A STUDY OF CRAFT, DESIGN AND TECHNOLOGY AMONG 14 YEAR OLDS: THEIR ATTITUDES, RELATED VIEWS, ASSOCIATED PERSONALITY TRAITS AND GENDER DIFFERENCES

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ABSTRACT

A Study of Craft, Design and Technology (CDT) among 14 Year-Olds: Their Attitudes, Related Views, Associated Personality Traits and Sex Differences, by John Waller, Brunel University 1988.

This research is concerned with investigating the attitudes of 3rd year secondary pupils towards CDT; with establishing any differences, in both attitudes and personality in the way the two sexes regard CDT and why more girls do not continue with the subject after the 3rd year. The field study for this was completed in 1982. There was a follow up of the sample at the post 16+ stage in order to investigate the actual take-up of further study of CDT subjects to examination level at 16+ and to compare those who passed well ('high flyers') with those who only gained a low pass grade ('low achievers') and compare attitudes and examination performance in the sample schools.The research began with three questionnaires designed and administered in 1982 in several coeducational schools in Hertfordshire - two attitude questionnaires to 405 pupils (301 boys & 104 girls) in 7 schools and the 'engineer' questionnaire to 150 pupils (87 boys & 63 girls) in 3 schools.

A total of four questionnaires were used - an attitude questionnaire with a five point Likert scale; an open-response attitude questionnaire and a questionnaire designed to find out how the pupils perceive the engineer. Cattell's HSPQ was also used.

Across the whole of the five attitude scales, the two sexes presented completely different profiles. Both sexes expressed a desire for more practical work. Pro-CDT pupils were influenced by a family member with technical skills and tended to be tough-minded rather than tender-minded. Boys who are in favour of CDT are likely to be far more controlled and conscientious; introverts rather than extraverts;neurotic rather than stable and slightly more inclined to like working with things rather than people. In contrast, pro-CDT girls are likely to be stable extraverts, with a slight tendency to prefer working with people and to be lax and expedient. These terms are explained within the thesis.

Girls were on the whole more concerned about the form of the lessons, claimed to be more relaxed in workshop sessions in CDT and enjoyed the lessons more than boys. The boys in their personality responses revealed some degree of concern and anxiety. However, there was an almost total rejection by the girls for continuing CDT - especially amongst the intelligent ones - although they found the subject enjoyable and within their capabilities.

The girls' attitudinal responses showed that in CDT they lacked confidence with tools and machines even after three years in secondary education. This may be related to their previous lack of 'tinkering' experience.

Boys seemed to have a far greater enjoyment and appreciation of the value and skills of practical technical work although they tended to be weak mathematically and less inclined than girls to continue with graphical work. They expressed a greater intention of continuing with CDT and taking up a technical career.

Twice as many boys (80%) took up technical studies (CDT) as opposed to technical drawing (41%). Only one girl took any CDT subjects. In practically-based CDT examinations, the 'high flyers' demonstrated a greater pro-CDT stance and found the work more relaxing than the 'low achievers'. In graphical examinations, the 'high flyers' were more critical of the way the subject was taught; were more concerned about the effects of technology on society and were far more relaxed compared with the 'low achievers'.

These findings are compared with other research that was going on at the same time. It is hypothesized from the findings that more girls may take up CDT if there was an increase in investigative work and a greater time allocation. Possible sources of further research are discussed in the concluding chapter.

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John Waller

PREFACE TO STUDY

This study was started in mid 1980. During the course of this study there has been a tremendous change throughout the educational world which has been reflected in the way that CDT has become more design and technologically orientated.

These changes have been discussed in this study.

When the initial questionnaires were designed in 1982 it was quite difficult to decide on the most suitable terminology in order to describe all the various aspects of technical work carried out in the seven sample schools. At that time all the schools referred to their departments by the title 'Technical Studies' and in six of the schools the examinations taken by the pupils at CSE level were entitled 'Technical Studies' and 'Technical Drawing'(indeed examinations with technical studies in the title were taken until the GCSE was introduced in 1986). Technology in some form was taught in four schools.

Nationally, the subject area was in a state of change with a greater emphasis being placed on the teaching of design and technology. In order, to reflect this change the title for the technical departments was changed to Craft, Design and Technology (CDT). This change coincided with an increased awareness of the general public to the increasing role that design and technology was playing in industry, commerce and leisure activities.

This was quite noticeable because when the author went to administer the questionnaires in 1982 he was dealing with pupils in the technical studies departments. On his subsequent dealings with the schools in 1985 to ascertain how many pupils had in fact taken a technical examination he was asking about pupils who had taken examinations in the CDT department.

FORMAT FOR QUESTIONNAIRES

Fortunately, in all sample schools the basics taught included the use of metalworking and woodworking tools and some form of graphics and design. To avoid confusion with school technology reference to technology, in the attitude and information questionnaires, was reserved for things outside the school environment.

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1.0 INTRODUCTION

1.1 REASONS FOR STARTING

This research work was born out of frustration. Frustration about the lack of appreciation shown by society for those involved in the creation of artefacts - those who work with their hands as well as their brains. Society depends so much on these people from the most skilled designer to the everyday car mechanic. Without their expertise, life in the late 20th century would grind to a halt.

This lack of appreciation may well start in schools. The 3rd year in secondary education is when pupils select their subjects for further study to examination level (4th, 5th and maybe 6th form). It would appear that pupils of this age would need to have established well defined attitudes towards all school subjects in order to make an effective selection. For this reason, this study was based on the 3rd year pupils. 405 3rd year pupils (301 boys and 104 girls) from seven Hertfordshire coeducational schools formed the sample for this study (chapter 2B).

1.2 AIMS

1.2.1 PRIMARY AIM

To investigate the dimensions of attitudes of 3rd year secondary school pupils towards Craft, Design and Technology (CDT).

1.2.2 SECONDARY AIMS

(1) To investigate any differences, in both attitudes and personality, in the way the two sexes regard CDT

(2) To attempt to ascertain why more girls do not continue with CDT after the option stage in the 3rd year.

(3) To follow up the sample until the post 16+ stage in order to investigate the actual take-up of further study of CDT subjects to examination level at 16+.

(4) To compare the attitudes of those who passed well ('high flyers') with those who only gained a low grade pass ('low achievers').

(5) To compare the attitudes and examination performance of pupils in the sample schools in order to ascertain whether there was any significant difference between the schools.

1.3 DETAILED OBJECTIVES OF THE INVESTIGATION

The overall plan for this study is to produce a battery of tests which would:

(a) Reveal the dimensions of pupils' attitudes towards CDT at the end of the critical third year of secondary education, when further study of the subject area becomes optional.

(b) Identify other factors, such as family background and mathematical ability, which may have a bearing on liking for CDT and intention to pursue it as a career.

(c) Obtain simple validatory measures of liking for CDT.

(d) Explore differences between liking for the design plus practical areas and graphical aspects within CDT.

(e) Confirm the dimensions of personality derived from Cattell's HSPQ and investigate therewith the personality profiles associated with attitudes to and other measures of liking for CDT.

(f) In all these measures, pay particular attention to differences between the sexes, in the hope of establishing why girls are reluctant to pursue CDT-based careers.

(g) Compare attitudes and examination results in the sample schools.

1.4 TERMS USED IN THIS STUDY TO DESCRIBE TECHNICAL WORK

There has been a tremendous development in technical work since the early 1960's. This escalated in the next two decades with two important projects centred on design (Eggleston) and technology (Harrison). (These two projects formed the basis of the three new CDT examinations introduced with GCSE in 1987). They were followed by initatives such as the Technical and Vocational Initiative (TVEI), Interactive Technology, the Sainsbury Trust and Education for Capability. The Design Council Reports led to a national debate on design which culminated in a two part documentary entitled 'Designs on Britain' shown on BBC 2 on the 10th and 11th September 1985.

This tremendous activity that has taken place, especially during the early 1980's (when this study was commenced) has led not only to an enhancement of the subject area but also to changes in the titles used to describe the departments in which the technical work was carried out. Since the 1960's there have been several different titles used to reflect the changing nature of the subject area in schools. Four of these titles - Craft; Technical Studies; Craft, Design and Technology and finally Design and Technology are used to describe the departments involved in this study and other studies that are reviewed. The subject area has become more academic in nature and in consequence more the 'hub of the educational wheel' instead of a timetable appendage.

It is not possible to give exact dates when the titles changed because in various parts of the country the names of the departments were changed at different times. This often reflected local technical initiatives. However the speed at which technical work developed led to several terms being used to describe the departments and the work being done within them.

In some cases the department title was not changed quickly enough and therefore did not describe accurately the type of technical work being done (which was the case in six of the seven sample schools).
The major terms used have been defined.

1.4.1 CRAFT

Craft is historically a term common to a number of methodologies - craft of poetry, craft of warfare - in fact a general way of depicting a general sense of techniques. Within technical work craft has a specific meaning.
Armstrong (1980) suggests that craft 'is a calling requiring special skill and knowledge, especially a manual art'. 'Craftsmanship' thus implies more than working at a craft - it implies concern and caring for the work.
The HMI paper (1982) entitled 'CDT, A curriculum statement for the 11-16+ age group' maintains that "Craftsmanship relates directly to the extent to which natural or manufactured materials have been selected, worked, assembled and finished with care and sensitivity. In this way craft skills provide the unifying factor of CDT".
The Design Council' Primary Education Working Party' define craft as:
"Giving children the opportunity to transform any materials they work with , by purposeful activity and the use of tools, into useful and attractive products, having a value not possessed by the original materials".
Within the context of this study the following model of craft is adopted: Craft in schools when used as a departmental title (late 1960's - early 1970's) refers to work that is 'teacher centred'. This mainly involved metal and woodworking skills taught by demonstration, initially by set projects. Craft is an integral part of Craft, Design and Technology (CDT) (section 1.4.6), concerned with ensuring that projects are made accurately and given the best possible finish.

1.4.2 DESIGN

Historically there was a separation between craft and design. Sturt writing in the 19th century describes the craftsman as following rules and tradition but not trained in design. In schools craft was taught without reference to design.

Any craft requires some element of design and planning to facilitate the possible realisation of the workmanship. Design is basically working out in graphical form the best way of solving a required need.

Armstrong (1980) suggests that design 'is a plan or scheme, conceived in the mind, of something to be done'.

In their conference handbook for 1982, the Educational Institute of Design, Craft and Technology describe design in today's schools as, 'the animating principle for all creative processes'. The aforementioned HMI paper (1982) suggests that "To be successful, a design solution must satisfy both visual and technical considerations. This requires of pupils an ability to organise and control the elements governing the visual relationships they create in a design between related parts and between the parts and the whole product when they strive to achieve a particular effect".

One of the major changes in CDT has been the stress on design and the rationale of the product.

At one level 'design' means deciding graphically which of several possiblities is the best solution and then planning how this can be realised. In pedagogical terms it implies the pupil being asked to think about what they are doing.

The move from craft to design is a move from passive reception to active thinking. Thus changing to a child-centred approach

In the Design Council Report (1980) entitled 'Design Education at Secondary Level', it is stated that: "To design is always to prescribe some form, structure, pattern or arrangement for a proposed thing, system or event.

A design is always an integrated whole, a balanced prescription - a product of judgement and invention as well as knowledge and skill".

The term 'design' has occasionally been used to describe a technical department. This generally indicates a more child-centred approach to the subject area, as opposed to the term 'craft' (early 1970's).

Within the context of this study, the following model of design is adopted: Design within a technical department (which is also an integral part of CDT and in some cases technical studies) is a graphical expression of possible solutions to problems which involves a consideration of fitness for purpose, correct materials of manufacture, appreciation of appearance, durability and the importance of safety.

1.4.3 TECHNICAL STUDIES

'Technical studies' was the title used to describe some departments before it was finally phased out nationally when the new GCSE examinations started in 1987. Up until this time, many CSE boards offered examinations in technical studies and technical drawing. In many ways this title was confusing because the main examinations taken were entitled 'technical studies' (practically based) and technical drawing (graphically based) when the departmental title was simply technical studies. However the majority of schools had changed the title of their technical department to 'CDT' by the mid - 1980's. Indeed many had changed before the start of the decade. The work that was carried out in most technical studies departments involved the use of various types of wood and metal to design and make projects suitable for the home environment.

The teaching of technical drawing was done mainly by the technical studies department and occasionally by the mathematics department. However in many schools, including the Hertfordshire sample schools, plastics was involved as well as the basic materials of wood and metal. In addition there was an element of design involved. Instead of set projects, a thematic approach was adopted in years 1 - 3 (together with basic technology in some schools including such elements as structures and electronics) with a free choice of projects in years 4 and 5. This term 'technical studies' was used to describe a technical department (prior to CDT) involved in craft activities, with some design work, together with technical drawing. Within the context of this study, the following model of technical studies is adopted: Technical studies is a practically-based subject in which set projects were made in the first three years usually in wood and metal, during the first three years with some limited choice (involving basic design work) in years 4 and 5. The projects were mainly concerned with the home environment. There was a minimal element of technology.

1.4.4 TECHNICAL DRAWING

This includes geometrical and engineering drawing, with an added imput of design from the late 1970's with some examination boards and a considerable input of various forms of graphical representation with other boards. This subject had much in common with art in that it helped to develop spatial ability. It was also helpful for those who studied mathematics and for employment in various areas of industry. Cockcroft (1983) argued that engineering drawing is undoubtedly a worthwhile skill for the young mathematician.

Fitzgerald (1985), discussing the new technology and mathematics required in employment, refers to the need for transformation geometry - two dimensional applications of symmetries, reflections, rotations, enlargements - and for three dimensional geometry for planning the movement of a robot for a particular task.

Within the context of this study, the following model of techncial drawing is adopted: Technical drawing is a graphically-based subject involving geometrical (including two and three dimensional representation) and engineering drawing with an element of design or graphics.

1.4.5 TECHNOLOGY

Pre-industrial craft was the technology of the past. Present-day technology tends to be closely associated with applied science. However whereas pure science is concerned with the explanation of events, technology is concerned with the creation of devices within the man-made environment by using structures, mechanisms, electronics and the like.

According to Marshall (1974), "Technology is the purposeful use of man's knowledge of materials, sources of energy and natural phenomena." By purposeful use, it is implied that technology is more than an academic study of materials, rather the positive and practical application of this study to the service of man.

Technology is primarily concerned with the creation of artefacts and devices. Its major concern whether something works of not, whether it helps to achieve some control of the environment.

A scientific view of technology is concerned with analyzing devices to see why they work, to evaluate the scientific principles underlying hardware or more practically to apply scientifc principles to problems.

In some schools in the late 1970's and the 1980's, the science department decided to teach technology on their own. However, usually the teaching of technology has been undertaken by the technical departments. In some instances a technology department evolved which involved both CDT and science staff (Eggleston 1986). The significance of this was appreciated by the examination boards because many offered two technology examinations when GCSE started in 1987, one intended for each of these two departments.

The technology of CDT is largely with creative production, with trying to make things work by trial and error if need be. Here the emphasis is on practical work.

Within the context of this study, the following model of technology is adopted: Technology (which is also an integral part of CDT) in the late 1970's was regarded as a 'pupil centred' activity in which pupils engaged in solving problems in a creative way using appropriate materials, sources of energy and methods of control. This usually involved a knowledge of materials, processes, structures, mechanisms, electronics and pneumatics and provided an opportunity for the application of knowledge for multi-disciplinery working and problem-solving. The appropriate materials could also include various types of construction kits.

1.4.6 CRAFT, DESIGN AND TECHNOLOGY

In order to demonstrate how the subject area was becoming more design and technologically based many departments changed their title to CDT in the 1970's. This combination of craft, design and technology provided a wider range of learning and activity. Several definitions are offered for consideration.

A book entitled 'Craft, Design and Technology in Schools - some successful examples', published in 1980, was based on HMI's observations in 1977 when they revisited 12 schools selected from the 130 schools originally observed. In response to the question 'What is CDT?', it is suggested that "This label is applied to a range of learning that goes on in the school workshops. Taken separately, each of the words 'craft', 'design' and 'technology' means something different. So do the traditional subject labels 'woodwork', 'metalwork', 'technical studies' and the many other terms that identify practical studies in the school curriculum. Yet they are all part of the family of practical activities which give pupils experience of designing and making.

Unfortunately, the English language has no single word like 'literacy' or 'numeracy' which might be used to denote competence in working with materials. But even if there is no one word there is an acceptance, in British education, that boys and, to an increasing extent, girls should discover the physical and aesthetic qualities of materials, acquire the skills to shape them and perhaps, above all, learn to plan and execute work of their own design."

School Curriculum, published by DES in 1981, contained the following description of CDT: "CDT encourages creative skills and the ability to identify, examine and solve problems , using a variety of materials."

Swain (1981) suggests that "Whatever aspects pupils study within CDT, and the range is wide, designing and making should be central activities".

Kirton et al (1984) investigated the origins and growth of CDT and found that "Craft, Design and Technology (CDT) now appears to be the generally accepted terminology to cover a range of subjects and a variety of titles.

Though it is criticized as a generic term in that 'craft' may imply too close a connection with craft skills and that 'technology' is a multidisciplinary concept in itself, it seems likely that in this case the whole is greater than the sum of the parts.
Making something whilst developing manual skills is also the testing and refinement of the creative act of design. Technology in this context is seen as the process of using all areas of knowledge, not just scientific , to solve problems. CDT does then seem to emerge as a coherent and potentially valuable area of study. Such a discussion of titles is not mere semantics. Craft, Design and Technology has taken many years to emerge from its origins in handicrafts."

McCulloch et al (1985) found the term CDT to be confusing: "... the combination of craft, design and technology often seemed an unwieldy and artificial alliance which still awaited a formula for a working coalition in curriculum terms".

Within the context of this study, the following model of CDT is adopted for the late 1970's: CDT is a 'pupil centred' activity in which pupils are encouraged to demonstrate their creative design and making skills using a variety of materials (usually wood, metal and acrylic). The problem solving element is also considered to be important. Many departments also included graphical work, either for the enhancement of project designs or as an examination subject taken in addition to the practically-based ones.

1.4.7 SUMMARY

The models for technology and CDT are similar in some respects. This is only to be expected, since in some CDT departments, technology takes on a major role, whereas in other schools all the technical work has become exclusively technological (and sometimes taught exclusively by the science department).

The major difference between the late 1970's models of technical studies and CDT was that in CDT, there was a much greater emphasis on pupils designing projects of their own choice, including an element of problem-solving. However when the sample schools were compared with 75 schools in the Girls and Technology Education research project, the examination work done in the Hertfordshire schools was in line with the current thinking at that time (early 1980's) which tended towards more design and problem-solving with a multi-media approach (chapter 11, section 11.3.4). This seems to indicate that although six of the seven sample schools' technical departments were known by the title technical studies, the work being done was similar to those departments with the title CDT.

1.5 CDT, MATHEMATICS AND SCIENCE

There is an ever-increasing link between CDT, mathematics and science. Indeed the Secretary of State for Education in September 1988 referred to the importance of mathematics and science for those who are studying technology.

Science and mathematics have certain features in common with CDT which are:

(a) The need for linguistic skills, in both the understanding of instructions and communicating solutions.

(b) A dependence on spatial ability.

(c) The problem of differential attraction of the sexes.

Science and CDT have in common:

(a) The relation of practical work and theory.

(b) Scope for planning of project work.

(c) A dependence on mathematical skills.

Fitzgerald (1985) in 'New Technology and Mathematics in Employment' referred to the need for craftsmen to be familar with certain areas of mathematics:

(a) The use of computer systems for controlling metal-working machines and robots used by craftsmen and technicians, requiring some algebraic and numerical thinking.

(b) The use of coordinates was necessary for skilled toolroom craftsman being re-trained to work on computerised machines.

In 'Options and Careers', a support publication for the 'Girls into Science and Technology ' study, reference was made to the wide range of jobs for which CDT, science or mathematics are useful qualifications.

Perhaps another pointer towards the increasing relationship between CDT, science and mathematics is the fact that all three disciplines were experiencing difficulty in recruiting staff in the 1980's. This was so marked by the mid 1980's that a finanical inducement was offered by the DES to those willing to re-train for these subjects.

1.6 CAREER OPPORTUNITIES FOR CDT PUPILS

The development of technical work, leading it to become more design and technologically based, greatly enhanced the career opportunities for pupils.

1.6.1 LATE 1960'S

Up until the late 1960's, a large majority of pupils who enjoyed and were competent in technical work gained employment in the engineering industry and the various building trades. A few very able pupils went on to higher education, gaining engineering and building qualifications with 'City and Guilds' and through various engineering courses achieving Ordinary and Higher National Certificates.

Other gifted pupils went to various colleges for the making of musical instruments or to specialise in furniture design. Some of these pupils eventually became technical teachers.

1.6.2. EARLY 1970'S

The broadening of the subject; its growing closeness to applied science; its practical problem-solving approach and its opportunities for design have helped to develop its status widen its appeal and provide answers to the demands of industry and government alike.

The career avenues for pupils have increased enormously.These opportunities are referred to in 'Options and Careers': "Technical craft subjects are not simply the road to engineering, or the basis of home hobbies. In the best CDT courses children also acquire the ability to communicate graphically, acquire active design and problem solving skills, and, as consumers, to assess and criticise manufactured products in our technological environment. In adult life they may then better understand all kinds of plans and instructions, from self-assembly kitchen units to local redevelopment schemes".

The point is made in the booklet that girls can be interested in a wide range of jobs for which CDT, science or mathematics are useful qualifications. "Engineering and Industrial design are seen as 'mens' work' but in tomorrow's world women will want to contribute too. Mainly men design kitchens because they are the building technologists and architectural technicians. But the job might well appeal to a girl. Most children can be excited by the thought of contributing to the design and production of everyday things - telephones, children's toys, bicycles, cameras, food and drink and airports. If the approach is from this angle at first, girls can wait till later before deciding whether they want to go in for mechanical or civil engineering.

A girl who is keen to work abroad probably does not know that agricultural engineering would provide the opportunity. Girls are traditionally keen on 'helping people' but usually unaware that the jobs of many engineers can involve the protection of operating personnel and problems of health and safety at work. Having studied CDT at school may make it easier for girls to enter engineering where they may have to 'prove' themselves to potential employers in the way that boys do not".

The opportunity taken by some schools to design and make aids for handicapped people brings the pupils into the environment of health care, providing yet another avenue for numerous careers.

All these factors were beginning to affect the status, nature and methodology of CDT at a point when this thesis began in 1980.

1.7 1980 - A TURNING POINT IN HISTORY?

When the history of the twentieth century is written, it may show that 1980 was a turning point in education, a watershed, a realisation; a time when many influential people came to appreciate that if Britain did not act and try to implement at least some of the suggestions made in Mr. Callaghan's famous 'Ruskin Speech' in 1975, we would be on course for a decline in our country's wealth and influence abroad. Yet the decade started with Government cuts, in the funding of the Technological Universities.

The need for skilled engineers caused people to look to a new source of talent - women. This went hand in hand with the movement towards social justice for women, both in industry and at school. There was also concern for the future of engineering both in industry and through Craft, Design and Technology in schools.

Schools were slowly implementing the requirements of the Sex Discrimination Act of 1975, and arranging for both girls and boys to do courses in CDT and Home Economics (HE).

Socially and legally, the implications of the race and sex discrimanation acts were being worked out. In 1980 the Equal Opportunities Commission published a report predicting that tens of thousands of female clerical jobs would disappear within ten years as a result of technological innovations. The Employment Secretary said that the Government would like to see more women in the skilled and technical areas of work and the President of the CBI commented on "Industries' medieval attitude to women".

There were many reports and investigations carried out in 1980. The 'Finniston Report' expressed the need for more young people to train in applied science, engineering and CDT in schools. An HMI discussion paper 'Technology and the Core Curriculum' was published. The Assessment of Performance Unit published a discussion document 'Understanding Design and Technology'. The Design Council produced a report entitled 'Design Education at Secondary Level'.

1.8 OUTLINE OF STUDY

The research took place at a point when girls, for the first time, had a legal right to take CDT. The subject was in the process of changing, yet its appeal as an examination subject was limited. Despite the need for good engineers and designers (perhaps the vocational outcome of CDT), comparatively few seemed interested in taking up these careers, especially through CDT. The research began by looking at pupils' perception of the engineer. It then sought to analyse the attitudes of pupils towards CDT and to look at their personality profiles.

In brief outline, the study takes the following form:

Chapter 2 reviews the resistance of schools and society towards the practical aspects of CDT. The position of the sample schools up to the time of the study and then from 1982 to 1988 is outlined in some detail in this chapter.

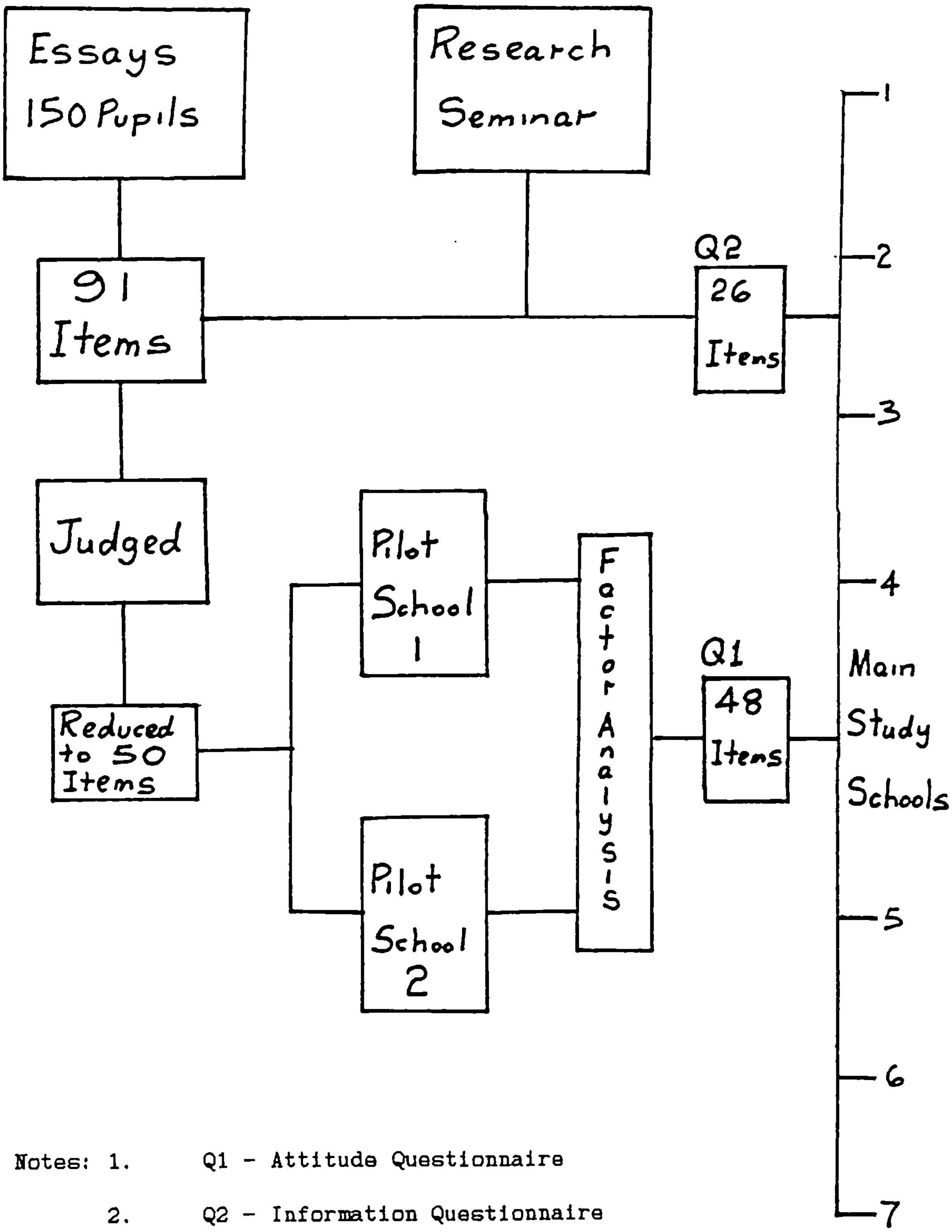
In chapter 3, the somewhat scanty research which has been conducted in CDT is reviewed and augmented with relevant findings from the much more abundant research in science education. A brief review of attitude and personality research has been included in this chapter.

Chapter 4 is concerned with the various research methods that have been used in this study.

The next three chapters (5, 6 and 7) cover the central experimental investigation of the study - the piloting, final construction and administration of the attitude test instrument and related questionnaires. These were used to gather simple quantitative and qualitative data, designed to gain more information about pupils' attitudes to CDT

Chapter 5 describes the collection of attitude statements and the pilot study. This is illustrated in part of figure 1.1. In chapter 6, the administration of the full battery of the attitude and ancilliary questionnaires to the main sample is described and the ancilliary data is analysed. This is illustrated in the rest of figure 1.1

In chapter 7, the final elucidation of the factorial structure of attitudes to CDT is reported. For each sex, the factor scores are related to the short-scale quantitative variables, covering such things as ability in mathematics; family background to technical work and intention to study CDT further.



Notes: 1. Q1 - Attitude Questionnaire

2. Q2 - Information Questionnaire

Figure 1.1 Graphical Representation of Pilot Study

Chapter 8 deals with the structure of personality, and from the 140 items in Cattell's HSPQ, it elicits by factor analysis of questionnaire data gathered from the sample a six-factor model of pupil personality at this stage of development. The independent factors are:

intelligent v unintelligent

tough-minded v tender-minded

neurotic v stable

preference for working with people rather than things

careful, conscientious v lax, expedient

extraverted v introverted.

This is supported by other studies at Brunel University.

In chapter 9, the personality profiles are related to the attitude scores and the scores on the other short quantitative variables. These were compared for the separate sexes.

Figure 1.2 covers the whole scheme of the investigation.

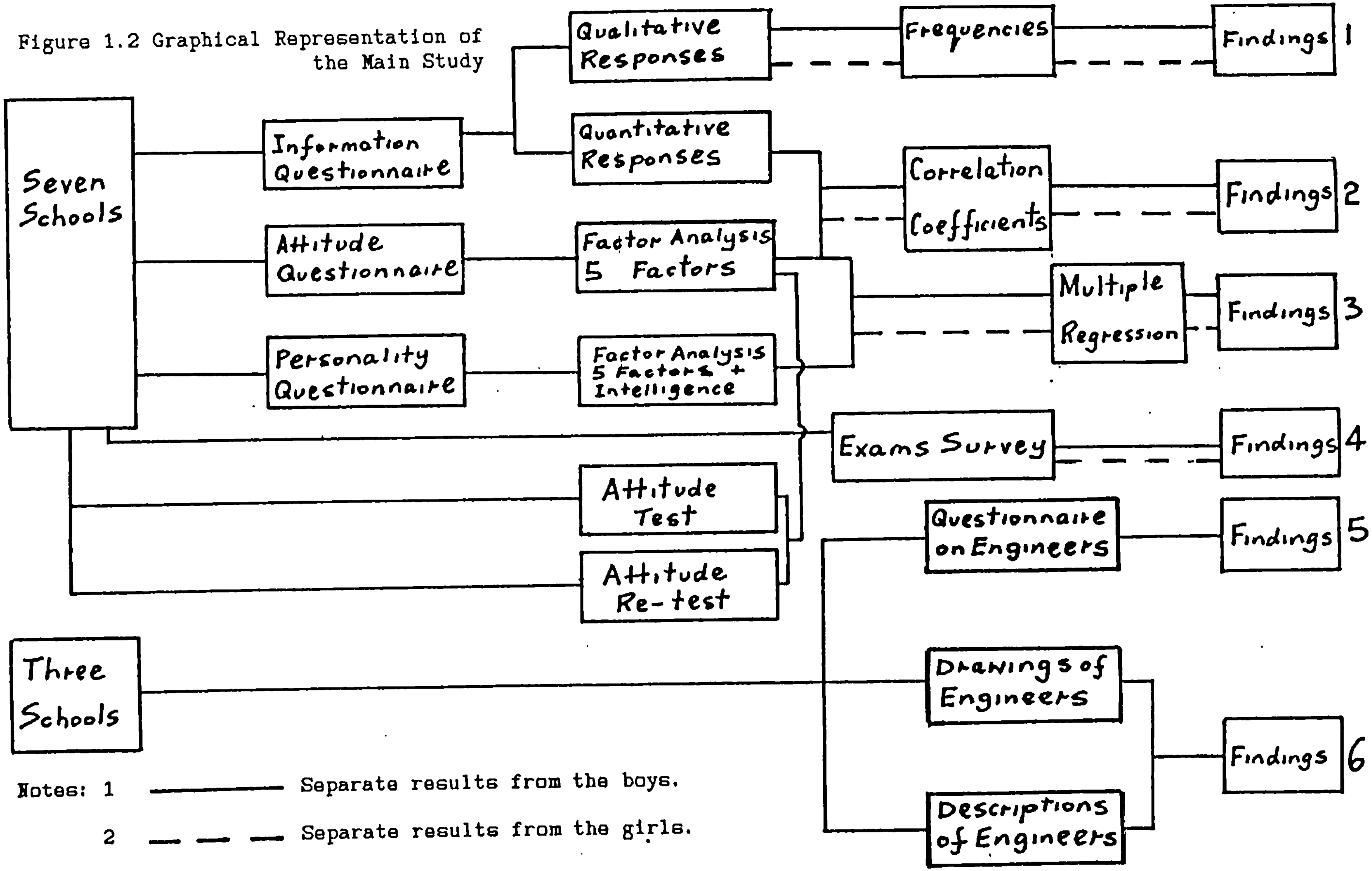
Chapter 10 reports a follow-up of the sample two years later to see how many pupils actually took CDT public examinations at 16+.

The examination results gained and the attitude profiles of the pupils in the sample schools are compared. In addition the attitude profiles of those who achieved high grades ('high flyers') and those who only gained low grades ('low achievers') were compared.

Chapter 11 contains a review of other similar research in CDT (started about the same time as this study), highlighting areas where the findings have been similar to those in this study.

Chapter 12 summarizes the findings and taking these into consideration makes recommendations for further research.

Figure 1.2 Graphical Representation of the Main Study



Notes: 1 ——— Separate results from the boys.

2 — — — Separate results from the girls.

1.9 HOW PUPILS PERCEIVE THE ENGINEER

1.9.1 AN INVESTIGATION

Pupils who have included some technical education during their school life enter a number of different careers which make full use of the varied CDT experience that they have had.

In one of the sample schools, in 1981, over one third of the boys entered a career in the engineering industry (refer appendix B).

It was thus decided as a preliminary measure, to conduct a survey in three schools to ascertain how the pupils perceive the engineer - the first tentative piece of research in this thesis.

Although it is appreciated that the image created by engineers is not central to this thesis, which is involved with attitudes towards CDT, the survey did produce some interesting material. The survey, together with views of influential members of society, has been reviewed in the appendix A.

1.10 OVERVIEW

The scenario in technical education is presented, showing the tremendous activity that was taking place during the early 1980's.

The title used to describe technical work has changed, and indeed is still changing (in the late 1980's some departments were changing their titles to 'Design and Technology') to reflect the way the discipline has improved its image. It has become more academic in nature and in consequence has become more the 'hub of the educational wheel' rather than a timetable appendage. The generic term 'CDT' is defined.

The improved image of technical work has led to more interesting career opportunities becoming available to pupils involved in CDT.

The overall plan of the thesis is presented with the aid of diagrams showing how the pilot and main studies were conducted.

1.11 CHAPTER 2A

1.11.1 THE GENERAL PROBLEM OF THE RESISTANCE OF THE PRACTICAL ELEMENT DENOTED BY CDT

In order to help to understand this problem, a brief outline of early societies and the craftsman's role within them is undertaken. The long history of practical work in schools; the way the first craft teacher was appointed to Beethoven school in London, the development of practical work until the late 1980's, when the emphasis changed to include more of the academic aspects of designing and problem-solving, and all the associated problems involved at each stage of technical evolution are discussed.

CHAPTER 2 (A) THE GENERAL PROBLEM OF THE RESISTANCE TO THE PRACTICAL ELEMENT DENOTED BY CDT IN SCHOOLS AND IN SOCIETY

(B) THE SAMPLE SCHOOLS (1) UP TO THE TIME OF THE STUDY (2) FROM 1982 ONWARDS

2.1 THE EVOLUTION OF PRACTICAL SKILLS

2.1.1 THREE MAIN PERIODS OF DEVELOPMENT

The flow of practical experience in our culture can be divided into the periods of time in our history when significant changes occurred in the way that practical work was presented in schools and the way it was regarded by society. There are three main periods:

(1) The period of time from early societies until the first attempts were made to teach practical work at Beethoven School, in 1885 when practical work was seen as providing a discipline, a form of vocational training and an apprenticeship for working class boys.

(2) From the late 19th century until the post 'Butler Act' era was the second period. Here practical work (wood and metalwork) had low status and was directed to working-class boys and seen as a vehicle for education, a school subject. Technical teachers however strove to ensure that their pupils' work gained pride of place within the school. Practical work was then seen as providing a subject involving real, practical, concrete experiences for average and below average boys. Towards the end of this period practical work was virtually relegated to secondary modern schools.

(3) After the fight for technical survival when the first comprehensives were set up in the 1960's and the consequent tremendous spate of activity from many areas of society CDT started widening its appeal.

The emphasis changed to designing as well as making, problem-solving and not just the acquistion of skills and the application of appropriate knowledge culminating in CDT becoming a more academially based subject.

In the 1970's due to an increased awareness of the importance of design and technology and the passing of the Equal Opportunities Act CDT has come to attract boys and girls of all abilities. Also there has been an increase in the modules that made sense of scientific principles - electronics, structures, mechanisms and the like.

At the time of the study we had moved from 2 to 3.

2.1.1.1 TEACHING OF PRACTICAL WORK PRE BEETHOVEN

The teaching of practical work has existed in some form throughout our history from the member of the earliest tribes passing on his special skills through to the craft guilds which started in the 12th century developing an embryo form of apprenticeship developed for over 500 years before the demise of the guilds.

There are many examples in the 19th century of farmwork and crafts being taught in schools set up by philanthropists, children's societies and religious organisations. In some cases they catered for orphans, and young criminals. Examples were: William Allen a Quaker, who set up a school in 1825 in Sussex teaching farmwork and allied activities; schools in Hackey Wick and Ealing Grove where farmwork, carpentry and bricklaying were taught.

An increase in general unrest in the 1840's led to to Kay-Shuttleworth, Secretary of the Committee of Education suggesting an increase in the Ragged Schools of London. The reason is clearly shown in an extract from an HMI report in 1852: "... education of the children of the labouring classes that is not accompanied by industrial training, and their actual employment in manual and useful labour, will entirely fail in checking the growth of crime."

Fortunately others saw practical work as a way of preparing the boy for his future since it inculcated the habits of industry and obedience which strengthened their resolve to learn to read and write well.

Examples being William Davies who taught printing in Gower's Walk school in Whitechapel and Edward Thring, head of Uppingham school who saw craftwork providing recreation and leisure activity and demonstrating the practial applications of science. In 1859 he opened woodwork and metalwork workshops at the school.

The Sloyd movement in Scandinavia was in many ways responsible for putting pressure on schools in England to teach more practical work using carpentry tools - saws and chisels and not the knife and file which were the main tools of the Sloydists. Another contributory factor was our poor showing at the Paris exhibition of 1867.

Although the London School Board resisted moves to set up any form of trade school they allowed an experiment at Beethoven school where the boys were given instruction in making for the school benches and greenhouses by the school caretaker who was also a skilled carpenter. This was in 1885 when the start of technical teaching in England was made.

2.1.1.2 POST BEETHOVEN TO POST BUTLER

In the early part of the 20th century there was a reaction to the rigid training and skills laid down for craftwork which was taught under the title of 'Manual Instruction' in schools. A philosophy developed that craftwork should be directed towards more general educational aims which led to a relaxation of the rather limited freedom allowed the pupil to take part in simple decision-making and designing. Unfortunately during this experimental period little help and guidance was given and thus there was a sudden decline in craft standards causing derision from those outside education. At this stage industrial needs changed so the vocational emphasis of stage 1 was no longer appropriate.

In 1913 the manual instruction title was dropped and handicraft became an integral part of the school curriculum. The Board of Education recognising that "it was unnatural for children to be confined to the mental processes surrounding bookwork to the neglect of other activities in the psychomotor sphere" During the 1920's and early 1930's there was a hardening of attitudes towards craft processes together with a stress on design. Because in many schools the standard of craftsmanship and design was considered to be low the 'Millbank' scheme was introduced which was a series of set projects essentially aimed towards craftsmanship. Although in many cases the craftsmanship in handicrafts improved the negation of design lowered its educational value.

Just prior to the second world war there was a revival in the value of design thought to be the common ground between art and craft, a view supported by the Newsom Report (1963). The Crowther Report (1959) reaffirmed the Board of Education's view (1913) when it suggested that many pupils would benefit by 'the alternative route of knowledge' which lay in practical subjects since some seemed to lose their intellectual curiosity before they had exhausted their capacity to learn. The alternative route making progressively exacting intellectual demands.

Three major reports Hadow (1926), Spens (1939) and Norwood (1943) all stressed the need for a variety of schools which would cater for the educational needs of different children in different institutions.

The Norwood Report defined three types of mind and proposed three types of schools: the pupil who was to go to the grammar school was 'interested in learning for its own sake'; the technical school would take pupils 'whose interests and abilities lay markedly in the fields of applied science or applied art': while the third and much larger group would consist of those who deal 'more easily with concrete things rather than with ideas'.

The 1944 Education Act (Butler Act) enshired the main thrust of the Norwood report since it promised the opportunity of education for all in grammar, technical and secondary modern schools. It was a great pity that the eminent politicians responsible for drafting the act, due to their lack of awareness, devalued the secondary modern schools since the education in them was to be determined by the fact that the future employment of pupils would not demand any measure of technical skill and knowledge (pamphlet 1 - National schools). In biblical terms 'the hewers of wood and drawers of water in society'.

The technical schools, many of which were closely linked with the local technical college, were known as junior technical schools. They were not encouraged to flourish due to lack of funding and their inability to compete with the grammar schools. They mainly recruited at the age of 13, lacked experience of the development of a full secondary course, had no sixth forms and did not prepare pupils for prized secondary school examinations. Neither the schools themselves nor the teachers enjoyed the public esteem of the grammar schools. The author attended a junior technical college in Luton, Bedfordshire, for two years from the age of 13 to 15 and left with only a report showing his position in each end of term examination.

Hudson (1986) and Meyer (1986) suggest that the most critical period for the technical schools was from 1945 to 1965. Thereafter the policy of abolishing selection in secondary education was as incompatible with the retention of the selective technical as of the grammar school; but table 2.1 suggests that by 1965 the battle was already lost.

Table 2.1 Secondary Schools and Pupils in England and Wales (from Statistics of Education, Vol 1, 1976)

	1955	1965	1975
All maintained secondary schools	5,144	5,863	4,562
Pupils	1,914,814	2,819,504	3,619,302
Maintained technical schools	302	172	29
% of total	5.9	2.9	0.6
Pupils	87,366	84,587	18,049
% of total	4.6	3.0	0.5

With the gradual demise of the technical schools the gulf between the grammar and secondary modern school increased and with it went a general lack of appreciation of the type of education offered by secondary modern schools. Politically, because of the strong views held by the socialist government after the Second World War, the policy of 'low grade' education for the masses could not be presented under the umbrella of a vocational system. Instead it was distinguished as 'practical' education for children for whom the academic approach was thought to be unsuitable. Thus this system became the main objective of the secondary modern schools. These new secondary modern schools were usually built with well-appointed workshops, excellently equipped with machines and tools to give boys training in their use. Likewise for the girls there were well-equipped kitchens, needlework rooms and typewriting facilities. It was generally expected that such schools would provide the future workforce in the lower echelons of factory life.

If any similar facilities were provided in the grammar schools they were usually situated in separate accommodation apart from the main school building, and the subjects were taught as a leisure pursuit or a way of keeping the less able pupils occupied. Traditional academic education in these grammar schools paid only scant attention to any technical work. The majority of the pupils were being trained to staff the offices of local and national government, as well as industry and commerce.

Therefore society in general did not give much esteem to the technical work taught in secondary modern schools and even less to any form of technical work taught in grammar schools.

2.1.1.3 COMPREHENSIVE EDUCATION

With the establishment of the comprehensives, there was an attempt to point out the value of technical subjects for 'grammar' pupils and girls as well as boys. The new schools required a new curriculum and a new philosophy to match the changes observable in an increasing technological society. Around this period of time, there was an increased impetus, in some schools towards technology (Project Technology, 1966-72 - Harrison); an increased awareness of the importance of good design (Keele Project, 1967-73 - Eggleston) a greater career and industrial awakening and the setting-up of initiatives to broaden the curriculum in order to increase the flow of able students towards higher education in engineering. There were several CDT conferences held at universities and the setting up of local CDT associations, designed to help and encourage CDT teachers to meet the challenges of change. There were also plans formulated to start a more technologically orientated national forum for CDT teachers and advisory staff. To mark these developments in technical education the title was changed from 'Technical Studies' of the late 1950's and early 1960's to 'CDT'.

At the other end of the educational spectrum, CDT was being introduced in an embryo form in primary education. In 1975, the Sex Discrimination Act was passed, which gave 'equal opportunites' to boys and girls in all areas of education.

The 1980's began with concern being shown about design education: (a) Lucas Report, Design Council, (b) Craft, Design and Technology in Schools - some successful examples - DES, based on HMI's observations and (c) A document entitled 'Understanding Design and Technology' by the Assessment of Performance Unit. Throughout this decade, there were numerous links formed with industry, investigated by the 'Cast Committee (1980) and the 'Cooper Report' (1981). The City and Guilds of London Institute a year later introduced the pilot schemes for the Certificate of Pre-Vocational Education (CVPE), designed for the non-academic sixth form pupil. At the end of 1982, the first moves were made to set up the new government initiative, the Technical and Vocational Educational Initiative. In the mid 1980's, there was a wealth of activity centred on the way that the 'Equal Opportunities Act' was being implementated. Around this time, there was a move towards 'Interactive Technology', large-scale 'hands-on' experiments, 'Test Bed and Launch Pad' at the Science Museum at the end of 1984 being an example. The idea of taking technology to the schools in technology buses was taken up by some of the Home Counties - an ironic reminder of the old hand cart on which science experiments were taken from school to school at the turn of the century. This was followed by the 'Sainsbury Project'(1984), designed to encourage the most able pupils to consider taking up some form of engineering in higher education.

In 1986 three GCSE CDT subjects were introduced to cover areas of (1) designing and making ; (2) graphics and (3) technology. The Keele project and Project technology initiatives were responible for creating the foundations for these new CDT courses.

All this activity over the last three decades has meant that CDT has widened its appeal and is now more universally acceptable to all abilities and to both boys and girls. The emphasis has changed to include design demonstrated in a sophisticated way using graphics, problem-solving, the ability to control through the medium of electronics or computers, the practical understanding of scientific principles through structures, mechanisms, pnematics and electronics and the skill to realise projects in model form or totally in the most suitable materials. Also the appreciation and use of computer aided design and manufacture.

2.2 OVERVIEW

Practical education seems to have always been the 'cinderalla' of the education system. In many ways a bad start was made in 1885 since the first 'teacher' of technical work held an inferior position to other teachers because he was (a) not trained to teach;(b) not given full teacher status and (c) was the school caretaker.

Although various reports and initiatives, the most technically important being Norwood (1943), Crowther (1959) and Newsom (1963) with the design (Eggleston) and technology (Harrison) projects of the late 1960's, have championed the benefits of technical work the real break-through does not appear to have taken place until the 1980's. The scenaro before this period of time is amplified very well by Lawton(1977) "...technical studies, art and craft, handicraft, technology and, most recently, design and technology so far all have failed to find a permanent or an adequate place in the secondary time-table.

This is a sad story which illustrates from one particular viewpoint many of the current weaknesses of the English educational system. It is, on the whole, a system which is snobbish and divisive; it is a system which divides pupils into academic and non-academic, and knowledge into high-status and low-status. Technical knowledge has, in the past, been seen as low-status knowledge suitable only for the less academic pupils destined to become manual workers. Technology has been neglected and has been regarded as suitable for training the 'lower orders' rather than as liberal education".

CDT is starting to enjoy real status with the national curriculum. This has been partly due to the fact that the subject has changed the scope of its appeal with the extra money available and the 'breath of fresh air' accorded to technical work due to TVEI and the associated in-service training. The increase in national competitions, industrial links, CDT television programmes and the growth of technical work in primary education have all helped to bring the subject to the attention of the general public more and highlight its strength as a 'core' subject. Last, but by no means least, the refreshing new GCSE examinations which highlight the strength of good design and technology in our modern society have become instrumental in widening the subject appeal to inspire a much wider cross-section of pupils to become totally immersed in what is now a very exciting and acedemically fulfilling area of schools work.

It is most important to note that CDT now provides the type of technical education intended in the Norwood Report (1943) for technical school pupils 'whose interests and abilities lay markedly in the fields of applied science or applied art'.

2.3 CHAPTER 2B

2.3.1 REVIEW OF THE SAMPLE SCHOOLS

This part of chapter 2 introduces the sample schools and demonstrates the various resources available to them in 1982 when the attitude and personality questionnaires were administered.

The schools are then compared, using the variables resulting from the questionnaires, to establish any significant differences between them.

Finally, the progress of the schools since 1982 is discussed.

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(1) UP TO THE TIME OF THE STUDY

(2) FROM 1982 ONWARDS

CHAPTER 2B LIST OF TABLES

Chapter 2B THE SAMPLE SCHOOLS (1) UP TO THE TIME OF THE STUDY (2) FROM 1982 ONWARDS

2.5 UP TO THE TIME OF THE STUDY

2.5.1 BACKGROUND

It was decided to concentrate in this study on coeducational comprehensive schools for two main reasons: (a) the majority of pupils in this country attend such schools. (b) There were very few girls schools where CDT was taught (chapter 6, section 6.1). Ten schools were invited to assist with this study, seven accepted and they had a full age range from 11 and 18 years.

In order to give a clearer impression of the sample schools some background details have been given. All seven became coeducational comprehensives at the beginning of the 1970's. The oldest school, which opened in the early 1900's, was originally a trade school, changing immediately after the second world war to a technical high school. Another of the sample schools started as a technical high school in the early 1950's and during the next 20 years gradually changed its status to that of a grammar school. The largest of the sample schools was formed into a comprehensive school from a 850-pupil grammar school and a 450-pupil secondary modern school. The other four schools were orginally neighbourhood secondary modern schools, one with a religious foundation. The numbers of pupils who attended the seven sample schools is set out in table 2.2.

Table 2.2 Details of sample schools - teachers and rooms

School	Pupils	Boys	Girls	Teachers	Male	Female	College	Ex-Indust	Other	Met.	Eng	Wood	TD	Tech.
1	1264	752	512	5	5	0	3	2		1	1	2	1	0
2	910	606	304	5(4F+1PT)	5	0	3(1PT)	2	½(Phy)	1	1	1	0	1
3	750	369	381	4(3F+1PT)	4	0	2	2(1PT)	½(CDT)	1	0	2	1	With Met.
4*	955	450	505	5(4F+1PT)	4*	1	4(1PT)	1	½(Maths)1		1	2	1	0
5	850	450	400	5	5	0	4	1		2		2	1	Motor Veh
6	853	473	380	3	3	0	3	0		1	1	1	1	0
7	951	502	349	3	3	0	3	0		1	0	1	1	0

Notes: (1) - * In 1981 there were two female teachers in this school. They taught together for three years, 1979 - 1981. After the survey was done in 1982 the other female teacher left the school. (2) Ex - Indust. - Ex - Industry (Engineering) (3) Met. - Metalwork Room (3) Eng - Engineering (4) TD Technical Drawing (5) Tech - Technology (6) F - Full- time (7) PT - Part-time (8) Phy - Physics (9) Motor Veh - Motor Vehicle

2.6 SAMPLE SCHOOLS - 1982

2.6.1 COMPARISON OF RESOURCES

Five of the sample schools were from South West Herts, the other two were from Mid Herts. Generally the resources, both in teaching staff and equipment, in the South West Herts schools was similar, except three schools were teaching technology - one in the 3rd year and the other two in the 4th, 5th and 6th form. They used fairly basic equipment installed on a self-help basis.

In contrast, one of the Mid Herts schools had just had a technology room installed to allow staff to teach pneumatics, electronics, structures and mechanisms. However, the methods used for the teaching of metalwork, woodwork and auto-engineering were similar to those used in the South West Herts schools.

The five South West Herts schools were engaged in CSE and O level examinations which included a high degree of design and some problem-solving work. For example, the CSE technical studies and the O level Craft and Design (Wood or Metal) courses used the following methods of assessment:

(a) Written examination incorporating a section on design

(b) Design and realisation of a project in an extended period of time.

(c) Design folios

(d) Coursework.

The CSE Technical Studies course all included work in at least three materials - metal, plastics and wood.

One of the schools in Mid Herts was involved in design and problem-solving activities, with a large number of their pupils taking technology examinations.

2.6.1.1 TEACHERS AND WORKSHOPS - MAIN RESOURCES

Five of the sample schools, at the time of the testing in 1982, were reasonably well staffed. Schools 6 and 7, had insufficient CDT staff in relation to the numbers of pupils.

Full details for all the schools are shown in table 2.2, the number and type of workshops being on the right-hand side of the table.

Reference to this table shows that out of the twenty-seven full-time CDT staff, a total of seven entered the teaching profession after a number of years in the engineering industry.

It is also of interest to note that at one school, for a period of three years, there were two female teachers.

2.6.1.2 WORKSHOP RESOURCES

Generally the resources for all the sample schools with regard to metalwork and woodwork rooms were similar. This was because Hertfordshire has a standard policy for the numbers and types of machines in their school workshops. The major difference in the resources in the sample schools was in the amount of plastics and technological equipment. Reference to table 2.3 shows that all schools had a plastics line bender. Two schools (2 and 4) had additional vacuum-forming equipment and school 4 had dip-coating facilities.

There was evidence of some form of technology in three schools (1,2 and 7). One of the other schools had been a pilot technology school in the 1970's, but by 1982 the subject had been discontinued.

Schools 1 and 7 were preparing their first pupils for O level technology examinations at 16+ . Subsequently in 1985 they both entered 3 candidates selecting the electronics, structures and mechanisms modules. In school 2 there were very good resouces for the teaching of technology and 6 pupils were entered for O level and 11 for CSE. They included a choice of pneumatics in addition to the three modules above.

Table 2,3 Details of sample schools - resources for practical work

School	Resources	Type of TS work	Evidence of design	Evidence of technology
1	Line bender for plastics, School produced basic technology equipment	Skills based	Within set projects	Some electronics in 3rd yr,
2	Line bender and vacuum forming machine for plastics, Technology room for electronics, structures, mechanisms and pneumatics,	Technological based	Within technological projects	Emphasis on this area
3	Line bender for plastics,	Skills based	Within set projects	None
4	Line bender, dip coating and vacuum forming,	Skills and design based	Within themes	None
5	Line bender for plastics,	Skills based	Within set projects	None
6	Line bender	Skills and design based	Within themes	None
7	Line bender	Skills based	Within set projects	Electronics and mechanisms

2.6.1.3 EVIDENCE OF DESIGN

There was evidence of design work in all of the sample schools since both the CSE and O level examinations taken by these schools included design in both the practical and the theoretical papers (refer to GATE in chapter 11, section 11.3.3).

Schools 4 and 6 adopted a thematic approach, favoured by many examination boards for the new GCSE examination. An example of this being an investigation of the development (over a selected period of time) of ways of producing surfaces on which to put a tray set for an afternoon tea. Several possible design ideas suitable for the environment decided by the pupil were drawn out and the best one choosen, modelled in card and realised in a suitable material. School 2 gained its design experience from technological projects.

All other schools encouraged pupils to design within a set project format.

2.6.1.4 TEACHERS IN THE SAMPLE SCHOOLS

Out of the twenty-nine male teachers and one female teacher in the sample schools, twenty-two were college-trained and eight were from industry with an engineering background.

There was one female teacher in the sample schools (school 4), when the questionnaires were administered. For three years, 1979 - 81, there were two female teachers in the CDT department of school 4. One was full-time CDT, specialising in woodwork and the other taught in both the art and CDT departments and specialised in silversmithing and art metalwork.

Three of the sample schools had some background of A level teaching:

School 1 had some ten years teaching experience of A levels in Elements of Engineering Design and Engineering Drawing. The average size of the Elements group being three students and the Drawing four students.

School 5 had a similar experience of teaching A level Engineering Drawing with a group of 2 or 3 students.

School 2 prior to 1982 had entered pupils for some fifteen years for A level Engineering Drawing. Here groups varied from one year when 25 students started the course to three of four students in the late 1970's.

The majority of the teachers in the sample schools were in mid-career, around forty years of age.

2.6.1 5 STYLE OF TEACHING - TECHNICAL STUDIES

The five South West Herts formed the major part of the local CSE technical studies group. The overall standard of the work in South West Herts was under constant scrutiny when local examiners went to area standardisation meetings were the work being used to set examination standards was always inferior (to that made in South-West Herts) in both design and craftsmanship. Also a moderator from the CSE board visited the school where the work was set out for local moderation every three years and each moderator in turn expressed the opinion that the work on display was of a very high standard of design and craftsmanship in comparison with other schools in London and the South East. In addition members of the local examining group were involved in marking and moderating schools in the Home Counties which gave another yardstick to judge the work being done in South West Herts.

There was a similar method of checking standards in the Mid-Herts schools where there was also a high standard of design and craftsmanship with the projects in school 2 being more technologically orientated.

2.6.1.6 GRAPHICAL RESOURCES

Grouped together on Table 2.4 are the graphical resources and type of drawing work done by the pupils . Only one of the seven sample schools used parallel motion drawing equipment. All the other schools, due mainly to the large capital costs involved in changing to parallel motion, were still using drawing boards and tee-squares.

In five of the sample schools, technical drawing was taught as a separate subject with only a passing reference to practical work. There was much expertise within the local examining groups which were under scrutiny in a similar way to that which operated for technical studies.

In school 2, the major part of the graphical work was involved with the design of technological projects.

In school 4, there was no formal course in technical drawing when the questionnaires were administered (although the subject had been taught up until 1980). The graphical work was concerned with the design of practical projects.

2.6.1.7 ALLOCATION OF TIME AND EQUAL OPPORTUNITIES

Tables 2.5a and b show the time allocation for the first three years for all the sample schools. Scrutiny of this table demonstrates whether these schools are providing equal opportunities in accordance with the act of 1975. None of the schools were fully implementing the 'Equal Opportunities Act' and clearly school 5, except for the first year, was accommodating very few girls within the CDT teaching.

Table 2.4 Details of sample school - graphical resources

School	Resources	Type of TD work
1	Drawing board and tee square	Geometrical and engineering drawing
2	Parallel Motion	Design drawings for technological projects
3	Drawing board and tee square	Geometrical and engineering drawing
4	Drawing board and tee square	Design drawings for TS projects
5	Drawing board and tee square	Geometrical and engineering drawing
6	Drawing board and tee square	Geometrical and engineering drawing
7	Drawing board and tee square	Geometrical and engineering drawing

Notes; (1) TD - Technical Drawing (2) TS - Technical Studies

Table 2,5a Details of sample schools - time allocation

School	1st Yr Boys	1st Yr Girls	2nd Yr Boys	2nd Yr Girls	3rd Yr Boys	3rd Yr Girls
1	10 week rotation,All pupils doing W, M, P,HE, and N Total time/ week 1hr 10mins		Choice of three from W, M,TD,HE and N (one / term on each) Total time / week 1hr 10mins		Choice of two from W, M, TD, HE and N 1hr 10mins for each subject Total time / week - 2hrs 20mins	
2	None	None	W and M, Grap and HE Total time / week 1hr 10mins		Choice of two from W, M, Tech, HE and N *1 hr 10mins for each subject* Total time / week - 2hrs 20mins	
3	Half yearly rotation All pupils doing W, M, HE and N Total time / week 1hr 10mins		Choice of three from W, M, HE and N (one term on each) Total time / week 1hr 10mins		Choice of one from W, M, TD, HE and N Total time / week - 1hr 10mins	
4	Half yearly rotation All pupils doing W, M, P, HE and N Total time / week 1hr 10mins		Choice of three from W, M, HE and N (one term on each) Total time / week 1hr 10mins		Choice of one from W,M,HE and N Total time / week - 1hr 10mins	

Table 2,5b

5	Half yearly rotation All pupils doing W, M, HE and N Total time / week 1hr 10mins	Boys had the choice of W of M A small number of girls were able to take these if they requested to do so Total time / week 1hr 10mins	Boys had the choice of W, M and TD A small number of girls were allowed to take these if the requested to do so Total time / week - 1hr 10mins
6	Half yearly rotation All pupils doing W, M, HE and N Total time / week 1hr 10mins	Half yearly rotation for boys only taking W and M Total time / week 1 hr 45mins	Boys had the choice of W, M and TD, Total time / week - 1hr 45mins
7	Half yearly rotation boys only taking W and M Total time / week 1hr 10 mins	Choice of W, M, HE and N (one term on each) Total time / week 1hr 10mins	Choice of two from W, M, TD, Tech, HE and N 1hr 10mins / subject Total time / week - 2hrs 20mins

Notes: (1) W - Woodwork (2) M - Metalwork (3) TD - Technical Drawing (4) Tech - Technology (5) HE - Home Economics
(6) N - Needlework (7) Grap - Graphics

2.7 COMPARISON OF SCHOOLS - SIGNIFICANT DIFFERENCES

2.7.1 VARIABLES USED

One of the sample schools (No 1) had a significant numbers of pupils who entered work, when they left school, in various types of engineering (details in appendix B). To ascertain whether there was a significant difference between the schools, this school was compared in turn with all the other schools, for each sex, using the following variables:

Attitude Scores derived from Attitude Questionnaire and other variables:

VASTEC - Factor 1 - representing a strong pro-CDT stance

CRITEC - Factor 2 - a group of items that are critical of technical work

DRAWTEC- Factor 3 - items concerned with technical drawing

SOCTEC - Factor 4 - comments on the effects of technology on society

RELXTEC- Factor 5 - items indicating that technical work can be relaxing

TSLIK - Liking for technical work

TOTTS - Total number of technical subjects in Favourite Five

FAMSKIL- Family member in work requiring technical skills

TUTS - Intending to take technical studies in the 4th year

TUTD - Intending to take technical drawing in the 4th year

TCAR - Intending to take a technical career.

MATH - Ability in mathematics

TECS - Ability in CSE or O level practical examination

TD - Ability in CSE or O level graphical examination

2.7.1.1 COMPARING SCHOOL 1 AND SCHOOL 2 (BOYS)

The boys in school 2 included more technical subjects in their favourite five (TOTTS - p = .000), had more intention of taking up a technical career (TCAR - p = .022), but were more critical of the way that technical work was taught (CRITEC - p = .002). However, boys in school 1 were far more relaxed whilst taking technical work (RELXTEC - p = .000); gained higher grades in technical studies examinations (TECS - p = .036) and had more ability mathematically (MATH - p = .038).

2.7.1.2 COMPARING SCHOOL 1 AND SCHOOL 3 (BOYS)

The boys in school 1 had a more pronounced pro-CDT stance (VASTEC - p = .000); a greater liking for technical work (TSLIK - p = .001) and were more concerned about the effects of technology on society (SOCTEC - p = .024). This was despite the fact that boys in school 3 included more technical subjects in their favourite five (TOTTS - p = .005), indicating that they enjoyed taking technical subjects.

2.7.1.3 COMPARING SCHOOL 1 AND SCHOOL 4 (BOYS)

The boys in school 4 were overall more favourably inclined towards technical studies (VASTEC - p = .000, TUTS - p = .034, TSLIK - p = .003), whilst those in school 1 had a greater liking for technical drawing (DRAWTEC - p = .001).

2.7.1.4 COMPARING SCHOOL 1 AND SCHOOL 5 (BOYS)

The only significant difference was that the boys in school 1 were more relaxed whilst engaged on technical work (RELXTEC - p = .000).

2.7.1.5 COMPARING SCHOOL 1 WITH SCHOOL 6 (BOYS)

There was a greater liking for technical work expressed by the boys in school 1 (TSLIK - p = .023) although the boys in school 6 included more technical subjects in the favourite five subjects (TOTTS - p = .028).

2.7.1.6 COMPARING SCHOOL 1 WITH SCHOOL 7 (BOYS)

A more pronounced stance towards CDT was shown by boys in school 1 (VASTEC - p = .038), together with more affinity with technical drawing (DRAWTEC - p = .027) and more ability in mathematics (MATH - p = .026).

2.7.1.7 COMPARING SCHOOL 1 WITH SCHOOL 2 (GIRLS)

Girls in school 1 demonstrated a strong stance towards CDT; (VASTEC - p = .017) were more relaxed whilst engaged in technical work (RELXTEC - p = .001); had a greater affinity with technical drawing (TUTD - p = .030) and were more concerned about the effects on society of technology (SOCTEC - p = .001).

However girls in school 2 were more inclined to continue with technical studies in the 4th year (TUTS - p = .002) and take up a technical career (TCAR - p = .048).

2.7.1.8 COMPARING SCHOOL 1 WITH SCHOOL 4 (GIRLS)

School 4 was the school where two women teachers had been employed in the CDT department (table 2.2). The girls in school 4 demonstrated a greater liking for technical work. (VASTEC - p = .013, TSLIK - p = .006 and RELXTEC - p = .000) but the girls in school 1 were more concerned with the effects of technology on society (p = .001).

2.7.1.9 COMPARING SCHOOL 1 AND SCHOOL 5 (GIRLS)

There was a greater intention expressed by the girls in school 1 to take up a technical career (TCAR - p = .002).

2.7.1.10 OVERALL COMPARISONS

The boys as well as the girls in school 2 expressed a greater desire to take up a technical career in comparison with school 1. Both sexes demonstrated more enthusiasm for technical work in school 4 in comparison with school 1.

It is significant that the girls in school 4 where there were two women CDT teachers demonstrated through several variables a greater liking for technical work. It is interesting to note that boys at the same school also were favourably inclined towards technical work.

2.7.1.11 EXAMINATION RESULTS (discussed in more detail in chapter 10)

With the exception of the comparison of school 1 and school 2 which demonstrated that the boys in school 1 gained significantly higher grades (which may have been due the difference in the pupils' mathematical ability in the respective samples) all other comparisons indicated a similar standard of examination attainment.

Four of the other five schools were situated in South-West Herts and there was no significant differences between school 1 and these four schools when considering the level of examination passes. This is after all what one might expect of several coeducational schools situated in one area of Hertfordshire. It does show that as far as the sample is concerned, that there was a similar standard throughout in the teaching of CDT examination groups within those schools.

2.8 SAMPLE SCHOOLS

2.8.1 POST 1982

Three years after the initial research testing was done, a reliability check was carried out in one of the sample schools (chapter 7, section 7.6.1).

In the same year, 1985, an approach was made to all the sample schools to ascertain how many pupils actually took technical examinations. (chapter 10).

In 1987, six of the sample schools started the new GCSE examinations in the following subjects:

CDT Design and Realisation

CDT Design and Communication

CDT Technology

In addition, two schools also entered pupils for Graphic Communication.

One of the sample schools has closed due to falling roles.

Generally the schools towards the centre of Hertfordshire seemed to have fared better than those on the edge of the county. For example, the schools selected for the initial TVEI scheme, in 1983, were all clustered in one central area. Four years later one of the South West Herts schools was among successful applicants to become a TVEI extension school.

Although there was far less money available for this extension scheme in comparison with the vast sums spent on the initial TVEI, some computer-aided machines and computer-aided drafting equipment were made available. In additional the same school in September 1988, became one of the twelve schools in Hertfordshire involved in a pilot technology scheme which includes all the boys and girls in years 3, 4 and 5.

2.9 OVERVIEW

2.9.1 TEACHERS

There were 26 male and one female teacher in the sample schools. Nearly three quarters (20 - 74%) of them were college trained (including the female teacher). The others (7 - 26%) entered the teaching profession after several years in the engineering industry. Five of the seven sample schools included ex- engineers in their technical staff (table 2.2).

2.9.2 RESOURCES

Reference to table 2.3 reveals that in general all sample schools had similar practical resources except that school 2 (one of the Mid-Herts schools) was more well-endowed with technology equipment. Only one school used parallel-motion drawing boards. This was possibly due to the cost involved and the relatively high number of pupils taking graphical courses.

2.9.3 PRACTICAL WORK

In all the schools (table 2.3) there was some emphasis placed on design work. Three schools included some form of technological work in the first three years (also these schools entered pupils for technological examinations in the 5th year in 1985).

2.9.4 GRAPHICAL WORK

All schools taught some form of graphical work (table 2.4), five as a separate examination subject in additional to designing projects and two to assist the production of design drawings for various projects.

2.9.5 ALLOCATION OF TIME AND EQUAL OPPORTUNITIES

Reference to table 2.5a and b clearly shows that there was insufficient time available for all sample schools to thoroughly teach all the various aspects of CDT in order either to prepare pupils for: (a) further study of the subject in the 4th and 5th years, (b) or to provide a three year course to giving pupils confidence in designing, using tools, machines and graphics.

Six schools were engaged in some form of rotational timetable in the 1st year. Five schools followed a mini-option scheme for boys and girls. School 6 allowed enthusiastic girls to take technical subjects in the 2nd and 3rd and school 6 provided courses for boys only (table 2.5a and b). Clearly in none of the sample schools were all boys and all girls able to take both CDT and Home Economics (HE) for all three years. Therefore it appears that none of the seven schools were fully implementing the Equal Opportunities Act.

2.9.6 COMPARISON OF SCHOOLS - SIGNIFICANT DIFFERENCES

School 1 was used as a 'marker' because there were two ex- engineers on the CDT staff and a significant number (33%) of pupils (mainly boys) who took-up a career in the engineering industry (refer appendix B - survey 1985).

2.9.6.1 CDT - BOYS

More boys in schools 2,3 and 6 expressed an intention of taking-up more technical subjects in the 4th year than boys in school 1 (TOTTS - number of technical subjects included in their favourite five subjects).

2.9.6.2 PRACTICAL WORK - BOYS

There was a more pronouned pro-CDT stance (VASTEC - 1st attitude factor and TSLIK - liking for technical studies) shown by the boys in school 1 compared with those in schools 3,6 and 7.

2.9.6.3 GRAPHICAL WORK - BOYS

There was a greater regard for graphical work (DRAWTEC - 3rd attitude factor) demonstrated by boys from school 1 in comparison with schools 4 (expected since there was more graphical work done in school 1) and 7.

2.9.6.4 MATHEMATICAL ABILITY AND EXAMINATIONS

Boys in school 1 had more ability in mathematics compared with those in schools 2 and 7. The grades gained in technical studies and technology examinations by boys in school 1 were higher than those in school 2 (only to be expected due to the difference in mathematical ability).

2.9.6.5 CDT - GIRLS

Girls from school 1 were more concerned about the effects of technology on society than those from school 2 and 4 (SOCTEC - 4th attitude factor). There was a greater intention of taking up technical work expressed by girls from schools 2 and 5 (TCAR). However girls from school 1 appeared to be more at ease in technical work (RELXTEC - 5th attitude factor); had a greater pro-CDT stance (VASTEC - 1st attitude factor) and a greater affinity for technical drawing (TUTD). This is not surprising since there was more graphical work done in school 1 than school 2.

2.9.6.6 OVERALL SIGNIFICANT DIFFERENCES

Although all schools had different backgrounds (section 2.5.1) when they became comprehensives, they were allocated similar resources (tables 2.2, 2.3 and 2.4) and time (tables 2.5a and b). The only possible exception was school 2 which had greater technological resources. There are individually significant differences when six of the samples are compared with the 'marker' school. However, these significant variables are not present in all schools to form a pattern of significance difference, except for school 4 where there appears to be a greater affinity for technical work demonstrated by both boys and girls. This will be discussed in more detail later.

It would appear that overall, except for school 4, there are no significant differences between the sample schools. The presence of eight ex-engineers (seven full-time and one part-time) on the CDT staff in five schools appears not to have significantly affected the balance of those departments.

2.9.6.7 COMPARING SCHOOL 1 AND SCHOOL 4

Some of the significant differences between these schools have been referred to above. However there is one area where the differences stand out showing a much more favourable inclination by both boys and boys from school 4 when compared with school 1.

For the boys this includes VASTEC - a pro-CDT stance; TUTS - intention of taking up technical studies and TSLIK - liking for technical studies. The girls included VASTEC and TSLIK and in addition they were more at ease during technical lessons (RELXTEC - 5th attitude factor).School 4 had two women teachers employed teaching CDT (table 2.2). It does demonstrate that perhaps the women teachers may have influenced all pupils to have a very high regard for CDT when compared with the 'marker' school 1.

2.10 CHAPTER 3

Chapter 3 is a review of the somewhat scanty research that has been done in the area of CDT. Where it was felt to be applicable, science research has also been reviewed since in some schools the CDT and science departments work closely together teaching technology.

Chapter 3 REVIEW OF RESEARCH AND INFORMED OPINION

3.1 PAUCITY OF RESEARCH IN THE CRAFT, DESIGN AND TECHNOLOGY AREA

One of the problems encountered at the initial stages of this study was the lack of good CDT research literature. The author has been able to find some evidence of research work in the CDT area, but not enough to justify a chapter. Unfortunately, all that could be added to it may be termed a wealth of informed opinion on the problems of CDT and certain findings of research in science education, which appeared to have some relevance to these problems. Science seemed to be an obvious choice, especially as, in many schools, the CDT and science departments share the teaching of technology. Also, science has certain features in common with CDT as discussed in chapter 1, section 1.5.

Many of these factors have been explored by research in science in Britain and North America, and in the absence of similar research in CDT, some clues can be gleaned for solving its problems.

CDT is at present having to fight for its place in the curriculum, as did science from the mid 19th century onwards. Also, due to the dearth of rigorous research into the problems of CDT, much of what is reported in this chapter is not strictly research but informed opinion of experienced individuals, interested bodies and committees. Another consequence of the paucity of research into CDT is that any report on it is bound to be somewhat fragmentary. In order to distinguish between research findings and opinions of various kinds, the following procedure has been adopted:

CDT research findings marked, e.g. Jones (1985 CDT)

Science research findings marked, e.g. Brown (1980 Sc.)

However, over the period of this research there was a gradual increase in CDT research. This has meantthat by the end of the data collection period literature was available that had not been available before. This has been reviewed at a later stage in the thesis in chapter 11.

3.2 RESEARCH SOURCES

3.2.1 BACKGROUND MATERIAL

There have been numerous publications that have been produced to provide assistance to educationalists who are involved in the teaching of technical work. Those that the author has referred to, in order to obtain the necessary background for this study, are listed in appendix C, section C1.

3.2.2 COMPUTERISED LIBRARY SEARCHES

3.2.2.1 DESCRIPTION OF THREE SEARCHES CARRIED OUT

In order to obtain details of any research work that had been and was being done in the CDT area, three computerised library searches were conducted.

The first two were mainly concerned with research involving attitudes to technical work. These were conducted in 1982 and 1985.

The third search was mainly concerned with research involving personality studies and was conducted in 1987.

All three searches were very disappointing and revealed that there was very little research being conducted in the CDT area, with the exception of the area of equal opportunities. This research is discussed in this chapter, section 3.6.2 and in chapter 11.

A full report on these computerised searches is given in appendix C, section C.2. to C 4.5.

3.3 ATTITUDES TOWARDS PRACTICAL WORK

One of the main similarities between CDT and science is that they both have a reasonably large practical component, chapter 1, section 1.5. Also practical work played a large part in early society and technical education often being used as a controlling influence, chapter 2A. It seems therefore to be prudent to examine what effect the teaching of practical work has in CDT and science noting that perhaps one of the main attractions of practical work derives from the fact that sitting at a desk, listening, thinking, writing or drawing is rather a passive occupation for lively youngsters.

3.3.1 BENEFITS OF PRACTICAL WORK IN SCIENCE

Ormerod and Duckworth (1975 Sc.) cite several examples of the appeal of practical work to science pupils. Kerr (1963 Sc.) reported that, while the 701 sample teachers in his study put the "promotion of interest in the subject-matter" on the part of the students last in the order of importance of the ten possible attributes of practical work, when the 624 students were polled in retrospect on six ways in which they felt practical work had been of value, they put 'interest and reality' at the top of the list. A study by Rowland (1965 Sc.) underlined the value of practical work in assisting socially-disadvantaged pupils in their study of sciences. Taylor (1971 Sc.) noted that practical work attracted more boys than girls.

Brown (1972 Sc.) reports the enthusiasm of Scottish 12 year-olds with the 'new' practical work of the revised Scottish syllabuses.

3.3.2 BENEFITS OF PRACTICAL WORK IN CDT

Secondary Technical Schools in the 1950's were the pioneers of the 'practical' approach in education, an approach which provided an intellectual challenge to able boys and led to the conception of 'The Alternative Road', outlined in the Crowther Report (1959).

The Newsom Report (1963), like Rowland, was also concerned with those who experienced difficulty with reading. "Our pupils need every inducement to read, and their practical activities ought to provide many starting points for doing so...Most practical experiences, if they are to totally justify the time spent on them, should lead to thought and expression: they are not to be regarded as a substitute for thought for the less able".

Page (1965 Sc. and CDT) reported that "The notion that boys who are bright academically are unlikely to be good with their hands is now archaic. All but one school in the survey (251 out of 252 answering the relevant question) said academic ability was quite compatible with manual and practical dexterity. Many schools visited recognised that the best future scientists needed constructional skills as much as did future engineers".

Page also reported on those teachers who were teaching constructional skills. 111 schools indicated that they had staff involved in what they regarded as engineering or applied science activities. Of these, 75% were 'handicraft teachers', trained at teacher-training colleges and the other 25% were engineering or science graduates. Page summarises the importance of these teachers with regard to practical work: "Undoubtedly, these craft teachers are potentially much more important to engineering then engineers, in general recognise. They are important both as the men concerned with craftsmanship, and as the men who in many cases represent engineering in the eyes of the schoolboy - not only the schoolboy who takes metalwork but, perhaps more importantly, the one who doesn't. That latter point makes them very important - actually, not just potentially - if only for negative reasons".

In his survey, Page asked schools to respond to a given list of attitudes. A summary of the replies from the 111 schools discussed above is shown in table 3.1

The fact that academically-bright pupils could also be good with their hands, confirmed in Page's study, was also supported in the feasibility study of the Schools Council Working Paper 26 (1969). This paper appreciated the potential contribution of the workshops to the education of the most able pupils, as well as to the education of the average and less able pupils.

Page and Nash (1980 CDT and Sc.) found that "The most striking factor emerging from the case studies is that favourable attitudes to technology and industry tend to be found in schools which have strong Science and CDT departments, especially where courses are based on practical, experimental work".

Nicholson and Dobson (1980), in an article exploring links with industry, reported that "While the firms did rate mathematics and science as important, they were also prepared to say that the attributes in young people developed in the workshops were vital too. Attitudes about practical work as well as more specific skills and knowledge were valued. It was fascinating to note that firms were prepared to assign high values to kinds of learning that they had hitherto failed to specify as important prerequisities for employment in their firm".

Table 3.1

Relationship of Types of Workshop Staff to Attitudes on Workshop Teaching.

Attitudes	Handicraft* masters only 33 Schools		Handicraft and †Non-handicraft masters 50 Schools		Non-handicraft masters only 28 Schools	
(a) "It instructs in the elements of hand and machine tool operation."	21	64%	33	66%	11	39%
(b) "It interests pupils without the pressure of an examination."	11	33%	20	40%	8	29%
(c) "It makes pupils less afraid of using their hands."	11	33%	29	58%	11	39%
(d) "It is in itself a personally satisfying and rewarding activity."	27	82%	43	86%	25	89%
(e) "It is concerned with creative project work, not conventional practical exercises."	23	70%	32	64%	13	46%
(f) "It sets out to enable pupils to make a more balanced choice between pure science and applied science or engineering."	13	39%	31	62%	12	43%
(g) "It is a means of discovering the engineering applications of science."	9	27%	30	60%	14	50%
(h) "It is a means of developing the engineering and problem solving approach to science."	16	48%	33	66%	11	39%
(i) "It enables science lessons to make more sense."	13	39%	24	48%	11	39%

* Handicraft masters in this table are those trained at teacher training colleges.

† Non-handicraft masters are graduates or graduate equivalents in engineering, science or mathematics.

A Schools Council bulletin, entitled "Craft, Design and Technology Links with Industry'(1980), under the heading 'practical ability', stated that " Workshop experience gained at school, including confidence and ability in using materials, tools and machines, is valuable for future operatives and technicians. It is of considerable importance for craft apprentices".

Breckon (1979) reported the results of a survey conducted with 36 pupils taking Design and Technology at O level. They showed that 83% of the pupils thought that the design and practical work involved in the subject made it the most enjoyable one in the school curriculum.

Peters(1984), one of the country's most respected cabinet makers, made a forthright and thought-provoking comment on Britain's lack of appreciation of craftsmen and the value of practical work. He stated: "It is because of this ingrained prejudice against manual work in British education that I and others like me are inundated with requests for training from young people who have been steered by the system into advanced academic education which did not provide them with fulfilment, only frustration. If I had the stamina, I could fill my workshop many times over with disenchanted university graduates who see nothing demeaning in working with their hands as well as their heads".

There were very clear recommendations in the 'Hargeaves Report'(1984) concerning practical work: "Assess practical and / or applied work as well as the academic aspects of achievement, and accord them equal value...continue to exert pressure on examination boards to revise their syllabuses and examination requirements so as to include more practical work".

Although not directly pertinent to school CDT, it is interesting to note that one of the findings of a study involving university graduates entitled 'The Goals of Engineering Education Project' by Beuret and Rule (1984), with a sample of 250 graduate engineers, found that 59% stated the course should have included more work of a practical nature.

3.4 DESIGN AND GRAPHICAL COMMUNICATION

The art of communicating graphically was in evidence in all the sample schools. It was used as a design tool to explore possible solutions to thermatic or project related problems prior to realisation in all CDT departments. In addition five of the sample schools (not numbers 2 and 4) technical drawing was taught by the CDT staff but was not linked directly with any practical course of work. However the orthographic and pictorial representations of drawings was directly applicable for designing practical projects.

In all schools therefore the ability to visualise in order to solve design and technical drawing problems was very important.

3.4.1 IMPORTANCE OF SPATIAL ABILITY.

Spatial ability is required for graphical expression and for solving design problems. Therefore, before attitudes to design and graphical work are discussed, the origins of spatial ability need to be dealt with. Spatial ability was discovered by El Koussy in 1935, working at London University under the guidance of Stephenson. He submitted scores obtained from items on standard intelligence tests to factor analysis and found that the items split into two types, one measuring verbal reasoning and the other measuring spatial reasoning. Later, much more sophisticated tests of spatial ability were devised, in which three-dimensional principles were included.

According to Macfarlane Smith (1964), spatial abilities are necessary for the successful study of most practical and technical subjects and the more advanced branches of mathematics, physics and engineering.

Kelly et al (1984) found evidence to suggest that performance in spatial ability may be improved by learning experiences in CDT. Leonardo da Vinci is an excellent example of someone who possesses a very high general ability. He was extremely versatile, since he was outstanding in architecture, engineering, painting and sculpture, all of which required a high degree of spatial ability. James Brindley, an illiterate millwright who was a self taught engineer and a talented canal-builder, is an outstanding example of someone who possessed a very high degree of spatial ability. Other examples are Einstein and chess grand masters. Down (1986) suggested that "Central to visual-spatial ability are the capacities to perceive the visual world accurately, to transform one's initial perceptions and to be able to re-create one's visual experience, even in the absence of relevant physical stimuli. It is the ability to visually manipulate objects in space."

3.4.1.1 SPATIAL ABILITY AND THE SEXES

Terman's (1926) classic study of gifted children revealed that in general, gifted girls have interests more like the gifted boys than the control group of girls in the study. Saraga (1975) found that with spatial ability, there is a great amount of overlap between the sexes. There is also evidence to suggest that those with non-verbal intelligence tend to take up the study of sciences, and those with a verbal bias are inclined to favour the arts subjects - Sauders (1948), D.H.Ormerod (1969). It follows that there must be a need for a high degree of spatial ability for biology, the science subject favoured by girls, as well as for chemistry and physics, the sciences favoured by the boys. Ormerod (1975) provides overwhelming evidence that girls favour biology, and boys chemistry and physics.

Maccoby and Jacklin (1975) conclude that boys excel in spatial ability. Gardner (1985) suggests that since hunting was mainly a male preoccupations which required a high degree of spatial ability, there may be a selective advantage for males to evolve highly developed visual-spatial abilities. Fennema and Tartre (1985) in studying the relationship between mathematics and spatial ability suggested that it was incorrect to believe that all girls are less able than all boys to use their spatial visualisation skills appropriately in mathematics.

3.4.1.2 SPATIAL ABILITY CAN AID THE VERBALLY DISADVANTAGED

Wagner (1967) gave science demonstrations to economically-advantaged and disadvantaged pupils, aged 12. He told them to represent suitable applications of experiments that they had just seen. They could express themselves by writing, verbally or pictorially, using specially designed templates.

The economically-advantaged were superior in written or verbal responses, but they had no superiority over the economically-disadvantaged when they represented their answers pictorially, hence using spatial ability. Thus, working through spatial ability is particularly advantageous for the economically and verbally disadvantaged.

3.4.2 ATTITUDES TO DESIGN

The 'Keele Project'(1967-1973) was responsible for influencing technical teachers to become aware of the importance of design within their own departments and in the departments of home economics and art,especially in the first year of secondary education. Schools involved in the project were invited to take a combined design approach to practical work.

Sir Alex Smith, director of Manchester Polytechnic, speaking in the third Stanley lecture, October 1980, said: "To design is to make a coherent set of decisions. It is my view that this activity of designing and making ought to be the spinal column of the school curriculum for all pupils... We are very good at educating in mathematics or physics or English but making a coherent set of decisions is a rather different skill every bit as much in need of being developed".

The Lucas Report (1980) has a very clear message about attitudes towards design education in secondary schools:

"If education is concerned with trying to fit children to play a full part in the adult life of tomorrow, there can be few more important educational experiences for the children than to grapple with the sort of problems they will meet as adults - problems of the environment, of man-made things and how they can be improved, of the quality of living - or, in other words 'design' in all its forms. As such design education is the concern of all boys and girls, not just those who might eventually go on to a design-related adult occupation".

Mason (1983), chairman of the National Association for Design Education, reported that "Few local authorities have adopted a coordinated design policy for their schools, the trend towards a faculty system has meant that teachers themselves have had to take the responsibility for developing curriculum policy. Also, the design area of the curriculum has lacked the central development projects enjoyed by the humanities and sciences. Development of design educational policy has been patchy in geographical terms".

Design education received a boost in 1983, through the TVEI course 'Product and Graphics Design', which gave many CDT and art departments the chance to develop areas of design within their departments.

A two-part television documentry, shown on BB2 on the 10th and 11th of September 1985, referred to in appendix A, section A.1, entitled 'Designs on Britain', gave a very clear indication of how Britain was not retaining its best designers, since they were able to gain more lucrative employment abroad to assist other countries to create superior designs. According to Woudhuysen (1985), "It is clear that industrial design now plays a key role in international trade. Trade is now a question of the qualities of the product, not just the quantitative dynamics of the production. This is the reason why America is now beginning to debate whether poor industrial design is the root of its trade deficit with Japan. More and more, therefore, state intervention in and sponsorship of industrial design, pioneered by Britain, is being taken up by administrations in the West...Far from being a topic free of partisanship, design has now emerged as a highly tangible form of economic aggression".

In October 1986, a seven-year project was started, (TES 17.10.86, page 39) involving 15 schools in the London Boroughs of Bromley and Sutton, Gloustershire and Cleveland intended to introduce a design dimension to the teaching of all subjects in an attempt to change the attitudes of pupils towards design. The teachers taking part in the project are being eased from the rigid path of didacticism into the more open, but more difficult path of consultancy: provoking pupils into involvement in practical problems, to which they must find their own answers, rather than demanding 'right' or 'wrong' replies to abstract questions. The aim of the project is to develop young people's awareness of design and understanding of the man-made environment, its products and images.

3.4.3 ATTITUDES TO GRAPHICAL WORK

Technical drawing is the subject that has been mainly responsible for developing spatial ability of pupils perhaps more than any other subject in the curriculum, with the possible exception of art. Up until the mid 1980's, when the subject was superseded by design or graphical communication courses, technical drawing was one of the most under-rated subjects in secondary schools. It is very surprising that many have considered technical drawing to be a 'soft option', when it is such a good medium for helping to develop spatial ability. This view was not shared by Cockcroft (1983) when he addressed a Maths, Design and Technology Conference at Brunel University. He said: "An example of the importance of practical contexts of problem-solving to mathematical development was the precision that engineering drawing brings to , say, the geometry of curves. Such precision would help any mathematician: engineering drawing is undoubtedly a worthwhile skill for the young mathematician".

3.4.4 TECHNICAL DRAWING REPORTS

3.4.4.1 ENGINEERING DRAWING AT GCE A LEVEL - SCHOOLS COUNCIL EXAMINATIONS BULLETIN 26 (1972)

According to statistics produced by the DES, there was a twelve-fold increase in the number of passes in engineering drawing during the period 1955-65. During the same period, there was a three-fold increase in the number of passes in mathematics. The numbers passing graphical examinations is still increasing but not so dramatically (table 3.2).

Table 3.2

Number of passes at GCE A level in Engineering Drawing

	Year	Engineering Drawing Passes
1955	215	
1960	951	
1965	2622	Bulletin 26
1967	2781	
1970	2713	
1975	3246*	This Study
1984	3857*	

Note: * Figures taken from details sent to the author by all the main examinaing boards. These figures include all graphical subjects: design, graphical communication and engineering drawing. Some of the reasons for the rapid growth of the subject were:

'For many students the subject affords a pleasant break from desk and laboratory work, and they enjoy it'.

'It is an alternative second or third choice subject for a candidate with a practical turn of mind'.

'For many sixth form students the subject is less forbidding than some of the traditional subjects'.

The status of the subject can be judged by reference to the Schools Council Bulletin 26:

"Almost without exception the universities decline to accept a pass in a technical drawing examination as one of the two qualifying A level passes... It is probable that some universities take more kindly to the subject if it is offered as the applicant's third A level subject along with mathematics and either physics or engineering science".

3.4.4.2 REPORT ON TECHNICAL DRAWING, HANNAH MORE CENTRE, BRISTOL(1980)

This report suggests that there should be a drastic reappraisal of the aims and objectives of this subject and that the introduction of innovations is necessary for it to play a role in curriculum development. More co-operation with industry is also required.

3.4.4.3 TECHNICAL DRAWING AND INDUSTRY

Davies (1980) reported on a study carried out by the Institution of Engineering Designers, in 1978, of the aims and objectives of graphical subjects in schools. The main findings were:

(1) Less than 50% of the companies sampled required a school-leaving qualification in technical/engineering drawing.

(2) Evidence from industry suggested that experience of technical drawing within secondary school was better than no experience at all. Therefore, a balanced input of academic knowledge and practical experience was the essential ingredient of course design at the further education level of instruction.

(3) Evidence received from those involved in graphicacy within secondary education indicates a conflict is arising between vocational relevance and the need to develop a reasonable level of general communication in graphics.

An element of confusion seems to exist over the specific position of technical/engineering drawing within school curriculum developments generally and the technology/craft area in particular.

3.4.4.4 TECHNICAL DRAWING COURSES IN SECONDARY SCHOOLS, AN HMI DISCUSSION PAPER (1984)

In compiling this report, 75 schools, 11 industrial companies and 15 institutions of further and higher education were visited.

One of the major recommendations of the report supported those of the Hannah More Centre - "Current developments in technical and pre-vocational education including computer aided design, computer graphics both in schools and industry, assessment strategies, methods of examination at 16+ and general developments in the area of design and technology all suggest that the time is opportune for a reappraisal of technical drawing in schools. It is hoped that this paper will contribute to discussion amongst those involved in this area of education and so assist in that reappraisal".

3.4.4.5 THE FULMER/RESEARCH PROJECT: TOWARDS MORE RELEVANT EDUCATION (CDT,Sc.)

Davies (1984 CDT and Sc.), in an outline of a project being undertaken in four Berkshire schools over a six-year period, expressed the projects views on communication skills:

"The need to understand and to make oneself understood are, of course,major emphasis in English, and in foreign language teaching.

The skills of listening, clear thinking and clear expression, both verbal and written, must take an important place alongside the encouragement of imaginative writing and the teaching of literary criticism.

These skills are important in all subject areas as is widely recognised. The development of written communication skills is now an explicit aim in many science courses as well as in humanities.

More emphasis needs to be placed on graphical communication in its widest sense. Students need to develop an understanding of sketches, drawings, graphs and charts to gain facility in using them to help express their ideas".

