, and those chosen 3 one point. Where joint selections have occurred, the points awarded have been divided evenly.

Table 4.24 - Career influences on students at Amy Johnson School.

Category	Points Awarded
Careers Service	3
Employers	2
Work Experience	7
Friends	4
Media	8
Father	39
Mother	48.5
Other Relative	24.5
Teachers	13

Not all students identified three category areas.

Current and Future Studies.

Q - What examinations do you expect to take whilst at school?

Table 4.25 shows the popularity of GCSE subjects amongst the selected group. This group were by no means as clear as the two previous groups regarding GCSE optional and compulsory subjects. Whilst all were aware that English and mathematics were compulsory, not all were aware of the fact that science and a foreign language were also compulsory. The popularity of a subject is identified by the number of students listing the subject as being taken at GCSE level. Grade 1 was to be taken by more than 75% of the students, grade 2 by 50% to 75%, grade 3 by 25% to 50%, and grade 4 by 10% to 25%.

Table 4.25 - GCSE subject popularity at Amy Johnson School.

Subject	Popularity
English	1
Mathematics	1
Science	1
French	3
History	2
Geography	2
Graphics/Media	-
Art and Technology	2
Expressive Art	3
Business Strudies	-
Information Technology	3
German	-
Home Economics/Cooking	3

There were mentions for home economics/cookery (44%), physical education (24%), and Spanish (12%).

Only one student indicated any interest in A-levels.

Q - After leaving school, do you intend to continue with studies e.g. at college or university. If your answer is yes, in which areas or courses will you study?

Table 4.26 - Higher Education destinations of Amy Johnson School students (n = 25 students).

Selected Option	Number of Students
University	1
College	19
Drama School	0
Will not go further	5
No response	0

Although 20 students felt they would continue with their education upon leaving school, only 6 had selected potential areas. The subjects were child-care (2 students), hairdressing, typing, cookery, and science.

Subsequent Discussion.

Following the completion of the questionnaire, there was a short discussion followed by a group activity. The activity involved the class being divided into two groups. One group listed the skills they felt they would need for their chosen professions (non scientific/engineering based). The other group were asked to imagine they were going to be scientists and engineers. They were asked to list all skills they felt scientists and engineers would need. In both cases the students were requested to consider their responses to the questionnaire whilst completing the task. The results were written on flip chart paper and compared and discussed at the end of the activity. Table 4.27 records the results obtained.

Table 4.27 - Skills requirements indicated by Amy Johnson School students.

Scientists/Engineers	Non-Scientists/Engineers
Patience	Patience
Good communicator	Good communicator
Brave/determined	
Physical abilities	Physical abilities/skills
Qualifications/knowledge	Knowledge

The group looking at skill requirements of scientists and engineers tended to expand significantly in the area of knowledge including qualifications required for specific occupations, with mathematics and technology common. This suggests that engineers and scientists have to be very good at science subjects, and perhaps the students did not feel they were good enough.

The group looking at the skill requirements of non-scientists and engineers did not record such depth of knowledge requirements. This indicates for this group that scientific and engineering vocations appear to require a far greater initial depth of knowledge than the other professions considered. This concept may well have a negative influence on the choice of science and engineering as career options.

4.7 - WILLERBY CARR LANE JUNIOR SCHOOL.

Initial Discussion.

A time of one hour was allowed for this session. As a result limited discussion both before and following completion of the questionnaire was possible. The group consisted of all the female members of two classes. One class was from year 5 (9 to 10 years of age), one from year 6 (10 to 11 years of age) 33 students in all.

Q - Who do you think perform best at schools girls or boys?

The answer was unanimous, girls.

Q - Why do you think this is so?

There were several answers to this question. Firstly the group as a whole felt that girls were quieter than boys, listening more and taking more interest. One student suggested that boys tended to "mess about" more than girls, failing to take things seriously. They preferred to fight, swear and generally get into trouble more than girls. This idea gained support from about half the group. Another student stated that boys liked to be "bossy" and was supported by a few members of the group.

Q - Have you made up your mind which career you would like to follow?

When asked to name likely careers, the following list was obtained. Career areas listed were shopkeeping, clothes design, acting and/or singing, the Police Force, veterinary work, medical/surgery, air hostess, marine engineering, beauty therapy, a jockey, and teaching.

At this stage, the questionnaire was issued to the group and approximately 15 minutes allowed for its completion.

Questionnaire Results.

Age and Ethnic Background.

The group consisted of 31 White and 2 Asian female student.

Occupations of Close Relatives.

Table 4.28 records information regarding those relatives who formed a close part of the families at the time of the session. The "Other" section allowed the profession of a close relative or friend of the family to be stated.

Table 4.28 - Occupation of relatives to students at

Willerby Carr Lane Junior School.

Relative	Blue Collar	White Collar	House-person	Unemployed
Father	11	18	1	0
Mother	11	20	2	0
Brothers	1	0	0	0
Sisters	0	0	0	0
Others	0	4	0	0

<u>Chosen Career.</u>

Q - What do you think your chosen career (future job) will be? Please state why you have made this selection.

Most students identified a likely career path. Some students offered two options, in this case both have been recorded in table 4.29.

Table 4.29- Career choices of students at

Willerby Carr Lane Junior School.

Career	Number of Students
Air Hostess	3
Banking	1
Black Smith	1
Business Management	1
Clothes Design	1
Doctor	1
Engineering	1
Entertainer	5
Hair Dresser	2
Jockey	1
Law	2
Model	1
Office/Secretarial	2
Police	1
Social Work	1
Shop Work	3
Teaching	6
Veterinary Work	8
Working with Children	1
Undecided	2

Only one student selected a science/engineering career, this being a ship`s engineer.

Q - If you have not chosen a science or engineering career, please state why you do not feel a science or engineering career is for you.

Table 4.30 - Reasons for Willerby Carr Lane Junior School students not choosing a career in science or engineering (n = 33 students).

Reason	Number of Students
Am not good at science	0
Boring/Unenjoyable	16
Dirty job	0
Not a preferred career	4
More for males	3
No answer given	10

The high "no answers given" may be due to the fact that some girls had indicated a choice of a science career, or because never having considered a science or engineering career they could not effectively suggest reasons why they had not chosen one. Four students had commented that to pursue a science or engineering career an individual had to be very good at science subjects. When asked how good they were they responded good, but not good enough.

Which Groups Have an Effect on Career Selection.

Q - From the following groups, please indicate which three have had the greatest effect on your career selection. Select and number in importance from 1 to 3.

To quantitatively analyse the data attained from this question each category chosen as selection 1 has been awarded three points in the table 4.31, those chosen as selection 2 two points, and those chosen 3 one point. Where joint selections have occurred, the points awarded have been divided evenly.

Table 4.31 - Career influences on students at Willerby Carr Lane Junior School.

Category	Points Awarded
Career Services	0
Employers	0
Work Experience	6
Friends	24
Media	13
Father	46
Mother	50
Other Relative	10
Teachers	8

Not all students identified three category areas.

Current and Future Studies.

Q - What examinations do you expect to take whilst at school?

Within this age group the students knew little about the choice of GCSEs available at secondary schools so were given the following information. At GCSE you must study mathematics and English, all other subjects are voluntary. From the list of subjects given (mathematics, English, science, technology, history, geography, French, German, Spanish, physical education, religious education, art, drama, and home economics) which subjects would you like to study. Although this is not strictly true, as certain other subjects are compulsory, a free choice should indicate true preferences.

Table 4.32 shows the popularity of GCSE subjects amongst the selected group. The popularity of a subject is identified by the number of students listing the subject as being taken at GCSE level. Grade 1 was to be taken by more than 75% of the students, grade 2 by 50% to 75%, grade 3 by 25% to 50%, and grade 4 by 10% to 25%.

Table 4.32 - GCSE subject popularity at

Willerby Carr Lane Junior School.

Subject	Popularity
English	1
Mathematics	1
Science	4 (6 students)
French	2
History	4
Geography	-
Art and Technology	3
Drama	2
Home Economics	4
Technology	3
German	4
Spanish	4
Physical Education	4
Religious Education	-

One student selected music.

There was no examination of A-level subjects.

Q - After leaving school, do you intend to continue with studies e.g. at college or university. If your answer is yes, in which areas or courses will you study?

Table 4.33 - Higher education destinations of Willerby Carr Lane Junior School students (n = 33 students).

Selected Option	Number of students
University	24
College	5
Drama School	2
Will not go further	0
No response	1
Undecided	1

Nine of the students selected subjects they wished to study at university; 3 selected veterinary studies, 2 art, 2 law, 1 social work and 1 teaching.

<u>Subsequent Discussion.</u>

Following the completion of the questionnaire, there was a short discussion followed by a group activity. The activity involved the class being divided into two groups. One group listed the skills they felt they would need for their chosen professions (non scientific/engineering based). The other group were asked to imagine they were going to be scientists and engineers. They were asked to list all skills they felt scientists and engineers would need. In both cases the students were requested to consider their responses to the questionnaire whilst completing the task. The results were written on flip chart paper and compared and discussed at the end of the activity. Table 4.34 records the results obtained.

Table 4.34 - Skill requirements indicated by Willerby Carr Lane Junior School students.

Scientists/Engineers	Non-Scientists/Engineers
Caring/Gentle	Friendly/Patient
Good communicator	Good communicator
Confident/experienced	Sensible/Confident
Physical abilities/skills	Physical abilities/skills
Qualifications/Knowledge	Knowledge

The group looking at skill requirements of scientists and engineers tended to expanded in the area of knowledge covering the topics of maths, English, and science. This suggests that engineers and scientists have to be very good at science subjects, and perhaps the students did not feel they were good enough.

The group looking at the skill requirements of non-scientists and engineers did not record such depth of knowledge requirements. This indicates for this group that scientific and engineering vocations appear to require a far greater initial depth of knowledge than the other professions considered. This concept may well have a negative influence on the choice of science and engineering as career options.

4.8 - BRICKNELL PRIMARY SCHOOL.

Initial Discussion.

A time of one hour twenty minutes was allowed for this session. As a result considerable discussion both before and following completion of the questionnaire was possible. The group consisted of members from two year 6 classes (10 to 11 years of age) and one year 5 class (9 to 10 years of age) who had returned slips from their parents allowing participation in the project. In all 38 students participated.

Q - Who do you think perform best at schools girls or boys?

The answer was unanimous, girls.

Q - Why do you think this is so?

There were several answers to this question supported by almost all group members. Firstly the group felt that girls were more mature than boys of similar age. Girls had more patience, more common sense and made greater efforts to achieve goals. They liked to go out and to play, but realised their responsibilities to e.g. homework. Boys appeared more lazy and preferred to be "daft" and "mess around". They considered that when they left school employers wanted males, not females, so they could easily find jobs. Often if a boy were to show the same effort as the girls, he would be ridiculed by his friends.

Q - Have you made up your mind which career you would like to follow?

When asked to name likely careers, the following list was obtained. Careers included law, writing, acting/entertainment, the Police Force, veterinary work, medical including surgical, pathology and dentistry options, archaeology, business and marketing, working with children, hairdressing and beauty therapy, the Fire Brigade, art, Royal Engineering, and science.

At this stage, the questionnaire was issued to the group and approximately 15 minutes allowed for its completion.

Questionnaire Results.

Age and Ethnic Background.

The group consisted of 34 White, 2 Black and 2 Asian female students, 38 in total.

Occupations of Close Relatives.

Table 4.35 records occupations for those relatives who formed a close part of the families at the time of the session. The "Other" section allowed the profession of a close relative or friend of the family to be stated.

Table 4.35 - Occupation of relatives to students at Bricknell Primary School.

Relative	Blue Collar	White Collar	House-person	Unemployed
Father	21	14	0	0
Mother	16	11	6	2
Brothers	4	2	0	0
Sisters	4	0	0	0
Others	3	6	0	0

<u>Chosen Career.</u>

Q - What do you think your chosen career (future job) will be? Please state why you have made this selection.

Most students identified a likely career. Some students offered more than one option, in this case all have been recorded in table 4.36.

Table 4.36 - Career choices of students at Bricknell Primary School.

Career	Number of Students
Air Hostess	1
Archaeologist	1
Armed Forces (Army)	1
Doctor	4
Engineer	1
Entertainer	9
Hairdresser/Beautician	6
Law	5
Nurse/Midwifery	1
Police	3
Scientist	2
Social Work	1
Teaching	3
Veterinary Work	11
Waitress	1
Working with Children	4
Writer	3
Undecided	7

Only three student selected a physical science/engineering career as a possible option.

Q - If you have not chosen a science or engineering career, please state why you do not feel a science or engineering career is for you.

Table 4.37 - Reasons for Bricknell Primary School students not choosing a career in science or engineering (n = 38 students).

Reason	Number of Students
Am not good at science	0
Boring/Unenjoyable	26
Dirty job	0
Not a preferred career	3
More for males	2
No answer given	7

The high "no answers given" may be due to the fact that some girls had indicated a choice of a science career, or because never having considered a science or engineering career they could not effectively suggest reasons why they had not chosen one.

Which Groups Have an Effect on Career Selection.

Q - From the following groups, please indicate which three have had the greatest effect on your career selection. Select and number in importance from 1 to 3.

To quantitatively analyse the data attained from this question each category chosen as selection 1 has been awarded three points in table 4.38, those chosen as selection 2 two points, and those chosen 3 one point. Where joint selections have occurred, the points awarded have been divided evenly.

Table 4.38 - Career influences on students at Bricknell Primary School.

Category	Points Awarded
Careers Service	0
Employers	0
Work Experience	9
Friends	39
Media	23
Father	40.5
Mother	47.5
Other Relatives	35
Teachers	12

Not all students identified three category areas.

Current and Future Studies.

Q - What examinations do you expect to take whilst at school?

This group of students were quite aware of what GCSEs they would have to take at secondary school, these being mathematics, English, science and a foreign language. As they were not quite so certain of others they were given the same list of subjects offered previously. The list consisted of mathematics, English, science, technology, history, geography, French, German, Spanish, physical education, religious education, art, drama, and home economics. Table 4.39 shows the popularity of GCSE subjects amongst the selected group.

The popularity of a subject is identified by the number of students listing the subject as being taken at GCSE level. Grade 1 was to be taken by more than 75% of the students, grade 2 by 50% to 75%, grade 3 by 25% to 50%, and grade 4 by 10% to 25%.

Table 4.39 - GCSE subject popularity at Bricknell Primary School.

Subject	Popularity
English	1
Mathematics	1
Science	2
French	1
History	3
Geography	4
Art and Technology	1
Drama	2
Home Economics	3
Technology	3
German	3
Spanish	3
Physical Education	2
Religious Education	4

There was a single mention of child care.

There was no examination of A-level subjects.

Q - After leaving school, do you intend to continue with studies e.g. at college or university. If your answer is yes, in which areas or courses will you study?

Table 4.40 - Higher Education destinations of Bricknell Primary School students (n = 38 students).

Selected Option	Number of Students
University	16
College	15
Drama School	3
Will not go further	0
Not certain at present	2
No response	2

Five students had considered likely Higher Education courses, four wished to study art and one zoology/biology. Several students commented they felt attending college/university would provide better job opportunities.

Subsequent Discussion.

Following the completion of the questionnaire, there was a short discussion followed by a group activity. The activity involved the class being divided into two groups. One group listed the skills they felt they would need for their chosen professions (non scientific/engineering based). The other group were asked to imagine they were going to be scientists and engineers. They were asked to list all skills they felt scientists and engineers would need. In both cases the students were requested to consider their responses to the questionnaire whilst completing the task. The results were written on flip chart paper and compared and discussed at the end of the activity. Table 4.41 records the lists obtained.

Table 4.41 - Skill requirements indicated by Bricknell Primary School students.

Scientists/Engineers	Non-Scientists/Engineers
Bossy	Argumentative
Good communicator	Good communicator
Hard working	Imaginative
Physical abilities/skills	Skills
Knowledge	Knowledge
Good Manager	Strong/Patient

The group looking at skill requirements of scientists and engineers tended to expanded in the area of knowledge covering the topics of maths, English, and science. This suggests that engineers and scientists have to be very good at science subjects, and perhaps the students did not feel they were good enough.

The group looking at the skill requirements of non-scientists and engineers did not record such depth of knowledge requirements. This indicates for this group that scientific and engineering vocations appear to require a far greater initial depth of knowledge than the other professions considered. This concept may well have a negative influence on the choice of science and engineering as career options.

4.9 - WHEELER PRIMARY SCHOOL.

Initial Discussion.

A time of one hour thirty minutes was allowed for this session. As a result considerable discussion both before and following completion of the questionnaire was possible. The group consisted of all the female members of one class from year 5 (9 to 10 years of age) and one class from year 6 (10 to 11 years of age), 23 students in all.

Q - Who do you think perform best at schools girls or boys?

The answer was unanimous, girls.

Q - Why do you think this is so?

There were several answers to this question. Firstly the whole group felt that girls worked harder than boys, being naturally quieter and more attentive. Boys on the other hand did not like to listen to lessons, and were generally more interested in sports and fighting. They were described as being cocky and "gang" oriented, and generally naughtier than girls. There was also a feeling that perhaps girls were born with more brains than boys or perhaps a better ability to make use of them, an idea supported by a few members of the group.

Q - Have you made up your mind which career you would like to follow?

Asked to name careers, the list included law, writer/poet, acting/entertainment, the Police Force, veterinary work, medical work including surgical, pathology and dentistry, archaeology, hairdressing and beauty therapy, artist/sculptor, mechanical engineering, air hostess, model, Civil Servant, Armed Services, building, teaching, bar work (overseas), office work, and shop work.

At this stage, the questionnaire was issued to the group and approximately 15 minutes allowed for its completion.

Questionnaire Results.

Age and Ethnic Background.

The group consisted of 22 White and 1 Black female students.

Occupations of Close Relatives.

Table 4.42 records occupations for those relatives who formed a close part of the families at the time of the session. The "Other" section allowed the profession of a close relative or friend of the family to be stated.

Table 4.42 - Occupation of relatives to Wheeler Primary School students.

Relative	Blue Collar	White Collar	House-person	Unemployed
Father	19	1	0	3
Mother	14	2	4	3
Brothers	7	0	0	1
Sisters	4	1	3	0
Others	5	2	0	0

Chosen Career.

Q - What do you think your chosen career (future job) will be? Please state why you have made this selection.

All students identified a likely career path. Some students offered more than one option, in this case all options have been recorded in table 4.43.

Table 4.43 - Career choices of students at Wheeler Primary School.

Career	Number of Students
Air Hostess	1
Archaeologist	1
Armed Forces	1
Artist	2
Builder	1
Dinner Person	2
Engineer (Car Mechanic)	1
Entertainer	6
Hairdresser	3
Law	2
Model	2
Office/Secretarial	1
Physiotherapy	1
Shop Worker	2
Teaching	1
Veterinary Work	2
Writer/Poet	1

Only two students selected a physical science/engineering career, being builder or mechanic.

Q - If you have not chosen a science or engineering career, please state why you do not feel a science or engineering career is for you.

Table 4.44 - Reasons for Wheeler Primary School students not choosing a career in science or engineering (n = 23 students).

Reason	Number of Students
Am not good at science	2
Boring/Unenjoyable	12
Dirty job	4
Not a preferred career	2
More for males	0
No answer given	3

The high "no answers given" may be due to the fact that some girls had indicated a choice of a science career, or because never having considered a science or engineering career they could not effectively suggest reasons why they had not chosen one.

Which Groups Have an Effect on Career Selection.

Q - From the following groups, please indicate which three have had the greatest effect on your career selection. Select and number in importance from 1 to 3.

Tp quantitatively analyse the data attained from this question each category chosen as selection 1 has been awarded three points in table 4.45, those chosen as selection 2 two points, and those chosen 3 one point. Where joint selections have occurred, the points awarded have been divided evenly.

