A COMPUTER DATABASE FOR SCHOOL DESIGN AND TECHNOLOGY: A FEASIBILITY STUDY

by

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Abstract

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An overview is presented of the development of design and technology teaching in secondary schools during the 1980s. In this decade, teachers were encouraged to involve pupils more in research and decision making activities which were increasingly identified as important educational elements of the discipline. Evidence from public examination work indicated that pupils were not engaged in these activities in very meaningful ways, particularly during practical project work. The author's own experience of teaching in schools indicated that resources and guidance to help develop research and decision-making skills in pupils were not readily available. Subsequently, when visiting schools as a teaching practice supervisor, it was noticeable that pupils appeared to be spending considerable time waiting for teaching assistance during project sessions.

The aim of this study was to explore the feasibility of developing and using a microcomputer database as an alternative source of help for pupils when they needed to make routine decisions during their project work. A preliminary investigation was undertaken to ascertain the extent and type of pupils' questions to the teacher, and the nature of the difficulties which hinder pupils' progress when working on their design and technology projects. This was done using observation and interview techniques.

To ensure that the microcomputer database reflected current school design and technology practice, information for its content was gathered from teachers using a survey questionnaire. Recognising time constraints, the content was confined to the practical activities highlighted as difficulties during the preliminary investigation and to the provision of routine information.

After appraising a number of commercially available database and microviewdata packages, software was produced which incorporated aspects of database and microviewdata package design, yet operated on microcomputer equipment known to be available in schools.

The software produced was trialled in schools. Its effectiveness and reliability were evaluated by the use of questionnaires distributed to pupils and teachers. Within the limitations of this feasibility study, it was concluded that, with an increase in content and refinement, the microcomputer database developed could provide a useful source of routine information to help pupils with design and technology research and decision-making processes, and enable teachers to manage project work sessions more effectively.

Chapter 1

RECENT DEVELOPMENTS IN SCHOOL DESIGN AND TECHNOLOGY COURSES

Summary

The development of design and technology from the material-based traditional disciplines of woodwork and metalwork is discussed and the pressures from politicians and senior educationalists for changes in the school curriculum are outlined, particularly those related to design and technology. The contributions of two funded projects are considered in the context of the support given for teachers who were developing the new discipline. The nature of design and technology is reviewed using examples of the many diagramatic models which have been produced. Finally, a rationale for the current feasibility study is put forward.

1. The Political and Economic Context

The economic problems of the nation during the second half of the 1970s caused several eminent politicians and educationalists to turn their attention to the education system, particularly schools. The concern centred on two key issues. Firstly, the content of the curriculum with particular reference to the lack of practical application, particularly in the areas of mathematics, science and technology. Secondly, the effectiveness of education in preparing young people for the world of work. These two issues were highlighted in Prime Minister Callaghan's speech at Ruskin College, Oxford (1976). Kimbell (1979) suggested that Callaghan had avoided taking the simplistic view that pupils required more maths and science, and had argued for a more technological bias to the curriculum that would lead towards practical applications in industry rather than academic studies.

Maddoc (1980), Principal of St. Edmund Hall, Oxford, when discussing the economic problems, suggested that the education system must educate young people about the way the country earns its living as an industrial nation. He alleged that our economic decline was related to the lack of suitably educated young people taking up careers in industry. He suggested that "unless we have top class craftsmen, technicians and administrators of facilities", the country was going to fail economically. He went on to say that the country had in fact "started to fail", but revenue from oil was propping up the economy and hiding this.

This view was supported by Smith (1980), Director of Manchester Polytechnic, when delivering the Stanley lecture:

> "We are failing to earn a living. We, as a community, as a nation, are failing to earn our living amongst the community of nations, and we avert our eyes from the failure; it is just too awkward to face up to."

Smith supported his point about economic failure with statistics, giving the details of imports and exports, and was able to demonstrate our economic decline by comparing our country's export performance with that of other nations in the western world.

Smith cited the education system as being one of the contributory factors to economic deterioration. He suggested that the Government's White Paper "The Regeneration of Industry" (1974) and the White Paper "An Approach to an Industrial Strategy" (1975), had failed to recognise that the education of young people should be an important factor in any policies developed to stem the economic decline. He suggested that there could not be a strategy for industrial regeneration without a strategy for education to provide the foundations for it. He went on to say that even the Department of Education and Science (DES) had not given any priority to a 1977 report entitled "Industry, Education and Management" which the Department itself had been involved in preparing.