3.4.5 COMPUTER AIDED DESIGN

Poole (1985) suggested that it was time some research was done to qualify or quantify the transition from manual to computerised draughting. He argued that inherent spatial ability characterises most good graphical communicators and those using Computer Aided Design (CAD) equipment still require "Fundamental training in the basic concepts of engineering drawing, and even more surprising, a similar degree of spatial ability to that of his/her manually skilled predecessor to be able to generate professionally accepted engineering drawings".

3.5 ATTITUDES TO TECHNOLOGY

3.5.1 THE IMPORTANCE OF SCHOOL TECHNOLOGY

An occasional HMI paper, entitled 'Curriculum 11-16' (1977), demonstrated the importance of technology to all pupils in secondary education: "It should be regarded as an essential part of general education that all children, including the most able, should be introduced to technology during the first three years of secondary education. This introduction should not only develop in all children an awareness of the significance of technology, but should also by enabling children to sample and experience technological activities, give opportunities for those with the potential for technological capability to become 'switched on' to technology and become motivated to pursue relevant and necessary subjects while at school...

National and economic survival is largely dependent on industrial and technological competance. It should therefore, be incumbent upon schools to ensure that their output creates a large pool of able young people in skilled, technical and professional fields, capable of fulfilling the industrial roles which generate a major part of the nation's wealth".

Nash et al (1984 CDT and Sc) suggested that attitudes to technology involved curricular issues: "The lack of a clear, co-ordinated curriculum policy throughout a school presents a real barrier for any new subject seeking to gain acceptance in a system where each subject has to fight independently for its own existence, or where the curriculum is developed in a piecemeal and pragmatic way, a new subject such as technology which does not have the status of the established academic subjects will find it impossible to make significant inroads.

A review of 90 schools (mostly secondary) involved in the teaching of technology was presented in a DES publication entitled 'Technology in Schools' (1982). It was found that only a minority of pupils took courses in technology and those that did were predominately boys. Only in the small number of primary and middle schools was the full range of ability represented with both boys and girls taking the subject.

Page et al (1981 CDT and Sc.) developed an attitude scale for technology, in order to assess specific attitudes towards technology and industry. They were investigating the criticisms that schools have formed and reinforced negative attitudes in the minds of pupils towards such things as technological awareness and industrial careers. This resulted in many young people not seeing technology as a poverty reducing agent, but as a necessary evil; thus they rejected a career in industry because of the low esteem in which it is held. There have been several suggestions put forward for this state of affairs, but many are merely speculative, apart from one or two reports, e.g. Hutchings (1963) and Page (1965). When the attitude scale devised by the Engineering and Industrial Training Board (EITB) was used, in 1985, on a group of 41-first year apprentices, sponsored by British Rail, the lack of strength of their attitude towards technology reflected the uncertainty felt by them, when viewing their futures in industries forced by economics to avail themselves of technological advance, thus leading to corresponding pressures to reduce manpower.

Nash et al (1984 CDT and Sc.) made a study of 369 pupils, made up of 275 boys (60 technologists, 215 non-technologists) and 94 girls (2 technologists, 92 non-technologists) among the more able 4th year secondary pupils. In the replies to their questionnaires there were only five 14+ girls taking technology, from groups in four schools.

The lack of a clear consensus about the nature of technology and its place in the curriculum, whether indeed it is a distinct subject or aspect of other subjects, provides an additional barrier to the introduction into the curriculum of all pupils. This lack of a clear identity for the subject , and whether it is intended educationally for all or vocationally for some, has hindered recognition of the subject by employers and higher education. Consequently pupils, parents, and teachers are reluctant to give the subject the recognition it deserves. Just as a lack of a coherent school curriculum policy has prevented technology as a separate subject being introduced, so the perceptions of science and CDT teachers, in whose subjects technology can most naturally find a place, hinder its introduction there. Science is often seen as content dominated and CDT courses as concerned with the mastery of skills. In consequence, technology may then be perceived as the application of scientific knowledge and technical skills - a watered down academic study - rather than as a problem solving process which may draw on the resources of either subject. Where such perceptions exist there well may be reluctance to introduce technology through CDT or Science".

3.5.2 GENDER DIFFERENCES

Page and Nash (1980 CDT and Sc.) reported a strong suggestion that within the general population of 4th year pupils in secondary school, boys are far more positive in their attitudes to technology and industry than girls.

Millman (1984 CDT) observed that boys were more interested in technology: they had technological leisure pursuits and enjoyed the technology sessions more than the girls.

Only two of these girls responded to the questionnaire, and consequently girl 'technologists' were not discussed in the results of their study.

Girls' responses in this research suggested they were more career - conscious than boys, but in practice girls still tend more than boys to make option choices at 14+ which effectively close certain career routes to them. Their lack of knowledge about the technology option probably reflects both patterns of socialisation which discourage girls from becoming interested in technolgy and sex-stereotyping of school subjects. In this study, it was found that boys took a greater interest (3:1) in the way that technology was developing (chapter 6, section 6.3.2.2).

3.5.2.1 SINGLE-SEX EDUCATION

Nash et al (1980 CDT and Sc.) suggested that there is a strong possibility that in the general population of 4th form-female pupils, girls in single-sex schools are more favourably disposed in their attitude to technology and industry than girls in mixed schools. Also, there is evidence to suggest that within the general population of 4th-form boys, those in mixed schools have more favourable attitudes to technology and industry than boys in single-sex schools.

In investigating 14+ pupils' preferences and choices of all school subjects, Ormerod (1975 Sc.) classified all school subjects as either 'male' or 'female', according to his own data on 1200 pupils in a variety of coeducational and single-sex schools and on the latest available national percentages of the sexes entered for these subjects at GCE O level. Thus he produced the gender spectrum of common school subjects, table 3.3.

The gender spectrum of common school subjects. The rows show the critical ratio (CR) in Mann-Whitney U test for difference between sexes in subject preference, and the percentage of 1972 GCE entries from boys

	Male ←				neutral point									→ Female
	C	Ph	Ma	Geo	↓	Mu	B	Hi	2Fl	L	A	F	E	RI
CR	9.3	8.2	4.5	0.6		0.4	0.5	1.0	1.1	1.5	2.5	6.8	7.1	7.3
% boys	70	79	61	55		36	37	48	41	49.7	43	46	43	37

In discussing his 'Gender Spectrum', Ormerod (1975 Sc.) placed engineering, metalwork and woodwork with boys' games and PE at the extreme male end, with needlework, cookery and girls' games and PE at the extreme female end. Some subjects were left out of his spectrum diagram for reasons of space.
He constructed his polarization hypothesis initially to explain the fact that single-sex educated girls expressed greater preference and choice for physics, chemistry (and in the 6th form, mathematics) than their coeducational 'sisters'; but less preference for biology. The reverse was true for single-sex educated boys. The difference between chemistry, physics and mathematics on the one hand, and biology on the other, was that the former three were 'male' on the gender spectrum and biology was 'female'. The polarization hypothesis stated that "when the preferences for, and choices of, school subjects were compared at 14+ for single-sex and coeducational pupils, each sex in the coeducational situation expressed greater preference, and where possible choice of subjects of their own gender, and a reduced preference and choice of subjects of opposite gender, compared with their opposite single-sex educated contemporaries." This hypothesis was found to be supported in 13 out of 16 cases for girls' subject preferences and in 15 out of 17 cases for boys' - results highly significant by the sign test, Siegel (1956). These results were also strongly supported by DES figures, based on 6th form choices in 447 schools - 'Curricular Differences for Boys and Girls' (Educational survey No. 21), HMSO 1975.
The association of subjects with gender was also explored by MacDonald (1980) who developed the idea of 'gender codes'. MacDonald argues that gender is re-contextualised within schools - the notions of appropriate behaviour for each sex are converted into the appropriate academic behaviour - so that some school subjects come to be seen as masculine and others as feminine.

Thus Nash's finding that girls in single-sex schools were more favourably disposed to the 'male' subject of technology is entirely compatible with the polarization hypothesis, as is one of Nash's other findings that 4th-form boys in mixed schools have a more favourable attitude to technology and industry than boys in single-sex schools.

Ormerod suggested that over and above linguistic and spatial attributes of mind which predispose the sexes towards certain subjects, was the fact that the need to assert gender roles was particularly strong at puberty and that the sexes were influenced by their hormones in expressing greater liking and choice of subjects of their own gender, when educated alongside each other.

Particularly significant in this context is the work on 'Teaching Technology to Girls', Millman (1984 CDT) who found that "the girls' experience in the mixed group appears to have resulted in far more negative attitudes towards technology lessons and a technological career than they would have held if they had been in a single-sex group or had not attended the course at all".

Also Catton (1985 CDT) states that "At adolescence, girls are anxious to adopt a strongly feminine image and boys a masculine image. These images may be enhanced through subjects with the appropriate 'gender stamp'. For example, girls will choose home economics and needlework, and boys will choose woodwork and technical drawing. The young people appreciate, consciously or not, what society expects of them, and choose subjects accordingly".

3.6 EQUAL OPPORTUNITIES

3.6.1 BACKGROUND

Gender stereo-typing seems to start from the cradle, with boys in blue and girls in pink. From early childhood, the majority of boys are encouraged to play with construction-type toys, whilst girls dress dolls. There was a partial break with tradition with the advent of 'Action Man', which boys could dress in various forms of battle gear. Until recently, the books designed to be read during early childhood have not assisted in breaking the long-established pattern of expected behaviour for girls and boys. Many teenagers of today had a pre-school literature diet of 'Janet and John' and 'Topsy and Tim'. John and Tim were always involved in the more adventurous or naughty activities. The literature that pupils read in schools also endorses traditional male and female roles.

Sturt (1984) discusses this aspect "...even more worrying, and far more difficult to do anything about, are the attitudes that prevail in the generality of our literature, on which so much of our secondary teaching is perforce founded. Nearly all literature, from Chaucer to the 20th century is male-dominated and reinforces the concepts of male and female traditions. It is interesting, and depressing, to note that female authors are every bit as bad in this respect as their male counterparts. There are plenty of books about women, of course, and books about heroines; but few of them break the long established mould. Shaw is perhaps the exception, but is seldom set by examination boards. Jane Austen offers some comfort in 'Persuasion' to those who have the subtlety to see her point. Mrs Gaskell and George Eliot occasionally raise a flicker of hope but do not sustain it.

Some of Charlotte Bronte is not much more than up-market Barbara Cartland, and a book like 'Jane Eyre', avidly consumed by every fairly literate adolescent girl in the Western world, probably does more harm to the feminist cause than most books written by men".

Skelton (1985) believes the 'gender trap' starts at primary school. "Quite frequently, primary schools reinforce the gender stereo-typing learned at home or from the media instead of offering alternative views on life for males and females... Young children often find their teacher is a woman, but the powerful positions in the school are usually occupied by men. Most primary heads and deputies are male. Even the female cleaners are supervised by a male caretaker. The notion that it is the males that exercise power follows the children in the playground which are usually dominated by boys kicking balls or running about. Some primary schools even condone such sex divisions by separate playgrounds, one for boys and the other for girls and infants".

3.6.1.1 CAN WE LEARN FROM OTHERS?

Perhaps we can learn from other societies, who treat their girls and boys in a similar way, and thus prepare them for all types of employment, instead of the gender orientated jobs that our young people seem to do. In Russia, girls find themselves in a society with a completely different set of values. This system seems to bring out the greater sensitivity of girls to the benefit of both State and the individual. The State reaps the benefit of a highly-developed work force, and the individual achieves a high place within it. A look at the early years in the life of Russian children may reveal why many more girls become engineers than is the case in the Western countries.

In Russia, a larger proportion of children spend the early part of their lives, not being looked after by their parents during the day, but in communities. The children tend to be taken to creches from six months until they are transferred to kindergartens at the age of three. In these communities, they are given graded mental stimulation by qualified staff. The ratio of staff to children is very generous, being one to every four children. There is no distinction made between the stimulation given to the sexes, and all children are encouraged to develop spatial awareness by playing with well-designed toys and games. This is in direct contrast with most Western countries, where children up to the age of three usually remain in the home environment or are taken to a child 'minder'. The amount of mental stimulation that they receive depends on several factors: the number of other children and relatives that the parent is responsible for within the home environment; the training and intellect that the parent can offer and in some cases the type and space available for stimulating the children with toys and games can have a considerable effect on the way they develop spatial ability. The number of children looked after by a 'minder' is often more than the Russian ratio of one to four children. Therefore the early development of children in most Western countries tends to be a rather 'hit and miss' affair, which seems to neglect the development of spatial ability in girls. This tends to lead to a lack of confidence in senior schools to take up engineering, technology or scientifically-based subjects in a majority of girls.

Coupled to this effect there is not the same 'feminine image factor' in Russia, i.e. girls are well aware from experience and propaganda that it is not unusual for women to be engineers.

3.6.2. RESEARCH PROJECTS

This is the one area in CDT where there has been some meaningful research undertaken. The Equal Opportunities Commission, The Engineering Council (who were responsible for 1984 being designated 'Women into Science and Engineering Year' [WISE]), Chelsea College, London (Girls and Technology Project [GATE]) and the Girls into Science and Technology Project (GIST), based at Manchester University, were the main groups who conducted or stimulated research in education with special reference to CDT. This project and other studies involving Equal Opportunities are review in chapter 11.

Equal Opportunities Commission (EOC)

The Equal Opportunities Commission was set up to ensure the effective enforcement of the Sex Discrimination Act (1975) and the Equal Pay Act (1970), and to promote equality of opportunity generally between men and women.

The Engineering Council

The Engineering Council owes its existence to the Finniston Report, (1980) which recommended that the new engineering authority should have a statutory basis. This recommendation was not accepted by the Secretary of State for Industry. In its place he proposed the establishment by Royal Charter of 'The Engineering Council' in November 1981. In 1983, all 53 of the professional institutions previously in the Council of Engineering Institutions joined The Engineering Council. The main aim of The Engineering Council is 'To advance education in and to promote the science and practice of engineering and relevant technology for the public benefit and thereby to promote industry and commerce'(The Engineering Council Newsletter, April 1985).

Women into Science and Engineering Year (WISE)

The Engineering Council and the Equal Opportunities Commission designated 1984 as Women into Science and Engineering Year (WISE) and campaigned energetically to carry the message to girls and women, their educators and employers. According to Ferry (1985), by the end of August, the EOC could list hundreds of projects undertaken by schools, colleges, universities, employers and other organisations. The response from industry was predictably one of self-interest. Large, high - technology firms, facing a shortage of skilled engineers, scientists and technicians, supported the campaign generously and enthusiastically. Although WISE cannot claim to have inspired every schoolgirl with a burning ambition to be an engineer, or every employer with the philanthropic zeal for equal opportunities, those it has reached have taken more than a passing interest.

If only a few people can be persuaded to rethink their attitudes to women as scientists and engineers, there is hope that more will follow, through the snowball effect.

Girls into Technology Project (GATE 1981 - 1984 CDT)

The GATE project was concerned with girls' technological education in particular, along with their involvement in design and technology activities at secondary school level.

The main findings on the organisation of CDT in the early years of coeducational schools were "That the curriculum in the early secondary years in the majority of mixed schools is differentiated by sex. In CDT in these schools, the experience of girls is of diminishing time spent on workshop activities as they proceed through school".

For boys, on the other hand, the time spent on CDT courses increases with the passage of each school year, as more girls either opt out of CDT or are excluded. Such differentiation occurs either directly - by operating a purposefully discriminatory policy - or indirectly - by organising the curriculum in response to pressures unrelated to gender, but which have the effect of limiting access to girls.

The main pressure that leads schools to adopt an organisational system which unintentionally results in low participation rates by girls, seems to be the problem arising from the low share of curriculum time allocated to CDT in years 1 - 3.

In this study in chapter 6, section 6.3.2.3, figure 6.4, only 24% of the girls thought that they had learned enough practical skills in years 1, 2 and 3 to allow them to get on quickly with 4th-year projects, and 63% of the girls expressed a desire for more time for technical studies in years 1,2 and 3, section 6.3.2.7, figure 6.7.

Girls into Science and Technology (GIST 1979 - 1984 CDT and Sc.)

GIST was an action-research project concerned to explicate the reason for girls' under-achievement in physical science and technical studies at school, and, simultaneously, to explore the feasibility and effectiveness of interventions aimed at improving the situation.

This project followed a cohort of pupils in eight coeducational comprehensive schools from the time they entered secondary education until they made their option choices at the end of the third year.

The main findings were "On average approximately 4% more of the year group of girls chose physics in the GIST cohort than in previous years: in technical craft the change was even smaller."

There was a small, but consistent trend for children in action schools to show a more positive (or, to be more accurate, less negative) attitude to changes than children in the control schools. This was particularly striking on measures of stereotyping, where children in action schools became markedly more egalitarian.

3.6.3 SEX DISCRIMINATION ACT

The Sex Dicrimination Act and the way that it has been implementated in schools is referred to in chapter 11.

The implementation of this act was both a challenge and also a problem for the staff of the CDT and HE departments. Before the Act arrived on the statute book, the two departments in many schools were providing equal opportunities for boys and girls in the first year of secondary education. The pupils usually went around the departments sampling various disciplines; spending eight to ten weeks on each.

Unfortunately, Heads of CDT and HE were slow to respond to the requirements of equal opportunities, because they appreciated that to offer them it effectively halves the experience for all pupils. To gain full benefit and true equal opportunity the time available for CDT and HE needs to be doubled and extra staff appointed, (Waller 1985).

Many schools found it difficult to fully implement 'Equal Opportunities' The situation that existed before is summed up by Hoare (1967) " British education is from a rational point of view grotesque, from a moral one, intolerable and from a human one, tragic... continued sexual discrimination against girls in every type of school".

3.6.3.1 SYSTEMS DEVEOLPED TO ATTEMPT TO PROVIDE EQUAL OPPORTUNITIES FOR BOYS AND GIRLS

There were various rotational systems (chapter 11, section 11.7.2.1) that were tried in coeducational secondary schools in an attempt to provide some form of technical work for both boys and girls.

Most girls when they were given the opportunity to do technical work appeared to lack confidence, Harding (1981 CDT), Millman 1984 (CDT), Kelly, Whyte and Smail (1984 CDT and Sc.) and Catton (1985 CDT).

This lack of confidence demonstrated by the girls could have been due to the fact that generally the majority of boys spend some of their leisure time with constructional-toys, model-cars and trains and helping their fathers in repair work around the home. These activities have been labelled 'tinkering' - discovery learning (chapter 11, section 11.7.1). In contrast, many girls are expected to prefer dolls and soft toys and helping their mother with the housework.

Millman (1984 CDT) reported that boys were quicker to get started on practical work than girls: "The boys seem to work more independently and were prepared to learn by mistakes."

3.6.3.2 BOYS TRY TO GET ALL THE ATTENTION

This lack of experience may be the reason for girls' reluctance to use equipment and machinery. Boys, on the other hand, try to get more than their fair share of the time available for using machines, and, if allowed, will gladly perform machining operations for girls. Other boys will use subtle pressures to 'jump the queue' when waiting for equipment or machinery. According to Catton (1985 CDT) "Boys often appeared keen to use machines in CDT lessons. They were confident, even when they clearly didn't know the correct or appropriate way to use the machine. Girls in mixed groups, on the contrary, often displayed reluctance to use a machine, even after being shown how it is used".

In chapter 6, section 6.3.2.8 in response to item 13 - write down the name of the best project that you have made in technical Studies - girls tended to favour projects that are usually made in the first year of a technical course. There could be several reasons for this:
(1) Due to the choice system that existed in the sample schools, some girls only took a technical practical subject during the first year.
(2) The girls tended to make less demanding projects than the boys.
(3) The teachers favouring the boys in the group. Spender (1978 and 1982), claims that teachers almost inevitably favour boys in class.
It is possible to examine this further by looking at the responses to item 14 - Which machine do you most enjoy using?, section 6.3.2.9.
It is significant that 48% of the boys enjoy using the most complicated piece of machinery, the lathe. Whereas only 7% of the girls favour this machine. This clearly demonstrates that girls are reluctant to use some of the machinery, as found by Catton (1985 CDT and Sc.) above.
It can happen that when a boy calls out in class he gets the teachers attention. If a girl calls out she could get told to raise her hand and wait her turn. Boys seem to get more praise, more criticism and, ultimately, more education than girls attending the same lesson. Wilce (1985) referred to this tendency not to treat boys and girls equally, and also reported on some research work, investigating classroom interaction, completed in 1983 by David and Myra Sadker in America.

They watched more than 100 classrooms in four States in the District of Columbia, and concluded that teachers respond to pupils in four different ways:

(1) Praise - (excellent, well done)

(2) Acceptance ('OK')

(3) Remediation ('How did you get that answer' - 'Are you sure you're right'

(4) Criticism ('no, that's wrong', - You'll fail your exam if you don't pull your socks up')

They then found out that boys get more of every kind of response than girls, although the category where the difference was least marked, acceptance, was the one which, they contend, is the least educationally productive.

Having classified these responses, they also noted that boys were about eight times more likely to call out than girls, and that a good half of the classrooms they studied were divided in some way into groups of boys and girls. David and Myra Sadker have devised a course designed to change teachers' behaviour so that they treat boys and girls equally.

The findings of the Sadker and Sadker study is supported by previous research ,Sears and Feldman (1974); Wernersson (1982) have shown that on average teachers interact more with boys than with girls in the classroom. Spender (1982) suggests that "...it is almost impossible to reduce preferential treatment of males so that teacher time and attention are distributed equally to both sexes".

The differences of behaviour of girls and boys in a workshop environment is also reviewed in chapter 11, section 11.7.5

3.6.4 CREATIVITY

3.6.4.1 CREATIVITY IN CDT

Johnson (1985) refers to knowledge acquisition and general background information being essential to creative technology "Thus, what might be loosely described as a cognitive context - the need for a pool of information from which fruitful associations may be drawn is stressed in Johnson's dissertation. An argument is developed to show that the individual's creative development is severely handicapped when he is lacking in knowledge and skills considered to be essential for creative expression. Research evidence is provided to show that worthwhile creations are preceded by a thorough background knowledge and hard work. Little support is given to chancy methods of developing creativity where too much emphasis is placed on discovery learning. It is considered that the student faced with too many problems all at once may be inhibited. Thus, on these grounds the knowledge and skills necessary to prime the student are regarded as an essential pre-requisite to creative development...

If the suggested criteria for the development of creativity are ignored in the teaching of CDT, then there is likely to be little creative development. The danger foreseen is that the student may become inhibited to such an extent that he will lose confidence, and may then never realise the creative potential he may possess". It was noted by Torrance (1963) that, initially, when girls were introduced to scientific toys they seemed to be completely lost on how to play with them in a creative way. In fact, they scored much lower than boys on tests designed to gauge the creative use of the toys. A second matched sample was taught in a different way. They were encouraged to consider learning experiences in a creative way.

When they were tested a year later there was no significant difference between girls and boys. Therefore, it may be possible to encourage a more balanced development of both verbal and spatial ability in girls, if they are given the necessary stimulation in early play and in infant school. In the Equal Opportunities Commission booklet entitled 'Do you provide educational opportunities?' there was a reference to creativity on page 8 "Is there an imaginative play area where children can create their own environment and activity, and develop their own roles... Training and practice in the use of essential tools should start as soon as children begin school, and all facilities should be available to girls and boys".

The Schools Council Cast Committee in a bulletin entitled 'Craft, Design and Technology' (1980) made a reference to creativity: "The shortage of creative engineering designers and production engineers is the most damaging skill shortage for the engineering industry".

3.6.5 GIRLS ENJOY CDT BUT FEW CONTINUE WITH IT AFTER THE THIRD YEAR

In a booklet published in 1983 by the 'Equal Opportunities Commission' entitled, 'Equal Opportunities in Craft, Design and Technology; reference was made on page 7 to the fact that girls, even when given the opportunity, do not always continue with CDT after the 3rd-year.

"In many mixed state schools, girls and boys study a common set of practical subjects for the first two or three years. It appears that girls enjoy the experience of CDT at this stage, seemingly doing well in the various aspects of the work. Teachers of the subject have reported, to several working party members, that, in general, girls achieve as well as boys and frequently better than boys, at this stage.

In conversation with a visitor to her school, one girl observed "We were expected to use brazing torches - just like the boys - it was great!". A second girl commented "It gives you a good feeling when you make something and see it finished". Another girl added "Its better still when you use your own ideas".

As soon as they are given a choice, however, pupils opt on very traditional lines and very few 4th and 5th year-girls are to be seen working in CDT workshops in most schools. Certainly, a very small percentage of girls enter for public examinations in CDT". At least 95% of entries in all technical subjects are from boys (DES,1983). In this study, chapter 7, section 7.3.9, girls expressed a strong liking for CDT up to and including the 3rd-year, and they were more relaxed in the workshops and less critical of the subject than the boys. All, seemingly, very potent reasons for continuing with the subject in the 4th and 5th-years. The reality was that only 1% of the girls took examinations in CDT, (chapter 10, section 10.3.1)

3.6.6 EQUAL OPPORTUNITIES IN THE CURRICULUM IN SINGLE SEX SCHOOLS

All previous discussion has been centred naturally on coeducational schools providing equal opportunities. An initiative in ILEA concerning single-sex schools has been undertaken. A number of pairs of single-sex schools, close to each other, have co-operated to enable a number of girls and boys to take subjects previously considered to be outside their traditional areas.

Bird and Varlaam (1985) reported that, overall, there was more interest expressed by both boys and girls in taking technical subjects than in taking domestic subjects. It appears that the effect of taking a course outside the traditional domain can lead to a broadening of attitude towards work roles. Pupils were asked how their parents felt about their taking the particular courses.

Many parents did not expressed a view. Of those who did, a few (3%) were opposed. The greatest opposition came from fathers to their sons' taking domestic subjects, (12%). Girls from families where the mother worked outside the home showed greater interest in CDT, compared with those whose mothers did not. In chapter 7, section 7.3.10(2), in this study, the most potent influence on girls taking up technical subjects was a family member with technical skills.

3.7 INDUSTRY

3.7.1 PUPILS' PERCEPTIONS OF ENGINEERING

With the introduction of TVEI in 1983, and then CPVE together with more links being formed between schools and industry following 'Industry Year', there may be a change in attitude towards the engineer and to considering a career in engineering. Certainly, the reports and the research studies that were done in the early 1980's show that many pupils have a poor image of the engineer, and very little desire to make a career in engineering, (appendix A, sections A.7.4 and A.7.5). The Finniston Report (1980) pointed to the relatively low status and poor public esteem enjoyed in Britain by members of the engineering profession. Support for this assertion was drawn from the results of a survey, conducted by National Opinion Polls, reported in Appendix G of the report on pages 242-246. The poll demonstrated widespread confusion of what an engineer actually did. Over 2/3rds of the sample of over 2000 thought that the engineer was involved in:

(1) Work at a manual level.

(2) Involved in making things.

(3) Working with machinery.

Only 1/8 of the sample correctly understood the major areas of the work of an engineer since they thought that an engineer was involved in the following areas of work:

(1) Professional level;

(2) Design.

(3) Planning.

(4) Research.

It would appear that the terms 'engineer' and 'mechanic' are more or less equivalent to many people. This was also demonstrated in appendix A, section A.6.8.1.

The assertion made in the Finniston Report on page 25 "It is our firm belief that improved standing for engineers and greater attractiveness for the career among their ranks will only come with enhanced recognition of the nature and importance of engineering", in many ways echos the tenor of the Dainton Report (1968).

To acquire this 'greater attractiveness' for a career in engineering, there are two areas of confusion to be investigated.

(1) The question of the general status of professional engineers.

(2) The effect that this perception of this status and other aspects of engineering may have on pupils enthusiasm to consider a career in engineering.

Smith (1982), in a study of first year pupils' in three secondary schools in West Yorkshire, found that they perceived all three engineering occupations (mechanical, civil and electronic) as 'dirty work', involving a long day and being a relatively subordinate type of career. When compared with other occupations (biologist, physicist, economist, accountant, sales representative, lawyer, and estate agent) there was a strong tendency to perceive engineers as 'scruffy' and as relatively 'unintelligent'.

Claridge (1984) replicated some of Smith's work with a mixed group of 100 Ist and 4th year secondary school pupils, but he reduced the occupations to mechanical engineer, sales representative, lawyer. electronic engineer and civil engineer. This sample perceived the mechanical engineer as being involved with dirty work, but only 2/5 thought this to be so for the electronic engineer and around 1/2 for the civil engineer.

In this study, using similar methods to Smith, (appendix A, section A.6.8) the pupils perceive the engineer as a confident, intelligent, inventive, cheerful, sociable and scruffy person who receives good pay for working a long day doing interesting and dirty work. A survey carried out in 1986 by Opinion Research and Communications for the Committee for research into Public Attitudes,was reported on page 8 in the spring edition of the 'View' magazine, in 1986. This survey was carried out with the aim of attracting bright students into industry. 3,333 brighter pupils in 131 schools in England and Wales were questioned in depth about career choice and motivation. The research found that school children still have a depressing image of industry and they have little understanding of the importance to society of the wealth creation role of industry. The survey had some revealing facts:

"The depressing image of industry among school children may, in part, be due to the fact that, despite vigorous activity by some organisations and individual companies, industry as a whole does not seem to be selling itself as well as its competitors... one of biggest 'turn offs' from industry was that the work would be too routine and boring".

3.7.2 SCHOOL LINKS WITH INDUSTRY

CDT through the full sequence of designing and making, and, in the case of some courses in addition, the use and understanding of technology, can now make a significant contribution to general education - especially in the development of transferable skills and positive personal attitudes. All pupils have the potential to undertake planning procedures. With practice and encouragement they can examine a project and plan the sequence of operations which are necessary in order to make an artefact. In doing so they learn to take decisions, consider alternative methods, and anticipate problems which may occur. According to Mathews (1977), all these skills have been recognised as important for the aspiring engineer.

Unfortunately, many pupils are not fully aware of the types of exciting careers that industry has to offer.

Kirton et al (1984 CDT and Sc.) reported that: "There is, on the whole, no clear coherent picture presented in most schools of the engineering dimension as it exists within industry and the public service, in spite of the efforts made in developing general school /industry links".

One of the improvements suggested in the Finniston Report (1980, p165) was for:

"A more positive and informed presentation of engineering to pupils in schools, including improved careers advice, more short secondments to industry of teachers and senior pupils, and more emphasis upon industry and technology within teacher training programmes".

The relevance of CDT as a training for life skills and a preparation for an industrial career, was referred to in Schools Council Cast Committee Bulletin (1980, p26) "Many teachers feel strongly that their main concern is to prepare boys and girls for life.

In this respect, one of the major contributions of CDT lies in providing opportunities for the realisation of personal development and satisfaction through designing and making. This may seem more related to human spirit than to industrial activity. One of the fascinating results of this inquiry is that industry values highly the personal qualities which arise from such work, difficult to measure though it will be".

The Cooper Report (1981) entitled 'School - Industry Link Schemes, A Study and Recommendations', on page 11 deals with initiatives outside link schemes: "Many useful initiatives are being taken, without direct involvement of the school/industry link organisations ...... Local activities are frequently built around work experience schemes... 'twinning' arrangements between schools and industries and visits involving pupils, teachers and managers... The ideal situation is one in which school teachers and industrial managers talk to each other, visit each other, learn about each other's work".

Davies (1984 CDT and Sc.) reported that, despite the Fulmer Research Institute and Berkshire LEA getting involved in many local and national schemes designed to bring about a greater mutual awareness between industry and schools, "...the central problem of the cultural mismatch between school and industry still remains".

3.8 FAMILY INFLUENCES ON PUPILS CHOICE OF CAREER

3.8.1 IMPORTANCE OF PARENTAL SUPPORT

It has been recognised, for a long time, that parental support is a very powerful influence on the development of childrens' career aspirations. Furthermore, throughout history skills have been passed on in families, Medvene and Shueman (1978) found that, amongst those preparing for an engineering career, there is a significant relationship between choice of major job function and early parent-child interactions.

The influence of a male member of the family having technical skills appears to be a strong factor when younger members are choosing careers was noted by Ainley and Clancy (1983).

In this study, the presence of technical skills in the family is by far the most potent influence on girls taking up technical subjects, (chapter 6, section 6.3.2.12 and chapter 7, section 7.3.10 (2)).

3.9 OVERVIEW

The results from the three computer searches, two attitudinal and the other on personality, were disappointing since they revealed the paucity of research in the CDT area, but at the same time satisfying because they confirmed the results of the author's manual searching for CDT studies.

There are sufficient studies that have been done in CDT and science to demonstrate the value of practical work to both disciplines.

The importance of spatial ability, for the technical and scientifically orientated pupil, is well supported by research studies and examples of famous people who used this ability.

The Keele project, the Design Council, the National Association for Design Education and the media have made sure that the design aspect of CDT is fully appreciated.

Technical Drawing is a subject that has developed despite its critics, although Sir Wilfred Cockcroft believes the subject to be a worthwhile skill for mathematicians. Certainly, with the impact of more graphics and computer aided design, this area of CDT will gain in status.

Boys appear to have a more positive attitude towards technology than girls in coeducational schools. In single-sex schools girls are more favourably disposed in their attitude to technology.

It does appear that the passing of the Sex Discrimination Act, because schools were not prepared to allocate sufficient time to fully implement the spirit of the Act, has led to a reduction in the experience gained by many pupils in both CDT and HE. The various ways that have been used to ensure that some form of equal opportunities for boys and girls operate have also had the effect of many courses being rather dis-jointed and lacking in continuity.

It does appear that girls will gain in confidence if they are given more exposure to 'tinkering activities' in primary school. For those girls who do not get this experience, there is some strong feeling that they should be given extra lessons, without the boys, so that they can 'catch up' with them in this important confidence building area.

Male teachers, especially those in CDT, should be aware of the well proven fact that boys do try to get an unfair share of their attention in classroom and workshop situations.

It is interesting to note that when given the chance to 'catch up' girls seem to be as creative as boys.

It is very disappointing that more girls do not continue with CDT after the 3rd-year, when the research evidence clearly shows that they are confident and uncritical of the subject.

There are three other studies that indicate the influence of a family member on the selection of technical work.

There appears to be a need for an increased amount of research work into the reasons why engineering has such a depressing image in the minds of many pupils. There is sufficient evidence to suggest that this is perhaps one of the most important areas to be addressed by the Engineering Council.

Although the Engineering Council have mounted a small scale advertising campaign described in appendix A, section A.5.1, much more clearly needs to be done to re-educate the general public and parents in particular. There has been a considerable amount of research work centred around Equal Opportunities. Since these studies were 'on-going' at the time the data was being collected for this study it has been decided to devote chapter 11 to reviewing them The findings of all these studies including the present study have been compared and many interesting similarities have been highlighted.

3.10 CHAPTER 4

3.10.1 RESEARCH METHODS

Since the main research satistics have been based on attitude and personality questionnaires a review of the meaning of attitudes, the measurement of attitudes and personality traits has been undertaken. The types of questionnaire, the attempts made to overcome bias towards CDT and extraction of factors is reported. Finally the way the examination survey was done is discussed.

CHAPTER 4 RESEARCH METHODS USED

4.1 APPRECIATION OF PROBLEMS INVOLVED IN INITIALLY SETTING UP THIS STUDY

The author having decided to do an attitudinal study in CDT with groups of 3rd year pupils (chapter 1, section 1.1) faced several problems.

(1) A limited period of time available during the week to visit schools, attend seminars and such like. The first three years of the study the author was allowed to be away from his post as a full time head of a technical department for 3 ½ hours weekly (all free periods taken together).

(2) The lack of any form of attitudinal questionnaires in CDT.

(3) The limit of a maximum of a double period (70 minutes) to carry out any testing in the pilot schools. This was the maximum time that could be negotiated with the senior staff at the schools.

Due to these restrictions it was decided to limit the study to schools within areas of the county of Hertfordshire in easy assess of the author's school and to devise questionnaires that could be completed with ease within the time available (maximum - 70 minutes).

To obtain personality profiles for the pro-CDT pupil an 'off the shelf' personality questionnaire Cattell's HSPQ, was used.

4.2 PRIMARY AND SECONDARY AIMS

In order to objectively consider the primary and secondary aims of this study (repeated below for reference), the term 'attitude' is defined; methods of attitude testing is discussed; how the attitudes were tested in this study is reviewed; personality is defined and how they were used with attitude measures to establish profiles of a pro-CDT boy and girl.

4.2.1 PRIMARY AIM

To investigate the dimensions of attitudes of secondary school pupils towards Craft, Design and Technology.

4.2.2 SECONDARY AIMS

(1) To investigate any differences, in both attitudes and personality, in the way the two sexes regard CDT.

(2) To attempt to ascertain why more girls do not continue with CDT after the option stage in the 3rd year.

(3) To follow up the sample until the post 16+ stage in order to investigate the actual take-up of further study of CDT subjects to examination level at 16+.

(4) To compare the attitudes of those who passed well ('high flyers') with those who only gained a low pass ('low achievers').

(5) To compare the attitudes and examination performance of pupils in the sample schools in order to ascertain whether there was any significant difference between the schools.

4.3 ATTITUDE AND ATTITUDE MEASUREMENT

4.3.1 TERMS USED TO FULFIL THE AIMS

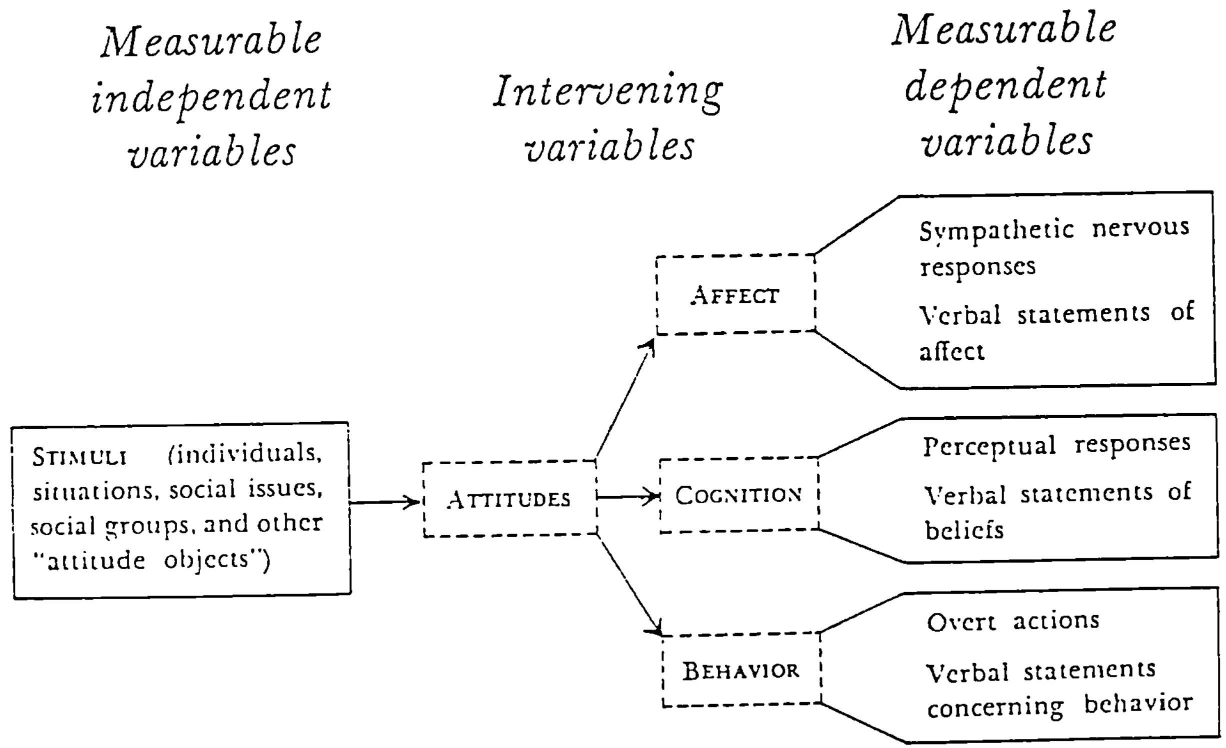
There are terms used which need to be defined and / or explained. These are 'attitude'and 'attitude measurement'.

4.3.2 THE MEANING OF THE TERM 'ATTITUDE'

The study of different aspects of attitude has a long history. McDougall (1908) referred to three types of attitude response that are designated in the 1980's as cognitive, affective and behavioural (table 4.1). Two decades later other researchers were concentrating on the affective response.

In 1929 Thurstone described an attitude as "the affect for or against a Psychologoical object". Three years later, Likert was referring to "a certain range within which responses move".

Table 4.1 Schematic Conception of Attitudes



Allport (1935) gives what is thought to be the most comprehensive definition at that stage in the development of opinion on attitudes: "An attitude is a mental and neural state of readiness, organised through experience, exerting a directive or dynamic influence upon the individual response to all objects and situations with which it is related."

In the next two decades, writers were reconsidering the other dimensions of attitude. Krech (1946) includes a cognitive dimension, suggesting that attitudes are "attempts at solution". Katz and Stotland (1959) refer to "stable or fairly stable organisation of cognitive and affective processes". Triandis (1971) supports the re-consideration of new dimensions within attitudes, stating that an attitude is "an idea charged with emotion".

Cook and Selltiz (1964) analysed attitudes in behavioural terms, noting that attitudes on their own do not control behaviour, instead "They enter along with other influences into the determination of a variety of behaviours".

It would be incorrect to assume that all those concerned with the meaning of attitudes always were in total agreement. The 'measurement enthusiasts' did not support these theories, since Defleurs and Westie (1963) argued for precise attitudes to specific social objects in specific situations, as defined be a particular measuring technique.

Rosenberg at al (1963) indicate "that attitudes are predispositons to respond to some class of stimuli with certain classes of responses and designate the three major types of response as cognitive, affective and behavioral". They are represented in a simple schematic diagram (table 4.1).

Oppenheim (1979) argues that "an attitude is a state of readiness, a tendancy to act or react in a certain manner when confronted with certain stimuli. Thus, the individual's attitudes are present but dormant most of the time; they become expressed in speech or other behaviour only when the object of the attitude is perceived ...
Attitudes are reinforced by beliefs (the cognitive component) and often attract strong feelings (the emotional component) that will lead to particular forms of behavior (the action tendancy component).In all definitions one idea is common, the essential feature being that an attitude is preparation or readiness for response. An attitude is not behaviour but is the pre-condition of behaviour. It may exist in all degrees of readiness from the most latent, dormant, traces of forgotten habits to the tensions which are actively determining a course of conduct that is under way".

Emerging from the above definitions is the fact that attitudes probably have three components. These are cognitive, affective and conative. These components can be present in a variety of intensities, giving rise to an infinite possibility of combinations.

The origins of attitudes according to Wood (1983) "are a blend of what the person has learned or perceived formally or informally, his personality which may temper or heighten the perception and his social, political and religious background. But even when an attitude has evolved there is no guarantee as to how it will manifest itself.
Two people may have the same attitude but may reveal it quite differently, depending upon their personality and the environment in which they find themselves at the time".

4.3.3 THE MEASUREMENT OF ATTITUDES

4.3.3.1 EARLY METHODS

From almost the beginning of the century, psychologists have attempted to measure attitudes by requiring people to write paragraphs or essays, measuring writing pressure or pulse rate or blood pressure. Graphic rating scales were devised where respondents marked their own position regarding a certain attitude along a line on which the steps were indicated by words, numbers or phrases. This rating could also be done by others.

Quite reliable methods of measuring attitudes to various school subjects have been devised by Ormerod and Billing (1984), in the 'Brunel Subject Preference Grid' where school subjects are listed and the respondent was asked to give one of five responses:

	like very much	like	indifferent	dislike	dislike very much
Score	5	4	3	2	1

Teachers were rated on a three point scale:

	like	uncertain	dislike
Score	3	2	1

Subject choice, where it was available for the next year, was measured by 'Take' and 'Drop' scoring 2 and 1. This, to some extent, validated subject preference by correlating with it, although it must be remembered that some choices were exercised for future career reasons or because of pressure from the school. Teacher liking was also found to correlate significantly with subject preference in all subjects at 14+.

Gradually, however, in the general field of attitude measurement, quantitative efforts began to centre on the ranking or scoring of statements purporting to represent varying degrees of a 'pro' or 'anti' attitude to a specific object. These eventually gave rise to the two classical methods of attitude measurement in the 'pre computer age':

(1) Thurstone's method of equal appearing intervals (Thurstone and Chave, 1929), used first to measure attitudes to religion.

(2) Likert's method (1932) of summated ratings.

These methods will be dealt with in some detail because Thurstone's method has some points of methodology still valuable in attitude scale constructions and Likert's method has enjoyed widespread use and in some ways is the ancestor of modern attitude scales.

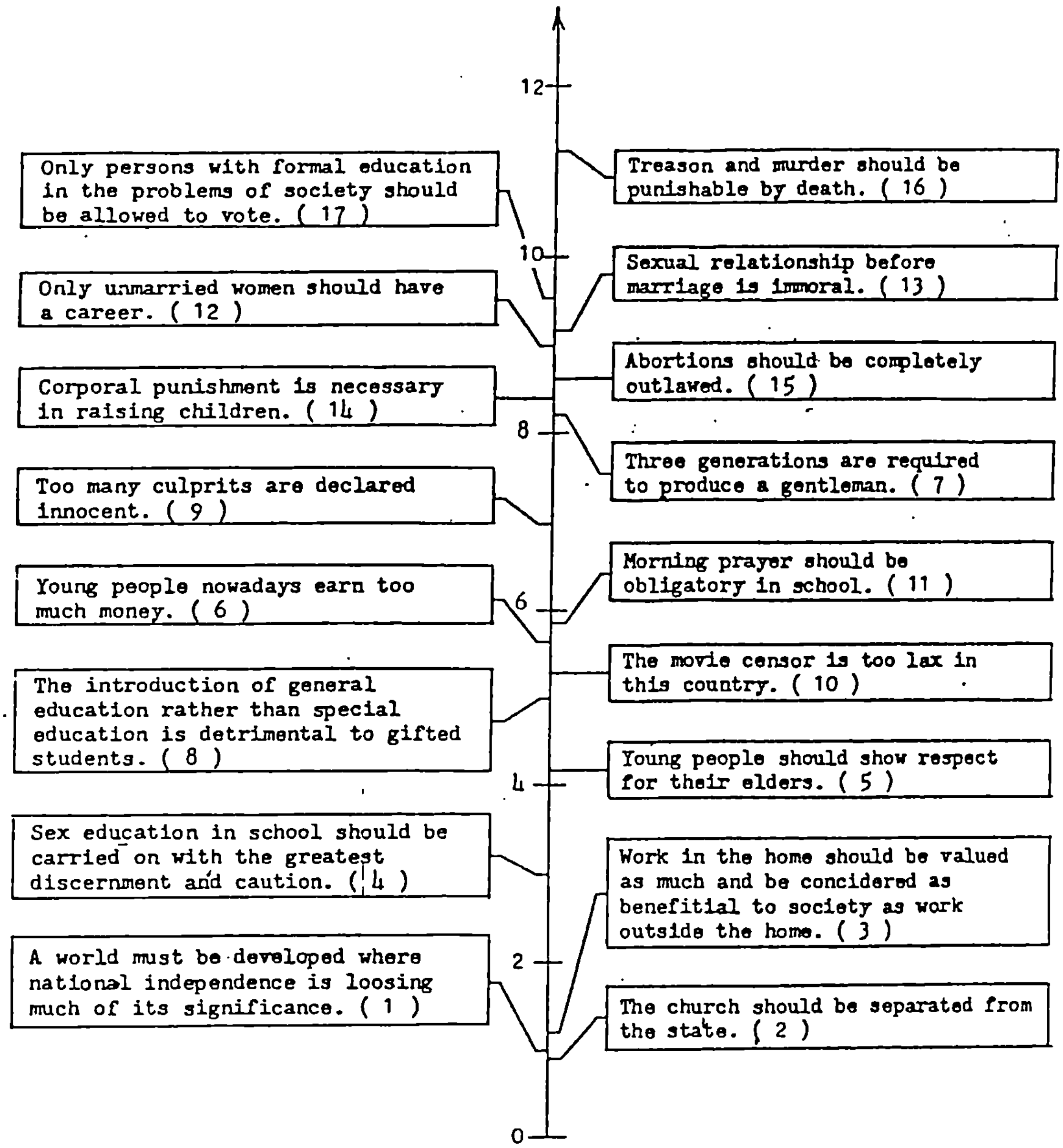
4.3.3.2 THURSTONE'S METHOD OF EQUAL APPEARING INTERVALS

Thurstone's objective was to get a range of statements relative to a certain attitude of such a nature that they could be spread along a continuum from one extreme of attitude to the other. Each statement could be assigned a numerical scale value from its position on the scale.

Such a scale is illustrated in table 4.2 with a scale for the measurement of 'Authoritarianism ' with the most 'anti' authoritarian statements at the bottom and the most 'pro-authoritarian' statements at the top. The degree of authoritarianism in a respondent would impel them to agree with statements a certain distance up the scale but disagree with those beyond this stage. The respondents score could then be taken as the average (mean or median) value of the scale location of the items with which agreement was recorded.

The essence of the method has now been abandoned but two stages in constructing the scale are still of value. Thurstone paid great attention to the stability of the statements that went into the scale using the following techniques for this purpose.

Table 4.2 Location of items from a Thurstone type Attitude Scale on a 12 point continuum



The above gives the scale (S) values, ie. the medians of the judges' ratings, on a scale measuring authoritarianism. An individual's score on a Thurstone scale of this sort is the average (expressed as a mean or median) of the locations of the items with which he agrees.

(1) A number of criteria were devised which statements had to meet in order to be included. Thurstone and Chave's original criteria were expanded by other researchers and are detailed in table 4.3. These criteria are still of value in selecting the most suitable items for attitude scales, though often neglected.

(2) The use of 'judges'- Thurstone used sixty judges to rate the position of each of his potential items on a nine point scale, (others have used 7, 9 or 13 point scales and reduced the number of judges down to as low as ten)

From the judges rating he got two values: (a) A scale (s) value which was the median rating of all the judges for that item. (b) A 'Q' value - This was the range of the scale over which the middle 50% of the judges rated the statement i.e. the inter quartile range of the judges ratings for that statement. If the statement was vague and imprecise the judges would tend to spread the ratings over a wide range and it would have a high 'Q' value. Thurstone and Chave selected the statements with the lowest 'Q' values to gave them a series of statements covering the continuum of the whole attitude range,

It was later found (Edwards, A.L. 1957) that neutral statements were a source of ambiguity and unreliability in attitude scales, since some respondents took them one way and some another.

4.3.3.3 LIKERT'S METHOD

This method had a different rationale to Thurstone's method. A Likert scale consisted of a series of statements to each of which there were usually five responses (but sometimes only three), typically of the form, "strongly agree, agree, uncertain, disagree, strongly disagree". If the statement was a 'pro' attitude statement these would be scored 5,4,3,2,1. If it was 'anti' the scoring would be reversed.

The selection of the most suitable statements was done initially by a correlation method.

Table 4.3

EDWARD'S INFORMAL CRITERIA FOR ATTITUDE STATEMENTS

"Wang (1932), Thurstone and Chave (1929), Likert (1932), Bird (1940), and Edwards and Kilpatrick (1948) have suggested various informal criteria for editing statements to be used in the construction of attitude scales. Their suggestions are summarised below:

1. Avoid statements that refer to the past rather than to the present.
2. Avoid statements that are factual or capable of being interpreted as factual.
3. Avoid statements that may be interpreted in more than one way.
4. Avoid statements that are irrelevant to the psychological object under consideration.
5. Avoid statements that are likely to be endorsed by almost everyone or by almost no one.
6. Select statements that are believed to cover the entire range of the affective scale of interest.
7. Keep the language of the statements simple, clear, and direct.
8. Statements should be short, rarely exceeding 20 words.
9. Each statement should contain only one complete thought.
10. Statements containing universals such as *all*, *always*, *none*, and *never* often introduce ambiguity and should be avoided.
11. Words such as *only*, *just*, *merely*, and others of a similar nature should be used with care and moderation in writing statements.
12. Whenever possible, statements should be in the form of simple sentences rather than in the form of compound or complex sentences.
13. Avoid the use of words that may not be understood by those who are to be given the completed scale.
14. Avoid the use of double negatives.

In addition to the above suggestions, Payne (1951) has provided a checklist of things to be considered in preparing single questions for public opinion surveys. Many of the items in his list are also applicable to the phrasing of statements for attitude scales."

The test was administered to a suitable number of respondents (about sixty would be adequate). Each item was scored and the scores for the respondents would be correlated with the total scores on the rest of the test. The items with the highest correlations with the rest of the test would be selected as the most suitable.

Later another method of selecting the best items was introduced, (Edwards , 1957). The test was scored and the top and bottom groups, usually 23 to 25% of each, were separated out.

The average scores of these two groups on each item was calculated and 'T-tests' were performed to find the significance of the difference between the scores of these two groups on each item.

The items exhibiting the most significant differences between these two groups were chosen for inclusion in the final test.

4.3.3.4 THURSTONE AND LIKERT METHODS COMPARED

As with most scales up to a point, reliability increases with length of scale, unless many unsuitable items are present or the scale is so long that boredom (on the part of the respondent) sets in. This can, of course, vary with the type of respondent. Edwards (1957) reports reliability of Thurstone type scales to be from .52 to .80 for a 20 item scale and .68 to .88 for 40 item scales.

Likert scales have been reported with reliability of .81 to .90 for a 24 item scale on internationalism and .80 to .92 for a 12 item scale on imperialism and .79 to .91 for a 14 item scale on attitudes to negroes. By and large, Likert-type scales were recognised as giving higher reliabilities.

4.3.3.5 CRITERIA FOR SELECTION OF ITEMS

Although Likert gave some suggestions for selecting suitable items they were not as thorough as the criteria of Thurstone et al (table 4.3). The tedium of using judges and calculating 'Q' and 'S' values was entirely avoided, although some researchers, without good justification, had cut the judges down to ten.

One of the most difficult things to establish in an attitude scale is its validity - that is sound evidence that it is measuring what it claims to measure - other than 'face validity' (the survey of the content of the items used in the test).

An additional value of Thurstone's method was that it informed the judges about what the scale was trying to measure. The scrutiny of the items by the judges was an additional contribution to validity, if the judges were asked to point out irrelevant or ambiguous items.Nevertheless, the relative ease with which Likert scales were constructed led to Likert's method becoming the favourite method of attitude scale construction. However thoughtful researchers, like Edwards (1957), suggested a combination of the two methods. This involved the use of judges and the criteria of Thurstone et al (table 4.3) for editing statements, followed by Likert's method of scoring and selecting the final items by the correlation of item scores with the rest, or by the way in which they distinguished between high and low groups.

4.3.3.6 UNIDIMENSIONALITY

The ultimate criteria for acceptability of both a Thurstone and a Likert set of items was unidimensionality, that is their capacity to measure a single pure dimension of attitude, whether it be attained by Likert's techniques or by the use of judges and calculating 'Q' and 'S' values. Further elaborate methods, particularly Guttman's Scalogram Technique (1950), were developed to ensure unidimensionality.

4.3.3.7 SUMMARY - ATTITUDE SCALE CONSTRUCTION

Attitude scale construction, especially by Likert's method, was a fairly simple operation and it seemed to arouse a fascination, especially for science teachers working for masters degrees.

Gardner (1975) criticised some attitude construction scales. However, most of the weakness of such scales can be traced to faulty items. This may be due to failure to edit items by the Thurstone et al. criteria, or failure to submit them to the scrutiny of judges.

The methods used in this study are those described in the first paragraph above suggested by Edwards.

4.4 PERSONALITY AND ATTITUDE MEASURES

In order to fulfil the first secondary aim it was necessary to compare attitude and personality measures. Some basic explanation of psychology together with a definition of traits and personality measures has been included.

4.4.1 SUB-AREAS OF PSYCHOLOGY

According to Zimbardo et al (1977), the sub-areas of psychology can be generally classified in one or two orientations. The first orientation looks inside the person (investigating the person's unique internal characteristics) for answers about individual behaviour, whilst the second orientation looks outside the person (at external social influences on that person). The 'inside' approach is demonstrated by physiological psychology (which studies such things as the brain, hormones and the nervous system); and by much of traditional personality and clinical psychology, which focus on the individual's stable or dispositional traits, personality structure, and mental disorders. In contrast, the 'outside' approach is used by social and experimental psychologists, who study how the individual is affected by such factors as the physical environment and the presence (real or implied) of other people.

4.4.2 TRAITS AND ATTITUDES

A trait is a form of readiness for responses and so too is an attitude. A trait is individualised, distinctive of its possessor as is an attitude. A trait guides the course of behaviour and may often become dynamic and compulsive, as may an attitude. And yet there are several distinctions:

(1) An attitude has a well-defined object of reference, either material or conceptual, whereas traits have no such definite reference to objects. The more numerous the objects that arouse an attitude, the more closely does the attitude resemble a trait. The more the attitude is specific and stimulus-bound, the less does it resemble a trait.

(2) Attitudes may be specific as well as general, whereas a trait may only be general.

(3) The term attitude usually signifies the acceptance or rejection of the object or concept to which it is related. Ordinarily, attitudes lead one to approach or withdraw, to affirm or to negate. Traits as a rule have no such clear-cut direction.

The term attitude, then, is an independent concept, distinct from all other types of acquired and conditioned action patterns .

4.4.3 PERSONALITY MEASURES

There are several research studies that have employed personality measures to describe those who have chosen to work in the sciences.

Kelly (1961) suggests that, both in schools and at home, independence and confidence, traits he associates with typical scientists, are encouraged more in boys, as are the types of play which may develop abilities to perform well in the physical sciences.

Hudson (1966) describes science specialists as convergent thinkers, while divergent thinkers, he says, prefer the arts.

Child and Smithers (1971) suggest a tendency for university students, attracted to the scientific studies to be interested in and prefer working with objects rather than people.

Head (1980) describes boys opting for science as being emotionally reticent, introvert, authoritarian, conservative and controlled whereas girls opting for science are only noticeably low in self-esteem.

4.5 METHODS OF DATA COLLECTION

4.5.1 INTERVIEWS OR QUESTIONNAIRES

There are two main methods of gathering information for educational surveys and these are interviews or questionnaires.

4.5.1.1 THE INTERVIEW

The great advantage of the interview in the hands of a skilled interviewer is its flexibility according to Oppenheim (1979). The interviewer can make sure that the respondent understands the questions and the nature of the research. The interviewer can 'probe' further when certain responses are given. the interviewer can build up a rapport so keeping the respondent interested and responsive to the end of the interview. However the interview has many disadvantages. There are great possibilities of bias. the interviewer may convey their own feelings by tone of voice or gestures. An interviewer may misunderstand or fail to obey instructions. Not many respondents can be included in the sample because the method is very time-consuming.

4.5.1.2 QUESTIONNAIRES

There are several advantages of administering a questionnaire: these are;

(a) It is far less time consuming.

(b) A much larger sample can be covered.

(c) The bias that could be present in the interview situation may be eliminated by a careful structuring of the items. The main disadvantage is that this method could lack the richness of response that could be achieved by a good interviewer.

4.5.2. THE METHOD SELECTED

It was decided to gather the data by using questionnaires for the following reasons:

(a) It was envisaged that several schools would be included in the study. Initial contacts with the schools indicated that although they were willing to help with the collection of research material, the pupils were only available for a limited period of time.

(b) Since this study was being done by a full-time practising teacher, time out of the classroom was at a premium.

(c) It was not possible to carry out interviews for three main reasons;

(i) it had been indicated by the senior staff at the schools that there was a maximum of 70 minutes available for testing. This was just sufficient to administer the questionnaires and would leave no time for carrying out interviews.

(ii) Even if had been some extra time available the author on his own would have found that interviewing an adaquate number of pupils would have taken up more time than his allocated 3½ hours allowed weekly by his school.

(The author tried doing some trial interviews at his own school with some 3rd year pupils. He found that to establish a rapport and obtain meaningful data meant spending a considerable amount of time, in the order of at least 20 minutes for every interview.)

(iii) Had extra time been available then perhaps a team of interviewers could have been asssembled. However as the author at that time was unaware of other researchers working in the CDT area even this would not have been possible.

4.5.2.1 QUESTIONNAIRE TYPES DEVISED SELECTED

There were four different questionnaires were used.

(1) In order to establish how pupils perceive the engineer, a questionnaire with pairs of descriptors outining aspects of the engineers appearance and personality (for example, scruffy - smartly dressed) was devised (appendix A, table A.3).

(2) To gain information about the attitudes of pupils towards CDT, two questionnaires were devised:

(a) An attitude questionnaire, was designed by extracting items from pupils essays described in chapter 5, section 5.1. This was a 'closed' type questionnaire giving respondents a choice of five alternative replies using Likert's method of summated ratings.

(b) In order to give the respondents the opportunity of giving more detailed opinions about their attitudes to CDT an 'open-ended' information questionnaire was devised (decribed in chapter 6, section 6.1).

(c) In order to establish any differences between the psychological profiles of pupils who choose CDT after the 3rd year and those who do not. Cattell's High School Personality Quotient Questionnaire was used (chapter 8, section 8.1).

The main reasons for using 'an off the shelf' questionnaire were that:

(a) It was a questionnaire that had been widely used sucessfully by researchers for several years.

(b) There was considerable experience gained by researchers using this questionnaire at Brunel University.

(c) The questionnaire included an intelligence test.

4.5.2.2 OVERCOMING CDT BIAS

The attitude questionnaires were administered in the seven sample schools to pupils in mathematics, English, classical studies, chemistry, CDT, home economics, art and careers lessons. A number of different lessons was selected in an attempt to overcome a bias towards CDT that may have resulted if only CDT lessons were used (chapter 6, table 6.1).

4.5.2.3 EXTRACTING FACTORS

It was necessary to simplify the interrelated measures present in all three questionnaires. These interrelated measures or factors were obtained by using 'factor analysis'. Factor analysis according to Child (1979) "...seeks to do precisely what man has been engaged in throughout history, that is to make order out of the apparent chaos of his environment." Child gives an example. "Another commonplace illustration of methods parallel to factor analysis can be seen in the field of medicine. There are numerous ways in which ill-health becomes manifest. Temperature, heart beat, physical growths, pain and so on are observed and by noting the recurrence of certain physical symptons the doctor builds up a cluster of symptoms which always seem to appear together - a syndrome."

A brief account of factor analysis is given in appendix D.

4.6 INVESTIGATION OF ACTUAL TAKE - UP AT 16+

In 1985, three years after the administration of the questionnaires, arrangements were made to establish how many pupils took technical examinations at 16+.

The details of technical examinations were collected from six of the seven sample schools (one declined to assist in this investigation).

In addition to establishing how many pupils actually took technical examinations and comparing this against their responses to TUTS (intention to take-up technical studies) and TUTD (intention to take-up technical drawing), the examination results achieved by the six sample schools was compared. Correlations between the pupils examination scores with the five attitude factors and seven other variables (table 4.4) were obtained to establish any significant relationships. This enabled a profile to be built up of the pupil who took technical examinations. This was done for both technical studies and technical drawing.

Finally the examination results achieved by 'high flyers' (O level A-C and CSE 1) and the 'low achievers' (CSE 4 and 5) were compared and significant differences discussed.

4.7 OVERVIEW

Attitudes, attitude measurement, personality and personality traits form the basis of the statistical work done in this study. They have been defined and discussed.

The reasons for using questionnaires as the main research tool have been reviewed.

The methods used to collect and analyse the results gained by those pupils who took technical examinations at 16+ has been outlined.

Table 4.4 CODE FOR SYMBOLS USED

Attitude Scores	Derived from Attitude Questionnaire
VASTEC	Factor one - Pro-CDT stance
CRITEC	Factor two - Critical of technical work or the way that it was taught.
DRAWTEC	Factor three - Items concerned with technical drawing.
SOCTEC	Factor four - Comments on the effects of technology on society.
RELXTEC	Factor five - Items indicating that technical work can be relaxing.
Other measures of relevance in CDT	
TSLIK	Liking for technical work
TOTTS	Total number of Technical Subjects in Favourite Five
FAMSKIL	Family member in work requiring technical skills
TUTS	Intending to take technical studies in the 4th year
TUTD	Intending to take technical drawing in the 4th year
TCAR	Intending to take a technical career
MATH	Ability in Mathematics

4.8 CHAPTER 5

4.8.1 PILOT QUESTIONNAIRE

The methods used for collecting items, the way that they were judged and then formed into a pilot questionnaire are outlined.

The way the pupils completed questionnaires was analysed to enable a number of factors to be formed. This is discussed in some detail.

Finally the factors were allocated suitable descriptors and the main questionnaire was prepared.

CHAPTER 5 LIST OF FIGURES AND TABLES PAGE NO.

CHAPTER 5 PILOT QUESTIONNAIRE

5.1 COLLECTING ITEMS

Several methods of collecting items were considered. It was thought to be wise to get items from pupils similar in age to the study group, i.e. third year.

One hundred and fifty pupils spent one hour and ten minutes writing their opinions on three topics namely:

(a) Consider the time that you have spent so far in school life, doing technical studies (metalwork, woodwork or technical drawing), write an essay outlining your likes and dislikes and how you think lessons could be improved.

(b) Modern technology has given us calculators, digital watches, T.V. games, computers, advances in weapons for defence, advances in travel, advances in medicine, robot workers in factories. How do you think these advances will affect your working life?

(c) Are advances in technology harmful or helpful to mankind? State fully your reasons for your answer.

Ninety two pupils were members of the third-year. Thirty-six were in the fourth-year and twenty-two were in the fifth year. Out of the ninety-two third year pupils, eighty boys and twelve girls, thirty-one intended to take up technical subjects in the fourth year. In the group of third years there was a large number who were not taking a technical subject in the senior school, but could be expected to have well-defined opinions. The fourth and fifth years were all taking a technical subject. Their views were sought to give a more balanced set of opinions. The essays written by the pupils were carefully read and ninety two items were extracted.

Because of its importance to the sense of the items key words like Technical Studies and Technology were printed with initial capitals.

5.2 SORTING OUT THE ITEMS

5.2.1 GROUPING OF ITEMS

Pro-Technical Studies	Anti-Technical Studies
Pro-Technical Drawing	Anti-Technical Drawing
Pro-Technology	Anti-Technology
Management of Technical Department	

They were then studied to ensure that all were unique. Then they were formulated into a collection of ninety two items, using Edwards Informal Criteria, table 5.1. The collection of items is shown in tables 5.2a to 5.2f.

5.3 JUDGING

5.3.1 TYPES OF JUDGES

Amongst the judges were engineers (sales, production, pump and turbine), nurses, teachers (technical, science, and primary), medical students, an accountant and four sixth form technical pupils.

They were asked to judge the items according to nine points, categories A-I, divided into three main groups, using the format shown in table 5.3.

Although thirty minutes was spent explaining to each judge how to rate the items, the results were not good. They rejected some of the most discriminating items and left unsuitable ones in, as judged by a seminar of experienced research students and staff, discussed in section 5.3.4.

5.3.2 REJECTED ITEMS

The items rejected were:

Technical Studies is just as important as other subjects.

Technical Studies is a welcome break from other lessons which are usually spent writing notes.

Technical Studies is a boring subject.

I like the fresh smell of wood being machined.

Table 5.1

EDWARD'S INFORMAL CRITERIA FOR ATTITUDE STATEMENTS

"Wang (1932), Thurstone and Chave (1929), Likert (1932), Bird (1940), and Edwards and Kilpatrick (1948) have suggested various informal criteria for editing statements to be used in the construction of attitude scales. Their suggestions are summarised below:

1. Avoid statements that refer to the past rather than to the present.

2. Avoid statements that are factual or capable of being interpreted as factual.

3. Avoid statements that may be interpreted in more than one way.

4. Avoid statements that are irrelevant to the psychological object under consideration.

5. Avoid statements that are likely to be endorsed by almost everyone or by almost no one.

6. Select statements that are believed to cover the entire range of the affective scale of interest.

7. Keep the language of the statements simple, clear, and direct.

8. Statements should be short, rarely exceeding 20 words.

9. Each statement should contain only one complete thought.

10. Statements containing universals such as *all*, *always*, *none*, and *never* often introduce ambiguity and should be avoided.

11. Words such as *only*, *just*, *merely*, and others of a similar nature should be used with care and moderation in writing statements.

12. Whenever possible, statements should be in the form of simple sentences rather than in the form of compound or complex sentences.

13. Avoid the use of words that may not be understood by those who are to be given the completed scale.

14. Avoid the use of double negatives.

In addition to the above suggestions, Payne (1951) has provided a checklist of things to be considered in preparing single questions for public opinion surveys. Many of the items in his list are also applicable to the phrasing of statements for attitude scales."

Watching a casting poured, in Metalwork lessons, is fascinating.

Technical Studies should be more creative.

There is too much filing and hacksawing in metalwork lessons.

Teachers of other subjects do not appreciate how interesting and enjoyable Technical Studies lessons can be.

After Mathematics and English, Technical Studies is the most useful subject.

Advances in Technology will cause too much unemployment.

Technological advances in the form of robots to do basic tasks could make us lazy.

Advances in Technology tends to make jobs boring.

Modern building Technology is producing too many ugly town centres.

Advances in Technology are increasing the pace of life too much

Advances in Technology has produced too many cheap material things of low quality.

Advances in Technology will give us more leisure time.

We must make advances in Technology to progress as a Nation.

Pupils who take Technical Studies usually do well in life.

The projects in Technical Studies take too long to make.

You can relax in Technical Studies.

I especially enjoy making projects that involve using the brazing hearth.

Learning about Technical Studies is not important to my education.

All pupils should try to improve their Technical skills.

There are too many demonstrations in Technical Studies lessons.

Table 5.2a Items collected from the pupils' essays

Item No.	Item Content
01	Technical Studies lessons are very enjoyable.
02	More time should be spent, during the school day, on Technical Studies.
03	The skills learned in Technical Studies are helpful after leaving school.
04	It is easier to make projects in wood than in metal or plastics.
05	The projects made in years one and two are well thought out.
06	Some pupils spend too much time on the lathes and others have to wait a long time.
07	Technical Studies is interesting when you are shown how to use the lathes, shaping and milling machines.
08	Technical Studies is as important as other subjects.
09	There should be a smaller number of pupils in the workshops for Technical Studies.
10	The demonstrations take too long in Technical Studies.
11	There should be two groups in the workshop; one group for faster workers, and one group for slower workers.
12	Technical Studies projects should be designed during Technical Drawing lessons.
13	In Technical Studies lessons you have to concentrate to get good results on practical work.
14	Technical Studies is a welcome break from other lessons which are usually spent writing notes.
15	Technical Drawing is not an easy subject because it requires a lot of concentration to do the work in a limited time.
16	Technical Studies theoretical lessons are boring.
17	Engineers should be paid more.

Table 5.2b

Item No.	Item Content
18	We need more Technical Studies teachers.
19	The projects made in Technical Studies are not very interesting.
20	Metalwork is more exciting than Woodwork because there are more machines to use.
21	The knowledge gained in Technical Studies will be of great benefit when we own a home.
22	Technical Studies is a boring subject.
23	I like the fresh smell of wood being machined.
24	Watching a casting poured, in Metalwork lessons, is fascinating.
25	Technical Drawing is enjoyable because a wide range of topics is covered.
26	Technical Studies could be improved by combining Metalwork, Woodwork and Technical Drawing, and working on one project involving the use of all three.
27	Technology is helpful to mankind because it has helped to improve the transplanting of human organs.
28	Technology helps to create jobs in computer programming.
29	Advances in Technology has provided better games and forms of entertainment.
30	Advances in Car Technology have produced Robots which build better cars.
31	Technology is helpful to mankind because modern aeroplanes fly faster.
32	Technology has produced the micro-chip which has made all electronically controlled projects much smaller thus saving space.

Table 5.2c

Item No.	Item Content
33	Technology has provided help for the disabled by providing electronically controlled wheeled cars, alarm systems etc..
34	Technology advances will, one day, produce a car that will travel great distances using electrical power.
35	Technical Studies could be more creative.
36	There is too much filing and hacksawing in Metalwork lessons.
37	There should be extra Technical Studies lessons, after school, for those who enjoy the subject.
38	In the Technical Studies rooms the wall charts show me how to use the tools.
39	The films shown during some Technical Studies lessons are helpful and interesting.
40	I would like to see the workshops made into more interesting areas by having more wall charts.
41	The work set out in the show-case gives a good idea of the standard of work at the school.
42	Teachers of other subjects do not appreciate how interesting and enjoyable Technical Studies lessons can be.
43	After Mathematics and English, Technical Studies is the most useful subject.
44	There should be more modern machinery in the Technical Department.
45	After a basic course of two years, pupils should be allowed to choose the type of projects they wish to make.
46	There should be more demonstrations in Technical Studies.

Table 5.2d

Item No	Item Content
47	Technical Drawing is a relaxing subject.
48	In Technical Drawing it is always a challenge to see what the end result of a drawing will be.
49	In Technical Studies you can make your own projects in the 4th year.
50	Advances in Technology will cause too much unemployment.
51	Technology can be harmful to mankind because advances in nuclear warheads threaten the world with destruction.
52	Technological advances, in the form of robots to do basic tasks, could make us lazy.
53	Advances in Technology tends to make jobs more boring.
54	Too much money is spent on advances in Technology.
55	Modern Building Technology is producing too many ugly town centres
56	Advances in Technology is increasing the pace of life too much.
57	Advances in Technology have produced too many cheap material things of low quality.
58	Money spent on Technology could be put to better use.
59	Advances in Technology are responsible for goods being produced with greater accuracy.
60	Advances in Technology will give us more leisure time.
61	To progress as a Nation we must make advances in Technology.
62	Advances in Technology are responsible for improving the food crops.
63	Without Technology we would still be in our bareskins.
64	Technology has improved waste disposal.
65	Advances in Technology make everyday life safer.

Table 5.2e

Item No.	Item Content
66	Without advances in Technology we would stagnate as a Nation.
67	Pupils who take Technical Studies usually do well in life.
68	Technical subjects are too difficult.
69	The Technical Studies teachers are too safety minded.
70	I don't like the harsh noises made by Metalwork tools.
71	The projects in Technical Studies take too long to make.
72	A knowledge of Technical Studies helps you to make projects more cheaply than the ones bought in shops.
73	I would like to do more design work in Technical Studies lessons.
74	the teachers in Technical Studies lessons show pupils how to make the projects properly.
75	The skills learned in Technical Studies lessons are a good investment for when you leave school.
76	The projects made in Technical Studies are well thought out.
77	You can relax in Technical Studies
78	Technical Studies is a good subject because, if you get behind, you can 'catch up' during lunch-time or after school.
79	Technical Drawing is important because several jobs need it.
80	I especially enjoy making projects that involve using the brazing hearth.
81	I don't like being stopped too many times, when I am working on a project, for the teacher's demonstrations.
82	All demonstrations should be done at the beginning of the lesson.
83	In Technical Studies you learn many different crafts.
84	More money should be spent on Technical machines and equipment.

Table 5.2f

Item No.	Item Content
85	Technical Studies is the most useful subject area on the timetable.
86	Learning about Technical Studies is not important to my education.
87	All pupils should try to improve their technical skills.
88	There are too many demonstrations in Technical Studies lessons.
89	In Metalwork lessons too much time is wasted waiting for tools and machines.
90	Metalwork is too noisy.
91	There should be more than one teacher in Technical Studies lessons.
92	Work sheets showing how projects are made would be helpful in Technical Studies lessons.

Table 5.3 Nine categories to allow judges to rate each of the 92 items

	A	B	C	D	E	F	G	H	I
Item No	Extremely Pro	Average Pro	Below Average	Pro-side of	Neutral	Anti-side of	Below Average	Average Anti	Very Anti
1									
2									
3									

5.3.3 RETAINED ITEMS

Some of the judges responses indicated that the following items would be suitable to include in the final group for the pilot study, (which, however, eventually were rated as unsuitable):

The films shown in some Technical Studies lessons are helpful and interesting.

I would like to see the workshops made into more interesting areas by having more wall charts.

The work set out in the show case/s give a good idea of the standard of work at the school.

The projects in Technical Studies are well thought out.

In Technical Studies you learn many different crafts.

Worksheets showing how projects are made would be helpful in Technical Studies lessons.

More time should be spent, during the school day, on Technical Studies.

5.3.4 REVIEW OF JUDGING

The results of the judging were presented at a research seminar by the author. This seminar was attended by two tutors and ten research students. It quickly became apparent that the judges had not made a worthwhile selection of the items. It was decided by the seminar group to act as judges and go through the items again. This was done and the item collection was reduced from ninety two to fifty.

5.3.5 POSSIBLE REASONS FOR THE JUDGING FAILURE

A review of the returns from the judges proved to be most interesting. There may be some reason why the judging indicated a removal of some of the most discriminating items.

The judges were divided into three groups, as shown in table 5.4. Group A, which contained four sixth form pupils who were in the first year of an A level course studying Elements of Engineering Design, was largely in agreement with the findings of the seminar group. These pupils were 'in tune' with the third year pupils who were largely responsible for providing the items that were being judged. They had also recently taken Technical subjects in the third year, and no doubt clearly understood the reasons.

In Group B there were eight judges all of whom had a technical or scientific background. They rejected some good discriminating items but by no means as many as those rejected by Group C. This group was mainly made up of eight semi or non-technical people. This group was mainly responsible for skewing the results of the judging. On reflection the judging may have been improved by having, as judges, all technical people instead of people from various professional areas. Oppenheim (1979) states that in the past judges have been selected from past university students. It is preferable to have judgements made by people who are similar to those to whom the finished scale will be applied.

5.4 PILOT SCHOOLS

5.4.1 PILOT QUESTIONNAIRE

The fifty items formed the basis of the pilot questionnaire - given in tables 5.5a, b and c. The method used to measure the attitudes of pupils toward the items in the questionnaire was carefully considered. It was decided to use the Likert type attitude scale, figure 5.1.

All the items represent a point of view. They were emotive rather then factual. The Likert scale ensures a gradient which was transferred easily into numerical scores.

Group A	Group B	Group C
4 Technical 6th Form Pupils	1- Medical Student	1- Accountant
	1- Production Eng.	2- English Teachers
	1- Pump Eng.	2- Primary Teachers
	4- C.D&T Teachers	2- Nurses
	1- Science Teacher	1- Sales Eng.
4	8	8

Table 5.4 Judges

Table 5.5a Pilot Questionnaire

Item No.	Item Content
01	The skills learned in Technical Studies are a good investment for when you leave school.
02	It is interesting when you are shown how to use the machines.
03	In Technical Studies you learn many different skills.
04	Technical Studies theory lessons are boring.
05	Watching a casting poured, in Metalwork, is fascinating.
06	Advances in Technology will cause unemployment.
07	I like the fresh smell of wood being machined.
08	Engineers should be paid more.
09	All pupils should try to improve their Technical Skills.
10	There is too much filing and hacksawing in Metalwork lessons.
11	I need more time to do Technical Drawing.
12	Technical Drawing is important and several jobs need it.
13	Technical Studies lessons are enjoyable.
14	Metalwork is too noisy.
15	Technical Studies teachers are too safety minded.
16	The projects in Technical Studies take too long to make.
17	Money spent on Technology could be put to better use.
18	Advances in Technology tend to make jobs boring.
19	Technical Drawing is an easy subject.
20	We need more Technical Studies teachers.
21	I enjoy watching demonstrations.
22	Modern Building Technology is producing too many ugly town centres.
23	Advances in Technology is increasing the pace of life too much.
24	Technical Studies could be more creative.
25	Pupils who take Technical Studies usually do well in life.

Table 5.5b Pilot Questionnaire

Item No.	Item Content
26	The wide range of topics makes Technical Drawing enjoyable.
27	Technological advances in the form of robots to do basic tasks could make us lazy.
28	Technical Studies is a welcome break from other lessons.
29	The best part of Technical Studies is making things oneself.
30	Advances in Technology will give us more leisure time.
31	Advances in Technology have produced too many cheap material things of low quality.
32	In Technical Drawing it is always a challenge to see what the end result of a drawing will be.
33	To progress as a Nation we need to make advances in Technology.
34	The knowledge gained in Technical Studies lessons will be of great benefit when I have my own home.
35	I especially enjoy making projects that involve using the brazing hearth.
36	You can relax in Technical Studies.
37	There should be more demonstrations in Technical Studies.
38	Teachers of other subjects do not appreciate how interesting and enjoyable Technical Studies lessons can be.
39	A knowledge of Technical Studies helps you to make projects more cheaply than those bought in shops.
40	Technical Studies lessons are boring.
41	After Mathematics and English, Technical Studies is the most useful subject.

Table 5.5c Pilot Questionnaire

Item No	Item Content
42	Technology helps to create jobs in computer programming.
43	Technical Studies subjects are too difficult.
44	Learning about Technical Studies lessons is not important to my education.
45	There are too many demonstrations in Technical Studies.
46	I find Technical Studies easy.
47	Technical Studies are just as important as other subjects.
48	Advances in Technology make every day life safer.
49	There should be more modern machinery in the Technical Department
50	Technical Drawing is a relaxing subject.

Figure 5.1 Likert method of scoring

		Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1	The skills learned in Technical Studies are a good investment for when you leave School.					

Scoring					
Favourable Item	5	4	3	2	1
Unfavourable Item	1	2	3	4	5

5.4.2 ADMINISTRATION OF PILOT QUESTIONNAIRE

This was administered in two co-educational comprehensive schools. One had 950 pupils and the other 1300 pupils. A group of 91 pupils (67 boys and 24 girls) completed the questionnaire.

5.4.3 SCORING OF PILOT QUESTIONNAIRE

The responses of the pilot population to the items included in the pilot questionnaire were scored as indicated in figure 5.1, in this section.

Examples of scoring (figure 5.1).

Item 1 - The skills learned in Technical Studies are a good investment for when you leave school.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
5	4	3	2	1

Item 4 - Technical Studies lessons are boring.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1	2	3	4	5

5.4.4 PREPARING COMPUTER PUNCH CARDS

In order to prepare all the data obtained from the pilot population it was necessary to prepare a punch card for each pupil. To ensure that each pupil's data was unique, numbers were allocated to their school and class. Also they were given a unique individual number, a number according to gender and their date of birth was recorded. An example of the numbers allocated to one pupil is shown in figure 5.2.

A score was allocated for each item including the practice item. The ability of the pupils for mathematics was also scored , 7 to 1 (mathematical very able through to remedial). An example of the numbers on one pupil's punch card is shown in figure 5.3.

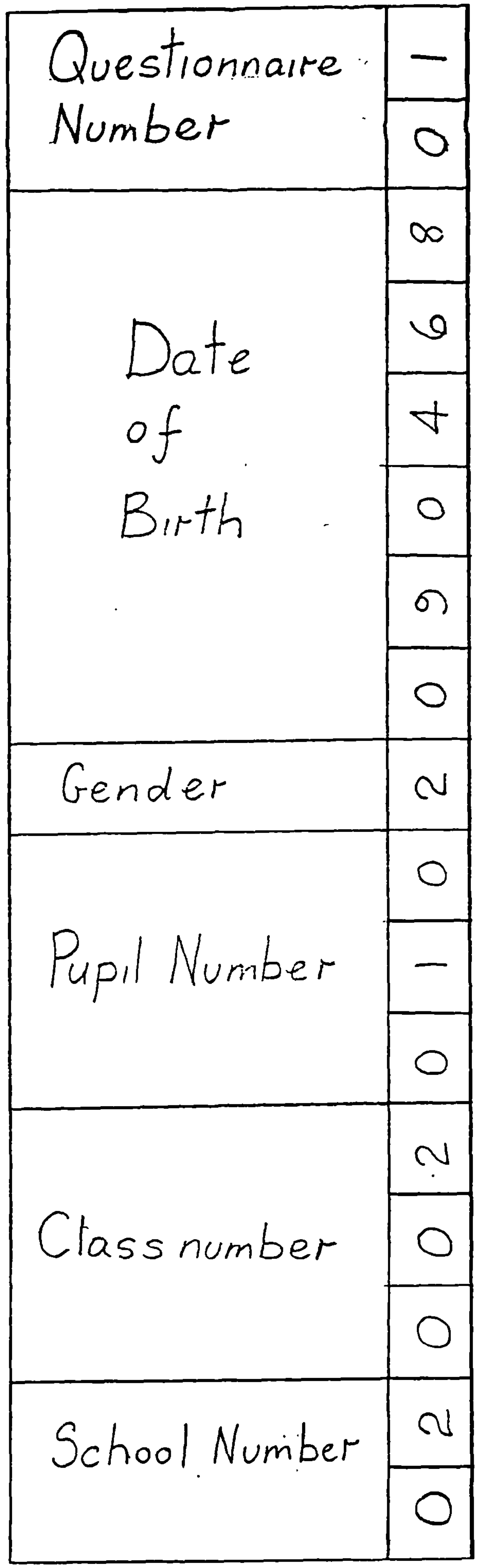


Figure 5.2 Numbering system used

Figure 5.3 The scores for one member of the sample

School No	Class No	Pupil No	Gender	Date of Birth	Questionnaire No	Items 1-15	Items 16-32
0 2	0 0 2	0 1 0	2	0 9 0 4 6 8	0 1	2 4 5 1 5 5 4 2 5 2 4 2 4 5 2	1 9 4 4 5 4 4 5 5 2 1 5 2 5 4 5 5

Items 33-48	Practice item	Ability-Maths
2 4 4 2 4 9 5 4 4 4 2 5 5 5 5 2	4	1

5.5 FACTOR ANALYSIS

5.5.1 CRITERIA FOR THE NUMBER OF FACTORS TO BE EXTRACTED

In order to establish the correct number of factors to be extracted, a Honeywell Multics Computer was used with an SPSS package (Nie et al, 1975). It was decided to use two sets of criteria in order to ascertain some guidance on the optimum number of factors that can be extracted before the intrusion of error variance becomes serious. The two methods used were (a) Cattell's Scree Test and (b) Kaiser's Criterion.

Cattell's Scree Test

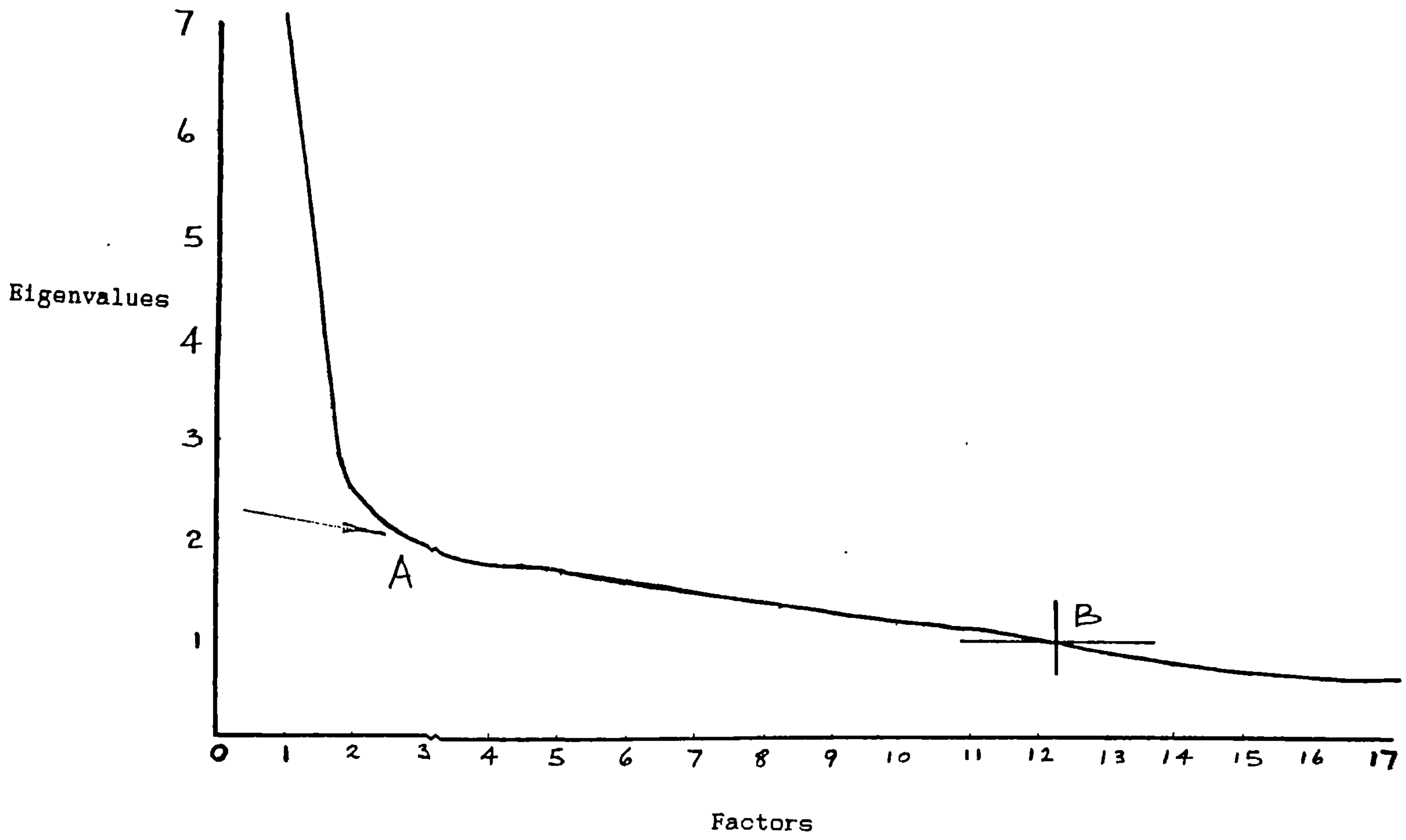
This is described in detail in appendix D, section D.1.5 (4).

Child (1979) describes it as an intriguing method. Basically the eigenvalues are plotted against the number of factors. The point at which the curve straightens out is taken as the maximum number of factors to be extracted. Beyond this point the curve flattens and we have what Cattell refers to as 'factorial litter or scree'. Scree being the geological term for debris collecting on the lower part of rocky slopes, figure 5.4b (plotted from eigenvalues shown in figure 5.4a). The rapid fall in eigenvalues in the first part of the curve represents a fall in the 'real variance' of true factors. The gentle slope of the scree represents the state of affairs when only 'error variance', which falls much more gradually, has taken over and the factors are no longer 'real'. Cattell (1978) states on page 79, that if the scree starts at the k+1th factor there are k 'true' factors. In practice there is often a curve at this point which renders the determination of the number of true factors imprecise. Thus, figure 5.4b predicts somewhere between three and five factors.

Figure 5.4a
Eigenvalues for 17 factor solution

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT
1	7.07662	25.3	25.3
2	2.37746	8.5	33.8
3	1.92103	6.9	40.6
4	1.86565	6.7	47.3
5	1.76981	6.3	53.6
6	1.64791	5.9	59.5
7	1.51351	5.4	64.9
8	1.39333	5.0	69.9
9	1.26557	4.5	74.4
10	1.18249	4.2	78.6
11	1.08622	3.9	82.5
12	1.02667	3.7	86.2
13	.95133	3.4	89.6
14	.82247	2.9	92.5
15	.74328	2.7	95.1
16	.69709	2.5	97.6
17	.66151	2.4	100.0

Figure 5.4b Cattell's Scree Test



Kaiser's criterion

States that only the factors having latent roots greater than one may be considered common factors, figure 5.4b. The SPSS factor procedure produces an orthogonal factor structure based on Kaiser's Criterion. Cattell (1978), criticises Kaiser's criterion as being overestimating the number of true factors when there are large numbers of true items as in this case. Here it is definitely right since Kaiser's criterion predicts 12 factors which is certainly a wild overestimate. In order to use both of these methods it was decided to extract a large number of factors so that a reasonable graph could be plotted for the Scree Test. A 17 factor varimax orthogonal solution was obtained, Figure 5.4a. From this factor solution a graph was drawn with eigenvalues plotted against the number of factors, figure 5.4b. According to Cattell's Scree Test the number of factors would be in the region 3 to 5. However, the number of common factors according to Kaiser's Criterion appears to be 12. However, based on previous experience at Brunel, it was decided to initially obtain solutions for a range of factors.

5.5.2 HOW MANY FACTORS?

It was decided to try two, three, four and five factor solutions as the first stage of the investigation of the dimensionality of the pilot questionnaire. The loadings of the 50 items for these solution are shown in tables 5.6 to 5.9.

The criterion for the value of significant loadings was $\geq .30$, with the second highest loading being approximately twice as large as the next largest loading.

An initial examination of the four factor solutions revealed that there were several items that had not met the criterion, table 5.10.