Table 4.45 - Career influences on students at Wheeler Primary school.

Category	Popularity
Careers Service	0
Employers	1
Work Experience	0
Friends	19.5
Media	5
Father	40.5
Mother	50.5
Other Relatives	14
Teachers	5.5

Not all students identified three category areas.

Current and Future Studies.

Q - What examinations do you expect to take whilst at school?

Some of the students in the class were aware that certain subjects had to be taken at GCSE level at secondary school, whilst others were options. Compulsory subjects were mathematics, English, science and a foreign language. Students were given the following list to assist their choice; mathematics, English, science, technology, history, geography, French, German, Spanish, physical education, religious education, art, drama, and home economics. Table 4.46 shows the popularity of GCSE subjects amongst the selected group.

The popularity of a subject is identified by the number of students listing the subject as being taken at GCSE level. Grade 1 was to be taken by more than 75% of the students, grade 2 by 50% to 75%, grade 3 by 25% to 50%, and grade 4 by 10% to 25%.

Table 4.46 - GCSE subject popularity at Wheeler Primary School.

Subject	Popularity
English	1
Mathematics	1
Science	3
French	2
History	3
Geography	3
Art and Technology	1
Drama	2
Home Economics	3
Technology	4
German	3
Spanish	2
Physical Education	3
Religious Education	3

One student mentioned Italian.

There was no discussion of A-level subjects.

Q - After leaving school, do you intend to continue with studies e.g. at college or university. If your answer is yes, in which areas or courses will you study?

Table 4.47 - Higher Education destinations of Wheeler Primary School students (n = 23 students).

Selected Option	Number of students
University	5
College	14
Drama School	0
Will go no further	3
No response	1

A range of subjects were recorded with hairdressing and English the two most popular with 2 students selecting these areas. The areas of veterinary studies, languages, art, mathematics, physiotherapy, archaeology, and law were each selected by 1 student.

Subsequent Discussion.

Following the completion of the questionnaire, there was a short discussion followed by a group activity. The activity involved the class being divided into two groups. One group listed the skills they felt they would need for their chosen professions (non scientific/engineering based). The other group were asked to imagine they were going to be scientists and engineers. They were asked to list all skills they felt scientists and engineers would need. In both cases the students were requested to consider their responses to the questionnaire whilst completing the task. The results were written on flip chart paper and compared and discussed at the end of the activity. Table 4.48 records the lists obtained.

Table 4.48 - Skill requirements indicated by Wheeler Primary School students.

Scientists/Engineers	Non-Scientists/Engineers
Approachable/patient	Approachable/patient
Good communicator/friendly	Good communicator/friendly
Ability to keep trying	Confident/out-going
Physical abilities/skills	Physical abilities/skills
Knowledge	Knowledge/memory
	Smart

Wheeler Primary students were slightly different from the other five in suggesting skill and ability levels virtually equal for both groups. When probed about their responses there was some suggestion that engineers and scientists have to be very good at science subjects, and perhaps the students did not feel they were good enough.

4.10 - ANALYSIS OF INITIAL QUESTIONNAIRE DATA.

As students in all six selected schools had now completed the initial questionnaire, it was important to analyse the data to find any emerging patterns and produce guidance for the following student interviews.

Ethnic Grouping.

The first area examined was the influence of ethnic background. The work of Grant (1994) suggested that ethnic minorities may place different emphasis on educational studies.

From the total of 167 students completing the questionnaire, the ethnic groups indicated were 8 Asian, 6 Black and 151 White, with 2 students failing to indicate an ethnic group. The questionnaire identified ethnic minorities of 4.8% Asian and 3.6% Black. These were too small in numbers to draw any reliable conclusions, but they are significantly more than may have been expected. The 1991 Hull Census revealed that there were only 3,183 non-white residents (1.3%) of the total residents in Hull.

Not one of the students from these ethnic minorities wished to follow a science or engineering career. The nearest career selection was that of veterinary surgeon and mid-wife. It would be fair to conclude that ethnic minority students were just as unlikely to follow an engineering or science profession as the group as a whole.

Chosen Careers.

The following tables indicates the careers chosen by students at the six schools. The figures are drawn from the tables used for each school earlier in the results section. Two tables have been produced to show similarities and differences in career choices at the six schools. The first, table 4.49, shows careers chosen by students of more than one school, the second, table 4.50, contains careers chosen by students of one school only.

Table 4.49 - Careers chosen by students at more than one school.

Career	Wolfreton	Newland	Amy Johnson	Willerby Carr Lane	Bricknell	Wheeler
Air Hostess	-	-	-	3	1	1
Archaeology	-	-	-	-	1	1
Armed Forces	-	-	2	-	1	1
Banking	-	-	1	1	-	-
Clothes Design	1	-	-	1	-	-
Chef	-	2	1	-	-	-
Doctor	1	2	1	1	4	-
Engineering	-	-	1	1	1	1
Entertainer	-	2	-	5	9	6
Hairdressing/ Beautician	2	-	1	2	6	3
Journalism	1	1	-	-	-	-
Law	4	1	2	2	5	2
Leisure	-	1	1	-	-	-
Model	-	-	-	1	-	2
Nurse/Midwifery /Paramedic	2	4	2	-	1	-
Office/Secretary	-	3	4	2	-	1
Physiotherapy	1	-	-	-	-	1
Police	1	2	-	1	3	-
Social Work	-	1	1	1	1	-
Teaching	2	1	3	6	3	1
Travel/Tourism	2	-	2	-	-	-
Veterinary Work	2	4	4	8	11	2
Working with Children	1	3	4	1	4	-
Writer	-	-	-	-	3	1
Undecided	1	-	-	2	7	-

Table 4.50 - Careers chosen by students at one school only.

Career	Wolfreton	Newland	Amy Johnson	Willerby Carr Lane	Bricknell	Wheeler
Accountant	2	-	-	-	-	-
Architect	-	-	1	-	-	-
Artist	-	-	-	-	-	1
Black Smith	-	-	-	-	1	-
Builder	-	-	-	-	-	1
Business Management	-	-	-	1	-	-
Computing	-	-	1	-	-	-
Criminal Psychology	-	1	-	-	-	-
Dentistry	1	-	-	-	-	-
Dinner Person	-	-	-	-	-	2
Jockey	-	-	-	-	1	-
Manual Work	-	-	2	-	-	-
Marine Biology	-	-	4	-	-	-
Retail Management	1	-	-	-	-	-
Scientist	-	-	-	-	2	-
Shop Worker	-	-	-	-	-	2
Waitress	-	-	-	-	1	-

Observing the careers chosen in both tables they would appear to be supportive of sex stereotyping. In table 4.49, with the exception of perhaps archaeology and engineering, predominantly chosen by the younger age group, the professions are associated with female candidates. Table 4.50 shows less stereotyping, but the professions listed generated considerably less interest. If the results were to be related to the work of West and Hunter (1993), there was little to suggest that single sex schooling had done anything to reduce sex stereotyping for these female students, and provided evidence to reach the opposite conclusion.

Reasons for not Choosing an Engineering or Science Career.

The reasons recorded at each school are shown in table 4.51.

Table 4 51 - Reasons for all student groups not choosing a career in science or engineering.

Reason	Wolfreton	Newland	Amy Johnson	Willerby Carr Lane	Bricknell	Wheeler
Am not good at it	1	2	0	0	0	2
Boring/ Unenjoyable	13	8	11	16	26	12
Dirty job	1	2	0	0	0	4
Not Preferred career	4	4	6	4	3	2
More for males	1	2	1	3	2	0
No answer given	3	7	7	10	7	3
School Total	23	25	25	33	38	23

There were some conclusions easy to make from table 4.51. There was some evidence that these careers are seen as a male area, but the support for this was small. Equally there was little evidence that females feel they are "poor" at science. The over-riding conclusion was that females find the subject boring (85 out of 167 or 51%). The immediate question to ask was why? Was it the subject, or the teaching of it. Clearly an avenue that had to be explored at the interview stage.

The high “no answers given” (37 out of 167 or 22%) may be due to the fact that some girls had indicated a choice of a science career, or because never having considered a science or engineering career they could not effectively suggest reasons why they had not chosen one.

Who has the Major Influence on Career Selection.

Students identified the three main influences on their career selection. First choice was awarded three points, second choice two points and third choice one point. Table 4.52 shows figures were obtained.

Table 4.52 - Career influences on all student groups.

Category	Wolfreton	Newland	Amy Johnson	Willerby Carr Lane	Bricknell	Wheeler
Careers service	13	12	3	0	0	0
Employers	1	3	2	0	0	1
Work Experience	4	11	7	6	9	0
Friends	5	15	4	24	39	19.5
Media	10	16.5	8	13	23	5
Father	34.5	17.5	39	46	40.5	40.5
Mother	38.5	38	48.5	50	47.5	50.5
Other Relatives	19	17	24.5	10	35	14
Teachers	13	13	13	8	12	5.5

Several conclusions could be drawn from these figures.

The **Careers Service** played a greater part with secondary school students than with primary school students, where it appeared to be almost non-existent. Should this be the case? If likely career paths are being formulated during primary years then access to information regarding career opportunities is equally important here.

Employers appeared to have little influence on career selection. If employers wished to attract more female scientists or engineers, perhaps a greater involvement with schools may be beneficial, particularly with primary schools.

Work experience appeared to have little effect on career selection, perhaps because it is only available to secondary school students in the 14 to 16 year age group when career selection probably has already been made. This may be an area for employers wishing to attract more females to engineering and physical sciences careers to address.

There appeared to be a far greater influence of **friends** on primary school pupils than on secondary school pupils. This appears contrary to the suggestions of West and Hunter (1993). In single sex schools the influence of males would be totally removed, and if there were no male friends to talk to about careers such as science and engineering, this may lead to increased avoidance of these vocational areas by females.

Although obtaining a reasonable score, it would appear that the **media** effects are not always immediately recognised by students. When asked why careers such as criminal psychology and marine biology had been selected, eventually television programmes Cracker and various wildlife series were mentioned. This indicated that students may not be directly aware of media influences. If the students cannot recognise these influences then this area may have been significantly understated.

The main influence on career selection came from **parents**. Here the question must be asked that if parents influence the career choice of their children so greatly, should the changes required by engineering and physical science employers be aimed as much at parents as at students? As in all of the six groups mothers provided a higher input than fathers, two groups of females may have to be persuaded of the validity of engineering and physical sciences as a career option to females. These figures also reflect that many of the students taking part in the survey came from single parent families where the guardian was the female parent.

Other relatives played a significant part in career selection, particularly for students from one parent families.

Teachers did not appear to play a significant role in career selection although the influence was greater in secondary schools than in primary schools.

Educational Objectives.

Students were requested to list the GCSE subjects they expected to take at secondary school. Some students, even at secondary schools, were uncertain as to which subjects were compulsory and which were optional. Table 4.53 provides an indication of the popularity of each listed subject. The popularity is identified by the number of students listing the subject as likely to be taken at GCSE level, primary school students being provided with a list of subjects from which to choose. Grade 1 was to be taken by more than 75% of the students, grade 2 by 50% to 75%, grade 3 by 25% to 50%, and grade 4 by 10% to 25%.

Table 4.53 - GCSE popularity amongst all student groups.

Subject	Wolfreton	Newland	Amy Johnson	Willerby Carr Lane	Bricknell	Wheeler
English	1	1	1	1	1	1
Mathematics	1	1	1	1	1	1
Science	1	1	1	4	2	3
French	1	1	3	2	1	2
History	3	3	2	4	3	3
Geography	3	4	2	-	4	3
Textiles	3	-	-	-	-	-
Graphics/Media	3	4	-	-	-	-
Art/Technology	4	3	2	3	1	1
Expressive Art	-	4	3	2	2	2
Business Studies	4	4	-	-	-	-
Information Technology	-	4	3	3	3	4
Child Development	4	-	-	-	-	-
German	-	4	-	4	3	3
Spanish	-	-	-	4	3	2
Home Economics	-	-	3	-	3	3
Physical Education	-	-	-	4	2	3
Religious Education	-	-	-	-	4	3

Almost all students were aware that English and mathematics were compulsory subjects, whilst almost all secondary students were aware that science was compulsory along with a foreign language. Where primary school students felt science may be an optional subject it was significantly less popular. Although the career aspirations of all groups of students were very similar, student`s ideas of how to attain them were very different. Some of the students of Wolfreton and Newland had already considered likely A-level subjects, which in turn would lead to Higher Education programmes. The students of Amy Johnson did no show the same vision, with only one student considering A-level options.

Table 4.54 shows planned educational progression routes after school for the surveyed students.

Table 4.54 - Higher Education destination of student groups.

Selected Option	**Wolfreton**	**Newland**	**Amy Johnson**	**Willerby Carr Lane**	**Bricknell**	**Wheeler**
University	14	4	1	24	16	5
College	5	16	19	5	15	14
Drama	0	2	0	2	3	0
Don`t know yet	2	0	0	1	2	0
Will go no further	1	2	5	0	0	3
No response	1	1	0	1	2	1
School Total	23	25	25	33	38	23

The career aspirations of all groups of students were similar, but their choice of Higher Education destinations were very different.

A comparison to the occupations of close relatives and family friends, previously shown to be the major career influence, provided valuable information at this point.

Table 4.55 - Occupation of relatives to student groups.

Employment Status	Wolfreton	Newland	Amy Johnson	Willerby Carr Lane	Bricknell	Wheeler
Blue Collar	36	30	36	23	48	49
White Collar	40	16	7	42	33	6
House Person	4	16	9	3	6	7
Unemployed	0	6	2	0	2	7

The figures once again indicated the influences of relatives and family friends on career selection. The three highest groups of "white collar" relatives and friends produced the three highest groups wishing to attend university.

4.11 - INTERVIEW RESULTS.

Questionnaires from the students at each of the six schools were examined and smaller samples of students, representative of the questionnaire answers, were selected for interview at each school so as to minimise class disruption. A maximum of ten students were selected at each school, the smaller sample expressing views that were represented of the original group, allowing for individual and multiple responses. The basis for selection was to fully explore all areas highlighted in the questionnaire survey. All students present on the allocated day were interviewed.

Wolfreton Upper School.

At the interview stage the students had transferred from the Lower to the Upper School. Ten students were interviewed, and the following results recorded.

Questions.

1) a) **Q** - What lessons do you find interesting and enjoyable at school?

This produced a long diverse list; English (6 students), geography (5 students), history (4 students), mathematics(4 students), textiles (3 students), physical education(3 students), drama and business studies (2 students each), French, child development, graphics, art, economics, religious education, and food technology (1 student each).
Science was supported by 5 students whilst the chemistry and biology parts of science lessons gained support from a further 2 and 1 student(s) respectively.

b) **Q** - Why is this?

Popular sessions had involvement and encouragement given by teachers who produced interesting, imaginative sessions which allowed students to be expressive producing enjoyment and satisfaction.

2) a) **Q** - What lessons do you find uninteresting and unenjoyable?

Mathematics (5 students), French, personal social education, history and physics (2 students each), drama, physical education, art, music, biology, and science (1 student each).

b) **Q** - Why is this?

The terms regimented and boring were common linked to confusion from too much detail. One interesting comment was supplied by a student who`s father was a qualified engineer. This student felt her father`s assistance had been counter-productive as she felt intimidated by his knowledge and lack of patience with her "slow" learning.

3) **Q** - Can you remember the names of your science teachers?

The students produced 31 names identifying 21 different teachers. Most students could remember the names of all teachers who had taught them science at the school. Ten teachers were female In the first three years the class science teacher had taught chemistry, physics and biology, but in the fourth year more than one teacher was involved, teaching one or two disciplines only.

4) **Q** - When did you make your decision on your chosen career(s)?

Students were divided on this question. Five students had offered more than one career option when completing the original questionnaire, four a single choice, and one no choice at all. Six stated that there choice was recent and in some cases changing, indicating that at this age career options may still be open and change possible. Four students stated their choice had been made a long time ago at primary school.

5) **Q** - You have stated that certain people had the greatest influence on your career choice. If they had discussed a career in science or engineering with you, do you think you would have been likely to follow such a career?

Only one student stated that she may have had more interest. The majority of the remaining nine were very adamant that this type of discussion would have had no effect on their choice.

6) **Q** - Would you like to discuss career opportunities at school?

All students stated that accessible opportunities to discuss career options were available at school, and all stated they did not make the best use of this service. All students would like to see more visits to the school by professional people e.g. nurses, doctors, vets, etc., who could give details of personal experiences. It would give the students a chance to find out details "first hand".

7) **Q** - If local companies with career opportunities in science and engineering (and possibly other areas) offered visits and work experience to groups of students at your school, would you take the opportunity to look at what they had to offer?

This was very popular with all students. All would like the chance to view all areas at companies to help career choices. Work experience opportunities in different areas were requested by nine of the students. This would offer the opportunity "to see what things were really like".

8) **Q** - If you were looking for employment, what is the main thing a prospective employer could do to attract you to work for them?

Although nine of the students mentioned money, seven stressed this was not the most important consideration. The people they would have to work with, work place position, working patterns and future prospects were equally important. Fringe benefits, company size and reputation were also considered important.

9) **Q** - Any avenues opened by the students were fully explored and noted where relevant. All sessions ended by asking the student if they had any questions or comments regarding either session that they would like to ask the

interviewer.

One student did enquire how details of university programmes may be found.

The following information on the school was received. The school employed 121 teachers, 62 male and 59 female. There was 18 teachers with science degrees, 6 in biology (2 male, 4 female), 5 physics (4 male, 1 female), and 7 chemistry (4 male, 3 female).

Newland School for Girls.

Nine students were interviewed, and the following results recorded.

Questions.

1) a) **Q** - What lessons do you find interesting and enjoyable at school?

Science (7 students, including individual areas), English (5 students), geography (4 students), expressive arts and mathematics (3 students each), history and information technology (2 students each), music, art and physical education (1 student each).

When discussing science, students considered science individually as biology, chemistry, and physics, not a combined subject.

b) **Q** - Why is this?

Enjoyable interesting lessons taught by good teachers. Again there was some support for expressive subjects, or subjects the students felt they were good at. One student's comment that "I like what I can understand" was worthy of note.

2) a) **Q** - What lessons do you find uninteresting and unenjoyable?

Science (4 students again identifying individual areas), French and physical education (4 students each), mathematics (3 students), English (2 students), religious education, history, geography, German, technology, and food technology (1 student each).

b) **Q** - Why is this?

Boring subjects and teachers not good at keeping interest were the two most significant reasons. Two students commented that as they were not good at mathematics they did not enjoy any subject with a reasonable mathematics content such as chemistry and physics.

3) **Q** - Can you remember the names of your science teachers?

The students produced 41 names identifying 10 different teachers, 3 female.

Most students could remember the names of all teachers who had taught them science at the school. In the first three years, the class science teacher taught chemistry, physics and biology, but in the fourth year all were taught by different teachers. Most students stated they were studying for a dual science award.

4) **Q** - When did you make your decision on your chosen career(s)?

Eight of the students stated that they had decided over 3 years previously which career they would like to follow. Three students had added a second career possibility to their long standing preferences during the last year, and only one had made a decision in the last year.

5) **Q** - You have stated that certain people had the greatest influence on your career choice. If they had discussed a career in science or engineering with you, do you think you would have been likely to follow such a career?

The group were completely split on this question. Four students said it would probably have influenced their choice, five said it would not. One member of the latter five stated that her father was an engineer, and discussions with him had not and would not influence her choice.

6) **Q** - Would you like to discuss career opportunities at school?

All students confirmed that one hour per week was given to career discussions with a member of staff. The whole group would have liked more discussions with people from outside the school "People who have the ability to tell us what careers are really like".