Smith summarized the issues in the following way:

> "Let us start with a definition of the requirements that are confronting us. These are, firstly, that:
>
> We, as a nation, need to earn a living;
>
> and, secondly, that:
>
> Men need to work."

He stated that our nation had founded its prosperity on the development of skills, but these were no longer respected in society. To illustrate this point, he recalled a visit to a school where he was taken to the workshops and:

> "....there on the bench was a most beautiful and competent piece of metalwork. It was a joy to look at, but it was described to me as a piece of work "by one of our less able pupils". It was an extraordinary description, which spoke volumes about our distorted scale of values."

To alter this attitude, Smith suggested that academics must develop a respect for practical skills. He argued that an educational strategy to achieve this should adopt the following principles:

> "(1) Every educated person ought to understand how the nation earns its living. This should be an integral part of the make-up of an educated person, as significant as the understanding of literature, science and history.

> (2) The activities of designing and making should be regarded as being, at the fundamental stage, every bit as important as reading, writing and arithmetic, and at the more advanced stages, as important as literature, science and history. Every child in every school, every year, should be involved in designing and making activity, on the grounds that, in its own right, it is a very valuable educational approach."

While Smith made a very convincing case for the inclusion of design and technology as a compulsory part of the school curriculum, he did not attempt to define the subject in detail. He did, however, use the term "designing and making" and said that education through this process would:

> "(i) Foster the ability to think through a whole problem;
>
> (ii) Develop a respect for skills;
>
> (iii) Foster the ability to make a coherent set of decisions."

The key words in this statement are "problem", "skills" and "decisions", and they give an indication of what Smith saw as the nature of design and technology. This lack, however, of a clear statement of the nature of design and technology, particularly its boundaries, has been a problem throughout the 1980s at a time when confidence in its contribution to the curriculum has been growing. In an interview with Festing (1981), Professor Bruce Archer added a lot of support for the discipline by saying:

> "Naturally, there have been advances in design orientated subjects. For instance, largely due to the endeavours of John Swaine HM Inspector, within the inspectorate, a revolution has occurred, in what was once called handicraft. Traditionally male dominated and geared to skills, rather than invention, it took a good look at itself, made concerted efforts to become instated as an examinable course, and emerged under a vigorous new label as CDT."

It is interesting that the word "invention" was used as part of the activity. Even though Festing did not define the nature of Craft, Design and Technology (CDT), she did report that CDT can bring together "knowledge, judgment and skills in making decisions".

Dodd (1978) used the words "decision-making" long before the above commentators added their weight to the debate about the value of design and technology in the curriculum. It would appear, therefore, that the ability to make decisions is an important part of design and technology education, as seen by senior educationalists.

During the latter part of the 1970s, Craft, Design and Technology was emerging from its traditional woodwork, metalwork and technical drawing ancestry, to become a more recognisable discipline, with clear educational aims and objectives. Technology had been introduced into the curriculum, in many cases as part of CDT. Wilson (1980) when discussing the contemporary demands of CDT stated:

> "It has to become the major vehicle through which technological literacy is given to all who pass through the school system."

Interestingly, he also echoed Smith's comments, by pointing out that the nation must address the problem of industrial decline. He put it in the following way:

> "We must discover the principle that the wealth which pays for our education, health and welfare services, depends on the profit of manufacturing operations."

The development of design and technology had been under way for many years within the teaching profession, before its importance received this political and economic recognition. In fact, throughout the 1970s, many CDT teachers in the CDT profession had attempted to put the three elements, Craft, Design and Technology together, despite a serious shortage of teachers, and against a climate of strong traditional views.

2. The Development of Design and Technology Education

As with most aspects of education, it is difficult to pinpoint a time when the development of design and technology in schools started. Probably, one of the factors facilitating its development was the Certificate of Secondary Education (CSE) examinations, which were introduced in 1963 and first examined in 1965. The CSE system encouraged teacher involvement in the setting and marking of the examination papers. Mode 1 CSE examinations were very similar to General Certificate of Education (GCE) "O" level examinations, except they were devised to examine a breadth of knowledge for a greater spread of ability within a pupil group. A significant feature of CSE was, however, the availability of Mode 2 and 3 systems of examining.