Table 5.6 Two Factor Varimax Orthogonal Solution

Item No.	Factor 1	Factor2
Q01	34	15
Q02	53	-02
Q03	49	11
Q04x	28	-08
Q05	44	-18
Q06x	19	26
Q07x	22	-11
Q08	19	32
Q09	36	19
Q10x	29	-17
Q11x	-01	08
Q12	38	13
Q13	56	13
Q14	68	-15
Q15x	15	00
Q16	48	04
Q17	38	21
Q18x	16	02
Q19x	-15	-25
Q20	19	31
Q21	-02	-31
Q22x	-03	22
Q23x	-09	19
Q24	31	-12
Q25	37	20
Q26	51	16
Q27x	07	23
Q28x	28	10
Q29	47	-03
Q30x	03	28
Q31x	12	28
Q32	44	10
Q33	07	54
Q34	53	42
Q35	38	00
Q36	-03	-41
Q37	47	26
Q38	32	11
Q39	35	40
Q40	61	25
Q41	38	14
Q42	-08	31
Q43	56	02
Q44	61	23
Q45x	02	-26
Q46x	-15	10
Q47	53	40
Q48	23	39
Q49	04	-34
Q50x	13	14

Factor	Eigenvalue	% of Variance	Cum %
1	6.76	77.1	77.1
2	2.00	22.9	100

Note: x - indicates an item that has a loading <.30

Table 5.7 Three Factor Varimax Orthogonal Solution - 'Varimax Rotated Factor Matrix After Rotation With Kaiser Normalization'

Item	Factor 1	Factor 2	Factor 3
Q01	12	36	16
Q02	37	38	00
Q03	50	19	13
Q04	07	33	-09
Q05	59	07	-19
Q06x	15	11	27
Q07x	27	06	-11
Q08	33	-08	34
Q09	19	31	20
Q10	01	42	-18
Q11x	-05	04	07
Q12	17	35	14
Q13	35	58	16
Q14	43	43	-12
Q15x	-06	27	01
Q16	11	59	05
Q17	-10	64	24
Q18x	-01	24	02
Q19x	-14	-05	-27
Q20	23	01	32
Q21	03	-04	-31
Q22x	-01	-04	21
Q23x	-22	08	19
Q24	01	36	-12
Q25	17	35	22
Q26	34	37	18
Q27x	-06	15	23
Q28	40	-02	12
Q29	48	18	-01
Q30x	-00	03	27
θ31x	036	12	27
Q32	34	28	11
Q33	-06	06	53
Q34	43	29	45
Q35	40	14	01
Q36	-02	-00	-41
Q37	17	39	27
Q38	47	-03	13
Q39	30	17	42
Q40	35	50	28
Q41x	24	27	15
Q42	-17	05	30
Q43	40	38	05
Q44	46	39	26
Q45x	00	06	26
Q46x	-15	-07	09
Q47	55	17	43
Q48	18	12	40
Q49	-00	08	-33
Q50x	08	09	15
Factor	Eigenvalue	% of Variance	Cum %
1	6.80	65.3	65.3
2	2.03	19.5	84.8
3	1.58	15.2	100

Notes: (1) Decimal points ommitted.
(2) x Indicates an item that has a loading <.30

Table 5.8 Four Factor Varimax Orthogonal Solution - Varimax Rotated Factor Matrix After Rotation With Kaiser Normalization

	Factor 1	Factor 2	Factor 3	Factor 4
Q01	25	31*	06	10
Q02	25	33	34*	-00
Q03	27	13	50*	16
Q04	-00	35*	15	-01
Q05	14	04	63*	-15
Q06x	27	06	08	21
Q07	-05	09	42*	03
Q08	40*	-18	13	17
Q09	31*	23	08	11
Q10	-04	44	10	-09
Q11x	-06	07	02	15
Q12	19	31*	18	16
Q13	42	49*	24	07
Q14	39*	35	26	-28
Q15x	06	26	-07	-00
Q16	18	56*	12	07
Q17	34	58*	-26	09
Q18x	-04	27	07	11
Q19	-44*	07	14	-00
Q20	32	-06	09	19
Q21x	-23	02	17	-17
Q22x	06	-06	-02	20
Q23x	-01	08	-21	19
Q24	00	38*	17	-03
Q25	42	24	-04	02
Q26	18	35**	43**	30**
Q27	02	16	-01	30*
Q28	35*	-01	21	-04
Q29	33*	11	35	-10
Q30	01	03	07	37*
Q31	08	11	07	33*
Q32	13	27	45*	24
Q33	14	03	-05	58*
Q34	61*	15	17	23
Q35	17	11	42*	05
Q36	-21	04	06	-34*
Q37	45*	29	-04	07
Q38	36*	-12	31	-00
Q39	52*	05	04	19
Q40	55*	38	12	07
Q41	41*	17	04	-04
Q42	-09	08	-06	44*
Q43	53*	26	13	-22
Q44	60	25	20	02
Q45x	05	04	-02	-28
Q46x	08	-10	-27	-03
Q47	63*	02	28q	21
Q48	29	07	11	36*
Q49	-07	10	-02	-36*
Q50*	19	05	-02	06

Factor	Eigenvalue	% Variance	Cum %
1	6.83	56.7	56.7
2	2.07	17.2	73.9
3	1.61	13.3	87.2
4	1.55	12.8	100

Notes: (1) x Indicates loading (2)Decimal points omitted
(3) * Loadings >.30 (4) ** Three loadings >.30 on one item.

Table 5.9 Five Factor Orthogonal Solution - 'Varimax Rotated Factor Matrix After Rotation With Kaiser Normalization'

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Q01	30*	06	24	02	16
Q02	32	35*	27	-10	09
Q03	26	51*	09	04	20
Q04	07	14	33*	-07	05
Q05	08	64*	06	04	-18
Q06	16	08	06	33*	04
Q07	-07	40*	09	-00	05
Q08	31*	17	-22	26	06
Q09	37*	09	15	-02	17
Q10	02	08	48*	04	-15
Q11x	-02	01	03	-08	24
Q12	28	18	25	-16	35*
Q13	47*	26	42	09	06
Q14	39**	29	33**	07	-37**
Q15x	14	-08	21	-08	05
Q16	27	11	52*	06	06
Q17	46	-25	49*	05	10
Q18	-02	06	30*	16	02
Q19	-50*	12	21	13	-12
Q20	22	12	-08	41	-03
Q21x	-21	15	06	-18	-10
Q22	-04	-02	-02	42*	-03
Q23x	04	-21	05	-01	25
Q24	03	16	40*	07	-09
Q25	49*	-02	13	-06	10
Q26	24	35**	30**	-03	62**
Q27	-00	-02	18	32*	14
Q28x	28	25	-13	16	-14
Q29	30	39*	08	08	-15
Q30	03	06	00	09	38*
Q31	-03	06	19	59*	03
Q32	16	44*	24	02	30
Q33	13	-06	-00	39	49*
Q34	57*	21	06	26	14
Q35	16	43*	08	00	08
Q36	-13	05	05	-40*	-15
Q37	46*	-02	22	21	-03
Q38	33	35*	-20	-05	06
Q39	46*	07	-02	35	02
Q40	56*	15	31	23	-03
Q41	42*	08	11	08	-08
Q42	-11	-08	11	31*	31*
Q43	58*	17	15	-13	-14
Q44	58*	24	17	20	-06
Q45x	-03	-20	06	-15	-24
Q46x	13	-27	-16	16	08
Q47	58*	33	08	22	14
Q48	27	11	00	21	30*
Q49	-07	-02	16	-07	-41*
Q50x	22	-00	-00	-02	10

Factor	Eigenvalue	% of Var.	Cum %
1	6.86	50.1	50.1
2	2.10	15.4	65.5
3	1.62	11.9	77.4
4	1.59	11.6	89.0
5	1.5	11.0	100.00

Notes: (1) Decimal points omitted
(2) x Loading <.30
(3) * Loadings >.30
(4) ** Three loadings >.30

5.5.2.1 COMPARISON OF 2, 3, 4, AND 5 FACTOR SOLUTIONS

Table 5.10 Number of items loading ≥.30

Table number	Factor number	Number of items ≥.30
5.6	2	33
5.7	3	35
5.8	4	40
5.9	5	42

Clearly, there seems to be little to be gained from proceeding with the two and three factor solutions since they have fewer significant items than the four and five factor solutions.

5.5.2.2 COMPARISON OF THE FOUR AND FIVE FACTOR SOLUTIONS

Table 5.11 Four and five factor solutions

Table No.	Factor No.	No. of items >.30	Itemsloading on 3 factors	second highest loading too high
5.8	4	40	1 (26)	6 (2,8,12,17, 32,38)
5.9	5	42	2 (14 and 26)	8 (2,8,12,17, 32,37,38, 48)

A strong item has a secondary loading approximately half the value of the primary loading.

Inclusion of items described above tends to raise the intercorrelation between the factors which is undesirable. The object is to obtain a number of independent factors with low interecorrelation between them.

Table 7.12 Four and five factor solutions - extracted variance

No of factors	F1		F2		F3		F4		F5
Four	6.83		2.07		1.61		1.55		
Difference		4.76		.46		.06			
% Variance	57		17		13		13		
Five	6.86		2.10		1.62		1.59		1.50
Difference		4.76		.48		.03		.09	
% Variance	50		15		12		12		11

A review of the extracted variance demonstrates that it may be possible to carry the solution to five factors although there will be a loss of strength in factor one (reducing from 57% to 50%).

Table 5.13 Summary of the comparisons of the four and five factor solutions

Table No.	Factor No.	No. of items	Items loading on 3 factors	Second highest loading too high
5.8	4	40	1	6
5.9	5	42	2	8

For the four and five factor solutions, if all the weak loading items were removed then the final number would be:

40 - 7 = 33 for the 4 factor solution.
42 -10 = 32 for the 5 factor solution.

There is very little to choose between the four and five factor solutions as demonstrated by tables 5.11 to 5.13.

The final decision was made by studying the item content, which was done at a research seminar, and deciding which of the two solutions provided the most discriminating set of items. The extra items that would have to be lost from the item banks of both solutions were considered.

The major differences were in the last two columns in table 5.9. If the five factor solution was adopted the following items would be lost to the item bank:

Item 37 There should be more demonstrations in Technical Studies.

Item 48 Advances in technology make every day life safer.

It was considered that these two items were good discriminators and, therefore, it was decided to adopt the four factor solution. However, in order to make a thorough final check on the strength of all the items, an oblique promax four factor solution was obtained, table 5.14.

5.6 PROMAX FACTOR SOLUTION

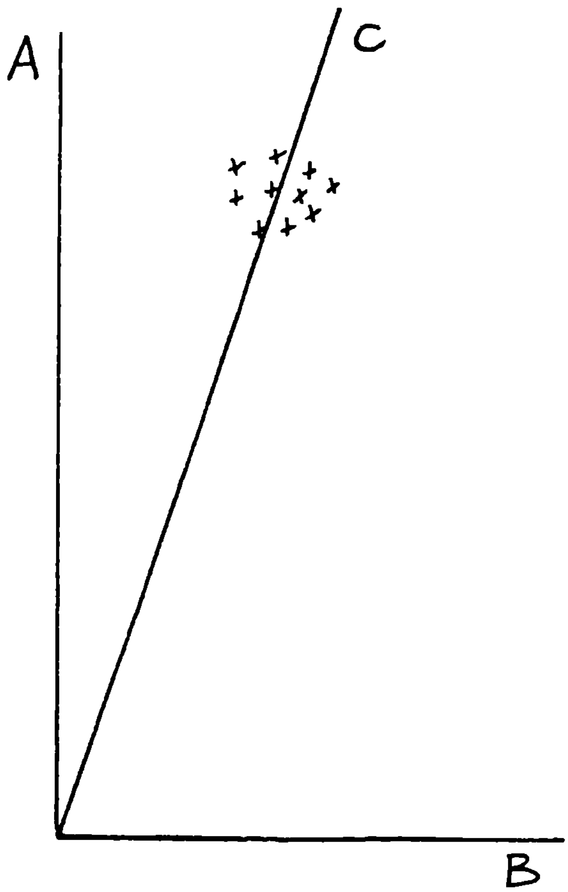
5.6.1 HOW THE PROMAX SOLUTION WAS USED TO HELP WITH THE DECISION ON THE NUMBER OF FACTORS

The promax analysis is an 'oblique' method of factor analysis. Instead of the axes being orthogonal it puts them through the centroids of the clusters of items which form the true factors. This is shown in figure 5.5.

Thus, the loadings on these new axes are maximized, and items which did not load $\geq .30$ on varimax axes will, in some cases, be increased to loadings of $> .30$ on the promax axes as proved to be the case, table 5.14.

Thus the promax analysis established that there were definitely four clusters of items, i.e. real factors in the pilot study pool.

Figure 5.5 Promax Rotation



Notes: 1- A and B are varimax axes.
2- C is a promax axes.

Table 5.14 Promax Four Factor Solution

Item	Factor 1	Factor 2	Factor 3	Factor4
001	-41	-04	-22	10
Q02	-31	10	-27	-26
Q03	-14	-10	-08	-48
Q04	-10	06	-44	-02
Q05	12	14	-09	-74
Q06	-05	-34	-04	-13
Q07	22	-01	-17	-47
Q08	-20	-22	35	-26
Q09	-47	-02	-10	06
Q10	-03	09	-55	-04
Q11	-03	-12	-10	14
Q12	-36	-03	-23	04
Q13	-49	-02	-34	-14
Q14	-36	27	-25	-37
Q15	-27	07	-26	24
Q16	-34	-01	-51	03
Q17	-65	-03	37	42
Q18	11	-20	-40	-04
Q19	63	-11	-35	-21
Q20	-09	-34	17	-22
Q21	29	24	-17	-24
Q22	19	-41	05	-06
Q23	-19	-18	-04	43
Q24	01	02	-49	-14
Q25	-67	09	-01	17
Q26	-21	-19	-34	-24
Q27	08	-44	-23	07
Q28	-13	01	23	-43
Q29	-17	12	-03	-51
Q30	-00	-39	-05	09
Q31	19	-58	-18	-14
Q32	-07	-17	-29	-33
Q33	-11	-61	01	20
Q34	-52	-22	05	-18
Q35	-05	-01	-06	-45
Q36	06	49	-08	-07
Q37	-52	-09	-10	08
Q38	-27	08	28	-38
Q39	-40	-25	15	-11
Q40	-56	-07	-16	-11
Q41	-46	08	00	-05
Q42	16	-55	-16	16
Q43	-65	32	-02	-13
Q44	-55	-01	-04	-23
Q45	-01	36	-06	-04
Q46	-31	10	25	39
Q47	-47	-18	16	-32
Q48	-21	-38	02	-05
Q49	09	37	-16	-14
Q50	-29	-01	10	07

Correlations among primary factors

1.00	.30	.15	.41
.30	1.00	.04	.21
.15	.04	1.00	.13
.41	.21	.13	1.00

Note: Decimal points omitted in main table

The promax analysis also reports, at the bottom of table 5.14, the correlations between the four clusters of items, indicating that the factors are not truly orthogonal but significantly correlated in the case of factor 1 and 2 (.30) and 1 and 4 (.41).

The promax analysis has effectively increased the value of the highest loading item on most factors, so that the task of deciding which items to select is made easier, e.g. items 1 and 13, table 5.14.

Items loading <.35 in the promax analysis and those with loadings smeared across three of the four factors were removed, as shown below:

Item 2	It is interesting when you are shown how to use the machines.
Item 08	Engineers should be paid more.
Item 11	I need more time to do Technical Drawing.
Item 14	Metalwork is too noisy.
Item 15	Technical Studies teachers are too safety minded.
Item 20	We need more Technical Studies teachers.
Item 21	I enjoy watching demonstrations.
Item 26	The wide range of topics makes Technical Drawing enjoyable.
Item 32	In Technical Drawing it is always a challenge to see what the end result of the drawing will be.
Item 38	Teachers of other subjects do not appreciate how interesting and enjoyable Technical Studies can be.
Item 50	Technical Drawing is a relaxing subject.

This left a pool of 39 items, with 14 items in factor 1, 12 in factor 2, 5 in factor 3 and 8 in factor 4.

5.7 FACTOR DESCRIPTORS

5.7.1 FACTOR ONE

There were 14 items within this factor. The example used as the "warm-up" item also seemed to be in the same grouping. The items were:

I enjoy Technical Studies.

The skills learned in Technical Studies are a good investment for when you leave school.

All pupils should try to improve their technical skills.

Technical Drawing is important because several jobs need it.

Technical Drawing is an easy subject.

Pupils who take Technical Studies usually do well in life.

The knowledge gained in Technical Studies lessons will be of great benefit when I have my own home.

A knowledge of Technical Studies helps you to make projects more cheaply than those bought in shops.

Technical Studies lessons are boring.

After Mathematics and English, Technical Studies is the most useful subject.

Technical Studies subjects are too difficult.

Learning about Technical Studies is not important to my education.

Technical Drawing lessons are enjoyable.

There should be more demonstrations in Technical Studies.

Most of the items seemed to be a comment on the benefits of taking Technical Studies. Since this indicated the subject was worthwhile and of value, the term VALTECH could be used to describe this factor.

5.7.2 FACTOR TWO

There were 12 items within this factor:

Advances in Technology will cause unemployment.

We need more Technical Teachers.

Modern building Technology is producing too many ugly Town Centres.

Technological advances, in the form of Robots to do basic tasks, could make us lazy.

Advances in Technology will give us more leisure time.

Advances in Technology have produced too many things of low quality.

To progress as a Nation we must make advances in Technology.

You can relax in Technical Studies.

Technology helps to create jobs in computer programming.

There are too many demonstrations in Technical Studies.

Advances in Technology make everyday life safer.

There should be more modern machinery in the Technical Department.

A large number of these items seemed to be concerned with "looking ahead". They describe what may happen in the future. The term FUTECH seemed to be an apt descriptor.

5.7.3 FACTOR THREE

There are five items in this factor.

Technical Studies theoretic lessons are boring.

There is too much filing and hacksawing in Metalwork lessons.

The projects in Technical Studies take too long to make.

Advances in Technology tend to make jobs boring.

Technical Studies should be more creative.

They are all critical of technical and technological work - the complaining factor.

The items are designed for those pupils who are not at all interested in technical work, to show in a qualitative way their feelings. They feel that the work is uninteresting and therefore - boring. This is an easy factor to find a descriptor for - BORTECH.

5.7.4 FACTOR 4

There were 8 items within this factor.

Watching a good demonstration in Technical Studies is very interesting.

Technical Studies is a welcome break from other lessons.

In Technical Studies you learn many different skills.

Watching a casting being poured in Metalwork is fascinating.

I like the fresh smell of wood being machined.

Advances in Technology are increasing the pace of life too much.

The best part in Technical Studies is making things oneself.

I especially enjoy making projects that involve using the brazing hearth.

These items are generally concerned with giving the pupils the opportunity to demonstrate their appreciation of the opportunities offered in technical and technological areas. In general, these items are describing the parts of the subject that the pupils enjoy being involved in. The factor was given the descriptor ENJTECH. Another possible descriptor could have been APP/TECH, the appreciation of technical work.

5.8. PREPARATION OF THE MAIN QUESTIONNAIRE

5.8.1 ADDITIONAL ITEMS ADDED

In a subsequent research seminar, the results of the pilot study were discussed. It was suggested that the nucleus of items that remained after the pilot study could be enhanced by adding some items about Technical Drawing. The wording of the new items to be similar to highly significant Technical Studies items. For example the wording of the item -'Technical Studies lessons are boring' could be used in an additional item - 'Technical Drawing lessons are boring'

These additional items were designed to fit into the four factor groupings. Thus, the two items above would be expected to be contained in the BORTECH factor - factor 3.

Other similar technical drawing items were added, and a framework for a 48 item Main Questionnaire was set up.

5.8.2 SUMMARY OF DESCRIPTORS

FACTOR 1	VALTECH
FACTOR 2	FUTECH
FACTOR 3	BORTECH
FACTOR 4	ENJTECH or APPTECH

The items were randomized and a main attitude questionnaire with 48 items was produced, tables 5.15 a, b, c and d.

Table 5 .15a

Brunel Technical Studies Survey — Questionnaire No 1

Read each sentence of the questionnaire carefully. Put a tick in the column which best expresses your own opinion about the sentence.

This is not a test, there are no right or wrong answers, we simply want to know your own opinion. Nobody in your school is going to see your answers so you need not be afraid of annoying anyone or hurting their feelings.

Example:

		Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	
I enjoy Technical Studies							

If you definitely are sure that you agree with this statement, tick in column "Strongly Agree".

If you merely agree with it, tick in column "Agree".

If you are sure you do not agree with it, tick in column "Disagree".

If you definitely are sure that you do not agree with this statement, tick in column "Strongly Disagree".

Only if you cannot make up your mind, tick in column "Uncertain".

Technical Drawing

If you have never taken Technical Drawing, put a ring around the statement number (e.g. (4) More visual aids should be used in Technical Drawing lessons) Do not put a tick in any column. Go on to the next statement.

Table 5.15b

Brunel Technical Studies Survey

Questionnaire No 1

School ____________________ Class ____________

Sex ____________ Date of Birth ________ Code Number ________

			Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	
1	The skills learned in Technical Studies are a good investment for when you leave school.							
2	Watching a good demonstration, in Technical Studies, in very interesting.							
3	Technical Studies is a welcome break from other lessons.							
4	More visual aids should be used in Technical Drawing lessons.							
5	There is too much machinery in the Technical Department.							
6	Technical Studies theoretical lessons are boring.							
7	All pupils should try to improve their Technical Skills.							
8	Advances in Technology will cause unemployment.							
9	We need more Technical Teachers.							
10	There is too much Filing and Hacksawing in Metalwork lessons.							
11	Technical Drawing is important because several jobs need it.							
12	Modern Building Technology is producing too many ugly Town Centres.							
13	The projects in Technical Studies take too long to make.							
14	In Technical Studies you learn many different skills.							
15	Technical Drawing is an easy subject.							

Table 5 15c

		Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
16	Technological advances, in the form of Robots to do basic tasks, could make us lazy.					
17	Watching a casting poured, in Metalwork, is fascinating.					
18	Pupils who take Technical Studies usually do well in life.					
19	Advances in Technology will give us more leisure time.					
20	I like the fresh smell of wood being machined.					
21	Advances ~~in~~ Technology are increasing the pace of life too much.					
22	The knowledge gained in Technical Studies lessons will be of great benefit when I have my own home.					
23	Advances in Technology tends to make jobs boring.					
24	The best part of Technical Studies is making things oneself.					
25	Advances in Technology have produced too many cheap material things of low quality.					
26	Technical Studies could be more creative.					
27	I especially enjoy making projects that involve using the brazing hearth.					
28	It is not difficult to make the projects in Technical Studies lessons.					
29	A knowledge of Technical Studies helps you to make projects more cheaply than those bought in shops.					
30	Technical Studies lessons are boring.					
31	In Technical Drawing you learn many different geometrical constructions.					
32	I enjoy making projects in wood.					

Table 5 .15d

		Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	
33	After Mathematics and English, Technical Studies is the most useful subject.						
34	Technical Studies subjects ~~are~~ too difficult.						
35	To progress as a Nation we must make advances in Technology.						
36	You can relax in Technical Studies.						
37	There are too many joints to cut when-making a piece of furniture.						
38	I especially enjoy making projects using the woodturning lathe.						
39	It is very satisfying to produce a well-made project.						
40	Learning about Technical Studies is not important to my Education.						
41	Technical Drawing lessons are enjoyable.						
42	Technology helps to create jobs in computer programming.						
43	There are too many demonstrations in Technical Studies.						
44	Technical Drawing lessons are boring.						
45	Advances in Technology make every-day life safer.						
46	There should be more modern machinery in the Technical Department.						
47	There should be more demonstrations in Technical Studies.						
48	Learning about Technical Drawing is not important to my Education.						

5.8.3 ADDITIONAL QUESTIONNAIRE

In a discussion at a research seminar, it was pointed out that the Attitude Questionnaire did not give a pupil the chance to express fully all his, or her, feelings about technical work. In order to give pupils this opportunity, an open-ended questionnaire was designed. This questionnaire was entitled the 'Information Questionnaire', tables 5.16 a, b and c.

5.9 OVERVIEW

The method of using essays for making the original item bank seemed to have been a reasonable method for the following reasons:

(1) The pupils who wrote the essays were not allowed to put their names on their work. This seemed to give freedom for them to clearly express their views about various aspects of technical work and technology in society.

(2) The mix of ages, and of gender, meant that opinions were gathered from those who hoped to take the subject in the senior school, as well as from those already engaged on some form of technical work.

(3) Extracting actual items directly from the essays written by the pupils, ensured that the pupils completing the questionnaires would have items that they would readily understand.

(4) The pupils, since they were playing the role of the consumer, were quite willing to express their opinions.

The first attempt at judging of the original item bank was by no means a success, but it did help to illustrate, when the items were re-judged by a group of researchers sharing a common aim, that the assessment of item banks are performed efficiently by those who are either going to use them or required to design them.

Cattell's Scree Test proved to be reasonably accurate, since it predicted three to five real factors for extraction.

It was very difficult to decide between the four and five factor solution, since they appeared to be so similar. However, the decision to adopt, at this stage, the four factor solution seems to have been confirmed by the promax rotation which gave four clear-cut factors.

The pilot study gave strong indications of the likehood of finding at least four factors in the attitude test instrument for the main study, with a possible fifth from the additional technical drawing items.

The decision to add an open-ended type questionnaire (referred to as the 'information questionnaire') to the main attitude questionnaire, should provide all the sample with the opportunity to fully express their views on the way they perceive all areas of technical work, projects, workshop or classroom environment, teaching and management techniques demonstrated by staff. The descriptors for the four factors, seem, at this stage, to be suitable and representative of the attitude dimension that they are each trying to measure.

FACTOR 1 - VALTECH: FACTOR 2 - FUTECH;

FACTOR 3 - BORTECH; FACTOR 4 - ENJTECH:

5.10 CHAPTER 6

5.10.1 DATA FROM INFORMATION QUESTIONNAIRE

The data collected from the information questionniare, which was administered to the whole sample, has been presented in tabular and graphical form. The various opinions that emerge are discussed in chapter 6.

Table 5.16a

Brunel Technical Studies Survey — Questionnaire No 2

School ______________________ Class ____________

Sex ____________ Date of Birth __________ Code Number __________

Put a tick in the box which you think represents your opinion about these questions.

Technical Drawing

If you have never taken Technical Drawing put a ring around the statement number (e.g. (8) Do you look forward to Technical Drawing lessons?) Do not ~~put a tick in any column~~. Go on to the next statement.

1 Do you take an interest in the way that Technology is developing?

- Yes, always ☐
- Sometimes ☐
- Never ☐

2 Do you look forward to Technical Studies lessons?

- Yes, always ☐
- Sometimes ☐
- Never ☐

3 Do you like practical sessions better than theoretical ones?

- Yes ☐
- No ☐

4 In ~~order of importance~~, ~~out of all~~ the subjects that you take, how do you regard Technical Studies?

- 1 ☐
- 2 ☐
- 3 ☐
- 4 ☐
- 5 ☐
- 6 ☐
- 7 ☐
- 8 ☐
- 9 ☐
- 10 ☐
- 11 ☐
- 12 ☐

5 Is Technical Studies as interesting as you thought it would be?

- Yes ☐
- Sometimes ☐
- No ☐

6 Do you think that you have learned enough practical skills in years 1, 2 and 3 to allow you to get on quickly with 4th year projects?

- Yes ☐
- No ☐

Table 5.16b

7	Do you enjoy taking things apart to find out how they work?	Yes No	
8	Do you look forward to Technical Drawing lessons?	Yes, always Sometimes Never	
9	In order of importance, out of all the subjects that you take, how do you regard Technical Drawing?	1 2 3 4 5 6 7 8 9 10 11 12	
10	Is Technical Drawing as interesting as you thought it would be?	Yes Sometimes No	
11	Would you like to spend more time doing Technical Studies?	Yes No	
12	Would you like to spend more time doing Technical Drawing?	Yes No	
13	Write down the name of the best project that you have made in Technical Studies.		
14	Which machine do you most enjoy using?		
15	Which part of Technical Studies lessons do you dislike?		
16	Which part of Technical Drawing lessons do you dislike		

Table 5.16c

17 How do you feel Technical Studies lessons could be improved?

18 How do you feel Technical Drawing lessons could be improved?

19 Is anyone in your family employed in a job requiring technical skills? e.g. Engineer, Draughtsman, Mechanic, Architect, Surveyor, Builder, etc.

Yes ☐
No ☐

If 'Yes', state type of work ☐

20 Do you intend to take Technical Studies in the 4th year?

Yes ☐
Undecided ☐
No ☐

21 Do you intend to take Technical Drawing in the 4th year?

Yes ☐
Undecided ☐
No ☐

22 Which is your favourite material for making projects?

Wood ☐
Metal ☐
Plastic ☐
Concrete ☐
Enamels ☐

• State other materials ☐ ☐

23 Which part of Technical Studies lessons do you most enjoy?

24 Which part of Technical Drawing lessons do you most enjoy?

25 List in order your 5 favourite subjects.

1 ☐
2 ☐
3 ☐
4 ☐
5 ☐

26 Do you intend to take up a Technical Career?

Yes ☐
Undecided ☐
No ☐

If 'Yes', state which. ☐

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CHAPTER 6 MAIN STUDY

6.1 THE ARRANGEMENTS TO ADMINISTER THE QUESTIONNAIRES

Ten coeducational comprehensive schools, nine in Hertfordshire and one in Bedfordshire, were requested to help with the main study.

The decision to restrict the study to this type of school was made because the majority of pupils in this country attend such schools.

Previous research has found that when boys and girls are educated together in lessons, their choice of science subjects appear to express greater divergencies of preference and choice than when they are educated apart. This has been termed 'polarisation', by Dale, (1974) who was the first to describe the phenomena. Evidence of 'polarisation' was also found by Ormerod (1975a) and in the DES report (1975). Ormerod examined the polarisation of preference and choice of 17 subjects at 14 plus. He showed that physics, chemistry, mathematics and geography, together with boys games, physical education and technical subjects are 'male' and all other subjects are 'female'. It is also interesting to note that it has been shown that girls in single sex schools are more likely to study science and mathematics at A level. These findings appeared in the Crowther Report (1959), DES Annual Report (1967) and Harding (1981).

From this body of research, and due to the fact that when this study was started in 1980 there were very few girls schools where any form of CDT was being taught, it was considered prudent to concentrate on coeducational comprehensive schools.

In seven cases the initial approach was made to the head of craft, design and technology (CDT) outlining how the questionnaires would be administered. A letter was then sent to the head teacher referring to the discussion with the head of department, enclosing copies of all questionnaires.

For the other three schools, since a link could not be made with the head of department, a letter requesting help was sent direct to the head teacher. Eight schools replied to the request to help with the administering of the questionnaires. All seven schools contacted via the head of department agreed to allow some of their pupils to complete the questionnaires. Only one head teacher refused to help. Replies were not received from two schools. It was thought that seven schools would be sufficient and would provide a worthwhile population for the main study. One of the seven schools agreed to their pupils also completing, in addition to the attitude and information questionnaires, a standard Cattell High School Personality Quotient questionnaire. Subsequent negotiations with the head of departments were carefully made to provide a balance of subject and pupil ability.

6.1.1 ARRANGEMENTS FOR TEACHING CDT IN THE SAMPLE SCHOOLS

In all the schools some type of option system operated to enable boys and girls to take CDT and home economics (HE). Various names were given to these arrangements- 'Circus' 'Carousel'.Basically,the time previously allocated to boys to study CDT and girls to study HE was shared by the boys and girls in years 1,2 and 3 (chapter 2B, table 2.5a and b).

6.1.2 EXPERIENCE GAINED WHILST ADMINISTERING THE QUESTIONNAIRES

At this point in the study it could be blandly stated that the questionnaires were administered in the seven schools and the results analysed. To do this would, in no way, reflect the great differences the author found in the schools, teachers and pupils. The experiences gained in administering the questionnaires were very interesting, because of the varying attitudes, preparation and approach of the schools towards the project. There are many important things to be learned about the most suitable day, time in the term, place where the questionnaires are to be administered, and support given by the staff.

6.1.3 THE WAY THAT THE INTRUSION OF A RESEARCHER WAS RECEIVED IN THE SAMPLE SCHOOLS

There were many different ways that the administration of the various questionnaires was received in the schools. This ranged from being received with enthusiasm, indifference or mild hostility.

Teacher enthusiasm

Type (a) The teacher seemed pleased to get some light relief from a difficult group and was quick to leave after the appearance of the researcher.

Type (b) The teacher seemed pleased to get some unexpected time off so that he could get on with some of his administrative tasks.

Type (c) The teacher who generally helped to distribute the questionnaires, settled the group down and then left. Returning later just before the end of the session to help collect in the questionnaires.

Pupil enthusiasm

Type (a) Pupils who were pleased to get a change of teacher or lesson.

Type (b) Pupils who felt that technical work could be improved or developed and were very willingly to complete the questionnaires.

Indifference

This was the response of some teachers and pupils to the administration of the questionnaires. The author found that this was usually due to the fact that they had not been told ,in good time, about the arrangements. This was rectified by explaining the purpose of the questionnaires and the value of research work.

Hostility

A slightly hostile reception was evident when boys and girls had to miss practical lessons in order to complete the questionnaires. This again was dealt with by explaining the value of research work.

Some teachers were also not too receptive if they were in the middle of an important topic, or the pupils had missed previous lessons for other reasons.

Despite all the varied receptions accorded to the author, he was able to conduct the administration of the questionnaires in a controlled and orderly atmosphere with the cooperation of the majority of the sample.

6.1.4 LESSONS LEARNED WHILST ADMINISTERING THE QUESTIONNAIRES

The lessons learned, and the improvements that could be made, in the administration of the questionnaires depend on several factors:

(a) The time available for the administration of the questionnaires.

(b) The time available for the researcher to visit the school on a preliminary visit to talk to the staff involved.

(c) Pressures on school time, examinations etc..

It may be argued that if the time was unlimited it may be prudent to plan more than one preliminary visit to the schools, making one of these visits at a similar time to that of the actual administration of the questionnaires.

The morning was found to be the best time. The pupils are not too tired. Generally , midweek was found to be the best time. Mondays and Fridays to be avoided. End of term , but not the last week , seemed to be preferred. Autumn term seemed to be the most suitable since there were less external pressures - visits planned , examinations. Practical lessons are to be avoided. Mathematics and English lessons were the most receptive groups. A large hall or a spacious room were found to be unsuitable. The best areas were reasonable size classrooms with the pupils sitting at separate desks. Support of the staff, although not essential, can be most helpful to the researcher.

Ideally staff help consists of assistance to settle the pupils, giving out the questionnaires, collection at the end of the session, and dismissing the pupils.

6.1.5 RAPPORT WITH SCHOOLS

In all cases the pupils and staff were thanked for their help with the questionnaires. The Head Teacher and the Head of CDT were also thanked at the end of the visit. When convenient to the school, the author had lunch with the senior staff. A letter of thanks was sent to the school, to both the Head Teacher and the Head of CDT.

6.1.6 SUMMARY

Table 6.1 provides a summary of the background to the administration of the questionnaires.

6.2 SCORING OF QUESTIONNAIRES IN PREPARATION FOR FACTORIAL ANALYSIS

6.2.1 ATTITUDE QUESTIONNAIRE

This questionnaire (chapter 5, section 5.8.2, tables 5.15a - d) was designed with a Likert style five point scale, ranging from 'strongly agree', 'agree', 'uncertain', 'disagree', 'strongly disagree'.

Pro-CDT responses were scored five points and anti-CDT responses one point, e. g.

Item 1 The skills learned in Technical Studies are a good investment for when you leave school. For this item 'strongly agree' would be scored five and 'strongly disagree' one point.

The way that the factorial structure was investigated is discussed in chapter 7.

School	Boys	Girls	Groups	Time minutes	When	Where	Behaviour
1	75	52	Maths. Eng. Classical Stds. & Chem.	5 groups each spent 70	December 2nd & 16th.	Class rooms	Excellent
2	35	19	C.D.T & H.E	55	February 17th	Dining Hall	Noise from kitchen No help from School Staff
3	62	0	C.D.T.	65	February 22nd	Drawing Office	Administered by the Head of C.D.T.
4	32	10	C.D.T. & Art	70	March 3rd	Drawing Office	Excellent. Staff helped to settle pupils. Plenty of space, single desks
5	31	20	Maths & English	2 groups each spent 45	March 10th.	Class rooms	Pupils too close together since small classrooms used No help from School Staff
6	42	0	C.D.T.	2 groups each spent 55	March 15th	Drawing Office	Very good, but they felt a sense of injustice since they missed practical work
7	24	3	Careers	60	March 31st	Class room	Excellent. Staff helped to settle pupils. Well spaced out.
	301	104					

Table 6.1 Summary of the administration of the questionnaires.

6.2.2 PERSONALITY QUESTIONNAIRE

The scoring for this questionnaire was on a three point scale based on criteria suggested by Cattell.

The identification of the personality factorial structure is discussed in chapter 10.

6.2.3 INFORMATION QUESTIONNAIRE

This questionnaire (chapter 5, section 5.8.3, tables 5.16a - c) was designed to obtain several different forms of responses from the sample.

(a) Guided forms of response, e.g. Item 1 Do you take an interest in the way that Technology is developing?

There were three possible responses for this item - yes, always; sometimes and never with a score of 3 , 2 or 1 .

(b) Definite response, e.g. Item 3 Do you like practical sessions better than theoretical ones?

Two possible responses for this item - yes or no.

(c) An invitation to write in an open-ended way in answer to a prompt, e.g. Item 18 How do you think Technical Drawing lessons could be improved?

The responses were analysed and each response was given a reference score. For some items there were as many as 60 sets of opinions recorded.

Some of the items from this questionnaire were used to provide extra variables for use with the attitude measures obtained from the attitude questionnaire. These items were selected from groups a and b.

TOTTS -(Based on item 25) Pupils were asked to list their five favourite subjects, from all their school subjects, in order of liking (design, metalwork, technical drawing, technical studies, technology and woodwork - each scored a point if they appeared in the list - Range 0 - 2).

FAMSKIL -(Based on item 19) Responses to item 'Is anyone in your family employed in a job requiring technical skills?' Range 1 - 2 (No, Yes).

TUTS -(Based on item 20) 'Do you intend to take Technical Studies in the 4th year? 'Range 1 - 3
(No, Undecided, Yes).

TUTD - (Based on item 21) 'Do you intend to take Technical Drawing in the 4th year?' Range 1 - 3
(No, Undecided, Yes).
TCAR - (Based on item 26) 'Do you intend to take up a technical career?' Range 1 - 3 (No, Undecided, Yes).
These variables were correlated with other variables and the attitude measures, and they played an important role in many of the findings of this study, (chapter 7).
Do to the wide variation in the scoring of this questionnaire, only frequencies of the responses could be ascertained. These responses did contain some very interesting opinions, and since they provided very useful background for the more statistically based attitude questionnaire they are discussed in more detail in this chapter.

6.3 AN ANALYSIS OF THE RESPONSES TO THE INFORMATION QUESTIONNAIRE

6.3.1 INTRODUCTION

Items 25 (table 6.2) force the sample into as many selections as they make rejections thus producing 'Ipsative' scores. This is particularly so with item 25, in which the subjects have been arranged in a 'force-choice' format. Therefore, each member of the population is required to make as many rejections as they do selections.

Table 6.2 Five favourite subjects, from which TOTTS was devised

1	
2	
3	
4	
5	

25 List in order your 5 favourite subjects.

This means that the resulting ratings of subjects, although comparable among themselves are not 'normally' distributed in the statistical sense and, therefore, cannot be used in the calculation of correlation coefficients, since correlation coefficients have scores which are normally distributed. Therefore, an adaption has been made to avoid this problem as set out in section 6.2.3-(c).

6.3.1.1 GRAPHICAL ITEMS

Special treatment had to be given to the items concerned with technical drawing. Due perhaps, to lack of opportunity or, alternatively, not wanting to take-up the subject, a significant number of the population did not express their opinions. The percentages, for these items, have been recalculated based on the number of respondents.

6.3.2 THE OPINIONS DEMONSTRATED BY THE POPULATION BY THEIR RESPONSES TO THE ITEMS IN THE QUESTIONNAIRE

6.3.2.1 GENDER DIFFERENCES

For a large number of the items in the 'Information questionnaire', two or three responses were required from the sample: 'Yes' or 'No' and 'Yes', 'Sometimes' 'No'.

In each case, there are different proportions of the two sexes giving the responses.

Knowing the numbers involved (which are large), as well as the proportions, it is possible to calculate the significance of the difference of the two proportions of replies of 'Yes' 'Sometimes' or 'No' by the different sexes by the method given in Guilford and Fruchter (1978). For a worked example of the method see Appendix E, Section E.1.

Thus, for the first case, 'The Fiddle Factor' illustrated in figure 6.1, the significance of the differences in the boys (92% or .92) and the girls (75% or .75) answering 'Yes' is $p=10^{-5}$, indicating that there is only one possibility in 100,000 of such a difference, in the population from which the sample is drawn, having arisen by chance.

In every case, in the replies to this and the subsequent items the 'Yes' and 'No' responses are significantly in favour of the boys replying more positively than the girls towards the aspect of CDT being queried.

In all the figures illustrating the responses, the levels of significance in favour of CDT by the boys are given under or by the side of the relevant bar charts. Only occasionally in the 'Sometimes' categories is the gender difference not significant (NS). The only exception to this is technical drawing, section 6.3.2.7, figures 6.5 and 6.9, where girls indicate very significantly more than boys that they find the subject more interesting and would like to spend more time doing it.

6.3.2.2 THE FIDDLE FACTOR

Item 1 Do you take an interest in the way that Technology is developing?

Item 7 Do you enjoy taking things apart to find out how they work?

The combining of these two items is based on the hypothesis that there is a relationship between an interest in technology and the desire to take things apart. A positive response to item 1 should be made by pupils interested in technology, with an enquiring mind, which is stimulated by discovering how things work. In fairly uncomplicated devices this can be done by taking the back off to find out how the components work together to produce the desired movement etc. Unfortunately, the more complicated devices do not reveal their secrets so easily.

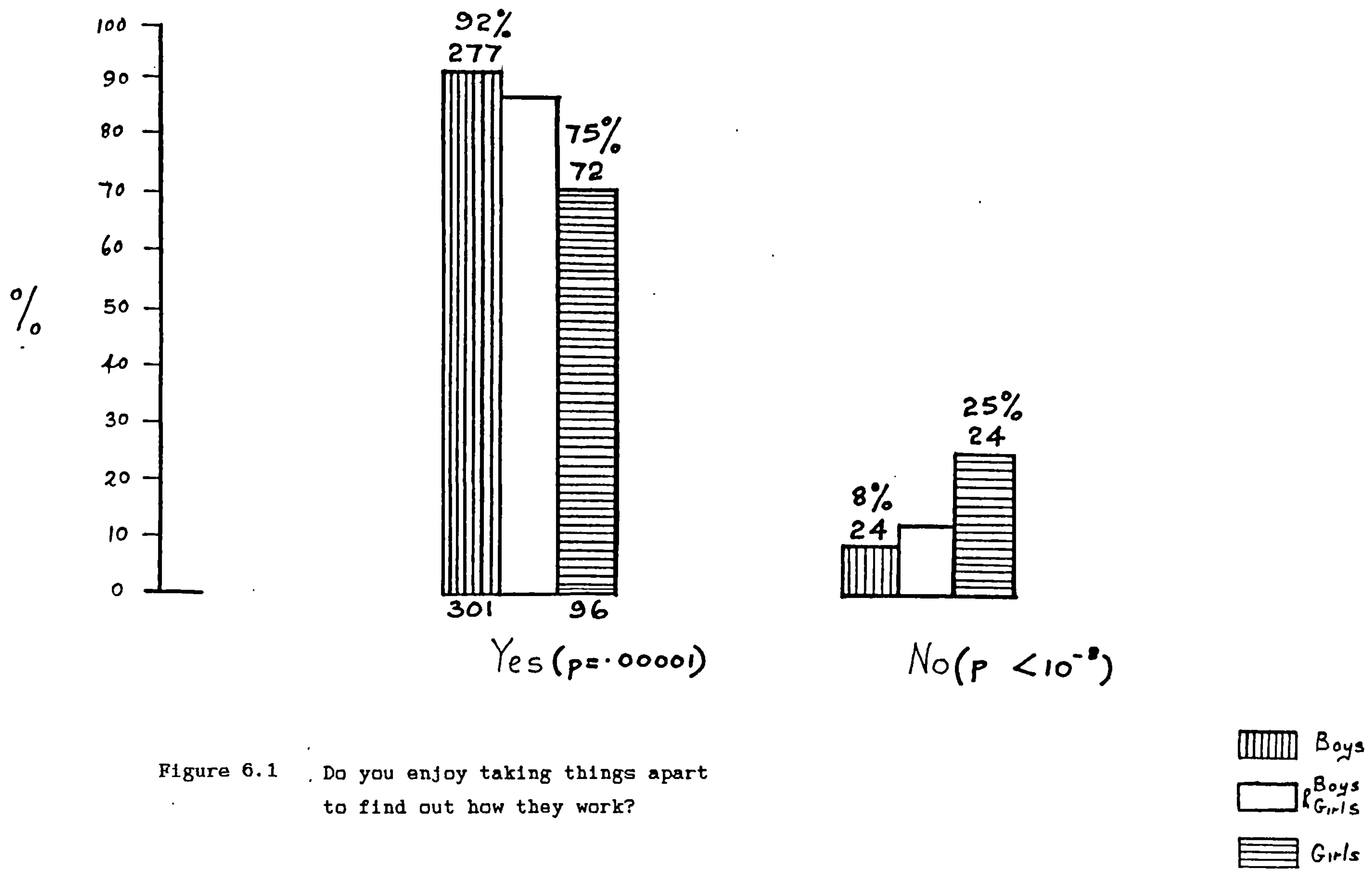


Figure 6.1 Do you enjoy taking things apart to find out how they work?

The responses to item 7 (table 6.1), demonstrates that there are a large number of pupils who like to 'fiddle' and find out how things work. Ormerod and Duckworth (1975) refer to 'Tinkerers' as likely candidates who would profit from discovery learning. Kelly et al (1984) found that boys had much greater experience than girls of 'tinkering activities'

Reference to figure 6.1 shows that 9 out of every 10 boys and 7 out of every 10 girls are 'fiddlers'.

For the 'Yes' answer the difference is significant at the .00001 level and for the 'No' response p= 10^{-8}.

There are not many boys who do not take some interest in technology. Figure 6.2 shows that only 1 boy in 20 lacks technological awareness. However, the girls do not demonstrate a similar degree of technological stimulation since over one quarter of them responded negatively.

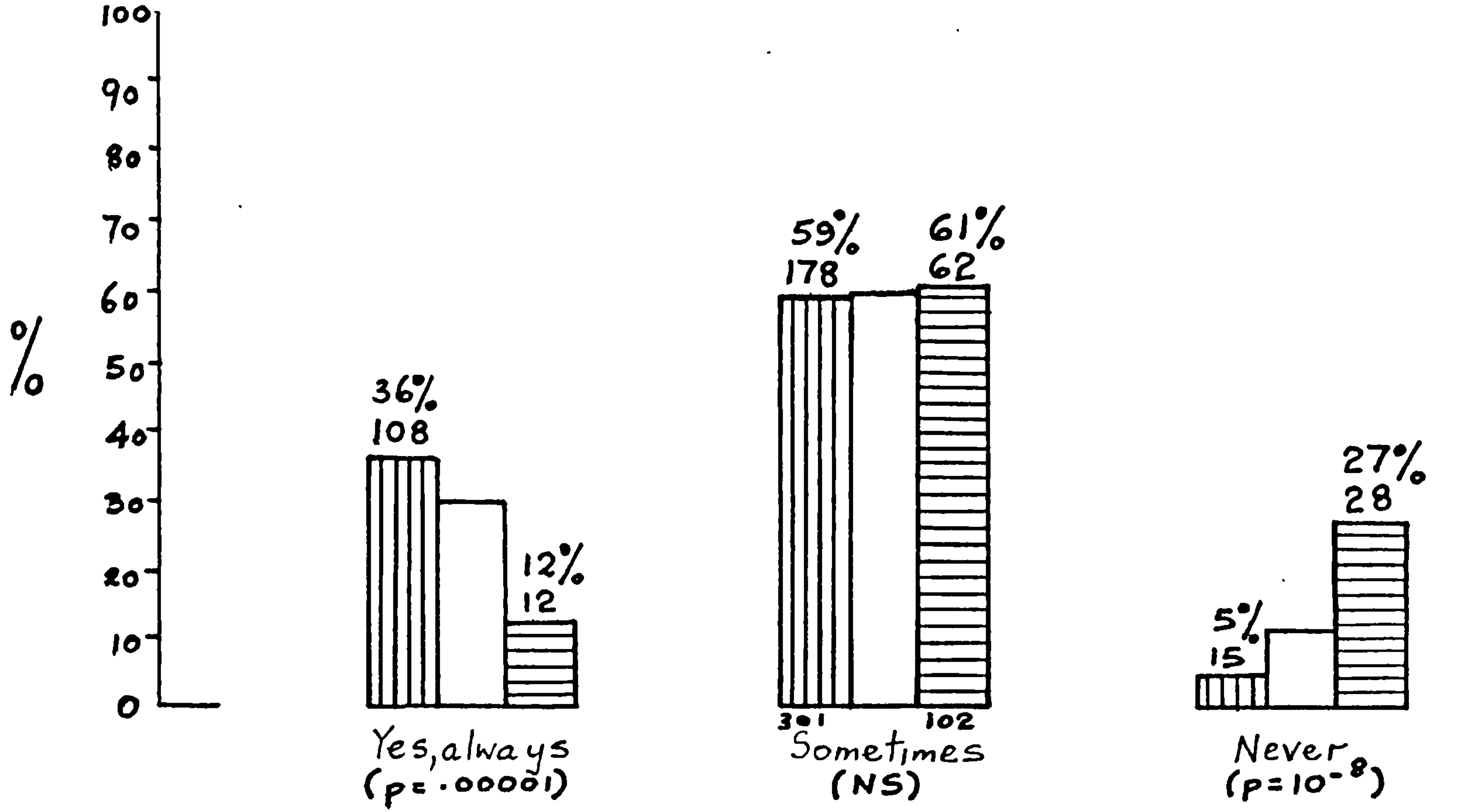
6.3.2.3 PRACTICAL SKILLS

Item 3 Do you like practical sessions better than theoretical ones?

Item 6 Do you think that you have learned enough practical skills in years 1,2 and 3 to allow you to get on quickly with 4th year projects?

The replies to item 3 were most enlightening .

There was a strong 'Yes' response from both sexes, indicating a generally strong opinion in favour of practical work (figure 6.3) with an average of 9 out of 10 pupils of both sexes expressing a 'Yes'. The proportion of boys being (95% or .95) was significantly higher than the proportion of girls (87% or .87), p = .01. Howevever, the proportion of girls expressing a 'No' response (13% or .13) as against 5% or .05 for the boys was also significant at the .01 level.



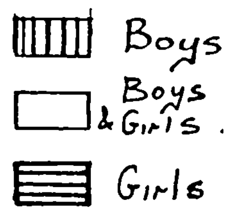


Figure 6.2 Do you take an interest in the way that technology is developing?

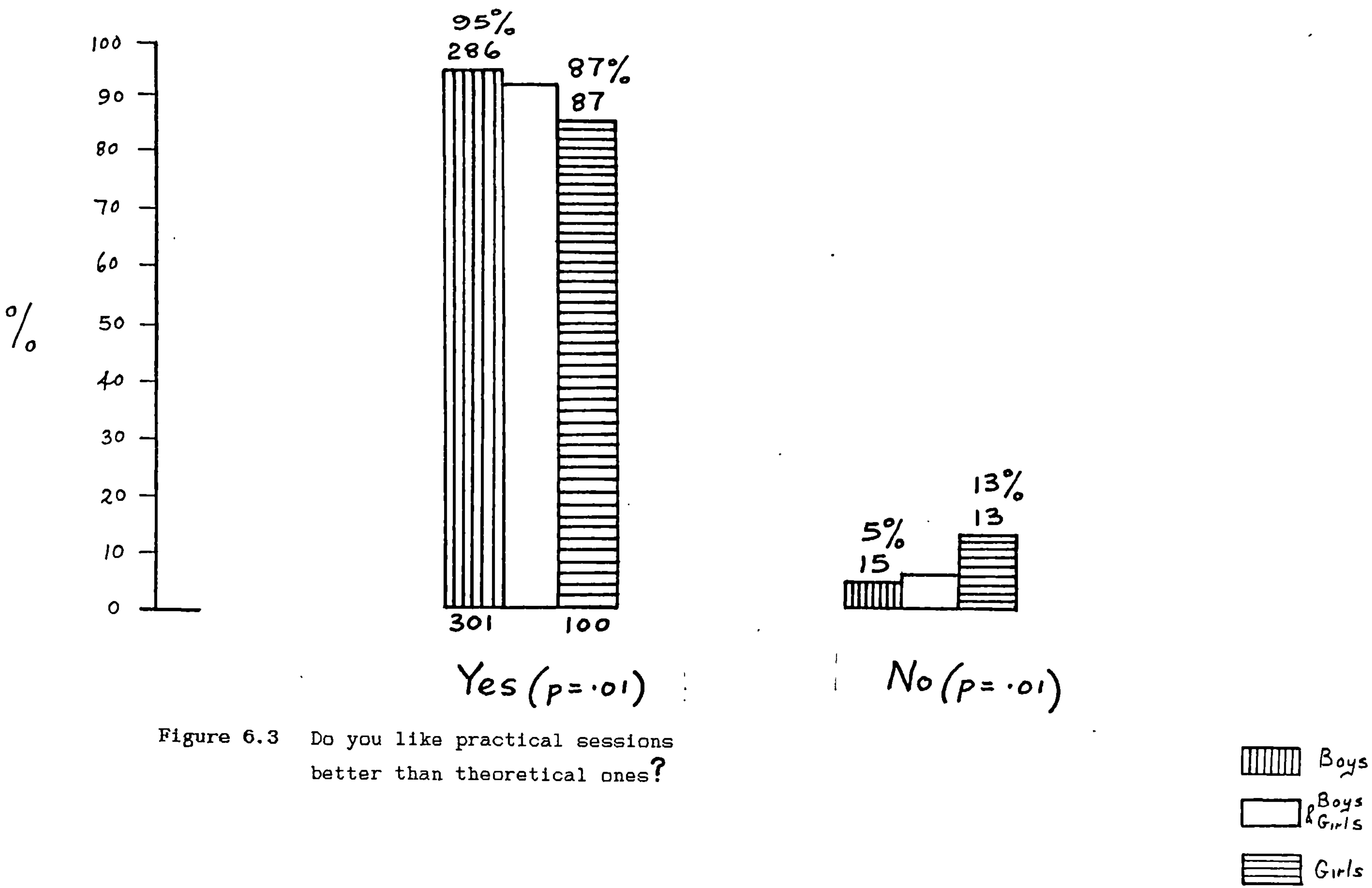


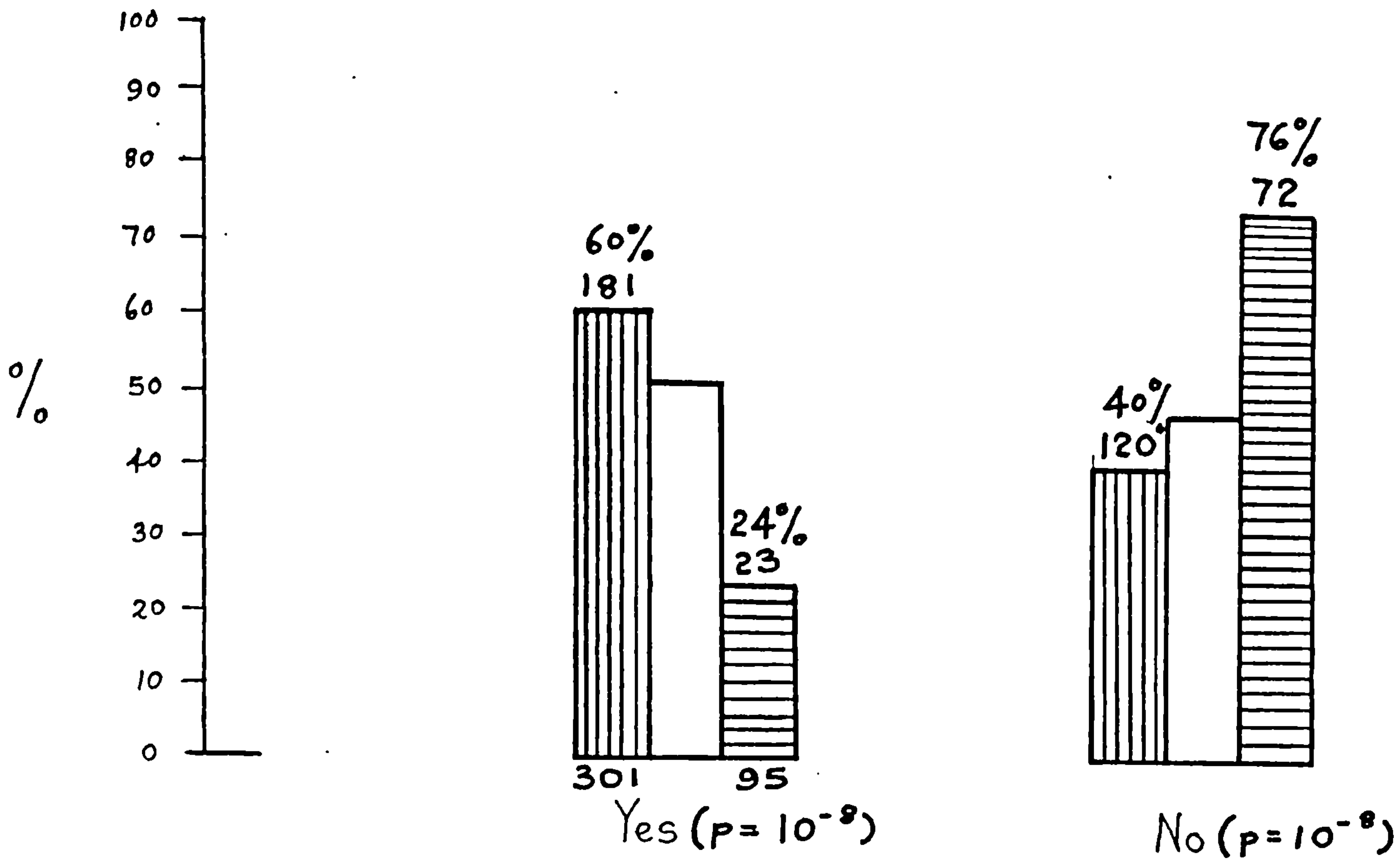
Figure 6.3 Do you like practical sessions better than theoretical ones?

The enthusiasm for practical work was further amplified in the replies to item 6. Figure 6.4 shows that 4 out of every 10 boys and 7 out of every 10 girls consider that they have not learned enough practical skills in years 1, 2 and 3.

Both these items demonstrate a very high level of discontentment amongst all pupils about the lack of time available for practical sessions.

Some pupils, because of their lack of confidence in practical skills, may decide not to consider taking a technical subject in the 4th year. This response is cause for some concern.

There must be some underlying reason for it. At a time when the attitude questionnaire was completed, all the schools in the population, were engaged in implementing the spirit of the equal opportunities act. In giving boys and girls the opportunity to select subjects from CDT and HE, within the timetable format that existed when these subjects were taught in strict gender groupings, the effect on the learning of even basic skills was very alarming. Effectively, the experience gained by all pupils was halved. To gain full benefit and true equal opportunity the time available for CDT and HE departments for year 1, 2 and 3 needs to be doubled. Waller (1984) and the report entitled 'Equal Opportunities in Craft, Design and Technology' (circ 1980) amplify the point further. 'Designing and making things well takes a long time. With the benefit of hindsight, it has clearly been unreasonable for headteachers and others to expect CDT departments to have taken on double the number of pupils without some help in terms of timetable time, staffing facilities and equipment. In some cases such resources appear not to have been available, and the result is that all pupils now experience all crafts, but for half the length of time for each, thus providing a shallow experience'.



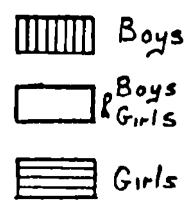


Figure 6.4 Do you think that you have learned enough practical skills in years 1, 2 and 3 to allow you to get on quickly with 4th year projects?

6.3.2.4 ENTHUSIASM FOR TECHNICAL SUBJECTS

Several items were probing, in slightly different ways, for some indication of enthusiasm for technical work.

Item 2 Do you look forward to Technical Studies lessons?

Item 5 Is Technical Studies as interesting as you thought it would be?

There was a marked difference, in the enthusiasm for technical work, between boys and girls. Only just under half of the girls showed any real enthusiasm for technical work, in comparison with 6 out of every 10 boys, (figure 6.5).

The replies to item 5 (figure 6.6), reveal that one third of the girls considered that the subject area could be made more interesting. Whereas only 2 out of every 10 boys were dissatisfied with the challenge presented by technical work

These two items clearly demonstrate a more possible commitment, on the part of boys, towards technical work.

6.3.2.5 ENTHUSIASM FOR GRAPHICAL WORK

The enthusiasm for graphical work was ascertained by the responses to items 8 and 10.

Item 8 Do you look forward to Technical Drawing lessons?

Item 10 Is Technical Drawing as interesting as you thought it would be?

The enthusiasm for technical drawing showed, again, a difference between the sexes. Comparison of figures 6.6 and 6.8 shows that boys looked forward to technical studies much more than they do to technical drawing lessons (58% / 33%). In contrast, girls prefer technical drawing (26% / 36%)

Boys demonstrated very strongly, as shown in figures 6.5 and 6.9, that they found technical studies more interesting than technical drawing (61% / 33%).

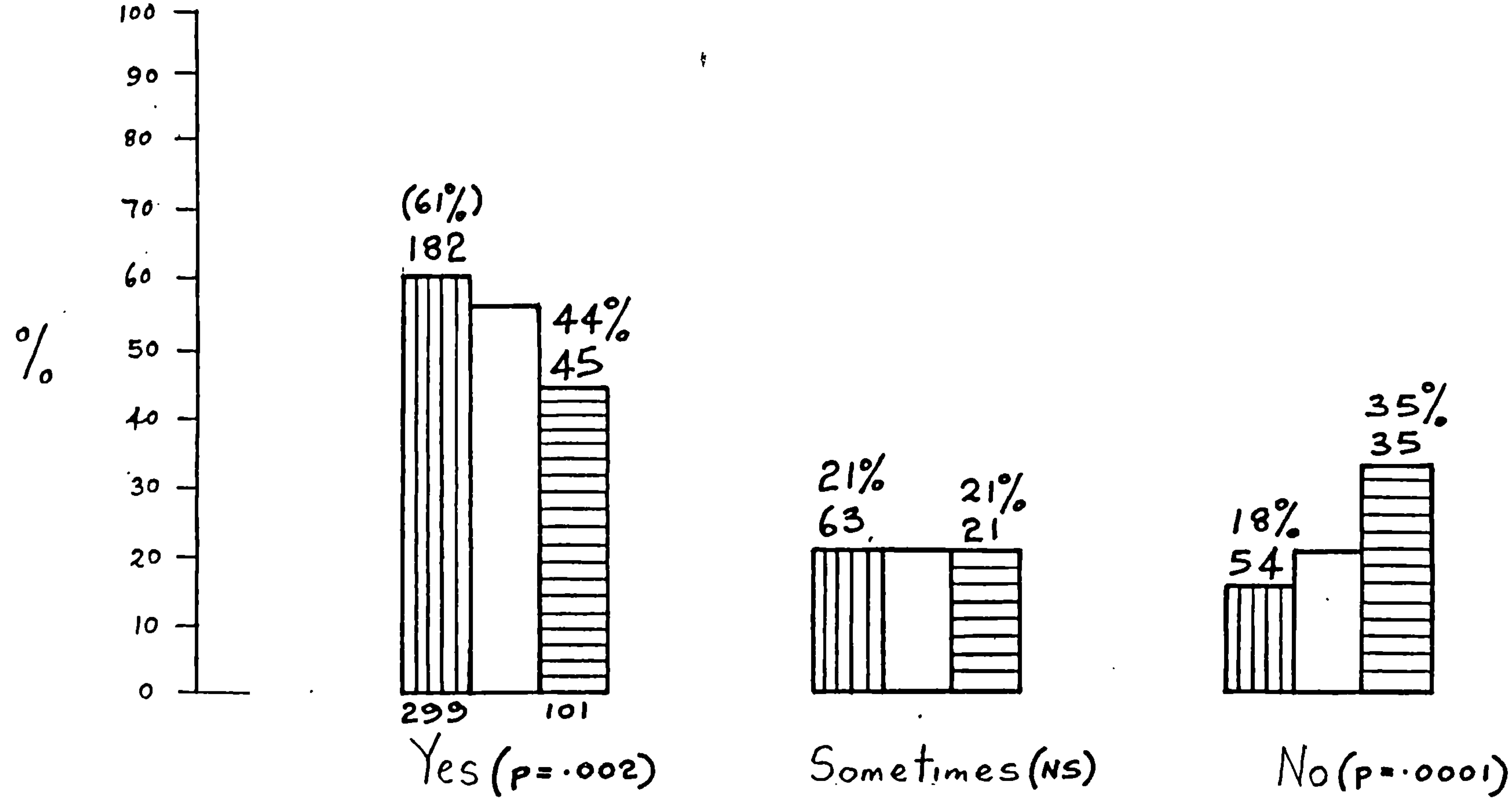


Figure 6.5 Is Technical Studies as interesting as you thought it would be?

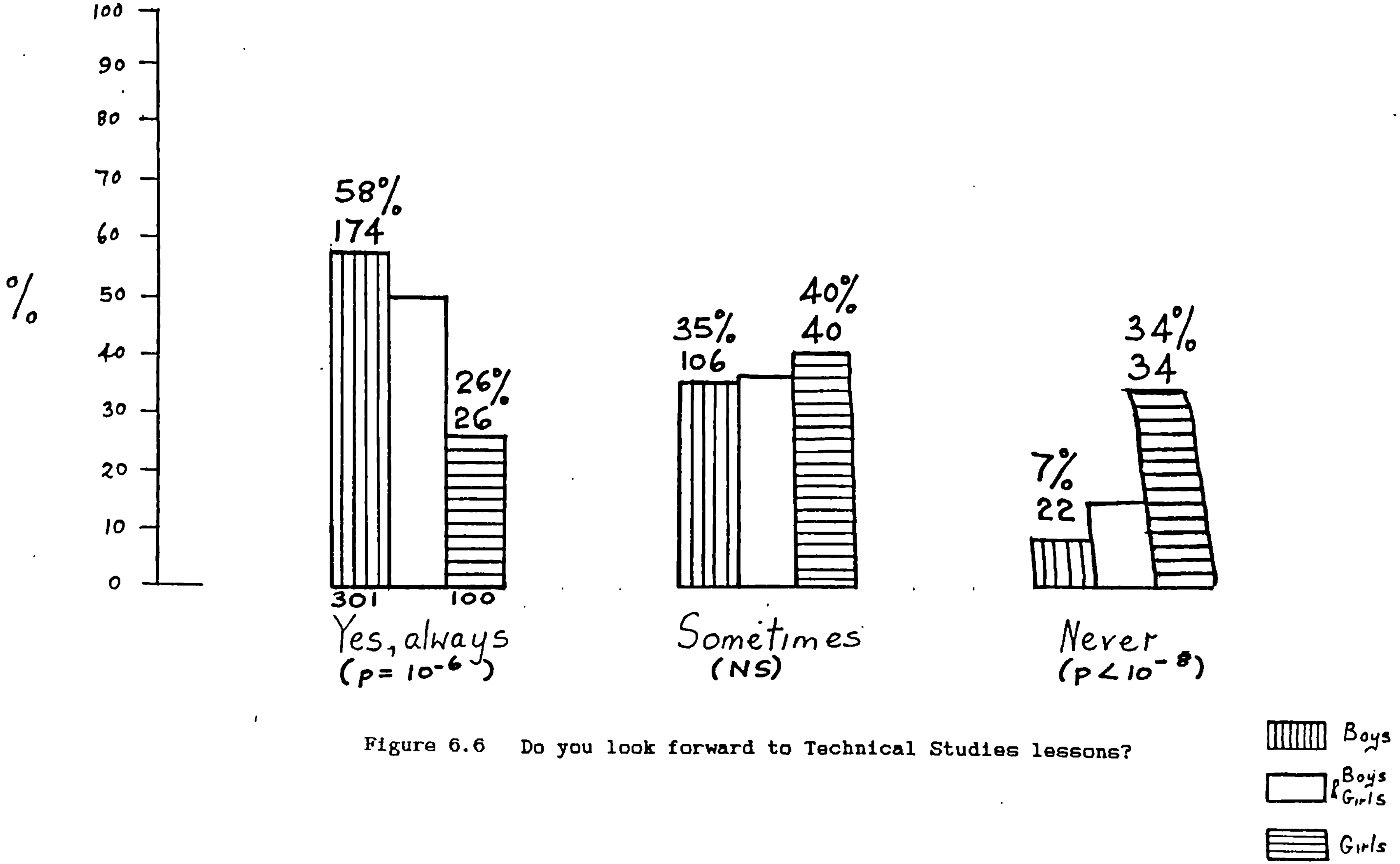


Figure 6.6 Do you look forward to Technical Studies lessons?

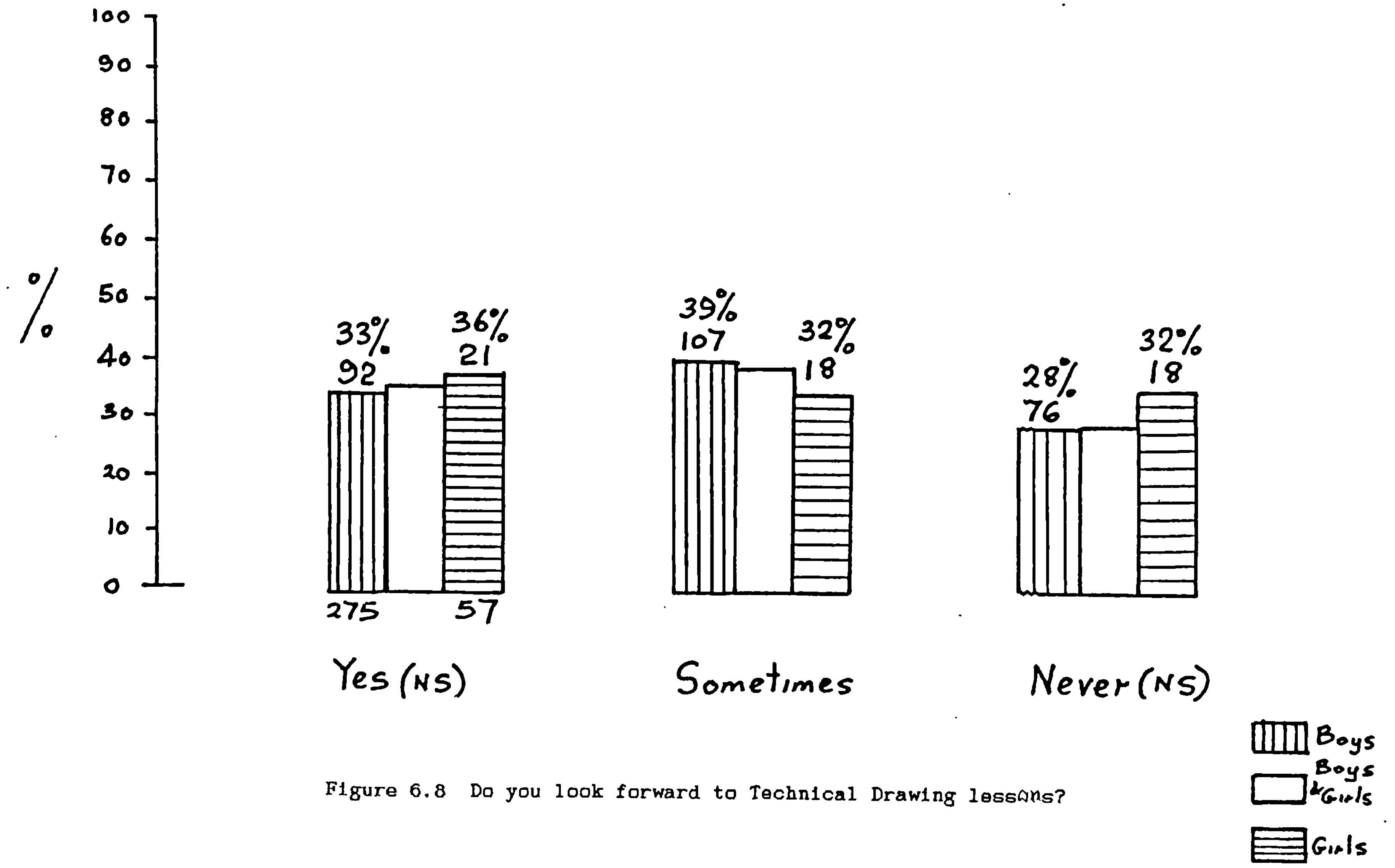


Figure 6.8 Do you look forward to Technical Drawing lessons?

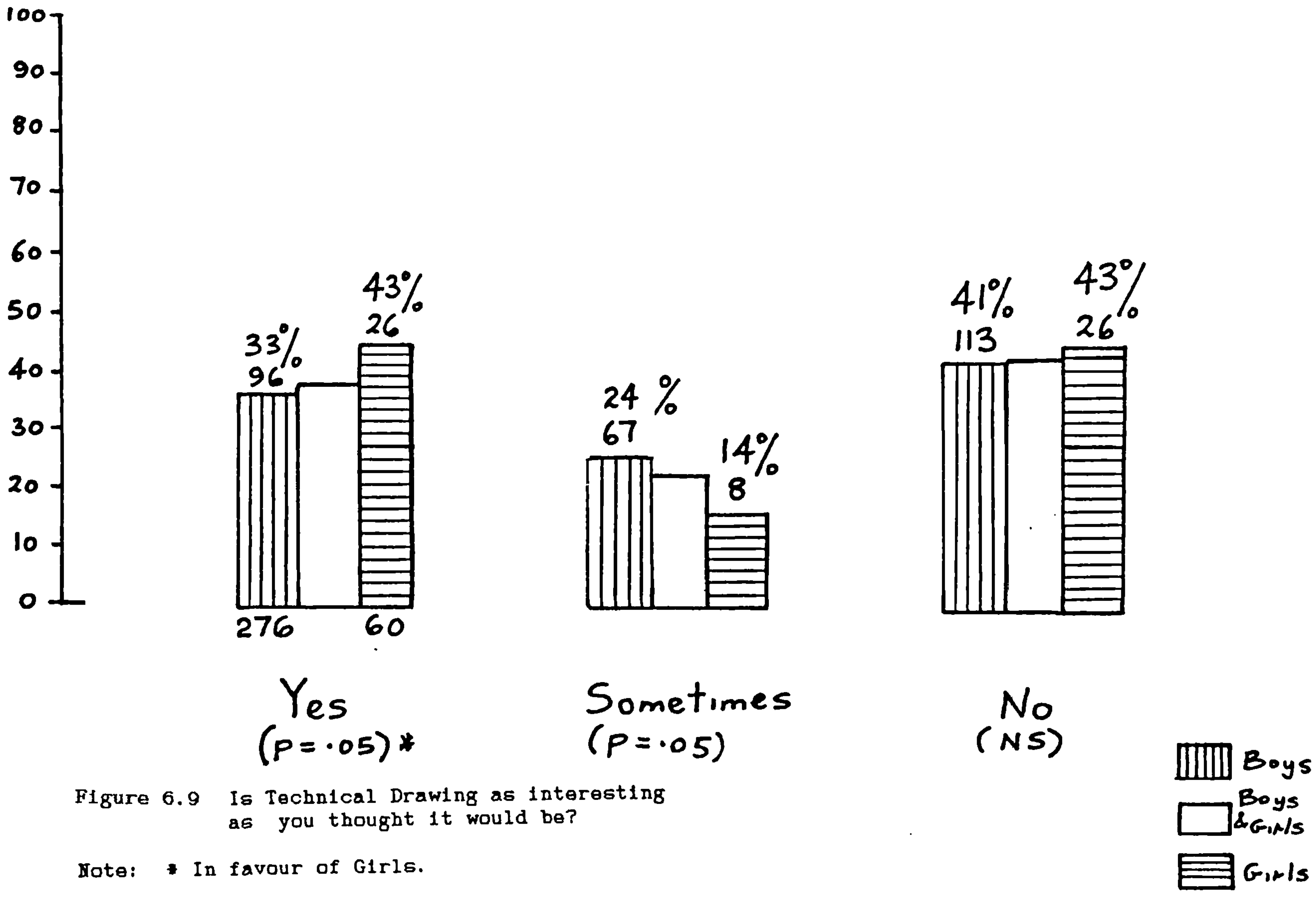


Figure 6.9 Is Technical Drawing as interesting as you thought it would be?

Note: * In favour of Girls.

However, the girls express similar feelings for both technical studies (44%) and technical drawing (43%) from an interest point of view. Outstanding among the replies to item 10, figure 6.9, was that girls, rather than boys, showed the significantly higher proportion answering 'Yes'.

6.3.2.6 PUPILS' RATING OF TECHNICAL SUBJECTS

Item 4 In order of importance, out of all the subjects that you take, how do you regard Technical Studies?

Item 9 In order of importance, out of all the subjects that you take, how do you regard Technical Drawing?

The responses to item 4 (table 6.3), show that boys have a much higher regard for technical studies than that demonstrated by the girls.

This preference is even more marked in the replies to item 9. Far more boys (54%) place the subject within the first 6 ratings compared with the girls(29%),table 6.4.

6.3.2.7 ALLOCATION OF TIME

Item 11 Would you like to spend more time doing Technical Studies?

Item 12 Would you like to spend more time doing Technical Drawing?

There was a very strong request, in the responses to item 11, for an increased allocation of time for technical studies, (figure 6.7) amongst the boys. This strength of opinion was not shared by the girls.

Again in the replies, this time to item 12, girls, rather than boys, showed the significantly higher proportion answering 'Yes' and the lower proportion answering 'No' (figure 6.10).

This agrees closely with the response to item 3, figure 6.3, 'Do you like practical lessons rather than theoretical ones? to which the girls gave a significantly less proportion of 'Yes' responses and a higher proportion of 'No' responses.

Order of Importance	Girls and Boys %	Boys %	Girls %
1, 2, 3	27	32	9
4, 5, 6	42 (69)	46 (78)	30 (39)
7, 8, 9	18 (87)	15 (93)	28 (67)
10, 11, 12	13 (100)	7 (100)	33 (100)

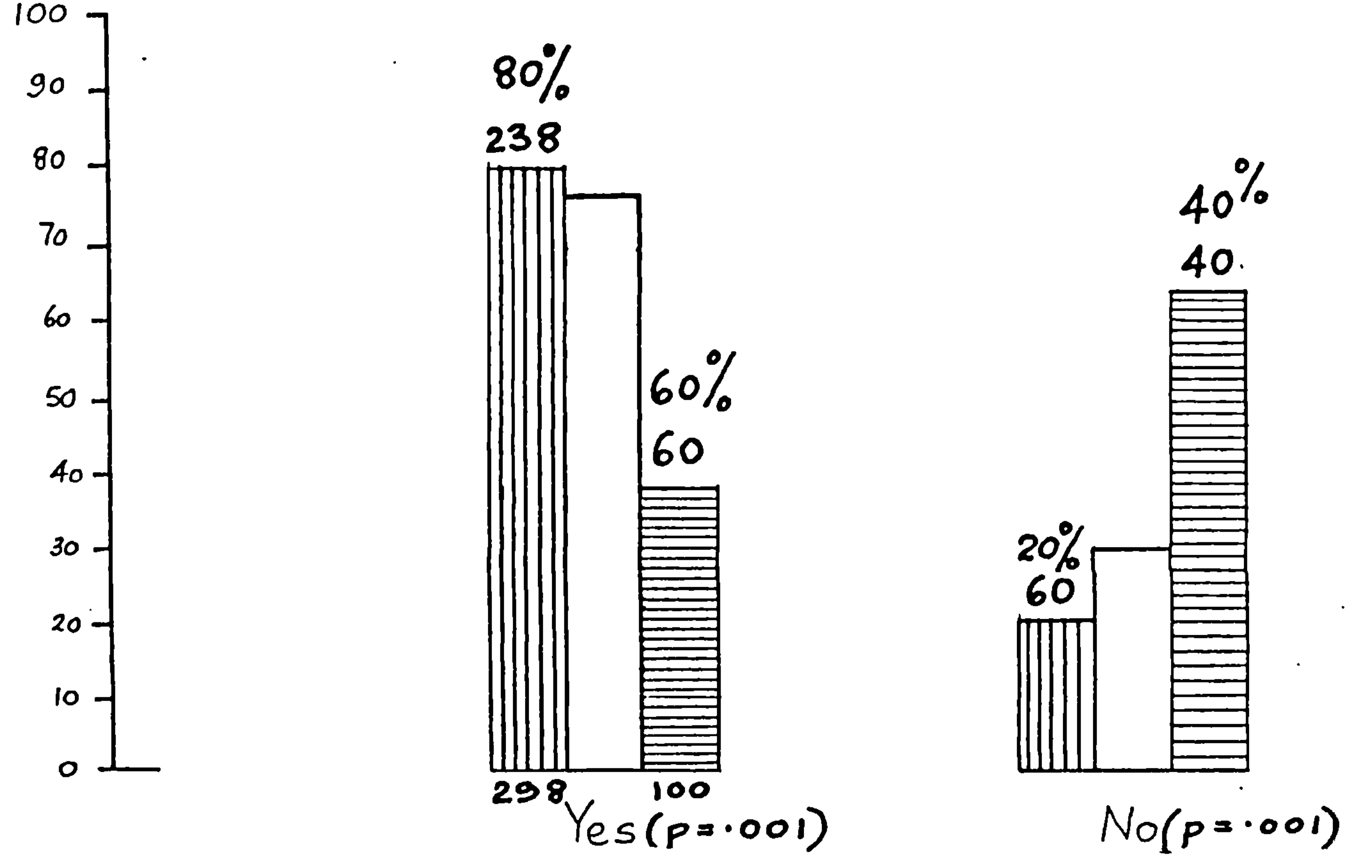
Note: % totals in ( )

Table 6.3 Item 4. In order of importance, out of all the subjects you take, how do you regard Technical Studies?

Order of Importance	Girls and Boys %	Boys %	Girls %
1, 2, 3	13	14	11
4, 5, 6	36 (49)	40 (54)	18 (29)
7, 8, 9	23 (72)	22 (76)	26 (55)
10, 11, 12	28 (100)	24 (100)	45 (100)

Note: % totals in ( )

Table 6.4 Item 9. In order of importance, out of all the subjects you take, how do you regard Technical Drawing?



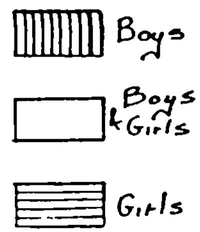


Figure 6.7 Would you like to spend more time doing Technical Studies?

Thus, it would appear that the girls greater preference for technical drawing (Figure 6.10) is connected with the greater aversion to practical work than the boys - a finding which also has been noted in science (Taylor 1971).

6.3.2.8 PROJECTS

Item 13 Write down the name of the best project that you made in Technical Studies.

A wide range of projects was selected, and 66 project groupings were referred to in the replies to this item.

The projects tended to be functional or decorative. It was interesting to note that some pupils made reference to practical work that they had done in technology lessons, e.g. electric motors, fischer technic constructions using pneumatics and solar energy. The most popular projects are set out in table 6.5.

A careful appraisal of these projects reveals great differences between those selected by boys and those by girls. The ones favoured by boys were those that required, for their completion, a considerable amount of drive and application. Whereas the projects favoured by the girls were those that are usually made in the 1st year.

It may be possible that due to the choice system that existed in the sample schools, there may have been insufficient timetable time in the CDT and HE departments so not so many girls selected to continue with CDT after the 1st year.

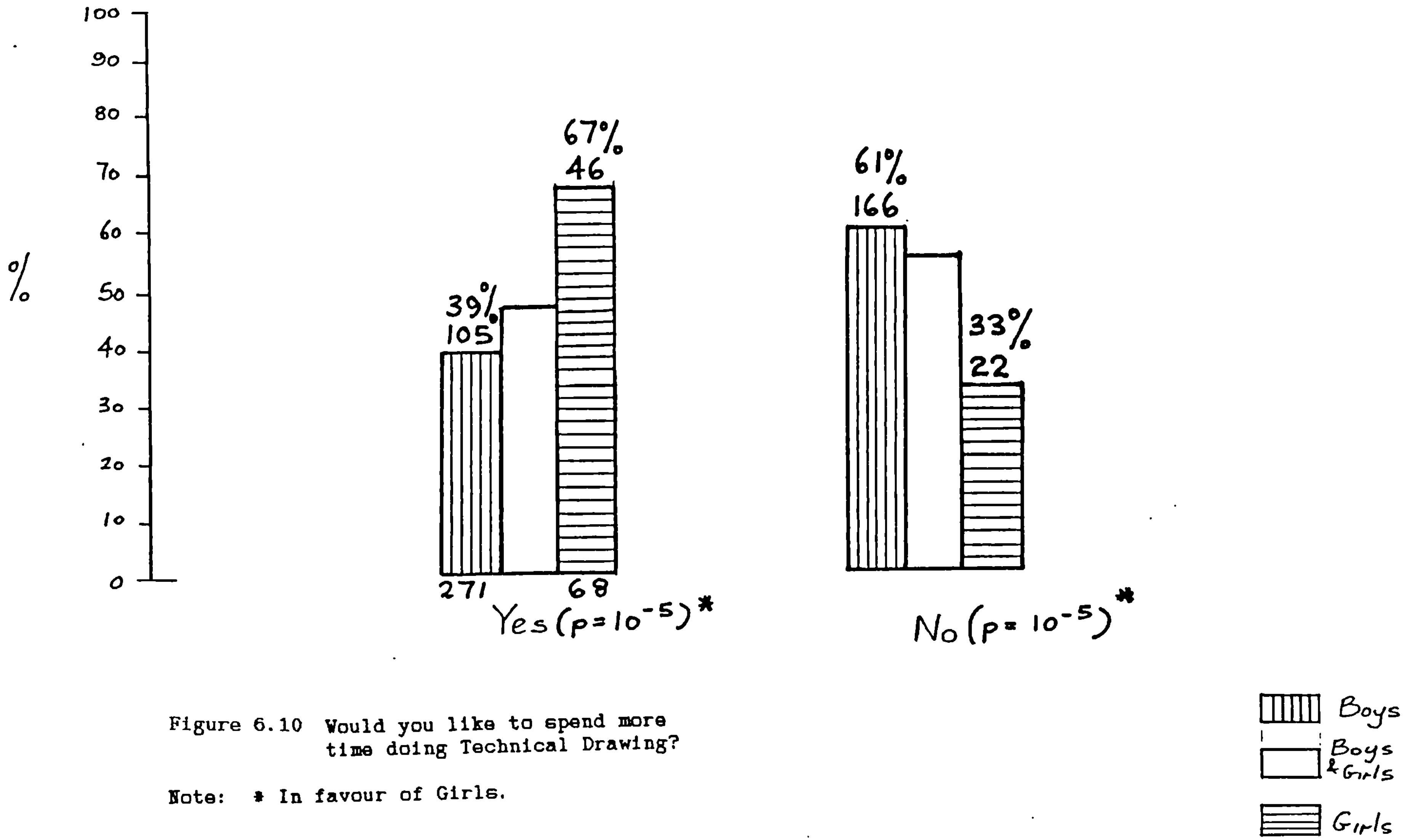


Figure 6.10 Would you like to spend more time doing Technical Drawing?

Note: * In favour of Girls.

Boys	%	Girls	%
Table, Coffee Telephone	13	Games, O&X Solitaire etc	33
Steam Engine	8	Key Ring	7
G. Gramp	6	Small Wooden Carving-bird etc.	6
Tack Hammer	6	Pendant	6
Box, Money, Fishing etc.	6	Garden tools	6
Garden tools, Trowel etc.	4	Cassette rack.	4

Table 6.5 Write down the name of the best project that you made in Technical Studies.

6.3.2.9 FAVOURITE MACHINES

The most significant of the 15 replies to this item are shown in table 6.6. The engineering lathe, which is the most challenging machine that is used during the first three years, is the one favoured by the boys. In contrast, the girls prefer the drilling machine which is used from the first year.

6.3.2.10 AREAS OF TECHNICAL WORK NOT HIGHLY REGARDED

Item 15 Which part of Technical Studies do you most dislike?

Item 16 Which part of Technical Drawing do you most dislike?

There were over 40 responses to each of these items. Demonstrations seem to be universally disliked in both technical studies and technical drawing. The most significant replies to item 15 are shown in table 6.7 and to item 16 in table 6.8

6.3.2.11 IMPROVEMENTS IN TECHNICAL WORK

Item 17 How do you feel Technical Studies lessons could be improved?

Item 18 How do you feel Technical Drawing lessons could be improved?

There were about 50 varying responses to each of the above items. In their replies to item 17 one in every seven of the sample took this opportunity to stress again their need for more time. The boys expressed a strong feeling for improved machinery, which was also high on the improvements for the girls. Although the girls seemed to be equally concerned to have a greater range of projects to make.

Other significant replies to item 17 are shown in table 6.9. There was a strong request in the replies to item 18 for more stimulating things to draw. Other significant responses to this item are shown in table 6.10.

Boys	%	Girls	%
Lathe	48	Drilling Machine	44
Drilling Machine	21	Buffing Machine	21
Brazing Hearth	15	None	13
Buffing Machine	7	Brazing Hearth	11
Wood Turning Lathe	2	Lathe	7
None	2	Power Saw	3

Table 6.6 Which machine do you most enjoy using?

Boys	%	Girls	%
Theory	28	Theory	37
Demonstrations	21	Demonstrations	23
I like all of it	10	I dislike all of it	14
Filing	7	I like all of it	7
I dislike all of it	5	Filing	5
The teacher	3	Deciding on the measurements	3

Table 6.7 . Which part of Technical Studies do you dislike?

Boys	%	Girls	%
I dislike all of it	27	I dislike all of it	29
I like all of it	18	I like all of it	25
Demonstrations	15	Demonstrations	21
The teacher	6	Working out spacing	4
Drawing the border	4	The teacher	1
Clearing up	4	Drawing the border	1
Colouring in	3	Colouring in	1

Table 6.8 Which part of Technical Drawing do you dislike?

Boys	%	Girls	%
More or better machinery and equipment	23	Greater range of projects	16
More time	14	More or better machinery and equipment	14
More projects designed by pupils.	8	More time	12
Projects more exciting	7	Projects more exciting	11
Greater range of projects	7	More projects design by pupils	9
It cannot be improved	7	Less theory in lessons	9
More practical work in lessons	5	More practical work in lessons	6
Better and stricter teachers	5	It cannot be improved	4
More teachers for each group in the workshops	3	More demonstrations	2

Table 6.9 How do you feel Technical Studies lessons could be improved?

Boys	%	Girls	%
More interesting things to draw	17	More interesting things to draw	22
It cannot	12	It cannot	12
More time	10	More time	8
New Equipment	9	Less Theory	6
Better teaching	6	Better teaching	4
More choice of things to draw	4	Harder drawings	4

Table 6.10 How do you feel Technical Drawing lessons could be improved?

6.3.2.12 FAMILY CONNECTIONS WITH TECHNICAL WORK

Item 19 Is anyone in your family employed in a job requiring technical skills? 6 out of every 10 had a member using technical skills at work, (figure 6.11).

The most popular type of work done by the relations of the pupils were engineering, building industry and employment as a car mechanic. They account for nearly half of the respondents, (table 6.11).

6.3.2.13 CONTINUING WITH TECHNICAL WORK

Item 20 Do you intend to take Technical Studies in the 4th year?

Item 21 Do you intend to take Technical Drawing in the 4th year?

There was a very marked difference between the way the boys and girls responded to item 20, (figure 6.12). 6 out of every 10 boys expressed a desire to continue with technical studies. In contrast, the girls expressed very little interest in continuing with the subject.

Boys did not seem as enthusiastic to continue with graphical work, and only 4 out of every 10 expressed a desire to continue with this subject, (figure 6.13). Again, the girls seemed to express only weak interest in continuing with work in technical drawing. The girls response to this item is somewhat confusing, since they had a much more positive approach when replying to items 8 and 10, (section 6.3.2.5).

6.3.2.14 FAVOURITE MATERIALS

Item 22 Which are your favourite materials for making projects?

Well over half of the population preferred to work in wood. Plastics was surprisingly unpopular, perhaps because, without careful handling, it can easily crack and spoil several hours of work. Concrete was a material selected by a small number of girls, table 6.12.