7) **Q** - If local companies with career opportunities in science and engineering (and possibly other areas) offered visits and work experience to groups of students at your school, would you take the opportunity to look at what they had to offer?

All students would like organisational representatives to visit their school to talk to them about career opportunities. All would like to visit companies and all would be prepared to try work experience in different areas. " It would give me an opportunity to try things first hand" was one reply. This type of opportunity appeared very appealing.

8) **Q** - If you were looking for employment, what is the main thing a prospective employer could do to attract you to work for them?

Financial reward was chosen by 6 students, but the location of employment and whether it was interesting and enjoyable was of importance to 4 students. The hours of work, including whether full or part time was also important to four students, whilst working conditions and career opportunities was mentioned by only one student.

9) **Q** - Any avenues opened by the students were fully explored and noted where relevant. All sessions ended by asking the student if they had any questions or comments regarding either session that they would like to ask the interviewer.

No questions were asked by the students, although their answers to all questions had been very comprehensive.

The following information on the school was received. The school employed 41 teachers, 15 male and 26 female. There were 7 teachers with science degrees, 2 in chemistry (1 male, 1 female), 1 in biology (female), 1 in physics (male), 1 in bio-chemistry (male), 1 in physiology and zoology (female), and 1 in science (male).

Amy Johnson School.

Nine students were interviewed, and the following results recorded.

Questions.

1) a) **Q** - What lessons do you find interesting and enjoyable at school?

Art (7 students), information technology, (7 students), English (4 students), geography (3 students), history (2 students), French (2 students), science and mathematics (1 student each).

b) **Q** - Why is this?

Art and information technology were clearly the most popular. All students felt they were reasonably good at art, but most stated that the teacher regularly told them they were good . Information technology allowed them to develop skills such as typing and word-processing, skills useful in other areas and clearly useful if they wanted to follow a secretarial career. English introduced literature and developed reading and writing skills.

2) a) **Q** - What lessons do you find uninteresting and unenjoyable.

Mathematics (5 students), physical education (4 students), geography (3 students), science (3 students), textiles (1 student).

b) **Q** - Why is this?

The mathematics class was described as "horrible" by one student, boring and hard by others. Many of the exercises performed in physical education were disliked, but the subject would be more popular if the students could select the exercises e.g. aerobics. Science was boring and uninteresting. When asked why compared to "liked" subjects the students said it was difficult to become involved in, so they quickly lost interest and concentration.

3) **Q** - Can you remember the names of your science teachers?

The students produced 31 names identifying six different teachers. As they were now in their fourth year most students could identify all teachers who had taught them science at the school. Two of the six teachers were female.

4) **Q** - When did you make your decision on your chosen career(s)?

Two of the students had selected two careers, one of which was a recent choice, one made a long time ago. Of the remaining students, 3 had made recent choices, four made the choices a long time ago at primary school.

5) **Q** - You have stated that certain people had the greatest influence on your career choice. If they had discussed a career in science or engineering with you, do you think you would have been likely to follow such a career?

Six students stated they would have been more interested, three said it would have made no difference.

6) Would you like to discuss career opportunities at school?

Eight of the students stated they had access to a careers officer who regularly visited the school. However only one student appeared to have made good use of this facility.

7) **Q** - If local companies with career opportunities in science and engineering (and possibly other areas) offered visits and work experience to groups of students at your school, would you take the opportunity to look at what they had to offer?

A visit by a representative of local company Smith and Nephew was remembered by many of the students. All students stated they would like to have more visits by representatives from local industries. They would also like to visit companies and if possible have work experience opportunities in many areas.

8) **Q** - If you were looking for employment, what is the main thing a prospective employer could do to attract you to work for them?

Only two students considered money would be a major factor. A job which was interesting and "offered something different" was very important. Social working hours, staff who were easy to get on with, and easy travelling arrangements were also important.

9) **Q** - Any avenues opened by the students were fully explored and noted where relevant. All sessions ended by asking the student if they had any questions or comments regarding either session that they would like to ask the interviewer.

The only item raised was a request for more work experience opportunities.

The following information on the school was received. The school employed 19 male and 12 female teachers. There were 6 teachers with science degrees in biology (1 female), colour chemistry (1 female), geology (1 male), physics (2 males), and zoology (1 male).

Willerby Carr Lane Junior School.

At the interview stage the students had transferred to Wolfreton Lower School. Eight students were interviewed and the following results recorded.

Questions.

1) a) **Q** - What lessons do you find interesting and enjoyable at school?

History (4 students), technology - mainly food technology (4 students), physical education (4 students), mathematics (3 students), art (3 students), English (2 students), science (2 students), and German (1 student).

b) **Q** - Why is this?

History was popular as students liked learning about people and why they had done things. Students liked preparing and consuming food in technology lessons, and enjoyed the activities, competition and fresh air of physical eduction. There was general support for lessons with a practical involvement.

2) a) **Q** - What lessons do you find uninteresting and unenjoyable.

Science and mathematics were least popular (3 students each); music, German and English were each selected by 2 students; and geography, art, music and history were each selected by 1 student.

b) **Q** - Why is this?

Lessons which were boring, confusing, difficult to do and explain, or which the students did not feel they were good at were not popular. Science and English/poetry fell into these categories.

3) **Q** - Can you remember the names of your science teachers?

The eight students produced 42 names which identified 6 different teachers (four female, two male) who had taught science to them.

4) **Q** - When did you make your decision on your chosen career(s)?

Five students had chosen their career a long time ago with only three students making or changing their career choice in the last year.

5) **Q** - You have stated that certain people had the greatest influence on your career choice. If they had discussed a career in science or engineering with you, do you think you would have been likely to follow such a career?

Six students stated it would not influence their choice, two said it may possibly have created more interest. An interesting comment made by one student was that if her friends went to science/engineering events or clubs, she would go with them.

6) **Q** - Would you like to discuss career opportunities at school?

All students stated they had never discussed careers at school, although one student did refer to our earlier group session. Seven of the eight would like to discuss career opportunities, the eighth would only like to discuss careers in which she had an interest.

7) **Q** - If local companies with career opportunities in science and engineering (and possibly other areas) offered visits and work experience to groups of students at your school, would you take the opportunity to look at what they had to offer?

All students would like to listen to employers and if possible visit them. The idea of visiting employers was very appealing especially if this led to work experience opportunities.

8) **Q** - If you were looking for employment, what is the main thing a prospective employer could do to attract you to work for them?

Whilst money was considered by four students, it was not the most important item for any student. The locality of the job, and the people with whom they would be working were selected by three students. Workplace facilities, hours of work, friendly atmosphere, and workloads were also considered.

9) **Q** - Any avenues opened by the students were fully explored and noted where relevant. All sessions ended by asking the student if they had any questions or comments regarding either session that they would like to ask the interviewer.

No matters were raised by the students.

The following information on the school was received. The school employed 4 male and 7 female teachers, none of whom had a science degree.

<u>Bricknell Primary School.</u>

Nine students were interviewed, and the following results recorded.

<u>Questions.</u>

1) a) **Q** - What lessons do you find interesting and enjoyable at school?

Art (6 students), English (4), mathematics (2), science (2), reading (1), physical education (1), and drama/singing (1).

b) **Q** - Why is this?

Art was popular because it was fun, often resulted in "getting messy", and there was a nice end product. English was popular for story writing which gave the students a chance to express their own thought and ideas. Experiments in science were enjoyable and did provide one student with a challenge.

2) a) **Q** - What lessons do you find uninteresting and unenjoyable?

Science (4), mathematics (4), religious education (3), geography (2), silent reading (1), and topic work (1).

b) **Q** - Why is this?

Experiments in science caused problems. Not everyone could perform them, and associated writing was boring. Mathematics was considered hard and boring. Religious education repeated information the students already knew and was again boring. Geography could be over complicated at times.

3) **Q** - Can you remember the names of your science teachers?

The students produced 32 names identifying 16 science teachers (12 female and 4 male).

4) **Q** - When did you make your decision on your chosen career(s)?

Six students had made up their mind a "long time ago", two in the last year, and one student remained undecided.

5) **Q** - You have stated that certain people had the greatest influence on your career choice. If they had discussed a career in science or engineering with you, do you think you would have been likely to follow such a career?

Six students felt they may be more interested, three said they would not.

6) **Q** - Would you like to discuss career opportunities at school?

Six students responded yes, and three no. All stated they did not have any discussions on the subject at present.

7) **Q** - If local companies with career opportunities in science and engineering (and possibly other areas) offered visits and work experience to groups of students at your school, would you take the opportunity to look at what they had to offer?

Five students stated they would like to listen to employers, whilst four students would not. Eight of the students would like to go on visits to see what employers had to offer, and obtain work experience. The response to visits was very positive.

8) **Q** - If you were looking for employment, what is the main thing a prospective employer could do to attract you to work for them?

Four students felt that work experience prior to employment would be attractive. One student stated that facilities for married females (e.g. creche) would be attractive. One student felt rates of pay and a safe environment would be attractive. Three students had no specific comments.

9) **Q** - Any avenues opened by the students were fully explored and noted where relevant. All sessions ended by asking the student if they had any questions or comments regarding either session that they would like to ask the interviewer.

Only one student commented that her ideas may change as she became older.

The following information on the school was received. The school employed 8 male and 15 female teachers, none of whom had a science degree.

Wheeler Primary School.

Nine students were interviewed, and the following results recorded.

Questions.

1) a) **Q** - What lessons do you find interesting and enjoyable at school?

English (5 students), mathematics (4), science (4), geography (2), art (1), and physical education (1).

b) **Q** - Why is this?

English was popular because the students had the opportunity to write stories. Mathematics was popular because the students knew if their work was correct, and experiments and investigations were popular in science.

2) a) **Q** - What lessons do you find uninteresting and unenjoyable.

Science (5), mathematics (3), English (1), geography (1), art (1), physical education (1).

b) **Q** - Why is this?

Science was unpopular because it was considered boring. Although it sometimes started as being interesting, the writing and drawing associated with science did not create the same enthusiasm as that in English. Mathematics was considered hard and did not allow the discussions and group work often present in other subjects.

3) **Q** - Can you remember the names of your science teachers?

The nine students produced 23 names which identified 13 different teachers (seven female, six male) who had taught them science.

4) **Q** - When did you make your decision on your chosen career(s)?

Six students had chosen their career "a long time ago" with only three students making there decision in the last year.

5) **Q** -You have stated that certain people had the greatest influence on your career choice. If they had discussed a career in science or engineering with you, do you think you would have been likely to follow such a career?

Four students answered yes, five no.

6) **Q** - Would you like to discuss career opportunities at school?

Eight of nine would like to discuss them, all students said there were no discussions at school at present.

7) **Q** - If local companies with career opportunities in science and engineering (and possibly other areas) offered visits and work experience to groups of students at your school, would you take the opportunity to look at what they had to offer?

All students would like to listen to employers and if possible visit them. The idea of visiting employers to see jobs being performed produced the most positive support with the word "definitely" attached to the majority of responses.

8) **Q** - If you were looking for employment, what is the main thing a prospective employer could do to attract you to work for them?

Eight of the students did not provide an answer, but the remaining student felt it was important that an employer convinced her that a job was interesting.

9) **Q** - Any avenues opened by the students will be fully explored and noted where relevant. All sessions ended by asking the student if they had any questions or comments regarding either session that they would like to ask the interviewer.

One student enquired if I had made up my mind about a career at her age. My reply was yes, but I changed it at age fourteen

The following information on the school was received. The school employed 5 male and 12 female teachers, none of whom had a science degree. Although four students stated they enjoyed science lessons only 2 students of the original group of 23 selected possible physical science or engineering career options in table 4.43.

4.12 - ANALYSIS OF PUPIL INTERVIEW RESULTS.

The views of the students interviewed have been summarised in this section.

Table 4.56 shows lesson popularity. The two most popular and two least popular lessons for each group of students at each school were listed together with the number of students selecting the lesson and the original sample size. Where joint popular or unpopular subjects were selected, all have been listed.

Table 4.56 - GCSE subject popularity with student groups.

School	Sample Size	Popular Lessons	Un-popular Lessons
Wolfreton	10	English (6), Geography (5), Science (5)	Maths (5), French (2), History (2), Physics (2)
Newland	9	Science*(7), English (5)	Science*(4), French (4), Physical Education(4)
Amy Johnson	9	Art (7), Information Technology (7)	Maths (5), Physical Education (3), Geography (3) Science (3)
Willerby Carr Lane	8	History (4), Technology# (4)	Science (3), Maths (3)
Bricknell	9	Art (6), English (4)	Science (4), Maths (4)
Wheeler	9	English (5), Maths (4), Science (4)	Science (5), Maths (3)

* Students at Newland divided sciences into biology, chemistry and physics selecting subjects they liked or disliked. This explains why eleven likes and dislikes were stated by 9 students. # Technology was predominantly food technology.

Terms such as expressive and imaginative were regularly used when describing popular subjects. Good teaching practices and being told they were good at subjects provided motivation in some areas. Practicals and activities were particularly popular at junior schools. Disliked subjects were described as regimented, boring, and confusing. Here teachers were not good at maintaining interest. The high mathematics content of chemistry and physics was not liked.

Students at junior and secondary school were taught science subjects by a single teacher to the age of thirteen. At fourteen the subjects were split into biology, chemistry and physics with different teachers for each area. The teachers teaching science at each school are shown in table 4.57.

Table 4.57 - Gender of science teachers at schools surveyed.

School	Total Science Teachers	Number of Female Science Teachers	Number of Male Science Teachers
Wolfreton	21	10	11
Newland	10	3	7
Amy Johnson	6	2	4
Willerby Carr Lane	6	4	2
Bricknell	16	12	4
Wheeler	13	7	6

Wolfreton had 18 science graduate staff members including 6 in biology (4 female, 2 male), 5 in physics (1 female, 4 males), and 7 in chemistry (3 females, 4 males).

Newland had 7 science graduates staff members including 1 in biology (female), 1 in physics (male), and 2 in chemistry (1 male and 1 female). There were also 1 (male) bio-chemist, 1 (female) physiologist, and 1(female) zoologist.

Amy Johnson had 6 science graduates staff members including 1 in biology (female), 2 in physics (2 male), and 1 in chemistry (female). There were also 1 (male) geologist and 1 (male) zoologist.

Carr Lane, Bricknell, and Wheeler had no science graduates amongst their teaching staff.

Students were asked when they made their career choices, either recently (within the last 12 months) or some time ago. They were also asked if engineering and science careers had been discussed more with their parents, would they have been more interested in following these careers. Their responses are shown in table 4.58.

Table 4.58 - Timing of career choice and promotion of careers in science and engineering.

School	Timing of career choice,		Discussion of ES Career,	
	Recent	Greater than 12 months ago	More Interest	No more Interest
Wolfreton	6	4	1	9*
Newland	1	8	4	5*
Amy Johnson	3	6	6	3
Willerby Carr Lane	3	5	2	6
Bricknell	2 #	6	6	3
Wheeler	3	6	4	5

* One student at both Wolfreton and Newland had engineering fathers. Both said they found discussions with fathers counter productive and these discussions had lessened their interest in the subject.

One student at Bricknell was still undecided about a likely career.

All three of the secondary schools, Wolfreton, Newland and Amy Johnson appeared to have an active careers service but few students made use of it. No such service appeared available at the junior schools although 7 students at Carr Lane, 6 at Bricknell and 8 at Wheeler would like opportunities to discuss careers.

Students were asked if they would like to see more visits from representatives of local industry and commerce, go on visits to companies, and have related work experience opportunities. Table 4.59 shows their responses.

Table 4.59 - Are students receptive to visits and work experience.

School	Number of Students	Would like to be involved with, Company visits to School	Visits to Companies	Work Experience
Wolfreton	10	10	10	9
Newland	9	9	9	9
Amy Johnson	9	9	9	9
Willerby Carr Lane	8	7*	8	8
Bricknell	9	5	8	8
Wheeler	9	9	9	9

* The eighth student stated she would only like to listen to people talking about careers she already had an interested in.

When asked what items would finally influence taking a specific job, although financial rewards were mentioned, it was frequently stressed that this would not be the main factor. The location of the company, its size, reputation, and the "people I would have to work with" were of equal or greater importance. Items such as creche facilities, and career breaks were mentioned but were not a major factor.

4.13 - INTERVIEWS WITH REPRESENTATIVES OF ORGANISATIONS CAPABLE OF INFLUENCING/CHANGING THE CURRENT SITUATION.

To examine and expand upon the earlier findings of this research, a number of individuals were contacted and each agreed to discuss the initial research findings. Each person contacted was either responsible for research covered in the literary review and/or had the ability to be influential in bringing about the changes this research indicated were necessary to encourage more females to take up engineering and science careers. A list of these individuals now follow.

Marie-Noelle Barton - Manager of the Women Into Science and Engineering (WISE) Campaign at the Engineering Council, London. The works of the WISE campaign has been covered in detail in the literature review section.

Rhian Chilcott and Frances Keenan - Training Policy Adviser and Senior Adviser - Equal Opportunities, of the Confederation of British Industry (CBI). The CBI (1994) described itself as an independent, non-party political organisation funded entirely by its members in industry and commerce. It exists primarily to voice the views of its members to ensure that governments of whatever political complexion, and society as a whole, understand both the needs of British business and the contribution it makes to the well-being of the nation. The CBI members come from every sector of UK business and includes more than 250,000 public and private companies.

The CBI (1996) produced a checklist for good practise. It states under **Positive Action**: taking steps to encourage under-represented groups to apply e.g. target recruitment adverts; offer pre-employment training or work experience; target training and development of existing employees; make reasonable adjustments for disabled applicants or employees.

Mike Koudra and Ben Brown - the Principal and Senior Research Officers of the Department for Education and Employment (DfEE), both operating within Analytical Services: Social Analysis and Research (SAR). The aim of SAR was to provide advice, information, and briefing on social aspects of the Department`s policies. This included developing and delivering a programme of research and evaluation on Equal Opportunities and disadvantaged groups in the labour market (disability, sex, race, older workers, lone parents). SAR provided briefing and advice to Ministers, Ministerial advisory groups and policy partners on the above areas.

Kate Merrell - Co-ordinator of the Gatsby Technical Education Project, London. Schools, Colleges and Universities can work in partnership with the Technology Enhancement Programme to enhance science and technology in academic and vocational courses.

Lynda Sharp - Development Unit for Women in Science, Engineering and Technology (SET) at the Department of Trade and Industry, London. This department had specific responsibility for progressing the outcomes of the Rising Tide report examined in the literature review section.

Interview with Marie-Noelle Barton Manager of the WISE Campaign at the Engineering Council.

Marie-Noelle Barton was the Manager of the Women into Science Campaign, the work of which has been extensively examined in the literature review section. Much of the impetus of this campaign was via a range of excellent booklets provided to primary and secondary schools in England and Wales and around 30,000 information packs had been provided by 1996. Although there had been no direct review of the effectiveness of these packs, the continued demand linked to the rising media coverage of the subject suggested they were effective.

The work of Brown (1989), which covered male dominance in certain primary school sessions, had been covered in some of the WISE literature. No recent expansion of this work had been reported to the WISE office.

Of particular significance to this research were the outcomes of the 1994 WISE essay competition. These recorded how female students, aged 14 - 18, felt more females could be attracted into science and engineering careers. The points gaining significant support were raised and discussed in some detail. The major concern raised was that science and technology subjects were not taught in an exciting or attention grabbing manner. In 1996 the Department for Education and Employment had taken some steps to rectify this by providing extra training to teachers via the teacher training establishment. It was considered that this may take some time to be noticed nationally.

Although there were some advances in media coverage of female scientific and engineering involvement, there was some way to go. The recent increase in journal and newspaper articles were encouraging and would hopefully continue to grow.