Mode 2 examination encouraged groups of schools to submit examination schemes to meet their specific requirements. Once accepted, these schemes were examined by the Examination Boards. The Mode 3 scheme placed even more emphasis on teacher involvement, by allowing local groups of teachers to prepare their own syllabuses and run the examinations themselves, including taking responsibility for coursework assessment, which was usually a significant element. While the Mode 2 and 3 schemes allowed a proliferation of syllabuses, which were difficult for employers to understand, they did enable teachers to analyse what they were teaching and, through discussion, develop new ideas.

The West Yorkshire and Lindsey Regional Examining Board (TWYLREB) was particularly keen on the development of the Mode 3 scheme. They set up local panels of teachers for each subject, which provided a forum in which an interchange of ideas could take place. This was particularly important for the traditional material-based subjects, such as woodwork and metalwork, as some teachers were attempting to improve the status of the subject within schools. It was a time when some traditional handicraft teachers were questioning the validity of the work they were doing.

Up to this time, the work in schools had been dominated by the GCE syllabuses. The GCE examination boards were slowly changing their syllabuses to include some elements of what they called design. For example, the Oxford Board (1968) had the following question as part of a metalwork examination:

> "Design a magazine rack, which is modern in appearance. The legs are to be made from mild steel rod and the holder can either have a wooden base with vertical rails, or a sling of expanded aluminium, or a slatted base with laced nylon thread."

Two interesting points are demonstrated in this question. The first is the fact that the design brief is stated and then virtually all the components of the solution are dictated. For example, the magazine rack must have steel legs, though candidates were given a limited choice for the base. The second is that while this was a metalwork question, candidates were being encouraged to work with other materials. Rather than designing from scratch, candidates were being allowed a choice from a very limited range of options. The Associated Examining Board (AEB) were early in providing design-based examinations with their "O" level "Design, Communication and Implementation", examined for the first time in 1966. This provided candidates with the opportunity of having their coursework, completed in years four and five, assessed as part of the examination. In addition, a design problem was set, which could be realised in a material chosen by the candidate. Also, candidates were expected to complete a written examination, dealing with a range of craft, design, realisation and technological knowledge. Both the Oxford Local Examinations Board and the AEB continued to develop their design-based examinations throughout the late 1960s and 1970s.

The Oxford Board Design examination at "A" level, introduced in 1972, was the first syllabus to reflect the full scope of designing as a school activity. The syllabus promoted adventurous open-ended project work, in a range of materials, and encouraged students to produce a structured design folio as part of their submission.

In the mid-1960s the Schools Council recognised the importance of the developments taking place in schools and funded two projects, Project Technology and the Design and Craft Project. These projects provided teachers with support for their work and gave some direction to the curriculum development taking place.

2.1 Project Technology

Project Technology was established in 1966 as a pilot study to enquire into the place of technology in the school curriculum. One objective of the project was to introduce technology as a new field of study, in which the technology was used in a creative way. To enable this to happen, it was recognised that it would be necessary to bring together several subjects which already existed. This would be done through the vehicle of project activity, which included designing, using technology and making. This project flourished initially at Loughborough College of Education. When Schools Council funding ended in 1972, the work was continued at Trent Polytechnic, in the National Centre for School Technology (NCST). This organisation was able to provide an extensive range of support for the teachers who were introducing technology in their schools, such as short courses and the development of teaching materials. The National Centre for School Technology also hosted the School Technology Forum, an organisation of associations brought together as the Standing Conference on School Science and Technology. The National Centre for School Technology became known to a large number of both craft and science teachers through the publication of the "School Technology" magazine and the School Technology Forum Working Papers which covered a whole range of topics related to the development of technology within the curriculum.

Dodd (1978) commented on the Project as follows:

> "Project Technology interpreted the fusion of technology and education into what its team members termed "the process of technology". This was essentially based on the problem-solving activity, based on the industrial design line, a disciplined activity, with facilities for a real creative response."