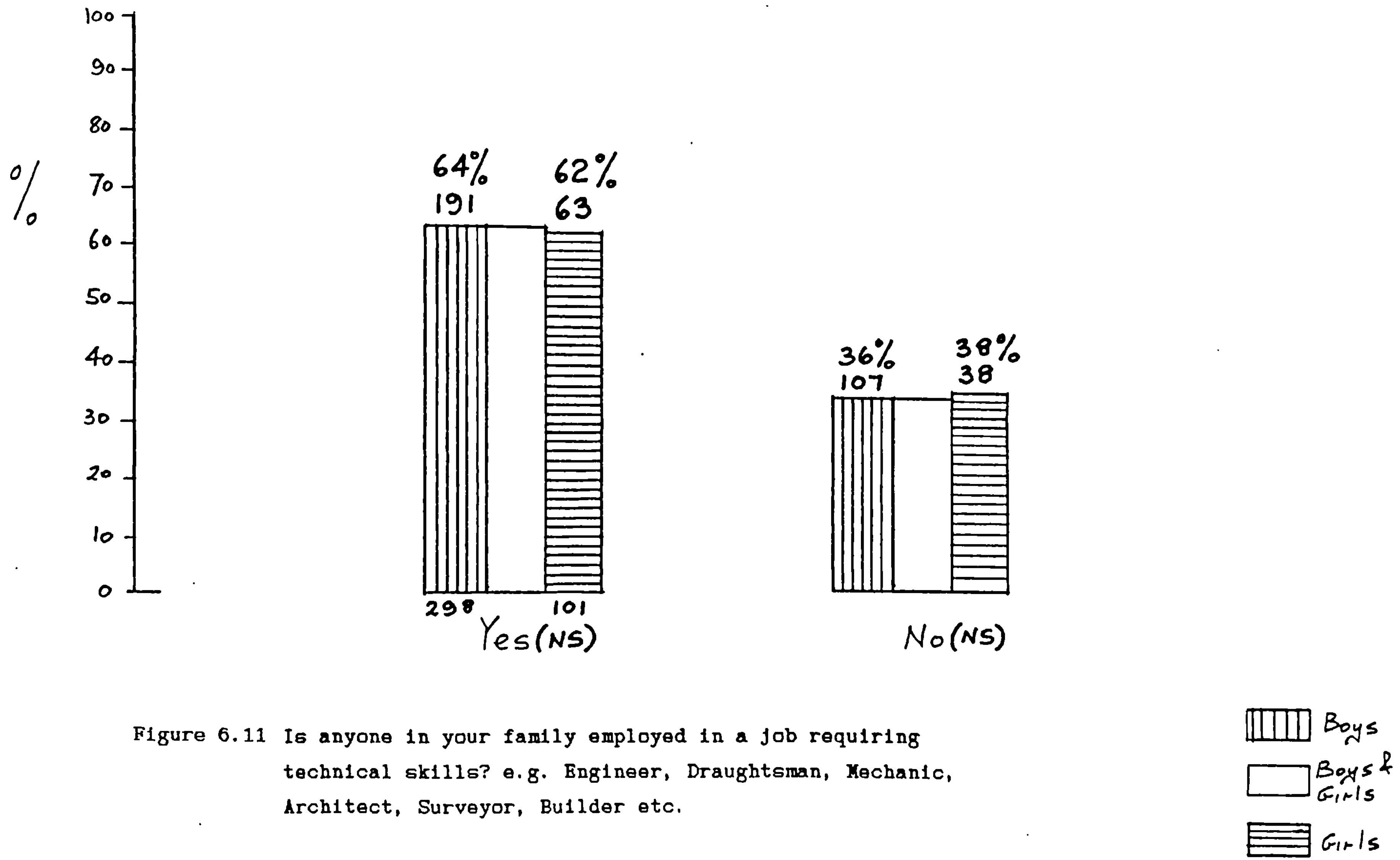
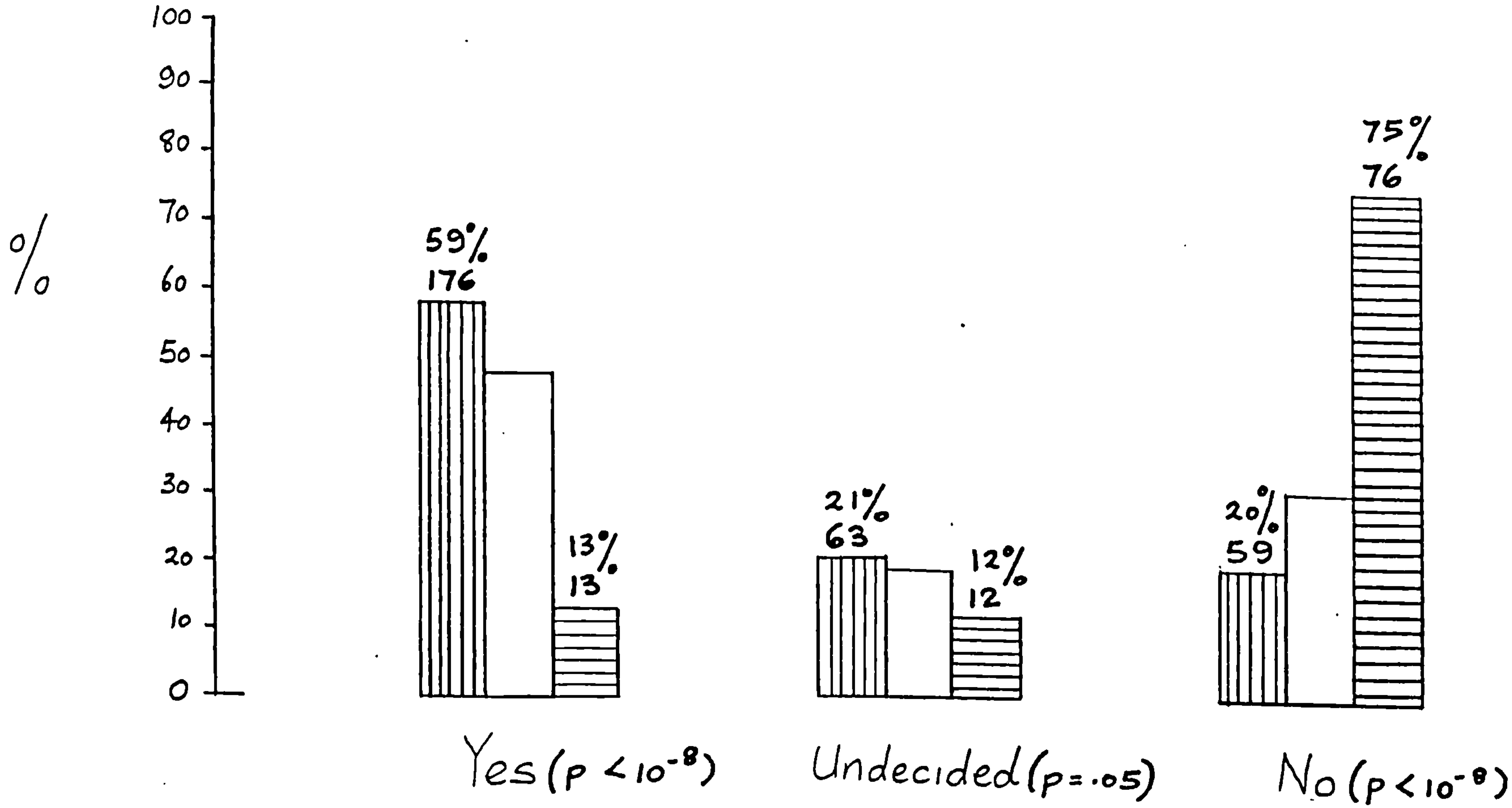


Figure 6.11 Is anyone in your family employed in a job requiring technical skills? e.g. Engineer, Draughtsman, Mechanic, Architect, Surveyor, Builder etc.

Boys	%	Girls	%
Engineering	25	Engineering	19
Building	22	Building	19
Mechanic	10	Mechanic	12
Draughtsman	8	Computer Operator	9
Carpenter	8	Draughtsman	9
Electrician	5	Carpenter	5
Architect	4	Printer	3
Plumber	4	Computer Programmer	2

Table 6.11 If yes, state type of work.



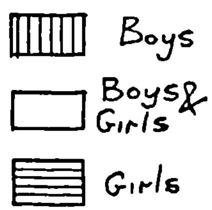


Figure 6.12 Do you intend to take Technical Studies in the 4th year?

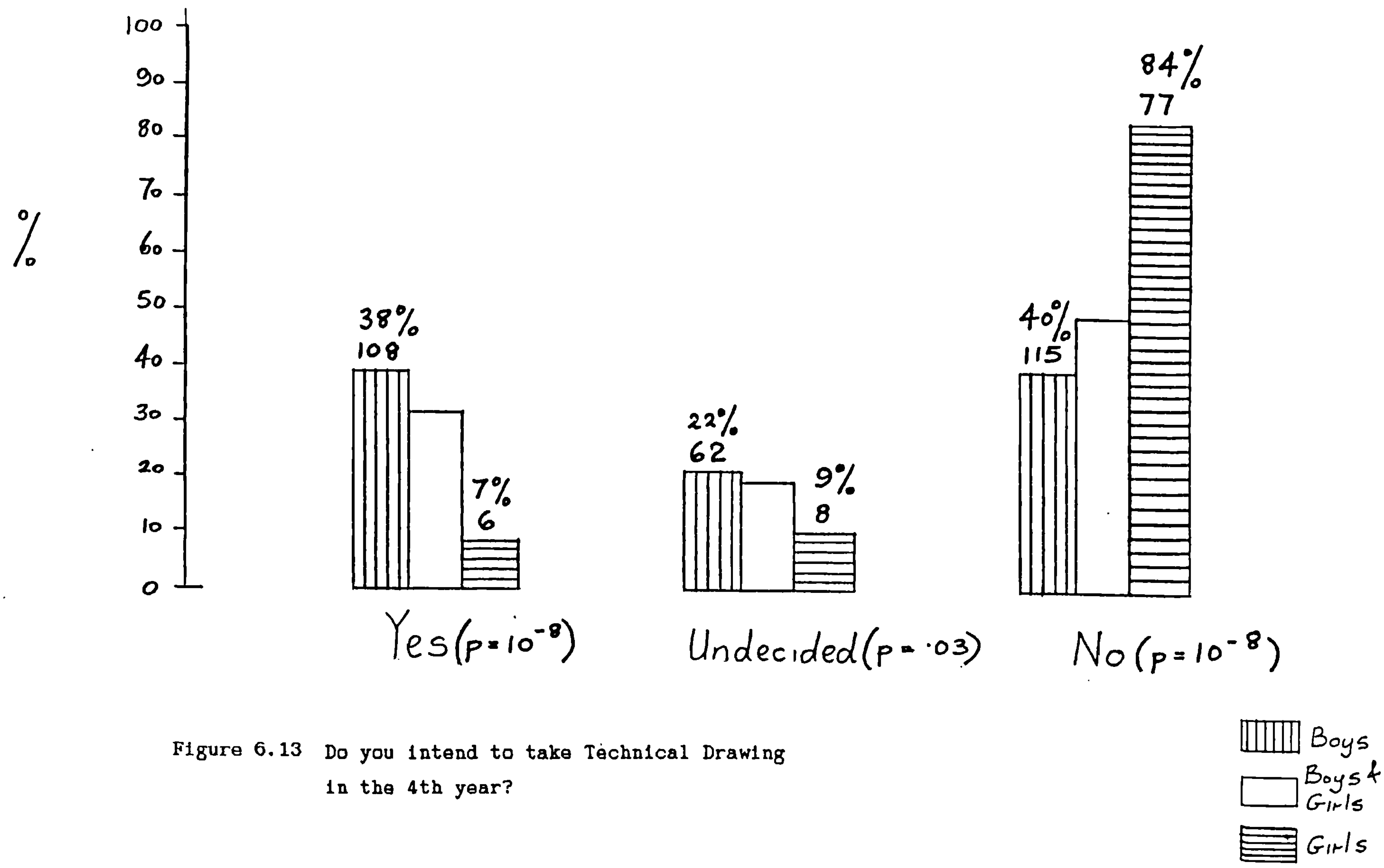


Figure 6.13 Do you intend to take Technical Drawing in the 4th year?

Boys	%	Girls	%
Wood	56	Wood	60
Metal	38	Metal	24
Plastics	5	Plastics	8
		Enamels	3

Table 6.12 **What is your favourite material for making projects?**

6.3.2.15 THE MOST ENJOYABLE PARTS OF TECHNICAL WORK

Item 23. Which part of Technical Studies lessons do you enjoy?

Item 24. Which part of Technical Drawing lessons do you enjoy?

There were 74 different responses to these two items.

Half of the population took the opportunity to again demonstrate their enthusiasm for practical work in their replies to item 23. Some expressed a pride in the finished project, (table 6.13).

One third of the boys and nearly half of the girls enjoyed actually drawing, (table 6.14). It was interesting to note that only a small proportion of the boys enjoyed designing, but, for the girls, 8% enjoyed adding colour to the drawing and completing a difficult drawing. The latter may be another indicator of the more favourable attitude of girls towards graphical work.

6.3.2.16 FAVOURITE SUBJECTS

Item 25. List, in order, your five *favourite subjects*.

Three tables have been drawn out to tease as much information as possible from this data.

6.3.2.16.1 FAVOURITE FIVE - BOYS (table 6.15)

It is interesting to note that, when the boys are given a completely free choice of subjects, they do not select any subjects from the HE department. Throughout the five choices, there is no reference to any of these subjects.

6.3.2.16.2 FAVOURITE FIVE - GIRLS (table 6.16)

In their selections, especially for the first two subjects of the favourite five, the girls seem to prefer creative subjects.

They also include both Technical Studies and Technical Drawing, albeit in the fourth and fifth choices. This indicates that there is more interest in CDT shown by both sexes in comparison with HE. This was also found by Bird and Varlaam (1985), chapter 3, section 3.6.8.

Boys	%	Girls	%
Practical Work	49	Practical Work	53
Machine Work	16	Machine Work	20
All of it	6	I don't	6
Admiring the finished work	5	Admiring the finished work	4
I don't	2	The finishing touches	4

Table 6.13 Which part of Technical Studies do you most enjoy?

Boys	%	Girls	%
The Drawing	33	The Drawing	44
I don't	25	I don't	18
All of it	9	All of it	4
Designing	3	Colour work	4
		Finishing a hard drawing	4

Table 6.14 Which part of Technical Drawing do you most enjoy?

Table 6.15 FIVE FAVOURITE SUBJECTS - BOYS

First		*	Second		*	Third		*	Fourth		*	Fifth		*
Subject	%	%	Subject	%	%	Subject	%	%	Subject	%	%	Subject	%	%
Games/PE	24	-	Games/PE	15	-	Maths	10	11	English	13	14	Maths	12	14
Maths	10	13	English	8	9	Tech,Drg,	10	11	Games/PE	9	-	English	11	13
Tech/Stds,	8	10	Tech/Std	8	9	Games/PE	10	-	Maths	9	10	Games/PE	10	-
Physics	6	8	Maths	8	9	Art	8	9	Geography	8	9	History	8	9
Chemistry	6	8	Geography	8	9	Tech/Std	8	9	Physics	8	9	Physics	6	7
Art	5	7	History	8	9	English	8	9	Tech,Drg	7	8	Biology	6	7
English	5	7	Tech,Drg	7	8	Physics	7	8	Tech/Std	6	7	Tech/Std	6	7
Geography	5	7	Art	7	8	Geography	7	8	French	3	3	Geography	6	7
History	5	7	Chemistry	6	7	Biology	6	7	Chemistry	3	3	Chemistry	5	6
Woodwork	4	5	Physics	5	6	History	5	6	Woodwork	5	6	Tech,Drg	4	5
Technology	3	4	Biology	4	5	Chemistry	4	4				French	4	5
Tech,Drg	3	4	Woodwork	4	5	Metalwork	3	3				Science	4	5
Biology	3	4	Design	3	4							Art	3	4
Metalwork	3	4												
Design	3	4												

Notes; (1) The second column for all five choices excludes Games and PE, marked thus *,

(2) Games/PE - Games & Physical Education; Tech/Stds, - Technical Studies, Tech, Drg, - Technical Drawing,

Table 6.16 FIVE FAVOURITE SUBJECTS - GIRLS

First		*	Second		*	Third		*	Fourth		*	Fifth		*
Subject	%	%	Subject	%	%	Subject	%	%	Subject	%	%	Subject	%	%
English	20	24	Needle/k	18	20	English	13	15	English	12	13	Maths	14	16
Home/Ec,	20	24	Home/Ec,	17	19	Needle/k,	11	12	Geography	10	11	History	12	14
Games/PE	18	-	Art	13	15	Games/PE	10	-	Maths	9	10	Games/PE	10	-
Biology	8	10	Games/PE	12	-	Home/Ec,	9	10	Biology	9	10	English	8	9
Art	6	7	Maths	9	10	Art	8	9	Home/Ec,	8	9	Art	7	8
Child/Care	6	7	Biology	7	8	Biology	8	9	Art	8	9	Biology	7	8
History	5	6	English	7	8	Chemistry	6	7	Chemistry	8	9	Geography	6	7
Needle/k	3	4	History	6	7	German	6	7	Games/PE	7	-	Tech,Drg	5	6
			Geography	4	5	French	6	7	French	6	6	German	5	6
			French	3	3	History	4	5	Needle/k	5	5	French	5	6
						Maths	4	5	History	5	5	Science	4	5
									Tech/Std	3	3	Home/Ec,	4	5
									Physics	3	3	Needle/k	3	3
												Rel/Ed,	3	3

Notes: (1) The second column for all five choices excludes Games and PE, marked thus *,

(2) Games/PE - Games & Physical Education; Tech/Stds, - Technical Studies; Tech, Drg, - Technical Drawing; Home/Ec, - Home Economics; Needle/k, - Needlework; Rel/Ed, - Religious Education,

6.3.2.16.3

FAVOURITE FIVE - BOYS AND GIRLS (table 6.17)

In this table the subjects have been placed in faculty groupings. The time allocation, for each of these faculty groupings in the sample schools, was between two hours and twenty minutes and three and a half hours. It must be stressed, however, that the sample schools did not teach in these faculty groupings.

There is a very positive indication, by both sexes, for creative work. Even when Art is removed, creative subjects are still the most liked group for the first three of the favourite five, e.g for the first selection - boys - creative (1) 38% - 7% {Art} = 31%. For girls - creative (2) 42% - 7% {Art} = 35%.

There is no doubt that there is a very positive attitude towards creative subjects demonstrated by both boys and girls. As far as the boys are concerned, they demonstrated in their responses to the 'Favourite Five' a far more positive attitude towards CDT than was shown when they eventually selected their option subjects at the end of the 3rd year, reported in chapter 12.

The 'blanket' rejection of any HE subjects by the boys seems to indicate that they are still thinking along traditional lines.

There appears to be 'a glimmer of hope' with the girls since they do include both Technical Studies and Technical Drawing within their 'Favourite Five' selections.

6.3.2.17 TECHNICAL CAREER

Only one fifth of the boys rejected thoughts of a technical career, figure 6.14. There was a far higher rejection by the girls, three times that shown by the boys (63% - 21%).

Table 6.17 FIVE FAVOURITE SUBJECTS - BOYS AND GIRLS

First		Second		Third		Fourth		Fifth	
Boys	%	Boys	%	Boys	%	Boys	%	Boys	%
Creative (1)	38	Creative (1)	29	Creative (1)	32	Creative (1)	18	Science	25
Science	20	Social Sc.	18	Science	19	English	14	Creative (1)	16
Social Sc.	14	Science	18	Social Sc.	14	Science	12	Social Sc.	16
Maths	13	Maths	9	Maths	11	English	14	Maths	14
English	7	English	9	English	9	Maths	10	English	13
Girls	%	Girls	%	Girls	%	Girls	%	Girls	%
Creative (2)	42	Creative (2)	54	Creative (2)	32	Creative (2)	23	Social Sc.	21
English	24	Social Sc.	12	Science	16	Science	22	Creative (2)	16
Science	10	Maths	10	English	15	Social Sc.	16	Maths	16
Social Sc.	6	English	8	Languages	14	English	13	Science	13
		Science	8	Maths	5	Maths	10	Languages	12
				Social Sc.	5			English	9

Creative (1) - Technical Studies, Technical Drawing, Metalwork, Techmnology, Woodwork, Design & Art.

Creative (2) - Home Economics, Needlework, Child Care & Art.

Science - Biology, Chemistry, Physics & Science. Social Science - History & Geography.

Mathematics. English.

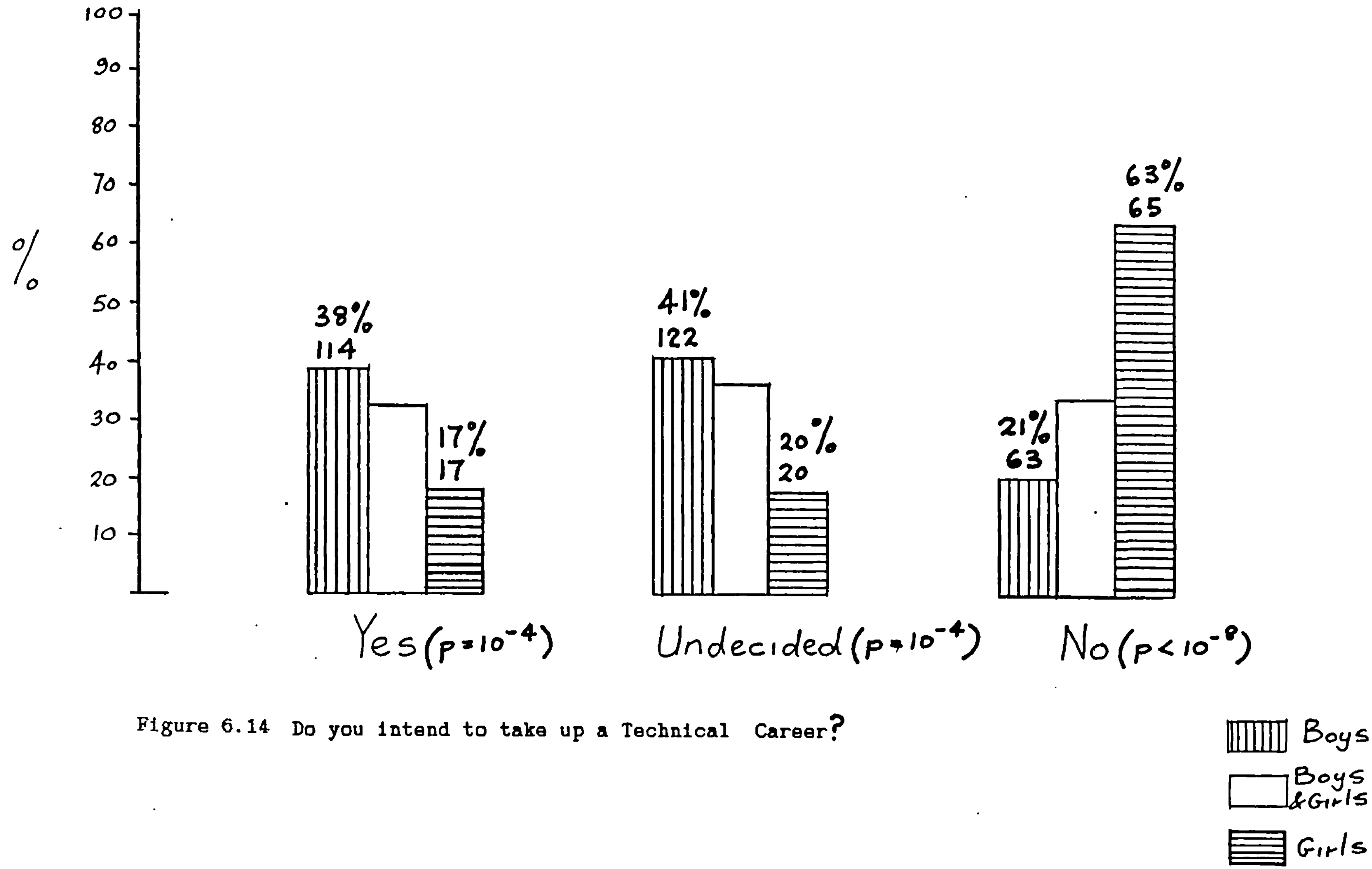


Figure 6.14 Do you intend to take up a Technical Career?

Engineering was the most popular choice of technical career amongst the boys. For the girls, computing and designing were the most popular with types of engineering and mechanic being well favoured, table 6.18.

6.4 OVERVIEW

Although it has not been possible to factor analyse and statistically check all the collected data (except for those items that were used in the correlation coefficients, described in chapter 7), as was the case for the attitude and personality studies, chapters 7,8 and 9, the frequencies from the information questionnaire, nevertheless, provide interesting insights into the way that boys and girls perceive CDT.

In many ways, the open-ended format of the items, in the information questionnaire, have allowed the sample to provide much more information about various aspects of how they view the subject, their opinions of the equipment, the workshop and classroom management of the teaching staff, the projects they have made and the materials used for making them, and their career aspirations.

The major findings of this chapter are:

(1) A significant number of the boys and girls expressed enjoyment in being allowed to 'fiddle', section 6.3.2.2, figure 6.1. The boys being slightly more curious than the girls. Ashton (1965) found 11 year-old boys more curious than girls, of a similar age, about strange objects.

(2) There were two items, section 6.3.2.3 figures 6.3 and 6.4, which probed for the views of the population about practical work. There was an emphatic plea, from an overwhelming proportion of the sample, for more time to be made available for practical work.

Boys	%	Girls	%
Engineer	11	Computer Programmer	18
Carpenter	10	Designer	18
Mechanic	8	Engineer	9
Architect	4	Mechanic	9
Electrical Engineer	4	Electronic Engineering	9
		Bricklayer	9
		Tracer	9

Table 6.18 Type of technical career.

This seemed to be uppermost in their minds throughout the time when they were completing the questionnaires since, whenever they found the opportunity, they stressed their feelings about inadequate time available, section 6.3.2.11, tables 6.9 and 6.10.

(3) The time allocated for graphical work seemed to be adequate, for the boys but not for the girls.

(4) Generally the boys were more enthusiastic about technical studies than the girls. However the girls were more critical of the subject, and expressed a view that it could be made more interesting.

(5) The responses to the items on projects, item 13, and favourite machine, item 14, pose two questions (a) why did the boys seem to make more ambitious projects than those made by the girls? and (b) why did the boys appear to be more confident than the girls were, in the use of machinery as demonstrated by their choice of favourite machine? It could be as Millman (1984) found '...that girls work with confidence and single-mindedness at benchwork activities, but become quickly inhibited when working as part of the mixed group'. Also Page and Nash (1980) suggest that girls may lack confidence in undertaking practical work of a technological nature, and have more favourable attitudes to technology in a single sex environment.

(6) A significant number of the boys expressed a desire to continue with technical studies in the senior school. They were not so enthusiastic to continue with graphical work. The girls expressed only weak interest in continuing with any type of technical work into the 4th year.

(7) As many girls as boys had members of their family involved in some form of technical work. The proportions, between the sexes, did not differ significantly showing that family influence which will be shown to be potent in chapter 7, section 7.3.10 (2), had an equal opportunity of being exerted on both sexes.

(8) In all indices of interest in technical studies, the boys express their liking in significantly greater proportions than the girls. The only exception being in areas of graphical work:

(a) Section 6.3.2.5, figure 6.9 - Girls indicated in significantly higher proportions than boys that they found the subject to be interesting.

(b) Section 6.3.2.7, figure 6.10 - Where girls recorded a significant request for more time to be spent on the subject, in greater proportion than the boys.

(9) The responses to item 25- favourite five subjects- have provided very interesting data. The three tables, 6.15, 6.16 and 6.17, compiled from the pupils responses show:

(a) An overwhelming preference for creative work. Two out of every five boys and girls select this area of work as their first subject choice, table 6.17.

(b) When given a free choice, boys are not selecting any of the subjects from the HE department.

(c) On the other hand, girls do include both technical studies and technical drawing within their favourite five subjects.

(d) A summary of the boys (table 6.15) and girls (table 6.16) choices indicate that both sexes are still selecting subjects on a traditional basis.

(e) The very significant interest amongst the boys for CDT is not reflected in the 'take up' of the subject as shown in chapter 10.

6.5 CHAPTER 7

6.5.1 ANALYSIS OF ATTITUDE QUESTIONNAIRE

The results from the final factor analysis of the attitude questionnaire, which was administered to the whole sample, are discussed in chapter 7.

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CHAPTER 7 LIST OF FIGURES AND TABLES

PAGE NO.

7.0 THE FACTORIAL STRUCTURE OF ATTITUDES TO CDT

7.1. INTRODUCTION TO FINAL FACTOR ANALYSIS OF THE ATTITUDE QUESTIONNAIRE

The construction of the attitude questionnaire has been discussed in chapter 5. Piloting the questionnaire was conducted with 91 pupils from two schools (chapter 5, section 5.4.2), and eventually yielded at least a four factor solution (section 5.6).

The item battery was then augmented by a further set of technical drawing items. These items had not been pilotted but were similar in wording to a set of highly significant items referring to technical studies in the pilot study. These were items 4, 31, 41, 44, and 48, (see chapter 5, section 5.8.1). This was done to see if, given an adequate number of items, those concerned with technical drawing would form a separate factor - as indeeed they did in the main study.The attitude questionnaire was then administered to 301 boys and 104 girls drawn from seven schools.

It was thought that, with this increased sample, the factorial structure would alter in the direction of becoming more reliable and representative of the population from which the sample was drawn, and the number of viable factors would increase.

At this stage in the research work a more powerful computer package entitled 'SPSSX' became available. The results were subjected to three, four and five factor solutions, using a principal components analysis followed by varimax rotations using the new SPSSX package.

The solution with the best reliabilities was the five factor solution, in which 47 of the 48 items had significant loadings >.30, refer to table 7.1. The extraction was carried to the fifth factor in an attempt to reduce the large number of items in factor one.

Since the reliability of the fifth factor had decreased to .45, extraction beyond this point could not be justified,table 7.2.

Table 7.1

VARIMAX CONVERGED IN 16 ITERATIONS.

ROTATED FACTOR MATRIX:

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
A01	.58308				
A02	.49185		.29197		
A03	.37397		.28721		.39287
A04	-.33943				
A05	.29569		-.44578		
A06		.35808			
A07	.52770				
A08				.39371	-.30869
A09	.40951				
A10		.55385			
A11			.49715		
A12				.46892	
A13		.44757			
A14	.53935				
A15					-.53106
A16					-.39869
A17	.35169	.31773			
A18	.35676		.46989		
A19	.30605				
A20		.29806			
A21				.58793	
A22	.58875				
A23				.55822	
A24	.51020				
A25				.53137	
A26		.41336			
A27	.47404				
A28					-.35019
A29	.42365				
A30	.44465	.40381			.28849
A31			.46405		
A32	.37628				
A33	.42593				
A34	.32818				.46237
A35	.37756	-.34407		.35613	
A36				-.28049	.34421
A37		.62732			
A38	.28844				
A39	.54354				
A40	.48082				
A41			.62359	.35731	
A42	.35681				
A43		.29578		.30683	
A44		.30084	.54952	.29134	.29475
A45	.34804				
A46	.40718		-.28121		
A47					.40871
A48	.36074		.40428		

Table 7.2 Factorial Structure of the Five Factor Attitude Scale

Factor Number	1	2	3	4	5
Reliability	.85	.63	.65	.59	.45
Number of items	26	11	7	8	8

Scrutiny of the intercorrelations between the five factors, for the whole sample, shows that the squares of all these coefficients are well within the usually accepted .05 level of significance, table 7.3, below. Since the squares of product moment correlation coefficients represent the fraction of common variance between any two factors, it follows that for any two factors with a correlation $\leq$ .224 (whose square = .05), the hypothesis of significant common variance can be rejected at the .05 level. The top right hand triangle represents the actual intercorrelations of the five factors in table 7.3 below. The bottom left hand triangle represents their squares to the nearest 3 decimal places.

Table 7.3 Intercorrelations for the five factor solution

	NSF1	NSF2	NSF3	NSF4	NSF5
NSF1	1.000	.008	-.007	.010	.000
NSF2	.000	1.000	.004	.004	000
NSF3	.000	.000	1.000	.003	.005
NSF4	.000	.000	.000	1.000	.008
NSF5	.000	.000	.000	.000	1.000

7.1.1 NATURE OF THE FIVE FACTORS

The five factors were conclusively identified by the combined expertise of a seminar of about twenty fellow research students and staff, each of whom was provided with a list of items loading on each factor.

The significant loadings for each factor is shown on table 7.1.

Factor 1 (table 7.4)

It was difficult to select a single descriptor for this factor since it appeared somewhat heterogeneous.

There were groups of items appreciating skills and techniques, and others the benefit, or value, of taking up technical work and the enjoyment gained from it. VASTEC seems to be a suitable acronym.

Examples of items are:

Value of technical work: 'The knowledge gained in technical studies lessons will be of great benefit when I have my own home.'

Skills: 'All pupils should try to improve their technical skills.'

Techniques and enjoyment: 'Watching a casting poured, in metalwork, is fascinating.'

Thus, collectively this factor represents a strong pro-CDT stance.

Factor 2 (table 7.5)

This factor grouped together all items that were critical of technical work or the way that it was taught. CRITEC is the suggested descriptor.

Examples of items are:

'Technical studies could be more creative.'

'There are too many demonstrations in technical studies.'

Factor 3 (table 7.6)

All the items that were concerned with technical drawing were grouped together in this factor, and DRAWTEC appears to be a suitable descriptor.

Example:

' Technical Drawing is important and several jobs need it.'

FACTOR ONE(VASTEC) Table 7.4a

Item No.	Item Content	Loading
01	The skills learned in Technical Studies are a good investment for when you leave school.	59
02	Watching a good demonstration, in Technical Studies , is very interesting	48
03	Technical Studies is a welcome break from other lessons.	37
04	More visual aids should be used in Technical Drawing lessons.	33
05	There is too much machinery in the Technical Department.	30
07	All pupils should try to improve their Technical Skills.	53
09	We need more Technical Teachers	41
14	In Technical Studies you learn many different skills.	54
17	Watching a casting poured, in Metalwork, is fascinating.	35
18	Pupils who take Technical Studies usually do well in life.	36
19	Advances in technology will give us more leisure time.	31
22	The knowledge gained in Technical Studies lessons will be of great benefit when I have my own home.	59
24	The best part of Technical Studies is making things oneself.	51
27	I especially enjoy making projects that involve using the brazing hearth.	47

FACTOR ONE(VASTEC) Table 7.4b

Item No.	Item Content	Loading
29	A knowledge of Technical Studies helps you to make projects more cheaply than those bought in shops.	42
30	Technical Studies lessons are boring.	44
32	I enjoy making projects in wood.	38
33	After Mathematics and English, Technical Studies is the most useful subject.	43
34	Technical Studies subjects are too difficult.	33
35	To progress as a nation we must make advances in Technology.	38
39	It is very satisfying to produce a well-made project.	54
40	Learning about Technical Studies is not important to my Education.	48
42	Technology helps to create jobs in computer programming.	36
45	Advances in Technology make everyday life safer.	35
46	There should be more modern machinery in the Technical Department.	41
48	Learning about Technical Drawing is not important to my Education.	36

FACTOR TWO (CRITEC) Table 7.5

Item No.	Item Content	Loading
06	Technical Studies theoretical lessons are boring	36
10	There is too much Filing and Hacksawing in Metalwork lessons.	55
13	The projects in Technical Studies take too long to make.	45
17	Watching a casting poured, in Metalwork, is fascinating.	32
20	I like the fresh smell of wood being machined.	30
26	Technical Studies could be more creative.	41
30	Technical Studies lessons are boring.	40
35	To progress as a nation we must make advances in Technology.	34
37	There are too many joints to cut when making a piece of furniture.	63
43	There are too many demonstrations in Technical Studies.	30
44	Technical Drawing lessons are boring.	64

FACTOR THREE(DRAWTEC) Table 7.6

Item No.	Item Content	Loading
05	There is too much machinery in the Technical Department.	44
11	Technical Drawing is important because several jobs need it.	50
18	Pupils who take Technical Studies usually do well in life.	47
31	In Technical Drawing you learn many different geometrical constructions.	46
41	Technical Drawing lessons are enjoyable.	62
44	Technical Drawing lessons are boring.	55
48	Learning about Technical Drawing is not important to my education.	40

Factor 4 (table 7.7)

Comments on the effects of technology on society are grouped together in this factor, hence SOCTEC.

Example:

'Advances in technology are increasing the pace of life too much.'

Factor 5 (table 7.8)

The items in this factor indicated that technical work can be relaxing, providing the descriptor RELXTEC.

7.2 MERGING OF THE NEW FIVE FACTOR SOLUTION WITH ALL THE OTHER DATA

In order to compare the responses, made to the attitude questionnaire and other relevant items in the information questionnaire, it was decided to merge data together and then set up a computer programme to show how they correlated.

The first stage in this merging process was to establish the five factor scores for all the sample from their responses to the attitude questionnaire. The conversion of this data means that each factor of the five factor solution is perfectly uncorrelated, and given a similar range of scores irrespective of the number of items. these scores range from 0 - 20 with a mean of 10 and a standard deviation of 3.00

7.2.1 FAVOURITE FIVE

Item 25, in the information questionnaire, required the sample to list in order their five favourite subjects. The way that this item was worded produced ipsative scores. In order to respond to this item the sample had to make as many rejections of subjects as they made selections. The profile of ipsative scores describes the peaks and valleys of an individual's profile, using the individual as the reference point.

FACTOR FOUR(SOCTEC) Table 7.7

Item No.	Item Content	Loading
08	Advances in Technology will cause unemployment.	39
12	Modern Building Technology is producing too many ugly Town Centres.	47
21	Advances in Technology are increasing the pace of life too much.	59
23	Advances in Technology tends to make jobs boring.	56
25	Advances in Technology have produced too many cheap material things of low quality.	53
35	To progress as a Nation we must make advances in Technology.	36
41	Technical Drawing lessons are enjoyable.	36
43	There are too many demonstrations in Technical Studies.	31

FACTOR FIVE(RELXTEC))

Table 7.8

Item No.	Item Content	Loading
03	Technical Studies is a welcome break from other lessons.	39
08	Advances in Technology will cause unemployment.	31
15	Technical Drawing is an easy subject.	53
16	Technological advances, in the form of Robots to do basic tasks, could make us lazy.	40
28	It is not difficult to make the projects in Technical Studies lessons.	35
34	Technical Studies lessons are too difficult.	46
36	You can relax in Technical Studies.	34
47	There should be more demonstrations in Technical Studies.	40

Ipsative scores derived from forced ranking among the rest of the data with which correlations are required because the rest of the data is normative, i.e. the respondents are not forced to assign a different score, as they do in ranking, to every item which is contributing to the overall score on a variable. Correlating ipsative scores with other normative scores therefore leads to misleading results (Closs, 1976).

This problem, which was not initially realised, was overcome by obtaining normative scores from the 'favourite five' by totalling for each pupil the number of times a technical subject appeared in his or her list of five subjects. In all the sample schools pupils were usually limited to a maximum of two technical subjects therefore the range can be considered as 0 - 2, although there were six subjects to choose from. It was judged that this data could be converted to normative scores by recording the number of times, in the favourite five, a pupil selects a technical subject and then totalling them. This group of technical subjects was named TOTTS - total of technical subjects.

The total of technical subjects, within the favourite five, was then merged with the factor scores.

7.2.2 OTHER VARIABLES CONSIDERED RELEVANT

The attitude questionnaire contained two variables that were not included in the attitude factor analysis. These were: The example item. 'I enjoy Technical Studies', and the mathematical ability of the whole population.

There were many interesting responses to the items in the information questionnaire. These are discussed in some detail in Chapter 6, section 6.3)

7.3 SCRUTINY OF ALL CORRELATIONS

7.3.1 CORRELATIONS BETWEEN FACTORS OF SEPARATE GENDERS

Correlations between the factors were obtained for both gender groups and they are set out in tables 7.9 and 7.10.

The square of the product moment correlation coefficient represents the fraction of common variance between any two factors and the square root of .05 is .224. Only in one case out of the possible 20 correlations is the value of .224 exceeded, ie .304 for the girls correlation of CRITEC (Factor 2) and RELXTEC (Factor 5), and, thus, only in this case are we unable to reject the hypothesis of common variance between factors at the .05 level of significance, and, even here, the level of rejection is only .09. Thus, we can claim that the five factors are virtually orthogonal, and independent, after the sample is broken down into the separate genders, except in the case mentioned above.

Table 7.9 Correlations between the Five Factors for the Boys (N=301).

	VASTEC	CRITEC	DRAWTEC	SOCTEC	RELXTEC
VASTEC	1.0	.01 P=0.44	-.06 P=.15	.04 p=.24	-.10 P=.04
CRITEC	.01 P=.44	1.0	.04 P=.27	-.01 P=.42	-.07 P=.10
DRAWTEC	-.06 P=.15	.04 P=.27	1.0	-.02 P=.36	.02 P=.37
SOCTEC	.04 P=.24	-.01 P=.42	-.02 P=.36	1.0	.02 P=.35
RELXTEC	-.01 P=.04	-.07 P=.10	.01 P=.37	.02 P=.35	1.0

Table 7.10 Correlations between the Five Factors for the Girls (N=104).

	VASTEC	CRITEC	DRAWTEC	SOCTEC	RELXTEC
VASTEC	1.0	.01 P=.15	.10 P=.16	-.17 P=.05	.20 P=.02
CRITEC	.10 P=.15	1.0	-.11 P=.13	.08 P=.22	.30 P=.00
DRAWTEC	.10 P=.16	-.11 P=.13	1.0	.07 P=.25	-.06 P=.28
SOCTEC	-.17 P=.05	.08 P=.23	.07 P=.25	1.0	-.06 P=.29
RELXTEC	.20 P=.02	.30 P=.00	-.06 P=.28	-.06 P=.29	1.0

Note: P= indicates level of significance of a correlation of the magnitude stated above it, i.e. how significantly does a correlation of this magnitude with the sample size involved (boys = 301 and girls = 104) differ from a correlation of zero.

7.3.2 DIFFERENCES IN CORRELATIONS BETWEEN GENDERS

The majority of differences between correlations within the factors for each sex are not significant. However, two pairs of differences stand out between the sexes, namely VASTEC (Factor 1) and RELXTEC (Factor 5), where the girls' correlation is positive indicating that girls with an overall favourable attitude to technical studies also find the subject somewhat relaxing. Whereas, with boys, the correlation is negative indicating that a favourable attitude arouses some degree of tension. This may be due to the fact that more intelligent girls enjoy technical studies, whereas the less intelligent boys are inclined to continue with these studies, refer 'Relationships with Intelligence', section 7.5. With the other pair CRITEC (Factor 2) and RELXTEC (Factor 5), girls who are uncritical of technical studies find them comparatively relaxing, whereas for boys the opposite is the case, probably for the same reason.

7.3.3 OTHER QUANTITATIVE VARIABLES

The following variables obtained from the information questionnaire, scattered among 26 items which yielded useful but unquantifiable information about school technical subjects, were renamed for convenience in ensuring tables and their discussion.

TOTTS - the scoring of this variable has been fully discussed in section 7.2.1. Range 0-2.

FAMSKIL - Responses to the item: 'Is anyone in your family employed in a job requiring technical skills? Range 1-2 (No, Yes).

TUTS - 'Do you intend to take technical studies in the 4th year? Range 1-3 (No, Undecided, Yes).

TUTD - 'Do you intend to take technical drawing in the 4th year?'

Range 1-3 (No, Undecided ,Yes).

TCAR - 'Do you intend to take up a technical career?'

Range 1-3 (No, Undecided, Yes).

The other two variables were obtained when the attitude questionnaire was completed.

TSLIK - The example item: 'Do you enjoy technical studies?'

Range 1-5 (Strongly disagree to Strongly agree)

MATH - Mathematical ability. Range 1-7 (Remedial to Very good)

7.3.4 GENDER DIFFERENCES IN MEANS OF ATTITUDE SCORES AND OTHER VARIABLES

The means (M) and standard deviations (SD), for the separate sexes, are given in Table 7.11, with significance of the difference between the means.

The only factor with a significant gender difference is factor 1(VASTEC), indicating a far greater enjoyment and appreciation of the value and skills of technical studies among boys. This is reflected in the similar significantly higher scores on TOTTS - the higher ranking of technical subjects among boys; TUTS, their greater intention of taking technical studies in later years, and TCAR their intention of taking up a technical career.

In spite of this, it will be seen, in table 7.12, that the actual correlations of these variable scores with VASTEC does not differ significantly for the sexes, with the exception of TSLIK where the girls' correlation is significantly higher. These correlations are all positive and significant apart from TOTTS, and it is these correlations which provide validatory evidence for VASTEC.

Table 7.11 Difference between Means for the Sexes

Variable	Range	Boys		Girls		t- test	
Factors		M	SD	M	SD	t	p <
1 (VASTEC)	0-20	10.62	2.81	8.14	2.81	7.78	.001
2 (CRITEC)	0-20	9.88	3.14	10.28	2.62	-1.15	ns
3 (DRWTEC)	0-20	10.06	3.10	9.78	2.74	0.81	ns
4 (SOCTEC)	0-20	10.12	3.03	9.69	3.11	1.24	ns
5 (RELXTEC)	0-20	10.03	3.05	9.61	2.81	1.60	ns
Other Variables							
TOTTS	0-2	1.07	0.79	0.20	0.53	12.6	.001
MATHS	1-7	3.89	1.68	4.37	1.58	2.62	.01
TSLIK	1-5	4.14	0.89	3.33	1.06	7.06	.001
TUTS	1-3	2.46	1.10	1.44	1.02	8.53	.001
TUTD	1-3	2.36	1.80	1.98	2.36	1.05	ns
TCAR	1-3	2.22	0.93	1.51	0.75	7.75	.001
FAMSKIL	1-2	1.69	0.74	1.69	0.87	0.02	ns
INTELLIGENCE	0-10	6.32	1.53	6.72	1.69	-1.25	ns

Key to descriptors

TSLIK - Liking for Technical Studies

TOTTS - Total number of Technical Subjects in Favourite Five

FAMSKIL - Family member in work requiring technical skills

TUTS - Intending to take Technical Studies in the 4th year

TUTD - Intending to take Technical Drawing in the 4th year

TCAR - Intending to take a technical career

MATHS - Ability in Mathematics

INTELLIGENCE - see section on 'Relationships with Intelligence'

Table 7.12 Relationships between Attitude to Technical Subjects Scores and Questionnaire Variables

Girls N = 104

	TSLIK		TOTTS	FAMSKIL	TUTS	TUTD	TCAR	MATHS
VASTEC	558*	(F1)	027	061	343	-034	318	+293
CRITEC	321	(F2)	067*	119	051*	104	-034*	+253*
DRWTEC	308	(F3)	340	010	054	041	125	-122
SOCTEC	199	(F4)	126	-043	196	030	-182*	+240
RELXTEC	404*	(F5)	-073	168*	111	128	-205	+392

Boys N = 301

	TSLIK		TOTTS	FAMSKIL	TUTS	TUTD	TCAR	MATHS
VASTEC	341	(F1)	179	005	360	-024	177	+084
CRITEC	438	(F2)	300	205	319	139	298	-037
DRWTEC	259	(F3)	266	028	079	125	246	-164
SOCTEC	066	(F4)	086	031	028	123	091	+192
RELXTEC	146	(F5)	-031	-146	051	-028	-070	+255

Notes:

1. Decimal points omitted
2. In the case of a significant difference at the .05 level or better between the girls correlation and the corresponding boys correlation the upper, ie girls correlation, is starred.
3. In the case of girls no correlation < .192 is significantly different to zero at the .05 level and in the case of boys, because of the larger number, the corresponding threshold value is .113.

On the other hand, the means of the other five factor scores do not exhibit significant gender differences. Nor does FAMSKIL - the amount of technical skills within the family, or, more surprisingly, TUTD, the intention to study technical drawing in future years, nor does 'intelligence' differ between the sexes.

7.3.5 RELATIONSHIPS BETWEEN THE ATTITUDE SCALES AND OTHER QUANTITATIVE VARIABLES

The scores on each of the five attitude scales were converted to factor scores, with a range of 1-20; they were perfectly uncorrelated. These scores were correlated with the quantifiable scores from the questionnaire data itemized previously. Since the latter data was on short scales, the product moment correlations were underestimates, and were corrected using divisors suggested by Guilford and Fruchter (1978). The correlations are shown in table 7.12.

7.3.6 FACTORS 1 (VASTEC) AND FACTOR 2 (CRITEC)

VASTEC is significantly more strongly related to liking for technical studies (TSLIK) for girls (r=.558) than for boys (r=.341) (P=.05). There was a significantly weaker relationship between mathematical ability (MATH) for boys (r=.084), not in itself significantly different to zero, than for girls (r=.293). The difference is significant at the .05 level. Scores on CRITEC, and the preference for technical subjects indicated by the TOTTS score, are significantly more strongly related for boys (r=.300) than girls (r=.067), indicating that the girls' liking for technical subjects is appreciably less specifically based than that of the boys. This contention is supported by the significantly (p=.01) stronger relationship between the boys intention to take up a technical career (TCAR), and a critically favourable view of technical subjects as evinced by CRITEC correlations (r =.298), as against the negative but insignificant relationship for girls (r=.-034).

As with VASTEC, the critically favourable view of technical subjects is positively associated with mathematical ability (MATH) (r=.253) for girls, although, with boys, there is virtual independence between the two variables (r=-.037). This gender difference is only significant at the .10 level, however.

7.3.7 FACTOR 3 (DRAWTEC)

This factor reveals no significant gender differences in its correlating variables.

7.3.8 FACTOR 4 (SOCTEC)

There is only one gender difference, (p =.05), in the relationships between a favourable view of the social value of technical subjects and the choice of a technical career. These two are negatively related for girls (r=-.182), and slightly positively related for boys (r=.091). This may be due to the girls almost blanket rejection of technical careers, in spite of liking the subject and a favourable family background.

7.3.9 FACTOR 5 (RELXTEC)

Liking for Technical Studies (TSLIK) had a stronger relationship with RELXTEC for girls (r=.404) than boys (r=.146). Family experience of technical skills (FAMSKIL) had a fairly strong positive association, with girls finding technical subjects relaxing (r=.168), whereas with boys it apparently led to slight tension (r=-.146). The gender difference was significant at the .01 level.

7.3.10 INTERCORRELATIONS BETWEEN ALL THE QUANTITATIVE QUESTIONNAIRE VARIABLES

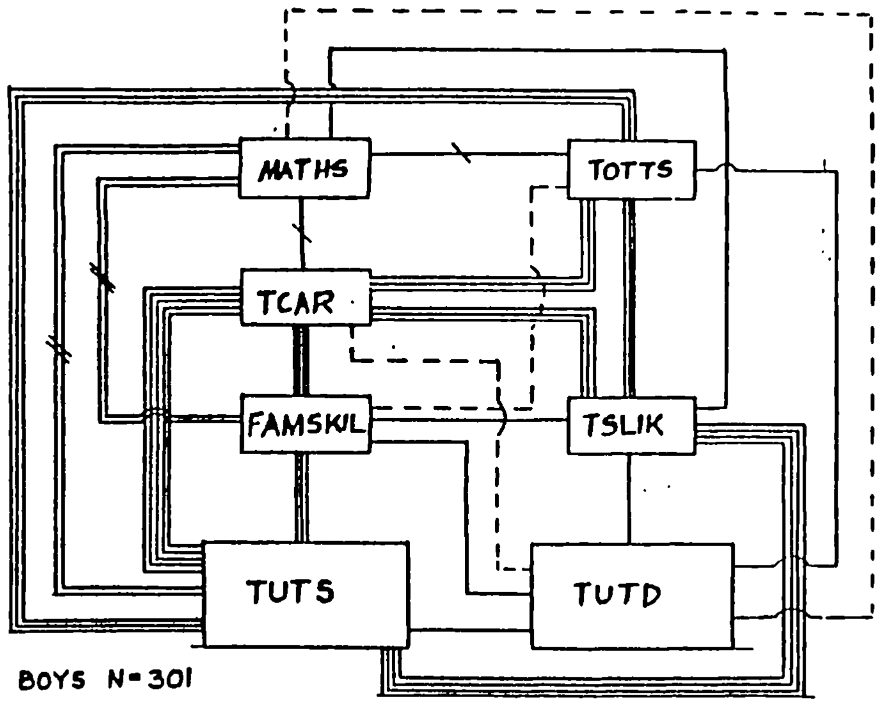
Table 7.13 and figure 7.1 show these relationships diagrammatically. These have been discussed in section 7.3.3. They all have short scales, so the corrections for attenuation of the range has been applied, as previously, according to Guilford and Fruchter.

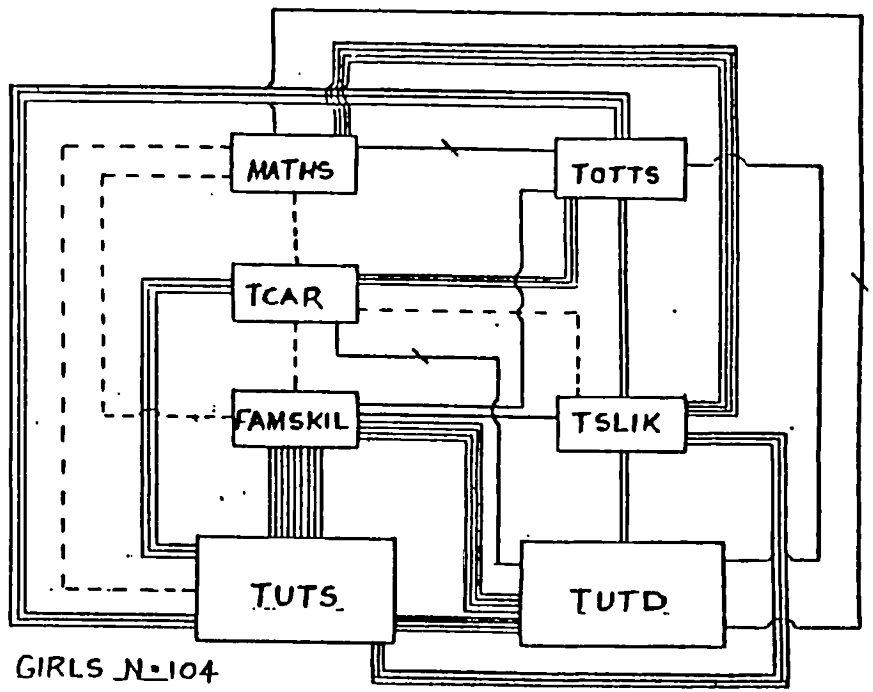
Table 7.13 Intercorrelations between all the Quantitative Variables for the Separate Sexes

Girls / Boys	TSLIK	TOTTS	FAMSKIL	TUTS	TUTD	TCAR	MATHS
TSLIK		342	120	447	072	296	078
TOTTS	161		-026	341	115	288	-140
FAMSKIL	115	063		340	090	441	-250
TUTS	343	256	859		069	521	-157
TUTD	177	078	441	432		028	001
TCAR	010	305	027	267	-141		-122
MATHS	425	-122	015	001	-133	025	

Notes:
1. Decimal Points omitted
2 See note 3 table 7.12
3 Meanings of descriptors (TSLIK etc. as in table 7.11

Figure 7.1 Diagrammatic Representation of Contrasting Strengths of Relationships between Questionnaire Variables for Separate Sexes





Notes: (1) Negligible correlation -----

(2) Negative correlation

(3) Magnitude of correlation rounded to first decimal place represented by the number of connecting lines

e.g. corresponds to .351 - .450

(4) Meanings of decriptors (TUTS etc.) as in table 7.11

(1) Correlations between TOTTS, based on the number of preferred technical subjects and straightforward liking for technical subjects (TSLIK), are significantly stronger for boys (r=.342) as against (r=.161) for girls.

(2) By far the greatest difference, between the sexes, is in the TUTS-FAMSKIL relationship, which, for boys, is in itself considerable (r=.340), whilst, for girls, the value of r rises to .859, a difference significant at $p=10^{-8}$! Thus, the presence of technical skills in the family is, by far, the most potent influence on girls taking up technical subjects.

Yet it would appear from chapter 6, section 6.3.2.12 and figure 6.11, that there was no significant difference between the sexes in the proportion of the two sexes who had members of their families employed in technical work.

(3) Again, taking up technical drawing (TUTD) is far more strongly related to family technical skills (FAMSKIL), in the case of the girls, (r=.441) , than with the boys, where it is negligible (r=.090). The difference being significant at the .001 level.

This may also be connected with the fact (chapter 6, section 6.3.2.7 and figure 6.10), that girls, significantly more so than boys, would prefer to spend more time doing technical drawing.

(4) When we turn to proposed choice of a technical career and family experience (TCAR - FAMSKIL), the relationship remains potent (r=.441) for boys only. This is possibly due to technical skills residing mainly in the males of the family and the boys, but not the girls, being inclined to imitate the male pattern. This connection is noted in Australia (Ainley and Clancy, 1983).

(5) Connected with this we find that, in the case of girls, liking for technical studies (TSLIK) has a negligible correlation with intention to take up a technical career (TCAR) (r=.010), whereas, with boys the relationship is positive and significant but not strong (r=.296).

(6) Liking for technical studies, in the case of girls, is significantly positively related to mathematical ability (r=.425), but not for boys where the relationship is insignificant (r=.078).

(7) Family technical experience (FAMSKIL) has a negligible relationship with mathematical ability, in the case of girls, (r=.015) with a low, but significantly negative, one for boys (r=-.250),(p =.05).

Boys difficulties with mathematics may account for their tendency to find tension in CDT, as opposed to the relaxation revealed by girls in RELXTEC scores.

7.4 DIFFERENCES BETWEEN INTENDING TO TAKE TECHNICAL STUDIES (TUTS) AND INTENDING TO TAKE TECHNICAL DRAWING (TUTD),(Table 7.14).

For both boys and girls the correlations for intending to take technical studies (TUTS) with all the other variables in the group: Liking for technical studies - naturally - (TSLIK); family connections with technical work (FAMSKIL) and thinking of a technical career (TCAR) are all significantly higher than those for taking up technical drawing. Although the sex differences are not statistically significant, except that the correlation of FAMSKIL with TUTD is far higher for girls, there is a reversal in the correlations shown with these two variables and mathematical ability. Weak mathematical ability being related to intending to take up technical studies (TUTS) for boys, and intending to take up technical drawing (TUTD) for girls.

Table 7.14 Contrasts in correlations between Taking up Technical Studies and Technical Drawing for the Separate Sexes

	TSLIK	TOTTS	FAMSKIL	TCAR	MATHS
TUTS (Boys)	447	341	340	521	-157
TUTD (Boys)	072	115	090	028	001
TUTS (Girls)	343	256	859	267	001
TUTD (Girls)	177	078	441	-141	-133

Notes: (1) Decimal points omitted
(2) See note 3, table 7.12
(3) Meanings of descriptors, (TSLIK, etc.) as in table 7.11

It would appear, therefore, that for both sexes the reactions to technical studies are different from those to technical drawing, although the means of the sexes for TUTD and DRAWTEC are not significantly different.

It was also noted in chapter 6, section 6.3.2.7 and figure 6.10, that a significantly higher proportion ($p = 10^{-5}$) of girls would like to spend more time doing technical drawing . This response, together with their higher proportion than boys indicating interest in technical drawing, are the only instances in the questionnaire of girls evincing a greater interest in aspects of CDT.

7.5 RELATIONSHIPS WITH INTELLIGENCE

Although it was not possible to administer a standard intelligence test, Cattell's HSPQ contains a factor B labelled 'intelligence' which is, in fact, a verbal intelligence measure which had a reliability of .59 when it was administered to 105 (62 boys and 43 girls) pupils within the main sample. This showed no significant differences between the sexes, table 7.11.

Cattell's factor 'B' was correlated with the five factor scores for each sex. For boys all five correlations were negligibly low, but for girls four of the five correlations were significant at the ,05 level, namely:

VASTEC	CRITEC	DRAWTEC	SOCTEC	RELXTEC
.28	.26	-.09(NS)	.33	.38

With the quantifiable variables most correlations with Cattell's intelligence measure were low and non-significant. As might be expected, however, the correlations with mathematical ability were significant at .21 (p=.05) for boys and .55 (p=.001) for girls.

Intention to take up technical studies in the 4th year correlated significantly with intelligence at -.31 (p=.001) for boys but the corresponding coefficient for girls was negligible at .01. On the other hand, the correlation between boys liking for technical studies (TSLIK) and intelligence was negligible, but the corresponding coefficient for girls was .40 which is fairly high and highly significant (p =.005). Thus, it would seem that technical studies are attracting less intelligent boys for further study, but it is the more intelligent girls that express a liking for technical studies albeit with negligible intention to pursue them further.

7.6 RELIABILITY OF THE ATTITUDE QUESTIONNAIRE

7.6.1 TEST - RETEST

Three years after the attitude questionnaire was administered to 405 pupils in seven schools, it was decided to conduct a reliability check on the questionnaire.

In one of the sample schools during 1985 the attitude questionnaire was administered to 114 pupils, under similar conditions to those of 1982 when the original research testing was done.

Seven days after the first administration of the attitude questionnaire, in 1985, the group repeated the questionnaire. A total of 88 pupils completed the two tests, (many missed the second test due to school visits and illness)

Both questionnaires were scored and the first one was referred to as the 'pre-test' and the second as the 'post-test'. The scores of each pupil on the 'pre-test' was correlated with his or her score on the 'post-test' and the overall correlation was .77. This is reasonable, although above the reliability of factors 2 - 5 in table 7.2. However the reliability of the first factor is .85 and this factor contains over half the items in the test and will influence the overall reliability more than any other factor.

7.7 OVERVIEW

Girls are favourably inclined towards technical work at 3rd-year level, and find the subject relaxing. They are not as highly critical of the subject as the boys, who demand more stimulus from CDT. Many girls appear to gain support for liking technical work from a family member with technical skills.

(This area was suggested as a possible source for investigation by Page and Nash (1980) in the conclusions of their survey on 'Teenage Attitudes to Technology and Industry'. "..factors outside this survey which might have considerable impact on attitudes to technology and industry. The influence of home background, parental occupation and teachers' attitudes might all prove fruitful areas for investigation".) This influence seems to ebb away when careers in technical work are considered, especially those in technical drawing. This is curious, since most other correlations for girls in respect to taking up technical drawing are higher than the corresponding ones for boys.

Although boys are very favourably inclined towards technical work at the 3rd-year level, they do not find it as relaxing as the girls do. They, in fact, express some signs of tension which could well be because of the association of boys intending to take up technical studies with weakness in mathematics and intelligence. Boys enjoy a wider range of CDT subjects as shown by the responses to the five favourite subjects (TOTTS). Also, boys demonstrate a much greater intention than girls to continue with technical work after leaving school.

Technical Studies and Technical Drawing appear to be subjects within the CDT area that do not gain similar support. There appear to be weaker, or negiglible, relationships with the other variables in the case of taking up technical drawing.

The latest moves within the new GCSE CDT examinations should help to encourage pupils towards a greater interest in graphacy, since all the subjects have a common design and technological theme incorporated in them. Sex differences emerge throughout the findings of this study, indicating that the sexes may need different treatment in this as in other areas of study, e.g. science (Ormerod with Duckworth, 1975).

7.8 CHAPTER 8

7.81 INDENTIFICATION OF THE FACTORIAL STRUCTURE OF THE HPSQ

The chapter reviews other studies that have used models of personality. It then shows how the factorial structure was set up for this study.

CHAPTER 8 THE IDENTIFICATION OF THE FACTORIAL STRUCTURE OF THE HSPQ IN THIS STUDY (SAMPLE 191) BY ITEM ANALYSIS

CHAPTER 8 LIST OF FIGURES AND TABLES

PAGE NO.

8.0 THE IDENTIFICATION OF THE FACTORIAL STRUCTURE OF THE HSPQ IN THIS STUDY (SAMPLE 191) BY ITEM ANALYSIS

8.1 INTELLIGENCE FACTOR

In the factor analysis of the item scores on this and other studies at Brunel University , Ormerod and Billing 1982; Carroll 1982; Asiedu 1986 (ongoing) McKenzie 1987 (ongoing); and this study, the 10 verbal intelligence items (Cattell's primary trait B) have been omitted. The reason for this is that they always seem to separate out as an independent factor which complicates the factor analysis. Intelligence is however, always regarded as a component of personality. Therefore, when discussing say a five or six factor solution from a factor analysis described here, it is implicit that the additional factor must be added. Thus, intelligence will in effect provide an extra factor giving a six or seven factor model of personality overall.

8.1.1 PREVIOUS STUDIES IN THIS FIELD

Table 8.1 summarises various other studies which have yielded six or less factors (except for Cattell himself who claimed at one stage to have obtained eight factors by second order factor analysis of his adult 16PF data).

Table 8.2 contains other studies mainly conducted at Brunel University by Ormerod and his students. Both tables 8.1 and 8.2 distinguish the factors by 'Markers', i.e. positive or negative loadings of three or more items from the same Cattell primary trait although the signs may be reversed in different studies.

An example of this is:

Tender v Tough mindedness (psychoticism): I+ v. E-

Neuroticism v Stability : D+ v. C- Q4+

Table 8.1

Reproduced from a paper entitled 'A Six Orthogonal Factor Model of Adolescent Personality derived from HSPQ', by Ormerod and Billing, (1982 Personality and Individual Differences 3, pp107 - 117)

Models of personality related to Cattell's second-order factor structure of the 16 PF

Model								
Cattell's 16 PF	Introversion–extraversion (A+, E+, F+, H+, Q2–)	Low vs high anxiety C–, H–, L+, O+, Q3–, Q4+	Sensitivity vs tough poise A–, I–, M–, E+, L+	Dependence vs independence E+, L+, M+, Q1+, Q2+	Naturalness vs discreetness (N+, A+, M–, O–)	Cool realism vs prodigal subjectivity (I+, M+, L–)	Low vs high intelligence (B+)	Low vs high superego strength (G+, Q3+, F–)
Warburton (1968)	Introversion (1) (A–, F–, H–)	Anxiety/neuroticism (C–, D+, L+, O+, Q3–, Q4+)	Tendermindedness (I+, N–)	Introversion (2) (E+, Q2)		Radicalism (M+, Q1+)		Morality (G+)
Howarth* (1976)	Surgency	Emotional stability	Co-operative-considerate	Extraversion		Emotional maturity		Superego
Saville† (1978)	Group adherence (males: A+, F+, Q2– females: F+, Q2–)	Anxiety (C–, O+, Q4+)		Dominance-assertiveness (E+, L+, H+, N–)		Tendermindedness (I+, M+)	Intelligence (B+)	Superego strength (G+, Q1–, Q3+)
	FOR COMPARISON:							
Eysenck and Eysenck (1975)	Introversion–extraversion	Neuroticism-stability	Psychoticism (toughmindedness)			Psychoticism (toughmindedness)		
Ormerod *et al.* (1981) (HSPQ)	Classical introversion (A+, F+, H+, J+)	Anxiety-neuroticism (C–, D+, Q4+)	Toughmindedness (I–, E+)	Non-classical extraversion (A+, J–, Q2–)			Intelligence (B+)	Careful–careless (F+, G–, Q3–)

* Howarth's (1976) model is not based on the 16 PF but on an unrotated factor solution of Cattell's (1947) rating study.

† Saville reports six factors as above but reports that, with females, a seventh factor of warmheartedness separates from the A+, F+, Q2– factor which Saville terms 'Group Adherence'.

Table 8.2 Studies conducted at Brunel University by Ormerod and his students

Author	Year	No of Factors	1	2	3	4	5	6	7	8
Ormerod and Billing	1982	5	2,Q2,A- J(0,79)	4,D-,Q4- C(0,75)	1,I,E- (0,75)	3,H-,F- A-(0,76)				5,6-Q3- (,70)
Asiedu	1985	5	2,Q2-,A- H(0,88)	1,Q4,D, H-(0,86)	5,I,E- (0,71)	4F,H (0,76)				3,6,Q3 F-(0,78)
Carroll	1982	5	1,Q2,A., +I(0,88)	2,Q4,A- H-,D+ (0,86)	4,I,E- (0,74)	5,H,F+ J+(0,74)				3,6,Q3 F-(0,76)
Waller	1985	5	4,Q2-H, F-(0,74)	6,D,C- Q4(0,78)	9,I-,E, (0,84)	2,A,H, (0,70)				4,6,F-, Q3(0,76)
McKenzie	1987	5	(6E,(L)) ((Q1)) (0,71)	1,Q4,D C-H- (0,89)	5,I(M) (0,73)	2,A,H F,Q2 (0,84)				3,6,F- Q3(0,82)
Identity			People -Thing	Neurotic -Stable	Tender -Tough	Classical Extraversion			Intell -igence	Conscient ious

Notes; 1-The first number gives the order of the factors extracted ,
2-The number in brackets refers to the reliability,
3-All on HSPQ except Mckenzie which is on 16PF,

The consensus of tables 8.1 and 8.2 is for a six factor solution when intelligence is included as the 'silent' factor in all studies where it is not explicit.

8.1.2 THE BRAND OSGOOD SIX FACTOR MODEL OF PERSONALITY (Brand 1984)

Recently Chris Brand (1984) has suggested a wide ranging six factor model of personality embracing the work of no less than 14 sets of authors (table 8.3) including Cattell, Eysenck, Guilford and Ormerod and Billing.

Brand starts with Osgood's three major dimensions of personality (table 8.4) represented conically with adjectives which tend to define them.

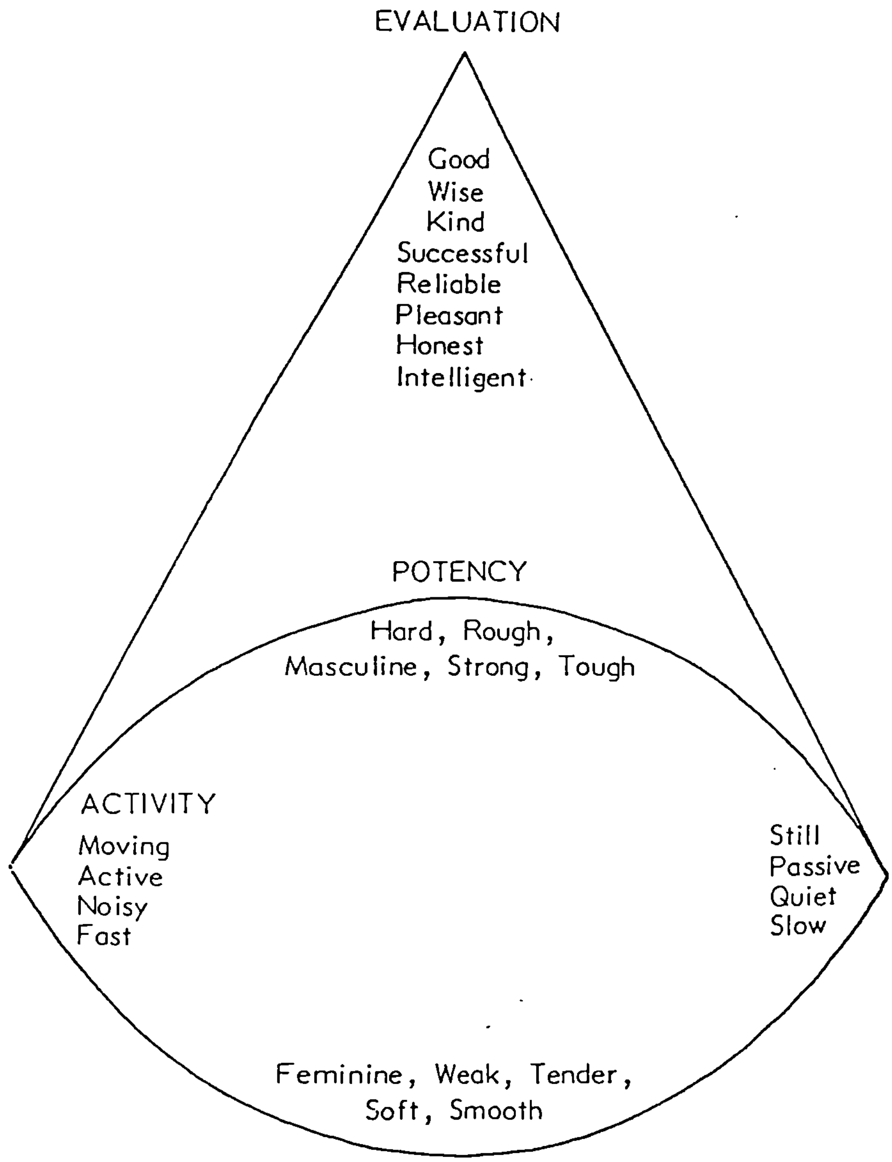
On the basis of the cone we have descriptors opposite POTENCY and ACTIVITY which describe the converse of these traits and these four sets of descriptors on the base represent other personality descriptors distinct from, but not necessarily antithetical to, those connected with evaluation at the apex of the cone.

Brand bases his classification of six aspects of personality by representing three pairs of putative dimensions of personality as aspects of Osgood's three dimensions of meaning:

Table 8.3 Personality studies reviewed by Brand (1984)

Brand (see text)			
ENERGY (e)	WILL (w)	CONSCIENCE (c)	AFFECTION (a)
Cattell and Kline			
EXVIA Surgency Boldness Affiliation	INDEPENDENCE Self-sufficiency Dominance Radicalism	GOOD BREEDING Superego Self-control 'Anality'	PATHEMIA Tendermindedness Trust Affiliation
Eysenck			
EXTRAVERSION Sociable Lively		CONSERVATISM 'LIE' SCALE -Impulsiveness	TENDERMINDEDNESS -PSYCHOTICISM
Guilford			
SOCIAL ACTIVITY Sociability General Activity Ascendance		INTROVERSION Restraint Reflectiveness	-Paranoid disposition Co-operative
Comrey Personality Scales			
SOCIAL EXTRA-VERSION ACTIVITY	MASCULINITY (vs EMPATHY)	ORDERLINESS, CONFORMITY	EMPATHY, TRUST
California Personality Inventory			
SOCIAL EXTRA-VERSION	INDEPENDENT THOUGHT	CONVENTIONALITY	SENSITIVITY
Jackson Personality Research Form			
ASCENDANCE	INDEPENDENCE	INFANTILE CONTROL	AESTHETIC-INTELLECTUAL ORIENTATION
Edwards Personal Preference Schedule			
Exhibition (Dominance)	Autonomy Aggression -Abasement	Order -Deference Endurance (= persistence)	Nurturance Affiliation (-Achievement)
Grygier's Dynamic Personality Inventory			
Phallic Scales (= excitement seeking)	Oral Aggression Initiative	Anal Scales (= liking for order)	Oral dependence Feminine interests
Howarth, 1976 (2)			
(2) SURGENCY Energetic Cheerful Talkative	(3) Independ-ent, Strong-willed, Analytical (4) Self-contained	(5) SUPEREGO Responsible Conventional Conscientious	(1) CONSIDERATION CO-OPERATIVE Other-oriented Tender-hearted
Forbes, 1980 (1)			
(1) EXTRA-VERSION Sociability Dominance, Optimism	(4) SELFISH-NESS (-Empathy)	(5) ORDERLINESS (6) CONFORMITY	(2) CYNICISM Accept others Trust
Rushton and Chrisjohn, 1981			
EXTRAVERSION Sociable Affiliative Exhibitionistic	TOUGH AUTONOMY (-Succorance -Abasement -Nurturance)	HARD WORK Achievement Order Endurance, Play	OPEN-NESS TO EXPERIENCE Sentience Understanding
Ormerod and Billing, 1982			
CLASSIC EXTRAVERSION Zestful Surgent Adventuresome	NON-CLASSIC EXTRAVERSION Self-sufficient Aloof Individualistic	CONSCIENTIOUS CAREFUL -EXPEDIENT Superego Self-control	TENDERMINDEDNESS Submissive
Kline and Cooper, 1983			
EXTRAVERSION Surgent Adventuresome	MASCULINE DOMINANCE Suspicious Coarse Radical	OBSESSIONALITY Fascism Militarism Superego Anality, Self-control, -Psychoticism	-MACHIAVELLIANISM Anti-hedonistic Tender-minded -Psychoticism
Nowlis Mood-Adjective Checklist (e.g. Johnstone and Hackman, 1977)			
Lively Depressed	Confident -Fearful	Alert -Fatigued -Casual	Affectionate -Hostile

Table 8.4 From Brand,C.R.(1984), Personality Dimensions: An Overview of Modern Trait Psychology in Nicholson, J and Halla Beloff, Pyschology Survey 5 , Leicester: British Psychology Society.



Osgood's dimensions of meaning	Putative Psychometric dimensions of personality
EVALUATION	general intelligence(g)
	stability v neuroticism(n)
POTENCY	will(w) ,independence
	affection(a) ,sensitivity
ACTIVITY	energy(e) ,responsiveness
	conscience(c) ,carefulness

He claims that the first two dimensions: general intelligence (g) and stability v. neuroticism (n) are so well defined and have been for so long generally accepted that they can be taken as components of all the 14 models of personality listed in table 8.3 without including them in that table. He then goes on to suggest that these 14 authors' models of personality can have three or four other aspects of personality which he classifies under the other four identifications he has derived from Osgood's POTENCY and ACTIVITY, which he puts at the head of his table, i.e. respectively: energy (e), will (w), conscience (c) and affection (a).

These aspects of personality identify with the four traits found in this study and the Ormerod and Billing, Carroll, McKenzie and Asiedu studies as:

(1) Classical extroversion

(2) Non Classical introversion (preference for things and ideas rather than people)

(3) Conscientious-careful v lax expedient- (superego)

(4) Tender/Tough-mindedness

In his table Brand uses capitals for titles of author's dimensions as named by them and giving the author's factor numbers in some cases. Lower case is used to indicate components that load on the putative dimensions. Such components in brackets indicate a reversal to fit the authors relevant dimension.

Although not tied in with the rigour that the dimensions in this study have been, since they are related to Cattells dimensions and the other studies in table in 8.1 and 8.2, this collection of studies underlines how widespread is the concept of six dimensions of personality. Thus, it provides further justification for the findings of this study and the other studies by Ormerod and Billing, Carroll Asiedu and McKenzie.

8.2 THE MODEL OF PERSONALITY PROPOSED IN THIS STUDY

8.2.1 FIVE FACTOR MODEL

This is a five factor model (plus intelligence - Cattell's trait B- making a six factor model in all), obtained by factor analysis followed by varimax rotation on the SPSSx1 package and selecting items with loadings ⩾.30 for inclusion.

These items are identified by their Cattell primary trait A to Q4 plus a number from 1 to 10 for the component of the trait, e.g.Q4 6.

The descriptors of the traits are given in Table 8.5 and are Cattell's own. Table 8.6 relates these items to their own item numbers from 2 to 141 on the version of the HPSQ. The five factor solution obtained by the factor analysis and varimax rotation (excluding intelligence) is given in tables 8.10a and b. The items loading on each factor can be divided into two classes: 'markers' and 'stragglers' as shown in table 8.11. 'Markers' are items mostly three or more in number which are derived from single traits. They are so named because they occur again and again in factorial analysis of the HPSQ as shown in table 8.2 as distinguishing indicators for certain well defined psychological aspects of personality i.e. in this study:

I-, E+	Tough v. Tender-mindedness
D+, C-, (Q4+)	Neuroticism v. Stability
F-, G+, (Q2+)	Controlled , conscientious v. Lax expedient
Q2-, H+, F+	People v. Things (Non-classical extroversion)
A-, (H+), (F+)	Classical extroversion v. Introversion

Certain markers only appear as two items in this study but are classed as 'markers' because they appear as more than two items in more than one other study.

Table 8.5 Cattell's descriptors of the 14 primary traits

Jr.-Sr. H S P Q TEST PROFILE

LOW SCORE DESCRIPTION		HIGH SCORE DESCRIPTION
RESERVED, DETACHED, CRITICAL, ALOOF, STIFF (Sizothymia)	A	WARMHEARTED, OUTGOING, EASY-GOING, PARTICIPATING (Affectothymia, formerly cyclothymia)
DULL, CONCRETE-THINKING (Lower intelligence)	B	BRIGHT, ABSTRACT-THINKING (Higher intelligence)
AFFECTED BY FEELINGS, EMOTIONALLY LESS STABLE, EASILY UPSET, CHANGEABLE (Lower ego strength)	C	EMOTIONALLY STABLE, MATURE, FACES REALITY, CALM (Higher ego strength)
UNDEMONSTRATIVE, DELIBERATE, INACTIVE, STODGY (Phlegmatic temperament)	D	EXCITABLE, IMPATIENT, DEMANDING, OVERACTIVE, UNRESTRAINED (Excitability)
OBEDIENT, MILD, EASILY LED, DOCILE, ACCOMMODATING (Submissiveness)	E	ASSERTIVE, AGGRESSIVE, COMPETITIVE, STUBBORN (Dominance)
SOBER, TACITURN, SERIOUS (Desurgency)	F	ENTHUSIASTIC, HEEDLESS, HAPPY-GO-LUCKY (Surgency)
DISREGARDS RULES, EXPEDIENT (Weaker superego strength)	G	CONSCIENTIOUS, PERSISTENT, MORALISTIC, STAID (Stronger superego strength)
SHY, TIMID, THREAT-SENSITIVE (Threctia)	H	ADVENTUROUS, "THICK-SKINNED," SOCIALLY BOLD (Parmia)
TOUGH-MINDED, REJECTS ILLUSIONS (Harria)	I	TENDER-MINDED, SENSITIVE, CLINGING, OVER-PROTECTED (Premsia)
ZESTFUL, LIKES GROUP ACTION (Zeppia)	J	CIRCUMSPECT INDIVIDUALISM, REFLECTIVE, INTERNALLY RESTRAINED (Coasthenia)
SELF-ASSURED, COMPLACENT, SECURE, PLACID, SERENE (Untroubled adequacy)	O	APPREHENSIVE, SELF-REPROACHING, INSECURE, WORRYING, TROUBLED (Guilt proneness)
SOCIABLY GROUP-DEPENDENT, A "JOINER" AND SOUND FOLLOWER (Group dependency)	Q_2	SELF-SUFFICIENT, PREFERS OWN DECISIONS, RESOURCEFUL (Self-sufficiency)
UNCONTROLLED, LAX, FOLLOWS OWN URGES, CARELESS OF SOCIAL RULES (Low self-sentiment integration)	Q_3	CONTROLLED, EXACTING WILL POWER, SOCIALLY PRECISE, COMPULSIVE, (High strength of self-sentiment)
RELAXED, TRANQUIL, TORPID, UNFRUSTRATED, COMPOSED (Low ergic tension)	Q_4	TENSE, FRUSTRATED, DRIVEN, OVERWROUGHT, FRETFUL (High ergic tension)

Table 8.6 Relationship between HPSQ Item numbers and Trait numbers

A1 = 2	C1 = 4	D1 = 7	E1 = 8	F1 = 10	G1 = 11	H1 = 12
A2 = 3	C2 = 5	D2 = 27	E2 = 9	F2 = 29	G2 = 31	H2 = 32
A3 = 22	C3 = 6	D3 = 46	E3 = 28	F3 = 30	G3 = 51	H3 = 52
A4 = 42	C4 = 25	D4 = 47	E4 = 48	F4 = 49	G4 = 71	H4 = 72
A5 = 62	C5 = 26	D5 = 66	E5 = 68	F5 = 50	G5 = 90	H5 = 92
A6 = 82	C6 = 45	D6 = 67	E6 = 88	F6 = 69	G6 = 91	H6 = 93
A7 =102	C7 = 65	D7 = 86	E7 =107	F7 = 70	G7 =110	H7 =112
A8 =103	C8 = 85	D8 = 87	E8 =108	F8 = 89	G8 =111	H8 =113
A9 =122	C9 =105	D9 =106	E9 =127	F9 =109	G9 =130	H9 =132
A10=132	C10=125	D10=126	E10=128	F10=129	G10=131	H10=133

I1 = 13	J1 = 14	O1 = 16	Q2 1 = 17	Q3 1 = 19	Q4 1 = 20
I2 = 33	J2 = 15	O2 = 36	Q2 2 = 18	Q3 2 = 39	Q4 2 = 21
I3 = 34	J3 = 35	O3 = 56	Q2 3 = 37	Q3 3 = 59	Q4 3 = 40
I4 = 53	J4 = 55	O4 = 57	Q2 4 = 38	Q3 4 = 79	Q4 4 = 41
I5 = 54	J5 = 75	O5 = 76	Q2 5 = 58	Q3 5 = 80	Q4 5 = 60
I6 = 73	J6 = 95	O6 = 77	Q2 6 = 78	Q3 6 = 99	Q4 6 = 61
I7 = 74	J7 =115	O7 = 96	Q2 7 = 98	Q3 7 =100	Q4 7 = 81
I8 = 94	J8 =116	O8 = 97	Q2 8 =118	Q3 8 =119	Q4 8 =101
I9 =114	J9 =135	O9 =117	Q2 9 =138	Q3 9 =120	Q4 9 =121
I10=134	J10=136	O10=137	Q210 =139	Q310 =140	Q410 =141

Stragglers are other items appearing in ones and twos on each factor and appear miscellaneous. The 'stragglers' and the 'markers' that appear on more than one factor, e.g. A and F, raise a problem in the mind so long as one retains the impression that Cattell's primary traits are homogeneous in item content. Cattell never claimed this and Adrian Woods' study of the cumulative reliability of these primary traits (chapter 9, section 9.4.11) has shown that the reliabilities of most traits peak after about five items on the average. The remaining items drag their reliabilities down indicating negative correlation with the earlier items and certainly lack of homogeneity in the trait. Only trait I attains a high reliability, about .75 with up to nine homogeneous items in this study.

8.2.2 THE EVIDENCE FOR THE MODEL OF PERSONALITY PROPOSED IN THIS STUDY

Essentially this is a matter of demonstrating that collections of items that load on one factor each produce scales therein with the responses to items serving to produce sets of scores which enable the investigator to place respondents on a set of continua each of which is a recognised dimension of personality .

It will be simpler to produce the evidence for a five factor model (+ intelligence), rather than a six factor model + intelligence, after a discussion of the basic five factor model. This study is one of four performed in the Department of Education subsequently the Faculty of Education and Design at Brunel University involved with the factorial structure of the HSPQ as a primary step to the elucidation of the personality profiles of, respectively of science and arts students at 14+ (Ormerod and Billing); biological and physical science orientated students at 14+ (Asiedu); mathematics at 14+ (Carroll) and CDT students, (this study).

The first of these was that of Ormerod and Billing (1982) and Billing (Ph.D thesis 1984).

1. Firstly the 14 studies quoted by Brand (1984) point to a six factor solution (including intelligence) in which the five other dimensions of personality with varying degrees of precision can be identified with the five traits found here (but not in the same order). These dimensions are identified with greater precision in six of the studies in tables 8.1 and 8.2 (which include five Brunel studies)

2. Although in the studies in tables 8.1 and 8.2 the dimensions are identified briefly by dominant traits or 'markers' (which in actual fact vary in prominence from one study to another) the similarity between the factors found in the five Brunel studies (table 8.2) does not just extend to the marker traits, but also to the presence of specific items. This is brought out later in this study in table 8.11 where the items occurring in the Ormerod and Billing study on the corresponding factor are marked with an asterisk.

3. Ormerod and Billing isolated the same five dimensions of personality albeit in a different order by both orthogonal factor analysis of the items and by second order factor analysis of the scores on the 13 Cattell primary traits, A to Q4. (table 8.5)

4. The most rigorous identification of the factors in the Ormerod and Billing study (and in the other Brunel studies) depend on the scrutiny of the wording of all the separate items loading on one factor and the high scoring response to each (bearing in mind that if an item has a negative loading the high scoring response is assigned to what was the low scoring response in Cattell's published marking scheme). In this scrutiny the trait to which the item belongs must be ignored and it is remarkable how both the 'marker' trait and 'straggler' items with the appropriate responses conforms to present a consistent picture of the high and low scoring respondents on the whole set of items. Thus, they possess the characteristics defined by the two ends of the psychological dimension concerned, e.g. the classic neurotic as moody, anxious, oversensitive,easily distracted and irritable in contrast to the absence of these characteristics in the stable personality.

5. Ormerod and Billing did not rely on text book definitions of the personality dimensions. Indeed there were none for Controlled - conscientious v Lax expedient and the People - Thing dimension which they named Non - classical extraversion. They had the assistance of two experts: Professor V.D. Furneaux and Dr. Peter Saville. Professor Furneaux is a psychometrician of International standing who has worked with Eysenck and designed one of the published personality scales, the Junior Maudsley Personality Inventory.

Dr. Peter Saville worked as a senior research officer at the National Foundation for Educational Research and was responsible for British norms for the Cattell adult 16PF personality inventory based on a national sample of over 2000. He published the findings in Saville and Blinkhorn(1976) and took his analysis further in his Ph.D thesis completed in the Department of Education at Brunel (Saville 1978). These two experts scrutinized the items, identified the three classical Eysenck factors: Tough v. Tender minded (Eysenck's Psychoticism = Tough mindedness); Neuroticism v. Stability; and Classical extraversion v. introversion, and advised on the identity and naming of the two other factors: Controlled - conscientious v. Lax expedient and Non classical extraversion, the Interest in people v. Aversion to people and interest in things and ideas. Cattell's descriptors of the major 'marker' traits on each factor also provided clues on identification.

8.2.3 THE ORMEROD - BILLING (1982) FACTORS AS OBTAINED FROM ITEM ANALYSIS

The factors with their main distinguishing traits and descriptions are shown in table 8.7.

8.2.4 INTERCORRELATIONS BETWEEN ORMEROD AND BILLING FACTORS

These intercorrelations are shown in table 8.8. It can be clearly seen from this table that the five factors in this study are virtually independent of each other which is an added asset to the model.

Table 8.7 The factors and their main distinguishing traits and descriptions from the Ormerod and Billing study

Factor	Main Dist-inguishing Traits		Description	
			High Scoring	Low Scoring
1	I+,E-	Tender Minded ness	Tended Minded-ness	Tough Minded ness
2	Q2+A-,J+	Non-Classical Introversion	Reserved detatched Self sufficient Restrained Things	Warmhearted Group dependent, Zestful People orientated
3	H-,F-,(A-)	Classical Introversion	Shy,Sober Serious	Enthusiastic Adventurous Happy go lucky
4	D-,Q4,-C+	Neurotic - Stable	Excitable Tense Anxious	Undemonstratative Relaxed
5	G-,Q3-	Careless , Lax v Conscientious Meticulous Precise	Casual Uncontrolled	Conscientious Controlled

Table 8.8 Five Factor Solution - All Cattell's 130 personality Items

Factors	2	3	4	5	Sq. of highest loading
1	.21	-.17	-.15	.08	$.21^2 = .0441$
2		.01	.06	-.20	
3			.19	.12	
4				-.04	

Thus the hypothesis of no common variance (r^2) between all factors can be rejected at the .05 level since in no case is $r^2 > .05$.

No. Sig. Loadings > .30 omitted leaving 111 items

Factors	2	3	4	5	
1	.17	-.08	.18	.26	$.26^2 = .0676$
2		-.05	.22	-.05	$.22^2 = .0484$
3			.10	.17	
4				-.02	

Thus the null hypothesis of no common variance between factors 1 and 5 cannot be rejected at the .05 level, since $r^2 = .0676$, but only by a small margin.

8.2.5 INTERCORRELATIONS BETWEEN THE FIVE REFINED FACTORS OBTAINED IN THE FINAL ANALYSIS (reported in section 10.4)

The intercorrelations (r) and their squares (r^2) between the five factors after the items had been reduced to 93 items, as described in section 10.4 are shown in table 10.9.

If the value of r^2 is less than .05 the hypothesis of common variance can be rejected at the .05 level of significance. This is so for the majority of the pairs of factors:

Factors 1 and 2; 1 and 4; 1 and 5; 2 and 3; 2 and 5;

3 and 5; 4 and 5:

It is just above the .05 level, at .057 for the positive correlation between factors 1 and 3 but this is not enough to matter.

It is greater, but not seriously so, for factors 2 and 5 at .078 for a negative correlation of -.028 representing 7.8% of common variance between the neurotic v. stable in factor 2 and controlled conscientious v, lax expedient in 4 which is a not an unexpected relationship.

The highest value is 0.116, i.e. 11.6% (with a +ve r value of 0.34) between the preference for people in factor 3 and classical extraversion in factor 5 which, again, is not unexpected. One of the possible reasons being that Cattell's relevant items were all designed to measure classical extraversion. These correlations will all be eliminated by generating totally uncorrelated factor scores for measuring relationships with other variables and personality.

Table 8.9 Intercorrelations between the five refined factors in this study.

	1	2	3	4	5
1		-.08	0.24	0.11	-.03
2	0.006		-0.15	-.028	0.17
3	0.57	0.225		0.00	0.34
4	0.012	0.078	0.000		-0.16
5	0.000	0.029	0.116	0.026	

Notes: 1 - The top right hand side of the table show, figures for the correlation coefficients (r) between the factors.

2 - The lower left hand side of the table shows values for the squares of the correlation coefficients (r^2).

8.3 PROCEDURE FOR THE ANALYSIS

8.3.1 FIVE AND SIX FACTOR SOLUTIONS OBTAINED

Initially, all the 130 items scored in the HPSQ (excluding the 10 intelligence items) were subjected to principal components analyses followed by varimax rotations to produce both five and six factor solutions.