The view was expressed that too few companies were aiming to attract and then keep female engineers and scientists. It made good economic sense to retain skilled staff and more could be done to highlight the benefits of attracting and retaining staff who may wish to take career breaks. Management culture was not considered correct to attain significant advances at the present time.

In terms of role models the two most effective areas were considered to be young females, under 25, to whom the students could relate, together with females currently occupying senior level positions. The latter would demonstrate the career advancement potential that exists.

One of the suggestions in the WISE essay conclusions, was that publications should target girls in years 10 and 11 (15 - 16 years old) in secondary schools. It was now considered that a better target age may be year 9 at GCSE choice stage. Marie-Noelle Barton was consulted during this research period and agreed that this latter figure may need to be reviewed and probably lowered considerably.

When asked what were the current beliefs as to the main causes of this situation, and what methods could be used to overcome them, the following suggestions were made. Sex stereotyping and prejudice were still commonplace and examples could be seen in many areas e.g. toys, and the teaching of science subjects. A lengthy study of the teaching of both science and technology subjects to segregated single sex classes may be beneficial. There also needs to be significant changes in the engineering and science culture, particularly regarding parents, schools, and employers if there is to be a marked increase in the number of females entering and remaining in engineering and science careers.

Interview with Rhian Chilcott and Frances Keenan of the Confederation of British Industry.

Initial discussions covered the performances of males and females at GCSE level. Whilst these figures currently showed females out-performing males, in vocational areas (NVQs) males still outnumbered females by about 55% to 45%, with females only taking the lead in areas such as business administration. Nationally, targets for the attainment of NVQs were not being achieved. In the East Yorkshire region, discussions with employers suggested a reluctance to accept vocational qualifications as matching the status of a similar academic qualifications. As such the fact that males outnumber females in vocational areas may only indicate the higher abilities demonstrated by females means they are attracted to higher profile qualifications leaving males to dominate the remaining areas.

Initial findings of this research suggested that career plans were being formulated at primary school for many, if not the majority of female students. This was, perhaps, an area requiring greater input to rectify the current gender imbalance of scientists and engineers. An article in CBI News (March 1997) examined increasing or re-allocating the nations education budget. It clearly identified a need to examine the provision of education in primary schools. One of two suggestions for using any savings from the education budget was to provide more resources for those parts of the system where they are most needed - smaller classes for 5-7 year olds and better information technology, equipment, and buildings. However, the same article did state that redistributing funding to primary schools and pre-school education from other parts of the system could be risky.

Other initiatives such as the Fairplay Initiative and Modern Apprenticeship were mentioned. Fairplay was aimed to involve local people at a local level in tackling the barriers of equality. The specific aim is to provide equal opportunities for education, training and employment for both genders in all areas. This initiative had not been mentioned at any school or company visited during this thesis so doubts on its impact and thus its value in this region must be cast. It was suggested that Modern Apprenticeships were leading to gender equality. Reference was made to some figures provided by the Department for Education and Employment in June 1996 which stated that following concern about Modern Apprenticeship schemes initially being male dominated by an 8:1 ratio, by June 1996 these figures were almost 1:1.

After obtaining the intake figures for modern apprenticeships to January 1997 from The Department for Education and Employment, the figures proved somewhat misleading. Although overall intake figures for females had risen from 36% for the period Oct-Dec 1995 to 52% in Apr-June 1996, they had fallen back to 42% for Jul-

Sept 1996 and only averaged 40% of the total intake to December 1996. The figures for sector breakdown in January 1997 showed 78,911 starts of which 31,441 (39.8%) were female. The areas of engineering and physical science are shown in table 4.60.

Table 4.60 - Modern Apprenticeships with low female starts.

Sector	Total Starts	Percent Female Starts
Chemical Industry	435	14.3
Electrical Installation	3,961	1.2
Engineering, Manufacture	12,490	3.6
Engineering, Construction	442	1.8
Construction	6,027	1.4
Plumbing	929	0.5
Motor Industry	6,642	2.2

In some areas females were shown as by far the greatest percentage, and higher start areas are listed in table 4.61.

Table 4.61 - Modern Apprenticeships with high female starts.

Sector	Total Starts	Percent Female Starts
Business Administration	10,855	79.9
Childcare	2,270	97.6
Travel Service	1,442	85.3
Hairdressing	5,657	91.8
Health and Social Care	3,740	88.2

Similarly gender equality in certain sectors had been reached and examples of the sectors with highest starts are shown in table 4.62.

Table 4.62 - Modern Apprenticeships with balanced gender starts.

Sector	Total starts	Percent Female starts
Retailing	6,559	56.1
Accountancy	1,660	58.7
Hotel and Catering	5,251	47.8

The Humberside Training and Enterprise Council (TEC) were contacted and provided figures for Modern Apprenticeship starts for the years 1996/7, 1997/8, 1998/9. The figures were very similar to the National figures with female starts in 1996/7 507 of 1,187 (43%), in 1997/8 644 of 1,435 (45%), and in 1998/9 553 of 1,246 (44%). The areas specific to engineering and science are shown in table 4.63. The table shows the Modern Apprenticeship starts using the sectors as named by the

Humberside TEC each year specific to engineering and physical sciences.

Table 4.63 - Modern Apprenticeship Starts for Engineering and Physical Science Sectors in The Humberside TEC region for years 1996/7, 1997/8, and 1998/9.

Sector	Starts 1996/7		Starts 1997/8		Starts 1998/9	
	Male	Female	Male	Female	Male	Female
Chemical/Gas/Petroleum	not used		14	0	not used	
Electrical Engineers	2	0	6	0	3	0
Electrician/Electric	50	1	63	0	68	0
Engineering Technician	not used		1	0	2	0
Industrial Plant	9	0	1	0	not used	
Laboratory Technician	4	1	5	5	4	4
Mechanical Engineers	15	0	15	0	22	0
Other Electrical	7	0	2	0	6	0
Other Engineers/Technicians	2	0	1	0	6	0
Other Scientific	1	0	1	0	not used	
Science/Engineering Associated Professions	7	0	not used		not used	
Sci./Eng. Professions	1	1	not used		not used	
Skilled Engineering	3	0	1	0	not used	
Totals	**101**	**3**	**110**	**5**	**111**	**4**

Not used indicates a sector title not used that year. Sector titles change from yearto year.

There appeared to be no evidence from these figures to suggest that the Modern Apprenticeship was breaking down the gender barriers that appear to exist in physical science and engineering fields. In fact one could state that the Modern Apprenticeships were helping to maintain sex stereotyping in these and many other employment areas.

Another area considered during the interview was the high level of drop-outs of female engineers. Clearly more must be done to retain females who do enter engineering professions, and encourage their return after career breaks.

As females were outperforming males at GCSE level and A-level in almost all science areas, the recruitment of a male majority in science and engineering areas may mean that CBI members are having to accept second best. The question was asked, "Would members be happy to accept such a situation where they may be accepting second best". It was stated that CBI members would not be happy to accept second best, but the CBI could not support any interventionist approaches which were considered to be counter productive. Positive action involving best practices would be supported by the CBI.

The CBI would like to see three main areas targeted to improve the current situation.

1) Encouragement of educational links between companies and schools, especially at primary level. This should involve curriculum changes to give a better understanding of industry, particularly with respect to careers

education and guidance.

2) There must be greater effort to remove prejudice in the workplace. The creation of a supportive atmosphere for minority groups and as Adair Turner (1997) states a "family friendly employment" must be encouraged. There was also a need to advance the growing provision of career breaks with associated support for returners.

3) It was estimated that 80% of the current workforce would make up the workforce in the first decade of the next century. Steps were needed to promote women to more senior positions in many areas, including science and engineering, so that examples were available to encourage aspirations in female school students.

Interview with Mike Koudra and Ben Brown of the Department for Education and Employment.

Initial discussion on the current performance of females at GCSE level was supported by the following data supplied by the department. The Department for Education and Employment Separate Tables of Statistics on women and men in education, training and employment (1997) listed entries and achievements for candidates at A-level science subjects in England in 1994/5. These figures showed 122,173 male and 80,376 female entries. The percentage pass rate for females was higher in all areas apart from computer studies where males outperformed females by 75.1% to 67.5%.

The fact that fewer females than males are studying A-level sciences does cause some concern, but the SAR section was not aware of any action to try to change this situation. In fact no remedial action may be required as the choice of A-levels may reflect the choice of individual students influenced by other factors, such as the range of job opportunities and their competing attractions in occupations, which may not require an academic background in science.

As the number of students taking science A-levels has fallen quite significantly from 1995 to 1996 (Halpin 1996 A-Level of concern), did the DfEE feel that this may be a result of the national curriculum method of teaching combined sciences via single and dual awards? It was not possible to agree with such a statement as there may be other influences playing a far greater part such as current employment trends which may attract females away from science and engineering areas. Students will be influenced to study A-levels which offer the best potential for employment and these will alter with time.

Figures provided by the Department of Education (1993) showed that there was far less likelihood of a primary school pupil being taught science by a science graduate, than a secondary school pupil. In this research project there were no science graduates in any of the three primary schools studied. Is it not important that when interests in subjects and careers are being formed, pupils should be taught by graduate scientists who clearly have a great interest in and knowledge of the subject. It was considered that as greater knowledge of the subject was probably required by teachers of older children, for this reason the greatest number of science graduate teachers were to be found in secondary schools. Although suggested that school budgets may promote employment of non-graduates in primary schools, the suggestion did not gain much support.

There were no planned interventions e.g. establishment of technical schools, or raising the image of science with pupils, to change the current situation under active consideration. It was accepted that such action could not be ruled out.

Interview with Kate Merrell Co-ordinator of the Gatsby Technical Education Project.

The initial discussion enquired why female students did not wish to enter science and engineering careers. It was felt that a natural dislike of the subject appeared to form at an early age and may be genetic in origin. The subject may appeal less because it appears to require a great degree of arrogance, something more applicable to males than females. An example in the field of civil engineering was given. Here males will view projects as a job requiring efficient completion. Females would be more likely to take a wider view e.g. environmental repercussions, and as such the very thought of taking such a role where they may not be allowed to examine such aspects may alienate them from this type of career. Similarly females may find it more difficult to work in the field of medical sciences because of the moral dilemmas involved.

It was also considered that engineering professions are given poor media coverage often being portrayed as boring and low paid. This is despite the fact that one in three members of the board of directors of most companies were engineers, a fact which is rarely conveyed.

In terms of how to improve the current situation and attract more females into science and engineering, several suggestions were considered. The first item considered was image. Engineering and science subjects were not considered "sexy"! If other careers have greater initial appeal, careers in engineering and science are always likely to be fighting a losing battle. It may be more applicable therefore to target areas where the option of a career in science and engineering looks far more attractive than others career opportunities currently on offer.

Teaching of mathematics, science and technology subjects in schools required improvement, particularly at primary level. Interest must be nurtured and maintained and it was hoped that the Gatsby Technical Education Project would be one way of aiding this improvement.

Interview with Lynda Sharp of the Development Unit for Women in SET.

Lynda Sharp was working for the Development Unit on Women in Science, Engineering , and Technology (SET), set up to promote the role of women in science engineering and technology. One current responsibility was to progress the outcomes of the Rising Tide report, an area examined at some length during the interview. The main aim of the Rising Tide report was to allow women to fulfil their employment potential, particularly in areas of SET. Whilst the Government of 1996 was fully aware of the current under utilisation of women in SET areas, it did not appear to have set any specific targets to increase participation in these areas. The only current targets were national targets set for both genders and not in specific employment areas. Company goals were considered far more important than national targets.

At this point a copy of Making the Most (1995), a DTI/Opportunity 2000 publication aimed at moving towards a balanced workforce was introduced. This booklet showed how six of the UK's leading enterprises were making the most of women specialists, and highlighted the business benefits which this was bringing them. The booklet put forward the case for taking action to attract and retain talented women as an integral part of building a world-class workforce for sustained competitiveness. Examples from the booklet now follow.

Rank Xerox stated,

> "Twenty percent of graduates in engineering and technology are, today, women. Our business will flourish when we can attract and develop the best performers from this strategic recruitment source. We see excellent opportunities ahead".

Glaxo-Wellcome have seen an increase from 10% to 18% from 1990 to 1994 in the representation of women in Glaxo Research and Development Management and International Specialists. Figures for women employees returning after maternity leave have increased from 40% in 1988 to 90% in 1994.

Unilever have shown a considerable increase in the number of female applicants to appointments at Technical Graduate level. In 1988 25% of applicants were female, but only 16% of appointments were female. By 1994 31% of applicants were female, but 38% of appointments were female.

Esso noted the general decline in first degree chemical engineering graduates from universities over the period 1987 to 1992, from 950 to 800. At the same time the number of female graduates rose from 110 to 200. In face of increasing competition for a decreasing resource Esso forged its initial equal opportunities plan to meet future needs.

The following points were drawn from the booklet conclusions. To meet world class innovation, products and performance in SET the following points should be closely interlinked.

1) Demonstrable career opportunities for boys and girls.

2) Teacher and parent involvement.

3) Equal access and encouragement of girls and boys.

4) Aspiration into SET.

5) Positive consideration of a career in science and industry.

6) A good feedstock of SET based staff are required by employers.

7) Employers valuing equality and promoting diversity.

8) Merit based career and environment.

These points should be used as the basis for policy formation and action planning by the Opportunity 2000 department.

On expanding into educational areas there was concern that more appeared to be being done in Scotland than in England and Wales to attract females into SET areas. The advantages of a broader curriculum to encourage the study of science beyond the age of 16 had already shown promising results in Scotland. Expansion of this project into the rest of the UK should increase and retain for longer an interest in SET subjects. The following figures demonstrate how changes to the Scottish educational system in terms of a broader post 16 educational base have affected A-level selection. The ratio of male to female students on A-level courses in Scotland (1995/6) were Technology 3:1 (England 4:1), Physics 2:1 (England 3:1). At this point the performance of Hackney Community College in attracting females onto A-level Science courses was mentioned, and this specific area will be examined later.

There had been no evidence that combining the sciences of biology, chemistry and physics to form single and dual science awards could be turning students against science. However, it was considered that "forcing" a student to study an area they disliked with areas they may like could have an overall harmful effect.

The fact that it is quite difficult for females in SET to take career breaks was considered a major influence in career choices. It was felt that far more could be done to attract back females to these professions, particularly in the areas of skills/information updating. Providing this service was not enough, making students aware of its existence was considered equally important.

When asked what would be the major factors in influencing a change in the current gender bias, a holistic approach was favoured. Here females could not only be targeted but inspired to follow such careers. Equality of opportunity at all stages would be the key, possible with a framework for teaching science and technology to single gender classes. There must be a networking of organisations to utilise current and increasing role models available via the existing support schemes nationally co-ordinated but with regional based contacts. When questioned as to the number and availability of female role models, there did not seem any shortage to fulfil this task on either a national or regional basis. These schemes have access to support material as well as personal role models to support any related project. Utilisation of this resource was considered fundamental to establishing a major advance.

Innovations at Hackney Community College Encouraging Girls into Science.

Mahoney (1997) produced a report on the innovations at Hackney College which was reported in Past Science. The project started in 1990 when Hackney College reflected the national trend of under-representation of young women in science. The following details show precisely the advances this project has achieved in the period 1990 to 1996.

In 1990 there were three entries for females in A-level science subjects with one pass. Between 1991 - 96 there have been 198 entries with 160 passes, 50% in A - C grades. There were no female students progressing to University in 1990, but between 1991 - 96, 81 students have progressed with over 90% studying science or science related courses. Subjects studied included biochemistry, biology, genetics, microbiology, pharmacy, polymer science, psychology, radiography, zoology, and photographic and electronic imaging in science. These gains were not made at the expense of boys as A-level entries and success has increased from 16 entries and 13 passes in 1990 to 162 entries and 137 passes between 1991 - 96.

What exactly were the reasons for this dramatic turn-around? To respond to this situation existing at Hackney College in 1990, the project included the following explicit strategies in its action plan.

1) Creating an ethos and learning environment which eliminated the "male image" of science.

2) Prioritising recruitment of young women.

3) Ensuring balanced groups avoid overt domination by male students.

4) Providing support mechanisms and extra-curricular activities to enhance achievement and progress.

5) Delivering the curriculum and adopting teaching strategies in ways which encouraged rather than alienated young women.

The use of information technology and multi-media, student presentations, regular practical work and evaluations, and specifically highlighting the contribution of women scientists, were part of the methodology. Other significant items were;

6) Enhancement of the curriculum to include A/S levels in chemistry, physics and science, technology and society, the latter particularly attracting young women because it provided the opportunity to discuss political, philosophical, environmental and ethical considerations in science.

7) Establishment of a "mathematics for scientists" supplementary course, which enabled girls to develop their mathematical skills and practice these in a scientific context.

8) Provision of additional language and physics support.

9) Extra-curricular activities including field trips, residential trips, courses, visits, lectures, job shadowing, summer schools and industrial experience.

Over the five years so far the project team established a clear curriculum plan which evolved each year. Initially it emphasised positive recruitment, tracking, skills audits and support networks. Lesson delivery methods which encapsulated the view of science as "men in white coats" were disbanded in favour of interactive learning in which science was seen as an active process involving people. The project was operated as a totally holistic approach by staff members (male and female) highly experienced and committed to equal opportunities.

This project was considered of immense value because of the particular values women can offer science. These are;

a) In the current advanced technological society, women bring a particular vision, imagination and care to solving scientific problems.

b) Women generally possess numerous skills valuable in scientific areas, i.e. problem solving, practicals, collaborations, and the ability to consider diverse opinion and draw rational conclusions.

c) Women can bring a particular perspective to the many scientific issues and problems, which very directly effect them e.g. reproductive technology, contraception, genetic engineering and environmental issues.

d) Women have a traditionally practised science in their daily lives, e.g. agriculture, diet, health and safety, nursing, nurturing, cooking, and therefore, can bring valuable practical experience and skills to science

e) By increasing the number of young females progressing to and achieving in science has resulted in an increasing number of young people concerned with the added value to society of science advancement, rather than individual career aspirations of "power, wealth and status".

To complete this part of the study the Hackney College was contacted directly. When asked exactly how the programme had managed to attract and maintain so many students Pat Mahoney stated that the former was the difficult part, the latter far easier. The course team spent a lot of time visiting schools in the area to attract students on to their science A-level programme demonstrating specifically that it should not be considered a male dominated area of study. Once the break through had been made in the first year, word was passed around so maintaining and increasing numbers was not considered a problem. Satisfied, successful students appeared to be the most marketable asset.

4.14 - QUESTIONNAIRE RESPONSES FROM EMPLOYERS IN THE HULL AND EAST RIDING OF YORKSHIRE AREAS.

The questionnaire recorded in Appendix 3 was prepared as a result of some of the findings of this results section. It was sent to local employers of young people in the engineering and physical science sectors to provide further primary research data to be used during the following discussion section.

The questionnaire was sent to 4 large and 4 small to medium employers (SMEs) in the Hull and East Yorkshire region. A 100% response rate resulted in the following data.

Employer Questionnaire

The following questions refer to young people (aged between 16 and 25) entering employment in areas of engineering and physical sciences. Would you please provide your responses either in the spaces provided or on a separate piece of paper if the spaces provided are insufficient for your needs. (* Please delete as appropriate.)

1) **Q** - Do you find it difficult to attract young people to apply for vacancies in the areas of engineering and physical sciences? Is there a difference in the number of males and females who apply for these vacancies and are you able to quantify the difference?

Three large and one of the SME employers stated there appeared to be no major difficulty in attracting young people to apply for positions in these areas. The percentage of females applying for these vacancies varied from 1% to 10%. The others reported difficulty with two SMEs recording a total lack of female applications.