The five factor solution from this analysis is reproduced in tables 8.10a and 8.10b and salient loadings, on the five factors, indicated as 'markers and 'stragglers' are given in Table 8.11 with the identification of the factors and a comparison with the factors obtained in the previous study of Ormerod and Billing (1982).

A six factor solution was also produced. The next task to be undertaken was to decide whether the five of six factor solution (excluding intelligence) should be adopted.

8.3.2 FIVE OR SIX FACTOR SOLUTION?

The reliabilities for these are :

Factor	1	2	3	4	5	6
Five	0.84	0.78	0.68	0.75	0.71	
Six	0.82	0.78	0.74	0.74	0.70	0.70

Thus, on the grounds of reliability the six factor solution would be just acceptable.

8.3.3 ARGUMENTS FOR THE FIVE FACTOR SOLUTION (excluding intelligence)

(a) The scree test (figure 8.1) although as usual somewhat imprecise points more to a five factor than a six factor solution.

(b) The vast majority of solutions in other studies reviewed by Brand (1984) or the more specific solutions in tables 8.1 and 2 are five factor solutions.

Table 8.10a Full item Varimax Solution

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
ITEMA1	-0.28398	.01739	-0.16929	.22295	-0.27529
ITEMA2	-0.09425	-0.02756	.07760	.24992	.48339
ITEMA3	-0.32937	-0.09727	.08399	.13157	.30059
ITEMA4	.04404	-0.26360	-0.14274	-0.00513	-0.11530
ITEMA5	-0.27034	.09957	.20513	.17301	.17131
ITEMA6	-0.00493	.00573	-0.15334	.26538	-0.30519
ITEMA7	-0.04487	-0.07973	-0.30184	.14314	.03512
ITEMA8	-0.00013	.10005	.07672	.47451	.11928
ITEMA9	.10948	.14567	-0.36401	.11938	-0.35099
ITEMA10	-0.41261	-0.09374	.11169	.23934	-0.01203
ITEMC1	.45785	-0.15715	.05200	.24529	.01380
ITEMC2	.27295	-0.38281	.10802	-0.15664	.14684
ITEMC3	.29974	-0.02929	.31549	.14509	.09955
ITEMC4	.14200	-0.09947	.43071	.19429	.07442
ITEMC5	.35720	-0.11745	.00944	-0.03537	.08813
ITEMC6	-0.13672	-0.36963	.27348	.14839	.02789
ITEMC7	.25804	-0.34367	.15580	-0.09047	-0.08558
ITEMC8	.04328	-0.29131	.21305	.26721	.17136
ITEMC9	.34609	-0.14187	.05802	.18972	.12705
ITEMC10	.13129	-0.16385	.13820	.37353	.14970
ITEMD1	-0.06644	.23674	-0.00408	-0.06144	.03172
ITEMD2	.01805	.46693	-0.17685	-0.16762	-0.02343
ITEMD3	-0.11228	.48614	-0.00059	-0.21799	-0.03399
ITEMD4	-0.02168	.08256	-0.16750	.06107	.41127
ITEMD5	-0.03634	.26053	-0.17302	-0.28829	.09677
ITEMD6	.05525	.37549	.03468	.06614	.06730
ITEMD7	-0.03436	.51408	.02500	.05360	-0.01771
ITEMD8	.01034	.46635	-0.08959	.17969	.08063
ITEMD9	.08849	.34905	.18603	.08655	-0.05109
ITEMD10	-0.21605	-0.01444	-0.01646	-0.26325	.33694
ITEME1	.30431	.33926	-0.08340	.01844	.04330
ITEME2	.35436	-0.15934	.02163	.08957	-0.02743
ITEME3	.13387	.36170	-0.09571	.18482	.03002
ITEME4	.15049	-0.04613	-0.40137	.25268	-0.14592
ITEME5	.57036	.09193	.02832	-0.07606	-0.04571
ITEME6	-0.41161	.08480	-0.24508	.17388	.11715
ITEME7	.28074	-0.22290	-0.17313	.11479	.21411
ITEME8	.30570	-0.11320	.04271	.08928	-0.21586
ITEME9	.51321	-0.01128	.17425	-0.00306	.00764
ITEME10	.38093	.26419	.01393	.08611	-0.18588
ITEMF1	.33811	.32901	-0.20841	-0.06450	.20534
ITEMF2	.24090	-0.02414	-0.16891	.12072	.21077
ITEMF3	.05259	.13087	.17416	.19857	.35357
ITEMF4	-0.27263	.26490	-0.32193	.22143	-0.15917
ITEMF5	-0.03687	.19333	-0.09627	.47302	.24894
ITEMF6	-0.15914	.27821	-0.32711	.21111	.12044
ITEMF7	.15605	.22290	-0.09675	.38983	.19205
ITEMF8	.21048	.10032	-0.30902	.22806	.30137
ITEMF9	-0.08489	.04871	-0.40332	-0.06447	.20397
ITEMF10	.14496	.16036	-0.26648	.03390	.01340
ITEMG1	.00561	-0.02154	.05543	.01106	.12231
ITEMG2	-0.27639	-0.08322	.28573	.06810	.00343
ITEMG3	-0.07190	.16442	.20551	-0.02999	.21803
ITEMG4	-0.17199	.06382	.41786	-0.09505	.02259
ITEMG5	-0.15553	-0.09528	.47168	.22432	-0.11275
ITEMG6	-0.23449	-0.24264	.23131	.01572	.08343
ITEMG7	.12463	-0.32135	.43429	.01624	.31621
ITEMG8	.04304	.43411	-0.08853	-0.08747	.07030
ITEMG9	-0.01763	.09762	.23285	.14969	.39676
ITEMG10	.07384	-0.00854	.46874	-0.02484	.00611
ITEMH1	-0.02124	-0.20521	-0.04860	.31425	.09334
ITEMH2	.09922	-0.04839	-0.08654	-0.04056	.10701
ITEMH3	.24198	-0.28364	-0.13299	.21584	.04219
ITEMH4	.11582	-0.28399	-0.00051	.24466	.18437
ITEMH5	.08882	-0.10349	-0.03413	.26389	.54810
ITEMH6	.10654	-0.07474	.06677	.25652	.34903
ITEMH7	.09845	-0.26024	.14936	.34034	.03363
ITEMH8	-0.09281	.04108	-0.19473	.34426	.24565

Table 8.10b Full item Varimax solution

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
ITEMH9	.23227	.05042	.21450	.31089	.22620
ITEMH10	.35848	-0.08653	-0.11430	.27085	.22287
ITEMI1	-0.10976	-0.37541	.19420	-0.07568	.04558
ITEMI2	-0.47301	-0.04049	-0.03021	-0.14149	.10179
ITEMI3	-0.41449	-0.27193	.07382	.07556	.03020
ITEMI4	-0.37647	.10062	.00947	-0.00681	-0.11687
ITEMI5	-0.41485	-0.04562	-0.20451	.15572	-0.04861
ITEMI6	-0.33066	-0.18442	.13461	.00866	-0.16229
ITEMI7	-0.56099	-0.02712	-0.03916	.04867	.02548
ITEMI8	-0.43834	-0.07619	.15758	.11987	.08357
ITEMI9	-0.48495	-0.00273	-0.12126	.09628	-0.15978
ITEMI10	-0.61898	.09319	.13353	-0.06337	.04231
ITEMJ1	.09581	.32038	.12182	-0.02776	.06885
ITEMJ2	-0.03891	.15996	.12556	.06662	.00738
ITEMJ3	.12474	.26578	.14617	-0.19711	-0.01685
ITEMJ4	.06019	-0.09975	.24597	-0.37416	.00853
ITEMJ5	.29493	.14422	.05101	-0.24366	.08650
ITEMJ6	.16870	.17354	.00145	.00991	.18758
ITEMJ7	-0.08500	.09454	.25023	.00648	.24099
ITEMJ8	.11048	.01985	-0.04557	.06147	-0.12177
ITEMJ9	.25734	-0.20169	.19365	-0.09611	.02428
ITEMJ10	.13683	.08953	-0.02833	.06386	.42665
ITEMC1	-0.03490	.37215	.07040	-0.12991	-0.38961
ITEMC2	-0.27332	.03343	-0.26495	-0.32640	.06245
ITEMC3	.10527	.08597	-0.53947	-0.22098	.12979
ITEMC4	-0.03201	.12657	-0.06364	-0.43541	.02567
ITEMC5	-0.10483	-0.00637	-0.28105	-0.02618	-0.11692
ITEMC6	-0.33291	.11221	-0.16512	-0.15755	.22006
ITEMC7	-0.15396	.02838	-0.08337	-0.29129	.00170
ITEMC8	-0.07418	.19960	-0.23015	-0.15516	.08341
ITEMC9	-0.04483	-0.07186	-0.03312	-0.09510	-0.28863
ITEMC10	-0.16932	.41233	.04387	-0.21389	.05089
ITEMQ21	.19743	-0.33869	.04268	-0.17879	.00596
ITEMQ22	-0.07365	-0.04334	.05710	.58836	-0.01167
ITEMQ23	.16443	-0.00652	-0.11454	-0.47119	.06134
ITEMQ24	.02807	-0.05931	.17362	-0.50383	-0.00018
ITEMQ25	.12421	-0.29095	.29347	-0.34579	-0.02388
ITEMQ26	.42139	.01581	.18544	-0.03461	.14085
ITEMQ27	.45015	-0.08081	-0.07858	.13257	-0.03725
ITEMQ28	.11001	.16978	.01988	-0.24697	-0.11726
ITEMQ29	.02102	-0.18225	.44134	-0.18312	.09386
ITEMQ210	.39572	.06948	.05565	.02540	.31986
ITEMQ31	.17295	-0.17194	.22590	-0.09795	-0.01761
ITEMQ32	.05744	.02144	.54527	.12015	.10249
ITEMQ33	.19663	-0.20290	.12773	-0.40168	-0.05733
ITEMQ34	.11734	-0.14230	.07040	-0.02889	-0.03306
ITEMQ35	.02898	-0.29944	.14270	.00268	-0.00227
ITEMQ36	.07964	.06049	-0.18441	.01354	.60854
ITEMQ37	-0.11585	-0.21090	.21488	-0.28216	.00780
ITEMQ38	.07081	-0.14949	.16703	.19146	-0.31405
ITEMQ39	.14555	-0.33559	.25310	.25455	-0.00395
ITEMQ310	.03626	-0.03234	.51552	.07622	.00921
ITEMQ41	-0.02400	.12684	-0.02071	-0.21594	-0.06350
ITEMQ42	-0.14849	.15592	-0.01971	.08130	-0.27748
ITEMQ43	-0.20399	.09494	-0.11759	-0.02018	.28852
ITEMQ44	.02492	.53918	-0.18993	.01380	.06147
ITEMQ45	-0.47672	.16644	.04069	-0.28120	-0.08944
ITEMQ46	-0.05063	.01500	.50523	-0.17958	-0.07224
ITEMQ47	.01484	.11890	.04738	-0.04612	.07893
ITEMQ48	-0.35947	.25275	.16178	-0.06061	-0.17283
ITEMQ49	-0.06970	.43606	-0.05735	-0.10913	-0.06544
ITEMQ410	-0.23727	.28260	.04225	-0.07355	-0.00057

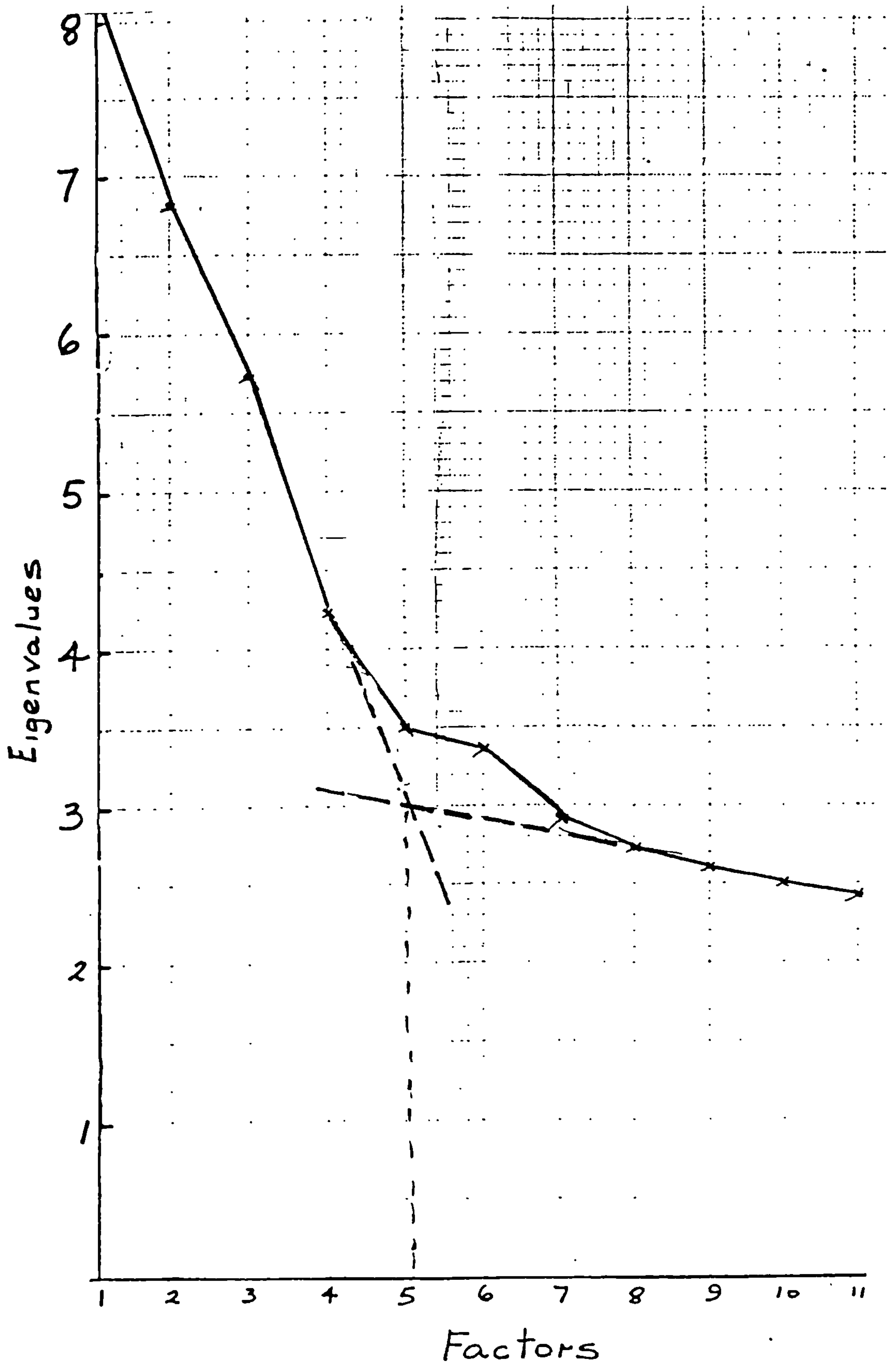
Table 8.11 Five Factor Solution of the HSPQ in this study (excluding intelligence)

Group	Factor1 Items	Group	Factor2 Items	Group	Factor3 Items	Group	Factor4 Items	Group	Factor5 Items
M	I8-*	M	D7+*	M	G5+*	M	Q2 2+*	M	A2+*
	I3-*		D8+*		G7+*		Q2 4-*		A9-
	I9-*		D2+*		G10+*		Q2 5-*		A6-
	I7-*		D3+*		G4+*		Q2 3-*		A3+*
	I5-*		D6+*		F9-*		H8+*		H5+*
	I10-*		D9+		F4-		H1+		H6+*
	I4-*		C7-*		F6-		H7+		F3+*
	I6-*		C2-*		F8-		H9+		F8+*
	I2-*		C6-		Q3 2+*		F5+*	S	D4+
	E5+*		Q4 4+*		Q3 10+*		F7+		D10+
	E9+*		Q4 9+*		A9-	S	A8+*		G9+*
	E6+*		O10+*	S	A7-		C10+*		G7+
	E10+*		O1+*		O3-*		O4-*		O1-*
	E2+	S	E3+		E4-		O2-		Q2 10+*
	E8+*		E1+		Q2 9+*		J4-*		Q3 6+
	E1+*		G8+*		Q4 6+		Q3 3-*		Q3 8-
S	A10-*		G7-		C4+				J10+*
	A3-		F1+		C3+				
	C1+*		J1+						
	C5*+		Q2 1-						
	C9+		Q3 9-*						
	F1*		I1-						
	H10+*								
	O6-								
	Q2 6+*								
	Q2 7+*								
	Q2 10+								
	Q4 5-*								
	Q4 8-*								

Tough v Tender Minded	Neurotic v Stable	Controlled conscientious v Lax expedient	People v Things Non Classical Extraversion	Classical Extroversion
Loadings 29	22	18	16	17
Rel,-0,84	0,78	0,68	0,75	0,71
O&B Fact,1	4	5	2	3

Notes; 1- * Indicates all those items that also appear in the Ormerod and Billing study,
2- Rel, Indicates reliability
3- O&B Fact, Indicates the equivalent factor in the Ormerod and Billing study,
4- M refers to 'Markers',
5- S refers to 'Stragglers',
6- Items arranged in order of ascending reliability, within each trait, e,g, factor 5 - A 2 has a realiability of ,59 and A 9 one of ,69 ,

Figure 8.1 An example of Cattell's Scree Test



In the Ormerod and Billing (1982) study a six factor solution (excluding intelligence) was specially rejected on the grounds that the communalities of the factor five items or any other group did not increase going from a five to a six factor solution, whereas they did in going from a three to a four and then again from a four to a five factor solution.

8.3.4 EXAMINATION OF THE ITEM CONTENT OF THE FIVE AND SIX FACTOR SOLUTIONS

A more potent argument in this study arises from the examination of the content of the factors in the five and six factor solutions. The relevant details are set out in table 8.12. The five factor solution has the five clear cut factors which have been defined in other studies.

In the six factor solution, however, factors three and five both seem to be measuring much the same thing, namely the controlled conscientious v lax-expedient dimension, except that the items belonging to the same primary trait in factor five (six factor solution) are loading with opposite signs to the ones in factor three (six factor solution). Refer to the left and right hand columns in table 8.12. This occurs with the 'marker' items G, F and Q3 so that, in fact, the high scorer on factor three (six factor) is controlled conscientious and the low scorer is lax and expedient, whereas the converse is true for factor five (six factor solution).

Table 8.12

Comparison of Factors 3 and 5 in the 6th Factor Solution with Factor 3 in the 5 Factor Solution.

Factor 3 in 6 Factor Solution	Factor 3 in 5 Factor Solution	Factor 5 in 6 Factor Solution
items	items	items
G5+*	G5+*	G2-*
G7+*	G7+*	
		G6-*
G10+*	G10+*	G10-*
	G4+*	G4-*
F9-*	F9-*	F1+*
	F6-	F7+
	F4-	
	F8-(0,25)	F10+(0,27)
Q3 2+*	Q3 2+*	Q3 4-(0,24)
Q3 10+*	Q3 10+*	Q37-
	A9-	
	A7-	
C3+	C3+	C1+
C4+	C4+	C6-*
O3-8	O3-*	
O2-,O5-,O8-	E4-	E4+,E1+,E10+
Q2 9+*	Q2 9+*	Q2 10+
Q4 6+	Q4 6+	Q4 6-
		Q4 5-
		I5+
No.of Items. 14	18	18
O&B. 8	9+1	6+1

Notes: 1- * Indicates loading on Ormerod and Billing Factor 5 - Lax expedient(high scoring) v Conscientious, controlled (low scoring)

2-O&B refers to the number of items that occur in the Ormerod and Billing analysis in Factor 5 and loading > 0,30 or between 0,25 and 0,29

3- M refers to 'Marker

4- S refers to 'Stragglers'.

Factor three (six factor solution) on the left in table 8.12 has 8 items from the Ormerod and Billing factor five. It also has 11 of its 14 items in common with factor three (five factor solution) in this study including three of the four G items in the latter and the two Q3+ items but only one F+ item among the 'markers' and also three +C, O3- and Q2+ items among the 'stragglers' Thus, in content it resembles factor three (five factor solution) much more in item content (and also signs of items) than does factor five (six factor solution) which has only two common items G-10 and Q4- 6 common to all three factors as shown in table 8.12. Nevertheless, factor five (six factor solution), although it has all major items reversed in sign, still from the item content is measuring the same psychological trait (or its converse).

8.3.5 EXAMINATION OF WORDING OF ITEMS AND RESPONSES (Tables 8.13a and b and 8.14a and b)

Superficially, this reveals an almost equal balance of items whose wording could be claimed to be distinguishing between the conscientious and the lax-expedient respondents, including 12 out of 16 items in factor three (six factor solution) and 14 out of 18 in factor five (six factor solution) with four more problematic items in factor three which, nevertheless, are loading on the same factor and contributing positively to the reliability.

Table 8.13a
Factor 3 (6 factor solution)

Item	Trait	Trait No.	Load -ing
039 Do people say you are a person who can always be counted on to do things exactly and properly? a. yes, b. perhaps, c. no.	Q3	2	+53
056 Do you feel that you are getting along well, and that you do everything that could be expected of you? a. yes, b. perhaps, c. no.	O-	3	-54
090 When you have homework to do, do you: a. very often just do it, b. in between, c. always get it done on time?	G	5	+49
140 Are you usually a very careful person? a. yes, b. in between, c. no.	Q3	10	+43
025 Do you completely understand what you read at school? a. yes, b. usually, c. no.	C	4	+51
120 Do you sometimes feel so mixed up that you don't know what you are doing? a. yes, b. perhaps, c. no.	Q3	9	+36
036 Do you sometimes feel you are not much good, and that you never do anything worthwhile? a. yes, b. perhaps, c. no.	O-	2	-46
110 Do you spend most of your weekly allowance for fun (instead of saving for future needs)? a. yes, b. perhaps, c. no.	G	7	+38
109 Are you best thought of as a person who: a. thinks, b. in between, c. acts.	F-	9	-43
138 Which kind of friends do you like? Those who like to: a. "play around," b. uncertain, c. be more serious?	Q2	9	+32

Table 8 13b
Factor 3 (6 factor solution)

	Item	Trait	Trait No.	Load -ing
097	Do you wish you could be more carefree and lighthearted about school work? a. yes, b. perhaps, c. no.	O-	8	-.36
061	If someone puts on noisy music while you are trying to work, do you feel you must get away? a. yes, b. perhaps, c. no.	Q4	6	+33
006	When you decide something, do you: a. wonder if you want to change your mind, b. in between, c. feel sure you're satisfied with it?	C	3	+37
076	Can you always tell what your real feelings are, for example, whether you are tired or just bored? a. yes, b. perhaps, c. no.	O-	5	-35
132	Are you so afraid of what might happen that you avoid making decisions one way or the other? a. often, b. sometimes, c. never.	H	9	+37

Controlled Conscientious (high score) v Lax Expedient (low score)

Table 8.14a
Factor 5 (6 factor solution)

	Item	Trait	Trait No.	Load -ing
091	Do you discuss your activities with your parents? a. yes, b. sometimes, c. no.	G-	6	-53
031	Do you ask advice from your parents? a yes, b. sometimes, c. seldom.	G-	2	-48
045	Have you always got along really well with your parents, brothers and sisters? a. yes, b. in between, c. no.	C-	6	-43
010	Would you say that *some* rules and regulations are stupid? a. Yes, and I don't bother with them if I can help it, b. uncertain, c. no, most rules are necessary and should be obeyed.	F	1	+42
128	On your birthday, do you prefer: a. to be asked beforehand to choose the present you want, b. uncertain, c. to have the fun of getting a present that's a complete surprise?	E	10	+40
100	Would you rather spend a break between morning and afternoon classes in: a. a card game, b. uncertain, c. catching up on homework?	Q3-	7	-46
008	If friends' ideas differ from yours, do you keep from saying yours are better, so as not to hurt their feelings? a. yes, b. sometimes, c. no.	E	1	+31
129	Are you very careful not to hurt anyone's feelings or startle anyone, even for fun? a. yes, b. perhaps, c. no.	F	10	+40
071	If everyone was doing something you think is wrong, would you: a. go along with them, b. uncertain, c. do what you think is right?	G-	4	-34

Table 8.14b
Factor 5 (6 factor solution)

	Item	Trait	Trait No.	Loading
048	When you are on a bus or train, do you talk: a. in your ordinary voice, b. in between, c. as quietly as possible?	E	4	+39
061	If someone puts on noisy music while you trying to work, do you feel you must get away? a. yes, b. perhaps, c. no.	Q4-	6	-40
070	Do you like doing really unexpected and startling things to people? a. yes, b. once in a while, c. no.	F	7	+32
060	When something important is coming up, such as a test or a big game, do you: a. stay very calm and relaxed, b. in between, c. get very tense and worried?	Q4-	5	-30
139	If you were not a human being, would you rather be: a. an eagle on a far mountain, b. uncertain, c. a seal, in a seal colony by the seashore?	Q2	10	+32
004	When you do a foolish thing, do you feel so bad that you wish the earth would just swallow you up? a. yes, b. perhaps, c. no.	C	1	39
131	Do you take trouble to be sure you are right before you say anything in class? a. always, b. generally, c. not usually.	G-	10	-32
079	When something is bothering you a lot, do you think it's better to: a. try to ignore it until you cool off, b. uncertain, c. blow off steam?	Q3-	4	-33
054	which would you rather take: a. practical mathematics, b. uncertain, c. foreign language or drama?	I	5	30

Controlled Conscientious (high score) v Lax Expedient (low score)

There are also four more problematical items in factor five of which the last Q3 4 (No.79) and especially +I 5 (No.54) (table 8.14b) do not connect easily with the gist of the others and lead to a slight diminution in the cumulative reliability (0.713 to 0.709 to 0.702)- a very uncommon occurrence in these five and six factor solutions of the HSPQ.

A more thorough scrutiny of the items actually rated as distinguishing between the conscientious and the lax-expedient gives an indication of the subtle difference between the two factors. This is that those agreeing with some of the relevant factor five items could be rated as not just conscientious but over precise and punctilious in a way that might strike the average 14 year old as a trifle 'sissy' or 'prissy'.

These are in particular the highest loading items contributing most to the cumulative reliability, i.e. (table 8.14 a and b) G6 (No.91) G2 (No.31) C6 (No.45), F1 (No10), Q37 (No.100) and F10 (No. 129) and possibly E4 (No.48). For instance, it is a very rare teenager who could say that he/she had always got along very well with parents, brothers and sisters (C6) or who prefers catching up on homework rather than a game in a break, unless they had neglected the homework in the first place or wanted to copy it from someone else. In which case they would be lax and expedient not conscientious anyway (opinion of two teachers each with over 20 years classroom experience and three and four children respectively of their own!).

This ,however, is a matter of shades of meaning and a moot point . It is, however, just possible that the typical 'average' conscientious character could give a typical conscientious response to the majority of factor three items whilst rejecting the more punctilious responses to the key items in factor five, thus, accounting for the reversal of loadings in factor five vis a vis factor three.

8.3.6 CONCLUSION TO FIVE V SIX FACTOR DISCUSSION

This research, however, is not primarily a psychological study per se but only a section of a study aimed at giving the overall attitudinal and personality profile of those interested in CDT or the converse.

It can be argued that such a nice distinction as has to be made between Factors five and six and a problematical one as well is not worth taking into the study and it would be more prudent, given the other arguments in favour of the five factor (+ intelligence) model to adopt this latter one in this study. This is, in fact, the course which is being taken.

8.4 THE FINAL IDENTIFICATION OF THE FACTORIAL STRUCTURE OF PERSONALITY

8.4.1 ESTABLISHING THE MOST RIGOROUS SOLUTION

The factor analysis of the whole 130 items does not yield the most rigorous solution to the factorial structure of personality in this study. The reason for this is that only 102 out of the 130 items have salient loadings $\geqslant .30$. The other 28 items present are, however, affecting the position of the orthogonal axes positioned to give maximum loadings to all the items even the ones loading $<.30$. Hence for the most rigorous solution, these items must be removed with the result that the loadings that remain will alter as the factor axes reposition themselves to maximize these loadings. This may result in some items which have initially loaded .30 falling below this criterion level. It is also possible that, given the chance, some other items now loading just below .30 may raise above this value on one factor. If we simply exclude all items loading $<.30$ this latter possibility would not happen. Thus the solutions must be approached in a stepwise manner.

A preliminary analysis excluding items loading below .27 was undertaken followed by other analyses which successively excluded items loading <.28 and <.29 on some factors, before a final varimax analysis excluding all items then loading <.30 on any of the five factors was adopted. This gave rise to considerable differences notably the factor 3 exchanged places with factor 4 and factor 5 had less loadings than before this final rotation. In fact, altogether only 100 salient loadings appeared. The final factor analysis showing these loadings is given in tables 8.15a and b and the results are summarized in table 8.16. In this table comparison has been made again with the Ormerod and Billing study. Detailed lists of items loading on the various factors are shown in tables 8.17 - 8.21.

8.4.1.1 THE IDENTIFICATION OF THE FACTORS IN THIS STUDY

(a) The item content given in table 8.6.

(b) The actual verbal content of the items loading on each factor. This is given in tables 8.17 to 8.25. On the right of each item is the primary Cattell trait letter, to which the item belongs, followed by its number from 1 to 10 within that trait, e,g, Q3 6. The actual number of the item in the HSPQ is given with the wording of the item (from 2 - 141). To the right of the trait number is given the loading of the item on its factor,

e.g. .-.52 on item I 8, in factor one. Tables 8.17 to 8.25 show the items in their factor grouping each item with three possible responses a, b and c which is scored either 1, 2 ,3 or 3, 2, 1. In each case the response attracting the high score of 3 is underlined. This is always a or c .

If the loading is positive this high scoring response is the one given in Cattell's own scoring key. If, however, the loading is negative on the factor it means that in effect when generating the factor scores the negative sign of the loading will reverse the scoring so what scored high on a positive loading will score low and vice versa. This is because some Cattell traits correlate negatively with each other so that pupils who scored high on one would tend to score low on the other, e.g. :

Trait	Low Score Description	High Score Description
E	Obedient , mild	Assertive, aggressive
I	Tough minded	Tender minded

Such opposite traits tend to appear on most of the five factors. If the scoring was left as it was the scores would tend to cancel out so that if factor scores were not being generated the scoring on that factor for items with negative loadings would have to be reversed. In other words the high scorers on positive loadings items would tend to be low scorers on negative loadings items. Thus, in order to indicate how pupils are likely to respond to negative loading items, if we underline the high scoring response on positive loading items we must underline the low scoring response (according to Cattell's scoring key) for negative loading items. Only then do the likely responses to such negatively correlating items appear consistent and give the correct clues to what the factor is really measuring.

Table 8.15a Varimax solution - reduced items

Item	Trait	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
003	A2	-04	-03	+29	+09	+50*
004	C1	+42*	-16	+27	+06	-17
005	C2	+28	-37*	-16	+09	+03
006	C3	+30*	-05	+15	+31*	-04
008	E1	+26	+28	-01	-07	+02
009	E2	+36*	-20	+13	+08	-02
010	F1	+34*	+33*	-00	-25	+16
012	H1	-00	-18	+29*	-07	+13
013	I1	-15	-38*	-21	+13	+05
014	J1	+05	+29	-12	+13	-00
016	O1	-11	+36*	_15	+12	-31*
017	Q2 1	+10	-36*	-20	+00	-12
018	Q2 2	-03	-07	+56*	+08	+07
022	A3	-29	-14	+20	+06	+22
025	C4	+12	-14	+14	+49*	+06
026	C5	+37*	-10	-07	+05	+12
027	D2	-04	+49*	-11	-16	+00
028	E3	+21	+35*	+28	+01	-02
030	F3	+07	+11	+12	+16	+27
033	I2	-48*	-06	-18	-06	+23
034	I3	-44*	-28	-04	+16	-03
036	O2	-24	+10	-30*	-34*	+12
037	Q2 3	+10	+09	-51*	-10	-00
038	Q2 4	-02	-06	-56*	+12	-02
039	Q3 2	+04	_07	+06	+50*	+06
041	Q4 4	+03	+53*	+09	-15	+10
045	C6	-08	-41*	+08	+22	+17
046	D3	-12	+51*	-19	+04	-05
047	D4	+02	+08	+11	-17	+49*
048	E4	+14	-00	+25	-34*	-12
049	F4	-26	+27	+25	-22	-16
050	F5	-07	+07	+51*	-13	+22
053	I4	-41*	+11	+00	+08	-10
054	I5	-50*	-06	+13	-24	-20
055	J4	+04	-15	-45*	+18	+03
056	O3	+07	+10	-18	-54*	+11
057	O4	-02	+15	-42*	-10	+04
058	Q2 5	+10	-27	-42*	+30*	+06
059	Q3 3	+15	-22	-40*	+01	-10
060	Q4 5	-47*	+20	-26	+07	-02
061	Q4 6	-06	+05	-26	+48*	-04
065	C7	+25	-37*	-06	+08	-15
067	D6	+07	+42*	+06	+07	+04
068	E5	+52*	+05	-16	+07	-08
069	F6	-17	+24	+34*	-25	+10
070	F7	+12	+18	+47*	-04	+10
071	G4	-16	+02	-01	+37*	+07
073	I6	-44*	-30*	-04	+11	-14
074	I7	-62*	-04	+06	+02	-00
077	O6	-33*	+14	-01	-15	+34*
078	Q2 6	+44*	-00	-04	+21	-09
080	Q3 5	+00	-32*	-00	+06	-19
086	D7	-05	+51*	+07	+02	-03

Note: * Denotes items with significant loadings.

Table 8.15b Varimax solution - reduced items.

Item	Trait	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
087	D8	+05	+48*	+24	-04	+12
088	E6	-42*	+04	+19	-24	+04
089	F8	+26	+14	+29	-34*	+24
090	G5	-18	-15	+12	+53*	-04
092	H5	+20	-08	+33*	+01	+54*
093	H6	+14	-10	+22	+10	+30*
094	I8	-52*	-06	+07	+22	-00
098	Q2 7	+45*	-09	+08	-08	-10
099	Q3 6	+15	+07	+16	-17	+59*
101	Q4 8	-38*	+25	-07	+14	-06
102	A7	-20	-12	+17	-32*	+05
103	A8	-00	+00	+45*	+00	+04
105	C9	+33*	_17	+18	+09	+00
106	D9	+08	+34*	+02	+28	-14
108	E8	+32*	-15	+08	+00	-27
109	F9	-04	+01	+04	-40*	+05
110	G7	+15	-33*	-03	+41*	+30*
111	G8	+03	+50*	-09	-04	+12
112	H7	+10	-24	+28*	+17	+00
113	H8	+03	+05	+40*	-22	+21
114	I9	-54*	-05	+00	-15	-15
119	Q3 8	+08	-12	+16	+16	-37*
120	Q3 9	+14	-36*	+23	+28	-13
121	Q4 9	-07	+41*	-03	-13	-04
122	A9	+07	+16	+15	-37*	-38*
123	A10	-42*	-11	+21	+12	-00
125	C10	+23	-16	+38*	+17	+11
126	D10	-17	+06	-22	-30	+42*
127	E9	+46*	+00	-08	+21	+02
128	E10	+34*	+27	+14	04	-29
130	G9	+04	+14	+18	+29	+40*
131	G10	+10	-02	-04	+44*	-08
132	H9	+23	-02	+28*	+26	+18
133	H10	+37*	-11	+31*	-13	+10
134	I10	-64*	+01	-07	-06	+11
136	J10	+11	+08	+10	+03	+43*
137	O10	-17	+42*	-16	+04	+10
138	Q2 9	+02	-20	-28	+42*	+11
139	Q2 10	+38*	+06	+08	+09	+20
140	Q3 10	+08	-02	-01	+56*	-04

Note: * Denotes items with significant loadings.

Table 8.16 Five Factor solution of the HSPQ in this study (Refined) - excluding intelligence

	Factor1 Items		Factor2 Items		Factor3 Items		Factor4 Items		Factor5 Items
M	I2-*	M	D2+*	M	H1+(.29)	M	G4+*	M	H5+*
	I3-*		D3+*		H5+*		G5+*		H6+*
	I4-*		D6+*		H7+(.28)		G7+*		A2+*
	I5-*		D7+*		H8+*		G10+*		A9-*
	I6-*		D8+*		H9+(.28)		F8-	S	D4+
	I7-*		D9+		H10+		F9-*		D10+
	I8-		C2-*		Q2 2+*		Q3 2+*		G7+
	I9-*		C6-		Q2 3-*		Q3 10*+		G9+*
	I10-*		C7-*		Q2 4-*	S	Q2 5+		Q3 6+*
	E2+		Q4 4+*		Q2 5-*		Q2 9+*		Q3 8-
	E5+*		Q4 9+*		F5+*		C3+		O1-*
	E6-*		Q3 5-*		F6+		C4+		O6+
	E8*		Q3 9-		F7+		A7-		J10+*
	E9+*		O1+*	S	O2-		A9-		
	E10+*		O10+*		O4-*		O2-		
	C1+*	S	G7-		A8+*		O3-		
	C3+		G8+*		C10+*		Q4 6+		
	C5+*		Q2 1-		J4-*		E4-		
	C9+		I1-		Q3 3-*				
S	Q2 6+*		I6-						
	Q2 7+*		F1+						
	Q2 10+		E3+						
	Q4 5-*								
	Q4 8-								
	A10-*								
	F1+								
	H10+*								
	O6-								

	Factor1	Factor2	Factor3	Factor4	Factor5
	Tough v Tender Minded	Neurotic v Stable	People v Things Non Classical Extraversion	Controlled conscientious v Lax expedient	Classical extravers -ion
Loadings	28	22	19	18	13
Rel.	.84	.79	.73	.74	.69
O&B Fact.	1	4	2	5	3

Notes: 1- * Indicates all those items that also appear in the Ormerod and Billing study.
2- Rel. Indicates reliability
3- O&B Fact. Indicates the equivalent factor in the Ormerod and Billing study.
4- M refers to 'Markers', (59 in the table)
5- S refers to 'Stragglers'.(41 in the table)

Table 8.17a

Factor 1	Item	Trait	Trait No	Load -ing
033.	Do some types of films upset you? a. yes, b. perhaps, c, no.	I-	2	-48
034	Would you enjoy more watching a boxing match than a beautiful dance? a. yes, b. perhaps, c. no.	I-	3	-44
053	In a play, would you rather act the part of a famous teacher of art or a tough pirate? a. yes, b. perhaps, c. no.	I-	4	-41
054	Which course would you like to take: a. practical mathematics, b. uncertain, c. foreign language or drama?	I-	5	-50
073	Would you rather spend a free afternoon: a. in a place with beautiful pictures and garden, b. uncertain c. in a duck shooting match?	I	-6	-44
074	Would you rather spend an afternoon by the lake: a. watching dangerous speed boat racing, b. uncertain, c. walking by the lovely shore with a friend?	I-	7	-62
094.	Which would you prefer to watch on a fine evening? a. car racing b. uncertain c. an open-air musical play.	I-	8	-52
114	What kind of film do you like best? a. musicals, B. uncertain, c. war stories.	I-	9	-54
134	Do some books and plays almost make you cry? a. yes, often, b. sometimes, c. no, never.	I-	10	-64
009	Do you usually ask someone else to help you when you have a hard problem a. seldom, b. sometimes, c. often.	E	2	+36
068	Are there times when you feel so pleased with the world that you just have to sing and shout? a. yes, b. perhaps, c. no.	E	5	+52
088	Would you rather be: a. someone who plans homes and parks, b. uncertain, c. a singer of member of a dance band?	E-	6	-42

Table 8 17b

Factor 1 Item	Trait	Trait No	Load -ing
108 Which would you rather read about: a. how to win at sport, b. uncertain, c. how to be nice to everyone?	E	8	+32
127 Would you rather be: a. teacher, b. uncertain, c. a scientist?	E	9	+46
128 On your birthday , do you prefer: a. to be asked beforehand to choose the present you want, b uncertain, c. to have the fun of getting a present that's a complete surprise?	E	10	+34
004 When you do a foolish thing, do you feel so bad that you wish the earth would just swallow you up? a. yes, b. perhaps, c. no.	C	1	+42
006 When you decide something, do you: wonder if you want to change your mind, b. in between, c. feel sure you're satisfied with it?	C	3	+37
026 When chalk screeches on the blackboard does it "give you the shivers"? a. yes, b. perhaps, c. no.	C	5	+37
105 Do you sometimes feel happy and sometimes feel depressed without real reason? a. yes, b. uncertain, c. no.	C	9	+36
078 Would you rather be: a. a builder of bridges, b. uncertain, c. a member of a travelling circus?	Q2	6	+44
098 Are you like a lot of people, slightly afraid of lightning? a. yes, b. perhaps, c. no.	Q2	7	45
139 If you were not a human being, would you rather be: a. an eagle on a far mountain, b. uncertain, c. a seal, in a seal colony by the seashore?	Q2	10	+39
060 When something important is coming up, such as a test or a big game, do you: a. stay very calm and relaxed, b. in between, c. get very tense and worried?	Q4-	5	-47

Table 8.17c

Factor 1	Item	Trait	Trait No	Load -ing
101	When you walking in a quiet street in the dark, do you often get the feeling you are being followed? a. yes, b. perhaps, c. no.	Q4-	8	-38
123	If you were to work on a bus, would you rather: a. be the conductor and talk to the passengers, b. uncertain, c. be the driver and drive the bus?	A-	10	-42
010	Would you say that *some* rules and regulations are stupid and out of date? a. yes, and I don't bother with them if I can help it, b. uncertain c. no, most rules are necessary and should be obeyed.	F	1	+33
133	When things are frightening, can you laugh and not be bothered? a. yes, b. perhaps, c. no.	H	10	+37
077	When things are going wonderfully, do you: a. actually almost "jump with joy", b. uncertain, c. feel good inside, while appearing calm?	O-	6	-33

Thus it would seem that from the high scoring responses marked a or c high scores on this factor represent tough-mindedness and low scores tender-mindedness.

Table 8.18a

Factor 2	Item	Trait	Trait No	Load -ing
027	When something goes all wrong, do you get very angry with people before you start to think what can be done about it? a. often, b. sometimes, c. seldom.	D	2	+49
046	If your classmates leave you out of a game, do you: a. think it just an accident, b. in between, c. feel hurt and angry?	D	3	+51
067	Do you often remember things differently from other people, so that you have to disagree about what really happened? a. yes, b. perhaps, c. no.	D	6	+42
086	If you keep breaking and accidentally wasting things when you are making something, do you keep calm just the same? a. yes, b. perhaps, c. no, I get furious.	D	7	+51
087	Have you ever felt dissatisfied and said to yourself, "I bet I could run this school better than the teachers do"? a. yes, b. perhaps, c. no.	D	8	+48
106	When people around you laugh and talk while you are listening to radio or TV: a. are you happy, b. in between, c. does it spoil things and annoy you?	D	9	+34
005	Do you find it easy to keep an exciting secret? a. yes, b. sometimes, c. no.	C-	2	-37
045	Have you always got along really well with your parents, brothers and sisters? a. yes, b. in between, c. no.	C-	6	-41
065	Do you often make big plans and get excited about them, only to find that they just won't work out? a. yes, b. occasionally, c. no.	C-	7	-37
041	Does it bother you if you have to sit and wait for something to begin? a. yes, b. in between, c. no.	Q4	4	+53

Table 8.18b

Factor 2	Item	Trait	Trait No	Load -ing
121	When someone is disagreeing with you, do you: a. let him say all he has to say b. uncertain, c. tend to interrupt before he finishes?	Q4	9	+41
080	Do you sometimes say silly things, just to see what people will say? a. yes, b. perhaps, c. no.	Q3-	5	-32
120	Do you sometimes feel so mixed up that you don't know what you are doing? a. yes, b. perhaps, c. no.	Q3-	9	-36
016	Can you stay cheerful even when things go wrong? a, yes, b. uncertain, c. no.	O	1	+36
137	Do your feelings get so, bottled up that you feel you could burst? a, often, b. sometimes, c. seldom.	O	10	+42
110	Do you spend most of your weekly allowance for fun (instead of saving for future needs)? a. yes, b. perhaps, c. no.	G-	7	-33
111	Do other people often get in your way? a. yes, b. in between, c. no.	G	8	+50
017	Do you try to keep up with the fads of your classmates? a. yes, b. sometimes, c. no.	Q2-	1	-36
013	When you rightly feel angry with people, do you think it's all right for you to shout at them? a. yes, b. perhaps, c. no.	I-	1	-38

Table 8.18c

Factor 2	Item	Trait	Trait No	Loading
010	Would you say that *some* rules and regulations are stupid and out of date? a. yes, and I don't bother with them if I can help it, b. uncertain, c. no, most rules are necessary and should be obeyed.	F	1	+33
028	When you finish school, would you like to: a. do something that will make people like you, b. uncertain, c make a lot of money?	E	3	+35

Thus the high scorer is anxious, tense and irritable i.e. typically neurotic.

Table 8 .19a

Factor 3	Item	Trait	Trait No.	Load -ing
012	Do you sometimes feel, before a big party or outing, that you are not so interested in going? a. yes, b. perhaps, c. no.	H	1	+29
092	When the class is discussing something, do you usually have something to say? a. almost never, b. once in a while, c. always.	H	5	+33
112	How do you rate yourself? a. inclined to be moody, b. in between, c. not at all moody.	H	7	+28
113	How often do you go to places or do things with friends: a. very often, b. sometimes, c. hardly ever.	H	8	+40
132	Are you so afraid of what might happen that you avoid making decisions one way or the other? a. often, b. sometimes, c. never.	H	9	+28
133	When things are frightening, can you laugh and not be bothered? a. yes, b. perhaps, c. no.	H	10	+31
018	Do most people have more friends than you do? a. yes, b. uncertain, c. no.	Q2	2	+56
037	when a group of people are doing something, do you: a. take an active part in what they are doing, b. in between, c. usually only watch?	Q2-	3	-51
038	Do you tend to be quiet when out with a group of friends? a. yes, b. sometimes, c. no.	Q2-	4	-56
058	If you found you had nothing to do some evening, would you: a. call up some friends and do something with them, b. not sure, c. read a good book or work on a hobby?	Q2-	5	-42

Table 8, 19b

Factor 3	Item	Trait	Trait No.	Load -ing
050	In a group of people, are you generally one of those who tells jokes and funny stories? a. yes, b. perhaps, c. no.	F	5	+51
069	When you are ready for a job, would you like one that: a. is steady ans safe, even if it takes hard work, b. uncertain, c. has lots of change and meetings with lively people?	F	6	+34
070	Do you like doing really unexpected and startling things to people? a. yes, b. once in a while, c. no.	F	7	+47
036	Do you sometimes feel you are not much good, and that you never do anything worthwhile? a. yes, b. perhaps, c. no.	O-	2	-30
057	Do you have trouble acting like or being other people expect you to be? a. yes, b. uncertain, c. no.	O-	4	-42
103	When you go into a new group, do you: a. quickly feel you know everyone, b. in between, c. take a long time to get to know people?	A	8	+45
125	If someone asks you to do a new and difficult job, do you: a. feel glad and show what you can do, b. in between, c. feel you will make a mess of it?	C	10	+38
055	Would you rather spend free time: a. by yourself, on a book or stamp collection, b. uncertain, c. working under others in a group project?	J-	4	-45
059	Would you like to be extremely good-looking, so that people would notice whereever you go? a. yes, b. perhaps, c. no.	Q3-	3	-40

Thus high scorers on Factor 3 are people orientated.

Table 8.20a

Factor 4	Item	Trait	Trait No.	Load -ing
071	If everyone were doing something you think is wrong, would you: a. go along with them, b. uncertain, c. do what you think is right?	G	4	+37
090	When you have homework to do, do you: a. very often just do it, b. in between, c. always get it done on time?	G	5	+53
110	Do you spend most of your weekly allowance for fun (instead of saving for future needs)? a. yes, b. perhaps, c. no.	G	7	+41
131	Do you take trouble to be sure you are right before you say anything in class? a. always, b. generally, c. not usually	G	10	+44
089	If you had a chance to do something really wild and adventurous, but also rather dangerous, would you: a. probably not do it, b. not sure, c. certainly do it?	F-	8	-34
109	Are you best thought of as a person who: a. thinks, b. in between, c. acts.	F-	9	-40
039	Do people say you are a person who can always be counted on to do things exactly and properly? a. yes, b. perhaps, c. no.	Q3	2	+50
140	Are you usually a very careful person? a. yes, b. in between, c. no.	Q3	10	+56
058	If you found you had nothing to do some evening, would you: a. call up some friends and do something with them, b. not sure, c. read a good book or work on a hobby?	Q2	5	+30

Table 8.20b

Factor 4	Item	Trait	Trait No.	Load -ing
138	Which kind of friends do you like? Those who like to : a. "play around," b. uncertain, c. be more serious?	Q2	9	+42
006	When you decide something,do you: a. wonder if you may want to change your mind, b. in between, c. feel sure you've satisfied with it?	C	3	+31
025	Do you completely understand what you read at school? a. yes, b. usually, c. no.	C	4	+49
102	In talking with your classmates, do you dislike telling your most private feelings? a. yes, b. sometimes, c. no.	A-	7	-32
122	Would you rather live: a. in a deep forest, with only the song of birds, b. uncertain, c. on a busy street corner, where a lot happens.	A-	9	-37
036	Do you sometimes feel you are not much good, and that you never do anything worthwhile? a. yes, b. perhaps, c. no.	O-	2	-34
056	Do you feel that you are getting along well, and that you do everything that could be expected of you? a. yes, b. perhaps, c. no.	O-	3	-54
061	If someone puts on noisy music while you are trying to work, do you feel you must get away? a. yes, b. perhaps, c. no.	Q4	6	+48
048	When you are on a bus or train, do you talk: a. in your ordinary voice, b. in between, c. as quietly as possible?	E-	4	-34

Thus high scorers are careful and conscientious.

Table 8.21a

Factor 5	Item	Trait	Trait No.	Loading
092	When the class is discussing something, do you usually have something to say? a. almost never, b. once in a while, c. always.	H	5	+54
093	Do you stand up in front of your without looking nervous and ill-at-ease? a. yes, b. perhaps, c. no.	H	6	+30
003	In a group discussion do you like to tell what you think? a. yes, b. sometimes, c. no.	A	2	+50
122	Would you rather live: a. in a deep forest, with only the song of birds, b. uncertain, c. on a busy street corner, where a lot happens?	A-	9	-38
047	Do people say you are sometimes excitable and scatterbrained though they think you are a fine person? a. yes, b. perhaps, c. no.	D	4	+49
126	When you raise your, hand to answer a question in class, and many others raise their hands too, do you get excited? a. sometimes, b. not often, c. never.	D	10	+42
110	Do you spend most of your weekly allowance for fun (instead of saving some for future needs)? a. yes, b. perhaps, c. no.	G	7	+30
130	If you are working with groups in class, would you rather: a. walk around to carry things from one person to another, b. uncertain, c. specialize in showing people how to do one difficult part?	G	9	+40

Table 8.21b

Factor 5	Item	Trait	Trait No.	Load -ing
099	Do you ever suggest to the teacher a new suject for the class to discuss? a. yes, b. perhaps, c. no.	Q3	6	+59
119	Do you feel you are doing pretty much what you should be doing in life? a. yes, b. uncertain, c. no.	Q3-	8	-37
136	In group discussions ,do you often find yourself: a. taking a lone stand, b. uncertain, c. agreeing with the group?	J	10	+43
016	Can you stay cheerful even when things go wrong? a. yes, b. uncertain, c. no.	O-	1	-31
077	When things are going wonderfully, do you: a. actually almost "jump with joy", b. uncertain, c. feel good inside, while appearing calm?	O	6	+34

With the exception of items 119 and 003 high scorers on this factor are adventurous, thick skinned, socially bold and warmhearted i.e. extroverts.

8.4.2 IDENTIFICATION OF FACTOR I

Summary Tough minded (high score) v Tender minded (low score)

8.4.2.1 COMPARISON OF LOADINGS (Table 8.15a and b and 8.16)

In the Ormerod and Billing study instead of just counting items, a score of 1 was allocated for items loading ≥.40 and ½ for items loading <.40 but >.30. The resulting scores have been put in brackets for the Ormerod and Billing study and also for this study for comparison purposes.

	This Study	Ormerod and Billing
Markers	9I- (8)	I+ (8½)
	6E+ (4)	E- (4½)
	4C+ (2½)	C- (1½)
Stragglers	2A- (2)	A+ (1½)
	1F+ (½)	F- (1)
	1H+ (½)	H- (½)
	1O- (½)	------
	3Q2+ (2½)	Q2- (1½)
	1Q4- (1)	Q4+ (1)
	--	J- (½)

8.4.2.2 NATURE OF THE MARKERS

	High Score	Low Score
Trait I-	TOUGH-MINDED	TENDER-MINDED
	rejects illusions	sensitive, clinging, over-protective.
Trait E+	ASSERTIVE	OBEDIENT
	aggressive, competitive, stubborn.	mild, easily lead, docile, accommodating.
Trait C+	EMOTIONALLY STABLE	AFFECTED BY FEELINGS
	mature, faces reality.	easily upset, changeable.

8.4.2.3 ACTUAL ITEM COUNT (Tables 8.17a, b and c)

Out of 28 items loading over 0.3, 20 were found in the Ormerod and Billing study loading over 0.3 and two more loading between 0.25 and 0.29. These include 13 of the 19 'marker' items and 5 of the 9 'stragglers'.

8.4.2.4 EXAMINATION OF ACTUAL ITEMS - FACTOR ONE

It is the I items, E items and C items that define the factor with Cattell's descriptors.

The 'straggler' items drawn from other primary traits are compatible with the tough-minded stance of the high scorer. This factor gives the most straightforward identification of the five factors.

8.4.2.5 RELIABILITY

The reliability for this factor is 0.84 which is very high for a personality measure.

8.4.3 IDENTIFICATION OF FACTOR TWO

	Low Score	High Score
Summary	STABLE	NEUROTIC, anxious

8.4.3.1 COMPARISON OF LOADINGS (Table 8.15a and b and 8.16)

	This Study	Ormerod and Billing
Markers	6D+ (6)	D+ (4½)
	3C- (2)	C- (2½)
	2Q4+(2)	Q4+(4½)
	2O+ (1½)	O+ (1½)
Stragglers	1E+(½)	E- (½)
	1F+(½)	
	1Q2-(½)	------
	2Q3-(1)	Q3-(1)
	1I-(½)	-----
	1G+(½) 1G-(½)	G+ (1)
	------	A+ (½)

8.4.3.2 NATURE OF THE MARKERS

	High Score	Low Score
Trait D+	EXCITABLE	UNDEMONSTRATIVE
	demanding, overactive.	inactive, deliberate.
Trait C-	AFFECTED BY FEELINGS	EMOTIONALLY STABLE
	easily upset, changeable.	mature, faces reality.
Trait Q4	TENSE	RELAXED
	frustrated, driven.	tranquil, composed.
Trait O	APPREHESIVE	SELF-ASSURED
	self-reproaching, worrying, troubled.	complacent, secure, serene.

8.4.3.3 ACTUAL ITEM COUNT (Table 8.16)

Five of the studies in tables 8.1 and 8.2 for this factor contain (O) items and there are two in this study. Of the 22 items in this study 13 load on the corresponding Ormerod and Billing items >.30.

8.4.3.4 EXAMINATION OF WORDING OF ITEMS (Tables 8.18a and b)

Both the 'marker' and the 'straggler' items loading significantly on this factor give the general impression that the high scorers on this personality trait are anxious, tense, irritable, easily distracted and upset. These are traits of the classic neurotic. It is significant that this factor contains the only I item (I1) that does not load on factor one, in this study. It should be noted that in Woods's cumulative reliability (chapter 9, section 9.4.11) it is an item causing a more rapid reduction in reliability towards the end of the scale.

This indicates that it is incompatible with its own primary trait. On the other hand the low scoring responses to the items in this factor indicate the pupil who is not easily distracted, is calm and collected, i.e. is stable.

8.4.3.5 RELIABILITY

The peak reliability with all the items of 0.79 is quite acceptable for a personality scale.

8.4.4 IDENTIFICATION OF FACTOR THREE

Summary

Preference for being with people (high score) rather than things (low score). (Non classical extraversion) = Ormerod and Billings Factor Two.

8.4.4.1 COMPARISON OF LOADINGS (Table 8.15a and b and 8.16)

	This Study	Ormerod and Billing
Markers	1Q2+ (1)	Q2- (1)
	3Q2- (3)	Q2+ (4½)
	6H+ (3½)	H- (1)
	3F+ (2)	F- (1½)
Stragglers	2O-(1½)	O+ (½)
	1A+(1)	A- (3)
	1C+(½)	-----
	1J-(1)	J+ (2)
	1Q3-(1)	Q3+ (1)
	-----	E+ (1)
	-----	G+ (½)
	-----	Q4+ (½)

8.4.4.2 NATURE OF THE MARKERS

	High Score	Low Score
Trait H	ADVENTUROUS	SHY
	'thick skinned',	timid,
	socially bold.	threat-sensitive.
Trait F	ENTHUSIASTIC	SOBER
	heedless, happy-go-lucky.	taciturn, serious.
Trait Q2	SELF-SUFFICIENT	SOCIALLY GROUP DEPENDENT
	prefers own decisions,	a 'joiner' and sound
	resourceful.	follower.

8.4.4.3 ACTUAL ITEM CONTENT (Table 8.16)

It will be noted that the signs of all major loadings are reversed for the Ormerod and Billing study, i.e. high scorers on the latter study scored preference for other things v people - meaning that it was non classical introversion although the title was reversed to extraversion to conform with other studies. Of the 19 items in this study 11 were common to the Ormerod and Billing study with loadings of >0.30 on the latter with another item being a near miss at 0.27. This is a higher proportion of agreement than in factor four of this study. The trickiest point is distinguishing this from Classical extraversion which is factor five in this study. The distinguishing feature between this factor and 'non classical extraversion', i.e. the people - thing dimension is the presence of the Q2 items in this dimension in all studies in tables.8.1 and 8.2

8.4.4.4 EXAMINATION OF THE WORDING OF ITEMS (Table 8.19a and b)

The Q2 items all bring out the interest in people, even the Q2 item of opposite sign, i.e. Q2 2 which has a +ve loading and therefore does not need a reversal of the scoring conforms to this picture. This item also occurs with the reversed loading to all the other Q2 items in the Ormerod and Billing and Carroll studies. The 'straggler' items also conform to the interest in people idea, e.g, A8. There are more H items on this factor than on the corresponding factor in the Ormerod and Billing study. However, H1 definitely indicates interest in people although H9 could as easily be a member of the fifth factor-classical extraversion.

8.4.4.5 RELIABILITY

The reliability of 0.73 is quite satisfactory for a personality measure.

8.4.5 IDENTIFICATION OF FACTOR FOUR

Summary

Controlled conscientious (high score) v Lax , expedient (low score)

8.4.5.1 COMPARISON OF LOADINGS (Table 8.16)

	This Study	Ormerod and Billing (Factor 5)
Markers	4G+ (3½)	G+ (5)
	2F- (1½)	F- (1½)
	2Q3+ (2)	Q3+ (3)
Stragglers	2A-(1)	-----
	2C+(1½)	C+ (1½)
	1E-(½)	-----
	1Q2+(1½)	Q2+ (1)
	1Q4+(1)	---
	2O-(1½),	O- (1)

8.4.5.2 NATURE OF THE MARKERS

	High Score	Low Score
Trait G+	CONTROLLED CONSCIENTIOUS persistent, staid.	DISREGARDS RULES expedient.
Trait F-	SOBER taciturn, serious	ENTHUSIASTIC 'thick skinned', socially bold.
Trait Q3+	CONTROLLED exacting will power, socially precise.	UNCONTROLLED lax, follows own urges.

8.4.5.3 ACTUAL ITEM COUNT (Table 8.15a and b and 8.16).
This factor has 18 items loading over 0.30 and of these only 8 of Ormerod and Billing's loadings over 0.30 are common with one other loading, a near miss at 0.25. It must be remembered that the corresponding Ormerod and Billing factor is factor five. This is their weakest factor with only 16 items loading >0.30.

8.4.5.4 EXAMINATION OF THE WORDING OF ITEMS (Table 8.20a and b)

The core of 'markers' justify Cattell's descriptors but it is remarkable the fact that there are only four out of ten G+ and two out of ten F-, and two of Q3+ falling on this factor. Carroll and Ormerod and Billing both found four Q3+ items and Asiedu found three of this Cattell descriptor.

The 'stragglers' conform to this controlled precise image (Table 8.16). There is little doubt from the item content that this factor is measuring controlled conscientious high scorers v expedient low scorers, despite items not present in the corresponding Ormerod and Billing factor.

8.4.5.4 RELIABILITY

Reliability at 0.74 is quite satisfactory.

8.4.6 IDENTIFICATION OF FACTOR FIVE

Summary

Classical extraversion (high score) v Introversion (low score)

8.4.6.1 COMPARISON OF LOADINGS(Table 8.16)

	This Study	Ormerod and Billing
Markers	1A- (½)	A- (2)
	1A+ (1)	-----
	2H+ (1½)	H- (5½)
		F- (3½)
Stragglers	2D+ (2)	-----
	-----	E- (½)
	2G+ (1½)	G+ (½)
	1O- (½), 1O+(1)	O+ (1½)
		Q2+(1½)
	1Q3+(1), 1Q3-(½)	-----
	-----	Q4+(½)

8.4.6.2. NATURE OF MARKERS

		High Score	Low Score
Trait H		ADVENTUROUS	SHY
		'thick skinned',	timid, threat-sensitive.
		socially bold.	
Trait A		WARMHEARTED	RESERVED
		outgoing, easy-going,	critical, aloof,
		participating.	stiff.

8.4.6.3 ACTUAL ITEM COUNT (Tables 8.15a and b and 8.16)

Of the 13 items loading on this factor >0.30, 9 occur in the Ormerod and Billing study. The 1+A items in this study are partly equivalent to the 2A- items in the Ormerod and Billing study. There are no corresponding items in the Ormerod and Billing study to the 1A- item shown in this study. The 2H+ items are also encountered in the Ormerod and Billing study . It will be noticed that the signs of all the common 'markers' are reversed in the Ormerod and Billing study, i.e. the Ormerod and Billing factor measures introversion for high scorers and extraversion for low scorers, although the name was reversed to conform to other studies.

The Ormerod and Billing study is richer in H- items, containing six altogether and also in F- items containing four. It must be noted, however, that the Ormerod and Billing factor is the third one whereas in this study it is the fifth factor. There is usually a diminution in salient items (and indeed reliability) from the first to the last factor.

The Ormerod and Billing factor contains 26 compared with 13 in this study. This is the weakest identification by corresponding item content and the identification is mainly justified by the wording of the items.

8.4.6.4 EXAMINATION OF THE WORDING OF THE ITEMS (Tables 8.21a and b)

By and large the items high scoring response reveals the characteristics of the extravert, especially readiness to put oneself forward rather than hang back as the classical introvert would do. e.g. H5, A2, Q3 6,and H6 ; taking the chance to 'show off' (G9) readiness to take responsibility (D4) non conformity with the crowd (J10) or impervious to adverse conditions (-O1). However, the one negative loading A item, A9, demands a high score which contradicts the image of an extravert who should prefer to live on a busy street corner rather than in a deep forest (A9)

A9 is possibly acceptable on the grounds that the extravert is indulging in contrary behaviour to that expected of most pupils.

8.4.6.5 RELIABILITY

The reliability of .69 is acceptable for a fifth factor of a personality scale of only 13 items.

8.5 RELATIONSHIP BETWEEN 'MARKERS' AND 'STRAGGLERS' AND THE CUMULATIVE RELIABILITY OF THE CORRESPONDING SCALES

Woods's cumulative reliability package has thrown a valuable light on the reliability of the 14 primary traits in the HSPQ. In general it has shown that the reliability rises with the stepwise inclusion of about half of the items and then begins to fall off, though the point at which it does so varies from trait to trait and to a lesser extent from study to study. This has been discussed fully in chapter 9, section 9.4.11. and is illustrated in this chapter in tables 8.23a and b together with table 8.24 showing a summary of three studies including this one. In almost every case in these studies some items have to be removed to give maximum reliability. The items in any trait scale can be classified in two groups: those contributing to rising reliability (R+items), and those past the peak reliability contributing to falling reliability (R- items). An example of this is to be found in the Q4 scale. This is set out on the next page in table 8.22.

Table 8.22 Q4 Reliabilities

Reliability	Q4 items	
.398	08	
.398	05	
.408	10	R+ items
.411	04	
.435	09	
.437	02	
.411	07	
.392	06	
.358	03	R- items
.326	01	

It can be inferred from this sort of evidence, Cattell's own acceptance of items with saliency down to 0.20, his use of 'suppressor' items (which Saville and Blinkhorn in the 16 PF indicate as a source of unacceptable reliability) and the results of the five factor solutions found here and by Ormerod and Billing where we find a scatter of odd items from many traits smeared across all five factors as 'stragglers' that most of Cattell's primary traits consist of a core of fairly high correlating items (the R+ items) plus a collection of items remote from this cluster - the suppressors mainly - giving rise to the R- items.

This is not meant to be a rigorous dichotomy, there are likely to be intermediate cases, traits , e.g. trait I with only isolated R- items whilst in others, notably trait J, the reliability never rises above 0.38 across three studies (tables 8.23b, 8.24) and never contributes more than two items per factor in this five factor analysis or the Ormerod and Billing study.

It should also be noted that the 'straggler' items contain words in the items themselves which appear to make them compatible with the rest of the items 'markers' and 'stragglers' alike in a particular factor. Also, they must have a greater correlation with the rest of the items in the factor otherwise they would not appear with loadings above 0.30 on that particular factor.

In these circumstances it is tempting, with reference to the results in table 8.16 to examine the hypotheses that:

(a) The 'marker' items in each factor are derived from the core items of particular traits which are revealed as R+ items in the cumulative reliability tables for that trait, tables 8.23 a and b.

(b) That the 'straggler' items are drawn from the R- items in tables 8.23a and b. Or, alternatively, that they are drawn from the R+ as well.

The same tables were used to tease out the 'straggler' items R-. Then the specific items in the factor analysis (tables 8.15a and b, 8.16) were taken and marked against the full list of items as M1, M2 to M5 if they occurred as 'marker' items on any of the factors one to five or as S1 to S5 if they occurred as a 'straggler' item on the same factors, (table 8.25).

Table 8.23a Reliabilities according to Woods's criteria

Trait A		Trait B		Trait C		Trait D	
Reliab.	Item	Reliab	Item	Reliab.	Item	Reliab.	Item
397	A9	449	B8	476	C7	423	D7
397	A7	449	B7	476	C2	423	D2
440	A6*	491	B6	492	C1	481	D3
439	A1*	540	B9	512	C4	502	D8
411	A3*	550	B5	538	C10	528	D6
395	A5*	559	B3	562	C3	553	D9
388	A10	574	B1	584	C9	555	D5*
378	A2	581	B4	590	C8*	539	D1*
364	A8	592	B2	585	C5	511	D10
341	A4*	591	B10	577	C6	494	D4
2R+(1R+),3R-				8R+(1R+),1R-		6R+,2R-	

Trait E		Trait F		Trait G		Trait H	
447	E10	427	F6	611	G6*	399	H5
447	E5	427	F4*	611	G2*	400	H9
482	E1*	469	F9	475	G4	487	H6
507	E9	500	F5	475	G5	534	H4*
521	E2	491	F8	495	G7	555	H10
540	E8	506	F7	519	G10	564	H3*
544	E3	529	F10*	531	G9	573	H8
544	E4	528	F1	541	G3*	580	H7
550	E7*	527	F2*	524	G1*	591	H1
459	E6	530	F3*	470	G8	570	H2*
7R+,1R-		6R+(1R+),0R-		5R+(2R+),1R-		7R+(2R+),0R-	

Notes: (1) * Not in this analysis. (2) ( ) indicates where some items are loading on more than one factor.

Table 8.23b Reliabilities according to Woods's criteria

Trait I		Trait J		Trait O		Trait Q2	
Reliab.	Item	Reliab.	Item	Reliab.	Item	Reliab.	Item
670	I8	329	J10	403	O3	492	Q2 4
670	I3	329	J6*	403	O2	492	Q2 3
676	I9	319	J5*	445	O4	488	Q2 9
703	I7	345	J3*	476	O5*	503	Q2 5
718	I5	379	J1*	502	O8*	511	Q2 1
732	I10	378	J7*	494	O6	503	Q2 10
743	I4	368	J8*	507	O10	498	Q2 6
751	I6	332	J4	490	O7*	488	Q2 7
758	I2	283	J9*	489	O1	458	Q2 8*
739	I1	222	J2*	440	O9*	341	Q2 2
9R+(1R+),1R-		1R+,1R-		5R+(2R+),1R-(1R-)		5R+(1R+),4R-	

Trait Q3		Trait Q4	
Reliab.	Item	Reliab.	Item
426	Q3 10	398	Q4 8
426	Q3 2	398	Q4 5
471	Q3 9	407	Q4 10*
472	Q3 8	410	Q4 4
475	Q3 5	434	Q4 9
449	Q3 3	437	Q4 2*
458	Q3 1*	411	Q4 7*
459	Q3 7*	392	Q4 6
461	Q3 4*	358	Q4 3*
412	Q3 6	326	Q4 1*
5R+,2R-		4R+,1R-	

Notes: (1) * Not in this analysis. (2) ( ) indicates where some items are loading on more than one factor.

Table 8.24

RELIABILITIES OF HSPQ TRAITS

TRAIT	BILLINGS	WALLER	ASIEDU	CARROLL	TOTAL
A	.47	.34	.61	.52	.50
C	.44	.58	.41	.52	.73
D	.43	.50	.48	.38	.42
E	.46	.50	.48	.49	.44
F	.48	.53	.64	.52	.54
G	.51	.47	.62	.35	.44
H	.50	.57	.62	.46	.53
I	.74	.74	.71	.74	.77
J	.26	.22	.24	.36	.34
O	.38	.44	.41	.48	.54
Q2	.48	.34	.42	.24	.35
Q3	.42	.41	.39	.23	.35
Q4	.35	.32	.41	.14	.29

Table 8.25 'Markers' and 'Stragglers'

A1	C1 M1	D1*	E1	F1 S1,S2
2 S5*	2 M2	2 M2	2 M1	2
3	3 S4,M1	3 M2	3 S2	3
4*	4 S4	4 S5*	4	4
5*	5 M1,S4*	5	5 M1	5 M3
6	6 M2*	6 M2	6 M1*	6 M3
7 S4	7 M2	7 M2	7	7 M3
8 S3	8	8 M2	8 M1	8 M4
9 S4,M5	9 M1	9 M2	9 M1	9 M4
10 S1*	10 S3	10 S5*	10 M1	10

G1	H1	I1 S2	J1 S2	O1 S2,S5*
2*	2*	2 M1*	2*	2 S4,S3
3	3	3 M1	3	3 S4
4 M4	4	4 M1	4 S3*	4 S3
5 M4	5 M5,M3	5 M1	5	5
6	6 M5	6 M1	6	6 S1,S5
7 S2,S5,M4	7	7 M1	7	7*
8 S2	8 M3	8 M1	8*	8
9 S5	9 M3	9 M1	9*	9*
10 M4	10 S1,M3	10 M1	10 S5	10 S2

Q2(1) S2	Q3(1)	Q4(1)*
2 M3*	2 M4	2
3 M3	3 S3*	3*
4 M3	4*	4 M2
5 M3,S4	5 S2	5 S1
6 S1*	6 S5*	6 S4*
7 S1	7	7*
8*	8 S5	8 S1
9 S3	9 S2	9 M2
10 S1*,	10 M4	10

Number of R- items = 31 (* by the item number)
Number of R+ items = 99

No. of Markers on R- = 05
No. of Markers on R+ = 47
Total 52

No. of Stragglers on R- = 10
No. of Stragglers on R+ = 34
Total 44

No. of items not used R- = 14
No. of items not used R+ = 23
Total 37

8.6 TESTING HYPOTHESES FOR THE 'MARKERS' AND 'STRAGGLERS

8.6.1 TO TEST THE FIRST HYPOTHESES

That the 'marker' items on the five factors are drawn from the R+ items in the cumulative reliability tables and hence from the core items in the primary traits

In the 130 items of the 13 traits of the HSPQ, 33 were marked R- and the rest, i.e. 97 were hence R+ items, tables 8.23a and b.

There are 47 R+ items and 5 R- items which are 'markers' making a total of 52,(table 8.25). If there had been the same ratio of 'markers' on R+ items to 'markers' on R- items there would have been a ratio of 97:33 = .746:.294

The ratio of 47:5 is a greater ratio of markers on R+ items to stragglers on R- items than would be expected. The probability that this ratio of 47:5 is greater than the expected ratio of .746:.254 can be found by the binomial test (Siegel, 1956, pp 36-42). For an example of the calculation refer to Appendix E.2. The test of the hypothesis that the observed distribution of R+ and R- items is more extreme in favour of R+ items predominantly among the markers, in the poulation from which this sample is drawn, yields a level of significance of .007 for a one tail test. Thus, the hypothesis that the markers in this five factor analysis tend to be drawn from the R+ items, i.e. the ones contributing to a rising reliability in the individual traits, according to Adrian Woods cumulative reliability, is supported at a highly significant level.

8.6.2 TO TEST THE SECOND HYPOTHESIS

That the 'straggler' items were derived from the R- items in the cumulative reliability tables and that by inference they were not core items in the primary traits.

As before there are 97 items classed as R+ items and 33 classed as R- items.

In this case we have 12 'straggler' items occuring on R- items and 33 on R+ items giving a total of 45 'straggler' items altogether.

Since we have 33 'straggler' items drawn from R+ items and only 12 drawn from R- items, quite clearly it is no use testing the hypothesis that the straggler items are mainly drawn from the R- items.

We must, therefore, concentrate on the alternative hypothesis that the 'straggler' items are mainly drawn from the R+ items.

This again was done by the binomial test but in this case the result is not significant at all. Consequently, we can only say that the source of the 'straggler' items is indeterminate in the population from which the sample is drawn. Even though the majority of the 'straggler' items came from the R+ items the proportion which do so is not large enough for us to assert that this is a significant likelihood for the population at large.

8.6.3 THE DROP OUTS

The 'markers' and 'stragglers' accounted for 100 items out of the 130 items (excluding 10 B intelligence items) in the HSPQ. All these items had loadings on the five factors > .30.

It might be argued by Cattell and his supporters that the use of only 100 out of 130 items was a waste of data, but in view of Wood's researches on the cumulative reliability of primary traits something like 30 to 40 items, depending on the study, would have to be discarded to achieve maximum reliability for the traits.

8.7 OVERVIEW OF CHAPTER 8

8.7.1 FIVE OR SIX FACTOR SOLUTION?

It has been a tricky decision to select the optimium number of factors for this personality study.

At first the six factor solution seemed to be the correct choice. All six factors had an acceptable reliability and a good spread of items all with significant loadings, $\geqslant .30$.

However, all other personality studies conducted at Brunel have produced five factor solutions. To clearly establish the claims of the six factor solution a very thorough appraisal of its structure was carried out.

This appraisal of the six factor solution showed that two factors, three and five, appeared to be measuring a similar area of personality, namely the controlled conscientious v lax-expedient dimension (except the items belonging to the same primary trait in factor five are loading with opposite signs to the ones in factor three, section 8.3.4, table 8.12). It may be said that in effect the item content of the factor three and five is measuring the same psychological trait or its converse, but the factor five items represent such an over precise sort of personality that it is rejected by those who show up as reasonably conscientious on factor three.

The five factor solution, on the other hand, is measuring five clearly defined personality measures. The reliabilities of all factors, even factor five which has only 13 items, are all acceptable for personality measures. An examination of the wording of the items together with a comparison with a similar personality study performed by Ormerod and Billing (1982) strengthened the claims of the five factor solution.

It was decided for the following reasons to select the five factor solution:

(1) Two of the factors in the six factor solution were measuring the same personality dimension.

(2) All five factors, of the five factor solution had very reasonable reliabilities, .69 for factor five to .84 for factor one.

(3) An examination of the wording of the items, for each factor, confirmed the selected psychological trait. Factor five, classical extraversion v. introversion, provides examples of the way that the wording can confirm the choice of the personality measure- H5, A2, Q3 6, and H6 all demonstrate readiness to put one self forward rather than hang back as the classical introvert would do; taking the chance to show off (G9); readiness to take responsibility (D4) are all attributes *of the extravert*.

(4) Comparison with the Ormerod and Billing study revealed a large measure of agreement between the two studies.

(5) Comparison with other personality studies that have been conducted at Brunel, section 8.1, table 8.2, demonstrate that this study has similar major traits within its factors.

(6) Summary of the Final Five Factor Solution

	High Score	Low Score	Rel.
Factor 1	Tough	Tender-minded	.84
Factor 2	Neurotic	Stable	.79
Factor 3	People	Things	.73
Factor 4	Controlled Conscientious	Lax Expedient	.74
Factor 5	Classical Extraversion	Introversion	.69

Note: Rel = Reliability.

(7) The items loading ≥ .30 on any factor can be divided into 'markers' and 'stragglers'. The 'markers' are sets of items comprising three or more items drawn from any of Cattell's Primary traits, which help to define the nature of the factor. The 'stragglers' are isolated items or pairs of items drawn from a variety of other traits whose meanings, however, imply they are compatible with those of the 'marker' items. This phenomenon occurs in all the four personality studies, on the HSPQ, conducted at Brunel.

(8) The binomial test reveals that a highly significant proportion of the 'markers' are drawn from the R+ items which contribute positively to the reliability of Cattell's individual traits, section 8.6.2. A majority of the 'straggler' items are also drawn from the R+ items but the proportion is not so great as to be statistically significant for the population from which the sample was drawn.

8.8 CHAPTER 9

8.8.1 PSYCHOLOGICAL PROFILES

The relationships between the personality factors and attitude variables are analysed using regression equations. The personality profiles associated with attitudes towards CDT are discussed.

CHAPTER 9 DISCUSSION AND EXPLANATION OF THE PSYCHOLOGICAL PROFILES ASSOCIATED WITH THE ATTITUDES TO CDT OF THE SEPARATE SEXES

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CHAPTER 9 DISCUSSION AND EXPLANATION OF, THE PSYCHOLOGICAL PROFILES ASSOCIATED WITH THE ATTITUDES TO CDT OF THE SEPARATE SEXES

9 .1 INTRODUCTION

It must be said at the outset that these findings are bound to be tentative. This is because of the size of the sample. Although the structure of attitudes to CDT was worked out with a sample of 405 pupils of 14+, it was only possible to administer the HSPQ personality questionnaire to 105 of these pupils in one school. Later the total was made up to 191, the following year, by administering the questionnaire to more pupils in that school in order to get a sufficient number of HSPQ results. This was done to make the factor analysis of the 130 variables in the HSPQ valid, since the number of subjects must be greater than the number of variables for effective factor analysis. Factor scores were then generated for the analysis of all 191 pupils, but only in 105 cases (62 boys and 43 girls), could they be related to attitude scores and the scores for the other variables, TOTTS, FAMSKIL, TUTS, TUTD, TCAR, TSLIK and MATH.

As a consequence of this, levels of significance have been reported at the .10 and occasionally the .25 levels, in addition to the usually accepted .05 and .01 levels. With a larger sample these .10 and .25 levels of significance might well have been at the .01 and .05 levels although not necessarily so. Nevertheless, in the discussion below it will be shown that the personality traits exhibited in association with the attitude and other measures have a certain logic behind them. They are what one would expect and they fit in with other findings in the study.

9.2 THE MAIN FINDING

The main finding is certainly not vitiated by the smallness of the sample. It is that the two sexes are presenting across the whole of the five attitude scales a completely different psychological profile.

It will be seen from the code of symbols used in the regression equations that the five personality scores revealed by the factor analysis in chapter 8, section 8.4.2 and inferred from the table of HSPQ items loading on each factor (table 8.16) that each personality characteristic represents a continuum between two extremes of personality described by that factor , e.g. factor 1 - Tough - minded to Tender-minded, factor 2 - Neurotic to Stable. The factors have been named in such a way that the high scorer comes first and the low scorer description second, e.g. on factor 1 high scores are tough minded and low scorers tender minded (8.7.1 (6)).

Regression equations are of the form:

Dependent variable = Constant $-^{+}b_1X1, -^{+}b_2X_2, -^{+}b_3X$

where beside the initial constant there are other constants b_1, b_2etc multiplying the score on the related variable X_1, X_2, X_3 etc. whose relationship to the dependent variable is being investigated by the regression programme - in this case the factor scores on the five personality variables. The programme determines the value of all these constants and if the respondents personality scores are inserted as X_1, X_2etc. the equation will generate the respondents attitude factor score as the dependent variable.

The programme tests by the 'F test' which variables are significantly related to the dependent variable and reports an 'F value' from which the level of significance can be found from tables. Also by measuring the correlation of X_1, X_2 with the dependent variables r_1, r_2 calculates $r_1^2 \cdot r_2^2$ etc. which gives the proportion of the variance in the dependent variable accounted for by each variable X_1, X_2 etc.

Furthermore, if the constants b are positive it implies a positive correlation with the X value concerned and hence a high value of X, e.g. tough-mindedness is associated with the dependent attitude variable and if the constant is negative it implies a low value of X, e.g. tender-mindedness is associated with the high score on the dependent attitude variable.

9.2.1 FACTOR 1 . VASTEC (tables 9.1,2 and 3)

High boy scorers on this factor appreciate the value and skills of CDT and generally enjoy it. In the case of this attitude the only associated personality characteristic was a modest tendency to neuroticism whose chief characteristic is anxiety and worry. This is in keeping with the findings in Chapter 7, section 7.3.2 where it was found that in the case of boys there was a negative correlation between VASTEC and RELXTEC, again indicating that in the case of boys liking for technical studies was associated with some tension rather than relaxation as appeared with the girls. This situation in turn was probably due to the fact that technical studies were attracting the less intelligent and less mathematically able boys (Chapter 7, section 7.5).

Table 9.1 CODE FOR SYMBOLS USED IN REGRESSION EQUATIONS IN CHAPTER 7

Attitude Scores	Derived from Attitude Questionnaire
VASTEC	Factor one
CRITEC	Factor two
DRAWTEC	Factor three
SOCTEC	Factor four
RELXTEC	Factor five

Other measures of relevance in CDT	
TSLIK	Liking for technical work
TOTTS	Total number of Technical Subjects in Favourite Five
FAMSKIL	Family member in work requiring technical skills
TUTS	Intending to take technical studies in the 4th year
TUTD	Intending to take technical drawing in the 4th year
TCAR	Intending to take a technical career
MATH	Ability in Mathematics

Table 9.2 FIVE BASIC PERSONALITY SCORES

Factor	High Score	Low Score	code
1	Tough	Tender Minded	T/TM
2	Neurotic	Stable	N/S
3	People	Things	P/Th
4	Controlled Conscientious	Lax Expedient	CC/LE
5	Classical Extraversion	Introversion	E/I

Table 9.3 PSYCHOLOGICAL PROFILES ASSOCIATED WITH ATTITUDES TO CDT

Attitude No. 1 VASTEC

Boys

VASTEC =	9.2	+	.16 N/S		
%Variance			4.8		
Significance (F)			.10(3.0)		

Girls

VASTEC =	3.2	+	.27	+	.17
%Variance			6.4 E/I		4.1 N/S
(Total=10.5)					
Significance (F)			.10(2.8)		.25(1.89)

Notes on Regression Equations

The actual F values are given in brackets after the level of significance throughout. For the boys the levels of significance of the variables entered in the regression equations are given by the F test with the following degrees of freedom:

(a) Boys : First variable 1 and 60; second ,2 and 59; third, 3 and 58; fourth, 4 and 57 .

(b) Girls: First variable, 1 and 41; second, 2 and 40, third, 3 and 39; fourth, 4 and 38.

The personality pattern associated with VASTEC in the case of girls is mainly different. The main personality trait accounting for 6.4% of the variance was extroversion, which agrees with the finding that girls find technical studies relaxing (as discussed previously). This was only significant at the .10 level, however, possibly due to the fact that classical extraversion is the fifth and weakest factor with a reliability of only .60. A lower variance, 4.1%, is associated with neuroticism (anxiety). This cannot be due to lack of ability as in the case of the boys but may be present because girls display some anxiety at being present in what they rate as a male preserve.

Tables 11.9 - 15 give regression equations for the 'other' variables in the study relevant to interest in technical studies i.e, TSLIK, TOTTS, FAMSKIL, TUTS, TUTD, TCAR and MATH. All these variables correlate significantly with VASTEC (Chapter 7 table 7.12).

	TSLIK	TUTS	TCAR	MATH
GIRLS-Correlation r	.558	.343	.318	.293
% common variance r^2	31	11.8	10.1	8.6
BOYS -Correlation r	.341	.360	.117	.084
% common variance r^2	11.6	13	2.9	negligible

In the case of boys none of these variables are significantly related to neuroticism / stability (N/S) except MATH. Although this is surprising it is not impossible. The variance in VASTEC (only 4.8%) associated with personality could well be a different portion of the variance of VASTEC to that held in common with the above variables since it is very large.

Since MATH is also associated with N/S, in the case of boys, this might involve the variance of VASTEC which is associated with neuroticism. There could be another reason for the MATH N/S regression which will be discussed with the regression equations for these variables later.

In the case of girls TSLIK has a different personality pattern to VASTEC for similar reasons to that given for the boys. The TUTS regression equation, however, does contain an element of neuroticism (anxiety) probably for the same reason that the VASTEC equation does i.e. taking up technical studies later is a somewhat unusual thing for girls to do in a mixed school - which might cause some anxiety about how they will cope with it.

MATH ability is not a significant correlate of VASTEC in the case of girls but TCAR is, albeit to a lesser extent than with boys (.117), only accounting for 2.9% of common variance. Nevertheless, as with VASTEC the most significant term in the TCAR regression equation is extraversion in the case of girls.

9.2.2 FACTOR 2 CRITEC (Table 9.4)

Boys

CRITEC = None of the five major personality factors reaches significance in the prediction of this attitude. The total percentage variance predicted is only 4.8

Girls

CRITEC =	13.05	+ .29 E/I	-.20 P/Th	-.17 N/S -	.25 T/TM
%Variance		10.0	5.7	4.2	3.7
(Total=23.6%)					
Significance (F)		.05(4.49)	.10(2.65)	.10<.25(2.2)	.10<.25(1.99)

This factor has as high scorers those who reject criticisms of CDT studies.

Boys show no significant personality traits against scores on this factor.

In the case of girls the most significant personality trait is, as with VASTEC, extraversion although the correlation between the two factors is not significant (.16, common variance = 2.5%). The next personality factor associated with CRITEC scores is preference for working with things rather than people which is not unexpected for girls working in CDT.

The other two variables in the equation represent a trace of stability or contentment as opposed to anxiety and tender-mindedness - also to be expected among females in particular who are uncritical of a subject. The proportion of variance accounted for by personality is the highest for any measure (23.6%) for either sex.

9.2.3 FACTOR 3 DRAWTEC (Table 11.5)

Boys

DRAWTEC =	14.5	- .40 P/Th	+.21 CC/LE	-.16 N/S
%Variance		15	5	3
(Total=23%)				
Significance (F)		.005(9.0)	.05(3.1)	.10(2.4)

Girls

DRAWTEC =	5.4	+.25 P/Th	+.34 T/TM
%Variance		9.6	7.6
(Total=17.2)			
Significance (F)		.05(4.3)	.05(3.7)

This factor consists of a series of items concerned with technical drawing and the graphical representation of technical work. These items are scored in such a way as to indicate a pro-technical drawing stance, e.g.

'Technical Drawing is important and several jobs need it'.

Only two of the six items refer to enjoyment of technical drawing. The rest are concerned with its educational and commercial value.

It would be expected that the psychological profile of the high scorer on DRAWTEC would match that of the high scorer on TUTD, i.e. the pupil who contemplates taking up the further study of technical drawing. This is only partly true.

Thus for boys we have:

DRAWTEC = 14.35	-.40 P/Th	+.21 CC/LE	-.16 N/S
% variance	15	5	3
(total = 23%)			
Significance	.005	.05	.10

The personality measures account for the highest proportion of the variance on any measure except girls CRITEC and attain the highest level of significance.

The correlating personality measures are exactly what one might expect. The main variable, preference for things rather than working with people, the second being careful conscientious - certainly required for technical drawing and graphical work - and the last stability rather than neuroticism.

For TUTD in the case of boys we have:

TUTD =1.28	−.14 E/I	+.17 P/Th	+.09 CC/LE
% variance	5.7	6.1	2.6
(total = 14.4%)			
significance	05	.025	.10<.25

Hence the only exact match is with 'controlled conscientious'.
'People/Things' is the most significant trait but the sign is the other way round indicating that boys intending to take up technical drawing and graphical studies further prefer working with people to things. An almost equally important personality variable is introversion - again a reasonable aspect of personality to expect from those interested in studying technical drawing and graphical work.
These differences should not be surprising when it is noted that the correlations between DRAWTEC and TUTD are not high:
Boys .125(1.6% common variance).
Girls .041 (negligible common variance). Obviously scores on DRAWTEC are not measuring the same thing as TUTD, i.e. an appreciation mainly of the value of technical drawing is a different thing to the rationale behind pursuing the study of it further.

In the case of girls we encounter a similar degree of disparity between the personality profiles of the DRAWTEC High scorer and that of the girls intending to take up further study of it - TUTD.

DRAWTEC	=	5.4 +	.25 P/Th	+ .34 T/TM
% variance			9.6	7.6
(total = 17.2)				
Significance			.05	.05
TUTD	=	-1,17 +	.15 N/S	+.22 T/TM
%variance			4.7	3.8
(total = 8.5)				
Significance			.10<.25	.25

Tough-mindedness comes into both - probably due to the fact that girls willing to support and enter a province that has previously been male dominated have got to be rather tough-minded - more of a masculine than a feminine personality trait.

In girls' DRAWTEC there is the somewhat contrary aspect of the 'people/thing' personality factor - preferring working with people rather than things - just as in boys' TUTD and opposite to what was found in boys DRAWTEC.

The most prominent aspect of personality in girls' TUTD is however an element of stability as opposed to neuroticism. This is not present in boys TUTD but is opposite to the weakest personality element in boys' DRAWTEC where neuroticism , i.e. anxiety is present. This is possibly due to boys anxiety about the difficulties encountered in Technical Drawing which appeared in their inability to relax in technical work in general in contrast to the girls.

It should also be noted that in contrast to both boys 'DRAWTEC and TUTD and girls' DRAWTEC the proportion of the variance explained by the personality measures and their significance is far lower for girls' TUTD. This is due to the fact that girls' TUTD attracts far less numbers willing to contemplate further study of technical drawing hence a much lower variance and greater imprecision is associated with the measure.

9.2.4 FACTOR 4 SOCTEC (Table 9.6)

High scorers on this attitude measure show a favourable attitude to the influence of technology on society. Again, the personality pattern of the sexes associated with high SOCTEC scores are different:

BOYS: SOCTEC = 10.64	+.28 N/S	-.27 E/I
%Variance(Total =10.6%)	6.2	4.4
Significance (F)	.05(4.7)	.10(2.9)

GIRLS: SOCTEC = 10.65	-.20 N/S	+.28 T/TM
%Variance(Total =10.4%)	6.2	4.2
Significance(F)	.10(2.7)	.10<.25(1.9)

Thus, with boys favourable SOCTEC scores, are associated with neuroticism (anxiety) and classical introversion whereas with girls they are associated with the reverse of neuroticism - stability and slight tough-mindedness.

There seems to be no easy explanation relating these personality traits to SOCTEC or the sex difference.

Considering the SOCTEC relationships to the other variables it is found that the correlations are lower than for any other attitude.

	TSLIK	TOTTS	FAMSKIL	TUTS	TUTD	TCAR	MATH
BOYS	.066	.086	.031	.028	.123	.091	.192
GIRLS	.199	.126	-.043	.196	.030	-.182*	.240

The association with mathematics for both sexes is curious at first, but mathematics is the only one of these variables correlating with intelligence and it could be that only the more intelligent of both sexes appreciate the wider importance of SOCTEC.

The only statistically significant difference in these correlations is the difference in correlation with SOCTEC and TCAR: .091 for boys and -.182 for girls. A favourable view of the social implications of technology is slightly off putting to girls as regards a career based on CDT although the correlations with other variables expressing liking for CDT: TSLIK, TOTTS and TUTS are all higher for girls than boys although not significantly so. Thus favourable attitudes to SOCTEC seem slightly more helpful in getting girls to like CDT (TSLIK and TOTTS) and even study it further (TUTS) but leads to a rejection of a CDT based career.

It is also noteworthy that TUTS has a personality aspect, tough mindedness, in common with SOCTEC for girls. TCAR, where there is a negative association with SOCTEC in the case of girls, has exactly the opposite personality profile to TUTS, i.e. tender-mindedness and stability as against tough-mindedness and neuroticism for TUTS, (table 9 .14).