2) **Q** - With regard to the needs of your company do you consider that young people commence employment with:

a) good/poor* levels of knowledge, skills and abilities

b) good/poor* motivation, attitude and beliefs

With respect to these points do you detect any difference between males and females as they commence employment?

With regards to knowledge, skills and abilities, motivation and attitudes and beliefs the large employers were evenly split. Two employers felt they were good and two poor, although one of the employers who felt young people had good levels did feel that mathematics and English skills were sometimes poor. No significant difference between males and females were recorded. In the case of the SMEs all thought entry levels were poor with little or no experience of young female employees.

3) a) **Q** - What specific weaknesses have you detected in young people joining your company?

b) **Q** - What specific strengths have you detected in young people joining your company?

With respect to the points recorded in question 3 parts (a) and (b), do you detect any difference between males and females as they commence employment?

This question brought a wide range of responses with only a few common themes. Two significant areas of weakness were a lack of understanding about the area in which the young people were seeking employment and a lack of motivation/commitment. Areas of strength were IT skills and confidence. No significant differences between males and females were recorded.

4) **Q** - Do you feel young people could be better prepared for employment in these areas, and could you suggest how any improvements required could be achieved?

There was a general feeling amongst all employers that schools did not provide sufficient guidance to pupils with regard to engineering opportunities or the expectations of employers, FE and HE for progression. There did not appear any effort to remove stereotyping or promote engineering as an option to female students, a fact often confirmed during interviewing male and female applicants.

One SME suggested more work with basic literacy and numeracy would be an advantage and another SME suggested more work experience opportunities for 14 to 16 year old pupils, particularly those not particularly gifted academically.

5) **Q** - Do you find it difficult to retain young people in these areas and have you noted different retention levels for males and females?

Large employers had no difficulty in retaining young people and had not recorded any differences between males or females in this respect. SMEs were divided, two experienced problems, two had none. With very small numbers or no females present at the SMEs no difference in retention levels between males or females could be provided.

6) **Q** - Do you feel the current balance of young males and females entering these professions is correct? If you feel the balance is incorrect would you like to see the balance moving towards a greater percentage of males or a greater percentage of females?

The majority of large employers would like to see more female applicants but felt their current balance was satisfactory in terms of the standard of applicants of both males and females. The key to obtaining more females employed in these areas was to increase the number of applicants from females not by lowering the standards expected for female applicants compared to those expected of males. The small SMEs had so little experience of female employees in these areas that they did not feel able to comment on the present balance.

7) **Q** - Could you see positive benefits to engineering employers as a result of:

a) Engineers visiting schools to talk to pupils Yes/No*

b) Encouraging school visits to engineering companies Yes/No*

c) Providing engineering work experience opportunities to older school pupils Yes/No*

Could you suggest any other ways to make these employment areas more attractive to young people?

All large companies supported (a), (b), and (c). It was felt that if schools were not promoting engineering and physical science vocations effectively then perhaps colleges and institutes should take a greater responsibility for removing the "grey-areas" and providing role models to project a more positive perspective of these potential employment areas, especially to female pupils.

The SMEs responses were more varied. None supported engineers visiting schools as "a short visit would be lost in the school curriculum and have limited or no effect on career selection". Two SMEs supported school visits to engineering companies and three supported more work experience opportunities at engineering companies.

CHAPTER 5

DISCUSSION.

5.1 - INTRODUCTION.

This section compares the results to the previous chapter to the research performed during the literature review. For continuity, the results were considered in the order of, and under similar titles to those of the literature review. Only items raised in the literature review and results sections have been included. The purpose of this section was to relate thesis research to that of other researchers leading to a thesis conclusion where implications of the research provided direction for actions and possible future research. All discussion is on the basis of the evidence uncovered and recorded within the various chapters of the research.

5.2 - WHAT WAS THE PURPOSE OF THIS RESEARCH?

This project initially had three main objectives in mind. Firstly to highlight the low participation rates of females in some science and most engineering areas. Secondly to discover reasons for their absence, and thirdly to suggest ways of removing this gender bias. This was considered desirable because of the particular values women can offer science specifically listed under the innovations at Hackney Community College in section 4.13.

Department of Education and Employment figures (1995/6) record that females currently out-perform males in terms of A to C grades attained for mathematics and science at GCSE level, but they remain reluctant to study science subjects at Higher Education levels and pursue related careers, especially in engineering and physical science areas. This in turn may mean the overall standard of scientists and engineers in this country is considerable below its potential level.

Reasons for the low female participation rates are now discussed.

5.3 - HISTORICAL EFFECTS OF EDUCATION ON WOMEN.

Bryant (1979) used an observation that,

> "The daily life into which we are born, and to which we are absorbed before we are well aware, forms the chains which only one in a hundred has the moral strength enough to despise, and to break, when the right time comes"

This statement would clearly be applicable to women and engineering and science, but could equally be applicable historically to women and all professions. Bryant (1979) and Maclure (1986) both listed a series of events and Education Acts which indicated there was very little opportunity for further recognised educational progression for females beyond the elementary stage until the latter stages of the nineteenth century. This situation was to continue until well into the twentieth century with degrees not issued to women until 1919 at Oxford and 1921 at Cambridge. This indicated how educational organisations, in many cases dominated by religious governors (Cotsgrove - 1958), held back the educational progression of females. If this was a restriction that applied to the provision of education to all females, why have females made major progress in certain career areas, but significantly less progression in the areas of engineering and physical science?

Wilkinson (1994) stated that females have made major progress in certain professional areas. The sharpest increase in female graduates was as newly qualified solicitors (54%) and chartered accountants (37%). Both the Engineering Council (1995) and Some Facts about Women (1995) recorded female engineering graduates at around 15%. Could the difference in the participation rates between these professions be due to the provision of types of education, and specifically technical education? Cardwell (1957) highlighted how religious institutions had almost total control over educational establishments at the end of the nineteenth century and being in such control, influenced the educational progression of females. Cotsgrove (1958) recorded that the technical education system of that time, 1958, still retained in all too many respects, the form given to it by the nineteenth century. Cotsgrove questioned whether the system that existed could be flexible enough to meet the changing social needs.

There would appear to have been a general lack of progress made throughout the twentieth century regarding the provision of technical education. Initially this would have specifically prevented major female participation, and may well have held back female advancement in technical areas. Cotsgrove (1958) considered that figures for females entering technical higher education institutions were not significant until after world War II (1945). Many males were killed in the conflict, and this presented an opportunity for females. Cotsgrove also postulated two potential driving forces for the movement to technical education. Firstly a growing demand for technical staff since 1945 and secondly the resulting increased rewards of such occupations in terms of pay and prestige. These driving forces may have had an effect in terms of total student numbers but not in student equality. The Engineering Council (1995) records show that in 1950 the number of female engineering graduates as 0.5% of the total. By 1984 this was 8% of the total and by 1995, 15%. The potential driving forces suggested by Cotsgrove did not influence an influx of females in many technical areas.

It may well be that the male and religious control of educational establishments, technical institutes, and professional bodies have held back women entering and progressing in technical areas. Demand for technical staff and increased rewards have not promoted any major change as seen in the professions of law and chartered accountancy. When compared to other vocational areas the rate of female progression in the engineering and physical science professions has been limited, so to find a precise answer to continued male domination other areas needed to be examined.

5.4 - CHILD DEVELOPMENT.

Child development theory has been researched for many years and many differing philosophies recorded and discussed. The twentieth century has seen many studies performed with a main consideration, when does development start and effectively end? Some theories believe development is almost completed by adolescence with only fine tuning possible with greater maturity. Other theories suggest that development continues into middle-age and possibly beyond. Examination and application of child development theory was essential to this research and this section reviews some of the ideologies in comparison to the actual research findings of this study.

Piaget's cognitive theory is described by Lloyd and Mayes (1987) not as a steady accretion of skills, but as a series of sudden leaps. Development proceeds by way of a series of qualitative changes, often referred to as stages with one stage growing out of another. This may be a reconstruction of earlier knowledge, but the result is a new way of looking at things. Psychoanalytical theory, which includes the work of Erikson and Freud, is termed a dynamic theory of emotional development. Processes that brought unconscious motives, thoughts and feelings to consciousness, or which prevented this from happening were central to its aims.

Bee (1992) described the psychoanalysis theory as a method of explaining human behaviour by understanding the underlying processes of mind and personality. Development is governed by conscious and unconscious processes, the latter being present at birth, the former develop with time. Cognitive theory indicates that study groups should exhibit shared patterns of development, whilst psychoanalytical theory emphasises the importance of both shared and individual differences.
Psychoanalytical theory views change in stages whilst cognitive theory sees it as mainly sequential with some changes. Psychoanalytical development can be driven by unconscious processes e.g. dreams and fantasies, whilst cognitive development is

driven by the likes of logic and morals.

The research performed during this study found that although some students had not selected a likely career path, most had and had made their selection(s) at a fairly early age often at primary school. Despite the fact that development via cognitive growth may occur in an invariant order, growth cannot occur if the ideas or seeds of ideas are lacking. This can be related equally to psychoanalytical theory. If this process is driven by dreams and fantasies, then the few likely dreams of science and engineering experienced by females would probable be nightmares. The idea of engineering being a male area, with the vision of a dirty male holding a greasy spanner may be a fading image, but still appears to be one viewed by some teachers and careers advisors and was recorded as such by Hayley Gladstone whilst receiving the 1994 Young Woman Engineer of the Year award.

For any cognitive growth to occur, the child must have access to reference sources that allow growth or development to occur. The results sections records that the knowledge required to influence young females to consider engineering and physical science may not be conveniently available to females via relatives or close friends. Although booklets and other information regarding female engineering role models were available to schools, no schools in this research had either made pupils aware of the existence of this help or taken positive steps to use it. If this is so, potential development of young females into physical scientists and engineers is at best limited.

Piaget suggests that basic notions are formed in the age range 2 to 7. This is the second period of his development theory termed the preconceptual/intuitive period and will depend greatly on the child`s own environment. Erikson considers a similar developmental period called industry to inferiority, in the 6 to 12 year age group. If the results of such respected researchers are combined, then the prime age range for building notions and ideas is 2 to 12. The majority of pupils in the East Yorkshire region change schools at the age of 11, moving from primary to secondary school. It can be seen that the importance of establishing potential career opportunities and educational progression routes would appear to be of significant importance to primary school students. This research showed that in the schools surveyed the prime input regarding careers was at secondary schools i.e. at the age of 11 plus, far too late to be of significant influence. Even at secondary school, this research did not record any significant input by anyone from the careers area to the pupils involved. This lack of input appeared to offer science and engineering organisations and employers a great possibility to promote greater female participation by pro-active involvement.

Table 2.10 shows that primary schools employ very few science graduates. Whilst a burger bar sales assistant may be capable of repairing a motor car, most people would use the skills of a qualified motor mechanic. Using the same reasoning science graduates, and particularly female science graduates, are far more likely to teach science subjects from a base of knowledge and enjoyment and provide significantly absent role models, of major significance from the work of Foskett and Hemsley-Brown (1997), to this age group. Perhaps the term "boring", often recorded in the results section of primary schools pupils questionnaires and interviews, would not occur so frequently if science graduates taught science lessons.

Child development theory linked to the evidence from the results chapter recorded in this section indicates reasons why there is such limited involvement by females in physical science and engineering areas. It has also provided identification of areas which if addressed with enthusiasm, may promote a rapid attainment of gender equality. It does ask questions of the desire of educational establishments, science/engineering organisations, and employers to reach this status by inputting the required effort and finance to achieve these ends.

5.5 - SCIENCE, EDUCATION AND SCHOOLS.

Student Ideology and Beliefs.

The continuing absence in attaining gender equality in science and engineering areas demanded that all potential reasons for this absence, no matter how extreme, should be considered. One such suggestion was that a natural dislike of the subjects appeared to form at an early age and may be genetic in origin. The same person felt the subjects may appeal less because they appeared to require a great degree of arrogance, something more applicable to males than females and an idea supported by Harding (1986) referring to the socialisation, aspirations and values of women. An example in the field of civil engineering was given. Here males will view projects as a job requiring efficient completion. Females would be more likely to take a wider view e.g. environmental repercussions, and as such the very thought of taking such a role where they may not be allowed to examine all aspects may alienate them from this type of career. Similarly females may find it more difficult to work in the areas of medical sciences because of the moral dilemmas involved.

This theory was hard to accept, particularly as the major scientific area into which females have made significant advances was the area of biology, as table 2.1 demonstrates. If this reason was not supported, what other reasons could there have been? Could there be a conceptual problem in terms of the image of scientists? One person interviewed had stated that engineering and science subjects were not considered "sexy"! If other careers have greater initial appeal, careers in engineering and physical science were unlikely to be selected. It may be more applicable therefore to target areas where the option of a career in science and engineering looks far more attractive than others career opportunities currently on offer.

Primary and secondary schools play an important role in the development of their pupils and potentially a key role in influencing career selection. The following section examines how the ideas and beliefs with which students enter school have developed, and specifically how students view this development and their relationship with schools.

Student/School Relationship and Performance to GCSE Level.

The Keele University database (1993/4) recorded the attitudes of 7000-8000 young people at secondary school. Here only 50% of the students surveyed viewed themselves and the school as friends, 25% as distant relatives, 10% as strangers, and 6% as enemies. These were considered as figures of concern and suggest 50% of pupils were not happy in their relationship with their schools. If 50% of students were not happy with their relationship with schools how effectively could their schools prepare them for employment?

The Keele study also revealed an expanding gap in terms of achievement between boys and girls in the 16 age group. In traditionally strong female areas such as English and modern languages the gap was widening. In subjects where boys were considered strong such as science and mathematics, girls took the lead in 1993 and 1995 respectively. The study also revealed that girls were consistently more positive, better motivated, better behaved and attaining higher grades than boys. This was despite the fact that boys recorded higher perceptions of parental support with their school work than girls. More boys than girls considered themselves very able, and more girls than boys consider themselves below average. The truth was almost always the reverse.

Female participants in this research frequently recorded that to succeed in areas of science and engineering they would have to be very good at science subjects. Girls did not consider themselves good enough despite constantly being reminded of the male and female performances at GCSE level. This was an area where input from science teachers was required. Low esteem in these areas is misplaced but consistent even at the all girls school. Removing the male presence has done nothing to improve female perceptions of themselves in science areas. This feeling of low esteem in ability must be addressed to encourage more females to enter physical science and engineering professions.

The Keele University study (1993/4) does not reflect falling standards with the percentage of students obtaining higher grades at GCSE rising from 15% to 50% between 1955 and 1994. Similarly 30% of students now enter Higher Education compared to 3% in 1955. These figures again cause concern. If grades at GCSE are improving and females are now outperforming males, then the combination of both these facts suggest any improved educational performance has been far greater for females than males. This may promote the question which gender needs most help at secondary school, but cannot explain the low participation rate of females in physical science and engineering areas.

Gender, Primary Schools and the National Curriculum.

The work of Smithers and Zientek (1991) revealed that anthropological studies across a wide variety of societies show men tend to take on one set of tasks and women another. This could clearly be related to the male "domains" of physical science and engineering.

To try to examine these ideas further, a series of experiments were performed in schools. The results of these experiments showed sexual stereotyping of activities e.g. car repairs men only, washing clothes female only. Responses from teachers such as "I was not aware of their attitudes" to "We expected more or less the results we had" could hardly be considered constructive in terms of breaking down sexually stereotypical beliefs and actions. Thirty percent of teachers surveyed said sex-typing was news to them and seventy percent who had encountered sex typing said it was because boys and girls tend to be drawn to different things. Although eighty four percent of teachers stated they took positive steps to achieve a balance, previous answers suggest this action is neither recognised as necessary or not effective.

Department of Education (1993) figures show that the majority of teachers in nursery/primary schools are female (82%). Of the 218 teacher surveyed by Smithers and Zientek, 96% were female. From this data it could be considered that female teachers were doing little to change and may even be promoting the continuation of sexual stereotyping. Hardly a case of females promoting female equality.

Teachers interviewed by Smithers and Zientek viewed the National Curriculum as advantageous in the fact that neither pupils nor teachers would be able to opt out of their least favourite areas. In this case activities would be less likely to be sex stereotyped. This may have been the objective, but students participating in this research suggest other over-riding factors. In this thesis research, no science graduates were found present at the primary schools. This was hardly surprising as Department of Education (1993) figures show that although 42% of nursery and primary school teachers are graduates, only 0.2% are graduates of physics, 0.5% graduates of chemistry and 3.2% graduates of biology.

The survey also revealed that biology, chemistry and physics were taught by the same teacher. This would seem a demanding task for a teacher with probably limited knowledge, and dare one say limited interest in these areas. The National Curriculum may mean teachers cannot opt out of their least favourite areas, but it does not mean they teach science in an effective manner. If teachers did not have sufficient interest to study science subjects beyond GCE or GCSE level then should we be surprised that boring and uninteresting were amongst the most commonly used terms to describe science lessons in primary schools during this research.

The answers to question 4 on the student interview sheet (appendix 2) indicated that most students form ideas regarding their likely career path at a very early age, predominantly during primary school years. Table 4.49 showing careers chosen by students at more than one school show similarities between the choices of both primary and secondary school pupils. This indicates that many careers selected at primary school remain popular with secondary school pupils. It is important that when interests in subjects and careers are being formed, pupils should be taught by graduate scientists who clearly have a great interest and knowledge of the subject. If students are turned off to science subjects at primary schools then the contents of table 4.49 suggests the chance of a recovery being made at secondary schools is restricted at best. The aims of the National Curriculum may have been to remove sex stereotyping but there is no evidence in this research to suggest it promotes interesting, involved science teaching.

To remove gender stereo-typing in schools Smithers and Zientek produced a list of ten recommendations. The five recommendations significant to this research are listed next.

1) Teachers need to be made aware of gender stereotyping among young children.

2) Girls should be encouraged to fully involve themselves in the science and technology curricula.

3) Attempts should be made to attract more men into teaching in nursery/primary schools.

4) It is essential that more people with good science qualifications be attracted into teaching the youngest children.

5) The National Curriculum must be kept under scrutiny to avoid any advantage going unwittingly to one sex or to the other.

These points are fully supported by this research with emphasis on points (2) and (4) seen as essential. To attract more males into science teaching may initially appear counter productive in providing role models for females, i.e. female science teachers would appear more ideal. However, as most science graduates are male, the need to see more science teachers teaching at primary schools may necessitate the employment of more male teachers, possibly only as a short term measure.

Specific measures may be necessary to attract a higher number of science graduates into teaching, but these will not be examined in depth by this research. If cost is the major concern then use of "early retirement" scientists to teach science at primary schools may be an option worthy of consideration provided enthusiasm and motivation by these early retired people could be maintained. It should be noted that the large majority of such a resource would be male.

Student responses recorded during the research section of this thesis suggests an improvement in the teaching of science in primary schools is required. The CBI news (March 1997) identified a need to examine the provision of education in primary schools. It also recorded that the redistribution of funding from other parts of the system could be risky. Interest in these subjects must be nurtured and maintained if there is to be any hope of attracting more females into physical science and engineering professions.

Changes in the Provision and Examination of Science at GCSE Level.

Over the last decade there has been a great change in both the provision of science education and its examination at GCE and GCSE level. The Department of Education figures showed that in year 1988/9 the majority of students entered took

GCSEs in the separate science subjects of physics, chemistry and biology. By 1993/4 approximately 90% of students entered took GCSEs in single or double sciences, with only around 10% still taking separate exams for physics, chemistry and biology. In 1993/4 approximately 50% of the students examined in single and dual science at GCSE level were female, but the percentage females taking physics, chemistry and biology GCSEs were 34.5, 36.6, and 40.1 respectively. If these figures are compared to those who took GCSEs in 1988/9, then 50.2% taking single and double science, 29.5% taking physics, 44.2% taking chemistry, and 62.2% taking biology were female. These figures indicated that the National Curriculum has increased the percentage of female students taking science exams at GCSE level due to science now being a compulsory element of the National Curriculum.