9.2.5 FACTOR 5 RELXTEC (table 9.7)

This attitude measure only has significant personality variables in the regression equation for boys:

Table 9.7 Attitude No 5 RELXTEC

Boys

RELXTEC	= 4.04	+.40 T/TM	+ .18 CC/LE
%Variance		5.0	3.4
(Total = 8.4%)			
Significance (F)		.05(3.7)	.10(2.2)

This depicts the boy who is relaxed in CDT as tough minded and also controlled and conscientious.

Tough-mindedness is the commonest personality feature in the measures associated with liking for CDT for boys occurring in TSLIK, TOTTS, TUTS and TCAR (see summary table 9.16). Of these only TSLIK correlates significantly with RELXTEC for boys, but FAMSKIL correlates negatively (-.146) and presents the completely opposite principal personality profile, i.e. tender-mindedness instead of tough-mindedness.

Girls

RELXTEC None of the five personality factors has any significant correlation with RELXTEC.

9.3 SUMMARY

The relation of personality to the attitudes presents a useful picture which should lead to greater understanding of pupils of both sexes by teachers, if replicated with larger samples.

In particular the girls in no case present a common personality profile with the boys and isolated single personality factors in common with the two sexes are rare.

When the correlations of the attitude scores with the other measures 'TOTTS to TCAR' are examined some common personality measures appear but there are more differences. This indicates that the other measures of interest in CDT: TSLIK, TOTTS, TUTS, TUTD and TCAR (attitude correlations are shown in table 9.8) are not replicating the attitude measures even though they have some common variance, but in the main are measuring different aspects of interest in CDT which will be discussed in more detail at a later stage.

Finally, the personality profiles associated with the attitude measures have a validatory function insofar as, in general, they are the 'expected' personality profiles which are found in association with the different attitude scales and even where not quite expected there is a somewhat deeper explanation for their presence.

9.4 THE RELATIONSHIPS OF THE OTHER VARIABLES (TSLIK, TOTTS, FAMSKIL, TUTS, TUTD, TCAR and MATH) TO PERSONALITY

9.4.1 DEFINITIONS OF THESE VARIABLES

TSLIK - 'Do you enjoy technical studies?' Range 5-1 (Strongly agree to Strongly disagree)

TOTTS - Pupils were asked to rank their five favourite subjects in order of liking. This yielded ipsative scores which are technically undesirable see section 7.2.1. A satisfactory score was obtained by adding the number of technical subjects in the favourite five. Since this was in no case more than 2 the range for this variable was 0-2.

FAMSKIL - Responses to item 'Is anyone in your family employed in a job requiring technical skills?'

Range 1 - 2 (No, Yes).

TUTS - 'Do you intend to take technical studies in the 4th year?'

Range 1 - 3 (No, Undecided, Yes)

TUTD - 'Do you intend to take technical Drawing in the 4th year?'

Range 1 - 3 (No, Undecided, Yes)

TCAR - 'Do you intend to take up a technical career?'

MATH - Mathematical ability , range 7 - 1 (Good to remedial)

9.4.2 INTRODUCTION

Unlike the attitude scores which were generated as pure uncorrelated factor scores and hence could be expected to be associated with different facets of personality, these variables are all correlated to varying extents (refer table 9.8) - although some of the correlations differ significantly for the two sexes leading to the importance of setting up regression equations for the separate sexes.

These equations are shown in full in tables 9.9 to 9.15. A summary which is more convenient for comparisons is given in table 9.16. This summary table allows a certain amount of condensation of the data and its discussion which was not possible in the case of the attitude variables.

As in the case of the attitude variables, however, there are extensive differences between the sexes in the personality characteristics associated with each variable.

Table 9.8 Showing correlation of variables with VASTEC

		TSLIK	TUTS	TCAR	MATH
Girls Correlation	r	.558	.343	.318	.293
% Common Variance	r^2	31	11.8	10.1	8.6
Boys Correlation	r	.341	.360	.117	.084
% Common Variance	r^2	11.6	13	2.9	Negligible

REGRESSION RELATIONSHIPS OF OTHER VARIABLES (TSLIK, TOTTS, FAMSKIL, TUTS, TUTD, TCAR and MATH) WITH PERSONALITY

TSLIK (Table 9.9)

Boys

TSLIK =	2.88	+	.06 CC/LE	+	.07 T/TM
%Variance			5.6		2.4
Significance (F)			.05(4.00)		.25(1.53)

(Total = 8)

Girls

The only personality variable which attains any reasonable level of significance is :

TSLIK =	3.95	-	.07 P/Th
%Variance			3.4
Significance (F)			.25(1.45)

TOTTS (Table 11.10)

Boys

TOTTS =	-1.00	+.16 T/TM	-.05 N/S	+	.05 E/I
%Variance		8.7	3.3		3.0

(Total = 15)

Significance (F)	.01(8.2)	.05<.10(2.81)	.10(2.16)

Girls

TOTTS = +	.55	-	.03 N/S
%Variance	4.3		
Significance (F)	.10<.25(1.85)		

FAMSKIL (Table 9.11)

Boys

FAMSKIL=	1.95	+	.03 N/S	-	.04 T/TM
%Variance			4.0		2.5
(Total = 6.5)					
Significance (F)			.10(2.93)		.25(1.59)

Girls

FAMSKIL =	1.52	+	.06 E/I	-	.045 CC/LE
%Variance			11.9		7.9
(Total = 19.8)					
Significance (F)			.025(5.59)		.05(3.97)

TUTS (TABLE 9.12)

Boys

TUTS =	1.0	+	.13 T/TM
%Variance			2.5
Significance (F)			.25(1.55)

Girls

TUTS =	.67	+	.02 N/S	+	.03 T/TM
%Variance			4.3		3.8
(Total = 8.1)					
Significance (F)			.10<.25(1.94)		.20(1.65)

TUTD (Table 9.13)

Boys

TUTD =	1.28	- .14 E/I +	.17 P/TH	+ .09 CC/LE
%Variance		5.7	6.1	2.6
(Total = 14.4)				
Significance (F)		.05(4.09)	.25(5.43)	.10<.25(1.77)

Girls

TUTD =	- 1.17	+ .15 N/S +	.22 T/TM
%Variance		4.7	3.8
(Total = 8.5)			
Significance (F)		.10<.25(2.18)	.25(1.64)

TCAR (Table 9.14)

Boys

TCAR =	1.63	+ .09 T/TM	- .05 P/Th
%Variance		5.6	3.6
Significance (F)		.10(2.87)	.10(2.34)

Girls

TCAR= 1.53	+.07 E/I	-.09 T/TM	+.05 P/Th	-.04 N/S
%Variance	7.3	6.5	3.8	3.0
(Total = 20.6)				
Significance (F)	.10(3.46)	.10(3.41)	.25(1.87)	.25(1.43)

MATH (Table 9.15)

Boys

MATH =	5.4	+	.13 N/S	-	.12 CC/LE
%Variance			4.9		3.5
(Total = 8.4)					
Significance (F)			.05<.10(3.2)		.10(2.3)

Girls

MATH =	3.5	-	.12 CC/LE
%Variance			4.3
Significance (F)			.10<.25(1.84)

Table 9.16 SUMMARY OF PERSONALITY VARIABLES ASSOCIATED WITH ATTITUDES TO CDT AND RELATED VARIABLES: TSLIK, TOTTS etc

		BOYS					GIRLS				
	Factor	T/TM	N/S	P/Th	CC/LE	E/I	T/TM	N/S	P/Th	CC/LE	E/I
Attitude											
VASTEC	1		N(,1)					N(,25)			E(,1)
CRITEC	2	NO SIGNIFICANT VARIABLES					TM(,1<,25)	S(,1<,25)	Th(,1)		E(,05
DRAWTEC	3		S(,1)	Th(,005)	CC(,05)		T(,05)		P(,05)		
SOCTEC	4		N(,05)			I(,1)	T(,1<,25)	S(,1)			
RELXTEC	5	T(,05)			CC(,1)		NO SIGNIFICANT VARIABLES				
TSLIK		T(,25)			CC(,05)				Th(,25)		
TOTTS		T(,01)	S(,05<,1)			E(,1)		S(,1<,25)			
FAMSKIL		TM(,25)	N(,1)							LE(,05)E(,025)	
TUTS		T(,25)					T(,20)	N(,1<,25)			
TUTD				P(,025)	CC(,1<,25)	I(,05)	T(,25)	N(,1<,25)			
TCAR		T(,1)		Th(,1)			TM(,1)	S(,25)	P(,25)		E(,1)
MATH			N(,05<,1)		CC(,1)					CC(,1<,25)	
TALLY OF		Tough	Neurotic	People	Con,C,	Extrovert	Tough	Neurotic	People	Con,C,	Extrovert
PERSONALITY		5	3	1	4	1	4	3	2	0	4 HIGH
CHARACTER-		Tender	Stable	Things	Lax,E,	Introvert	Tender	Stable	Things	Lax,E,	Introvert
ISTICS(ex-		1	2	2	0	2	2	4	2	1	0 LOW
cluding MATH)											

Notes:(1) Each factor has two extremes -High and Low;

	T/TM	N/S	P/Th	CC/LE	E/I
High	T=Tough Minded	N=Neurotic	P=People	CC=Controlled Conscientious	E=Classical Extrovert
Low	TM=Tender Minded	S=Stable	Th=Things	LE=Lax Expedient	I=Classical Extrovert

(2)The decimal faction in brackets indicates the level of significance - ,05,,1,,25 etc,

(3)If in the regression equation the sign of the relevant personality measure is positive it is the high description T,N,P,CC or E which is associated with high scores on the dependant measure, If the corresponding sign is negative it is low descriptions TM,S,Th,LE or I which are associated with high scores on the dependant measure VASTEC to TCAR,

9.4.3 THE MEASURES RELATED TO LIKING FOR CDT(TSLIK, TOTTS, TUTS,

TUTD AND TCAR)

Although slanted slightly differently, all these variables are related to liking for technical work:

TSLIK and TOTTS most directly, TUTS and TUTD more indirectly because they are based on whether the pupils wish to follow technical studies when they become optional in later years. TCAR is the $64000 question 'Do you intend to take up a technical career?'

9.4.4 TSLIK, TOTTS AND TUTS

BOYS: The common feature in the regression equations for these variables is Tough-mindedness (refer to tables 9.9,9.10 and 9.12 and table 9.16). A common feature might be expected from the moderate correlations between these measures:

	TOTTS	TUTS
TSLIK	.342	.447
TOTTS		.341

TOTTS differs from the other two in having additional elements of stability and extraversion among its personality correlates whereas TSLIK is additionally associated with an element of 'Controlled conscientiousness' which is a very desirable attribute for a good CDT student.

TUTS on the other hand is distinguished only by the personality characteristic of tough-mindedness. The nearest thing to these variables is TCAR -' the intention to take up a technical career'. This also has tough-mindedness among its personality correlates. In this case it is associated with interest in things and ideas rather than people. Again this is a personality characteristic which is to be expected in the potential technician or technologist.

GIRLS: Here the pattern of personality characteristics is different but not entirely so.

Tough mindedness is associated with TUTS - 'intentions to take up technical studies further'.

This is more to be expected from girls who may feel they need a streak of tough mindedness in them to combat the alien environment. An element of neuroticism (anxiety) is not to be regarded as unlikely in the same environment.

TOTTS itself with girls is associated with stability as it is with boys but not with tough-mindedness or extraversion as with boys.

The only personality variable associated with TSLIK in the case of girls is interest in things rather than people which is again quite a likely trait for the technically minded.

Thus since the intercorrelations of these three variables for girls is slightly less than for boys:

	TOTTS	TUTS
TSLIK	.161	.343
TOTTS		.256

there is more dissimilarity in the personality patterns of these variables for girls .

9.4.5 TUTS AND TUTD

BOYS: It had been noted in the chapter on attitudes, (chapter 7, section 7.4 and table 7.14) that there were wide discrepancies in correlations of these two variables with other variables in the group.

This discrepancy is repeated in the personality profile of those boys proposing to study these two subjects (Technical Studies and Technical Drawing) further. With TUTS the only associated variable is tough-mindedness. With TUTD the most prominent personality characteristic is preference for people rather than things which is rather the opposite to what would be expected. On the other hand the other two associated variables are controlled conscientiousness and introversion both of which are only to be expected.

GIRLS: the dissimilarity of TUTS and TUTD does not however extend to the girls. Both TUTS and TUTD are associated with almost the same degree of Tough-mindedness and neuroticism. This is understandable since both TUTS and TUTD have been traditionally male preserves and are quite likely to require a degree of tough-mindedness and evoking a degree of anxiety (neuroticism) to enter them.

9.4.6 FAMSKIL

This a measure of technical skill in the family of the pupil. It is known from other studies (e.g. Ainley and Clancy, 1983) that parental technical skill and interest is a potent factor in inducing interest in technical studies and a technical career and it was found in this study that FAMSKIL was a high correlate of TUTS and TCAR in boys and TUTS and TUTD but not TCAR in girls.

	TUTS	TUTD	TCAR	MATH
FAMSKIL(BOYS)	.341	.090	.441	-.250
FAMSKIL(GIRLS)	.859	.441	.027	.015

However FAMSKIL has completely different personality correlates for the two sexes.

Boys: Here in contrast to boys associated with five of the other variables, boys with technical skills in the family, are predominantly tender-minded and also neurotic (betraying anxiety).

The reason for this latter aspect of personality is that these boys have a negative correlation with MATH performance. This weakness in mathematics is sufficient to explain this neuroticism.

Concern about their families reaction to their difficulties in CDT could aggravate their anxiety.

Girls from 'FAMSKIL' families seem rather 'devil may care'. They are lax and expedient rather than careful and conscientious which occurs in four personality profiles for the boys, (refer table 9.16). They are not anxious (neurotic) but extravert as they are if contemplating a career in technical work (TCAR) and also in VASTEC and CRITEC, whereas extroversion only appears once in boys personality profile with TOTTS.

9.4.7 PERSONALITY PROFILES ASSOCIATED WITH MATHEMATICS PERFORMANCE

BOYS: There are two traits, neuroticism possibly due to anxiety generated by the lower than average performance in mathematics of that group of boys probably most anxious to do well, i.e. the FAMSKIL group, and careful conscientious which is a trait that would be expected to be associated with good performance in mathematics.

GIRLS: The same trait, careful conscientious, is the only significant aspect of personality associated with mathematical performance in the case of the girls.

9.4.8 SUMMARY OF PERSONALITY CHARACTERISTICS ASSOCIATED WITH THE OTHER MEASURES TOTTS TO TCAR

Once again the majority of the personality traits associated with these measures are the logical and easily explicable ones adding to the profile of the keen and interested CDT student.

There are, as before, widespread sex differences although a few more similarities between the sexes than found in the personality characteristics associated with the attitudes to CDT.

9.4.9 OVERVIEW OF PERSONALITY CHARACTERISTICS EXHIBITED BY THE TWO SEXES

The five attitude variables and the other variables related to CDT liking and choice except MATH are all in one way or another pro CDT .

A tally of the total frequencies of the various high or low aspects of the five personality characteristics across all these variables results is a way of gaining a composite picture of the pro CDT pupil of both sexes at 14+. This has been done by adding the appearances of various high and low personality characteristics in the columns of table 9.16. These totals are shown at the bottom of these columns in that table. It is repeated, for convenience, on the next page.

Table 9.16 SUMMARY OF PERSONALITY VARIABLES ASSOCIATED WITH ATTITUDES TO CDT AND RELATED VARIABLES: TSLIK, TOTTS etc

		BOYS					GIRLS				
	Factor	T/TM	N/S	P/Th	CC/LE	E/I	T/TM	N/S	P/Th	CC/LE	E/I
Attitude											
VASTEC	1		N(,1)					N(,25)			E(,1)
CRITEC	2	NO SIGNIFICANT VARIABLES					TM(,1<,25)	S(,1<,25)	Th(,1)		E(,05
DRAWTEC	3		S(,1)	Th(,005)	CC(,05)		T(,05)		P(,05)		
SOCTEC	4		N(,05)			I(,1)	T(,1<,25)	S(,1)			
RELXTEC	5	T(,05)			CC(,1)		NO SIGNIFICANT VARIABLES				
TSLIK		T(,25)			CC(,05)				Th(,25)		
TOTTS		T(,01)	S(,05<,1)			E(,1)		S(,1<,25)			
FAMSKIL		TM(,25)	N(,1)							LE(,05)E(,025)	
TUTS		T(,25)					T(,20)	N(,1<,25)			
TUTD				P(,025)	CC(,1<,25)	I(,05)	T(,25)	N(,1<,25)			
TCAR		T(,1)		Th(,1)			TM(,1)	S(,25)	P(,25)		E(,1)
MATH			N(,05<,1)		CC(,1)					CC(,1<,25)	
TALLY OF		Tough	Neurotic	People	Con,C,	Extrovert	Tough	Neurotic	People	Con,C,	Extrovert
PERSONALITY		5	3	1	4	1	4	3	2	0	4 HIGH
CHARACTER-		Tender	Stable	Things	Lax,E,	Introvert	Tender	Stable	Things	Lax,E,	Introvert
ISTICS(ex-		1	2	2	0	2	2	4	2	1	0 LOW
cluding MATH)											

Notes;(1) Each factor has two extremes -High and Low;

	T/TM	N/S	P/Th	CC/LE	E/I
High	T=Tough Minded	N=Neurotic	P=People	CC=Controlled Conscientious	E=Classical Extrovert
Low	TM=Tender Minded	S=Stable	Th=Things	LE=Lax Expedient	I=Classical Extrovert

(2)The decimal faction in brackets indicates the level of significance - ,05,,1,,25 etc,

(3)If in the regression equation the sign of the relevant personality measure is positive it is the high description T,N,P,CC or E which is associated with high scores on the dependant measure, If the corresponding sign is negative it is low descriptions TM,S,Th,LE or I which are associated with high scores on the dependant measure VASTEC to TCAR,

Factor	1	2	3	4	5
High Description	Tough minded	Neurotic (anxious)	Pref for People	Controlled Conscientious	Extravert
Freq. (BOYS)	5	3	1	4	1
Freq. (GIRLS)	4	3	2	0	4
Low Description	Tender minded	Stable	Pref for Things	Lax Expedient	Introvert
Freq, (BOYS)	1	2	2	0	2
Freq. (GIRLS)	2	4	2	1	0
Overall high and low totals	12	12	7	5	7

The overall high and low totals approximately follow the order of the factors extracted which is to be expected since the order of the extraction follows the percentage of variance accounted for by each factor.

The most abundant personality characteristic is tough-mindedness accounting for one more case among boys (5:4) and three times as much as its opposite tender-mindedness (9:3).

The next most abundant characteristic is stability which is twice as frequent among the girls as the boys (4:2). This is equalled by its opposite, neuroticism.

Neuroticism is the same for both sexes (3:3). The next most frequent characteristic is extraversion which is definitely a girls characteristic in the ratio 4:1 compared with the boys with whom introversion is more dominant in the ratio of 2:0.

The other gender based characteristic is controlled conscientious which is in the ratio 4:0 with the boys the more dominant. Whereas with its opposite lax expedient there are low frequencies for both sexes with the girls having the edge with a ratio (1:0).

The most evenly distributed personality factor is number 3- preference for working with people on the one hand or things and ideas on the other. Preference for things is evenly divided 2:2 between the sexes. The total of four cases has the edge over the three instances of preference for people which divides itself 1:2 in favour of the girls. Preference for working with things might be expected among the CDT orientated who are much more likely to be boys than girls.

9.4.10 THE OVERALL PERSONALITY PROFILE OF THE PRO CDT BOY OR GIRL

Both sexes are likely to be tough-minded rather than tender-minded. Thereafter the sexes divide.

The girls are likely to be stable, extraverts with a slight tendency to prefer working with people and to being lax and expedient.

On the other hand the boys are far more controlled and conscientious, introverts rather than extraverts, neurotic rather than stable and slightly more inclined to like working with things rather than people.

Table 9.17 The Intercorrelations of the Personality Scores in the Sub Sample (105 pupils = 62 boys and 43 girls)

Boys = 62	HF1	HF2	HF3	HF4	HF5
HF1	1.00	.11	- .13	- .09	- .22
HF2	.11	1.00	- .21	- .00	.10
HF3	- .13	- .21	1.00	- .31	.07
HF4	- .09	- .00	- .31	1.00	- .09
HF5	- .22	.09	.07	- .09	1.00

The only correlations where we cannot reject the hypothesis of common variance at the .05 level is that between Factor 3 and 4, People v. Things and Controlled conscientious v. Lax expedient, where the correlation of .31 implies a $.31^2 = .096$ or 9.6% common variance.

Girls = 43	HF1	HF2	HF3	HF4	HF5
HF1	1.00	- .02	.04	- .53	- .04
HF2	- .02	1.00	.00	- .15	.02
HF3	.04	.00	1.00	- .30	- .04
HF4	- .53	- .15	- .29	1.00	- .04
HF5	- .04	.02	- .04	- .04	1.00

It is not possible to reject the hypothesis of common variance at the .05 level between Factors 1 and 4, Tough v. Tender-mindedness and Controlled conscientious v. Lax expedient. .53 produces $.53^2 = .281$ or 28.1% common variance.

Note: All correlations are to two decimal places.

Table 9.18 The Intercorrelations of Attitude Scores in the Sub Sample

Boys = 62	HF1	HF2	HF3	HF4	HF5
HF1	1.00	- .02	- .08	.21	- .03
HF2	- .02	1.00	.16	- .04	- .00
HF3	- .08	.16	1.00	- .25	- .04
HF4	.21	- .04	- .25	1.00	.24
HF5	- .03	- .00	- .04	.24	1.00

There are two sets of correlations where we cannot reject the hypothesis of common variance at the .05 level and these are between the two, pairs of Factors 4 and 3, SOCTEC and DRAWTEC (r^2 = 6.3%) and Factors 4 and 5, SOCTEC and RELXTEC, r^2 = 5.8%)

Girls = 43	HF1	HF2	HF3	HF4	HF5
HF1	1.00	.16	.23	- .02	.10
HF2	.16	1.00	- .18	.21	.26
HF3	.23	- .18	1.00	- .11	- .21
HF4	- .02	.21	- .11	1.00	- .18
HF5	.10	.26	- .21	- .18	1.00

It is not possible to reject the hypothesis of common variance at the .05 level between two pairs of Factors, 1 and 3, VASTEC and DRAWTEC (r^2 = 5.3%) and Factors 2 and 5, CRITEC and RELXTEC (r^2 = 6.8%)

Although with the whole sample N = 405 the factor scores for personality and attitude were pure uncorrelated scores the separation out of the sub sample of 105 pupils has distorted the situation slightly but not seriously.

9.4.11 COMPARISON OF PSYCHOLOGICAL PROFILES ASSOCIATED WITH THE ATTITUDES TO CDT BETWEEN THE FIVE PERSONALITY MEASURES AND CATTELL'S TRAITS

9.4.11.1 INTRODUCTION

The previous analysis of the psychological profiles of CDT students is based on the five factor + intelligence factor analysis of the individual items in Cattell's HPSQ (chapter 10). This has been replicated in three other Brunel studies Ormerod and Billing (1982); Carroll (1982) and Asiedu 1987 ongoing work, all yielding Tough/Tender-minded; Neurotic/Stable; People/Things; Controlled conscientious/Lax expedient and Extraversion/Introversion factors. This model of personality has received wider support from Brand's survey (1984) which cites 14 other studies which have suggested a six factor model of personality (including intelligence).

On the other hand Cattell in the HSPQ claims to have detected 14 traits including intelligence with 10 items measuring each. Unlike the above six factors, which are virtually independent even before generating factor scores, 13 of Cattell's traits are intercorrelated, of low reliability and based on loadings as low as .20. Many other research workers have failed to replicate Cattell's results.

Furthermore, the ongoing researches of Adrian Woods in the faculty of education and design at Brunel have developed computerized cumulative reliability methods for factored scales. In this method the computer selects the two salient items correlating most highly and hence contributing most to the reliability and then adds in successive items in order of the increase they supply to reliability.

In some cases the reliability rises to a peak or a plateau by the time all the items have been used (trait I, table 8.23b repeated with table 8.23a for convenience). In other cases the reliability after rising with a certain number of items begins to decline as other items are added, (Traits A,O,Q2,Q3 and Q4 table 8.23 a and 8.23b). Thus, these latter items detract from the reliability and should be discarded. This is precisely what happens with the majority of Cattell's primary HSPQ traits.

The effects of reliability is graphically shown in table 8.24, a summary of three studies including this one. In almost every case in these three studies some items have to be removed to give maximum reliability and the total reliability without these items becomes less.

In this study in calculating the scores for the 14 Cattell traits only the items leading up to the maximum reliability have been used in calculating the trait score.

As a result of all this less confidence is placed in the Cattell's traits than the five factors of personality used previously. Since other studies especially in America tend to use Cattell's traits uncritically, the relationships of attitudes to Cattell traits have been calculated and psychological profiles in terms of them produced in the following pages for completeness sake.

Table 9.19 Cattell's descriptors of the 14 primary traits

Jr.-Sr. H S P Q TEST PROFILE

LOW SCORE DESCRIPTION		HIGH SCORE DESCRIPTION
RESERVED, DETACHED, CRITICAL, ALOOF, STIFF (Sizothymia)	A	**WARMHEARTED**, OUTGOING, EASY-GOING, PARTICIPATING (Affectothymia, formerly cyclothymia)
DULL, CONCRETE-THINKING (Lower intelligence)	B	**BRIGHT**, ABSTRACT-THINKING (Higher intelligence)
AFFECTED BY FEELINGS, EMOTIONALLY LESS STABLE, EASILY UPSET, CHANGEABLE (Lower ego strength)	C	**EMOTIONALLY STABLE**, MATURE, FACES REALITY, CALM (Higher ego strength)
UNDEMONSTRATIVE, DELIBERATE, INACTIVE, STODGY (Phlegmatic temperament)	D	**EXCITABLE**, IMPATIENT, DEMANDING, OVERACTIVE, UNRESTRAINED (Excitability)
OBEDIENT, MILD, EASILY LED, DOCILE, ACCOMMODATING (Submissiveness)	E	**ASSERTIVE**, AGGRESSIVE, COMPETITIVE, STUBBORN (Dominance)
SOBER, TACITURN, SERIOUS (Desurgency)	F	**ENTHUSIASTIC**, HEEDLESS, HAPPY-GO-LUCKY (Surgency)
DISREGARDS RULES, EXPEDIENT (Weaker superego strength)	G	**CONSCIENTIOUS**, PERSISTENT, MORALISTIC, STAID (Stronger superego strength)
SHY, TIMID, THREAT-SENSITIVE (Threctia)	H	**ADVENTUROUS**, "THICK-SKINNED," SOCIALLY BOLD (Parmia)
TOUGH-MINDED, REJECTS ILLUSIONS (Harria)	I	**TENDER-MINDED**, SENSITIVE, CLINGING, OVER-PROTECTED (Premsia)
ZESTFUL, LIKES GROUP ACTION (Zeppia)	J	**CIRCUMSPECT INDIVIDUALISM**, REFLECTIVE, INTERNALLY RESTRAINED (Coasthenia)
SELF-ASSURED, COMPLACENT, SECURE, PLACID, SERENE (Untroubled adequacy)	O	**APPREHENSIVE**, SELF-REPROACHING, INSECURE, WORRYING, TROUBLED (Guilt proneness)
SOCIABLY GROUP-DEPENDENT, A "JOINER" AND SOUND FOLLOWER (Group dependency)	Q_2	**SELF-SUFFICIENT**, PREFERS OWN DECISIONS, RESOURCEFUL (Self-sufficiency)
UNCONTROLLED, LAX, FOLLOWS OWN URGES, CARELESS OF SOCIAL RULES (Low self-sentiment integration)	Q_3	**CONTROLLED**, EXACTING WILL POWER, SOCIALLY PRECISE, COMPULSIVE, (High strength of self-sentiment)
RELAXED, TRANQUIL, TORPID, UNFRUSTRATED, COMPOSED (Low ergic tension)	Q_4	**TENSE**, FRUSTRATED, DRIVEN, OVERWROUGHT, FRETFUL (High ergic tension)

Table 8.23a Reliabilities according to Woods's criteria

Trait A		Trait B		Trait C		Trait D	
Reliab.	Item	Reliab	Item	Reliab.	Item	Reliab.	Item
397	A9	449	B8	476	C7	423	D7
397	A7	449	B7	476	C2	423	D2
440	A6*	491	B6	492	C1	481	D3
439	A1*	540	B9	512	C4	502	D8
411	A3*	550	B5	538	C10	528	D6
395	A5*	559	B3	562	C3	553	D9
388	A10	574	B1	584	C9	555	D5*
378	A2	581	B4	590	C8*	539	D1*
364	A8	592	B2	585	C5	511	D10
341	A4*	591	B10	577	C6	494	D4
2R+(1R+),3R-				8R+(1R+),1R-		6R+,2R-	

Trait E		Trait F		Trait G		Trait H	
447	E10	427	F6	611	G6*	399	H5
447	E5	427	F4*	611	G2*	400	H9
482	E1*	469	F9	475	G4	487	H6
507	E9	500	F5	475	G5	534	H4*
521	E2	491	F8	495	G7	555	H10
540	E8	506	F7	519	G10	564	H3*
544	E3	529	F10*	531	G9	573	H8
544	E4	528	F1	541	G3*	580	H7
550	E7*	527	F2*	524	G1*	591	H1
459	E6	530	F3*	470	G8	570	H2*
7R+,1R-		6R+(1R+),0R-		5R+(2R+),1R-		7R+(2R+),0R-	

Notes: (1) * Not in this analysis. (2) ( ) indicates where some items are loading on more than one factor.

Table 8.23b Reliabilities according to Woods's criteria

Trait I		Trait J		Trait O		Trait Q2	
Reliab.	Item	Reliab.	Item	Reliab.	Item	Reliab.	Item
670	I8	329	J10	403	O3	492	Q2 4
670	I3	329	J6*	403	O2	492	Q2 3
676	I9	319	J5*	445	O4	488	Q2 9
703	I7	345	J3*	476	O5*	503	Q2 5
718	I5	379	J1*	502	O8*	511	Q2 1
732	I10	378	J7*	494	O6	503	Q2 10
743	I4	368	J8*	507	O10	498	Q2 6
751	I6	332	J4	490	O7*	488	Q2 7
758	I2	283	J9*	489	O1	458	Q2 8*
739	I1	222	J2*	440	O9*	341	Q2 2
9R+(1R+),1R-		1R+,1R-		5R+(2R+),1R-(1R-)		5R+(1R+),4R-	

Trait Q3		Trait Q4	
Reliab.	Item	Reliab.	Item
426	Q3 10	398	Q4 8
426	Q3 2	398	Q4 5
471	Q3 9	407	Q4 10*
472	Q3 8	410	Q4 4
475	Q3 5	434	Q4 9
449	Q3 3	437	Q4 2*
458	Q3 1*	411	Q4 7*
459	Q3 7*	392	Q4 6
461	Q3 4*	358	Q4 3*
412	Q3 6	326	Q4 1*
5R+,2R-		4R+,1R-	

Notes: (1) * Not in this analysis. (2) ( ) indicates where some items are loading on more than one factor.

Table 8.24

RELIABILITIES OF HSPQ TRAITS

TRAIT	BILLINGS	WALLER	ASIEDU	CARROLL	TOTAL
A	.47	.34	.61	.52	.50
C	.44	.58	.41	.52	.73
D	.43	.50	.48	.38	.42
E	.46	.50	.48	.49	.44
F	.48	.53	.64	.52	.54
G	.51	.47	.62	.35	.44
H	.50	.57	.62	.46	.53
I	.74	.74	.71	.74	.77
J	.26	.22	.24	.36	.34
O	.38	.44	.41	.48	.54
Q2	.48	.34	.42	.24	.35
Q3	.42	.41	.39	.23	.35
Q4	.35	.32	.41	.14	.29

9.5 PSYCHOLOGICAL PROFILES ASSOCIATED WITH ATTITUDES TO CDT

9.5.1 CATTELL'S TRAITS

As before, regression equations were used, (section 9.2). Instead of the five personality scores Cattell's original 14 primary traits with modified scoring were used. Cattell's own description of these 14 traits is given in table 9.19. The regression equations are set out below:

9.5.1.1 ATTITUDE NO. 1 VASTEC

Boys (Table 9.20)

VASTEC=	1.14	+.17H	+.34Q2	+.26F	+.27Q3
% Variance		10%	2%	3%	3½%
(18½% Tot.Var.)					
Significance (F)		.025(2.85)	.001(4.94)	.001(6.19)	.005(3.7)

This factor has as high scorers those who have a 'pro-stance' to CDT. According to Cattell's model of personality the main traits show that it is the bold (H) decision making (Q2) boy who is enthusiastic (F) but controlled (Q3) who has a positive attitude toward CDT.

Girls (Table 9.21)

VASTEC=	-13.3	+.41B	+.25F	+.40G	+.26(O)
% Variance		7½%	6%	9%	4%
(26½% Tot. Var.)					
Significance (F)		.025(2.8)	,01(4.4)	.01(6.7)	.05(2.4)

The traits that account for over 1/4 of the total variance for girls are intelligence (B), enthusiasm (F), persistance (G) with an outgoing nature with a suggestion of insecurity (O) possibly due to being in an area that was formerly a male preserve. An element of neuroticism (anxiety) was also found in VASTEC and the TUTS regression equation,(9.2.1). The relationship between liking CDT and intelligence was also found in Chapter 7 , section 7.3.10 (6).

9.5.1.2 ATTITUDE NO.2 CRITEC

Boys (Table 9.22)

CRITEC=	9.0	+.30A	-.46Q4	+.34O
% Variance		6%	4%	8%
(18% Tot. Var.)				
Significance (F)		.10(2.3)	.001(6.3)	.005(5.7)

Pupils who score highly on this factor reject criticism of CDT. The boys tend to be outgoing (A), relaxed (-Q4) with a slight tendency to insecurity (O), possibly due to the fact that the less intelligent and less mathematically able boys take up technical work (section 9.2.1).

Girls (Table 9.23)

CRITEC=	10.8	+.44B	-.20E
% Variance		6½%	6%
(12½% Tot. Var.)			
Significance (F)		.01(3.6)	.10>.25(2.7)

Girls who reject criticism of technical work are intelligent (B) and docile (-E).

9.5.1.3 ATTITUDE NO. 3 DRAWTEC

Boys (Table 9.24)

DRAWTEC=	15	-.40F	+.22H
% Variance		22%	6%
(28% Tot. Var.)			
Significance (F)		.01(22.5)	.01(5.1)

Boys who have a leaning towards the graphical area within CDT are serious (-F) and socially bold (H).

Girls (9.25)

DRAWTEC=	17.2	-.33Q3	-.19(I)
% Variance	12%	7%	
(19% Tot. Var.)			
Significance (F)	.01(3.7)	.01(3.4)	

The girls in contrast to the boys tend to be careless (-Q3) and are tough-minded (-I) which was also found present in TUTD, (section 9.2.3). This again supports the view that girls when entering a previously male dominated domain have to be tough-minded.

9.5.1.4 ATTITUDE NO. 4 SOCTEC

Boys (Table 9.26)

SOCTEC	=.96	+.36Cm	+.44Am
% Variance		7½%	7%
(14½% Tot. Var.)			
Significance (F)	.01(7.2)	.01(4.8)	

Boys with a favourable attitude towards the influence of technology in society are mature (C) and outgoing (A) which is only to be expected.

Girls (Table 9.27)

SOCTEC=	-.55	+.37B	+.36(O)	-.22Q4	+.42Q2	+.41A
% Variance		11%	7%	5%	4½%	5½%
(33% Tot. Var.)						
Significance (F)		.01(2.53)	.01(4.9)	.1<.25(1.6)	.01(5.1)	.02(3)

The traits that account for 1/3 of the total variance depict girls as intelligent (B), showing signs of apprehension (O), relaxed (-Q4) and outgoing (A).

A study of these traits indicates that they present an inconsistent personality profile. Trait +O (apprehension) and trait -Q4 (relaxed) seem to be at opposite ends of the continuum similar to the second personality factor Neurotic v Stable (N/S).

9.5.1.5 ATTITUDE NO. 5 RELXTEC

Boys (Table 9.28)

RELXTEC=	.38	+.17C	+.21E	+.17G
% Variance		8%	2%	3%
(13% Tot. Var.)				
Significance (F)		.10<.25(1.86)	.01(2.6)	.10<.25(1.8)

This depicts the boy who is relaxed in CDT as mature (C), aggressive (E) and persistent (G).

There appears to be some conflict here because the boy who finds technical work relaxing should have no desire to be aggressive. Signs of tension were found in Chapter 7, section 7.3.2 within the RELXTEC factor.

Girls (Table 9.29)

RELXTEC=	2.83	+.62B	+.13F
% Variance		14%	3%
(17% Tot. Var.)			
Significance (F)		.01(7.3)	.10>.25(5)

The girls display qualities of intelligence (B) and enthusiasm (F). These are traits that indicate that they are relaxed within the subject area and are enjoying it.

9.5.2 GENDER DIFFERENCES

To fully demonstrate that there are considerable differences between the personality profiles, resulting from a study of Cattell's primary traits, we shall firstly reflect on any similarities.

In VASTEC both boys and girls reflect enthusiasm which is only to be expected with a pro-CDT factor. It is worth noting that the girls % variance is twice that of the boys (6% v 3%).

The only other trait that occurs for both sexes is trait A (outgoing) within SOCTEC which is likely for pupils with a favourable attitude towards the influence of technology in society.

Throughout this study gender differences abound (sections 9.3, 9.4.9 and Chapter 7, section 7.4).

In VASTEC the boys appear to demonstrate more commitment towards technical work (Chapter 7, section 7.3.10 (1)). Again (Chapter 7, section 7.3.10 (6)), it is the intelligent girls that have a pro-stance towards CDT. They need the enthusiasm and persistence to gain as much as possible from the rather shallow background that the girls had in all schools in this study, (Chapter 8, section 8.1.1).

In both CRITEC and RELXTEC the boys are demonstrating insecurity (anxiety) and aggression which are both signs of tension. In contrast the girls significant traits, in the regression equations with these attitude measures, show that they have the intelligence and a relaxed, calm approach together with the enthusiasm to enable them to reject criticism of technical work and thoroughly relax whilst taking it.

In DRAWTEC the boys and girls are at the opposite ends of the 'careful -careless' continuum. There is some similarity between Cattell traits F and Q3. It would be expected that the serious boy would also display qualities of carefulness.

Boys appear to have a slightly more positive approach to the influence of technology in society, (SOCTECH).

9.6 PSYCHOLOGICAL PROFILES ASSOCIATED WITH OTHER CDT VARIABLES USING REGRESSION EQUATIONS

9.6.1 VARIABLES USED

TSLIK 'Do you enjoy Technical Studies?' Range 5-1 (Strongly Agree to Strongly Disagree). This item was the example item in the attitude questionnaire.

The following variables were obtained from the 26 item information questionnaire:

TOTTS - Pupils were asked to list their five favourite subjects, from all their school subjects, in order of liking. TOTTS is the number of CDT subjects in this list. Since no pupil cited more than two such subjects the range is 0-2.

FAMSKIL - Responses to item 'Is anyone in your family employed in a job requiring technical skills?' Range 1 - 2 (No, Yes).

TUTS - 'Do you intend to take Technical Studies in the 4th year? 'Range 1 - 3
(No, Undecided, Yes).

TUTD - 'Do you intend to take Technical Drawing in the 4th year?' Range 1 - 3
(No, Undecided, Yes).

TCAR - 'Do you intend to take up a technical career?' Range 1 - 3 No, Undecided, Yes).

MATH - Mathematical ability , Range 7 - 1 (Good to Remedial).

9.6.1.2 TSLIK (Liking for technical work)

Boys(Table 9.30)

TSLIK=	5.8	-.06D	-.06A
% Variance		6%	2½%
(8½% Tot Var.)			
Significance (F)		.05(3.6)	.25(1.66)

According to Cattell's model of personality the main traits show that it is the stodgy (-D) and critical (-A) boy who has a positive attitude towards CDT. These traits only account for less than 10% of the total variance.

Girls (Table 9.31)

TSLIK=	4.4	+.31B	-.16Q3	-.09D	-.08E	+.13A
% Variance		16%	5%	4%	3%	4%
(32% Tot. Var.)						
Significance (F)		.01(10)	.01(4.4)	.05(2.8)	.05(2.3)	.10(2)

The traits that account for 1/3 of the total variance show that the girls are Intelligent (B), careless (-Q3), stodgy(-D) docile (-E) and outgoing (A).

9.6.1.3 TOTTS (Totals of selection of technical subjects depicting a pro-CDT stance)

Boys (Table 9.32)

TOTTS	=1.56	+.07E	-.032(I)	-.05H
% Variance		11%	5%	4%
(20% Tot.Var.)				
Significance (F)		.01(5.1)	.01(4.9)	.01(2.84)

Boys who enjoy doing technical subjects are likely to be aggressive (E), tough-minded (-I) and shy (-H).

Someone who is shy is 'threat-sensitive' and would be expected to compensate for this by being aggressive and tough-minded. Cattell's primary traits E (aggressive) and I (tough-minded) are thought by many research workers to be measuring similar aspects of personality, (Ormerod and Billing , 1982).

Girls (Table 9.33)

TOTTS	=1.59	-.11Q3	-.37F	+.33C
% Variance		8%	5½%	3½%
(17% Tot. Var.)				
Significance (F)		.01(7.3)	.05(2.8)	.10<.25(1.64)

The traits depicting girls who would like to take technical subjects seem to be at variance with each other. They describe these girls as careless (-Q3), serious (-F) and mature (C). Usually someone who is serious and mature tends not to be lax (careless).

9.6.1.4 FAMSKIL (Member of the family with technical skills)

Boys (Table 9.34)

FAMSKIL	=1.58	-.034D	+.02F	+.024(I)
% Variance		2%	2%	2%
(6% Tot. Var.)				
Significance (F)		.01(2.7)	.25(1.4)	.25(1.2)

The significant traits associated with FAMSKIL achieved a total variance of only 6%. They show boys with a technical family member to be stodgy (-D), happy-go-lucky and tender-minded.

Girls (Table 9.35)

FAMSKIL	=.82	+.04H	+.05(O)	-.06B
% Variance		7%	5½%	4%
(16½% Tot. Var.)				
Significance (F)		.025(3.6)	.05(2.8)	.10<.25(2.1)

For girls the total variance reaches 16½% and they are depicted as socially bold('thick-skinned') (H), insecure (O) and a little less unintelligent (-B) than the average.

9.6.1.5 TUTS (Taking up technical studies)

Boys (Table 9.36)

TUTS	=1.97	-.24B	-.11(I)	+.11D	+.1G
% Variance		10%	4%	3%	4%
(21% Tot. Var.)					
Significance (F)		.01(4.9)	.025(2.9)	.025(3.2)	.05(2.8)

Boys who take up technical studies tend to be unintelligent (-B), tough-minded (-I), impatient (demanding) (D) and persistent(G).

Girls (Table 9.37)

TUTS	.83	+.04A	-.05Q3	+.03C
% Variance		6%	4%	7%
(17% Tot. Var.)				
Significance (F)		.10<.25(2.1)	.025(3.8)	.05(3.3)

It appears to be the outgoing (A), careless (-Q3) and calm (C) girls who have an intention of taking technical studies.

9.6.1.6 TUTD (Taking up technical drawing)

Boys (Table 9.38)

TUTD	-2.96	+.12G	+.12D	+.18B
% Variance		3½%	4%	3%
(10½% Tot. Var.)				
Significance (F)		.01(3.4)	.01(3.2)	.10(2.12)

Boys who intend to take up technical drawing tend to be conscientious (G), demanding (D) and intelligent (B).

Girls (Table 9.39)

TUTD	=-2.9	+.25H	-.12(I)	+.2Q4
% Variance		14%	4%	3½%
(21½% Tot. Var.)				
Significance (F)		.01(7.4)	.10<.25(1.9)	.10<.25(1.9)

Girls with a leaning towards graphical work tend to be socially bold (thick-skinned) (H), slightly tough-minded (-I) and tense (Q4).

9.6.1.7 TCAR (Intention of taking up a technical career)

Boys (Table 9.40)

TCAR	=.73	+.06H	+.06E	-.04F
% Variance		6½%	3%	4%
(13½% Tot. Var.)				
Significance (F)		.01(4.8)	.01(3.3)	.01(2.8)

Boys who demonstrate an intention of taking up technical work as a career are adventurous (H), aggressive (E) and serious (-F).

Girls (Table 9.41)

TCAR	=.395	-.09A	-.15B	+.08G	+.05D	.06(O)
% Variance		12½%	7½%	7½%	7%	3½%
(38% Tot. Var.)						
Significance(F)		.05(2.8)	.01(7.7)	.01(5.7)	.05(2.8)	.05(2.2)

The traits which accounted for nearly 2/5ths of the total variance show that these girls are critical (-A), unintelligent (-B), conscientious (G), demanding (D) and insecure (O).

9.6.1.8 MATH (Ability for mathematics)

Boys (Table 9.42)

MATH	2.86	+.26B	-.13(O)
% Variance		4½%	4%
(8½% Tot.Var.)			
Significance (F)		.05<.10(2.84)	.05<.10(2.8)

The traits associated with MATH depict boys as being intelligent (B) and self assured(-O).

Girls (Table 9.43)

MATH	5.6	+.73B	+.08I	-.19C	-.16D
% Variance		30%	6½%	3%	3½%
(43% Tot. Var.)					
Significance (F)		.01(31.3)	.10(1.99)	.01(6.23)	.01(3.26)

This is the regression equation with the highest value for total variance which shows that the girls are intelligent(B), tender-minded (I), easily upset(-C) and stodgy(-D).

9.6.2 GENDER DIFFERENCES

Again, there are considerable differences between the personality profiles between the sexes. There are only two sets of regression equations in which traits are repeated . In TSLIK both boys and girls are depicted as stodgy (undemonstrative) (-D) and in MATH where both sexes are shown to be intelligent. It is worth noting that the girls variance is nearly seven times as large as the boys variance, (30% v 4½%) in MATH.

In TSLIK the boys again express some form of dissatisfaction through trait A- (criticism) which indicates that they are under some tension whilst taking the subject. One of the few signs of a 'sparkle' in the traits for both sexes is with the girls who appear to be intelligent (B) and outgoing (A). The other traits associated with TSLIK paint a gloomy picture of the pupils, of both sexes, who are pro-CDT.

Certainly in TOTTS the boys reflect feelings of some tension. It would appear that the greater number of technical subjects that boys include in the favourite five the more aggressive they appear to become. Girls seem to more serious and mature when thinking of selecting more than one technical subject.

Having a technical family member seems to encourage boys to be under less tension whilst for the girls the traits indicate that an unitelligent girl needs support to 'put on a brave face' to cover up for her insecurity.

Considering taking up technical studies (TUTS) as with liking technical studies (TSLIK) and choice of more than one technical subject within the favourite five (TOTTS) all have traits associated with some type of aggression. Whereas in TUTS the girls appear to be relaxed and calm.

The balance of traits for boys intending to take up technical Drawing (TUTD) are those expected for graphical work. The stance of the girls of tough-mindedness with some degree of tension is once again only to be expected in a formerly male dominated and usually male led subject area, (9.4.5).

A study of the traits associated with intending to take up a technical career (TCAR) shows that the boys have a much more positive approach in comparison to the girls who express feelings of insecurity .

Although the variable based on ability in mathematics (MATH) in the regression equations indicates that the boys are intelligent and self assured they are not based on a very high value of variance, (8½%). The total variance shown for the girls equations is one of the highest in this chapter with 30% accounting for the intelligence trait. This confirms earlier suggestions that the girls mathematical ability among those interested in CDT is far superior to that of the boys, (Chapter 7, section 7.3.10 (6)).

9.7 COMPARISON OF CATTELL'S TRAITS WITH THE FIVE PERSONALITY MEASURES

9.7.1 INTRODUCTION

The main reason for carrying out the two sets of regression equations was to try to establish any similarities between both sets of personality measures. However, before proceeding to the comparison of these results which were obtained by the measurement of personality by the two different methods from the same data it is probably necessary to refresh the reader's mind on the structure of the five personality traits used in the first part of this chapter, (sections 9.1 to 9.4.9). The method of arriving at Cattell's 14 primary traits and its weaknesses have been discussed in section 9.4.11 which preceded the discussion of the relationships between the attitude and other measures of inclination for the study of CDT and these 14 traits.

The five personality traits were arrived at by factor analysis of the scores of 130 items, (excluding the 10 intelligence items), described in chapter 8, section 8.3 to 8.4.1). Briefly, 37 items (some of which may have contributed to Cattell's traits as measured in this study) have been rejected as not loading on any factor >.30. The remaining 93 items are distributed by factor analysis among five factors, (table 8.16 reproduced here as table 9.44).

It will be seen from this table that in the first four factors at least they are distinguished by several groups of 3 to 9 items drawn from single Cattell traits with high loadings on these single factors. These have been arbitrarily termed 'Markers' for the factor since their item content (chapter 3, section 8.5, table 8.22) largely contributes to the decision as to what the factor is measuring.

Table 9.44 Five Factor solution of the HSPQ in this study (Refined) - excluding intelligence

Factor1 Items	Factor2 Items	Factor3 Items	Factor4 Items	Factor5 Items
I2-*	D2+*	H1+(,29)	G4+*	H5+*
I3-*	D3+*	H5+*	G5+*	H6+*
I4-*	D6+*	H7+(,28)	G7+*	A2+*
I5-*	D7+*	H8+*	G10+*	A9-*
I6-*	D8+*	H9+(,28)	F8-	D4+
I7-*	D9+	H10+	F9-*	D10+
I8-	C2-*	Q2 2+*	Q3 2+*	G7+
I9-*	C6-	Q2 3-*	Q3 10*+	G9+*
I10-*	C7-*	Q2 4-*	Q2 5+	Q3 6+*
E2+	Q4 4+*	Q2 5-*	Q2 9+*	Q3 8-
E5+*	Q4 9+*	F5+*	C3+	O1-*
E6-*	Q3 5-*	F6+	C4+	O6+
E8*	Q3 9-	F7+	A7-	J10+*
E9+*	O1+*	O2-	A9-	
E10+*	O10+*	O4-*	O2-	
C1+*	G7-	A8+*	O3-	
C3+	G8+*	C10+*	Q4 6+	
C5+*	Q2 1-	J4-*	E4-	
C9+	I1-	Q3 3-*		
Q2 6+*	I6-			
Q2 7+*	F1+			
Q2 10+	E3+			
Q4 5-*				
Q4 8-				
A10-*				
F1+				
H10+*				
O6-				
Tough v Tender Minded	Neurotic v Stable	People v Things Non Classical Extraversion	Controlled conscientious v Lax expedient	Classical extravers -ion
Loadings 28	22	19	18	13
Rel, ,84	,79	,73	,74	,69
O&B Fact,1	4	2	5	3

Notes: 1- * Indicates all those items that also appear in the Ormerod and Billing study,
2- Rel, Indicates reliability
3- O&B Fact, Indicates the equivalent factor in the Ormerod and Billing study,
4- M refers to 'Markers', (59 in the table)
5- S refers to 'Stragglers',(41 in the table)

The list of items also contains other items, in ones and twos drawn from many other of Cattell's traits, which also load sometimes highly on one of the five factors and clearly by their item content are justified in being included in that factor. These are termed 'Stragglers'. Incidently, the appearance of these isolated items from many of Cattell's primary traits on various factors is an index of the lack of homogeneity of Cattell's primary traits in what they are measuring, (a claim that Cattell had never made but which is important for the acceptance of the confident measurement of specific traits).

It will be seen from table 10.16 that the five personality traits used in the first part of this chapter are founded on far larger numbers of high loading items giving greater confidence into what is being measured by each, (except the last factor)

Also Adrian Woods cumulative reliability method has been applied to these five scales and the reliability in all cases reaches a maximum or a plateau and does not decline as do the reliabilites of most of the Cattell traits. The reliabilities of the five scales in this study range from .45, on factor 2, to .84 on factor 1 as shown in table 11.45.

11.7.1.1 VASTEC (Table 11.46)

Boys

The trait Q3+ (controlled) was present in the Cattell traits and in the 'marker' items of the five personality measures. Enthusiasm (F+) and decision making (Q2) are also present in both regressions but only amongst the 'straggler' items. Although, at first, these two traits seem to be at variance with the mainly neurotic (anxious) nature of the personality measure (D+ demanding, C- easily upset, O apprehensive, Q4 tense -four of the five 'marker' items) it must be remembered that they are 'stragglers'.

Table 9.45a

Factor 1

Reliab.	Item No.	Load.
84	E8	31
84	E2	35
84	C9	35
84	F1	34
84	E10	38
84	C3	33
83	C5	35
83	Q2 10	40
83	H10	36
83	C1	46
82	Q4 8	-36
82	O6	-38
82	Q2 7	45
82	Q4 5	-48
81	Q2 6	42
81	I2	-47
80	I6	-38
80	I4	-38
79	E6	-41
78	A10	-41
77	I10	-62
75	E9	51
74	I5	-41
72	E5	57
71	I7	-56
68	I9	-48
67	I3	-41
67	I8	-49

Factor 2

Reliab.	Item No.	Load.
78	Q2 1	-34
78	D9	35
77	E3	36
76	F1	33
76	D6	38
76	O1	37
75	O10	41
74	C6	-37
74	Q3 9	-34
73	C2	-38
71	C7	-35
70	G7	-32
68	I1	-38
66	G8	43
65	Q3 5	-32
64	I6	-30
64	D3	49
61	Q4 9	44
57	D2	47
53	D8	47
45	D7	51
45	Q4 4	54

Notes: (1) Reliab = Reliabilty.
(2) Load = Loading.

Table 9.45b

Factor 3

Reliab.	Item No.	Load.
74	O2	-32
74	H9	31
73	C10	37
73	F6	30
73	H1	31
73	O4	-44
73	H10	31
73	H7	34
71	F7	39
71	Q2 3	-47
69	Q3 3	-40
67	J4	-37
64	H8	34
62	Q2 5	-35
60	Q2 4	-50
60	H5	30
60	Q2 2	59
60	A8	47
60	F5	47

Factor 4

Reliab.	Item No.	Load.
76	F8	-31
76	C3	32
76	A7	-30
75	G4	41
75	E4	-40
74	Q4 6	51
73	G10	47
72	Q2 9	44
70	A9	-36
68	F9	-40
68	Q2 5	-35
68	G7	43
65	C4	43
62	Q3 10	52
60	O2	-34
58	G5	47
53	O3	-54
53	Q3 2	55

Factor 5

Reliab.	Item No.	Load.
70	D10	34
70	O6	34
70	Q3 8	-31
70	O1	-39
69	A9	-35
67	J10	43
66	G7	32
63	H6	35
63	G9	40
62	D4	41
60	Q3 6	61
59	A2	48
59	H5	54

Notes: (1) Reliab = Reliabilty.
(2) Load = Loading.

Table 9.46 Comparison of results from regression equations of Cattell traits and Personality Measures

Attitude Scale	Cattell's Traits	Five Personality Factors
VASTEC		
Boys	H, Q2, F*, Q3*	HF2 (Neurotic/Stable) D, C-, Q3*, O, Q4, e, o, f*,g, q2*, j
Girls	B, F*, G*, O*	HF5 (Extraversion/Introversion) H, D, g*, q3, o- HF2 (Neurotic/Stable) D, C-, Q3, O*, Q4, e, o*, f*, g*, q2, j
CRITEC		
Boys	A ,Q4-, O	All Five factors failed to achieve significance in the prediction of this attitude.
Girls	B, E-	HF5 (Extravert/Introvert) H, D, g, q3, o-, HF3 (People v Things) G, F-, Q3, A-, c, o-, q2, q3, q4 HF2 (Nerotic/Stable) D, C-,Q3, O, Q4, e, o, f,g, q2, j+ HF1 (Tough/Tender) I-,E*, C, q2, q4-,a-, f-, h, d-
DRAWTEC		
Boys	F*-, H*	HF3 (People/Things) G, F-*, Q3+, A-, c, o-, q2, q3, q4 HF4 (Controlled Con./Lax Exped.) H*, F, Q2, Q2-, a, c, o-, j-, q3- HF2 (Neurotic/Stable) D, C-, Q3, O, Q4, e, o, f, h, d-
Girls	Q3-, I-	HF3 (People/Things) G, F-, Q3*, A-, c, o-, q2, q3*, q4 HF1 (Tough/Tender) I-*, E, C, q2, q4-, a-, f-, h, d-
SOCTEC		
Boys	C, A	HF2 (Neurotic/Stable) D, C-*, Q3, O, Q4, e, o, f, h, d- HF5 (Extravert/Introvert) H, D, g, q3, o-
Girls	B, O*, Q4-*, Q2*, A	HF2 (Neurotic/Stable) D, C-, Q3, O*, Q4, e, o*, f, h, d- HF1 (Tough/Tender) I-, E, C, q2*, q4-*, a-, f-, h, d
RELXTEC		
Boys	C*, E*, G	HF1 (Tough/Tender) I-, E*, C*, q2, q4-, a-, f-, h, d- HF4 (Controlled Con./Lax Exped. H, F, Q2, Q2-, a, c, o-, j-, q3-
Girls	B, F	None of the five major personality factors has any significant correlation with RELXTEC.

Note; Personality Factors
Upper case letters are 'Markers' , lower case are 'Stragglers'.

Girls

Insecurity (O+) was the only 'marker' that had a corresponding Cattell trait. All other correponding traits were 'stragglers'- enthusiasm (F+) and persistence (G+).

9.7.1.2 CRITEC

Boys

No comparison possible since all five factors failed to achieve significance in the prediction of this attitude.

Girls

The only Cattell trait, to reach significance was not present in the personality measures.

9.7.1.3 DRAWTEC

Boys

The traits depicting a serious (F-) and socially bold (H+) personality profile were present in Cattell's traits and the 'markers' within the personality measures.

Girls

The tough-minded trait (I-) as a 'marker' and the compulsive trait (Q3+) as a 'straggler' are the Cattell traits reproduced in the personality measures.

9.7.1.3 SOCTEC

Boys

There were no similarities between the two sets of regressions.

Girls

Insecurity (O+) was the only 'marker' within the personality measures which has a corresponding Cattell trait. Resourcefulness (Q2+) was present as a 'straggler'

9.7.1.5 RELXTEC

Boys

Two of the 'markers' for predicting the tough-minded trait, aggressive (E+) and maturity (C+) were present in both regressions.

Girls

No comparison was possible since none of the five major personality measures has any significant correlation with RELXTEC.

9.7.2 OVERVIEW

Although there are some similarities between the two sets of regression equations they appear rather tenuous.

Scrutiny of table 9.46 suggests that the five personality measures include far more items which help to give a more comprehensive personality profile than the respective Cattell traits. There are several reasons for this:

(a) If we exclude the intelligence trait (B+) there are several groups of two, or even less, Cattell traits available for use in predicting a personality profile, e.gs. CRITEC, girls,(E-) DRAWTEC, boys,(F-,H+); DRAWTEC, girls, (Q3-, I-); SOCTEC, boys, (C,A); RELXTEC, girls,(F+).

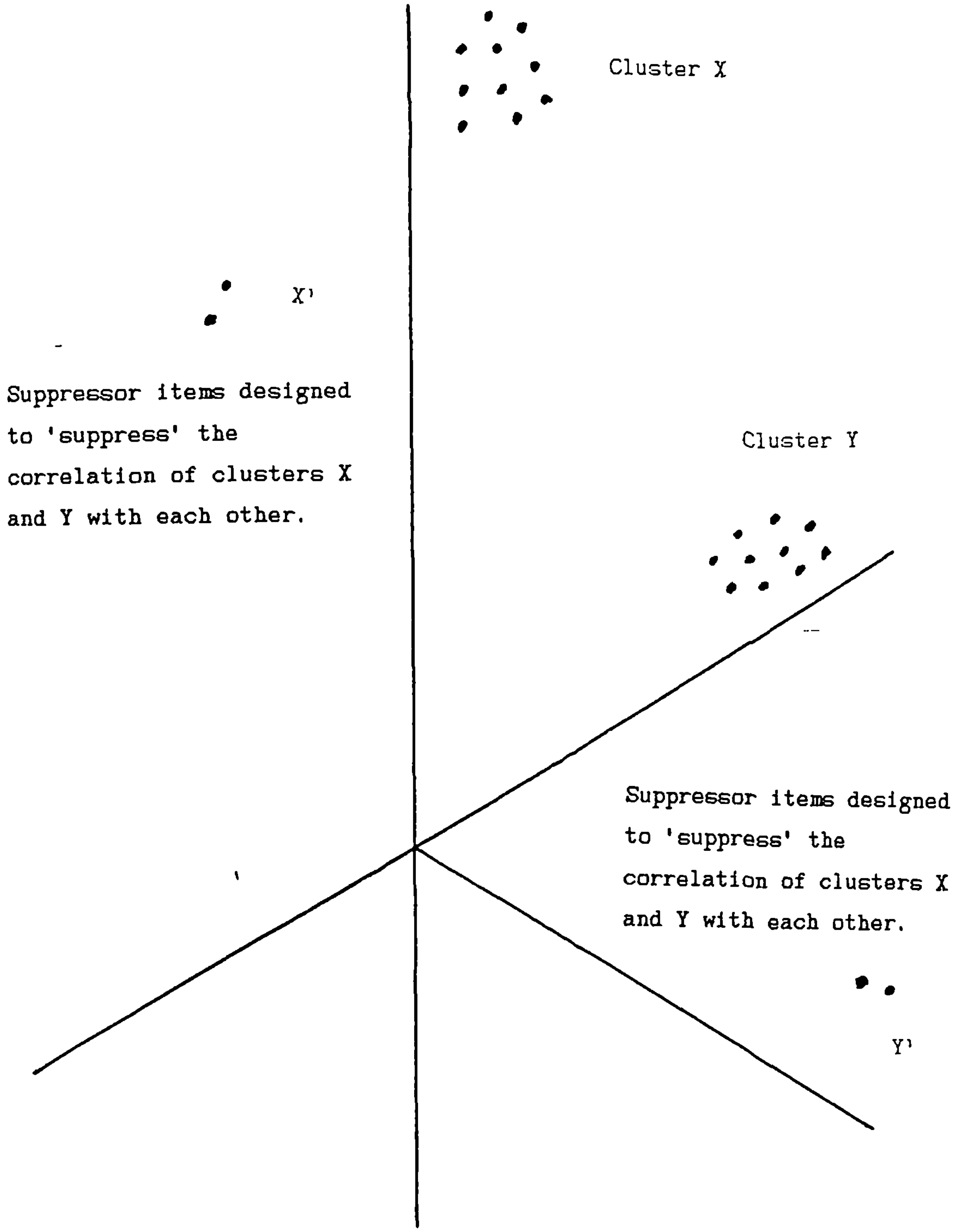
Even the weakest personality measure, factor 5, has four 'marker' traits and eight 'straggler' traits, which give a more thorough 'body of information' from which personality profiles can be drawn.

(b) The 93 items on which the personality measures are based are the most reliable of Cattell's traits. The rejection of the 37 items was done mainly by using the computerized cumulative reliability methods devised by Woods(1987), described in chapter 9, section 9.4.11, followed by the method discussed in chapter 8, section 8.5, (factor analysis repeated with most loadings with a value >.3 and a few loadings>.28. - a method designed to take full advantage of the realignment of marginal loadings on the factorial axis).

Many research workers have cast doubt on the value of Cattell's primary traits. They have found that some of these traits cannot be replicated when subjected to factor analysis. Cattell himself has accepted unacceptably low reliabilities for his traits arising from items with loadings of only .20. These loadings have arisen from what Cattell terms 'suppressor' items, (figure 9.1). Cattell traits are not independent but correlated because he uses oblique axes in his factor analyses to maximize his loadings.The'suppressor'items are those with very little correlation with items in the clusters,(figure 9.1). There is thus some doubt that Cattell's traits are measuring what he claims they do.

The studies done by Brand (chapter 8, section 8.1.2) suggest that there are not really 13 distinct factors of personality (plus an intelligence factor) which have validity for describing distinct aspects of personality, but only about six. Billing (1984) concluded that Cattell over-factored to produce 14 factors which were not unitary in the statistical sense, and Eysenck under-factored when he produced three orthogonal factors which he described as: extraversion/introversion; neuroticism and psychoticism. This orthogonal three factor model was obtained in research work based on extreme clinical cases. In addition to Billing's study, three others have been undertaken at Brunel in this faculty yielding the same five factors of personality (plus intelligence). Namely, this study, those of Carroll (1982) and Asiedu (ongoing 1987). Although looking at the Cattell traits that reached significance in the regression equations has supported some previous findings, (section 9.5), there are some cases of conflict with the data obtained for the personality measures. It was decided to accept the five personality measures as the most reliable and base the personality of the CDT orientated pupil on these results rather than Cattell's primary traits.

Figure 9.1 Cattell's 'suppressor' items



9.9 CHAPTER 10

9.9.1 INVESTIGATION - TECHNICAL EXAMINATIONS TAKEN BY PUPILS IN SAMPLE SCHOOLS

Three years after the administration of the questionnaires an investigation was made to find out how many pupils took technical examinations together with grades achieved.

These pupils responses in the questionnaires which demonstrated a desire to take up a technical subject were compared with what actually happened in the 5th year.

The examination grades achieved by each school were compared to establish any significant differences. Also the attitudinal profile of those pupils who gained high grades ('high flyers') and those who achieved low grades ('low achievers') was produced.

CHAPTER 10 AN INVESTIGATION TO ASCERTAIN HOW MANY PUPILS IN THE SAMPLE OF 405 ACTUALLY TOOK TECHNICAL EXAMINATIONS

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CHAPTER 10 AN INVESTIGATION TO ASCERTAIN HOW MANY PUPILS IN THE SAMPLE OF 405 ACTUALLY TOOK TECHNICAL EXAMINATIONS

10.1 THE APPROACH MADE TO SCHOOLS

It was decided to do a 'follow up' study on the 405 pupils, who as 3rd years completed the questionnaires in the early part of 1982.

This study was carried out in 1985, when the pupils were either in the 6th form, at college or out to work, having taken their public examinations at the end of the 5th year in 1984.

The most obvious measure of their orientation towards technical work could be obtained by :

(a) Ascertaining if they actually embarked on a technical course.

(b) If they completed the course and then took some form of technical examination.

It was therefore thought to be prudent to make an approach to each school requesting information about the pupils who originally completed the questionnaires.

The heads of CDT at the seven schools were contacted ways were discussed of teasing out the examination results of all the pupils in the original 405 population. Fortunately, since all schools now publish their results, or have their results available for perusal by prospective parents, the schools were mainly cooperative. Six schools readily agreed to let me have this information, but one school declined the author's request.

10.2 EXTRACTING THE RESULTS

As agreed with the heads of CDT, a letter was sent to each school with a chart enclosed with lists of pupils clearly marked on. All that they had to do was to put in the examination result. The various types of examination taken at each school had already been discussed. The chart sent to the schools included all these various examinations.

Three schools returned the charts completed within four weeks. The author visited the other schools and was allowed to extract the examination information from examination sheets or school records.

10.3 TECHNICAL STUDIES

10.3.1 AN APPRAISAL OF THE INTENTION OF PUPILS TO FOLLOW A TECHNICAL COURSE

The details collected from the schools included all pupils who started a technical course at the beginning of the 4th year. A small number did not complete their course. It is this initial starting number that is important since it can then be compared directly with their responses to the information questionnaire completed in 1982.

Table 10.1 shows full details of the examinations taken by the pupils.

10.3.1.1 BOYS

Originally 171 boys started a course involving some form of technical work. Due to moving schools, changing courses, not being of sufficient standard to take the examination, or selecting not to take it, 17 pupils did not complete their technical courses at least at that school.

63 boys started a course in some type of graphical work, 5 failed to complete it, (tables 10.2 and 10.3).

There were 214 boys who expressed an interest in continuing with technical studies in the 4th year, including 151 - yes and 63 undecided,(table 10.2). It can be argued from these figures that since 20 more boys started the course than those who replied yes(171 against 151) then the increase came , most likely, from those who were undecided (interested). Therefore all the percentage calculations are based on this hypothesis.

Boys interested in continuing with Technical Studies = 214

Boys who started a course at the beginning of the 4th year= 171

% of boys who continued with Technical Studies = 171/214 = 80%

Table 10,1 Details of all the various CDT examinations in the 5th year, (1985).

		Schools							
Students and Examination	O level, 16+ or CSE	1	2	3	4	5	6	7	Total
Craft and Design (Woodwork)	O Level	5		6	7	1			19
Design and Technology	O Level					1			01
Graphical Communication	O Level					1			01
Metalwork	O Level			6		6			12
Technical Drawing	O Level	7		6					13
Technology	O Level	3	6					3	12
Technical Drawing	16+					10			10
City and Guilds (Building)			2						02
City and Guilds (Engineering)					3				03
Motor Vehicle	CSE			5	2				07
Metalwork	CSE					7		6	13
Technical Studies (Combined Matls)	CSE		15						15
Technical Studies	CSE	21		18	12				51
Technical Drawing	CSE	13		12				9	34
Technology	CSE		11						11
Woodwork	CSE					5		5	10
Totals for Schools		49	34	53	24	31	0	23	214

Technical Studies - Girls in Sample = 001

Technical Studies - Boys in Sample = 154

Note: No results available from school 6.

Technical Drawing - Girls in Sample = 001

Technical Drawing - Boys in Sample = 058

Table 10.2 Details of pupils who continued with Technical Studies

Boys

1982

Do you intend to take Technical Studies in the 4th year?				Pupils who continued with Technical Studies.	
				1982	1984
Yes	Undecided	No	No Reply	Started	Completed
151	63	43	2	171	154

Table 10.3 Details of pupils who continued with Technical Drawing

Boys

1982

Do you intend to take Technical Drawing in the 4th year?				Pupils who continued with Technical Drawing.	
				1982	1984
Yes	Undecided	No	No Reply	Started	Completed
91	61	91	16	63	58

Note:

Since one school is not included the boys total has decreased from 301 to 259.

Table 10.4 Details of pupils who continued with Technical Studies

Girls

1982

Do you intend to take Technical Studies in the 4th year?				Pupils who continued with Technical Studies.	
				1982	1984
Yes	Undecided	No	No Reply	Started	Completed
11	22	70	1	1	1

Table 10.5 Details of pupils who continued with Technical Drawing

Girls

1982

Do you intend to take Technical Drawing in the 4th year?				Pupils who continued with Technical Drawing.	
				1982	1984
Yes	Undecided	No	No Reply	Started	Completed
5	17	73	9	1	1

10.3.1.2 GIRLS

Only one girl took any technical examinations out of the girls population of 104. She gained O levels in Design and Technology , Metalwork and Graphics with grades of A,C,A.

There were 33 girls who were interested in continuing with some type of technical work, including 11 - yes and 22 undecided , (table 10.4)

10.4 TECHNICAL DRAWING

10.4.1 AN APPRAISAL OF THE INTENTION OF PUPILS TO FOLLOW A GRAPHICAL COURSE

There were 152 boys who were interested in continuing with some type of graphical work in the 4th year. This was made up of 91 - yes and 61 undecided, table 10.3).

Boys interested in continuing with Technical Drawing = 152

Boys who started a course at the beginning of the 4th year = 63

% of boys who continued with a graphics course = 63/152 = 41%

Whilst 80% of boys of whom details were obtained took up technical studies was gained not only from those who had originally said they would but also those who were undecided, only 41% of boys took up technical drawing - which is less than the number who definitely intended to do so in 1982 (91 in table 10.2). Some of the 61 'undecided' might be in the 63 boys who decided to continue with the subject since the calculation of 41% is based on the total of the 'yes' + 'undecided' responses in a similar way that the 80% was calculated for technical studies. Also there were more of the sample who responded 'yes' (stating their intention to continue with the subject) for technical studies in 1982 whilst for technical drawing there was less.

This is another contrast between technical drawing and technical studies to add to those cited in section 7.4 where is was noted that the correlations between the intention to take up technical drawing (TUTD) and various measures of liking for technical studies (VASTEC, CRITEC, TSLIK, TOTS TCAR) and also FAMSKIL (table 10.6) were significantly weaker than the corresponding correlations with taking up practical technical studies (TUTS) for both sexes (section 7.3.5 table 7.12 and

section 7.3.10 table 7.13).

There were 22 girls who expressed interest in continuing with some *form of graphical work* , 5 *of whom* responsed with - yes and 17 were undecided. Only one girl decided to continue with a graphical course in the 4th and 5th year, (table 10.5).

10.5 EXAMINATION RESULTS

10.5.1 ALL SCHOOLS

With the exception of the comparison of school 1 and school 2 which demonstrated that the boys in school 1 gained significantly higher grades, all other comparisons indicated a similar standard of *examination attainment. It is interesting to note* that school 2 was one of the two schools (the other was school 7) in the sample situated in Mid-Herts.

There was no significant differences between school 1 and the other four schools in South West Herts when considering the level of examination passes. This is what one might expect of several coeducational schools situated in one area of Hertfordshire. It does show that as far as the sample is concerned there was a similar standard throughout in the teaching of CDT examination groups within those schools.

Table 10.6 CODE FOR SYMBOLS USED

Attitude Scores	Derived from Attitude Questionnaire
VASTEC	Factor one - Pro-CDT stance
CRITEC	Factor two - Critical of technical work or the way that it was taught.
DRAWTEC	Factor three - Items concerned with technical drawing.
SOCTEC	Factor four - Comments on the effects of technology on society.
RELXTEC	Factor five - Items indicating that technical work can be relaxing.
Other measures of relevance in CDT	
TSLIK	Liking for technical work
TOTTS	Total number of Technical Subjects in Favourite Five
FAMSKIL	Family member in work requiring technical skills
TUTS	Intending to take technical studies in the 4th year
TUTD	Intending to take technical drawing in the 4th year
TCAR	Intending to take a technical career
MATH	Ability in Mathematics

10.5.2 RELATIONSHIPS BETWEEN ALL BOYS WHO ENTERED FOR A TECHNICAL EXAMINATION AND SCORES FROM THE FIVE ATTITUDE FACTORS AND OTHER VARIABLES (table 10.6)

The practical examinations taken are shown in table 10.1
They include Craft and Design (Woodwork), Craft and Design (Metalwork), City and Guilds (Building, Engineering and Motor Vehicle), Design and Technology, Technical Studies and Technology. 154 pupils took these examinations.

There were a number of variables that had a significant relationship with those pupils who finally took a CDT examination. These were VASTEC (r = .16, p = .023) - which demonstrates a strong CDT stance; TSLIK (r = .204, p =.006) - liking for technical studies;
RELXTEC(r = 201, p =.006) - finding technical work relaxing and
TCAR (r = .20, p = .006) - intention of taking up a career in technical work. These were all positively related.

But there was a negative relationship with mathematics
(MATH r = -.246, p = .000).

This would indicate that those who take practically based technical examinations have a very positive attitude towards the subject area but were weak mathematically.

10.5.3 GRAPHICAL EXAMINATIONS

The graphical examinations taken are shown in table 10.1

They include graphic communication and technical drawing. 58 pupils took these examinations.

Apart from the obvious variable TUTD (r = .23, p = .035) - intention of taking up technical drawing, the only other significant variables were CRITEC (r = .21, p = .053) - criticism of the teaching of technical work and a negative relationship with mathematics (MATH r = -.44, p = .000)

Those taking examinations in graphical work endorsed their earlier intention of taking up the subject expressed in the 3rd year. They were critical of the way that it was taught but were weak mathematically.

10.5.4 COMPARING THE EXAMINATION RESULTS OF THE PUPILS WHO GAINED HIGH GRADES WITH THOSE ACHIEVING MUCH LOWER MARKS - PRACTICALLY BASED TECHNICAL EXAMINATIONS

It was decided to compare the pupils examination results with the scores for the five attitude factors (VASTEC, CRITEC, DRAWTEC, SOCTEC and RELXTEC). In order to do this, two separate groups of pupils were investigated:

(a) High Flyers - Pupils who gained grade A, B or C at O level or CSE grade 1

(b) Low Achievers - Pupils who just managed to gain one of the two lowest pass grades, CSE 4 or 5.

The numbers of 'high flyers' was 36 whilst there were 30 'low achievers'. There were two significant differences between the two groups of pupils.

The 'high flyers' demonstrated a greater pro-CDT stance (VASTEC- p =.05) and found the subject more relaxing (RELXTEC - p = .05).

The comparisons with the other three factor scores (CRITEC, DRAWTEC and SOCTEC) failed to reach significance.

10.5.5 GRAPHICAL WORK

There were not as many pupils taking a graphical examination and in order to obtain a reasonable number of pupils the range for the 'low achievers' was changed slightly.

High Flyers -Pupils who gained a grade A, B or C at O level or CSE grade 1

Low Achievers - Pupils who gained CSE grades 4 or 5 and those who were ungraded.

The number of 'high flyers' was 14 whilst there were 12 'low achievers'. There were three significant differences between these two groups. The 'high flyers' were far more critical of the way that the subject was taught (CRITEC - p = .05); they were concerned about the effects of technology on society (SOCTEC - p = .05) and were far more relaxed compared with the 'low achievers', RELXTEC - p = .05).

The comparisons with the other two factor scores (VASTEC and DRAWTEC) failed to reach significance.

10.6 OVERVIEW

10.6.1 TECHNICAL STUDIES -BOYS

The enthusiasm of the all the boys in the sample schools for continuing technical studies after the 3rd year was very marked since 80 % expressed degrees of interest. 59% totally commited and 21% interested , chapter 6, figure 6.12

The numbers of boys who finally took technical examinations reflect this interest. In fact eight out of every ten boys continued with some form of technical studies. The range of examinations that the pupils were entered for was quite varied:

City and Guilds (Building)

City and Guilds (Engineering)

City and Guilds (Motor Vehicle)

Craft and Design (Woodwork)

Design and Technology

Metalwork

Technical Studies

Technical Studies (Combined Materials)

Technology

Woodwork

A very high proportion of boys, who indicated an interest in some form of technical work when they completed the questionnaire, have continued with the subject. This is very encouraging and it does indicate a certain commitment towards this area of the curriculum. This is very positive support for the personality profile 'sketched out' by VASTEC, (chapter 9, section 9.5.2) and for the TUTS measure for the boys (table 10.6).

10.6.1.1 PRACTICALLY BASED TECHNICAL EXAMINATION RESULTS

The comparison of the examination results in the South-West Hertfordshire schools revealed no significant differences between them. This may have be due to the fact that there was considerable liason between the schools due to three of them sharing a mode three CSE technical studies examination which had been initially designed by the group in the early 1970's. Subsequent updating of the examination together with national and local moderation meetings led to a sharing of technical and teaching strategies between the schools. This together with the fact that generally all the schools had similar tools, machines and effective technical teaching staff appears to have created similar standards of pupil achievement.

The comparison of the practically based technical examination results with the five attitude factor scores confirmed that the boys had very pro-CDT stance with a definite commitment to take up a technical career. When the examination results of those who gained high grades are compared with those who just gained a low CSE pass (the high flyers and the low achievers) the 'high flyers' were far more positive and found the subject more relaxing then the 'low achievers'.

10.6.2 TECHNICAL STUDIES AND TECHNICAL DRAWING - GIRLS

The fact that only one girl embarked on a technical course is cause for some concern. She certainly had a great deal of parental support since she was the daughter of the Head of CDT!

All the schools in the population provided some form of technical education for both boys and girls in the first three years, (chapter 6, section 6.1.1).

There was a similar lack of interest shown by girls for CDT in the 4th and 5th year in the booklet published in 1979 by the 'Equal Opportunites Commission' entitled 'Equal Opportunities in Craft Design and Technology':

"There are many thousands of girls studying a whole range of Craft, Design and Technology (CDT) subjects in years one to three in secondary schools in this country, but very few remain with the subject area in years four and five. In 1979 there were a total of 305,095 candidates - entries for CDT subjects at CSE and GCE O level. Of those 7,478 were girls; a mere 2.45% of the total subject entry." There was some improvement four years later, when nearly 5% of the successful candidates taking O level, in design and technology and in technical drawing were girls (table 10.7).

Previous research findings have shown that girls' attitudes to science frequently declines sharply over the first three years (Brown and Davies,1973; Goodwin et al , 1981).

10.6.3 TECHNICAL DRAWING (BOYS)

The enthusiasm for technical drawing amongst the boys was not as marked as that for techncial studies since only 60% expressed degrees of interest in continuing the subject after the 3rd year. 38% of whom were totally committed and 22% expressing some interest. (chapter 6, figure 6.13). The numbers that finally took up technical drawing reflect those pupils who were totally committed in their responses. This is another demonstration of the greater interest in technical studies.

Six out of every ten boys decided not to continue with some form of graphical studies. Throughout the study, there is a much weaker relationship, between boys, for technical Drawing, as opposed to technical studies, (chapter 7, section 7.6). It is no surprise, therefore, that over half of the boys decided not to continue with the subject after the 3rd year.

	Numbers who gained O levels (A-C) 1983			
Subject	Boys	Girls	Girls/100 Boys	Ratio Girls : Boys
Design and Technology	10067	478	4.75	1:21
Technical Drawing	26388	1295	4.90	1:20

	Numbers who gained O levels (A-C) 1983			
Subject	Girls	Boys	Boys/100 Girls	Ratio Boys : Girls
Home Economics	22702	585	2.57	1:39

Table 10.7 School Leavers - Volume 2 in the Education Statistics series, published by the DES for Summer 1983.

10.6.3.1 TECHNICAL DRAWING AND GRAPHICAL EXAMINATIONS

The boys who took an examination in a graphical subject were weak mathematically. They endorsed their earlier intention to take up the subject although at the same time they were critical of the way that it was taught.

When the 'high flyers' were compared with the 'low achievers', it became apparent that it was the former group who had expressed a very strong indication that they were dissatisfied with the methods of teaching the subject. The 'high flyers' were more concerned about the effects of technology on society and they were far more relaxed compared with the 'low achievers'.

These findings seem to indicate that the ' high flyers' may have been better suited to a more technologically-based course

10.7 CHAPTER 11

This chapter seeks to review all similar research in CDT that was started about the same time as this study. Each of these studies is briefly described and the research methods used are explained. The findings from these studies have then been compared with those from the present study. Finally, common findings and observations from all studies have been reviewed.

CHAPTER 11 REVIEW OF OTHER SIMILAR RESEARCH IN CDT

11.1 INTRODUCTION

It is normal practice to review similar literature early on in the thesis, but much of the work on CDT and girls emerged late on in the research period and did not influence it. Nevertheless it is important to look at the the various findings and explanations from these studies and draw parallels with similar findings from the present study.

11.2 STATE OF DEVELOPMENT OF TECHNICAL WORK IN ALL STUDIES

In order to compare the studies it is necessary to establish the nature of the technical work described in each one. In Chapter 1 models were set up to describe technical work in the late 1970's. The terms most commonly referred to in other studies were:

(a) TECHNICAL STUDIES (chapter 1 , section 1.4.3);

(b) TECHNOLOGY (chapter 1, section 1.4.5);

(c) CDT (chapter 1, section 1.4.6).

11.3 THE GATE PROJECT

11.3.1 GENERAL DESCRIPTION

This was a three year project (1981 - 1984) , concerned with the education of girls in Design and Technology at secondary school level, conducted by Martin Grant, under the supervision of Dr. Jan Harding at Chelsea College. The project was supported by The British Petroleum Company.

This was an 'action' type project since it was involved with establishing ways of involving more girls in Design and Technology activities at secondary school level.

The data on this research project has been gained from a number of report booklets, describing various initiatives used and conclusions reached. As far as the author is aware, no overall findings were published for this project.

11.3.2. RESEARCH METHODS USED

(1) A study of 75 (29 O level and 46 CSE) workshop-based courses using the recommendations of the HMI Working Party Report 'Curriculum 11-16 (1977) as the measure (Report 81.1).

2) A conference was convened (three Design and Technology departmental heads, one head of science and design, one technology teacher, a Design Council education officer and five researchers and two from other 'technology' projects) to establish criteria for CDT that would be relevant to all boys and girls in 16+ examinations. This was a direct response to the critera agreed by the Joint Examination Council CDT working party (Report 82.2).

(3) A limited study of the difference between boys and girls design projects entered in a national design competition (Report 84:2).

(4) A response to TVEI (Report 83:1).

Its recommendations to the MSC were:

"Progress is made in developing 'Design and Technology' courses for more pupils, including girls.

The opportunities available for the lower-achieving, girls and women should be looked at carefully, as jobs they traditionally have filled disappear or become more technical.

Proposals for pilot schemes scrutinised for their provision for girls... a conscious effort should be made to reduce sex stereotypes.

The expansion of workshop-based courses in Design and Technology to include provision for all girls is not compromised by the lack of availability of qualified teachers."

(5) An investigation into the organisation of CDT in the first three years in coeducational secondary schools (Report 83:3).

A questionnaire was sent to 68 schools in two LEA's and completed by 80,000 pupils.

11.3.3 COMPARISON OF THE ETHOS OF THE SCHOOLS IN THE GATE PROJECT WITH THE SCHOOLS IN THE PRESENT STUDY

According to Page 6 of the GATE Report 81.1, 75 workshop based courses were initially considered for research purposes. They included the following diverse titles:

Metalwork, Woodwork, Craft, Design and Technology, Technology, Engineering science, Engineering Workshop Theory and Practice, Design in Craftwork, Design, Technical Studies, Motor Vehicle Studies and Craftwork.

These titles are similar to those courses taken by pupils in the present study.

Only three of the 75 courses have a similar method of assessment to the schools in the present study (45 of the courses had no reference to design in their methods of assessment).

Although the generic term 'Technical Studies' was used to describe six of the departments in the sample schools in the present study (the other school's 'CDT' department in Mid-Herts was involved in design and problem-solving activities with large number of pupils studying technology), they were engaged in CSE and O level examinations which included a high degree of design and some problem- solving work.

For example, the CSE technical studies and the O level Craft and Design (Wood or Metal) courses used the following methods of assessment:

(a) Written examination, incorporating a section on design

(b) Design and realisation of a project in an extended period of time.

(c) Design folios

(d) Coursework.

The CSE Technical Studies courses all included work in at least three materials - metal, acrylic and wood.

This comparison shows that the work done in the Hertfordshire schools was in line with the current thinking at that time (early 1980's), which tended towards more design and problem-solving with a multi-media approach. This demonstrates that although the title of the departments in six of the Hertfordshire schools was 'technical studies', the courses taken by the pupils included a significant amount of design and technology and the work done was more aptly described by the CDT model (chapter 1, section 1.4.6). It is also evident that the majority of practical courses considered in the GATE study had very little design content and may have been more accurately described as 'technical studies' courses.

11.3.4 GATE FINDINGS COMPARED WITH SIMILAR ONES IN THE PRESENT STUDY

Report 81.1 found that Design and Technology courses are likely to attract a greater proportion of girls than traditional woodwork and metalwork courses. It is suggested that different teaching approaches within the design and technology area could influence the way girls respond to the subject.

In the present study (chapter 6, table 6.9), 36% of the girls suggested that the projects could be improved by allowing them to play a much greater role in the selection of projects made and how they were designed. This indicates dissatisfaction with their present courses in technical work.

All examinations (report 82.2) should include the words 'design and technology'. Techniques of assessment thought to be applicable to such examinations are:

(a) Coursework ; (b) Extended design examination; (c) Design Folio

(d) Report /log to record the decision-making process; (e) Written examination.

All seven Hertfordshire sample schools were involved in examinations which included the above methods of assessment.

In report 84.2 there was a difference found between the girls' and boys' design projects that would tend to support the view that a greater emphasis on the social aspects of technology in school 'design and make' activities would be generally welcomed by girls.

In the present study girls, were found to have a more favourable view of the social implications of technology than boys, but it is associated with a rejection of a CDT-based career (chapter 9, sections 9.2.4).

The main findings from the investigation into the organisation of CDT in the first three years in coeducational secondary schools (report 83:3) were:

(a) The curriculum in the early secondary years in the majority of mixed schools is differentiated by sex.

(b) In CDT in these schools, the experience of girls is of diminishing time spent on workshop activities as they proceed through school.

(c) The main pressure that leads schools to adopt an organisational system which unintentionally results in low participation rates by girls seems to be the problem arising from a low share of curriculum time.

In the present study (chapter 2, tables 2.5a and b), the curriculum time available, for all the sample schools, was thought to be inadequate. The option system of choices, especially in the 3rd year, provides limited opportunity for girls to take a technical subject.

This is further amplified by the lack of confidence demonstrated by the girls in response to item 6 in the information questionnaire:
'Do you think that you have learned enough practical skills in years 1, 2 and 3 to allow you to get on quickly with 4th year projects'?
76% of the girls responded negatively (chapter 6, figure 6.4).

11.4 THE GIST PROJECT

11.4.1 GENERAL DESCRIPTION

This was an 'action-research' project (1979 - 1984) to explicate the reason for girls' under-achievement in physical science and technical subjects at school. It simultaneously explored the feasibility and effectiveness of interventions aimed at improving the situation. The project was jointly directed by Alison Kelly, Judith Whyte and Barbara Smail with additional help from Vera Ferguson, Dolores Donegan and John Catton. The project was based at Manchester Polytechnic and had five funding bodies: EOC/SSRC, Department of Industry, Shell UK, VEEP and the Schools Council.

11.4.2 RESEARCH METHODS USED

The two main thrusts of GIST, with regard to technical crafts, were:
(1) Making the curriculum more technologically relevant and(2) Encouraging girls into design and technology-based subjects.
The GIST project was unusual since it aimed at changing a situation as well as studying it. The project involved 2,000 pupils in ten coeducational comprehensive schools (eight as 'action' and two as 'control' schools) from three LEA's in the Greater Manchester area.
The research methods (as far as technical work was concerned) included a battery of questionnaires, examples of which were: Attitude - Technical Craft and Science, School, Family background, Gender Stereotype Inventry, Occupational Stereotype Inventry, Options. Cognitive - Mechanical Reasoning. Spatial Visualisation. Information - Careers (two).

The cohort of 2,000 pupils were monitered from entry at 11 until they made their option choices at the end of the 3rd year.

A number of intervention strategies were used throughout the project. A major one of these was a series of visits by women working in 'masculine' occupations to provide role models for the pupils.

11.4.3 COMPARISON OF THE ETHOS OF THE SCHOOLS IN THE GIST PROJECT WITH THE SCHOOLS IN THE PRESENT STUDY

It would appear that some of the schools in the GIST project initially were taking very traditional technical studies courses, as demonstrated on page 8 of the final report: "The addition to the team of John Catton, a former head of a school CDT department, greatly increased our credibility with the all-male staff teaching CDT... However the Schools Liaison work in CDT was also concerned with explaining the advantages for both sexes of a move away from the traditional craft courses to a design-based approach in which practical problems are solved in a creative yet logical manner".

Another indication of this appears on page 9: "A further problematic issue in CDT was the question of choice. Two schools in the GIST project, one action and one control, were possibly contravening the Sex Discrimination Act by teaching woodwork and metalwork to boys and cookery and needlework to girls in the first three years".

It would appear that if these comments aptly describe the technical stage reached by the schools at the start of the project, then they were far more traditional than the schools in the present study.

The description of technical work in the GIST project varies and the following terms are used:

technical subjects, technical crafts subjects (woodwork, metalwork and maybe plasics and technical drawing) as well as - according to a note at the beginning of the Technical Craft and Science Questionnaire - craft, CDT, technical craft, technology.

The term 'CDT' is generally used, and correctly so, when John Catton was engaged in a design-based situation.

The term 'technology' used in the GIST project is clearly not the same as the model set up in chapter 1, section 1.4.5.

It can be argued then that 'technical subjects'; 'technical crafts subjects'; 'craft'; 'technical craft' and 'technology' are all terms that could be replaced by a single descriptor - 'technical studies'.

Since this project also investigates mainly physical science, then a more apt title when the project started may have been 'Girls into Physical Science and Technical Studies'. During the latter years of the project, there was a considerable input from John Catton to persuade the schools to change to more design-based CDT work. At this stage, the title could have been 'Girls into Physical Science and CDT'.

Indeed Catton (1985) on page 7, refers to the GIST project as "This action-research project aimed to encourage more girls to study CDT and physical science".

11.4.4 GIST FINDINGS COMPARED WITH SIMILAR ONES IN THE PRESENT STUDY

There are similarites between the GIST Technical Craft and Science Questionniare and the Attitude and Information Questionnaire in the present study.

Although worded in slightly different ways, both questionnaires included items that:

(a) Led pupils to give an opinion on the best and worst aspects of technical work.

(b) Invited them to comment on the technical things they liked doing and the projects that they enjoyed making.

Other items that were similar were:

(a) Knowledge of technical work being an investment for the future.

(b) Level of difficulty (two items).

Included in the GIST Careers Questionnaire are eleven items inviting pupils to give their profile of an engineer. A similar questionnaire is included in the present study (Appendix A). In both projects, information was gained about the influence of the family on the choice of technical work. Both projects contained a 'follow-up' section.

GIST used a careers questionnaire and in the present study examination performance in the 5th year was reported on (chapter 10).