Department of Education GCSE results (1993/4) have shown that females now outperform males at GCSE level, but do not indicate whether the subjects were popular with females. This research study suggests they were not particularly popular and the main reason for the increased female participation is that the subjects are compulsory. As a result they will be disposed of at the first opportunity. The figures also supported one of the findings of this study, that biology was by far the most popular science with female students with chemistry and physics some distance behind in terms of popularity.

The National Curriculum Syllabuses for Single and Double Science Awards for the Southern Examining Group (1997) show that both awards have modular sections containing considerable biology, chemistry and physics content. Comments from several students studying single and dual awards were that they liked parts of science but not others. The integration of the sciences may make it difficult for a student to identify which part was chemistry, which physics and which biology. This linked to a high mathematics content, a subject several students recorded as an unpopular, in both physics and chemistry may make the overall popularity of science low but with biology clearly the preferred science of the three.

If the aim of the compulsory science element of the National Curriculum at GCSE level was to promote greater interest in science the following two sets of figures suggest it has not been a success. Halpin (1996) records that whilst the total number of A-levels taken increased from 725,992 in 1995 to 739,163 in 1996, there was an overall decrease in the number of science subjects taken. Biology was virtually stagnant from 51,848 to 51,894, chemistry fell from 42,280 to 40,455, and physics fell from 34,767 to 32,801. These figures were total and no gender based figures were available for this year. Department of Education figures for the period 1991/2 to 1993/4 were available on a gender basis. These showed the number of female students attempting A-levels or AS-levels for biology rising from 24,200 to 26,100, chemistry fairly static at 14,000 and 14,500, while physics fell from 7,200 to 6,300.

The figures above show a nett fall in the number of students studying physical science subjects at A and AS level and does not indicate the compulsory element of science in the National Curriculum at GCSE is promoting science to students of either gender. It could even be suggested that it may be counter-productive, as if all subjects have to be studied in combination, i.e. biology, chemistry and physics, none may be liked. These results certainly record falling interest levels in physical science subjects with both males and females.

Halpin (1996) recorded concern that science and technology subjects were not being taught in an exciting or attention grabbing manner. The Minister for Education and Employment (1996) had made some steps to rectify this by providing extra training to teachers via the teacher training establishment, but this will take some time to be noticed nationally.

Gender Differences and GCSE Results.

Department of Education figures (1994-1996) now show females outperforming males in attaining a higher percentage of A to C grades at GCSE level in all major subjects. Keele University (1994) examined the results of girls and boys at five Hampshire schools in 1992 and 1993 to try to explain this difference, postulating several reasons for this situation. Students appeared to enter secondary school highly motivated, but quickly became disenchanted with lessons. Increasing class sizes often led to boys "playing up" to gain more attention, but girls appeared to need reinforcement less frequently to maintain motivation. This study confirms these figures in that all students in all schools felt that girls worked harder at schools than boys. Words such as "girls are more mature than boys", and "boys only like fooling around", were frequently used.

The differing class performance of girls and boys indicates a difference in the way girls and boys develop. If so, continuing to teach science subjects in the same manner, a manner which has historically encouraged males and not females to follow higher educational routes in physical science and engineering (table 1) and take a large majority of training places (tables 4.60 and 4.63), is unlikely to promote greater female interest nor attract more females to science based professions. Table 4.56 shows science was considered a popular subject by some students at three of the schools visited during the thesis research. However, science was amongst the two least popular subjects at all six schools. Subjects which could be described as expressive and imaginative were popular, with practical involvement particularly popular at primary schools. Females surveyed stated they liked subjects during which teachers told them they were good at them. Equally they disliked subjects which were regimented, boring, uninteresting and confusing, terms recorded as describing science lessons.

It may be that boys have the same perceptions, but although these perceptions do not appear to lower female performance in these subjects, good performance may not be being recognised by females. Females at all schools felt that girls outperformed boys but clearly do not recognise their superior performances in science areas as an indicator to career progression to physical science and engineering based careers.

Ethnic Differences and Science Education for Girls.

The work of Solomon (1996) showed that the area of science was more popular with Asian girls than with similarly placed non-Asian girls. One of her conclusions was that Asian girls seemed keener than non-Asian girls in getting jobs in all categories except those which depended on a knowledge of current affairs (television and journalism). If Asian girls view careers in physical sciences and engineering as a possible option but have little knowledge of television and journalism, this suggests that television and journalistic products do not promote these careers to females? The fact that girls who do have a greater knowledge of television and journalism are more likely to view these career options in a less positive manner further suggests the media may be having a negative effect on the promotion of these career options to females.

Female career advancement for Asian girls was generally considered limited because they were expected to follow family traditions and marry early. To counteract this problem, a video to be watched by daughter, father and mother was produced in Urdu and Bengali versions with English subtitles. The initial response has been stated as very promising.

With the Hull area census (1991) revealing only 1.3% of the catchment area as non-whites, figures were always likely to be inconclusive in this area as was proven to be the case. It would be fair to conclude that female ethnic minority students in the East Yorkshire region were just as unlikely to follow an engineering or science profession as the group as a whole.

The importance of this section is that it does demonstrate that television and journalism may be used as a way to promote greater female participation in science, engineering and technology careers. This may be directly via television programmes and newspaper/magazine articles, or indirectly via videos produced and targeted to promote female participation.

Co-educational versus Single-Sex Schooling.

Single-sex education was largely removed in England and Wales with the reorganisation to comprehensive schooling in the 1960s. Single-sex schools survived mainly as grammar schools and selective schools and thus the ability of pupils must be considered when comparing performances of mixed gender schools to single sex schools. Equally important was parental background which can differ greatly when comparing schools that are selective to those that are not.

Smithers and Collings (1981) suggested that the choice of mathematics or science at A-level was purely down to ability. If this were so then current GCSE results suggest females should dominate all A-level programmes in mathematics and sciences, something which is not the case. Halpin (1996) recorded a continuing fall in 1996 of students selecting to study A-level mathematics and sciences, but this fall was lowest for girls at independent schools, a high percentage of which were single-sex schools. This would support the theory that removing males from science areas may promote female participation.

The Times Educational Supplement (Aug 25th 1995) quoted the work of Dr Lindsay Paterson and Leicester University. This recorded that although single sex schools did induce girls to adopt a more positive approach to mathematics and science, at least in the junior years, there was no evidence to suggest that girls at single sex schools did better at GCSEs than girls at co-educational schools. Smithers and Robinson (1995) also concluded that what at first sight appears to be improved performance at single sex schools is in fact mainly due to differences in intake, particularly ability and social class.

Researchers` data give confusing signals as to the advantages of single sex over co-educational schooling. This research survey found no significant difference in the aspirations of students in single sex and co-educational schools. A more recognisable note was that awareness of the differences between the sciences and a greater popularity was recorded at the single sex school. Unfortunately this was not reflected in a likely higher progression to careers in science, engineering or technology. Hence this research gives little support to activists wishing to separate the sexes for mathematics and science lessons as this alone will not promote increased participation and interest leading to more females progressing to physical science and engineering careers.

Teaching and Teacher Training.

.In the WISE essay competition (1994) 56% of the respondents stated that they did not consider technology or science was taught in an exciting manner likely to capture the attention of females. This promotes the question as to whether teachers, and primary school teachers in particular, can effectively prepare pupils for a science based career.

Figures from the Department of Education (1993) showed that although 42% of nursery and primary school teachers are graduates, only 0.2% are graduates of physics, 0.5% graduates of chemistry and 3.2% graduates of biology. The Department of Education had recognised there was a shortage of science teachers in schools and provided figures and projections for the period 1992/3 to 1997/8. Although showing consistent total intake figures of around 32,000 teachers per year, the figures showed an increase from 7.1% in 1992/3 to 12.8% in 1997/8 for science teachers. However the figures did not show whether these teachers would be biologists, chemists, or physicists, presumably as science was considered a single subject. Figures in this paragraph show there are significantly less graduates of chemistry and physics teaching than those of biology. Unless more physics and chemistry graduates than biology graduates undergo teacher training then physical science teaching may not receive any significant boost.

These figures did also suggest a move from primary to secondary teacher training. In 1992/3 there were 18,364 primary and 13,616 secondary training places but by

1997/8 these were to be 11,950 primary and 20,000 secondary. There was no indication of where the increased percentage science teachers were to be assigned, but the overall figures suggest they may not be in the primary area where they appeared to be needed most.

The findings of the OFSTED report on the Department of Teaching and Education at Lancaster University (1996) found the quality of training for the teaching of English, mathematics, assessment, recording and reporting, and quality assurance arrangements all unsatisfactory. With such problems identified in the areas of English and mathematics, there could quite easily be difficulties for the same teachers to effectively teach science. Turner (1996) interviewed some newly qualified teachers and recorded their findings. They commented that much of their training was spent on various teaching methodologies, concentrating on collaborative group learning with little emphasis on whole class teaching. Although not considering what may be pupils` preferred learning method, with large class sizes how effectively can any teacher promote learning to several different groups within a single classroom?

The research performed suggested all is not well with teacher training. A need to encourage more science graduates to teach at primary schools would appear to be evident. A change in teacher training would also be also required to identify best teaching strategies and adapt them to current classroom needs. However to promote the findings of Foskett and Hemsley-Brown (1997) to encourage more females to enter science and engineering professions, what better encouragement could there be than female role models in the classroom.

Many teachers appear to follow a school, teacher training, school route. Allowing science graduates, and particularly female graduates, to experience industrial positions prior to returning to teaching would help in providing role models. If this was not practical, secondment or exchanges to companies may be beneficial to both parties. Teachers could gain industrial experiences, and industries would gain direct contact to schools likely to produce future employees. The outcomes are that both parties could have a joint influence on both teaching and company development and employment plans.

There would appear to be one major problem with these suggestions. With relatively low numbers of female scientists and engineers, where should their main inputs be, as exemplars in industry or as classroom role models? Foskett and Hemsley-Brown (1997) state the importance of contacted images to young people to promote specific career opportunities. Thus the role of newly qualified female engineers and physical scientists is very important to promote gender equality in these professions.

Teachers, especially primary school teachers, will play a fundamental role in bringing about the changes this thesis demands in terms of equality. Effective strategy should be developed to meet both initial and changing requirements to effectively promote gender equality in science and engineering professions. Teachers should be aware of peer group pressures at school and home. They must operate a team philosophy to both break moulds, and supply the role models required. Only then will a situation occur where success breeds success and gender equality can be reached.

Careers Paths and Reasons for Their Choice.

The study revealed that the preferred career path chosen by students from the six primary and secondary schools were very similar and supportive of sex stereotyping. If these results were related to the work of West and Hunter (1993), there was little to suggest that single sex schooling had done anything to reduce sex stereotyping for these female students. Several students recorded they felt these careers would be boring and unenjoyable, the same way as science lessons at school were often described. Only 5% (9 in 167) of the students felt engineering and science was a males only job.

The thesis research provided some important directional pointers. Firstly students recorded that employers had little influence on career selection. If employers wished to attract more female scientists or engineers, perhaps a greater involvement with schools may be beneficial. Secondly the Careers Service played a greater part with secondary school students than with primary school students where it appeared to be almost non-existent. Should this be the case, especially in view of child development theory? If some reference point is required for development to occur, if this cannot be provided from relatives or friends, then it must be provided at school. The work of Foskett and Hemsley-Brown (1997) supports this point and suggests that positive images must be created at primary school to encourage more females into engineering and physical science professions.

Thirdly influences of parents and relatives were by far the greatest influence on career selection recorded at all schools. However the influence of friends, particularly at the primary schools were recorded as very high. This may once again be contrary to the suggestions of West and Hunter (1993). In single sex schools the influence of males, with the possible exception of teachers, would be totally removed. If there were no friends to talk about careers such as science and engineering the result may be increased career stereotyping.

The fourth and final comment made in this section regards the influence of the media. Although obtaining a reasonable score, it would appear that the media effects are not recognised by students. Careers such as criminal psychology and marine biology were probably selected as a result of the influences of television programmes (Cracker and wildlife programmes shown the week of the discussion). If the students cannot recognise these influences then this area may have been significantly understated.

The career aspirations of all groups of students were very similar, but students` ideas of how to attain them were very different. Some of the students of the suburban and all girls schools had already considered and planned higher education programmes. The inner city school students had similar career aspirations but relatively poor future plans as to how to attain them, which may be related to parental background. Inner city schools had a far higher percentage of "blue colour" than "white collar" parents, with several pupils coming from single parent families. Parents have a strong influence as to which career their children will follow, and this can be positive or negative. Two students had been put off engineering careers by parents who were engineers trying to positively influence such a career choice. However, 42% of students surveyed said they would have been more interested in a science or engineering career if one had been discussed with their parents.

Careers service at the schools surveyed appeared to have little influence on career selection. All three secondary schools studied appeared to have active careers services but few students made use of them. No such services appeared available at the primary schools.

A final point worthy of note was that when asked what items would influence taking a specific job, although financial rewards were mentioned, it was frequently stressed that this would not be the main factor. The location of the company, its size, reputation, and the "people I would have to work with" were of equal or greater importance. Items such as creche facilities, and career breaks were also mentioned. From this it could be concluded that there are many ways to attract female students to follow science and engineering careers, with salary not being a major issue.

Attracting Females to Study Science at Higher Levels.

The Department for Education and Employment Separate Tables of Statistics on women and men in education, training and employment (1997) listed entries and achievements for candidates at A-level science subjects in England in 1994/5. These figures showed 122,173 male and 80,376 female entries. The percentage pass rate for females was higher in all areas apart from computer studies where males outperformed females by 75.1% to 67.5%. The fact that fewer females than males were studying A-level sciences did cause some concern, but the Department of Education and Employment(DfEE) was not aware of any action to try to change this situation. In fact it was considered that no remedial action may be required as the choice of A-levels may reflect the choice of individual students influenced by other factors These factors may be such as the range of job opportunities and their competing attractions in occupations, and may not require an academic background in science.

As the number of students taking science A-levels has fallen quite significantly from 1995 to 1996, did the DfEE feel that this may be a result of the National Curriculum method of teaching combined sciences via single and dual awards? The DfEE representatives again stated it was not possible to agreed with such a statement as there may be other influences playing a far greater part such as current employment trends which may attract females away from science and engineering areas. Students will be influenced to study A-levels which offer the best potential for employment and these will alter with time.

Examining educational areas there was concern expressed during this research that in England and Wales not as much was being done as in Scotland to attract females into SET areas in schools. The advantages of a broader curriculum to encourage the study of science beyond the age of 16 had already shown promising results in Scotland. Expansion of this project into the rest of the UK should increase and retain for longer an interest in SET subjects. The following figures demonstrate how changes to the Scottish educational system in terms of a broader post 16 educational base have affected A-level selection. The ratio of male to female students on A-level courses in Scotland were Technology 3:1 (England 4:1), Physics 2:1 (England 3:1).

To state nothing or very little can be done to influence student A-level choices has been shown not to be the case by the example of the Hackney Community College. The College developed a programme to attract more female students onto their A-level science courses. From 1990 when there were 3 female A-level science entries with one pass, between 1991 - 96 there have been 198 entries with 160 passes, 50% in A - C grades. These gains were not made at the expense of boys as A-level entries and success has increased from 16 entries and 13 passes in 1990 to 162 entries and 137 passes between 1991 - 96. Subjects subsequently studied by female students from this programme at university included biochemistry, biology, genetics, microbiology, pharmacy, polymer science, psychology, radiography, zoology, and photographic and electronic imaging in science.

To promote change the Hackney College course team spent a lot of time visiting schools in the area to attract students on to their science A-level programme, demonstrating specifically that it should not be considered a male dominated area of study. Once the break through had been made in the first year, word was quickly passed around so maintaining and increasing numbers was not a problem in future years. Satisfied, successful students appeared to be the most marketable asset.

What exactly were the reasons for this dramatic turn-around? To respond to the situation existing at Hackney College in 1990, the following explicit strategy was developed into its action plan. The project was then operated as a totally holistic approach by staff members (male and female) highly experienced and committed to equal opportunities.

1) Creating an ethos and learning environment which eliminated the "male image" of science.

2) Prioritising recruitment of young women.

3) Ensuring balanced groups avoid overt domination by male students.

4) Providing support mechanisms and extra-curricular activities to enhance achievement and progress.

5) Delivering the curriculum and adopting teaching strategies in ways which encouraged rather than alienated young women.

The use of information technology and multi-media, student presentations, regular practical work and evaluations, and specifically highlighting the contribution of women scientists were part of the methodology. Other significant items were;

6) Enhancement of the curriculum to include A/S levels in chemistry, physics and science, technology and society, the latter particularly attracting young women because it provided the opportunity to discuss political, philosophical, environmental and ethical considerations in science.

7) Establishment of a "mathematics for scientists" supplementary course, which enabled girls to develop their mathematical skills and practice these in a scientific context.

8) Provision of additional language and physics support.

9) Extra-curricular activities including field trips, residential visits, courses, visits, lectures, job shadowing, summer schools and industrial experience.

Over the five years so far the project team established a clear curriculum plan which evolved each year. Initially it emphasised positive recruitment, tracking, skills audits and support networks. Lesson delivery methods which encapsulated the view of science as "men in white coats" were disbanded in favour of interactive learning in which science was seen as an active process involving people.

The good practices around which this scheme has been based could easily form a model for similar ventures around the country. Female encouragement matched to field trips and industrial experience were two of the prime areas this research suggests are necessary to promote significant change. The Hackney College experiences also demonstrate that females can be encouraged to perform alongside males and indicates that segregation of the sexes in science lessons is not necessary.

5.6 - EQUAL OPPORTUNITIES IN SCIENCE AND EDUCATION.

A fundamental part of this research was the examination of equal opportunities for females. If such opportunities do not exist then any attempts to gain equality would be hindered. This section examined the existing situation and movement towards a system of equal opportunities.

Equal Opportunities in Schools.

The importance of equal opportunities at school can be emphasised by the work of Brown (1989). Brown measured involvement at primary school level and found that males often dominated science sessions. She felt girls participation at this level was essential if they were to develop investigative experiences and skills to become scientists and engineers of the future. Brown (1989) identified the fact that girls and boys at nursery and primary level were often given different types of toys to play with, and led to a difference in basic skills development. As a result, she felt positive discrimination was necessary to change current trends. This fact was also identified by 47% of the respondents to the WISE essay competition (1994) who also identified this basic skill deficiency amongst young females, and the same causes, for a lack of interest in science.

One of the suggestions in the WISE essay conclusions, was that publications should target girls in years 10 and 11 (15 - 16 years old) in secondary schools. It was now considered that a better target age may be year 9 at GCSE choice stage. Following discussion during the interview stage of this research, it was noted that this figure may need to be reviewed and probably lowered significantly.

If female pupils and researchers felt there were not equal opportunities in schools, did investigative bodies agree with their hypothesis? The Equal Opportunities Commission (1996) produced a report covering the topic of equal opportunities in schools in some detail. The report tended to concentrate on curriculum practise and employment concerns rather than on pupil performance or on parental guidance. Support for equal opportunities has gradually moved from Local Education Authority (LEA) control towards that of individual schools as more and more schools opted out of LEA control. As 70% of schools questioned stated their local LEA had not provided any equal opportunities training, this could be considered to be a good step. The report also stated that pupil's perceptions of gender issues were seen as more open and sensitive to changing cultural expectations and/or changes in the labour market. Nevertheless, occupational choices for both sexes appear to remain conventional and stereotyped. These two statements are clearly in conflict. If occupational choices are stereotyped, then this can only be because of closed inflexible ideologies. This immediately casts doubts on the report as a whole.