The major difference between the two projects was that:GIST tended to include technical drawing with woodwork, metalwork and plastics and referred to them as technical crafts. The present study separated technical drawing and technical studies (metalwork, woodwork and plastics).

The GIST project also found that (with a sample of 116 parents) parents' educational aspirations for their children were high with little differentiation between the sexes, Kelly et al (1982). In the present study, there was a significant relationship, for both boys and girls, between liking technical studies (TSLIK) and a family member with technical skills (FAMSKIL) (chapter 7, section 7.3.10).

The GIST project concluded by using a mechanical reasoning questionnaire, that boys were a long way ahead of girls in this aspect of technical expertise. Smail and Kelly (1984) suggest that since"Most of the items on this test referred to experiences which are stereotypically associated with boys rather than girls and it seems likely that sex differences in play activities and hobbies have produced this sex difference in mechanical reasoning".

In the present study, girls were slightly less inclined to 'fiddle' (boys 92% and girls 76%) as demonstrated by their response to item 7 - Do you enjoy taking things apart to find out how they work? (chapter 6, section 6.3.2.2).

Girls were also not very confident about the practical skills that they had learned in the first three years in secondary edducation. Only 30% responded positively to item 6 - Do you think that you have learned enough practical skills in years 1, 2 and 3 to allow you to get on quickly with 4th year projects? (chapter 6, section 6.3.2.3). There are other indications of this lack of confidence with mechanical reasoning in replies to item 14 - Which machine do you most enjoy using? A significant number of the boys (48%) chose a relatively complicated machine - the metalworking lathe whilst the girls (44%) selected a basic machine - the drilling machine (chapter 6, section 6.3.2.9).

Both studies found that girls lack this 'discovery learning'experience and recommended compensatory experience for girls in the early years of secondary education. Both studies also found that the 'rotational craft timetable' system (where pupils of both sexes study subjects not traditional for their sex (Pratt et al, p59, 1984)) is detrimental to a programme of technical work. GIST - Kelly, Whyte and Smail (1984) refer to Harding and Grant (1983) who have shown how these mini-options can effectively foreclose non-traditional choices. In the present study a 'rotational craft' system operated in the first year and in most schools a 'mini option' system was preferred in the 2nd and 3rd years (chapter 2, table 2.5a and b). There is ample evidence of pupil frustration due to a lack of time for practical work and technical drawing in CDT (chapter 6, section 6.3.2.7, table 6.9 and 10).

11.5 TEACHING TECHNOLOGY TO GIRLS PROJECT

11.5.1 GENERAL DESCRIPTION

The Millman study (1981 - 1983) used a training workshop in Coventry. This training workshop had a predominantly male image, offering courses designed for boys at 16+ who had left school .

The project started in 1981, with twenty-two 3rd-year pupils in a pilot scheme. The numbers were extended to 120 (60 action and 60 control) in 1982 and 88 (44 action and 44 control) pupils were included in 1983.

The report describes one mixed group making an 'anti-mugging device' in 1982 and the work of three groups making an intercom set, designed mainly for the elderly people in the neighbourhood, in 1983. Included in these groups was a mixed set of three girls and eleven boys, and two single-sex groups of fifteen. Throughout the project each set, which in the latter stages of the project was 15, spent two weeks in the training workshop.

11.5.2 RESEARCH METHODS USED

The main thrust of the project was to:

(1) Produce an article for which there was a real need within the school's community.

(2) Show the relevance of certain school subjects to the world of work.

(3) Learn from and relate to other adults with an industrial background during the course of the project.

Pupils were observed during the lessons to assess how they initally set about considering the design of the project and how the pupils interacted with each other during design and practical sessions.

All pupils were given an attitude test and scores were obtained for:

Social implications of technology.

Normality of technology.

Attitudes to enquiry.

Adoption of technological attitudes.

Enjoyment of technology lessons.

Leisure interest in technology.

Career interest in technology.

Using these scores a profile was obtained for:

The girl's group ; girls in the mixed group; boys in the mixed group and the boys group.

The pupils were asked for their opinions at the end of the course.

11.5.3 COMPARISON OF THE THE ETHOS OF THE TEACHING TECHNOLOGY TO GIRLS PROJECT WITH THE SCHOOLS IN THE PRESENT STUDY

It appears that the making of both products was done by a demonstration and then a production process. For example all the electronic circuits, after a design session, were made in a similar way. The container for each project was the main part that appears to have been designed by the pupils themselves. The type of project, although discussed with the pupils, was not chosen by them. The reason for this may have been the lack of time available for each project.

This project also included other aspects. The pupils went out to local industrial concerns to try to market their anti-mugging device. They also installed the intercom systems in various places, including the homes of elderly people. All pupils completed a technology questionnaire.

There was certainly not time during this project to encourage creative design and making skills, or the ability to identify examine and solve problems, aspects of which form the basis of the models set up for CDT and for technology in chapter 1, sections 1.4.5 and 1.4.6. What in fact was being taught to the pupils, when they were making the projects, followed the model for technical studies (section 1.4.3).

11.5.4 MILLMAN FINDINGS COMPARED WITH SIMILAR ONES IN THE PRESENT STUDY

Male interests and approaches dominate in mixed groups (Millman p45). Millman suggests (p3) that girls and boys bring different sets of experience with them to the classrooms and the workshops, but in traditionally male areas of the curriculum it is still male values and attitudes which determine the pupils' learning environment.

In the present study, the two sexes presented, across the whole of the five attitude scales, a completely different psychological profile (chapter 9, section 9.2).

The majority of girls, whose potential is clearly equal to their male counterparts, are frustrated by the alien environment of the traditional workshop (p3).The main personality pattern associated with VASTEC (high scorers on this attitude factor appreciate the value and skills of CDT and generally enjoy it) for girls in the present study shows a main trait of extraversion with some association with neuroticism (anxiety). It may be that girls display some anxiety at being present in what they rate as a male preserve (chapter 9, section 9.2.1).

The following are observations made by the pupils in the Millman study:

"I found the practical work most difficult because I wasn't used to it at school. The boys probably enjoyed it more because they are used to practical work, the boys knew what some things were already" (p15).

In the present study boys looked forward to technical studies more than the girls did (61% / 44%) (chapter 6, section 6.3.2.4).

Also, far more boys than girls thought that they had learned enough practical skills to cope with a 4th year technical studies course (60% / 24%) (section 6.3.2.3).

80% of the pupils would have preferred more time in which to complete their project, (Millman p15). In the present study, a significant number of the boys (80%) and girls (60%) expressed a desire for more time doing technical studies (chapter 6, section 6.3.2.7).

"The boys felt more at home than we did. if there'd been more female teachers we might have got on faster"(Millman p15).

A review of the sample schools (chapter 2, section 2.9.6.7) found that women teachers appear to influence both girls and boys to have a more favourable attitude towards CDT. Also the boys 'may have felt more at home' due to more 'tinkering' experience. This was achieved at home and in their primary schools helping them to have more general confidence in the workshops, as discussed in the present study (section 6.3.2.3).

In contrast the boys in the Millman project (p16) all thought that the coursework would be useful to them in their future lives, both in employment and outside. In the present study there were significant relationship between TCAR (taking up technical work) and FAMSKIL (family member with technical skills) for boys (r=.441) but not for the girls (chapter 7, section 7.3.10 - 4). Only one fifth of the boys rejected thoughts of a technical career (chapter 6, section 6.3.2.17, figure 6.14). There was a much higher rejection by the girls, the figure being three times that of the boys (63% - 21%).

"The girls showed a better understanding of the practicalities of the situation (i.e. a person being mugged), generally took this aspect of the discussion more seriously then the boys, and offered more deeply thought out comments and suggestions" (Millman p10). This seems to indicate that the girls were far more aware of the social aspects of technology.

Girls in the present study had more favourable attitudes than the boys towards the social aspects of technology (chapter 9, section 9.2.4).

11.6 TEENAGE ATTITUDES TO TECHNOLOGY AND INDUSTRY

11.6.1 GENERAL DESCRIPTION OF THE SURVEY

This was a three year research survey (1977 - 1980), designed to respond to the need for a systematic survey of pupils' attitudes to technology and industry and for the study of some of the factors influencing those attitudes. The survey, which was initially based at Bath University and funded by the Department of Industry and was directed by Dr Ray Page, assisted by Melanie Nash.

11.6.2 RESEARCH METHODS USED

An instrumemt to assess attitude change was developed to evaluate whether one of the aims of the Schools Council 'Modular Course in Technology' had been achieved. This aim was the fostering of improved attitudes towards technology and industry on the part of those 4th and 5th year secondary school children who took the Modular Technology course.

A feasibility study was conducted, with some 100 pupils aged 13 - 16 years. They were interviewed to find out if they used the words 'technology' and 'industry', had some understanding of their meaning and if they could converse freely about technologists and their work, technical training and industrial careers.

Items were then collected by interviewing over 400 pupils drawn from a similar ability group and age range to those above. From these items, four major categories of attitude relevant to technology and industry were identified:

(1) Attitude to technology as a school subject

(2) Attitude to technology

(3) Attitude to an industrial career

(4) Attitude to technical training and education at tertiary level

The validity of the attitude scale was checked by forming 5 criteria groups (ranging from zero to 5 according to the number of technical and scientific subjects choosen) and checking the pupils ratings on each of the sub-scales. It was found that the higher the pupil's score, the higher was his/her criteria rating. Further evidence of the validity was provided by testing 44 apprentices.

The attitude questionnaire was administered to 10,000 pupils from 64 schools (47 coeducational, 9 girls' and 8 boys') from LEA's in Avon, Bromley, Hillingdon, ILEA, Nottingham, Sheffield and Wiltshire.12 case study schools were selected from those schools whose pupils scored significantly higher on the attitude scale. These schools were studied in depth in an attempt to isolate some common factors which might account for their pupils' favourable attitudes to technology and industry.

This was done by interviewing and recording conversations with heads or deputies (school history and organisation); teachers responsible for the timetable (grouping of pupils, numbers in groups); heads of CDT, science and careers and other interested teachers.

11.6.3 COMPARISON OF TEENAGE ATTITUDES TO TECHNOLOGY SURVEY AND INDUSTRY WITH THE PRESENT STUDY

Both studies included a sub-scale of attitudes to technology. The two studies also contained data concerning attitudes toward technical careers.

The teaching of technical work in the seven schools in the present study (although taught mainly in departments entitled 'technical studies', it conforms to the CDT model set out in chapter 1, section 1.4.6) appears to be similar to five (CDT model) schools in the Technology survey.

Of the twelve schools in the Technology survey, according to the models in chapter 1, sections 1.4.1; 1.4.3; 1.4.6, there were five teaching CDT, five teaching technical studies and two almost teaching at a craft level, since their technical work was mainly recreational.

Two schools were teaching technology (one linking with the science department) and one more was thinking of starting the subject.

In the science departments, there were only two teaching technology (one linking with CDT).

In general, very few of the schools appeared to have been involved in the teaching of technology.

Included with the technology questionnaire for the Technology survey, there is reference to technology in society and technologists working in society. Although a feasibility study was carried out at the outset to find out whether pupils were familar with and understood the words technology and industry and in addition were able to converse freely about technologists and their work , technical training and their careers, no model was set up to explain what is involved in the teaching of technology in schools. It would therefore seem to be quite difficult for pupils in some of these schools to respond to the items in the questionnaire involving the teaching of technology in schools.

11.6.4 TEENAGE ATTITUDES TO TECHNOLOGY AND INDUSTRY FINDINGS COMPARED WITH SIMILAR ONES FROM THE PRESENT STUDY

The Technology project found that within the general population of 4th year secondary school pupils, boys were far more positive in their attitudes to technology and industry than girls.

In the present study, the 3rd year boys were far more interested in the way that technology was developing. Only 5% of the boys never concerned themselves with technology compared with 27% of the girls (chapter 6, section 6.3.2.2, figure 6.2).

The Technology project found a strong correlation, for boys, between studying a technological option and a technological career, but not for girls.

In the present study it was found that, in the case of girls, liking for technical studies (TSLIX) has a negligible correlation with intention to take up a technical career (TCAR) (r =.01), whereas for boys the relationship is positive and significant, but not strong (r=.296) (chapter 7, section 7.3.10 - 5). There is also a greater correlation between intending to take up technical studies (TUTS) and intention to take a technical career (TCAR) for boys (r = .521) than girls (r = .267) (section 7.3.10, table 9.13).

Two of the twelve case study schools in the Technolgoy project stood out because of the large numbers of pupils that went on either to craft and technician apprenticeships or to applied science and engineering courses. In the present study , in one of the sample schools, 1/3 of the 5th year leavers in 1985 (mainly boys) took up employment in industrial concerns (appendix B).

Two case study schools in the Technology project were unable to offer CDT subjects to girls, or only able to offer them very limited experience in the workshops, due to lack of facilities or staff. Reference to chapter 2, section 2.6.1.7, table 2.5a and b of the present study shows that there are three schools which were also offering only a limited experience in the workshops for the girls.

11.7 FINDINGS IN COMMON (FROM PREVIOUS RELEVANT STUDIES) WITH THE PRESENT STUDY

There are several similar findings and observations that appear to be common to most studies (including those in sections 11.3 - 11.6) books and papers. These are:

(1) Lack of 'tinkering' experience for girls prior to secondary education (section 11.7.1).

(2) Allocation of time for technical work (section 11.7.2).

(3) Stereotyping and social aspects of practical work (section 11.7.3).

(4) Home background (11.7.4).

(5) Behavioural differences between boys and girls in the workshop environment (11.7.5).

(6) Gender personality differences (11.7.6).

11.7.1 LACK OF 'TINKERING' EXPERIENCE FOR GIRLS

Two separate American studies by Cooley and Reed (1961) and Walberg (1967), identifying a type of science student which they labelled as a 'tinkerer', are referred to by Ormerod and Duckworth (1975). They suggest that 'tinkers' are likely candidates to profit from discovery learning. This method of learning also can help to improve confidence. In a working paper by HM Inspectorate (1977), entitled 'Curriculum 11-16', many salient points about equal opportunities were made.

"Its (CDT's) central aim is to give girls and boys confidence in identifying, examining and finally solving problems with the use of materials..."

The HMI's discussion paper 'Girls and Science' (1980) found that girls lacked the experience of using tools and materials and suggested that they should receive initial help with practical work when they first arrive at secondary school. Millman (1984, p12) reported that boys were quicker to get started on practical work than girls: "The boys seem to work more independently and were prepared to learn by their mistakes. The boys' conversations were generally 'task-orientated'... The girls worked far more in a group with persistent social conversation... The girls seemed to find excuses and reasons for not getting on with the task; often this may have been a lack of confidence".

Catton (1985, p23) refers to the same topic and suggests that "Much of girls' reluctance to use equipment and machinery may well be directly related to their previous mechanical experience".

The final report of the GIST project (p6) suggested that boys would have had more experience than girls of 'tinkering' at home. Schools might provide compensatory experiences for girls at the start of post-primary education. They found that 55% of boys compared with 22% of girls had 'quite often' used a screwdriver. Assuming that they were using the screwdrivers to take the back off a piece of a machinery to see what was going on inside, then that is clearly 'discovery learning'. On the other hand, if the screwdriver is merely being used to wire up a 13amp plug then all that is being carried out is a fairly routine type of practical work.

In the book 'Ways and Means' by Catton (p29), there is a reference to an observation made by Whyte (1983) "The majority of boys spend their time playing with constructional toys, car and trains, whereas girls dominate the wendy house / home corner and doll's house". Catton suggests that girls' lack of 'tinkering' experience is likely to mean that they are initially less confident and less able to control tools and machines. They need a wide range of basic 'tinkering' activities to compensate for their deficiency.

'Option Choice' by Pratt et al (p 123) suggested that there should be "compensatory instruction for those with inadequate home-based experience (e.g. boys / cookery, needlework; girls / metalwork, woodwork)".

The APU survey of eleven-year olds showed great discrepancies between boys and girls, with boys fond of 'tinkering' activities such as making models; taking things apart; playing with electrical toys and playing billiards, while the girls said they cooked, knitted, sewed or collected wild flowers.

In a paper entitled 'Does the Train-set Matter?' presented at the Girls and Science and Technology conference in July 1987, Kelly stated that on average boys had much more experience of 'tinkering' activities than girls. She suggested the effect was that "Boys experience of 'tinkering' activities was *virtually unrelated to either achievement or* choice of scientific and technical subjects. However there was a small but consistent tendency for girls who had engaged in such activities to be more likely than other girls to continue with technical subjects".

The report of Baroness Platt's 'Leggatt Lecture', given on 13th June 1984 at Surrey University (p11), refers to The Equal Opportunities Commission pamplet entitled 'An Equal Start':

"One needs to start first of all at home and in the nursery class. The Equal Opportunites Commission have issued a new pamphlet 'An Early Start' showing girls playing with mechanical toys and boys kitchen utensils right from the start, so they are all familiar with the tools and materials and technology and the home. If girls never get the feel of wood and metal, and play with mechanical toys, they will never be able to understand their behaviour - in this case familiarity breeds comprehension not contempt... The important thing is that boys and girls get a fair hearing, a fair share of tools available, and learn to work together and value each other's viewpoint. Later in commercial enterprise... a girl applying her aesthetic as well as her technological principles may alter for the better the product that is finally sold".

In the present study, chapter 6, section 6.3.2.2 72% of the girls and 92% of the boys responded positively to the item 'Do you enjoy taking things apart to find out how they work?' This indicates that there was a highly significant number of girls, if given the chance, who would like to 'tinker' (described in the study as the 'fiddle factor'). The response to item 6 'Do you think that you have learned enough practical skills in years 1, 2 and 3 to allow you to get on quickly with 4th year projects?' demonstrated just how lacking in confidence in technical skills girls are (section 6.3.2.3). 76% of the girls and 40% of the boys felt that they had not learned enough practical skills. This lack of confidence was also apparent, since the projects made by the girls were less demanding than those made by the boys (chapter 6, table 6.5)and the boys were more ready to use the larger and more complicated machines (table 6.6).

11.7.2 ALLOCATION OF TIME FOR TECHNICAL WORK

The Sex Discrimination Act (1975), which applies to the whole of Great Britain but not to Northern Ireland, makes sex discrimination unlawful in employment, training, education, the provision of goods, facilities and services and in the disposal and management of premises. The Act gives individuals the right of direct access to the civil courts and industrial tribunals for legal remedies for unlawful discrimination.

The implementation of this Act was both a challenge and also a problem for the staff of the CDT and HE departments. Before the Act arrived on the statute book, many schools were already giving boys and girls equal opportunities in the two departments during the first year of secondary education. The pupils usually went around the departments, sampling various disciplines, spending 8 to 10 weeks on each.

Unfortunately, heads of CDT and HE departments were slow, at first, to respond to the requirements of Equal Opportunity because they appreciated that to offer it to all pupils would result in effectively halving the experience of a range of skills and techniques for all pupils. To gain full benefit and true equal opportunity, the time available for CDT and HE needed to be doubled and extra creative staff appointed (Waller 1985). Taking into consideration the restrictions placed on the time allocated to these creative areas it seems unlikely, unless there is a great change in the attitudes of senior teachers, that the extra time and staff needed to make equal opportunities really work in the way intended will be made available.

Many schools found it difficult to fully implement 'Equal Opportunities' as highlighted by John Swain, HM Staff Inspector for CDT. Speaking at the Royal Society of Arts on October 25th 1982, he said:

"There are schools up and down the country that have still not come to terms with equal opportunities".

11.7.2.1 SYSTEMS DEVELOPED TO ATTEMPT TO PROVIDE EQUAL OPPORTUNITIES FOR BOYS AND GIRLS

There have been many systems developed in an attempt to implement the spirit of the Sex Discrimination Act of 1975, in order to provide equal opportunities for boys and girls in CDT.

Grant (1983:3 GATE) describes the five most common systems employed by 67 schools in his sample.

Type 1 - Compulsory and uninterrupted

This system must be considered to be the only entirely satisfactory way of organising CDT courses in schools where the curriculum is subject-based. It is only the schools in this category that are able to provide CDT courses of adequate duration, to enable worthwhile and progressive design and makeing activities to be experienced by all pupils in the 11 - 14 age range, regardless of sex.

Type 2 - Compulsory and rotational

Complying with the provisions of the Sex Discrimination Act has meant doubling the number of pupils in subjects such as CDT and HE in schools where these subjects used to cater for one sex only. In coping with this change, many schools have organised their 'practical' and 'creative' subjects in such a way that all pupils experience a short 'taster' course in each area in preparation for subject choice at a later date.

Type 3 - Exclusion of girls from CDT

Exclusion of all girls from CDT and all boys from HE in the first three years of secondary school.

Type 4 -Option choice

Operation of an early option choice system at the end of the first or second year. This system requires pupils to choose one subject area for continued study, being CDT and HE or CDT, HE and Art.

Type 5 - Option choice followed by rotation

A combination of types 2 and 4. Pupils choose two or more courses at the end of the 2nd-year from a range of CDT, HE and Art courses and, following option decisions, rotate between this smaller number of courses.

In the author's school, for seven of the last ten years, a 'taster' system has operated for 1st-year pupils, with four ten-week courses in the CDT and HE departments. For the last three years, a four week basic computer course has been included, reducing the courses to nine weeks duration. In the 2nd-year, the pupils rotate on a termly basis, after choosing three from five courses within the CDT and HE departments. Additional time in the 3rd-year gives pupils an opportunity to choose two courses from CDT and HE which they study for the whole year. These arrangements do not comply with the Act, since all the boys and all the girls do not have an equal opportunity to take both CDT and HE. Overall, this compares with Grant's type 5.

In September 1987, the CDT department moved over to a compulsory and uninterrupted course in the 1st-year, with the 2nd and 3rd-years as described above. In future years, it is envisaged that compulsory and uninterrupted courses will be in operation throughout the first three years, providing 'true equal opportunities' at the school for the very first time. Grant (1983:3 GATE) himself points out that the rotational system has some major disadvantages:

(1) The limited time available for each short course, which results in a lack of depth in the treatment of the subject material .

(2) It is difficult to plan, design and make projects that will not overrun the time available. This can lead to numerous incomplete projects that pupils are likely to interpret as failure.

(3) In the short time available, it is difficult for the teacher to build good personal relationships with the pupils.

(4) In the year when option choices are made, some pupils will be required to make decisions before experiencing some of the courses.

(5) It is difficult to ensure continuity and progression over the three years.

There are other titles that have been given to systems developed in order to provide more opportunities to both boys and girls. The most commonly used of these are 'Roundabout', 'Carousel' and 'Circus' Pratt et al (1984 p226-7) found that 90% of mixed schools in his sample claim that they operate a rotational craft system at some stage before the pupils select options at 14+ : "Rotational Craft Timetables are often badly implemented, being offered in an abbreviated form, or irrelevant to examinations subjects, and so offer an inadequate experience base for pupils to make a serious choice".

Catton (1985) suggests that "organizationally, the 'circus' may be convenient, but, educationally, it is less satisfactory. The reality of such a scheme is that pupils experience a series of short, unconnected, areas of study".

Dodd and Clay (1982) report that "Many teachers are now less committed to the 'design circus' in the lower school ... This innovation of the late 1960's and early 70's is now seen by many as diluting the quality of experience offered to younger pupils".

In the present study (section 6.3.2.7) 80% of the boys and 60% of the girls expressed a desire to have more time doing technical studies. In addition 60% of the boys and only 24% of the girls consider that they have learned enough practical skills in years 1, 2 and 3 (section 6.3.2.3).

In the Equal Opportunities booklet, entitled 'Equal Opportunities in Craft, Design and Technology' (p 24), the way that schools responded to the Equal Opportunities Act is outlined: "The great majority of schools responded to the legislation by setting up rotational crafts systems, commonly referred to as 'circus' arrangements. This was undoubtedly the easiest way of ensuring that each pupil experiences the full range of craft subjects available, but educationally it is far from ideal. Experience over the past 10 years has highlighted a number of serious problems with circus arrangements; for example, shortage of time and lack of continuity and progression. Designing and making things well takes a long time. With the benefit of hindsight it has clearly been unreasonable for headteachers and others to expect Craft departments to have taken on double the number of pupils without some help in terms of timetable time, staffing facilities and equipment. In most cases such resources appear not to have been made available and the result is that all pupils now experience all crafts, but for half the length of time for each, thus providing a shallow experience."

The lack of experience of technical work afforded to girls in the first three years is aptly summed up in the GATE report (83.3, p 18): "In Craft, Design and Technology in these schools the experience of girls is of diminishing time spent on workshop activities as they proceed through school. For boys, on the other hand, the time spent on CDT courses increases with the passage of each school year as more girls either opt out of CDT or are excluded. Such differentiation occurs either directly - by operating a purposefully discriminatory policy - or indirectly - by organising the curriculum to pressures unrelated to gender, but which have the effect of limiting access to girls. The main pressure that leads schools to adopt an organisation system which unintentionally results in low participation rates by girls seems to be the problem arising from a low share of curriculum time allocated to CDT in years 1 -3".

11.7.3 STEREOTYPING

Sexual differentiation and the furtherance of stereotyping are still allowed to happen in a number of ways in schools, such as the way option groups are arranged, the attitudes of staff and careers advice. The GIST project (p 29) included a number of stereotyping measures in the attitude survey, and boys were consistently found to be markedly more sex-stereotyped then girls. "For both sexes a feminine self-image was linked to low academic achievement, and a masculine self-image to high achievement. Children who endorsed sex-stereotypes showed less interest than other children in learning about the areas of science traditionally associated with the opposite sex. Thus sex-stereotypes have the effect of restricting children's academic horizons even before they encounter the relevant subjects at school". However, the GIST project also found that able girls and those from middle class homes were slightly less stereotyped then others. In the present study, it was found that the more intelligent girls expressed a greater liking for technical studies (chapter 7, section 7.5).

Down (1986) suggested that "gender differentiation is built into our schools and with it goes the message that on average girls are not so good in maths, the physical sciences and CDT."

In its report (84:2, p1), the GATE project suggested: "Equally important, but less widely recognised, are the school institutional factors which lend support to gender stereotyped assumptions and which lead to an imbalance in educational outcomes between boys and girls. These factors operate through the timetable and option systems, welfare and career guidance, teacher expectations, teacher/pupil interaction, teaching materials and the hidden curriculum generally."

There are three studies that recognise the importance of the social implications of subjects in respect to girls. Ormerod (1971) found that girls who choose physical science subjects also recognise that science has social implications. Head (1982), from his work on the psychological aspects of subject choice, suggested that: "To obtain a major qualitative improvement to recruitment in science with more girls and with processing imaginative , flexible minds it would be necessary to make science more appealing to girls and boys... The probable implication is that science would need to be presented in the context of the needs of society and individuals." The GATE project (1982), in a limited study of pupil entries to a national design competition, found a difference between boys' and girls' design projects that would tend to support the view that a greater emphasis on the social aspects of technology in school 'design and make' activities would be generally welcomed by girls.

Catton (1985, p15) suggests that at adolescence, girls are anxious to adopt a strongly feminine image and boys a masculine image. These images may be enhanced through subjects with the appropriate 'gender stamp'. Thus girls will choose home economics and needlework, and boys will choose woodwork and technical drawing.

Delamont (1980) observed that schools develop and reinforce sex segregation, stereotypes, and even discrimination which exaggerate the negative aspects of sex roles in the outside world, when they could be trying to alleviate them

In the present study, only 1% of the girls continued with technical subjects after the 3rd-year (chapter 10, section 10.3.1.2).

Catton (1985, p21) reported that boys and girls seemed to be divided by gender in schools. This serves only to reinforce the stereo type and imply that learning and personality are directly dependent upon the gender of the pupil.

Millman (1984, p10) found that girls, when discussing the anti-mugging device, showed a better understanding of the practicalities of the situation (i.e. a person being mugged); generally took this aspect of the discussion more seriously than the boys and offered more deeply thought out comments and suggestions. This demonstrates that the girls were relating to the social implication of problems.

Pratt et al (1984 p 230) suggested that subjects that were traditionally stereotyped, such as needlework and metalwork, and the skills taught within those subjects were often sex-stereotyped. "Yet they can be identified and taught as general and transferable. For example, manual dexterity is learned in both needlework and metalwork; the translation of two - and three- dimensional representations is common to both. By formatting an array of skills in general terms... it is possible to develop them in a non - stereotype way".

In the present study (chapter 9, section 9.2.4), favourable attitudes to SOCTEC (4th attitude factor - high scorers on this measure show a favourable attitude to the influence on technology in society) seem slightly more helpful in getting girls to like CDT but it led to a rejection of a technical career. However, figure 6.2, chapter 6, shows that boys are three times as interested as girls in the way that technology is developing. Had the concern been actual social implications of technology, then perhaps the girls may have reacted more positively.

11.7.4 HOME BACKGROUND

Parental support is a very powerful influence on the development of many children. Medvene and Shueman (1976) found a significant relationship between choice of major job function and early parent-child interactions. Ainley and Clancy (1983) found the influence of a male member of the family who possessed technical skills to be a strong factor when younger members were choosing careers.

According to the GIST project (p29), parents were enthusiastic about their daughters' studying science, but neutral about craft subjects. However those mothers who did household tasks more usually undertaken by men had daughters who were less sex-stereotyped and who saw themselves as less feminine and more masculine than other girls. Fathers' behaviour was less influential and boys were apparently unaffected.

Kelly (1987) suggested that "Achievement in science was very highly correlated with home background". Rauta and Hunt (1975) found that high-aspiring girls came from more privileged backgrounds.

Pratt et al (p 110), referring to opposition to the rotational craft timetables in a Midlands Upper School and two Northern Comprehensives, reported that " It was implicit in all schools, insofar as craft staff often ascribed differences between the ability of boys and girls to influence in the home, which their programmes presumably were not designed to contradict or neutralize".

In this study, the presence of technical skills in the family seems to be by far the most potent influence on girls taking up technical studies (chapter 6, section 6.3.2.12 and chapter 7, section 7.3.10 (2)).

11.7.5 DIFFERENCES OF BEHAVIOUR OF GIRLS AND BOYS IN A WORKSHOP ENVIRONMENT

Boys generally seem to be more aggressive than girls, and this is reflected quite often in their behaviour in the workshop.

The GIST project found that when resources were limited, boys seemed to assume that they had automatic priority. They would exercise this priority by grabbing the equipment or, if the girl got there first, by breathing down her neck until she relinquished the desired object.

Catton (1985 p 22) reported that boys tended to monopolise resources:

"A boy wanted a hand drill which a girl was using. His technique was not to ask her to pass the tool across when she had finished, but rather to stand close to her, fold his arms and stare at the tool, the girl gave in before completing her drilling and was on the point of handing the drill over before the teacher intervened... often boys employ even less subtle techniques for setting their hands on equipment, rushing and pushing to get tools."

Millman (1984) found that often the boys' interests and demands dominate in mixed groups.

In the present study, it was found that girls made less ambitious projects (chapter 6, table 6.5) and favoured using the less complicated machines (chapter 6, table 6.6). This might perhaps indicate that the boys were monopolising both tools and machines.

However there is one study which diverges from all the above conclusions. Down (1986, p22) reported a study by Gay Randall (1985) which showed, in a limited study of CDT workshop activities involving project work, that girls had more contacts with the teacher than boys and that these contacts were longer. Girls also interrupted more and made more unsuccessful attempts to initiate contact.

11.7.6 GENDER PERSONALITY DIFFERENCES

Her Majesty's Inspectors (DES 1977) argued that 'the school curriculum is the key to pupils' achievement. Yet it has been found that the curriculum offered to both boys and girls differs greatly, (Dale (1974), Ormerod (1975), DES Annual Report (1975)). Pratt et al (p1) comment "It may be that society can justify the striking differences that exist between the subjects studied by boys and girls in secondary schools, but it is more likely that a society that needs to develop to the full the talents and skills of all its people will find the discrepancy disturbing".

It may be that the apparently different personalities of boys and girls is in part due to socialization and stereotyping in society and schools. MacDonald (1980, p38) postulates that the child learns class-based definitions of masculinity and femininity within the family as well as certain divisions of sexual labour. This sets up a 'gender code'. These notions of appropriate behaviours for each sex are converted into the appropriate academic disciplines:

"Despite the actual availability of all subjects, girls and boys of different classes learn the new ideology of sex differences which mixes a theory of biological sex differences with expected gender differences of intelligence, ability, interest and ambitions, making it appear 'natural' that boys and girls should study different school subjects".

GIST classroom observations (p33) offer support to MacDonald's analysis: "Boys bring with them to science lessons a conception of masculinity which includes toughness, aggression, activity and disdain for girls; girls bring with them a conception of femininity which includes insecurity, conscientiousness, deference, person orientation and a concern for appearance. These self- definitions lead girls and boys to behave in different ways, such that the boys come to dominate the laboratory and learn science more successfully than girls".

In the present study (chapter 9, section 9.4.3), girls intending to take up technical studies and technical drawing tended to be tough-minded and have a degree of neuroticism (insecurity). Girls demonstrated a preference for working with people rather than things in their responses to DRAWTEC (items involving technical drawing section 9.2.3).

Millman (1984, p3) suggests that "Girls and boys bring different sets of experience with them to the classrooms and the workshops, but in traditionally male areas of the curriculum it is still male values and attitudes which determine the pupils' learning environment. For the girl who has exceptional stamina and motivation it is possible to achieve some success in the male world. But the majority of girls, whose potential is clearly equal to their male counterparts, are frustrated by the alien environment of the tradition workshop. Bearing little relationship to their normal female experiences the working environment turns them off, stifling rather than fostering their interests and creativity".

11.8 OVERVIEW

There is no doubt that the thrust toward equal opportunities has produced the most meaningful research work in the CDT area over the last decade.

As far as the actual subject studied is concerned the state of development of technical work in schools by the early 1980's taking comments made in all the studies into consideration, reflected the technical studies model much more than the CDT or technology models (chapter 1,section 1.4.3; 1.4.5; 1.4.6).

While the present study referred mainly to technical studies departments as judged by the GATE criteria (section 11.3.3), the departments considered used a design, problem-solving and multi-media approach. Therefore the work that was being done by the majority of pupils was in fact more in line with the CDT model.

The studies reviewed in this chapter include a large number of pupils. GIST was concerned with ten comprehensive schools in three LEAs in the Greater Manchester area involving 2,000 pupils. GATE in their report 83:3 'Improving the Access' was concerned with one urban LEA and another LEA with a suburban, urban and rural mix with a total number of 80,000 pupils. They achieved a 58% response rate to a survey questionnaire (68 schools out of the 117 approached). Teenage Attitudes to Technology and Industry was involved initially with 10,000 pupils from 64 schools from 7 LEA's. Suitable schools were selected and case studies were conducted in twelve of them: three in Bromley; three from Sheffield; four from the Avon area and two from Wiltshire. Pratt et al used two samples (1) 139 schools from 63 LEAs and (2) 216 schools from six LEAs, including one from Scotland. Millman's research involved 230 pupils from a large comprehensive school in Coventry

The present Study involved 405 pupils from seven Hertfordshire schools.

There is some doubt about the descriptions of the technical work being studied in all these projects, when comparisons with the models set up for technical studies , CDT and technology (section 11.2) are made. References to craft, metalwork, woodwork and technical drawing abound with the generic term CDT being used to describe the work being done. However in most cases, it would appear that the correct title for the work being reviewed should have been 'technical studies'.

The work that was being done in six of the Hertfordshire schools, considered in the present study, was described using the generic term 'technical studies' (the seventh school in Mid Herts referred to their department as CDT - the work done there compares with the model set up for CDT, section 11.2.). The definition 'technical studies' indicates a 'process' as opposed to an 'activity', used in the definition of CDT and technology. Clearly the work that was being done in the sample schools, when compared with the GATE criteria and the various models set up for technical studies , CDT and technology, involved 'activity' and was in line with the current thinking at that time (early 1980's), since most courses included design and problem-solving with a multi-media approach. This demonstrates that although the title used for six of the sample schools departments was 'technical studies', most of the courses taken by the pupils included a significant amount of design and technology.

There was a direct similarity between the GIST schools and the sample schools, because in both studies there existed no formal links between the teaching of science and technical work in the first three years.

In many of the studies, there is a reference to 'tinkering activities' (discovery learning giving the opportunity to experiment in lessons)and to the lack of mechanical experience (acquisition of technical experiences using tools and machines) gained by girls in the primary sector. It is felt that perhaps schools might provide compensatory experiences for girls at the end of their primary school career or at the beginning of their secondary education.

There is overwhelming evidence from the studies demonstrating that all rotational craft timetables ('Roundabout', 'Carousel and 'Circus') are often badly implemented and offer an inadequate technical experience for both boys and girls.

The way that boys and girls are divided in some schools exacerbated moves towards Equal Opportunity in technical work. Stereotyping seems to lead boys and girls to select subjects with the appropriate 'gender stamp'

Girls seem however to be more attracted to technical work if projects are socially- orientated.

There is very strong evidence of the importance of home background when girls are considering subjects in the physical science and technical areas.

Boys appear to be far more aggressive and dominating, thus demanding more of the teachers' time than do the girls, according to most studies.

Girls and boys appear to have differing personality profiles which could affect their experiences within technical work.

Few similarities were found between the study on 'Teenage Attitudes to Technology and Industry' and the other projects, because the former was concerned with 4th and 5th-year pupils and the administration of the questionnaires was done just prior to the introduction of the Equal Opportunities Act. However, there is a large measure of agreement between the findings in most of the studies reviewed and the present study.

11.9 CHAPTER 12

This final chapter draws together all the findings of the study. They are analysed in respect to the orginal primary and secondary aims. Based on these findings, recommendations are made for any future research in CDT.

CHAPTER 12 RESEARCH FINDINGS AND RECOMMENDATIONS FOR FUTURE RESEARCH

12.0 RESEARCH FINDINGS AND RECOMMENDATIONS FOR FUTURE RESEARCH

12.1 INTRODUCTION

In this study, four questionnaires have been administered in an effort to satisfy the aims and objectives of this study, set out in chapter one. An attitude and an information questionnaire reviewed in chapter 6 and 7; Cattell's High School Personality Quotient questionnaire (HSPQ) discussed in chapters 8 and 9 and a questionnaire to find out how pupils perceive the role of the engineer in society, detailed in appendix A, constitute the battery of questionnaires used. In addition, a survey has been undertaken to ascertain how many pupils in the sample of 405 actually took technical examinations in the 5th year, reported in chapter 10.

The findings pertinent to the primary and secondary aims were reviewed in chapter 11 and compared with other projects and associated literature.

The problems encountered during the research period have been considered. Avenues of research that may have been followed have been considered and recommendations for future research suggested.

12.2 PRIMARY AIMS - REVIEW OF FINDINGS

12.2.1 PRIMARY AIM OF THIS STUDY

To investigate the dimensions of attitudes of 3rd year secondary school pupils towards Craft, Design and Technology

12.2.2 METHODS ADOPTED TO FULFIL THE PRIMARY AIM

This has been done by getting pupils to write about technical work in school and technology in society. Suitable items were extracted from these essays, which were then grouped together and judged. The most suitable items were then arranged in a 50 item pilot questionnaire. The items were piloted at two schools and from the most significant items a 48 item questionnaire was designed. Since this was intended to produce shades of opinion in a rather structured way, another more 'open-ended questionnaire' referred to as the 'information questionnaire' was designed . This is discussed in chapter 5.
These two questionnaires (attitude and information) were administered to 405 pupils (104 girls and 301 boys) in seven coeducational schools (chapters 6 and 7). A Cattell's HPSQ questionnaire was administered in one of these schools (chapters 8 and 9). The background to attitudes and attitude measurement is discussed in chapter 4.

12.2.3 METHODS USED TO ESTABLISH ATTITUDE FINDINGS

Three different ways of using the pupils responses to two of the questionnaires were used:

(1) Frequencies were obtained for the pupils responses to the information questionnaire. The frequencies for every item were then compared graphically (chapter 6).

(2) Correlations between the five attitude factors were obtained using the pupils responses to the attitude questionnaire (chapter 7).

(3) The more discriminating variables from the information questionnaire together with the pupils' mathematical ability and the pupils' response to the example item on the attitude questionnaire were correlated with the five attitude factors (chapter 7).

12.2.4 ATTITUDE FINDINGS

An analysis of the findings from the attitude questionnaire (chapter 7) and the information questionnaire (chapter 6) present separately the attitudes of boys and girls towards CDT. This is part of the primary aim of this thesis:

To investigate the dimensions of attitudes of 3rd year secondary school pupils towards Craft, Design and Technology.

12.2.4.1 WHERE GENDER ATTITUDES ARE IN AGREEMENT

Both sexes suggested the need for more modern machinery; they requested a greater range of more exciting projects in technical studies lessons and more stimulating things to draw in technical drawing lessons. They disliked theoretical lessons and demonstrations.

Boys and girls expressed a statistically significant desire for creative subjects (CDT, HE and art), even though their choices followed the usual gender stereotypes. However, girls demonstrated more interest in technical studies and technical drawing, as part of their favourite five school subjects, than the boys did in HE.

It would appear that for both sexes the reactions to technical studies are different from those to technical drawing.

12.2.4.2 GENDER DIFFERENCES

Boys take more interest in and choose more technical subjects than girls do; they look forward to the lessons more and make more challenging projects. They use the most complicated machines; have more confidence in their ability to cope with a 4th year technical course and have more interest in technology. In addition, they express a greater desire to take up technical studies and technical drawing (less enthusiastically) and follow a technical career.

Their greater appreciation of the value and skills of technical studies appears to be related, more strongly than girls, to a family member with technical skills and linked with criticism of the way that it is taught. Boys tend to be not as relaxed with technical activities and weaker mathematically than girls, both of which lead to some form of tension. Boys express a desire for more time to be spent on technical studies with the work practically based, preferably with machines, and including some degree of discovery learning ('tinkering').

One third favoured employment as engineers, carpenters and mechanics. It appears that technical studies, at the time of this research, was attracting less intelligent and less mathematically-able boys beyond the 3rd year.

Girls seem to enjoy and appreciate the value and skills of technical studies, although this is less specifically based than the boys. Girls, especially the intelligent ones, have a more general liking for technical studies; tend to be uncritical of the subject and are more relaxed than the boys in technical activities. They seem less inclined to make challenging projects and use the more complicated machines, appear unsure of their ability to cope with a 4th year technical course and express little desire to take up technical studies , technical drawing and a technical career.

They also wanted more time for technical studies, with the work practically based (where they demonstrated marginally more enthusiasm than the boys did). Preferably this would involve the use of machines and include some degree of discovery learning ('tinkering'). This was expressed to a slightly less degree than for the boys. However their intention of taking up technical drawing is strongly influenced by a family member with technical skills. Girls express a desire for more time to be spent on both technical drawing (unlike the boys) and technical studies.

12.3 SECONDARY AIMS - REVIEW OF FINDINGS

12.3.1 SECONDARY AIMS OF THIS STUDY

(1) To investigate the differences, in both attitudes and personality, in the way the two sexes regard CDT.

(2) To attempt to ascertain why more girls do not continue with CDT after the 3rd year.

(3) To follow-up the sample until the post 16+ stage in order to investigate the actual take-up of further study of CDT subjects to examination level at 16+.

(4) To compare those who passed well ('high flyers') with those who only gained a low pass grade ('low achievers').

(5) To compare the attitudes and examination performance of pupils in the sample schools.

12.3.2 SECONDARY AIMS (1) - BRIEF REVIEW OF METHODS USED

The identification of the factorial structure of the HSPQ in this study was carried out by item analysis with a sample of 191. After factor analysis, a five-factor structure of personality, together with the additional factor of intelligence, was adopted. This was based on the factor analysis of the scores of the 130 items in Cattell's HSPQ (i.e. excluding the 10 items on intelligence - chapter 10).

12.3.3 SUMMARY OF FINDINGS RESULTING FROM CORRELATIONS BETWEEN THE FIVE ATTITUDE FACTORS AND THE FIVE PERSONALITY FACTORS

12.3.3.1 GENDERS DIFFERENCES

The two sexes are presenting across the whole of the five attitude scales a completely different psychological profile.

Boys portrayed anxiety when appreciating the skills and techniques involved in technical studies and technology in society. Their appreciation of graphics was associated with liking for things rather than people and being persistent and serious. They displayed aggression and competitiveness (tough-mindness) with respect to technical studies being relaxing.

In their general profile girls appear as extraverts.Their appreciation of graphics and technology in society was associated with aggression and competitiveness (tough-mindedness). They also displayed stability when considering technology in society.

12.3.3.2 SIGNIFICANCE OF FINDINGS

The personality profiles associated with the attitude measures have a validatory function since they are the 'expected' personality profiles found in association with the different attitude scales. Studies of pupil performance across school subjects show that girls and boys tend to choose different options and subsequently 'A' levels. This tends to account for the poorer performance of many girls in mathematics. They have studied a narrower range of subjects in which mathematics is used then the boys have. The gender issue in CDT is reviewed in chapter 11.

12.3.4 SUMMARY OF FINDINGS RESULTING FROM CORRELATIONS BETWEEN THE FIVE PESONALITY FACTORS AND THE OTHER VARIABLES

12.3.4.1 WHERE GENDER ATTITUDES ARE IN AGREEMENT

Both sexes demonstrate stability in association with their choice of the number of technical subjects and aggression and competitiveness (tough-mindedness) with their intention to take-up a technical subject.

12.3.4.2 GENDER DIFFERENCES

For most of the variables associated with liking of technical studies, boys displayed aggression and competitiveness (tough-mindedness). In addition they demonstrated stability and extraversion in connection with the selection of the number of technical subjects included in their favourite five; were persistant and serious in association with liking technical studies and demonstrated an interest in things rather than people with intention of taking-up a technical career.

Girls displayed tough-mindedness and anxiety in association with intention to take-up technical studies. The number of technical subjects included in their favourite five was connected with stability and liking for technical studies with interest in things rather than people.

Intention of taking-up technical studies for boys is associated with tough-mindedness whilst intention to take-up technical drawing is linked to preference for people rather than things, persistence and seriousness (controlled conscientiousness) and anxiety.

For girls there is a similar association with tough-mindedness and anxiety for both intention to take up technical studies and technical drawing.

Boys display tender-mindedness and anxiety in association with having a family member with technical skills. Their ability in mathematics is connected with persistence and seriousness.

In contrast, girls display persistance and seriousness and an inclination to be 'happy go lucky' in association with having a family member with technical skills. However ability in mathematics is connected with persistence and seriousness and extraversion.

12.3.4.3 SIGNIFICANCE OF THE RELATIONSHIP BETWEEN PERSONALITY AND OTHER VARIABLES

There are some differences between boys and girls with regard to the relationship between personality and other variables. Tough-mindedness is the common feature for boys throughout the variables relating to the liking of and thinking of a career in technical work. This is only to be expected, since it is the mathematically-weak boys who enjoy doing technical work. To succeed they need to be purposeful.

The only variable associated with a liking for technical work in girls which is associated with tough-mindedness is taking up technical studies. This trait may be necessary to enter a previously male-dominated subject.

Boys and girls wanting to take up a number of technical subjects tended to show stability in their personality profile.

In the case of girls liking technical studies was associated with an interest in things rather than people - a good trait for the technically- minded.

Clearly the boys held a varying regard for taking up technical studies, as opposed to *taking up technical drawing*. *Taking up technical studies* is associated with tough-mindedness, whereas taking up technical drawing with preference for working with people, together with controlled conscientiousness and introversion.

In direct contrast, this dissimilarity did not extend to the girls. Both variables were associated with tough-mindedness and anxiety. One might expect this in girls who enter a previously male-dominated area.

Boys with a technical family member displayed anxiety in their responses. This may be due to their weak mathematical ability .
On the other hand, the girls who chose technical studies seem to have a 'devil-may-care approach', possibly to overcome what they feel is an alien workshop environment.
With the variable associated with mathematical ability, the boys again demonstrate anxiety because of weakness, whilst for girls it is associated with the personality characteristic of careful conscientious- a very positive trait for the able mathematician.

12.3.5 THE OVERALL PROFILE OF A PRO CDT BOY AND GIRL

A comparison of attitude and personality factors with other variables is set out in table 9.16, chapter 9 and a tally of personality traits (excluding mathematical ability) was made. From this, a profile of a pro-CDT boy and girl has been produced.
Both sexes are likely to be aggressive and competitive (tough-minded) rather than tender-minded. Thereafter the sexes divide.
The girls are likely to be stable extraverts, with a slight tendency to prefer working with people and an inclination to be 'happy go lucky'.
On the other hand, boys are far more persistent and serious introverts rather than extraverts; anxious rather than stable and slightly more inclined to like working with things rather than people (chapter 9, section 9.4.10).

12.3.6 WHY MORE GIRLS DO NOT CONTINUE WITH CDT AFTER THE 3RD YEAR (Secondary Aim 2)

12.3.6.1 GROUNDS FOR CHANGING PRACTICE

Certain possiblities emerge that might explain some of the data and provide grounds for changing practice.

The answer could lie in the considerable amount of research that has been done since the 'Equal Opportunities Act' was passed in 1975, chaper 3, section 3.6.2. Also some of the findings of this study support findings of other studies, as shown below.

12.3.6.2 TINKERING EXPERIENCE

HMI discussion paper entitled 'Girls and Science' (1980) refers to avery significant request by both sexes for more opportunity for 'tinkering' (chapter 6, section 6.3.2.2), highlighting the fact that many girls miss out on this experience. This could be one of the reasons why some girls seem to be lacking in confidence when they use tools and machines, Millman (1984). This lack of confidence in practical work shown by the girls is also referred to in Chapter 6, section 6.3.2.7 - they seem to prefer technical drawing rather than the more practically-based technical studies. In this study, chapter 6, section 6.3.2.3, figure 6.4 only 24% of the girls felt that they had learned enough practical skills in years 1, 2 and 3 to allow them to get on quickly with 4th-year-projects.

Further evidence of the importance of 'tinkering' experience is demonstrated in chapter 11, section 11.7.1.

12.3.6.3 ALLOCATION OF TIME

This study refers to the lack of time allocated as does Grant (1983, p24). He also (p15) makes a direct reference to how the lack of time can effect the girls: "For boys the time spent on CDT courses increases with the passage of each school year as more girls either opt out of CDT or are excluded".

Chapter 11, section 11.7.2 reviews the various attempts that have been made to implement equal opportunities. Most of them unfortunately resulted in girls not receiving an equal share of time similar to that allocated to the boys. This is demonstrated by reference to the GATE report (83.3, p 18): "In Craft, Design and Technology in these schools the experience of girls is of diminishing time spent on workshop activities as they proceed through school".

12.3.6.4 WHAT SOCIETY EXPECTS?

Ormerod (1975) in his 'gender spectrum' indicated that all school subjects tended to be either 'male' or 'female', with pupils selecting CDT and HE along traditional lines. The EOC booklet entitled 'Equal Opportunities in Craft, Design and Technology'(p8) makes reference to the fact that " as soon as they are given the choice, however, pupils opt on very traditional lines and very few 4th and 5th-year girls are to be seen working in CDT workshops in most schools". Catton (1985) "At adolescence, girls are anxious to adopt a strongly feminine image..."

In this study in chapter 6, section 6.3.2.16, table 6.17, in listing their five favourite subjects the pupils reveal very traditional choices for four of the first five selections.

12.3.6.5 PERCEPTION OF THE ROLE OF THE ENGINEER

The image of engineering as a dirty job and the engineer as a scruffy person (Appendix A) probably does not present a very attractive view of future propects for the technically-minded girl.

12.3.6.6 CAREERS ADVICE

Consistent with other research is the need for girls to be made aware of the opportunities for females in industry by careers advice and schemes such as WISE and GIST 'action research'.

12.3.6.7 SUMMARY

From the discussion above it would seem that to provide more stimulus to girls so that they continue with CDT after the 3rd year they need:

(1) More 'tinkering' experience in the primary schools.

(2) Extra time spent, without the boys, gaining 'tinkering' and extra practical experience at the start of their secondary education.

(3) An allocation of sufficient time spent on CDT to allow the same experience for all pupils. This will enable girls as well as boys to fully develop their technical and creative skills.

(4) A greater acceptance into the workshop environment. It is recognised that previously CDT has been a male-dominated subject area and it is a well-researched fact, chapter 3, section 3.6.5, that boys do try to get more than their fair share of attention. This may have had a considerable impact, in the past, on CDT lessons.

(5) To be given similar challenges to that given to the boys in practical work. In this study, it has been shown that girls do not seem to make as complicated projects as those made by the boys. They also tend to prefer the less complicated machinery, chapter 6, section 6.3.2.8, tables 6.5 and 6.6.

(6) To be made more aware of the many career opportunities for those pupils with technical and creative skills.

(7) To be made aware of the real work that the engineer does, and the environment in which he or she works, in the late 1980's.

(8) To be aware of the social implications of technology.

12.3.7 SECONDARY AIM (3) - A FOLLOW UP

To follow-up the sample until the post 16+ stage, in order to investigate the actual take-up of further study of CDT subjects to examination level at 16+.

12.3.7.1 SURVEY OF PUPILS 5th YEAR TECHNICAL EXAMINATIONS: ACTUAL FINDINGS

A survey of examination results was made (chapter 10) in six of the seven schools. One of the study schools refused the author's request for examination data.

The survey is therefore based on 363 pupils (259 boys and 104 girls).

More boys than expected from the TUTS (take up further technical studies) score actually took the examination, so amounting to 80% of the sample, whereas less than expected took up technical drawing - only 41% of the sample. This underlined the contrast between these aspects of CDT.

Only one girl studied either of the subjects to examination level and she was the daughter of the head of CDT at one of the sample schools. This was significantly less than the declared intention of the girls in the sample.

12.3.7.2 OTHER MEASURES OBTAINED

In addition to establishing which pupils finally took technical examinations, three other measures have been obtained:

(1) A comparison of the results in all schools with one of the South West Herts schools.

(2) The relationship between all boys who took a practical examination, scores from the five attitude scores and other variables (table 10.6).

(3) The establishing of two groups of pupils, 'high flyers' and 'low achievers', to compare their responses to the five attitude factors and thereby discover any differences.

It was decided to use school 1 as a 'marker' school since they had significant numbers of pupils (1/3 - mainly boys) who entered work, in various types of engineering when they left school at 16+ (appendix B). In addition, this school had two CDT teachers who previously had spent several years in the engineering industry. (For details of the comparison between the seven sample schools, see chapter 2, section 2.7).

School 1 gained significantly higher examination grades when compared with school 2 (which was one of the Mid-Herts schools).There was no significant difference between the examination grades achieved in four of the five sample schools, which were all situated in South-West Herts (one school declined to assist in this part of the study).

12.3.7.3 RELATIONSHIPS BETWEEN ALL BOYS WHO TOOK PRACTICALLY BASED TECHNICAL EXAMINATIONS (TECHNICAL STUDIES, TECHNOLOGY ETC.) AND SCORES FROM THE FIVE ATTITUDE FACTORS AND OTHER VARIABLES

There was a strong pro-CDT stance and an intention of taking up a technical career demonstrated by the boys who took practical examinations. However, their ability in mathematics was weak.

12.3.7.4 RELATIONSHIPS BETWEEN ALL BOYS WHO TOOK GRAPHICAL EXAMINATIONS (TECHNICAL DRAWING ETC.) AND SCORES FROM THE FIVE ATTITUDE FACTORS AND OTHER VARIABLES

These boys were critical of the way that the subject was taught and their ability in mathematics was weak.

12.3.7.5 SECONDARY AIM (4)

To compare those who passed well ('high flyers') with those who only gained a low grade pass ('low achievers').

12.3.7.6 HIGH FLYERS AND LOW ACHIEVERS - PRACTICAL EXAMS.

The 'high flyers' (pupils gaining grades A,B or C or CSE grade 1) demonstrated a greater pro-CDT stance and found the work more relaxing than the 'low achievers' (CSE grades 4 or 5).

12.3.7.7 HIGH FLYERS AND LOW ACHIEVERS - GRAPHICAL EXAMS.

The 'high flyers' were more critical of the way that the subject was taught; were concerned about the effects of technology on society and were far more relaxed than the 'low achievers'.

12.4 SECONDARY AIM (5)

To compare the attitudes and examination performance of pupils in the sample schools.

12.4.1 COMPARISON OF SCHOOLS

One of the sample schools (No 1) had a significant numbers of pupils who entered work, when they left school, in various types of engineering (details in appendix B). To ascertain whether there was a significant difference between the schools, this school was compared in turn with all the other schools, for each sex. (chapter 2, section 2.7). Except for school 2 there was no significant difference between schools for the examination performance. Boys in school 1 gained higher grades in CDT examinations than boys in school 2. However the ability in mathematics of the boys in school 1 was superior to the boys in school 2 which may account for the difference in examination performance between these schools.

12.4.2 SIGNIFICANT DIFFERENCES

Generally there were only slight differences between the attitudes of the pupils in the sample schools. However there was one set of comparisons that presented a striking difference. In the year prior to testing, school 4 had two women teachers employed in the CDT department. Both girls and boys from school 4, when compared with school 1, had a greater liking for technical work.

This could indicate that the presence of the two women teachers might have had a considerable influence on the girls' appreciation of CDT, which perhaps is to be expected. But not so obvious or expected is the similar effect on the way the boys regarded CDT.

12.5 PUPILS' PERCEPTION OF THE ENGINEER

According to the pupils' responses to the survey (appendix A), an engineer is a confident, intelligent, inventive, cheerful, sociable and scruffy person who receives good pay for working a long day doing interesting and dirty work.

12.6 AWARENESS OF THE LIMITATIONS OF THE RESEARCH METHODS

Further information may have been acquired by conducting interviews with pupils or by classroom observation of practical lessons, considering option choices and by including a measure of spatial ability. Due to the relatively small number of schools involved, the findings may be regarded to be of a rather tentative nature. However the credibility of these findings is enhanced when they are compared with those from much larger research projects, conducted on a full-time basis over several years, working with teams of researchers and research assistants (chapter 11). Examples are:

The GIST project and this study both found evidence of similar support for both boys and girls from technically-orientated parents and a lack of discovery learning demonstrated by the girls. In both studies pupils were invited to give their profile of an engineer.

Millman (1984) and the present study both found that girls have a completely different psychological profile from that of the boys in respect to technical work. Also both studies found frustration and anxiety displayed by the girls in the workshop environment and that the girls were more aware than the boys of the social aspects of technology. There are many other similarities reviewed in chapter 11.

12.7 RESEARCH RECOMMENDATIONS

(1) That this study, with some of the items in the questionnaires slightly modified (in line with the latest GCSE titles for the subjects within CDT), needs to be replicated with a larger sample of pupils, in various parts of the country. It would be useful for this to be done when the national curriculum is settled.

(2) In view of the importance of spatial ability to the pro-CDT pupil (Chapter 3, section 3.4.1), any future research may well benefit from the inclusion of a spatial measure within the test battery.

In addition, pupil- teacher interactions and material gained from interviewing pupils could be analysed as a counter-check to the test battery. Option choices, especially with regard to those made by girls may also provide more relevant information about the reasons why girls , in large numbers, do not choose CDT. Also, in view of its recent prominence, an awareness of the way that CDT is being taught in many primary schools may assist further research.

3) There is no doubt that there are still a large number of schools up and down the country who are not providing both boys and girls with (a) equal opportunity and (b) similar allocations of time to that enjoyed by other subject disciplines.

It is appreciated that more research has been done in the 'equal opportunity' area. However there is still a requirement to obtain the true picture from a large cohort of schools, so that all CDT departments are treated fairly and allocated sufficient time and resources to perform their work with efficiency and enthusiasm.

(4) There is a tremendous requirement for more research into ways of welcoming girls more readily into the workshop environment. It has been suggested that brightening up the workshops may help. In this study, although the pupils were provided with the opportunity to comment on the workshops, only a very few pupils, certainly not a significant number, referred to dirty equipment. The items of equipment referred to were the drawing boards and squares used in technical drawing. A coat of paint may not be a full answer! It does seem that there is a need to change the attitudes of teachers of CDT, teachers of other subjects, and indeed the pupils themselves. The closing words of the GIST project make this point rather well.

"The results of the GIST project might be something of a disappointment to anyone who thought that schools alone could solve the problem of girls' under-achievement in science and technology. But of course schools cannot act alone; they are enmeshed in the wider social structure. Parents, primary schools, peers and employers all influence children's attitudes and their choices. Teachers are reluctant to change their routines... Against these odds it is perhaps more surprising that GIST had any impact at all rather than that its impact is limited".

(5) Girls appear to be more interested in the social implications of technology (Millman (1984) and this study). An in-depth study of this may produce more enlightened methods of teaching and project selection which could influence more girls to take CDT subjects.

(6) All pupils seem to need more stimulating practical and graphical work. The new GCSE examination may have provided with its greater emphasis on design and technology a more interesting course with a greater range of projects. An analysis of the components of attitude towards design and technology may reveal that pupils are less critical and derive more benefit from these new courses.

(7) Despite the efforts of the Engineering Council, Industry Year and a great amount of rhetoric from many influencial people, there is still little understanding of the role of the engineer and his or her true value in society. Are pupils clear about all aspects of this career and the many other opportunities available to those who have studied CDT?

(8) There is a need to build on the findings of this research and other studies referred to in chapters 3 and 11, to search for more reasons why the intelligent pupils of both sexes reject CDT after the 3rd year.

(9) There is obviously a great amount of support gained by both boys and girls by having a family member with technical skills. This has been one of the findings of this study and studies by Rauta and Hunt (1975); Medvene and Shueman (1976) in America; Ainley and Clancy (1983) in Australia and the GIST project. There is a need for more in-depth research work in this area.

(10) Working alongside boys seems to have some adverse effects on attitudes and performance in CDT (which has a background of being regarded as a very 'male' subject) for the girls. It is well-established that girls' preferences for and choices of the male science subjects - physics and chemistry - are greater in general in girls' schools. Any future investigation of attitudes to CDT should include girls' schools in the sample where CDT is being adequately taught. If it can be arranged the monitoring of experiments in coeducational schools where CDT is being taught on equal terms to groups of boys and girls separately would also be most illuminating.

12.8 OVERVIEW

12.8.1 PAUCITY OF CDT RESEARCH

The author has been surprised by the paucity of research work in the CDT area. In comparison with science, it is a very under-researched discipline, except for the studies on Equal Opportunities (chap. 11). However towards the end of the research period, in the late 1980's there were signs of a greater interest in this subject area. Until there are more research studies undertaken, there can be little real progress in CDT. There has been tremendous development in CDT over the last two decades and this needs to be evaluated.

In the new courses in GCSE, we are constantly being advised to train our pupils to evaluate at the termination of each project. To progress as a school subject, there is an urgent need for a large body of research to be conducted into CDT, to evaluate and ascertain whether the subject is heading in the right direction. If no research work is forthcoming then we shall continue to go round in 'circles' or be like a rudderless ship - directionless!

12.8.2 PROBLEM OF RECENT RAPID DEVELOPMENT OF CDT

The preface to this study highlights the difficulty experienced by the author due to of the rapid developments in industry, commerce and leisure over the last two decades. These developments have coincided with an increased awareness, on the part of government and the general public, of the increasing role that design and technology is playing in work and leisure activities. Due to various technological and design initiatives such as TVEI, the Sainsbury Trust, Interactive Technology, Education for Capability, CDT has gained an enhanced status in secondary schools. The subject has also gained much support within the primary sector.

Although it was not appreciated at the time, the very object of this research was being continually changed. These changes are reflected in the way technical departments are described. Over the last decade the technical departments in some schools have changed their titles - from Technical Studies to CDT and then to Design and Technology. Indeed it was quite noticeable when the author went to administer the questionnaires in 1982 that he was dealing with pupils in the technical studies departments. On his subsequent dealings with the schools in 1985, he was asking about pupils who had taken examinations in the CDT department.

12.8.3 COMPARISON OF THIS STUDY WITH OTHER STUDIES (chapter11)

There appears to be a greater distinction, in this study, made between the technical and practically orientated aspects of CDT as opposed to graphical areas. Indeed one of the major findings is the different reaction of both sexes towards technical studies (practically based) and technical drawing (graphically based).

Discovery learning is referred to as 'tinkering' in this study whereas other studies seem to use the term 'tinkering' for both discovery learning and for prior practical experiences.

A combination of attitude and personality measures provides this study with a considerable degree of validity. This 'double checking' of findings does not appear to be present in other studies.

12.9 MAIN FINDINGS

12.9.1 OVERALL

The tenor of this report is mixed. The main findings are that the pro-CDT boy presents different personality profiles to that of the pro-CDT girl. They also react differently to practically based technical work and graphical work within CDT.

There is a highly significant interest and appreciation of CDT shown by both boys and girls. They appear to enjoy the practically based work, especially using machines, rather than theory and demonstrations. A significant number of boys and girls have the support of a family member with a technical background during the first three years. However, this is countered by an almost total rejection on the part of the girls to continue with the subject after the 3rd year.

There also seems to be an element of frustration demonstrated by both boys and girls because of insufficient time and resources and a lack of 'sparkle' in the way the subject is taught.

The influence of women CDT teachers heightens the enthusiasm of both sexes for CDT . There appears to be more interest shown by both boys and girls in CDT when compared with HE. Overall there is a highly significant desire for creative work (CDT, HE and art) shown by both boys and girls, although their choices follow the usual gender stereotypes.

12.9.2 BOYS

Practically based technical subjects in CDT are attracting the less intelligent and less mathematically-able boys who express criticism of the subject and show some signs of anxiety within the workshop environment.

However they appear to be confident that they have learned sufficient skills to 'cope' with 4th year CDT courses. They appear to have been able to make more interesting projects and use more complicated machines than girls and seem to have a greater appreciation of the value and skills of CDT which is more specifically based than the girls.

This appears to lead them to have a significant desire to continue with practically-based technical subjects, and to a lesser extent graphical work in the 4th year, and to take a technical career.

The overall personality of a pro-CDT boy suggests that he is tough-minded, persistent and serious (controlled and conscientious); an introvert rather than an extravert; neurotic rather than stable and slightly more inclined to like working with things rather than people.

12.9.3 GIRLS

Practically based technical subjects and graphical work within CDT are attracting intelligent and mathematically able girls.

They have appreciation of the value and skills of CDT. Girls seem to derive more enjoyment from CDT than the boys do, especially the more intelligent girls. They appear to be relaxed and uncritical of the way that the subject is taught.

Although girls have more appreciation than boys of technology in society, they do not express a desire to continue with practically-based technical subjects or graphical work within CDT in the 4th year. However they request more time for graphical work.

The overall personality of a pro-CDT girl suggests that she is a tough-minded, stable extravert, with an inclination to be 'happy go lucky' (lax and expedient) and a slight tendency to prefer people rather than things.

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APPENDIX A LIST OF FIGURES AND TABLES

APPENDIX A VIEWS OF INFLUENTIAL MEMBERS OF SOCIETY AND PUPILS ABOUT THE VALUE AND STATUS OF THE ENGINEER

A.1 BRIEF HISTORICAL REVIEW

Around the time of the Industrial Revolution the vision, daring and inventiveness of individuals made Britain the 'Workshop of the World'. Some 130 years ago Britain was at the pinnacle of its industrial supremacy due to products of industry and our proven ability as a trading nation. When the Empire was a dominant force in the world we could sell to those countries products which we wished to make at the prices that we wished to charge, and in return we purchased from them raw materials at a price that we were prepared to pay. Woudhuysen (1985) refers to this in connection with design, "Britain's historical complacency about design has a lot to do with her fondness for unloading 'duff' products on the Empire and subsequently the Commonwealth, poorly crafted pushbikes for Nigeria, awful Austins for India. This is why UK industry received such a nasty shock when , in the 1970's, much of the British population were willing to 'pay over the odds' for better quality European and Japanese alternatives". Whilst this situation existed and trading was so easy there was no need for our engineers to be imaginative and competitive making our manufacturing industry efficient. In direct contrast countries like Germany and America, who were outside this privileged trading position afforded by the Empire, had to be very efficient in order to be competitive. The main aim of the education system, at that time, was to produce good administrators to run the Empire rather than well trained engineers to improve the industrial marketing edge.

Thus, we had the well trained and highly respected organiser and the industrialist who wasn't required to exert himself to make a good living. There are parallels of this class system to be found in Victorian books and plays in which the daughter who married 'into trade' was considered by her parents to have taken a substantial step backwards.

It is felt by many influential people that this class system lingers on today in society and may be, in part, responsible for the lack of appreciation of industrialists in general and the engineer and craftsman in particular.

A.1.1 ENGINEERS IN OTHER MAJOR INDUSTRIAL COUNTRIES

There are considerable differences in the respect accorded to British engineers when compared with engineers in other major countries.

France - In France the higher education system in the Grandes Ecoles is basically technological. More importantly , those who go to the Grandes Ecoles - for which there is intense competition to form a very elite 'club', membership of which lasts throughout their lives. They do not, necessarily, practice engineering and a great many of them become administrators and go into government service as well as in industry. It is the products of these Ecoles, with their technological background, who determine French policy - both industrial and in government. Engineers move freely between academic institutions, government and industry.

Germany - According to Pringle (1981) the engineers in Germany earn considerably more than administrative civil servants at the equivalent level. The engineer dominates management in industry and has a high place in society. Engineers do not experience any type of prejudice because of working in industry. In fact they are considered essential to national success.

Some actual research, involving the study of more than 1000 engineers in West Germany has been undertaken by Hudson and Lawrence, reported by Wilby (1981) on the relative status of German engineers. Their main findings were, that in comparison with the British engineers:

(1) German engineers are better paid.

(2) They are more middle class.

(3) Better educated.

(4) More likely to reach the top than their British counterparts.

Hudson and Lawrence claim that German economic success is underpinned by the priority given to industrial design and production, and state that: "Theirs is the most unashamedly industrial of all societies. They do not expect to make a living from invisible exports or tourism but by business manoeuvres or brilliant marketing, by pricing policy or creative advertising".

The earlier part of a recent book by Bowers (1987), testifies to the superiority of German engineering and scientific expertise in all branches of weaponry: tanks, aircraft, gunnery and rocket propulsion throughout the second world war. This was fully realised by British, American and Russian counterparts and it led to a mad scramble between the Russians and Americans, in particular, for German technical experts and engineers, heedless of their involvement in war crimes. They were taken to America and Russia and were responsible for these countries re-armament in the cold war which followed and their competition in the 'space race'.

Japan - Is today an extremely successful innovative country. Although their engineers do not necessarily receive very high salaries by European standards, engineers and technologists are highly regarded in society and are thought to be towards the top of the status pyramid.
The leading article in the 'Engineering News', January 1986 reports that one in four Japanese firms have on their board a director expressly responsible for seeing that the latest technology is always a factor in the reckoning, whereas only one in ten achieve this position of top management in the USA, Germany and Britain. There is no doubting the ability that the Japanese have for 'picking industrial winners'. This is demonstrated by the fact that, in 1984, due to Japanese innovation electronics equipment accounted for 5.6% of their Gross National Product (GNP), whereas oil from the North Sea amounted to 4% of Britain's GNP!
Japan also have a much higher number of students in higher education than Britain. 50% of Japanese 18-years-olds elect to continue with their education in comparison to only 14% in Britain, according to Owen (1985).

A.2 SOCIETY AND THE ENGINEER

A.2.1 VIEWS CONSIDERED

In order to obtain a balanced view about the way society in Britain perceives the engineer the following strategy has been used:

(1) Under various headings comments made by influencial people have been grouped together to form a general impression of the way that some areas of society perceive the engineer.

(2) Views were gathered from 150, 3rd year secondary school pupils, by three different methods:

(a) Asking them to state in writing the meaning of the term 'Engineer', table A.1

(b) Getting them to draw a picture of the engineer at work, table A.2

(c) Inviting them to complete a questionnaire designed with ten sets of descriptors, table A.3

A.3 THE CLASS SYSTEM

A.3.1 ANTI INDUSTRIAL SOCIETY

Weinstock (1976) referred to an 'Anti-industry' bias... "At least since Plato, there has been a deep-seated preference in Western culture (reinforced in Britain by our class structure) for the life of the mind over the practical life".

Pringle (1981) in his presidential address, entitled ' The Engineer in British society' to the Institution of Mechanical and General Technician Engineers suggested that society in Britain has been based on a two-culture system of the arts and sciences. "Our classical tradition did, I suppose, grow up because of our need to educate leaders for the Empire. Whilst the Empire remained profitable, little priority was needed for engineering. Continental society defines a third culture 'technique', or the art of making things.

A.4 EDUCATION

A.4.1 DO TEACHERS IN SECONDARY SCHOOLS HAVE A POSITIVE APPROACH TO ENCOURAGING THEIR PUPILS TO CONSIDER INDUSTRIAL CAREERS?

A review of the opinions of industrialists and those involved in higher education should provide some indication of the encouragement offered to potential engineers.

A.4.1.1 IS THERE A BIAS IN SOME SCHOOLS?

In an article in the TES, 23.1.76, reflecting on the reasons for several major industrial cities failing to recruit as many apprentices as they required, Sir Arnold Weinstock, chairman of GEC and one of Britain's leading industrialists puts the blame directly on to teachers, "Teachers fulfil an essential function in the community but, having themselves chosen not to go into industry, they often deliberately or, more usually, unconsciously instil in their pupils a similar bias... But why should children be taught that the products of the brain will be valued more highly than the products of the hands? And why should parents seek to get their children into banks rather than into efficient factories"?

Sir Charles Carter, a senior economist, said in his presidential address to the British Association in September 1982, according to Tucker (1982), "Management insensitive to science and unable to make sound technological assessments was also liable to attempt great leaps forward in technology, instead of moving to sound positions". He suggested that there may be a bias in education. The schoolmaster who turned to his group after a factory visit and said,

"That's where you'll end up if you don't pass your A levels", may be imaginary, but the philosophy is uncomfortably familiar.

There are occasions when this alleged bias assists engineers, especially those in management.

Doe (1980) highlighted one of the complaints of the 'Great Debate', "One of the complaints in the 'Great Debate' was that teachers held industry in contempt and steered the best into other occupations. When Dr Roger Gill of New York State University looked at 55 British Management studies students he found that the most intelligent, according to an IQ test, did not shine at management skills. They did not learn such skills as establishing priorities and making effective decisions as well as the less intelligent did". Dr Gill told the British Psychological Society conference, in December 1980, that there seemed to an optimum level of intelligence beyond which managers benefit far less from training. He said, "The skills important in effective decision making may be less related to intellectual ability than to other human characteristics given a minimum required level".

This research work suggests that as far as industrial managers are concerned teachers with an 'anti-industry' attitude may unwittingly be doing a service for industry.

A.4.1.2 A CALL FOR MORE TECHNOLOGY IN SCHOOLS

There were some influential people who are concerned about the combination of subjects taught in schools, especially in the area of science and CDT.

Duckworth and Lewin (1981) refer to research work done by Liam Hudson at Cambridge University when he found that scientists were unhappy with an open-ended type of intelligence test (based on work of Getzels and Jackson using creativity and intelligence) and could only think of a limited use for familiar objects. Whereas the non-scientist performed better suggesting a phenomenal number of uses for the most mundane objects.

Although Duckworth and Lewin accept that this analysis has been criticized as being too extreme a view, they suggest that although there is no doubt that many scientists and engineers are imaginative, and not all non-scientists have high imaginative powers, they feel that the method of teaching science and technology in schools is too convergent. Although many imaginative children may be attracted to the sciences, they inevitably become schooled in convergent modes of thought. This convergent discipline has adverse economic and cultural effects. They suggest, "To correct this, we must considerably extend the changes already introduced in some of our most progressive science and technology teaching. Making clear the open-ended nature of the solutions to the problems these disciplines are ready to tackle. We must reverse the cultural tendency in our secondary system to encourage convergent thinking at the expense of divergence, and allow a real free choice in subjects and careers... There must be many able engineers who find it difficult to shake of the habits of thought inculcated at school, and hence realise their true potential to industry. There must also be many in non-science and non-technical career positions who yearn for the opportunity to practice an engineering skill for which they have no proper training. The number of people in non-technical positions who have hobbies which show a high degree of engineering skill is an illustration of this".

At a top-level seminar in Lancaster House, London, presided over by the Prime Minister, and designed to improve co-operation between those in industry and universities to boost British innovation, Flather (1983) reports the comments of a leading industrialist, Sir Clive Sinclair.

Sir Clive Sinclair told the seminar that it was time everyone received a technical education as well as a literary one. "I do not mean everyone should be taught science archaically divided into physics, chemistry and biology, but technology, the understanding of how things work".

The call for technology was supported by Ashworth (1985), speaking at the North of England Educational Conference, painting a gloomy picture when he stated that: "Unless technology education improves the British will end up like Indian peasants, working at imported Japanese plants. There was an urgent need for universities and colleges to provide graduates with the skills and education that the new industries require".

A.4.1.3 THE EXAMINATION SYSTEM

One group of academics suggest making entrance to engineering courses easier whilst another group of academics express concern about the way students in schools select A levels.

A report entitled 'Education Engineers and Manufacturing Industry' produced from a group set up in Aston University, under the chairmanship of Dr Pope in 1977, suggested that universities should drop A level physics as an entry requirement to attract more students. They argued that Mathematics was the critical subject for engineers and called on the government to take urgent steps to ensure that enough well qualified mathematics teachers entered into schools.

This report that was produced for the British Association for the Advancement of Science was discussed at their conference, at Aston University during September 1977.

There was little support for the reports plan to drop A level Physics summed up by Geoffrey Harrison, director of the National Centre for School Technology, and a former CDT teacher who said,

"At the moment the status of engineering in schools is low because any damn fool can get into university to do it. One effect of dropping physics would be to increase that effect. Teachers would see this as a lowering of the standards required".

Birley et al (1981), expressed concern about choices at A level, "Taken over recent years we (seven professors of university scientific and engineering departments) doubt whether the resources of higher education have been properly exploited to meet the needs of our industrial society. This creates a certain mismatch between output of graduates and requirements of the economy. The situation arises because the key decisions are taken by young people not only at the age of 18 but also at the preceding stage when they select A level courses, influenced by parents and teachers who do not have all the facts. One sometimes wonders whether some of the schoolteachers are aware that the sort of broad education appropriate to the days of the Empire does not generate the technical leadership required to modernise a paper mill and save the jobs of the workers employed".

An investigation by the National Economic Development Office under the supervision of the Director General, Mr Geoffrey Chandler, in 1982, highlighted main obstacles to change, these included:

(1) An examination system which was predominantly a filtering system for identifying the most able.

(2) Teacher training that was generally remote from industry.

A.4.1.4 CREATIVITY

The thrill of being creative begins from the very first day that a child enters into education, be it the most mundane play group or a purpose built nursery school. All teachers at this stage in education rely on guiding the young children in their care, through forms of creative expression. If this creativity is nurtured in the primary school then children will grow to appreciate the intense pleasure derived from designing and making things. This is an activity that is fundamental to all well rounded engineers and craftsman. Dr Kenneth Miller, director general of The Engineering Council, speaking about the need to harness the inventive and creative talent in Britain at a public lecture given at Leeds University in January 1983 referring to education said, "We must change the climate in our schools so that the culture of creating goods and artefacts to serve society will be upgraded in esteem so that our children will have a better understanding of the thrills of creating and making things". Creativity is also needed in higher education. In his presidential address, in October 1983, entitled 'Fitness for Purpose', Mr George Alder, chief executive of the British Hydromechanics Research Association, said that "Engineering is still too often taught as a series of disembodied techniques, the means to an end which is only dimly understood by the student and which is not central to , and the motivation for, the course content. I am referring to the creative process of design for manufacture, which should be the very core of any mechanical engineering degree".

A.5 LACK OF APPRECIATION OF ENGINEERING BY SOCIETY

'What me?' Become an engineer? you cry, 'a rude mechanic with dirt underneath his finger nails and his skin permanently begrimed with oil?' The opening sentences of the winning essay, (Ruddock 1983), in the TES engineering essay competition neatly summed up the recruitment problem of the engineering industry. New technology has changed industry beyond recognition and an engineer is just as likely to be found in front of a computer screen, working out the stress factor for the components of a space satellite as standing over a recalcitrant machine with an oily rag in his (or her) hand. Unfortunately, young people and their parents are not always aware of how fast the industry is progressing and the career opportunities which it can offer the really bright young man or woman.

To make the public more aware of what engineers do, McKay (1983) suggests that we get the message over that, "Engineers do not bash out things like cutlery - they devise and design the means of making these things. Surely we must emphasise the intellectual aspect and put in perspective the purely physical actions that arise from that intellectual activity".

Moffett (1984), referred to the way that some professions seem to be brought more into the public eye through television. All creatures Great and Small' , 'Dr Findlay's Casebook' and 'Tomorrows World' are a few examples. "As yet no engineer has avoided being called a scientist on television. Attracting the respect of others requires us to get out and tell people what we do. Maybe we need 'Crossthreads' the everyday story of a motor engineer. At least then, when teenagers are making their decisions, they will compare the other professions with engineering on the same basis".

A.5.1 MAKING THE PUBLIC MORE AWARE OF THE ENGINEER

In an effort to make society more aware of the engineer the Engineering Council arranged for a low cost advertising campaign to be placed in The Daily Telegraph, The Observer and The Times.

McEwan (1985) reports that the campaign was an overwhelming success.

"Picture the scene: young boy lolling on hillside, daydreams of the good life to come. Will he be prime minister? An ace tennis player perhaps? Or possibly a brilliant doctor... beneath the image, the line: 'He wouldn't dream of being an engineer of course'.

This press ad. and the two that followed have drawn more attention than the most enthusiastic adman might have hoped for. For some reason engineers have never fared well in the status stakes in the UK. There are those who still think of them as little scientific boffins or the chap who fixes the phone. The Ad-agency found ignorance and apathy rife in its initial research. Few people, it appears, know what engineers do, and even fewer care. In the UK at least, engineering is mighty short on 'glamour".

It is significant that the agency's post-campaign research revealed that over half of the readers of the newspapers generally acknowledged a lack of recognition for engineering compared with sportsmen, literary figures and statesmen. Also over one third of the readership demonstrated an increased level of awareness of The Engineering Council.

A.5.1.1 INDUSTRY YEAR

In 1986 engineers had a platform to make the general public more aware of engineering. Industry was styled as the creator of wealth in the country. The launch of 'Industry Year 1986' initiated by The Royal Society for the Encouragement of Arts et al. described industry as fundamental to almost anything we do.

Industrial success is necessary for the provision of food, shelter, warmth and travel: for the education of the young: for the care of the sick, old and handicapped; for a better quality of life for the individual and the community as a whole. Following in the steps of The Engineering Council 'Industry Year' made the general public much more aware of the importance of the engineer to our society.

A.6 3RD YEAR PUPILS IMAGE OF AN ENGINEER: AN INVESTIGATION

The foregoing opinions about the low status of engineers stimulated the author to undertake an investigation of his own to ascertain the actual image of the engineer held by the average 3rd year pupil at 14+, in 1985.

A.6.1 OTHER RESEARCHES IN THIS FIELD

There have been three recent research studies that have included opinions of school children about engineers. Smith (1982) (chapter 3, section 3.9.9.1) , Claridge (1984) replicated some of Smith's work , (chapter 3, section 3.9.9.1) and Kirton et al (1984), (chapter 3, section 3.9.9.2). These studies report confusion in the minds of school children about the role of the engineer in our society.

A.6.2 PLAN OF THE INVESTIGATION

In order to gain information from school children about engineers three different approaches were used in the investigation.

(1) Asking them to describe by writing the meaning of the term 'Engineer', table A.1

(2) Getting them to draw a picture of the engineer at work, table A.2

(3) Inviting them to complete a questionnaire designed with ten descriptors, (table A.3). This approach was based on the methods used by Smith (1982).

A.6.3 SAMPLE USED FOR GAINING INFORMATION ABOUT ENGINEERS

It was decided to obtain opinions from 3rd-year pupils in three co-educational comprehensive schools. The total number in the sample was 150, 87 boys and 63 girls. Since the schools involved in this questionnaire had already completed questionnaires 1 and 2, referred to in chapters 5, 6 and 7, the contact with the schools had already been made so it was relatively easy to obtain this information.

Table A.1 and Table A.2 Pupils' perceptions of the term 'Engineer'

Table A.1 Pupils' perceptions of the term 'Engineer'

You may or may not know that I am doing some research work into the attitudes of pupils towards Craft, Design and Technology . For some of my work I need to obtain opinions from pupils about what they think various words mean.

Can you explain below what you feel the meaning of the word ENGINEER, is?

Please do not ask others , I want your views only not ideas from a group of people.

Try to write as neatly as possible, please. Yours views , if recorded will be typed.

Table A.2 Pupils' drawings of the engineer at work

Thankyou for giving me your ideas on the meaning of the word ENGINEER.

Now can you please draw below the ENGINEER at work. Do not worry if you are not all that good at drawing, it is ideas that I want from you so matchstick men and women will be acceptable.

Table A.3 Questionnaire to establish how pupils' perceive the 'Engineer'

Below are words that can be used to describe someone who works as an engineer.

Please put a tick in one of the boxes, for each number, to show which best desribes your opinion of an engineer.

1	☐ Scruffy	or	☐ Smartly Dressed
2	☐ Good Pay	or	☐ Low Pay
3	☐ Intelligent	or	☐ Unintelligent
4	☐ Cheerful	or	☐ Gloomy
5	☐ Not Inventive	or	☐ Inventive
6	☐ Unsociable	or	☐ Gets on with people
7	☐ Clean Work	or	☐ Dirty Work
8	☐ Interesting work	or	☐ Boring Work
9	☐ A long Working Day	or	☐ A Short Working Day
10	☐ Confident	or	☐ Unsure

Example

ICI	☐ Lazy	or	☑ Hardworking

A.6.4 PUPILS RESPONSE TO THE SURVEY

The opinions expressed by the pupils, both by writing and by drawing have been grouped in the following ways:

(1) Areas of engineering.

(2) Drawings of the engineer at work.

(3) Written descriptions of the work done, the abilities needed by the engineer and the type of person required to do that work.

A.6.5 THE MEANING OF THE WORD 'ENGINEER'

Inspection of the opinions given by the pupils about the meaning of the word 'engineer' clearly demonstrate that they fully appreciated that there were several different branches of engineering. The various titles that they gave to differentiate between them is shown in table A.4

A.6.6 THE TYPE OF WORK AND THE ABILITIES NEEDED BY THE ENGINEER

There was a very wide range of activities and abilities attributed to the engineer. These have been set out in tables A.5a and b. Nearly half the pupils referred to the engineer engaged in making things. The well known programme, on television, entitled 'Jim'll fix it', hosted by Jimmy Saville is in danger of being taken over by engineers if the comments of the 3rd-year pupils are any indication.

46% of the sample refer to the ability of engineers to repair, mend or fix things. One boy suggests that the word fix should be included in his version of the meaning of the word 'engineer'. He suggested that 'engineering is a word which means to fix together'. Not to be outdone one girl stated that "If our car isn't working we take it to a garage and their engineers work on it and hopefully fix it". Unfortunately these youngsters are really referring to mechanics rather than engineers.

Table A.4 Different types of Engineer

Types of Engineer	Percentage of pupils
Bike Engineer	0.7
Building Engineer	2.0
Car Engineer	2.7
Chemical Engineer	0.7
Civil Engineer	6.0
Clock Engineer	0.7
Computer Engineer	4.0
Design Engineer	0.7
Electrical Engineer	8.0
Electronic Engineer	7.3
House Engineer	0.7
Mechanical Engineer	8.0
Metalwork Engineer	0.7
Medical Engineer	0.7
Road Engineer	0.7
Royal Engineer	4.0
Technical Engineer	0.7
Train Engineer	0.7

Table A.5a Range of activities and abilities attributed to the Engineer

Description	Percentage of pupils referring to each activity or ability
Make things	47
Repair, mend or 'fix it'	46
Design work	39
Works on or with machines	30
Concerned with engines	20
Concerned with metals	10
Works on structures (bridges etc.)	09
Draws plans	07
Works on repair, design or firing trains (steam)	07
Skilled job needing precision	07
Repairs aeroplanes	06
Uses computers	06
A craftsman	06
Clever, intelligent	05
Can be a man or woman	05
Reponsible for checks and testing of work on building sites	04
Concerned with electronics	04
Concerned with 'technical' work	04
Inventive	04
Dirty work	04
Maintains machines and equipment	04
Concerned with electrical work	04
Repairs lorries	04
Good with his or her hands	02

Table A.5b Range of activities and abilities attributed to the Engineer

Description	Percentage of pupils referring to each activity or ability
Work in factories	02
Hydraulics	02
Welding	02
Modelling	02
Complicated work	02
Concerned with materials	02
In charge - delegates	0.7
Buys equipment	0.7
Costing - estimating	0.7
Always a man	0.7
Strength needed	0.7
Concerned with telephones	0.7
Works on lighting equipment	0.7
Concerned with technology	0.7
Works on tractors	0.7
Works on ships	0.7
Concerned with video equipment	0.7
Noisy work	0.7
Construction work	0.7
Metalwork	0.7
Engineers are self assured	0.7
Engineers take orders	0.7
Projectionist	0.7
Works on oil rigs	0.7

A.6.7 DRAWINGS OF THE ENGINEER AT WORK (Figures A.1 to A.7)

In many ways these drawings show more clearly than words how youngsters perceive the work done by an engineer. Even those who found difficulty expressing themselves graphically used 'Matchstick' representation to effectively demonstrate their opinions.

The ethos behind the drawings divides into several groups or sets of opinions.

Figures A.1 to A.7 all suggest that the engineer is little more than someone who uses tools and machines to repair or make artefacts: car mechanic, washing machine mechanic, machinist etc. It is acknowledged that all the people who engage in these areas of work certainly acquire a breath of knowledge and depth of skills. A large number of people depend on using their expertise when the numerous machines and gadgetry, which seem to be an essential part of modern day living, go wrong. However, the rounded engineer has the knowledge and skills to be a mechanic in addition to the ability to plan, design and oversee the production of quite complicated artefacts.

Figures A.8 and A.9 extend the argument that many 14+ pupils perceive the engineer as someone involved in mending and repairing artefacts. Here the importance of using some form of heat is highlighted to enable metal to be shaped, joined together with other metals or moulded into shape. Again although a certain amount of expertise and skill is needed to perform the jobs illustrated they contain only a small part of the body of knowledge and expertise expected by a mechanical engineer.

Although presented in a rather humorous way figure A.10 does indicate that perhaps an engineer should be a 'thinker' as well as a 'doer'. It is also one of the first drawings to demonstrate that an engineer should have a good brain.

Figure A.1 An engineer 'fixes' and mends things.

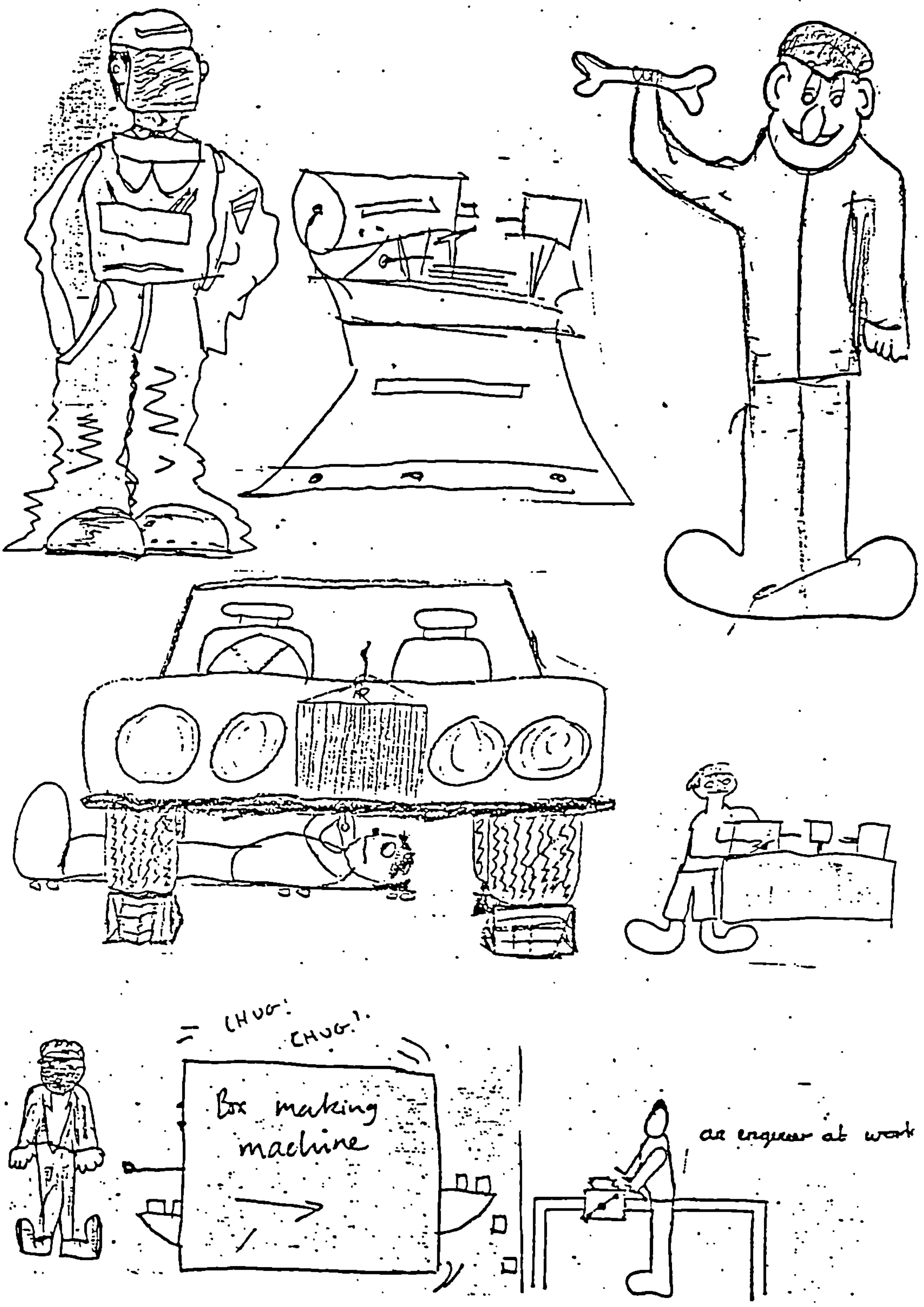


Figure A.2 Engineer

An engineer fixes machanical things Like Cars, and Drink + food machines. He also handles technical problems. Engineers are very good with the Hands and they have to know exactly what they are doing to Carry out there Job.