Schools and LEAs were found to be shaped largely by the culture of male management (in the staffing, and chairs of governing bodies). Clearly more female involvement would be of benefit to achieving gender equality. The report concluded that cultural, demographic and labour market changes have influenced the way students and teachers think about the schooling of girls and boys. In the competitive climate of the 1990's female students were proving attractive to schools in preference to lower performing boys.

From this report it was clear that schools were aware of gender issues in both school selection and career selection. However, it was only possible to conclude that schools were aware of the improved performance ratings of females over males but appear to be concentrating on exploiting female performance to enhance their own ratings, via league tables, rather than promoting female superiority to end career stereotyping. It could also be stated that females who do go on to take A-level science subjects tend to pursue science careers in stereo-typed areas, as the Hackney College report indicates. Here physical sciences were almost totally absent from the list of higher education programmes followed once A-levels had been completed.

The schools themselves may have some effect on the choice of university courses followed by their students, but so do universities and employers. These two groups need to adopt a similar policy to Hackney College in attracting more females leaving school into their respective programmes and careers to achieve gender equality.

Equal Opportunities in Employment.

Earlier sections in this discussion have noted the progression females have made in certain professions. They have also noted the slow progress towards gender equality in science and engineering professions. An example of the latter was the Institution of Electrical Engineers, which according to the Daily Mail (12th January 1995) listed only 200 females in a total of 28,000 members worldwide. This section examines if equal opportunities actually exist for females in science and engineering professional areas.

The same Daily Mail article reported the case of Hayley Gladstone who won the 1994 Young Woman of the Year Engineer Award. When she told her careers teacher at school she wanted to be an engineer, the teacher responded that she did not stand a chance, the teacher's image of an engineer being someone having grease behind the fingernails. This may have initially been considered a "school problem" as it was Hayley Gladstone's school which could easily have changed her career aspirations. Before blaming the school one must question how the teacher obtained this view and what is being done to change it by the people who promote science and engineering. Bronzi, Mason, Tarris, and Zaki (1995) recorded that most people do not know what engineering is, and those who claim to have negative and incorrect images of the field. Clearly school attitudes and career advise service need to change and the promotion of must be driven by employers and professional bodies. Are they taking the necessary steps to provide information and equal opportunities, and if not do such bodies wish to provide these?

The Engineering Council views the methods of attaining equality of genders in engineering as a global concern. The Women into Science and Engineering (WISE) campaign acknowledges the involvement of parents, primary and secondary schools, as well as employers in promoting and managing change. Areas identified by the WISE campaign to promote female involvement were equipment (scientific toys), experiences (doing rather than watching), entitlement (equal attention and support for girls and boys), encouragement (confidence building), esteem (feeling proud of achievements), and finally examples (female role models). The WISE essay competition (1994) report recorded that 43% of respondents viewed engineering companies as male dominated with little interest in the provisions for the needs of female engineers. The "token woman" was often only tolerated to promote the idea of gender equality in their workplace. From this exercise it can be seen that females in general do not feel that engineering and physical science employers are operating a true equal opportunities policy.

The findings of this thesis suggest that there are very few female applicants for engineering training/apprenticeship places in the East Yorkshire region. In terms of places offered these are far higher (in some cases ten times higher) than the national average percentage of female applicants for such roles. The national average figures for engineering based modern apprenticeship starts suggest somewhere around 2% of starters are female. In terms of science opportunities things look far better for females with local employers showing around 40% of training places taken by females and nationally 14% via modern apprenticeships. These figures suggest that in the Hull and East Yorkshire region employers are doing better than the national average, but could they do more to encourage increased numbers of female starters?

Approximately 98% of all primary and secondary school pupils stated they would like to see more companies visiting their schools to discuss employment areas. The students would also like the chance to visit companies and have work experience opportunities even in engineering areas. This offers employers great scope, if the results of the Hackney College programme are considered, particularly at primary schools where career aspiration may be more easily influenced.

The Department of Education (1997) figures for Modern Apprenticeships do not suggest equal opportunities in the science and engineering areas. There are 14.3% of female starts in a total of 435 chemical industry starts. However in Electrical Installations 1.2% in 3,961, 3.6% in Engineering Manufacturing from 12,490, 1.4% in construction from 6,027, 2.2% in motor industry from 2.2%. These figures were also supported locally by the data provided by the Humberside TEC and shown in table 4.63. If the performance of students taking GCSEs were to be considered here, the most suitable candidates for these positions are females. Why then do males continue to dominate?

The answer could be lack of encouragement by the recruitment sections of employers to actually recruit a higher percentage of females. The questionnaire sent to companies employing young people in the engineering and physical science sectors in the Hull and East Riding of Yorkshire area revealed that although large companies have attracted a low percentage of females to these areas, small to medium sized employers have very few or no female employees in these areas. It appears that many employers are happy to settle for what they have rather than promoting change by expending more on policies aimed at recruiting more females to these areas.

Perhaps they should remember the comments of some of the UKs larger companies made in Making the Most (1995). Rank Xerox stated,

> "Twenty percent of graduates in engineering and technology are, today, women. Our business will flourish when we can attract and develop the best performers from this strategic recruitment source. We see excellent opportunities ahead".

Glaxo-Wellcome have seen an increase from 10% to 18% from 1990 to 1994 in the representation of women in Glaxo Research and Development Management and International Specialists. The DTI/Opportunity 2000 booklet Making the Most (1995) recorded that figures for women employees returning after maternity leave have increased from 40% in 1988 to 90% in 1994. Esso noted the general decline in first degree chemical engineering graduates from universities over the period 1987 to 1992. In face of increasing competition for a decreasing resource Esso forged its initial equal opportunities plan to meet future needs.

As indicated by Glaxo-Welcome, recruitment is not the only problem area. In an interview conducted during this research, the Confederation of British Industry also reported that one of their major concerns was the high drop out rate of female engineers. This may be due to many reasons, sexual prejudices in the work place, lack of career break opportunities, poor skills updating opportunities after career breaks, are but a few possibilities. It makes good economic sense to retain skilled staff and more could be done to highlight the benefits of attracting and retaining staff who may wish to take career breaks. This research suggested that management culture was not considered correct to attain significant advances at the present time. With so few females entering engineering and science professions major effort must be expended to minimise female departures to both promote the attainment of senior positions by more female, and thus maximise the role model aspect. In terms of role models this research indicated the two most effective areas were considered to be young females, under 25, to whom the students could relate, together with females currently occupying senior level positions. The latter would demonstrate the career advancement potential that exists.

To meet world class innovation, products and performance in science, engineering and technology (SET), Making the Most (1995) suggested the following points to be closely interlinked.

1) Demonstrable career opportunities for boys and girls.

2) Teacher and parent involvement.

3) Equal access and encouragement of girls and boys.

4) Aspiration into SET.

5) Positive consideration of a career in science and industry.

6) Feedstock for employers.

7) Employers valuing equality and promoting diversity.

8) Merit based career and environment.

This could clearly be used as a basis for developing an action plan to remove the sexual bias this research clearly indicates is still in place, but certain areas will need to be significantly expanded.

To demonstrate equality of career opportunities to males and females there must be a networking of organisations including schools, universities, employers, training agencies. The use of current and increasing role models available via the existing support schemes nationally co-ordinated but with regional based contacts would seem essential. This research indicated there was no shortage of exemplars to fulfil this task on either a national or regional basis, or access to material to support any related project. What this thesis also indicated was a lack of knowledge of what was available, or desire to use it.

To achieve the aims of this research there must be better use of the media to create what Foskett and Hemsley-Brown (1997) term favourable divised images of career opportunities in engineering and physical sciences. This research has recorded significant advances in media coverage of female scientific and engineering involvement, but there remains some way to go. The recent increase in journal and newspaper articles were encouraging and would hopefully continue to grow. Employers can play an important role in the use of this valuable resource.

The final comment in this section regards gender prejudice. A possible conclusion that can be reached for the continuing female minority participation in engineering and many science professions is that of prejudice. If employers really wanted more female scientists and engineers, they would find them. Only once all prejudice in the workplace has been removed will gender equality be achieved.

5.7 - A FEMINIST PERSPECTIVE.

Eichenbaum and Orbach (1992) examined the historical, social and psychological demands on women. They stated that social pressures have historically led to women deferring to others, predominantly males, resulting in the feeling of becoming a shadow. Psychoanalysis had on the other hand encouraged individuals to act on their own behalf. The results of a combination of these two effects were that women felt they had changed a lot but society had not changed as quickly. Wilkinson (1994) identified a change in the national culture and female employment aspirations. The acceptance of low paid, often part time jobs by females had diminished dramatically. However, there remained a high negative reaction to males accepting females in employment regions which were still considered "male domains". This continues to cause conflict particularly with younger age group females brought up in a culture which tells them to no longer accept this situation.

Wilkinson (1994) recorded that females were moving from traditional values on family attachments and responsibilities, becoming more escapist, international, and being more inclined to take risks and be hedonistic. This has allowed women to take leading dominant roles which only 10 to 20 years ago would have been considered male roles. Jobs requiring physical strength have long been, and continue to remain in decline, and the movement of employers to flexible employment conditions also open more opportunities to women. Despite these changes many females considered there was a failure of institutions to deliver in meeting the growing female aspirations.

Females would appear to possess equal if not superior skills to males in terms of meeting current employment criteria. The Institute of Management (1994) considered managers no longer need to be the "Boss" but team leaders. Team working, consensus management, negotiating, interpersonal skills, and the ability to handle several projects at once would appear to make females more ideal as modern managers. There was also some evidence that females are fed up with waiting for change. The Centre for Policy Alternatives (1990) recorded that many females in the USA preferred to set up their own small businesses in preference to trying to alter existing work cultures.

Can the Pace of Change be Accelerated?

Wilkinson (1994) commented that older feminists tended to view male resistance to gender employment equality as "bloody-mindedness". Other researchers were less confrontational and offered options to move towards gender equality. A survey by the Guardian (1991) revealed 58% of females surveyed felt there was discrimination in the workplace. The survey also suggested that political initiatives were not seen as being required to bring about the desired changes. This view was supported by the Institute of Directors (1992) where a survey of women directors revealed the following. Over 70% felt women do not have equal opportunities in the workplace, with male attitudes (37%) cited as the most common problem. However 90% rejected quotas and 70% rejected targets as a method of reaching equality.

Overall this research revealed it was felt objectives could be more effectively met by employers providing both greater encouragement and progression routes to females. Cultivation of a more balanced working environment would, once achieved, be self generative. A holistic approach was favoured to influence the change in the current gender bias. Here females could not only be targeted but inspired to follow such careers. Equality of opportunity at all stages would be the key.

Wajcman (1996) stated that historical relationships of the genders must be sidestepped to gain equality. Perhaps looking backwards should be replaced by setting and achieving future targets to equality.

5.8 - CURRENT ACTION AND GOVERNMENTAL INVOLVEMENT.

The Rising Tide (1994) report detailed a series of actions considered necessary to promote greater female involvement in the fields of science, engineering and technology (SET). The report raised three principal questions. Firstly, how can girls become sufficiently interested in science, engineering and technology to choose to study these subjects at school, college and university? The recommendation was for the Department of Education, and education and training establishments to ensure the training of teachers on equal opportunities issues included guidance on means of maintaining the interest of girls and boys in all science subjects.

To achieve these aims all children need to acquire basic technical skills, and science and engineering must not be perceived as a masculine career option. Students must feel science and technology subjects are inherently exciting and challenging subjects, and learning materials, from nursery schools upwards, must not be gender typed. More work was required to validate claims that girls performed better in science in single sex schools, as current studies were mixed in their findings. With science and mathematics as core subjects and technology as a compulsory subject in the National Curriculum, it was hoped more 16 year olds would choose to study science and engineering. This has subsequently been seen not to be the case! Perhaps more engineering and physical science work experience opportunities, an idea supported by pupils and employers surveyed in this research, would show a more positive result.

A change in A-level provision providing a broader based system may encourage more females to study science and technology options. But is diluting an unattractive subject with inclusion of a more attractive subject a realistic option? Surely making the subject more attractive is the only true solution. Trying to delay the point at which science can be removed from the compulsory teaching syllabus will not make it more attractive in terms of vocational selection. Attending what are conceived as boring and uninteresting subjects for an even longer period of time is likely to have the very opposite effect.

The second question raised was how can careers in science and engineering be made more accessible and attractive to women, and result in their skills and expertise being used more effectively? Equal opportunities policies should be a recognised part of an organisation`s strategy. Training and Enterprise Councils (TECs) and Local Enterprise Companies (LECs) could play greater roles by encouraging girls to visit employers whose operations are science and engineering based. Once employed, flexible working patterns, child-care provision, and "keeping in touch" schemes during career breaks will all assist the attraction and maintaining of a higher proportion of female scientists and engineers.

The third question was how can it be ensured that more women are represented on, and chair, boards and bodies responsible for developing and managing policy in these areas? Establishing databases and networks of women scientists and engineers qualified for appointment to boards, committees or public appointments would provide the base for this progression. Career development plans must include projections of females and males to pivotal positions. Government departments and other employers should set targets specifically for all public appointments and senior positions in SET, including chairmanships, of at least 25% qualified women, by no later than the year 2000.

The report also highlighted the importance of the media. The image of scientists, engineers and technologists was considered to be strongly influenced by the media. The perceptions of children were often formed by their exposure to this media coverage. Developing and promoting a media strategy would be fundamental in bringing about the changes this thesis suggests are required.

CHAPTER 6

CONCLUSION.

To conclude this thesis, two questions have to be asked. Firstly why does entry to so many engineering and science vocational areas remain dominated by male candidates, secondly is this trend reversible?". This chapter has been divided into two sections, the first section examining why this situation exists, and the second at what steps appeared necessary to promote change.

6.1 - WHY DOES ENTRY TO SO MANY ENGINEERING AND PHYSICAL SCIENCE VOCATIONAL AREAS REMAIN DOMINATED BY MALE CANDIDATES?

There appeared to be three major reasons why this situation has occurred and continues at present despite significant rhetoric to the contrary. These three reasons are vocational and professional history, the teaching of science, and finally employment opportunities. Each have been reviewed in turn.

Vocational and Profession History.

Historically engineering vocations have often been dirty and physically demanding making employers very reluctant to consider females as desirable or suitable employees. Science professions have similarly excluded females although reasons for this are more difficult to identify. The failure of universities to grant degrees to females certainly prevented major involvement in science up to the 1930's, but why so little progress to senior academic and professional body committees has been made since was more difficult to understand. Perhaps these areas were still unofficially considered to be "male clubs" with conscious and unconscious effort made to exclude significant female presence.

This situation could equally have been applied to many other professions but as this research has demonstrated, professions such as law and accountancy show female involvement currently matching or exceeding that of males. It can be argued that senior positions in these professions remain dominated by males as well, but with so many females entering these professions this situation must change.

It would therefore be safe to conclude that exclusion of females from science and engineering professions can be partially blamed on historical circumstances, but how long can historical circumstances be blamed for continued male dominance of these professions? Current performances and expectations suggested this was a situation which should no longer exist.

Teaching of Science.

The second area considered was that of science teaching. From this research female students have continually reported that they find science lessons boring and uninteresting. Of the schools surveyed in this research, science was amongst the two least popular subjects for females at all six schools. Other lessons were not viewed in the same way and those that allowed expression and imagination were the most popular. There appeared to be a problem with the current teaching of science in both primary and secondary schools which was failing to capture the imagination of female pupils. The fact that the students in primary schools were very unlikely to be taught by a science graduate may have been significant. How effectively can complex subjects be taught by teachers who may have limited knowledge and enthusiasm for them? It seemed illogical not to teach a specialised subject by using teachers with specialist skills. The only justifications for not employing more graduate scientists at this level could have been availability and cost as there were far more employed at secondary level with the exception of female physics teachers.

Another area which caused concern was girls perceptions of their own abilities. Girls did not appear to consider themselves as able as boys, although current GCSE results suggest otherwise. Equally they did not consider themselves in possession of sufficient ability to pursue a science based career. "You need to be very good at science to follow a science career," was a frequent comment. The obvious conclusion being that girls felt they were not good enough. Perceptions of ability in sciences may be similar for males as well as females. If this were so it would explain in some way why the number of both male and female students progressing to take A-level science subjects continued to fall each year.

Employment Opportunities.

This was the most significant area of the three. As current GCSE results reveal girls now outperform boys in the areas of science and mathematics, one could suggest that females and not males would make the better scientists and engineers, all other things being equal. Developments in the last two decades have almost totally removed physical strength as being a major requirement for these professions. The qualities of team working, negotiating, inter-personal skills, and multi-tasking, are currently just as or in some cases more important to scientists and engineers, and are arguably possessed in greater abundance by females than males. If this were so, females again seemed more desirable than males for these professions.

This research has revealed that at modern apprenticeship level (16 to 20 years of age) only 15% of science starts and 2% of engineering starts were female. At university, entry of females to engineering programmes were around 15%. These figures seem ridiculously low when comparing male/female abilities and achievements at this age.

It could only be concluded that employers may state they would like to see more females in these areas, but are doing little to change this situation. Whether this is due to continuing male prejudice or lack of effort in trying to attract more females, the result is the same. The professions of science and engineering can never reach their true potential when many of the most able candidates are not entering them.

6.2 - IS THE CURRENT TREND REVERSIBLE?

The answer to this question is yes and exemplars such as the Hackney Community College have shown exactly how quickly such a situation can be reversed if the desire to do so were present. The consensus reached from areas examined suggested that strong interventions such as quotas would not be a desirable method of addressing the situation. Targets and persuasion were seen as the only acceptable intervention methods. To achieve gender equality a holistic approach would be necessary, and the following stages provide an action plan to achieve the desired results.

1) If cognitive and psychoanalytical child development theory were considered then the unconscious thoughts and feelings are just as important to the 2 to 12 age group as conscious thoughts. It is imperative that the projection of science and engineering as potential professions for females must be purveyed positively by parents, friends, teachers, careers staff, schools, colleges, universities, trainers, employers, and the media.

2) All children need to acquire basic technical skills, and science (particularly physical science) and engineering must not be perceived as a masculine career option. Pupils must feel science and technology subjects are inherently exciting and challenging subjects, and learning materials, from nursery schools upwards, must not be gender typed.

3) To assist in the attainment of point (2), teacher training and retraining must ensure science teachers create a learning environment which eliminates the "male image" of science. More emphasis on recognition of sex stereotyped behaviour and rectification methods should also be essential.

4) Science must be taught in a more exciting and inventive manner to attract and maintain the interest of both genders. Science and associated career options must be promoted more effectively and reverse the declining number of students taking science at A-level.

5) This research has shown that girls do not consider themselves as able as boys even though current GCSE results suggest they are more able than boys. Girls in science lessons must be constantly encouraged with good performances rewarded if their expectations and aspirations towards a science career are to be maintained and achieved. There was little evidence that gender separation for science classes will improve female participation in these career options.

6) The National Curriculum science provision should be examined. The teaching of combined sciences as single or dual science awards may mean that students who do not like one area are being "turned off" to all science subjects because all sciences have to be studied for a single or dual award. Are biology, chemistry and physics any more suitable to be taught as a combined subject than say economics, geography and woodwork?

It was quite clear that females can see a distinct difference between the three sciences and their preferences are biology, chemistry and then physics in that order. If students can detect significant differences between the subjects is it not time to admit there are significant differences and revert to teaching them as subjects in their own right, rather than a de-motivating mixture?

7) The possibility of a broader A-level curriculum should be examined. This may encourage a greater science involvement if the results of the Scottish experiences are maintained. This must be a selected attractive A-level route and not a compulsory one, or science will merely be dropped at age 18 instead of age 16.