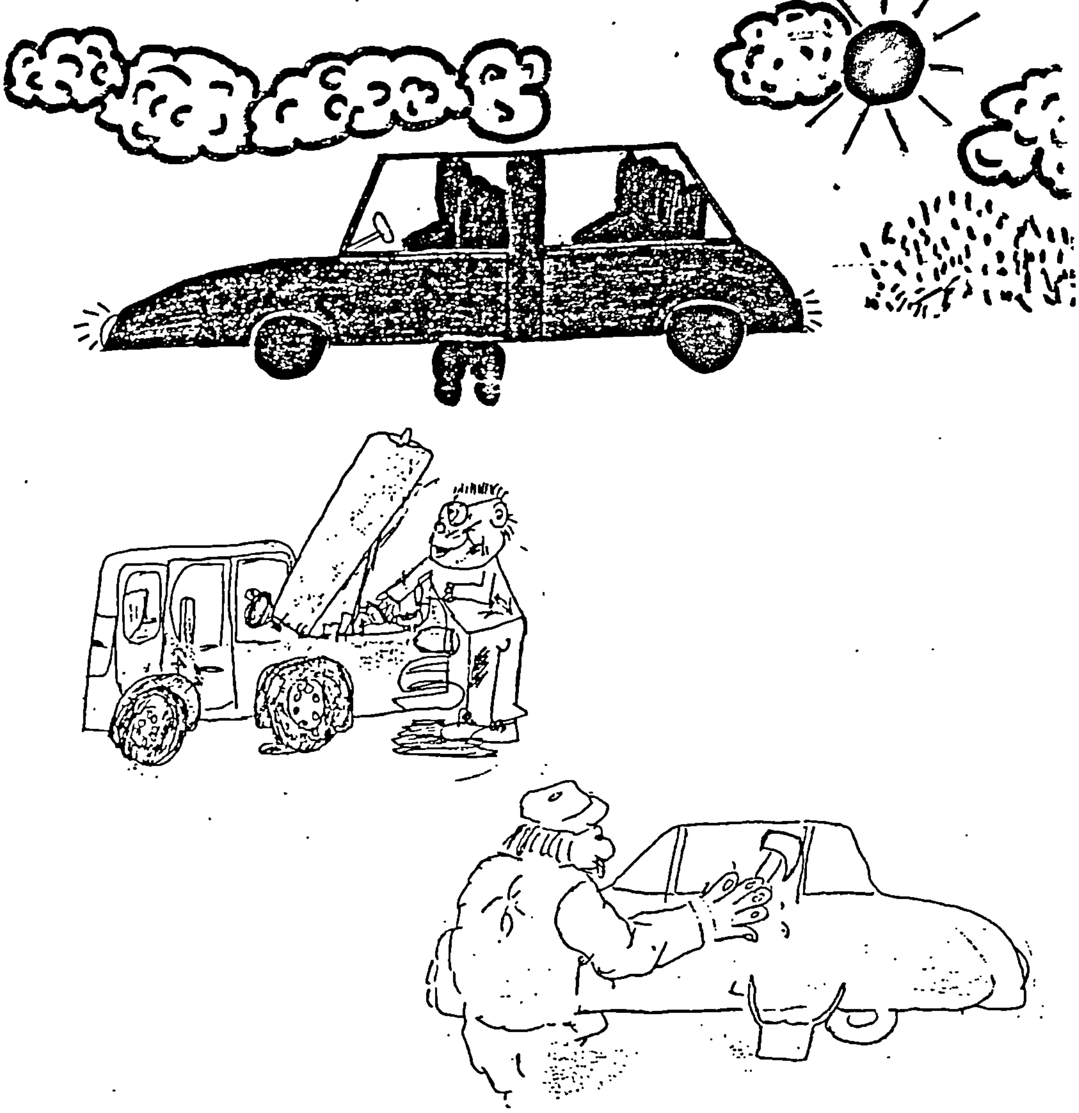


Figure A.3

An engineer works normally in factories making engines and all sorts of machines. He or she could wire phones fixing washing machines

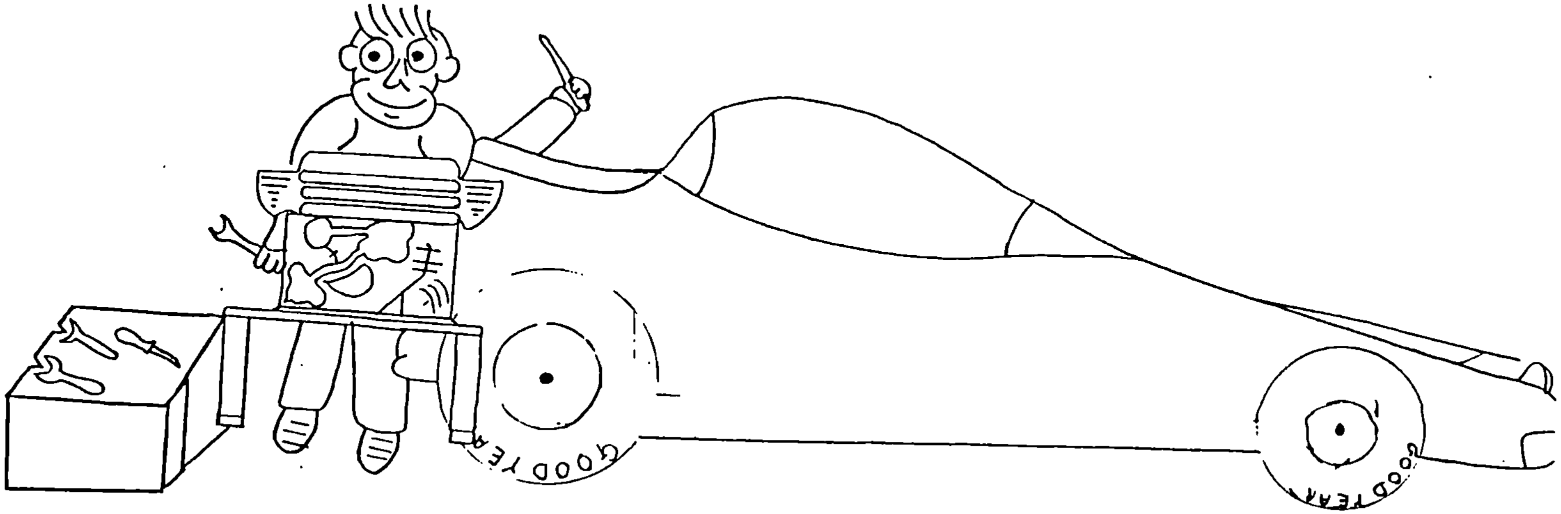


Figure A.4 My dad is an engineer - he 'fixes' cars and motor-bikes.

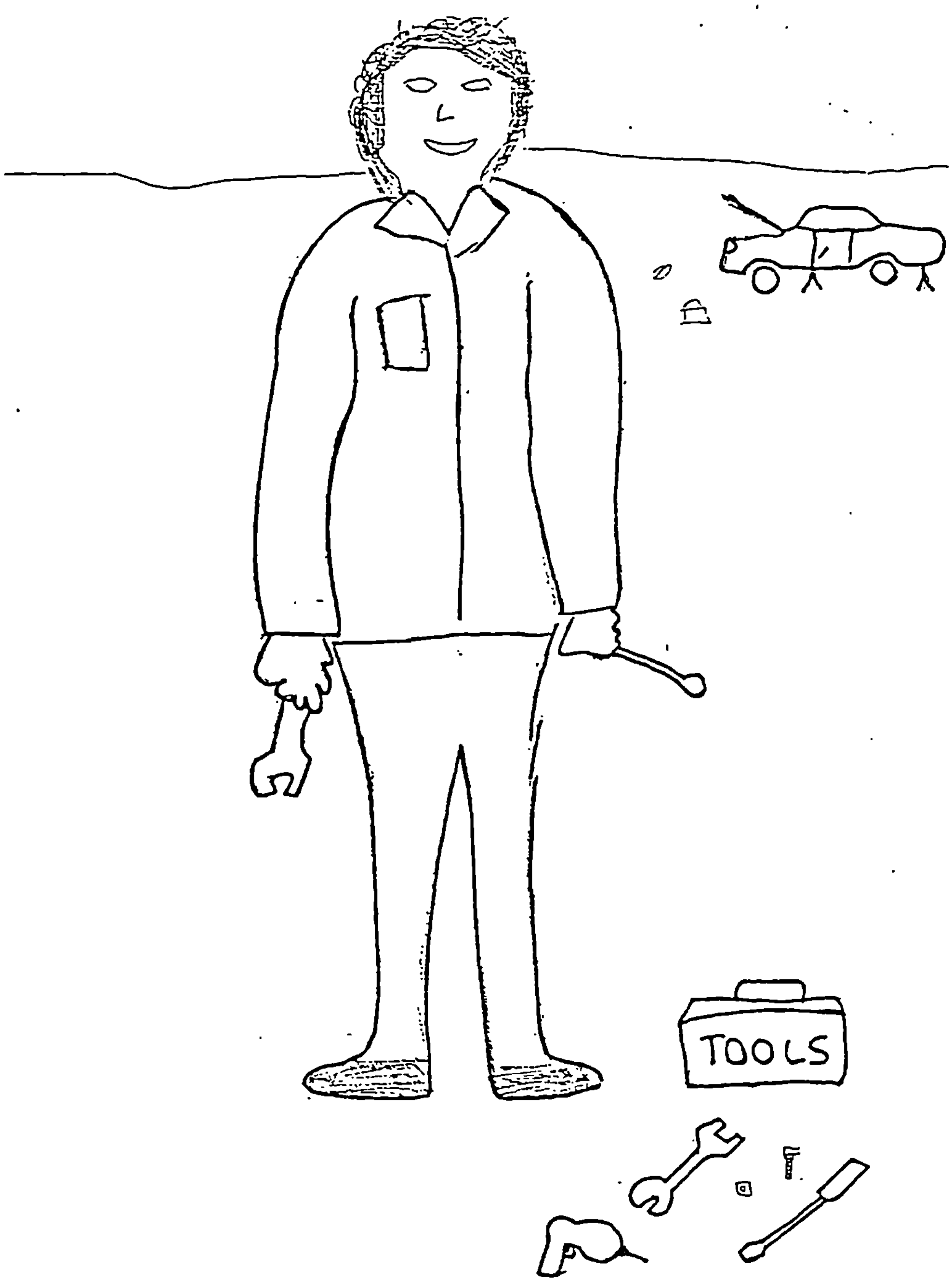


Figure A.5 Engineering is a word which means to 'fix' together. Young children can be a kind of engineer by 'fixing' a model together

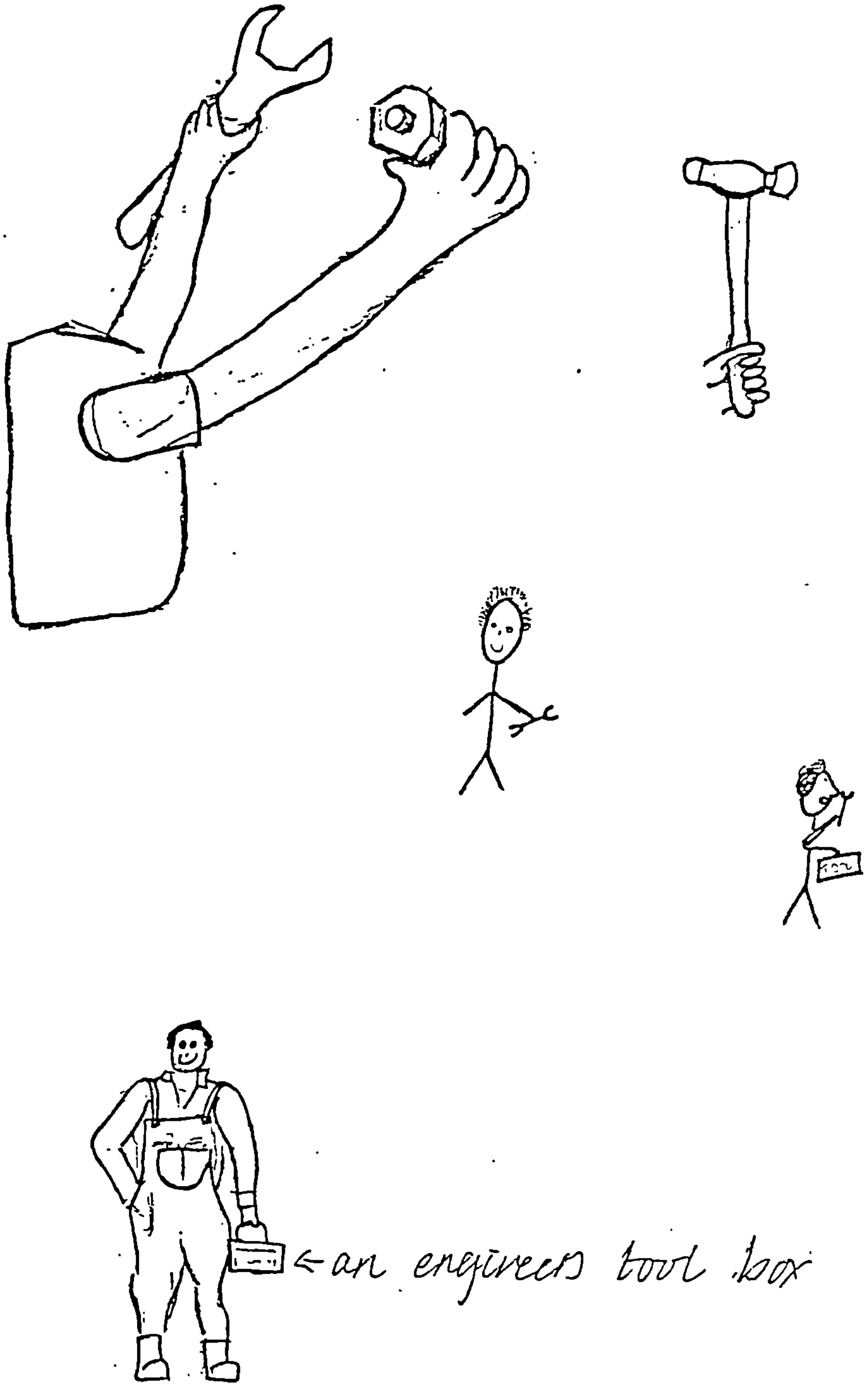


Figure A.6 ....'fixes' things together, mostly things in metal.

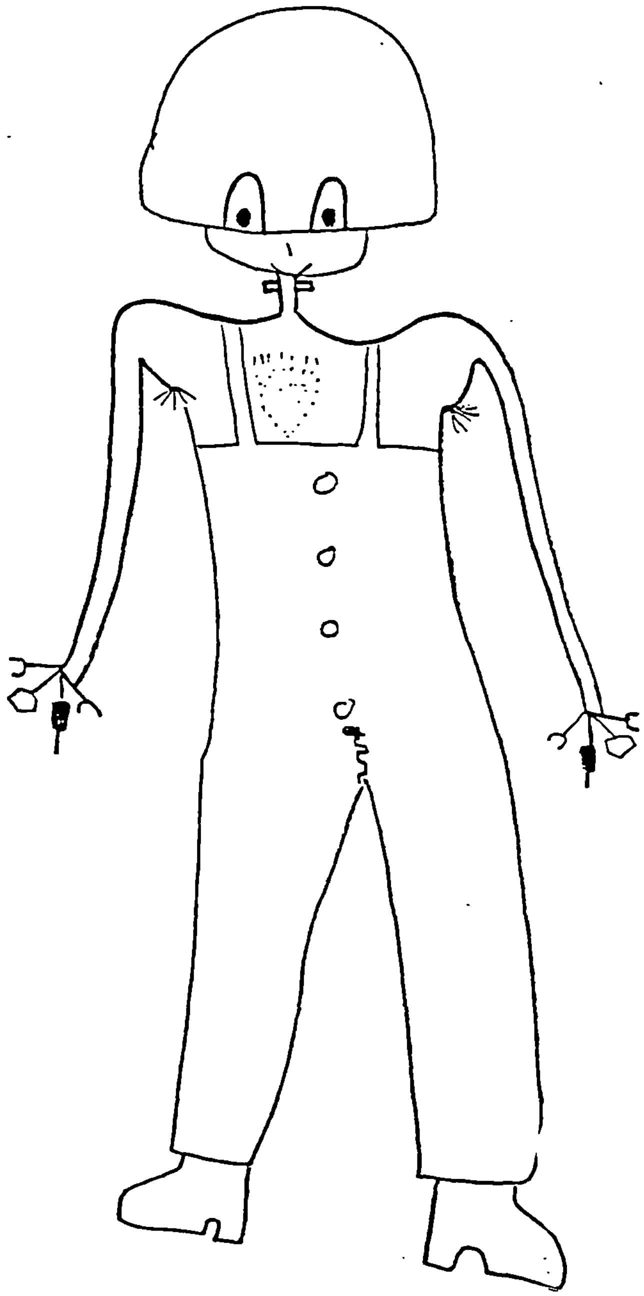


Figure A.7 An engineer is someone who repairs complicated equipment such as washing machines or helicopter engines. He buys the equipment after he has worked out on paper what he has to do to mend the equipment.

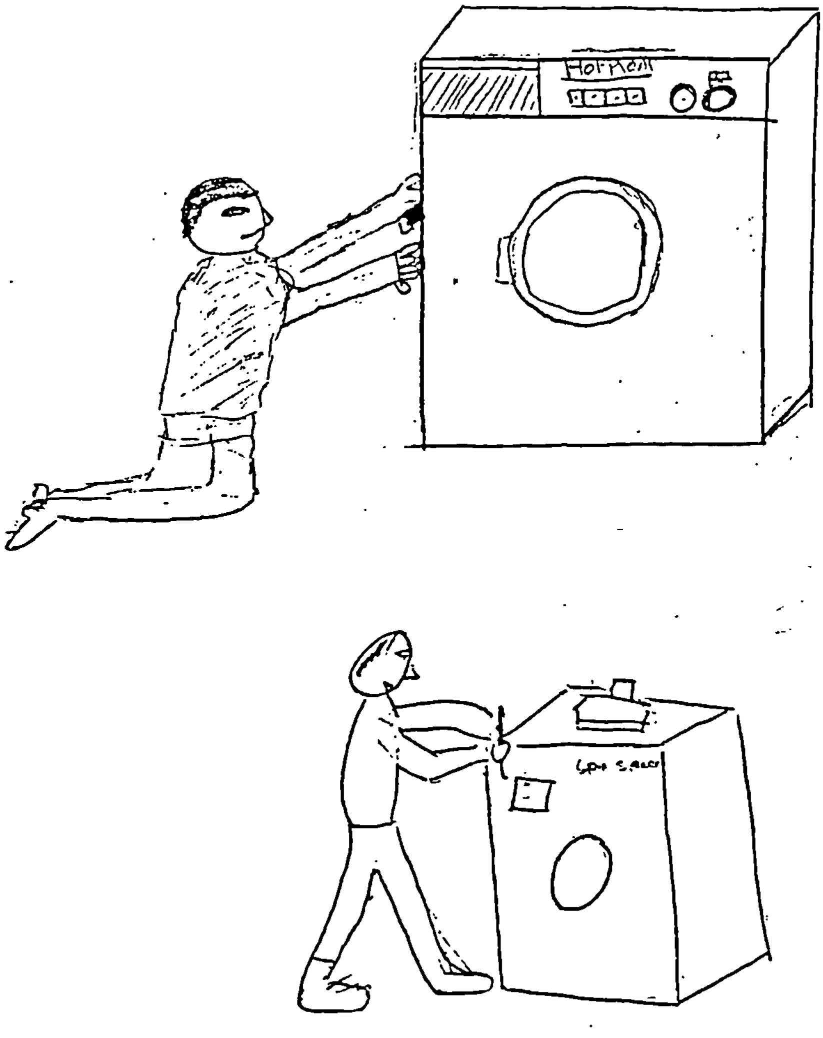


Figure A.8 . Engineers usually mend or repair things like pieces of machinery.

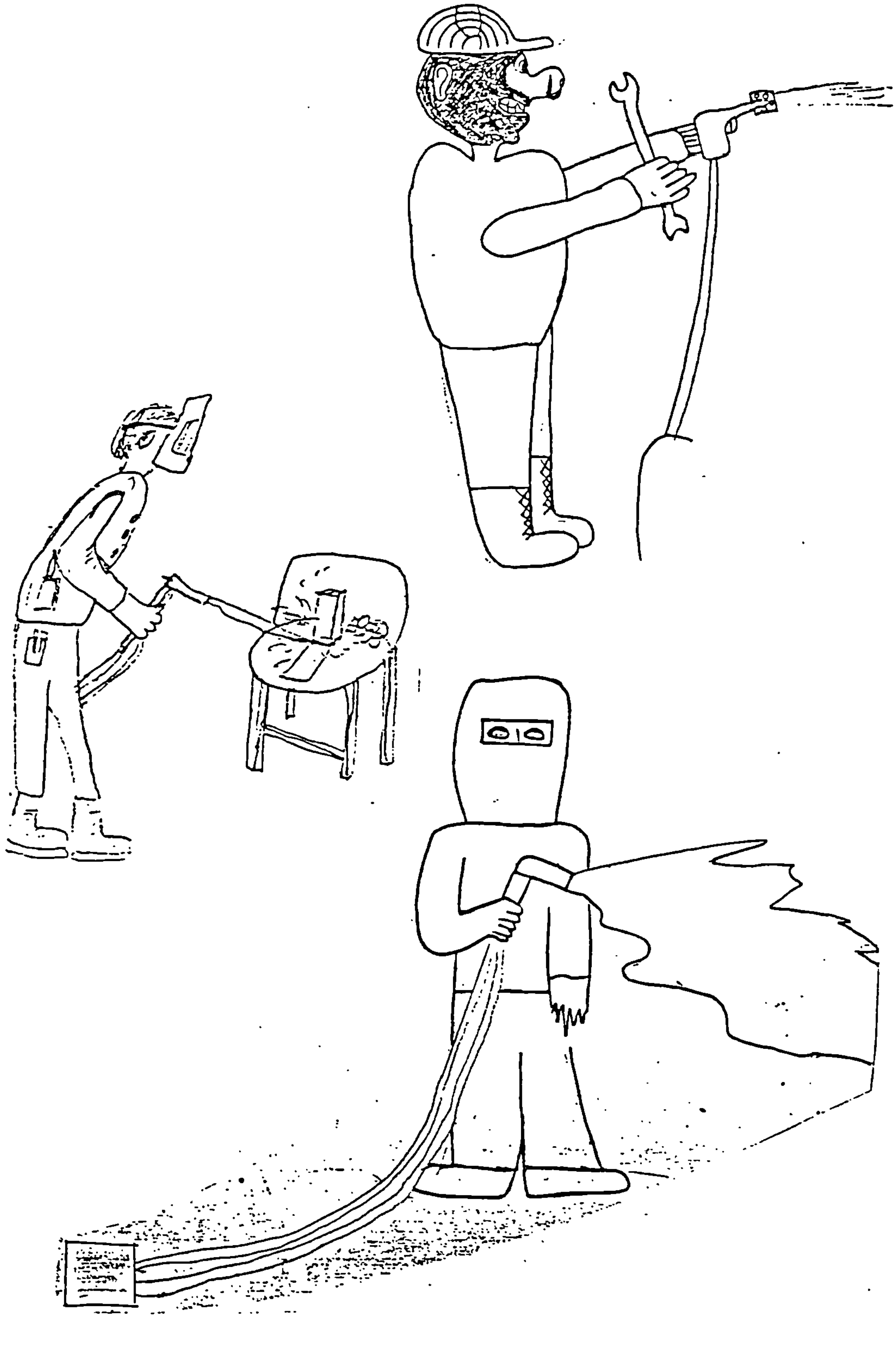


Figure A.9 An engineer may do some casting and some welding.

Figure A.10 An engineer is an inventive and probably clever person.

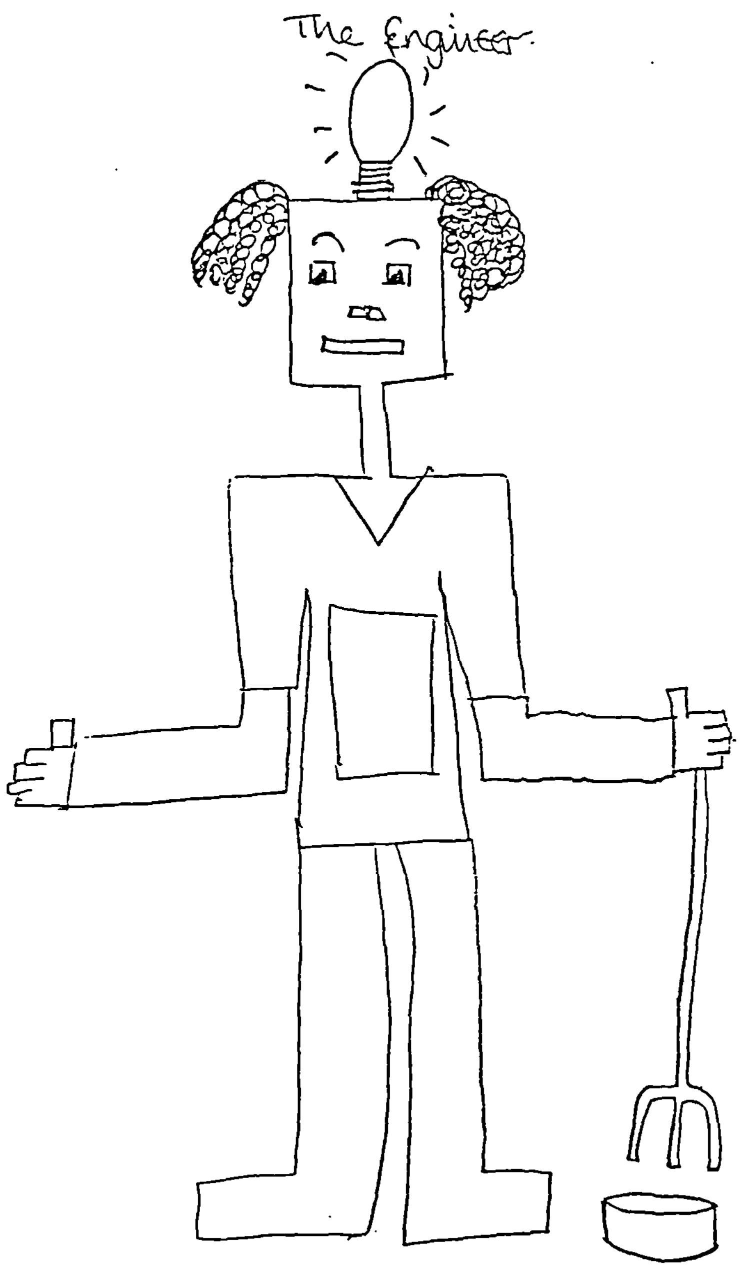
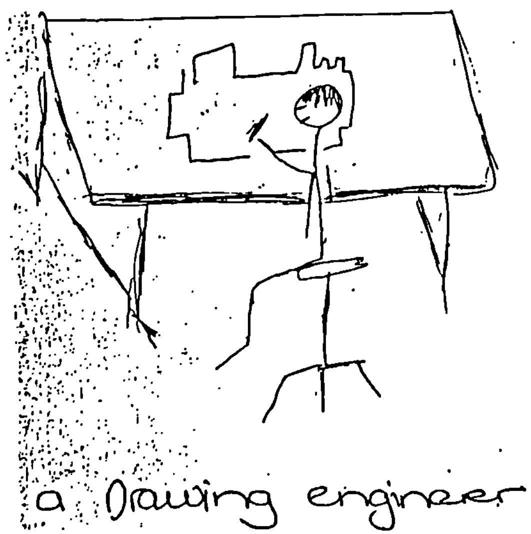


Figure A.11 An engineer is someone who designs things.



The most common idea of an engineer to me is someone who works in a garage

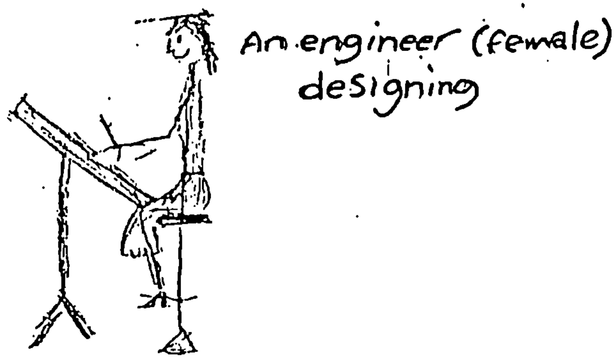
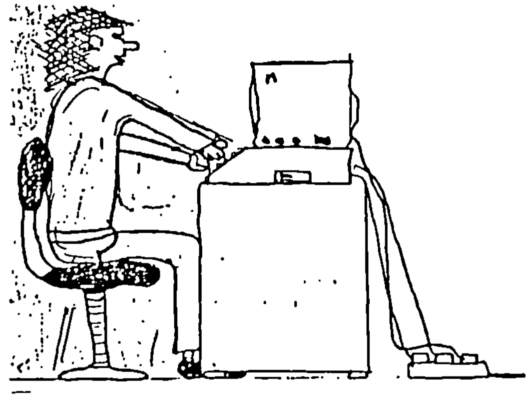
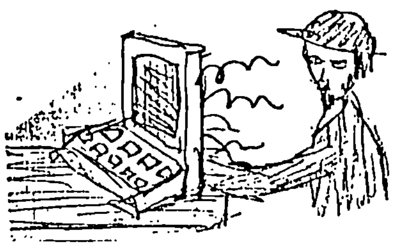


Figure A.12 Some engineers work in electrical areas and others work with computers





An electronic engineer soldering components to a board.

Figure A.13 An engineer designs and constructs buildings and other types of buildings, e.g. Bridges, flats etc.

The drawings grouped together in figure A.11 include the only drawing from the 150 sample of a woman in engineering.

The need for engineers to use computers is illustrated in figure A.12. However, even amongst the *drawings* there is a semi-skilled person working on circuit boards

Reference to the need for an engineer to be able to draw and design is illustrated in figures A.11 and A.13.

A.6.8 THE ENGINEER AT WORK

Written descriptions of the work done, the abilities needed by the engineer and the type of person required to do that work have been grouped together.

A.6.8.1 ENGINEERS WORK ONLY WITH ENGINES?

The first group of pupils' opinions show that pupils perceive the engineer as a person who only works on or with engines.

"I think an engineer is a mechanic who works on engines".

"Some engineers 'fix' engines, others work with things like telephones, video equipment or ovens, An engineer is a skilled person".

"An engineer is a person that 'fixes' and makes cars and things. He is quite like a mechanic. Train drivers used to be called engineers but they have almost nothing to do with the other type".

"If our car isn't working we take it to the garage and their engineers work on it and hopefully 'fix' it".

"An engineer oils and greases the engine".

"Engineer is another way of saying 'mechanic. This word means to mend engines... being an engineer is a skilled job and it takes many years to learn".

"There are many forms of engineering like working on cars and engines of trains and aeroplanes".

A.6.8.2 AN ENGINEER WORKS MAINLY ON MACHINES CUTTING METAL?

The second group of pupils' opinions show that many pupils believe that an engineer has a rather narrow occupation which is mainly concerned with making tools in metal whilst using a variety of machines.

"An engineer is someone who operates machinery. There are computer engineers, car engineers and road engineers".

"... makes different types of tools which need skilled men to make them".

"An engineer can be a miller or a turner. A precision engineer makes pieces of high quality equipment for machines".

"I think it means a man who works with hydraulics and metal".

"An engineer is a person who works with metals, e.g. mechanics".

A.6.8.3 ENGINEERING IS A DIRTY JOB?

Despite the fact that many areas of modern engineering are conducted in very clean conditions (e.g. electronic engineering) there are still many people who retain the image that all engineering seems to be associated with oil and dirty conditions. This seems to be reflected in the pupils' written responses.

"Most engineers are very strong and they need to be because they have to lift parts of trains and things like that. It is a very dirty job being an engineer. When they were on trains they had to get all the coal from the back and put it on the fire. A lot of this was done in the olden days".

"An engineer is someone who operates machinery and works in industry. He is supposed to design new machinery and make inventions. They often work in dirty, noisy conditions and always wear oily overalls".

"Engineering is a dirty sort of job because they can get oil, muck and other sorts of things on them".

A.6.8.4 WOMEN IN ENGINEERING

Several pupils indicated that engineering was a job that could be done by both man and women. However there was one pupil who expressed very strongly that women were not suitable for employment as an engineer.

"An engineer is a person who works for a designer or craftsman. Men or women can be an engineer".

"They look to see what is wrong with all kinds of vehicles. They also put equipment on the cars and lorries etc., like tyres, new bodies. Women do this as well as men. They wear overalls so they don't get dirty".

"An engineer is a man or woman who works on designing and working out what it will cost and how it will be built. He or she will make sure that it will work".

"An engineer can be a man or a woman. They don't have to work with motors or engines. They can work in libraries. My mother is a librarian in the Engineering Industry Training Board. Engineers can 'fix' engines, the same as mechanics. Engineers can work on a ship or with computers".

"An engineer is a man or woman who works in a factory or on a building site making things. There are several types of engineer: technical, design and craft engineer".

"An engineer is always a man. This is because he has to do a man's job. He has to mend cars and uses machinery... I don't think a girl could get an engineering job even if she wanted to. It's a man's job only".

A.6.8.5 AN ENGINEER 'FIXES' THINGS!

In addition to the examples in section A.6.8.1 there are other pupils opinions supporting the role of the engineer as a 'Mr fix it'.

"A person who 'fixes' things. For example a computer engineer fixes machines. Also engineers can work on railways, cars, aeroplanes etc. 'fixing' things,. An engineer would be good with his or her hands".

"An engineer is a person who 'fixes', develops or builds equipment".

"Electronic engineers mend electronic stuff and mechanical engineers mend mechanical things".

"An engineer is a person who makes or repairs machinery. I think that he or she is more important than a mechanic, because an engineer gives orders and designs things. A person who makes spare parts for injured bodies is known as a plastic surgeon, but really they are engineers".

A.5.8.6 THE DIVERSITY OF WORK IN ENGINEERING

There were several comments from pupils demonstrating that some fully appreciated the varied nature of work in engineering.

"They are inventive people who are very sure of themselves. In engineering there are several branches. Some draw plans, others work on scale models of structures to see if they work and some test the material to be used".

"A person who specialises in a technical job building computers and bridges".

"An engineer is someone who deals with the technical side of design and repair work".

"An engineer is a person who improves the efficiency of a factory. Also he mends things, designs things and programmes computers".

"An engineer is a person who designs new engines and puts them together. This is to see if they work or need modifying. So an engineer can get dirty, but he has a lot of paper work to do before designing an engine. An engineer has to have a wide variety of jobs from paperwork to metalwork and putting the engine together".

"Engineers can also do things with computers".

"There are many types of engineers, electronic, civil, mechanical and royal engineers. They normally invent and repair things".

A.6.8.7 DESIGN WORK

It was refreshing to find that some pupils are aware that the engineer can be involved in design work.

"An engineer is a designer and a craftsman. An engineer also draws and makes things".

"An engineer designs something and then tests the prototype".

"Engineers make things that they have designed. They do a skilled job which requires a lot of training. They make and mend very complicated things".

"An engineer is someone who works with machines and makes engineering tools and equipment. Engineers also design tools".

A.6.8.8 ENGINEERS NEED TO BE INTELLIGENT

Although many pupils commented on the the need for an engineer to be inventive there was only one reference to intelligence.

"I think that engineering requires a lot of intelligence because you have to understand all the machinery and different techniques. Engineers generally repair and mend things and I think they have to be constructive and inventive".

A.6.9 PUPILS' RESPONSES TO TERMS USED FOR DESCRIBING THE WORK THAT AN ENGINEER DOES AND HIS ATTITUDE TOWARDS THAT WORK

The pupils responses are set out in table A.6. No attempt was made to separate the views of boys and girls since this was only a small sample and Smith (1982) with a larger sample found that gender differences did not approach a statistical significance at the 5% level.

The most clearly defined responses are those requesting the pupils to choose between 'not inventive' /'inventive' and 'confident'/'unsure'

In both instances 9 out of 10 of the pupils selected 'inventive' and 'confident'. In all the other items the pupils have made a definite choice. Even the lowest percentage was 70% showing that the pupils thought engineers were 'cheerful'.

According to the pupils' responses an engineer is a confident, intelligent, inventive, cheerful, sociable and scruffy person who receives good pay for working a long day doing interesting and dirty work.

Table A.6 Engineers Job Characteristics

	No. Respond	No. Respond	%	Predominant Descriptions of an Engineer
Scruffy	114	148	77	Scruffy
Smartly Dressed	034		23	
Good Pay	113	150	75	Good Pay
Low pay	037		25	
Intelligent	129	148	87	Intelligent
Not Intelligent	019		13	
Cheerful	106	150	71	Cheerful
Gloomy	044		29	
Not Inventive	013	149	09	Inventive
Inventive	136		91	
Unsociable	043	146	28	Gets on with people
Gets on with people	103		72	
Clean work	023	150	15	Dirty work
Dirty work	127		85	
Interesting work	124	148	84	Interesting work
Boring work	024		16	
A long working day	118	148	80	A long working day
A short working day	030		20	
Confident	141	150	94	Confident
Unsure	009		06	

Note: Respond - Those responding to the questionnaire.

A.7 OVERVIEW

A.7.1 BRITAIN'S INDUSTRIAL SUPREMACY

The lack of foresight during the days of the British Empire has been one of the major factors in our decline as an industrial nation. We were 'feather bedded' during the days of the Empire by having easy access to inexpensive raw material for manufacturing artefacts that were sold in ready markets at prices set by ourselves. We have been overtaken by our competitors due to our lack of competitiveness,

The tendency to educate leaders for service in the British Empire in the classical tradition further exaggerated the divisions of the nation's two class system. Due to the favourable trading arrangements that we enjoyed at the time there was no urgency to improve our engineering training or the methods of manufacture that we were using. Most other developed countries show a higher regard for their engineers. In Germany the engineer dominates management and has a high place in society. Those with technological training determine policy both in industry and within the government, in France. In Japan, although they do not remunerate their engineers as well as they do in Germany and France, they are still highly regarded in society.

A.7.2 TWO CULTURE SOCIETY

It has been suggested that we are a two culture society (arts and science) with an anti-industrial bias within society and some schools. There seems to be insufficient regard given to the third culture, technique (the art of making things) which is well established in France and Germany.

Many influential people feel that there should be more design and technology taught in schools. Ashworth (1985) paints a gloomy picture of us working like Indian peasants at imported Japanese plants if technology education does not improve.

A.7.3 HIGHER EDUCATION

An attempt to increase the numbers of engineering graduates by lowering the entry requirements was firmly rejected. This problem of insufficient engineering graduates is still present in the late 1980's.

A.7.4 HOW THE GENERAL PUBLIC VIEWS THE ENGINEER

Due to the masking of the engineer behind the all embracing terms, science and scientist, that appear to be used by the media for any coverage of material that has a high dependence on engineering and engineering principles, it is no surprise that the general public are unaware of the role of the engineer. This was confirmed by the Engineering Council advertising campaign in which over half the readers of the newspapers involved acknowledged the lack of status of the engineer when compared with sportsmen, literary figures and statesmen. Smith (1982) and Kirton et al (1984) report confusion in the minds of school children about engineers.

The Industry Year organising committee and the Engineering Council went to great lengths to ensure that the general public became more aware of the role of the engineer within society.

A.7.5 HOW 14+ PUPILS PERCEIVE THE ENGINEER: ACTUAL FINDINGS

There is no doubt that many pupils perceive the engineer as a 'Mr fix it' who works on engines. They are of course getting confused with the role of the mechanic.

It is interesting to note that several pupils acknowledge that engineers can be men or women and that they appreciated the varied nature of work in engineering.

Many pupils still perceive engineering as a dirty job since in all three areas of the survey they clearly show their opinions especially in their responses to the questionnaire. 85% of the sample considered engineering to involve a dirty job.

APPENDIX B A SURVEY OF ALL 5TH YEAR O LEVEL PUPILS IN ONE OF THE SAMPLE SCHOOLS IN 1985

B.1 CAREERS INTERVIEWS

In careers interviews 40% indicated a strong desire to take up some form of technical work or enter the 6th form and subsequently take up technical work.

7% expressed interest in the building / furniture industry and 33% in engineering. They all took one or two O levels in technical subjects. 14% took 2 technical subjects and 86% took one subject.

In follow-up surveys in 1986 (when some pupils left after one year in the sixth form) and 1987 (after A levels) it was found that a significant number of pupils, who were 5th year in 1985, actually took up various jobs in the building industry (3%) or engineering (29%). In addition other pupils entered some form of further education taking various types of building (5%) or engineering courses (6%).

Overall 43% (35% engineering and 8% building industry) of the pupils in the 1985 survey actually took up technical careers.

B.2 A SURVEY OF THE UPPER SIXTH FORM IN ONE OF THE SAMPLE SCHOOLS (THOSE TAKING A LEVELS)

B.2.1 U6th 1985

Total 48

15 went to higher education

5 went to take technical related courses.

Of those who started a higher education course 33% took technically related courses.

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APPENDIX C RESEARCH SOURCES AND SEARCHES MADE

C.1 RESEARCH SOURCES

C.1.1 BACKGROUND MATERIAL

There have been numerous publications that have been produced to provide assistance to educationalists who are involved in the teaching of technical work. Those that the author has referred to, in order to obtain the necessary background for this study, are listed below:

A level Engineering Science: A progress report - University of Loughborough

Breaking and Entry (courtesy of Dr. Milton Ormerod) Brunel University

Computerised library search for references to attitude and personality studies in Britain and the United States of America, 1982, 1985 & 1986

Chartered Mechanical Engineer - Institution of Mechanical Engineers

City and Guilds Foundation Course pamphlets

Confederation of Design and Technology Associations - pamphlets and reports

Craft, Design and Technology Links with Industry-Schools Council, 1980

Craft, Design and Technology News - British Thornton

Department of Education and Science booklets and pamphlets

Design Council publications

Design in Craft Education - Association of Advisers in Design and Technical Studies

Education for Capability literature - Royal Society of Arts

Engineering Training Board research reports

Equal Opportunity Commission booklets

General Engineer - Institution of the General and Technical Engineer

Handicraft in the Sixth Form - The Institute of Handicraft Teachers

Hertfordshire Craft, Design and Technology heads of department meetings

HMI publications

HMSO Publications

Industry in Close-Up - Compiled by Metalbox plc

Industry in Perspective - Industrial consortium supported by the Industry Education Unit and The Department of Industry

Teacher Fellowships in Engineering - Institution of Mechanical Engineers

Mechanical Engineering News

New Scientist

News - Castrol Education Division

Practical Education - Journal of the Institute of Craft, Design, and Technology

Project - Engineers and Technologists for Tomorrow - Central Office of Information

Project Technology - Schools Council

Research Seminars

Report on Technical Drawing - Hannah Moore Centre, Bristol

Science and Technology Regional Organisations

Schools Council working papers

Smallpeice Trust - To promote the principles of good design

Standing Conference for School's Science and Technology publications

Test Bed and Launch Pad - An initiative to develop the public's awareness of Technology

The Goals of Engineering Education Project - National Academic Awards and the Department of Education and Science

The Guardian

The Independent

The Sunday Times

The Times Educational Supplement

View - Department of Trade and Industry

What is Engineering? - Prepared for the Womens Engineering Society

C.2. COMPUTERISED LIBRARY SEARCH - 1

C.2.1 DESCRIPTORS USED

In order to obtain details of any research work that was being done in the CDT area, a computerised literature search was conducted at Brunel University Library, on 5th May 1982. The search was performed on the British Educational Index, the Educational Resources Information Centre and the Educational Physiology, using the British Library Automated Information Service (BLAISE). The descriptors were chosen carefully, in order to obtain as many citations as possible referring to attitudinal research work that had been done in the CDT area. Since the beginning of technical work in secondary schools, during the late-19th Century, the departments responsible for its teaching have had several title changes. All were used as descriptors. The other descriptors were 'Attitudes' and 'Secondary Education'. The full list of desriptors used was: Craft, Handicraft, Technical, Technical Studies, Craft, Design and Technology, Student Attitudes, Teacher Attitudes and Secondary Education.

C.2.2 BRITISH EDUCATION INDEX

The search revealed twenty-six citations, fifteen of which cited articles in various technical and technological journals and the TES. Although these were very useful for background reading, the search did not cite any attitudinal material at all.

C.2.3 EDUCATIONAL RESOURCES INFORMATION CENTRE

This search gave 26 citations, none of which were the same as the British Education Index citations. Only one of the citations was even vaguely related to the CDT area. This was a trial CSE Handicraft Examination in 1966, and it was only of passing interest. All the other citations were concerned with the American definition of 'Handicrafts', e.g. Weaving, Patchwork Quilts etc.. It was obvious that any further computerized literature search into the American educational system required help from someone with local knowledge.

C.2.4 EDUCATIONAL PSYCHOLOGY

This search revealed only one citation, which was about attitudes, but unfortunately not in the CDT area.

C.2.5 REVIEW OF THIS SEARCH

The search was both interesting and disappointing. It was interesting to see, when the computer was going through the search, how many citations there were for attitudes in other subjects in secondary education, nearly all of which were removed as soon as the CDT descriptors were present. It was disappointing, although not unexpected, that the search revealed no evidence of any CDT attitudinal research work and only one article written about attitudes.

C.2.6 EXAMPLES OF CITATIONS

British Education Index

(1) Design and creative studies departments - have we gone too far? Cameron, Hilary. Studies in Design Education and Crafts, Spring 1977.

(2) Design and Technology , is progress real or apparent? Hughes, Marshall. Practical Education, Oct 1981.

(3) Handicraft: a question of attitude change. Penfold, John and Smalley, Margaret. General Ed. Summer 1979.

Educational Resources Information Centre

(1)Art and Craft-Point and Purpose. Dixon, Peter. Education, Oct. 1976

(2) Carving Wood Bowls. Mc Keegan, Paul. School Arts, Feb. 1981.

(3) Weaving. Counts, Rubynelle. Georgia State Department of Education. Atlanta. USA, 1976.

C.3 COMPUTERISED LIBRARY SEARCH - 2

C.3.1 REASONS FOR ANOTHER COMPUTERISED SEARCH

By the fifth year of this research, the author had, by regularly consulting the Technical Education Abstracts, found some evidence of research work in the CDT area. The amount of research work going on appeared to be very small, and in order to carry out a more thorough investigation, it was decided to do a second computer search, three years after the first, including American sources.

C.3.2 PREPARATION FOR THE SEARCH

In order to ascertain the correct descriptors for CDT in American schools, the American Embassy was contacted. During the course of our discussion, it became obvious that the following would serve as good descriptors: Drafting, Design , Metalwork, Woodwork, Engineering, Technical and Technology. The selection of these descriptors was supported by an article on American Education by Dorian (1982).

C.3.3 DESCRIPTORS USED

The search was performed on the British Education Index and the Educational Resource Information Centre, using the British Library on-line service (Blaise - Line).

For the British Education Index search, the following descriptors were selected, after an initial computer sorting procedure to obtain the best sets: Craft, Design and Technology, Design, Technology, Metal, Metalwork, Wood, Woodworking, Attitudes, Pupils, Student, Children, Secondary Schools.

The descriptors for the search on the Education Research Information Centre were: Craft, Design and Technology, Design, Engineering,Technical, Technology, Drafting, Woodwork, Metalwork; all with Student Attitudes.

C.3.4 BRITISH EDUCATION INDEX

The search revealed fifty-four citations, thirty-three of which cited articles in various technological and educational journals and the TES. There was one citation on some educational work (Page et al (1980). The author was familiar with the research work cited and also some of the articles. The other articles were very useful for background reading. The author was relieved to confirm the results of his own searches for evidence of other attitudinal research, or for that matter, any type of research in the CDT area.

C.3.5 EDUCATIONAL RESEARCH INFORMATION CENTRE

The search produced sixty-one citations, fifty-five of which involved educational areas. Included in the attitudinal work were twenty- three research reports, six of which had some technical element. There were also six articles in various technical journals which provided good background material.

C.3.6 REVIEW OF THIS SEARCH

The use of better descriptors led to a much wider and more relevant coverage of the technical attitudinal material that has been written in the United Kingdom and in the United States of America.

The search confirmed the limited amount of CDT research work that has been done in the UK. There has been slightly more technical attitudinal research taking place in the USA. As with the first search, extra invaluable material for background technical reading resulted from some of the citations obtained in this search.

EXAMPLES OF CITATIONS

British Education Index

(1) Girls in CDT - some teacher strategies for mixed groups. Catton, John. Stud. Design Education Craft Technology, Vol.15, No.1: Winter 1982, pages 12 to 14.

(2) CDT what's missing? Harding, Jan. Stud. Design Education Craft Technology, Vol 15, No 1: Winter 1982, pages 4 to 5.

(3) Craft, design and technology the spearhead for our future. Lewin, R.H. Stud. Design Education Craft Technology, Vol 14, No 1: Winter 1981, pages 21 to 22.

Educational Resources Information Centre

(1) Factors Influencing Attitudes to Technology in Schools. Heywood, John. British Journal of Educational Studies, June 1978.

(2) Student Attitudes Toward the Impact of Technology. Hirschhorn, Joel. Engineering Education, May 1974.

(3) Technical Report on the School Subjects Attitude Scales and Improving and Extending the School Subjects Attitude Scales and Manual for Administration, Scorings and Interpretation of the School Subjects Attitude Scales. Nyberg, V.R and Clarke, S.C.T. Alberta Department of Education, Edmonton, Canada. May 1974.

C.4 COMPUTERISED LIBRARY SEARCH - 3

C.4.1 REASONS FOR THIS SEARCH

When information from the results of the factor analysis of the personality questionnaire were being analysed (chapters 8 and 9) it was considered prudent to conduct a search for any relevant CDT personality research studies. This search was conducted in November 1986.

C.4.2 PREPARATION FOR THE SEARCH

Similar descriptors were used as for the 1985 attitude search, with personality replacing attitude.

C.4.3 EDUCATIONAL RESOURCES INFORMATION CENTRE

This search revealed only two citations.

(1) A Comparative Analysis of Personality Characteristics of Industrial Arts teachers in the United States, Herbert,G.R.(1978).

(2) Teaching Career Education in Industrial Arts, Ressler, R. (1975) Journal of Industrial Teacher Education.

C.4.4 EDUCATIONAL PSYCHOLOGY

This search revealed five citations; a reference to Industrial Arts was included in four of these titles. The other citation was:

An exploratory study of the correlation among selected psychological factors and the unsafe behavior of students in metal working, Nichols,G.V.(1972). Texas.

C.4.5 REVIEW OF THIS SEARCH

This search was very disappointing, because none of the citations revealed research material that was worth exploring. However, it was a further demonstration of the lack of research in the CDT area.

APPENDIX D LIST OF FIGURES AND TABLES

APPENDIX D FACTOR ANALYSIS - A BRIEF SKETCH

D.1 INTRODUCTION

Factor analysis is one of the most versatile of the multivariate analysis techniques (another is analysis of variance).

Although the theoretical basis was laid before the introduction of computers, its power, versatility and complexity has developed hand in hand with the growth of increasingly powerful computers and 'software' packages to enable the student who is not a programmer to use them.

The overall objective of multivariate analysis technique to introduce parsimony into the description of the data - that is to say to take a multitude of apparently unrelated data, e.g. the scores of say 190 respondents to a 130 item personality measure, e.g. the HSPQ described and analysed in Chapter 8. Something like 190 x 130 = 24700 pieces of information are first reduced to $\frac{130 \times 129}{2}$ = 8385 correlation coefficients .

These in turn can be reduced to about 140 'loadings' (some appear twice) on four factors ,i.e. columns of numbers ranging from -1.0 through 0.0 to +1.0 (in theory) as in table D.1. In practice they are seldom >0.7 and some 30 items have to be discarded since they produce no appreciable loading >0.3 on any factor.

D.1.1 THEORETICAL BASIS

The computer attacks the factor analysis problem by matrix algebra. We can start with a correlation matrix as shown in table D.2. The correlation matrix of n variables can be fitted into a triangular matrix of $\frac{n(n-1)}{2}$ elements (A) but to get a matrix we have to 'reflect' and thus duplicate the matrix in B. There remains the problem of what to put in the diagonal PQ which represents the correlation of every item with itself.

Table D.1 Example of a varimax orthogonal solution

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
H002	0.00036	0.29520	-0.05503	0.09130
H003	0.40891	0.21263	-0.10867	0.05652
H004	-0.28455	0.15490	0.34478	-0.09474
H005	0.28137	0.13218	-0.05832	0.25512
H007	0.19367	0.00331	0.26753	-0.07321
H008	0.33442	0.13649	-0.15051	0.07049
H009	0.32573	0.00698	0.30524	-0.23512
H011	0.03225	0.24707	-0.16786	-0.05521
H012	0.12028	0.12618	0.36797	-0.13166
H013	0.01982	-0.10571	0.24760	0.10475
H015	0.15225	0.15044	-0.33121	-0.08991
H016	0.10656	-0.20128	-0.31033	0.00272
H017	-0.02552	0.52150	-0.05472	0.08188
H024	0.14746	0.12508	-0.12403	0.45274
H025	0.32520	-0.05251	-0.08252	0.05767
H026	-0.03530	-0.10365	0.44647	-0.14716
H027	0.17412	0.26269	0.32381	-0.00744
H033	0.39677	0.05579	0.27002	-0.14550
H035	0.23276	0.27321	-0.07596	0.30690
H036	-0.09722	0.47913	-0.08281	0.07570
H037	0.01138	0.50324	0.06659	-0.13277
H038	0.05605	0.06580	-0.05315	0.45198
H040	0.00664	0.10332	0.49213	-0.15338
H044	0.07742	-0.11657	0.38210	-0.21276
H045	-0.13535	-0.17364	0.46853	0.02058
H046	0.02438	0.16406	0.06918	-0.13969
H047	-0.13019	-0.21408	-0.00320	0.31412
H049	-0.05436	0.50065	0.05532	-0.12640
H052	0.36604	0.02429	-0.07878	-0.06191
H053	0.45966	-0.08065	0.05606	0.22391
H054	-0.04915	0.38648	0.11913	-0.17161
H055	-0.06625	0.16057	-0.08455	0.49938
H056	0.03503	0.37565	-0.13505	0.08348
H057	-0.10765	0.39070	0.24344	-0.30162
H058	-0.14365	0.36195	0.20191	-0.01892
H059	0.45269	0.24335	-0.16414	-0.05886
H060	-0.04375	-0.24689	0.01707	0.42405
H064	-0.24286	0.07790	0.31555	-0.07739
H066	0.07159	0.03585	0.37703	0.03609
H067	0.47564	-0.14974	0.06906	0.06486
H068	-0.16082	0.32626	0.22494	-0.22849
H069	0.13288	0.42744	0.15374	-0.04632
H070	-0.13985	-0.03739	0.00932	0.32329
H072	0.40593	0.03354	0.27079	-0.10523
H073	0.57242	-0.04912	0.05923	-0.02069
H076	0.30338	-0.02435	-0.11618	0.12593
H077	0.41429	-0.03290	-0.02122	0.19026
H079	-0.00975	0.02250	0.29210	-0.05065
H085	-0.05348	0.05327	0.46488	-0.00065
H086	0.04417	0.23210	0.44635	-0.04487
H087	0.39227	-0.13698	-0.04667	0.22446
H088	-0.26462	-0.26639	-0.14672	0.30847
H089	-0.17238	0.11929	-0.13320	0.49891
H091	0.22094	0.36403	-0.07574	0.02614
H092	0.13468	0.22905	-0.09707	0.07369
H093	0.47623	-0.04262	0.07926	-0.19910
H097	0.42750	0.06167	-0.06172	-0.06869
H098	0.18896	0.19335	0.04979	-0.13369
H100	0.37318	0.05499	-0.20802	-0.10824
H101	0.01326	-0.17358	0.09909	0.27234
H102	-0.00433	0.41766	-0.00636	-0.01572
H104	0.31126	0.15744	-0.14245	0.03071
H105	0.06942	-0.00031	0.31410	0.22555
H107	0.28929	0.05154	-0.11604	-0.00334
H108	0.02619	-0.04003	-0.00305	0.34674
H109	0.17470	-0.01300	-0.31797	0.40072
H110	0.01725	-0.07311	0.42830	-0.05369
H111	0.11157	0.23393	-0.23257	0.14330
H112	0.01518	0.37371	0.02401	-0.21364
H113	0.52443	-0.00580	0.04778	0.14332
H118	-0.06064	-0.10630	0.08559	-0.12223
H119	-0.16692	-0.19573	0.33335	-0.25349
H120	-0.08301	-0.02874	0.38770	-0.12197
H121	-0.06066	-0.09368	-0.15681	0.35414
H122	0.39466	-0.18603	0.12346	-0.10636
H124	0.24543	0.35595	-0.14640	0.15666
H125	-0.15141	-0.16463	0.02022	-0.00976
H126	0.44726	-0.09310	0.01218	0.19655
H127	0.30650	0.03050	0.23771	0.01560
H129	0.07584	0.19450	0.10705	0.26054
H130	0.10384	-0.05589	-0.03773	0.37957
H131	0.23537	0.27546	-0.01637	0.22671
H132	0.37544	0.27139	-0.10203	-0.11955
H133	0.59388	0.03130	-0.00090	-0.05674
H135	0.11524	0.13202	0.07349	0.03333
H136	-0.16364	-0.13104	0.35665	0.02184
H137	0.02315	-0.24803	-0.18416	0.38922
H138	0.38707	0.07187	0.06179	0.08290
H139	0.08519	-0.03341	-0.04961	0.50644

Table D.2 Correlation matrix

	NV1	NV2	NV3	NV4
NV1	1.0000 (0) P=*****	0.5163 (405) P=0.000	0.1614 (405) P=0.001	0.4410 (405) P=0.000
NV2	0.5163 (405) P=0.000	1.0000 (0) P=*****	0.2917 (405) P=0.000	0.4105 (405) P=0.000
NV3	0.1614 (405) P=0.001	0.2917 (405) P=0.000	1.0000 (0) P=*****	0.2272 (405) P=0.000
NV4	0.4410 (405) P=0.000	0.4105 (405) P=0.000	0.2272 (405) P=0.000	1.0000 (0) P=*****

Theoretically, this should be a sequence of 1.00's if every item is assumed to correlate perfectly positively with itself.

If we do this as a start we actually perform, not a factor analysis, but a principal components analysis which, in theory, has as many real factors as there are variables, although most of the variance is usually concentrated in the first few factors.

Alternatively, since no test item is entirely reliable, the diagonal could be filled with some estimate of the reliability of each item in the scale. Then a genuine factor analysis will have been performed which should usually have only a small number of real factors. Most Modem packages allow a choice of which technique to start with, although the older packages usually use a principal components analysis as a starting point.

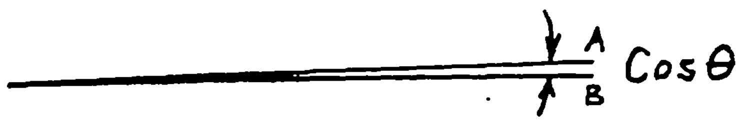
D.1.2 THE GEOMETRICAL BASIS OF FACTOR ANALYSIS

Although the whole subject can be treated by matrix algebra, it is usually simpler for the non-mathematical amateur to start with a geometrical approach.

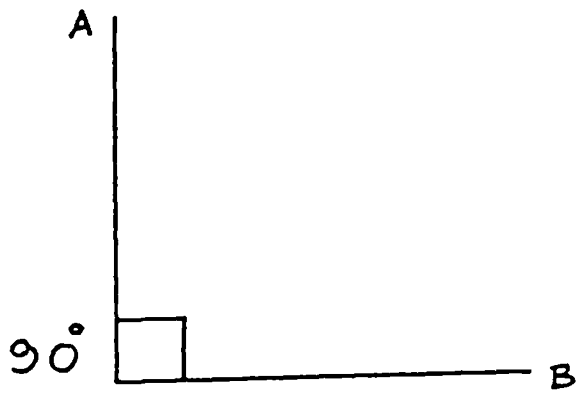
This is based on the simple relationship between the product moment correlation coefficient, which can range from -1.0 for perfect negative correlation through zero and from zero to +1.0 for a perfect positive correlation. Exactly the same properties are exhibited by the cosine of the angle, (figure D.1). Thus, it is possible to represent items by points in 'factor space' in such a way that they make angles with each other whose cosines are equal to the product moment correlation coefficients between them.

If there are more than three points each making a definite angle with the others, it is only in a few instances that the three lines bounding the angles will lie in one plane. They will usually lie in three dimensional space.

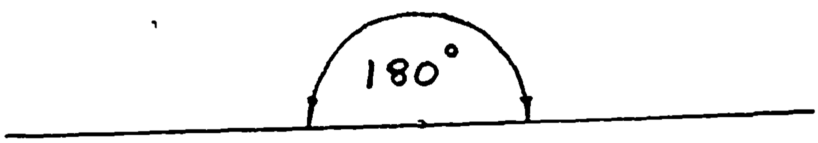
Figure D.1 Correlation



Perfect or near perfect correlation
Cos θ = 1.0 or almost 1.0



Zero correlation, A and B at right angles
Cos 90° = 0



Perfect negative correlation . A and b at 180°
Cos 180° = - 1.0

Thus, the points A, B and C will not lie in one plane (figure D.2), and any plane, wherever it lies, will only contain projections of the three points though it could pass through any two of them. With more than three points the situation gets more complex.

D.1.3 AXES

In order to locate the points A, B and C it is necessary to erect axes which can be orthogonal, i.e making right angles with each other. The dropping of perpendiculars to the axes enable the loadings of the items A,B and C on axes 1 and 2, which can, in theory, vary from +1.0 to -1.0 on any axes. A fourth variable D is shown with negative loadings on axes 1 and 2 , figure D.3. It should be noted that if A, B ,C and D do not all lie in one plane, they will have loadings on the third axis (3) at right angles to the other two (1 and 2). Thus three sets of loadings will be needed to describe the location of the points fully, (table D.3).

D.1.4 HYPERGEOMETRIC SPACE

With more than three factors existing mutually at right angles, or otherwise, it is impossible to imagine more than three interpenetrating axes or the points associated with them in ordinary three dimensional space. The factor analyst has to accept the idea of hypergeometric space in which he has to conceive as many dimensions as necessary to cope with a satisfactory parsimonious description of the data. Such descriptions would involve numerous plots in which each pair of axes is plotted in turn, and it becomes harder, and harder, to conceive what all these plots imply about the location of the points representing all the variables within them. Recourse is then usually made to the columns of factor loadings of the items on the successive factors extracted.

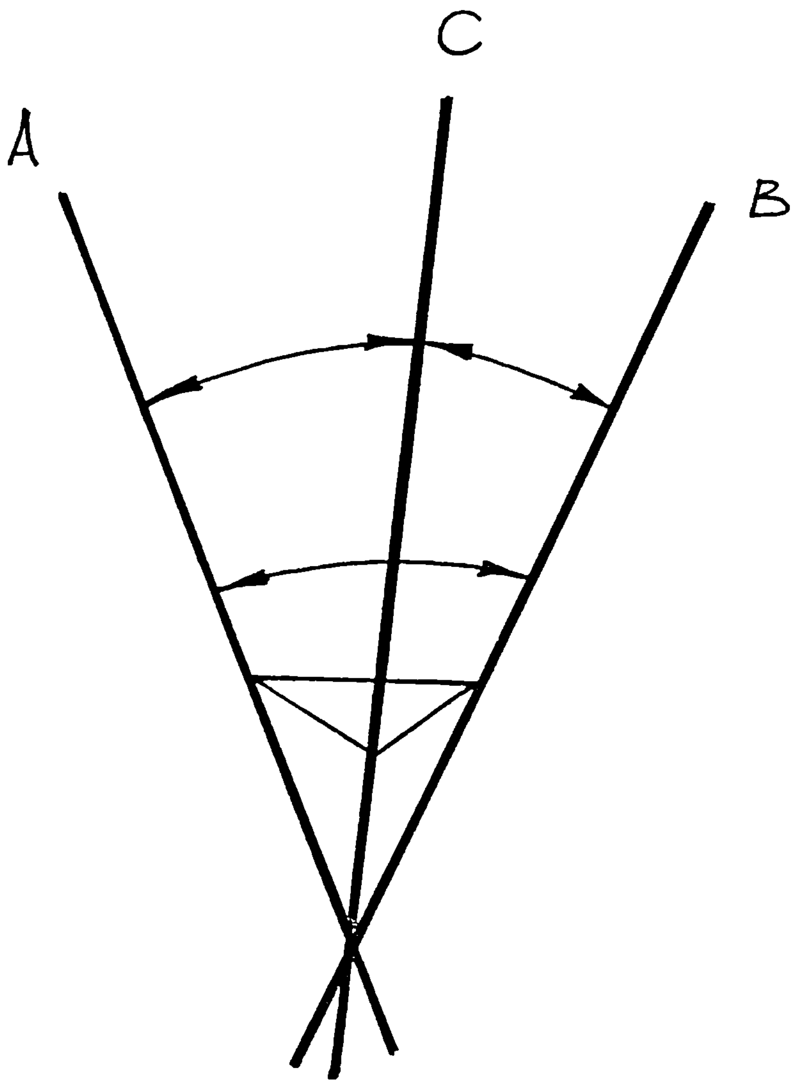


Figure D.2 3 Dimensional Space

Figure D.3 Loadings needed to describe the location of points fully

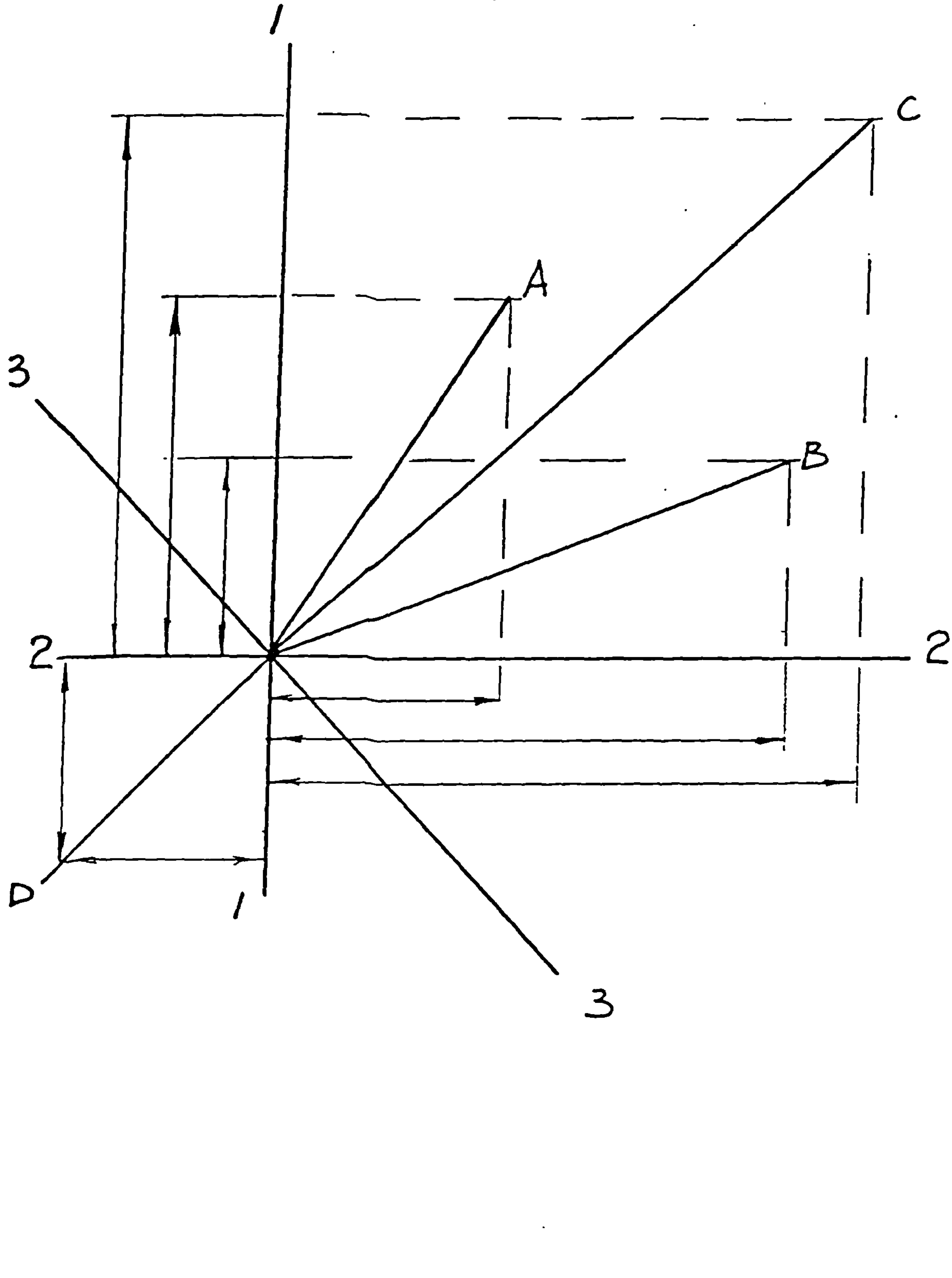


Table D.3 Three sets of loadings for locating points

Factors	1	2	3	Horizontal squares of loadings (Cummunality)
A	44	30	-12	02980
B	21	72	56	08761
C	86	85	03	14630
D	-22	-23	00	01013
Vertical sums of squares (Eigenvalues or Latent Roots)	10257	13838	3289	27384

Note: Decimal point omitted.

D.1.5 THE PROBLEM OF HOW MANY FACTORS TO EXTRACT

There are several ways of attacking this problem, which are conveniently summarized by Cattell in his book on factor analysis (1978).

(1) A method which can be used, if one can interfere with the workings of the computer, is to take out the variance in the correlation matrix associated with the first factor, the second factor and so on until the residual correlations are negligible - not accessible to the average Ph.D. student.

(2) An outdated method still implicitly present in computer packages is the Kaiser - Guttman criterion of extracting factors until the eigen - values (latent roots) fall below one. As Cattell (1978) points out, this technique under-estimates the number of factors when the number of variables is small, and grossly over-estimates them when the number of variables is high.

(3) Examination of the communalities (not what Cattell terms communalities but the sum of the squares of the loadings on every item across the number of factors extracted). Proceeding from the extraction of n factors to n+1 factors, one of two things will happen :

(a) No new variance will be associated with any but isolated items, and the communalities, including their total, will not increase appreciably. The loadings have merely been smeared across a greater number of factors. This indicates that we should have stopped at the extraction of n factors.

(b) Alternatively, there could be a group of items with low communalities whose communalities have increased appreciably, giving a higher total communality which will manifest itself as a new crop of loadings mostly >0.30 on items which have had no appreciable loadings before. This justifies accepting the n+1 factor and repeating the exercise with the n+2 factor until the total communality fails to increase appreciably.

This method was used by Ormerod and Billing (1982), for the decision to stop at five factors (excluding intelligence), in the analysis of Cattell's HSPQ.

(4) Cattell's Scree Test (Cattell 1978)

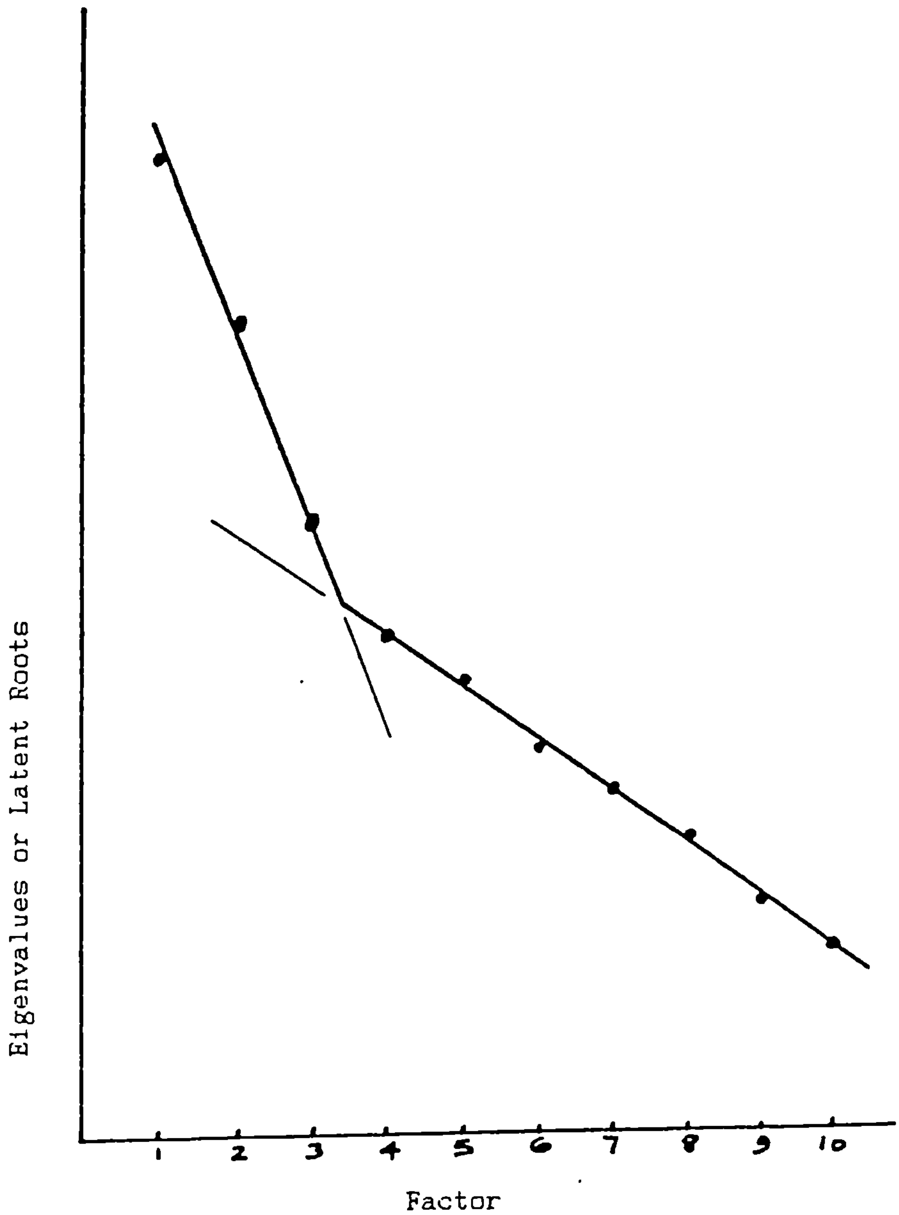
This involves a plot of the eigenvalues of successive factors against the factor number as shown in figure D.4. At first there is a sharp decline in the eigenvalues as the factors number increases. This represents a decline in the value of the real variance extracted by successive factors. At some point the real variance associated with successive factors ceases and is replaced by error variance which declines far less rapidly leading to a marked decrease in the slope of the graph. Thus, arriving at the scree which Cattell named by analogy to the geological terms, the debris of rock fragments which accumulate at the foot of any natural cliff.

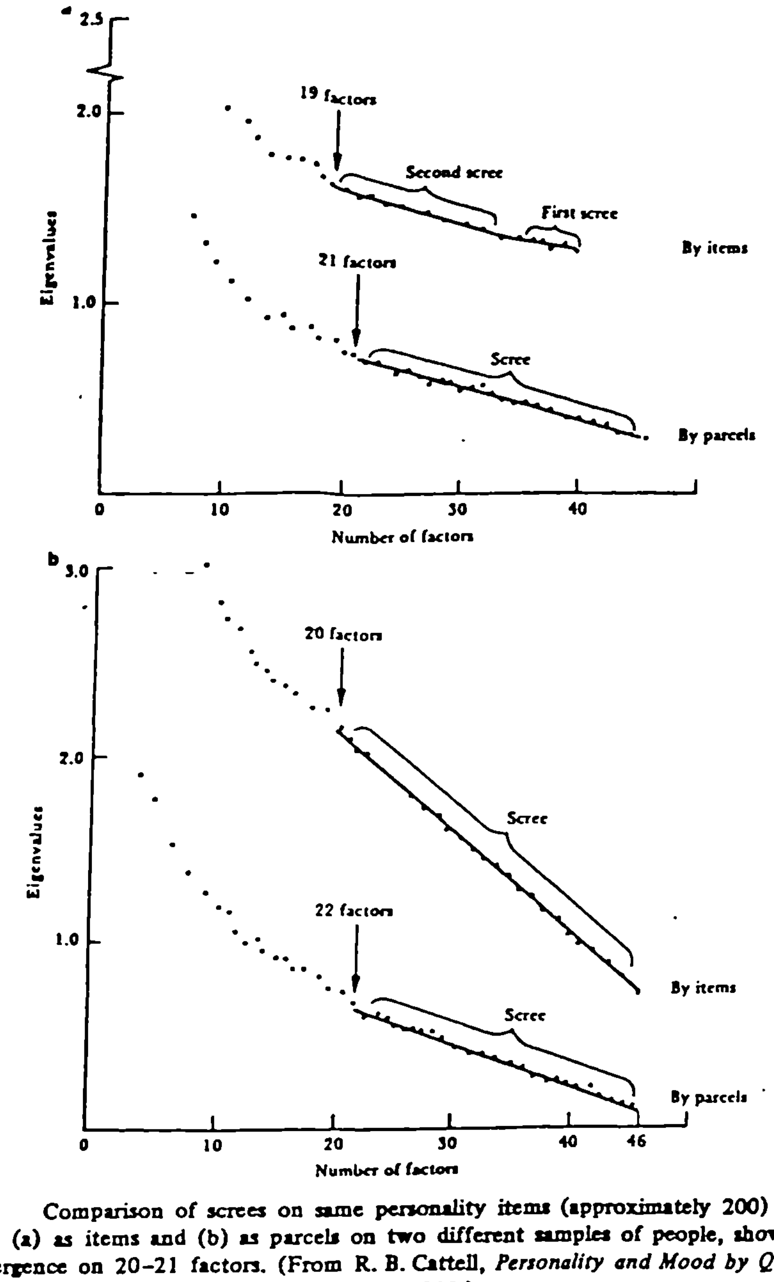
Empirically, Cattell gives the upper end of the scree to mark the $(k+1)^{th}$ factor where the true number of factors is k.

Scree tests are, in practice, not always as easy to interpret as this. Cattell sometimes postulates up to three levels of scree, as shown in figure D.5. Some of Cattell's examples of scree tests claiming 18 to 22 personality factors for his personality measure of the 16PF. look as though they could well account only for five or six main factors, (figure D.5).

(5) Another consideration which has a bearing on the number of factors extracted is connected with the reliability of scales. Cattell has erred in the opinions of many by extracting factors with loadings far less than 0.30.

Figure D.4 Eigenvalues plotted against successive factors





Comparison of screes on same personality items (approximately 200) factored (a) as items and (b) as parcels on two different samples of people, showing convergence on 20–21 factors. (From R. B. Cattell, *Personality and Mood by Questionnaire*, Jossey-Bass, San Francisco, 1973, p. 298.)

Figure D.5

(6) A final method of arriving at the acceptable number of factors in some cases arises from the most beautiful attribute of factor analysis. This is that so long as one is extracting real factors a scrutiny of the item content of those items loading >0.30 on any factor will reveal that there is some common aspect of meaning underlying the items loading on one factor. This is the pinnacle of our endeavour in conducting factor analysis, whether it be in attitude work or in personality profiles. Eventually, as the extraction of factors proceeds, this often breaks down and a 'rubbish' factor is encountered which makes no sense. It is wise, therefore, to stop at the factor before this one, i.e. the last meaningful factor.

Not one of these methods is paramount. A combination of considerations given in the last four methods is usually the best.

It is not until the number of factors is settled properly that the final rotations can be undertaken. Preliminary rotations will have to be made, if, say, method 6 is used to settle the number of factors as will selection of the significant items.

D.1.6 ROTATION OF AXES

It will be seen from figure D.3 that the points A,B,C and D do not lie as near as they could do to axis and factor 1 .

It is quite acceptable to rotate all three axes (keeping them at right angles - orthogonal rotation, or at other angles than 90°-oblique rotation) in order to maximize the loadings on all available axes. This would be easy with four points but with more than about ten it is a job for the computer. The usual technique is varimax rotation which endeavours to maximize the loadings on all the axes by minimizing the squares of the vertical distances of all the points from all the axes.

This involves repeated trial and error rotations on the part of the computer - iterations, as they are known. It gets more laborious as the numbers of points and axes increases.

In this study both the attitude and personality scales yielded five almost orthogonal axes, and so orthogonal axes and varimax solutions were adopted.

D.1.7 SELECTION OF SIGNIFICANT LOADING ITEMS

It is usually accepted that suitable items for loading on a factor should have a minimum loading of 0.30 and, if possible, less than half this loading on any other factor. Numerous items loading equally on two factors or more are ambiguous, and will lead to intercorrelation between the factors. They are better discarded, but it is possible to include occasional cases among a large number of loadings.

With a large number of items, e.g. in the personality data, there will be quite a number (in this study about 30) with no loading above 0.30 on any factor. These must be discarded and a re-analysis undertaken of the remaining items. These items, although negligible, have an effect on the location of the axes, and their removal will cause the axes to shift as they readjust to minimize the sums of squares of the vertical distances from the axes of the remaining variables.

The net result of this is that about ten out of, say, 130 items will alter their loadings sufficiently for some to fall below 0.30, while others which are below 0.30 increase. Hence, it is prudent not to exclude all items loading below 0.30, but to drop the threshold loading 0.27 or 0.28 and then repeat the rotation again after excluding all those below 0.30.

D.1.8 THE OVERALL OBJECTIVE OF FACTOR ANALYSIS

The overall objective of factor analysis is to separate out, on each factor, a collection of variables with loadings >0.30 which have something in common with each other, but differ in some significant recognizable respect from the collections of variables loading on other factors. For example (this study), the items loading on the different factors of the attitudes to CDT scales chapter 7, table 7.1 and tables 7.4 to 7.8, or the personality variables of the HSPQ loading on five different scales denoting distinct aspects of personality.

A word of warning is necessary here. Too enthusiastic a pursuit of a greater number of factors can turn up somewhat hair splitting differences between factors. Thus Ormerod (1975), in his SOCATT scales, has ten items relating to money spent on science. Five of these were pro science, e.g. 'Money spent on science is well worth spending' and five were 'anti science', e.g. 'It is wrong to spend millions sending people to the moon while millions on earth suffer and starve'. By carrying the extraction to six factors the 'pro' and 'anti' money items separated on separate factors probably because it is known that the human mind processes positive and negative information differently (Wason and Laird 1972).

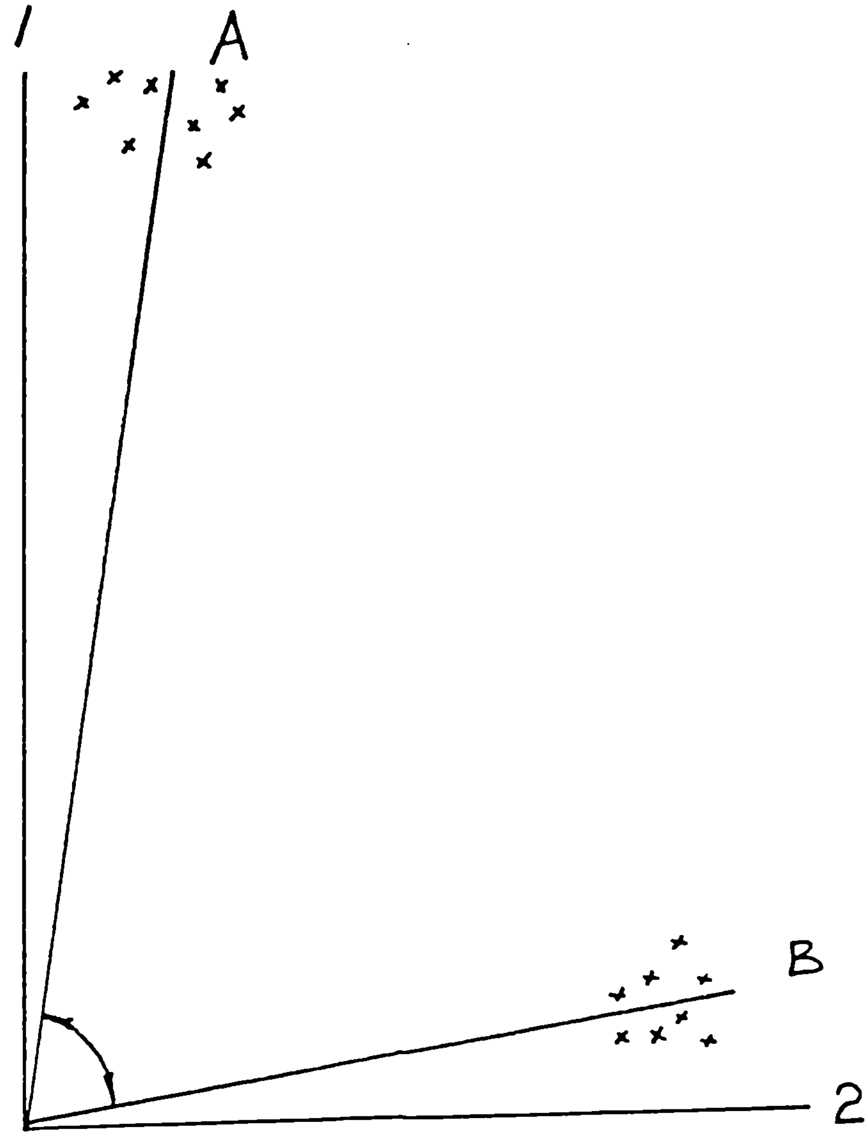
When the factor analysis was repeated on the same scales by Billing (1984), a five factor solution was adopted and all ten money items, both 'pro' and 'anti', all loaded on one factor, leading to greater economy in the test measure and greater reliability in the ten item scale as opposed to two five item scales.

Another more complex example occurred in Ormerod's (1975) thesis with the ten items concerned with the practical value of science to the individual or society. Six of these were straight forward and loaded on one factor, e.g. 'Modern inventions and medicines make life better' but in the other four there was an element of doubt which forced people to ponder and take refuge in 'uncertain' responses, e.g.
'Without science we should all be living in caves' or 'There are more good applications of science than bad ones'.
Among the less able, these last four items separated on different factors making seven factors in all, whereas when they were subjected to a five factor solution all ten items loaded on one factor. Thus, there is always a danger of pursuing factorization too far, and arriving at trivially differentiated factors - a trap Cattell may have fallen into with his primary traits, some of which are almost antithetic, e.g. E and I, load on the same factor when the number of factors is compressed.

D.1.9 FACTOR SCORES

One advantage of orthogonal rotation is the fact that it affords a means of generating absolutely pure uncorrelated factor scores.
Even with orthogonal rotation seldom can one find clusters of items whose centroids fall exactly on orthogonal axes. More often than not such clusters, e.g. A and B, will fall adjacent to, but not exactly on or around, orthogonal axes as do clusters A and B in figure D.6. As a result cluster A items have high loadings on Factor 1 but low loadings on factor 2, and with cluster B the opposite is the case. If scores were obtained for clusters A and B by adding the scores on the items in each case, they would be slightly positively correlated because their centroids make an angle $<90^{\circ}$ at the origin .

Figure D.6 Clusters of items



On the computer it is possible, however, by complex matrix algebra, to generate factor score coefficients for the loading of every item on every factor. These, when multiplied by the scores of each respondent operate in the following way:

(a) They boost the contributions of the items with high loadings on that factor to the total score of each respondent on that factor.

(b) In addition they suppress the contributions of items with low loadings on that factor to the total score of each respondent on that factor.

Thus, sets of pure uncorrelated scores for each respondent, on each factor, are provided based on the high loading items on each factor uncontaminated with the low loadings of other items on each factor.

These scores are initially put out as standard scores with a mean of zero and a standard deviation of one, i.e. they will range from about -3.0 through zero to about +3.0. They can be easily converted into scores with say a mean of 10, a deviation of 3 and a range of 0 to 20.

There is a slight loss of reliability in converting to factor scores. The raw scores contain three kinds of variance.

Factor variance + Common variance + Error variance.

Now the calculation of factor scores eliminates the common variance leaving - Factor variance + Error variance.

Thus, the error variance becomes a bigger proportion of the total variance, hence there is a fall in reliability which Ormerod (1979) found to average 0.05 with a range in the fall from 0.09 to 0.02, with attitude to science scales. This is not serious considering the advantage of pure uncorrelated scores.

E.1 CALCULATION OF THE SIGNIFICANCE OF THE DIFFERENCE OF TWO PROPORTIONS (GUILFORD AND FRUCHTER (1978a))

Example - calculations for **figure 6.1** - in response to item 7.

Item 7. Do you enjoy taking things apart to find out how they work?

<u>Responses to the 'Yes' question</u>

$\frac{277}{301}$ boys $= \frac{n1}{N1} = 92\% = .92 = p1$

$\frac{72}{96}$ girls $= \frac{n2}{N2} = 75\% = .75 = p2$

$N1 = 301, \; N2 = 96$

Estimated population proportion pe is given by the weighted mean.

$$\bar{pe} = \frac{n1 + n2}{N1 + N2} = \frac{277 + 72}{301 + 96} = \frac{349}{397} = .879$$

$$\therefore \bar{qe} = 1 - .879 = .121$$

The variance $\bar{pe} \times \bar{qe} = .879 \times .121 = .1063$

The Z value for the significance of the difference p1 - p2

$$Z = \frac{p1 - p2}{\sqrt{\bar{pe}.\bar{qe}\left(\frac{N1 + N2}{N1 \times N2}\right)}} = \frac{.92 - 72}{\sqrt{.1063\left(\frac{397}{301 \times 96}\right)}}$$

$$= \frac{.17}{\sqrt{\frac{.1063 \times 397}{28896}}} = \frac{.17}{\sqrt{1.46045 \times 10^{-3}}}$$

$$= \frac{.17}{3.8216 \times 10^{-2}} = .17 \times 26.167 = 4.448$$

$p = .00001$

E.2 BINOMIAL TEST (chapter 8, section 8.6.1)

Example of the Application of the Binomial test, (Siegel, 1956, pp 36 to 42).

The expected ratio of the R+ items to R- items in the 130 items in the 13 Cattell primary traits is 97:33 (tables 8.23a and b), i.e. .746:.254. The ratio is denoted by P:Q.

The observed ratio of 'markers' occurring on R+ and R- items is derived from table 8.25 and comes to 47:5 i.e. a total of 52 (=N), since some items are duplicated among the 59 markers (table 8 16).

The hypothesis to be tested is that in the population from which the sample was drawn the ratio of 'markers' on R+ as opposed to R- items is more extreme than the expected ratio of .746:.254.

When the ratio P:Q deviates markedly from ½ to ½, and N>25, the binomial test can only be used in NPQ>9. In this case NPQ = 9.85 so the test can be used. If x is the larger frequency (47) and N>25 the sampling distribution of x is approximately normal with a mean of NP = 52 x .746 = 38.792 and a standard deviation of NPQ = 3.138.

The significance of x can than be calculated from the expression:

$$p = \frac{x - \text{mean of } x}{\text{SD of } x} = \frac{x - NP}{NPQ}$$

However, the value of x which is a discrete variable in the binomial test must be corrected for continuity because the normal distribution is a continuous variable, i.e. x must be reduced by .5 if >NP so, therefore, becomes 46.5 instead of 47.

Thus, the expression becomes:

$$p = \frac{46.5 - 38.792}{3.138} = 2.45$$

From tables of probabilities of the normal distribution, Siegel p 247, this corresponds to a significance level of .007.