Greater science participation is desirable to reverse the fall in the number of students taking science A - levels. If this fall were not to be reversed, where will the graduate scientists and engineers of the future come from?

8) Science lessons in primary schools should be taught by science graduates who have demonstrated both knowledge and interest in the subject. To encourage a higher female participation, more female science teachers would be preferable to provide more role models. The shortage of female science graduates may in the short term mean these science teachers have to be predominantly male.

The use of science graduates who have taken early retirement, and the sharing of teachers between schools were other possible options to achieve this objective.

9) Science and engineering based educational and employment material, particularly audio, visual and multi-media products should be produced in a form which makes them essential to use at schools. Some good material was available at the time of this research, but it was clearly not reaching students.

10) Schools need to network effectively, particularly with other educational establishments and employers to both improve skills and become aware of current employment opportunities for their students. The use of female role models from science and engineering industries were freely available and considerably under used.

11) Training agencies (specifically TECs) and educational establishments must be set targets for female participation. These targets must not be overall targets, but broken into specific employment sectors. In this way low participation rates in one sector cannot be disguised by higher rates in another producing an apparently acceptable overall figure.

Employers and TECs should be expected to explain low female participation rates with penalties for unacceptable answers. Low numbers of applicants should be one unacceptable answer. These bodies must find why females are not applying and rectify the situation.

Students surveyed in this research indicated only 5% viewed science and engineering as a males only career. If 95% of potential female trainees have an open mind about these careers, training agencies appear to be doing little to attract more females to these areas.

12) Employers must take a more pro-active stance on attracting females to these areas. Pupils of all schools in this survey stated they would like to make more visits to companies and experience a range of work experience opportunities, and this view was supported by employers of young people in engineering and physical science sectors in the Hull and East riding of Yorkshire area. Visits involving primary school pupils may be the most rewarding as career decisions appear more flexible at this age. The opportunity to show males and females working alongside each other in science and engineering environments would produce an image hard to erase. These visits could be linked to school science clubs. The influence of friends on career choices, particularly at primary school level was very apparent in this research. Discussion and involvement were two items very important to creating and maintaining subject interest to female students.

Results may be enhanced further by the choice of schools targeted by employers. Science and engineering professions may not be a very acceptable option to females planning a career in law or accountancy, but very acceptable option to those likely to become shop assistants. Although a radical proposal, and not one to be maintained in the long term, in the short term it may produce the most significant results.

13) Attracting more females to these professional areas requires significant changes in company action planning and procedures. Allowing for career breaks, creche facilities, updating/retraining during and after career breaks, will attract more female to these professions and allow companies to retain highly skilled staff.

14) The media must present engineering and science careers in a more positive manner to create a more favourable devised image of these careers. The subjects may not be "sexy" but the drab way they are often reported does little to enhance them. The media effectively market employment fields and once again it is up to schools, colleges, universities, training agencies and employers to maximise this marketing potential.

This research has found no justification for the current low participation rates of females in physical science and engineering professions. As stated earlier, it appears employers do not fully appreciate the advantages of employing more females in these areas or cannot be bothered to expend the effort which would remove the existing male barriers and prejudices. Attracting more females to these employment areas will increase the added value to both society as a whole and science/engineering advancement in particular.

The government also has an important part to play in achieving gender equality in these professions. The current government was elected in May 1997 with the stated number one target of its leader Tony Blair,

"Education, education, education!"

It is surely time that any increased or redirected education and training funding should be used to ensure females are given the opportunity to participate equally vocationally in areas from which they have long been excluded.

It was the overall conclusion that the only missing ingredient to rectify this inequality was the true **desire** to do so. Unless the unjustifiable excuses generated and regurgitated by the male majority currently dominating these professions are stopped, future progression to gender equality in physical science and engineering professions will remain slow or non-existent. In a technological society such as ours, with an economy based on manufacturing, it seems ridiculous to continue a system which appears to prevent some of the potentially best employees even considering a career in engineering and physical science. By accepting what appears to be second best, the decline of the manufacturing base the UK cannot hope to be reversed.

Gender equality in all professions will result in maximising the potential of both employees and companies. It will result in greater personal growth and organisational performance, something which should be the goal of everyone. Maximising the female resources within this country will help maintain and almost certainly improve Britain`s position as an industrial world power.

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APPENDICES.

APPENDIX 1.

Sample Student Questionnaire.

School ______________________ Date ____________

Student Name ____________________ Date of Birth ______ Age __

Please tick below the one ethnic group most applicable to you.

Asian ___ Black ___ White ___

Please list the occupations (jobs) of your close relatives below.

Father ________________ Brother ________________

Mother ________________ Sister ________________

Other Relative (or Friend) ______________________________

What do you think your chosen career (future job) will be? Please state why you have made this selection.

If you have not chosen a science or engineering career, please state why you do not feel a science or engineering career is for you.

Please turn page.

From the following groups, please indicate which three have had the greatest effect on your career selection e.g. if you think your friends have had the greatest influence on your choice, give them number 1, if you feel employers are the next, give them number 2. Continue until you have selected numbers 1 to 3.

Careers Service ____

Employers ____

Work Experience ____

Friends ____

Media (TV, papers) ____

Father ____

Mother ____

Other Relative(s) ____

Teachers ____

What examinations do you expect to take whilst at school? Please indicate level (e.g. GCSE, A-level etc.) and subjects.

After leaving school, do you intend to continue with studies e.g. at college or university. If your answer is yes, in which areas or courses will you study?

Thank you for your time. AED/1995

APPENDIX 2.

Interview Guide for Students.

School ____________ Student Name ____________ Date ______

Questions.

1) What lessons do you find interesting and enjoyable at school?

Why is this?

2) What lessons do you find uninteresting and unenjoyable.

Why is this? **(If science was named as uninteresting in the questionnaire, ensure it is brought into the interview here.)**

3) Can you remember the names of your science teachers **(are they male or female)**?

4) You have stated you would like to follow a career in _________ . When did you make your decision?

Please turn page.

5) You have stated that ________________ had the greatest influence on your career choice. If they had discussed a career in science or engineering with you, do you think you would have been likely to follow such a career?

6) Would you like to discuss career opportunities at school?
(Do the students state they already discuss careers at school?)

7) If local companies with career opportunities in science and engineering offered visits and work experience to groups of students at your school, would you take the opportunity to look at what they had to offer?

8) If you were looking for employment, what is the main thing a prospective employer could do to attract you to work for them?

Any other comments.

Any avenues opened by the students will be fully explored and noted where relevant. All sessions ended by asking student if they have any questions or comments regarding either session that they would like to ask the interviewer.

APPENDIX 3.

Sample Employer Questionnaire.

Employer ______________________ Date ____________

The following questions refer to young people (aged between 16 and 25) entering employment in areas of engineering and physical sciences. Would you please provide your responses either in the spaces provided or on a separate piece of paper if the spaces provided are insufficient for your needs. (* Please delete as appropriate.)

1) Do you find it difficult to attract young people to apply for vacancies in the areas of engineering and physical sciences? Is there a difference in the number of males and females who apply for these vacancies and are you able to quantify the difference?

2) With regard to the needs of your company do you consider that young people commence employment with:

a) good/poor* levels of knowledge, skills and abilities

b) good/poor* motivation, attitude and beliefs

With respect to these points do you detect any difference between males and females as they commence employment?

3) a) What specific weaknesses have you detected in young people joining your company?

b) What specific strengths have you detected in young people joining your company?

With respect to the points recorded in question 3 parts (a) and (b), do you detect any difference between males and females as they commence employment?

4) Do you feel young people could be better prepared for employment in these areas, and could you suggest how any improvements required could be achieved?

5) Do you find it difficult to retain young people in these areas and have you noted different retention levels for males and females?

6) Do you feel the current balance of young males and females entering these professions is correct? If you feel the balance is incorrect would you like to see the balance moving towards a greater percentage of males or a greater percentage of females?

7) Could you see positive benefits to engineering employers as a result of:

a) Engineers visiting schools to talk to pupils Yes/No*
b) Encouraging school visits to engineering companies Yes/No*
c) Providing engineering work experience opportunities to older school pupils Yes/No*

Could you suggest any other ways to make these employment areas more attractive to young people?

Thank you for your assistance.

APPENDIX 4.

Information on Participating Schools.

Amy Johnson School.

Amy Johnson is an 11-16 year mixed comprehensive school, formed in 1988 as part of Hull`s re-organisation of secondary schools. It was formed by the amalgamation of Riley High School for boys and Amy Johnson School for girls. It`s student catchment area is West Hull.

During the first three years at the school, all pupils take the same range of subjects, English, mathematics, science, technology, modern languages, history, geography, art, music, physical education and religious education In the two years prior to taking GCSEs some choices can be made. The National Curriculum is taught and assessment is undertaken during this time.

The school has 570 students on the roll, and year 9 consists of 91 students in three tutor groups. All female students in year 9 took part in the initial briefing and q questionnaire session.

The DfEE Secondary School performance tables for Kingston Upon Hull (1997 and 1998) record the following data for students attaining 5 or more passes at GCSE grades A to C.

Table A3.1 - GCSE Grade A to C attainment at Amy Johnson, 1997/8.

Year	Attained	National Average
1997	4	45.1
1998	11	46.3

Bricknell Primary School.

Bricknell Primary School is a co-educational primary school with approximately 630 students in the 5 to 11 age group (Year 1 to 6). Some of the students of Bricknell Primary School transfer to Newland School on completion of year 6. As Newland is the only single sex secondary school for girls within the boundary of Hull, it draws students from many different schools. Although only a relatively small percentage of the pupils from Bricknell Primary School will ultimately transfer to Newland, Bricknell are one of the largest individual providers of students to Newland.

Students in year 5 and 6 are divided into mixed ability tutor groups approximately half female and half male. For the purpose of the study, one tutor group from year 5 and one from tutor group from year 6 were selected at random. All female students in each group participated in the study.

The DfEE Primary School performance tables for Kingston Upon Hull (1996, 1997 and 1998) record the following performance at Key Stage 2.

Table A3.2 - Key Stage 2 performance at Bricknell 1996 - 8.

Assessment	1996		1997		1998	
	Actual	Nat. Av.	Actual	Nat. Av.	Actual	Nat. Av
English Test	71	56.3	68	62.5	70	64.1
T.A. English	60	59.1	63	62.6	62	64.2
Maths Test	72	53.2	59	61.3	67	57.9
T.A. Maths	68	58.9	63	63.3	63	64.2
Science Test	74	61.2	85	68.1	74	68.6
T.A. Science	68	64.1	77	68.6	70	70.4

T.A. represents Teacher Assessment.

Sir Henry Cooper School.

Is a co-educational secondary school situated in North Hull. It has an urban position with a catchment area of predominantly North Hull. The school has approximately 850 student in the 11 to 16 age group.

The pilot group consisted of seven female students from year 11 (15 to 16 years of age). Year 11 consists of approximately 170 students in 6 mixed ability tutor groups.

The DfEE Secondary School performance tables for Kingston Upon Hull (1997 and 1998) record the following data for students attaining 5 or more passes at GCSE grades A to C.

Table A3.3 - GCSE Grade A to C attainment at Sir Henry Cooper, 1997/8.

Year	Attained	National Average
1997	14	45.1
1998	3	46.3

Newland School for Girls.

Newland School for Girls is an 11-16 year old single sex comprehensive school. It has an urban position with a catchment area of predominantly North and West Hull. The school has approximately 870 students, with 170 divided into six mixed ability year 9 tutor groups. One of these tutor groups was selected at random to take part in the programme.

The DfEE Secondary School performance tables for Kingston Upon Hull (1997 and 1998) record the following data for students attaining 5 or more passes at GCSE grades A to C.

Table A3.4 - GCSE Grade A to C attainment at Newland, 1997/8.

Year	Attained	National Average
1997	24	45.1
1998	33	46.3

Wheeler Primary School.

Wheeler Primary School is a co-educational primary school with approximately 400 pupils in the 5 to 11 age group (Year 1 to 6). Many of the pupils of Wheeler Primary School transfer to Amy Johnson School upon completion of year 6.

Students in year 5 and 6 are divided into two mixed ability tutor groups of approximately 30 students, half female and half male. For the purpose of the study one tutor group in year 5 and one tutor group in year 6 were selected at random. All female students in each group participated in this study.

The DfEE Primary School performance tables for Kingston Upon Hull (1996, 1997 and 1998) record the following performance at Key Stage 2.

Table A3.5 - Key Stage 2 performance at Wheeler 1996 - 8.

Assessment	1996		1997		1998	
	Actual	Nat. Av.	Actual	Nat. Av.	Actual	Nat. Av
English Test	42	56.3	48	62.5	43	64.1
T.A. English	37	59.1	50	62.6	66	64.2
Maths Test	29	53.2	70	61.3	48	57.9
T.A. Maths	27	58.9	71	63.3	73	64.2
Science Test	50	61.2	75	68.1	52	68.6
T.A. Science	44	64.1	77	68.6	75	70.4

T.A. represents Teacher Assessment.

Willerby Carr Lane Junior School.

Willerby Carr Lane School is a co-educational Junior school with 289 pupils in the 7 to 11 age range (Year 3 to 6). Many of the pupils of Willerby Carr Lane Junior School transfer to Wolfreton School upon completing year 6. The school teaches the revised National Curriculum with three core subjects, mathematics, English and science, and six non-core subjects, technology, history, geography, music, art and physical education.

Students in each of the four years are divided into two mixed ability tutor groups. For the purpose of this study all female students in one tutor group from year 5 and one from year 6 participated in this study.

The DfEE Primary School performance tables for the East Riding of Yorkshire (1996 and 1998) record the following performance at Key Stage 2.

Table A3.6 - Key Stage 2 performance at Willerby Carr Lane 1996 & 8.

Assessment	1996		1998	
	Actual	National Av.	Actual	National Av.
English Test	84	56.3	74	64.1
Teacher Assess. English	93	59.1	76	64.2
Maths Test	79	53.2	72	57.9
Teacher Assess. Maths	84	58.9	73	64.2
Science Test	87	61.2	92	68.6
Teacher Assess. Science	85	64.1	87	70.4

Wolfreton Upper and Lower Schools.

Wolfreton is an 11-18 year old mixed comprehensive school which serves Anlaby, Kirkella and Willerby in East Yorkshire. Wolfreton is a county secondary comprehensive co-educational day school with 2,036 students including 321 sixth form students. There are two sites, the Lower School (11 to 14) at Carr Lane, Willerby, and the Upper School (14 to 18) at Southella Way, Kirkella.

In the Lower School all students follow Key Stage 3 National Curriculum. The common course comprises tutorial and personal and social education (PSE), English, expressive arts, French or German (parental choice although both may be studied in year 9), geography, history, mathematics, physical education, religious education, science, and technology.

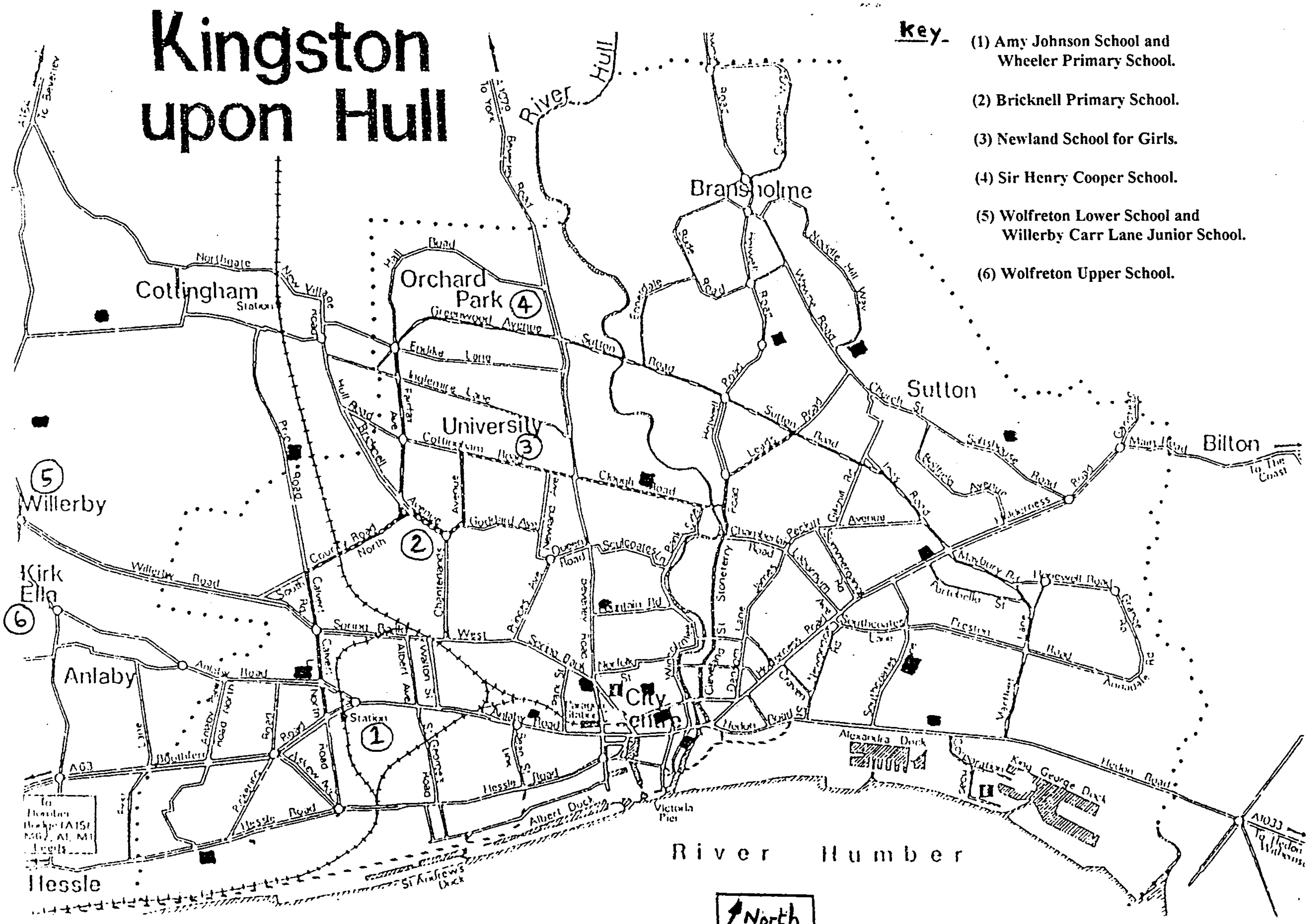
Year 9 has 348 pupils divided into 12 tutor groups of approximately 30 students each. For this project all female students in two tutor groups, chosen at random, participated in the study.

The DfEE Secondary School performance tables for the East Riding of Yorkshire (1997 and 1998) record the following data for students attaining 5 or more passes at GCSE grades A to C.

Table A3.7 - GCSE Grade A to C attainment 1997/8 at Wolfreton.

Year	Attained	National Average
1997	41	45.1
1998	54	46.3

APPENDIX 5.


Kingston upon Hull
Key.
(1) Amy Johnson School and Wheeler Primary School.
(2) Bricknell Primary School.
(3) Newland School for Girls.
(4) Sir Henry Cooper School.
(5) Wolfreton Lower School and Willerby Carr Lane Junior School.
(6) Wolfreton Upper School.
River Hull
Bransholme
Orchard Park
Cottingham
University
Sutton
Bilton
Willerby
Kirk Ella
Anlaby
Hessle
City Centre
River Humber
Alexandra Dock
King George Dock
Albert Dock
St Andrews Dock
Victoria Pier
Hedon Road
Holderness Road
Spring Bank
Anlaby Road
Hessle Road
Beverley Road
Cottingham Road
Greenwood Avenue
Sutton Road
Willerby Road
Boothferry Road
A63
A1033
North