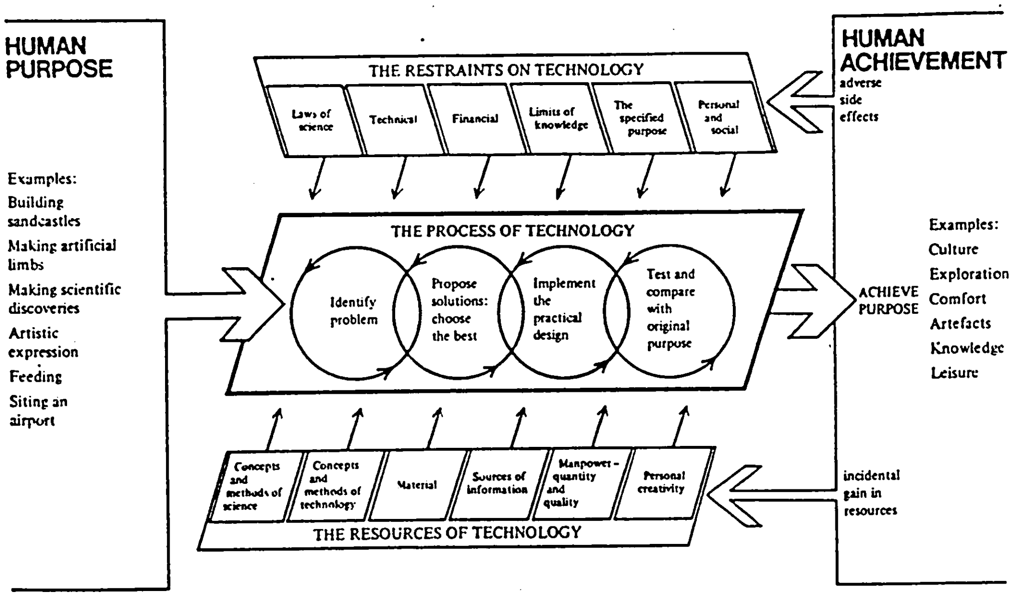
The School Technology Forum came to an agreement on a definition for school technology. Page (1980) described technology as follows:-

> "Technology is a problem-solving process which has as its goal, the improvement of the quality of human life, as its starting point human need, and as its continual companions the resources and constraints of human knowledge and natural resources."

The complex diagram reproduced in Figure 1.1, described by Page (1980) as being the "coat of arms" of the National Centre for School Technology and the School Technology Forum, was an attempt to describe the technological process.

Figure 1.1

The Technology Process produced by Project Technology The Next Two Years, Schools Council 1970



2.2 Design and Craft Project

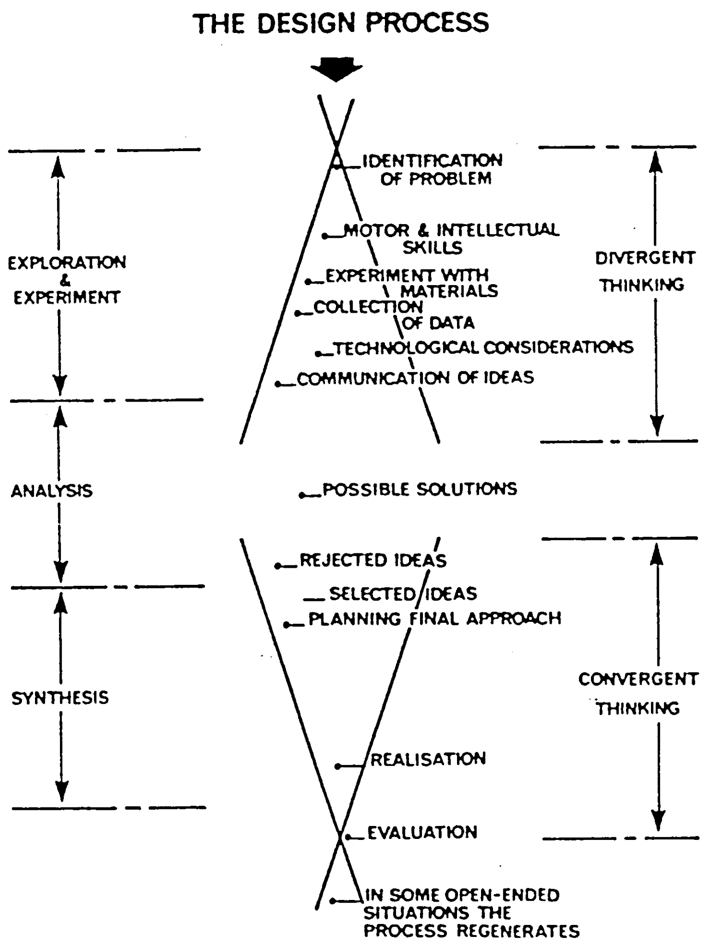
This Project started as a one year feasibility study in April 1967 and terminated in the report "Schools Council Working Paper 26, Education through the use of Materials" (1969). While a major part of the report was descriptive of the more enlightened activities going on in schools, it did focus attention on the necessity to relate design practice with educational objectives. The result of this report was the setting up of a five year project which started at Leicester University, but moved to Keele University when its Director, John Eggleston, moved to that establishment. It appears that the research team concentrated on the aesthetic aspects of design, rather than on producing design teaching methodology which teachers required at that time. When summarising the project's work, and the teachers involved, Dodd (1978) remarked:

> "Particularly in the area of "Design and Make", early attempts to introduce basic design courses were often misguided. Craft teachers modelled them on the foundation courses common in Colleges of Art, and in copying the style placed undue emphasis on the product. Consequently, the results were manifest in hundreds of collages made up of blocks of wood and shavings and totem poles cut from standard square timbers. Expression, freedom and experiment, were the key words, and many courses foundered because of a lack of direction and purpose."

However, Dodd credited the project team with an interpretation of the design process which "gave many teachers a logical form and structure on which to base their problem-solving activities". The diagram produced by the Project, Figure 1.2, forms the basis of many of the models subsequently used to describe the process of designing. It is interesting to note that even at this early stage in the development of design and technology education, "collection of data" was identified as being a stage in the process.

Figure 1.2

Design and Craft Project's diagram
of the design process



There is no doubt these two projects had considerable influence on the developments taking place in schools. Probably Project Technology and ultimately the National Centre for School Technology had the greatest impact because they seemed to work more at the teachers' level and were particularly good at providing support materials for use with pupils. The Design and Craft Project tended to work in areas the traditional craft teacher had difficulty in understanding, for example, aesthetics and design in the environment. Providing support materials for these activities was more difficult. The project team did, however, produce the periodical "Studies in Design Education Craft & Technology" which encouraged teachers to publish details of the innovative work they had been doing in their own schools, so providing a forum for the sharing of ideas. This, in itself, has been a valuable service to many teachers through a period of rapid development.

It can be argued that the setting up of these two projects, which ran parallel with each other, was divisive at a time when teachers in schools required guidance, in-service training and good quality curriculum support materials. The setting up of two projects emphasised that there were different views in the profession about design and technology. Little effort was made to provide a forum for debate about the overall nature of the subject and, therefore, schools have tended to develop both design courses and technology courses, often taught by specialist staff.

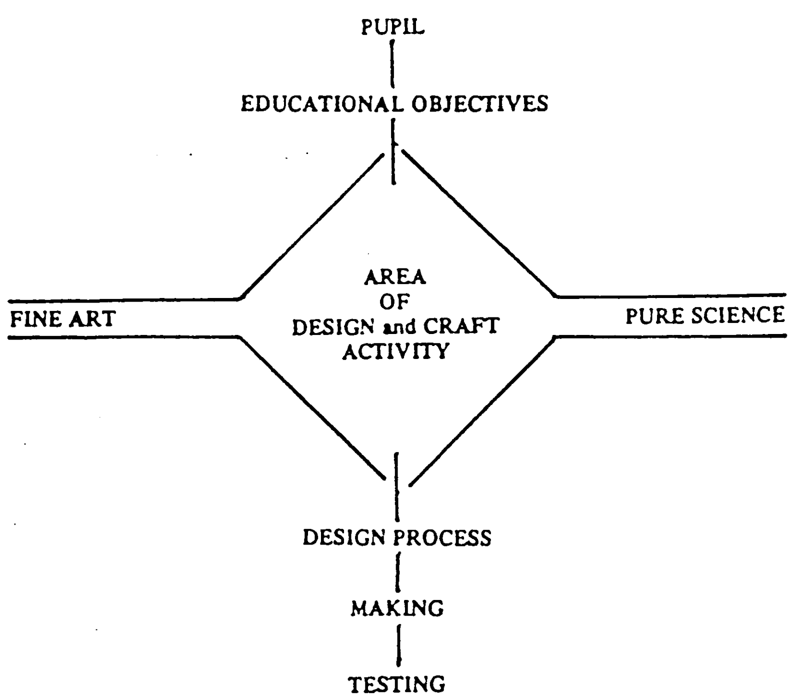
It is interesting that both these projects felt it necessary to produce a diagram to describe the process. Both diagrams are complicated and useful in an academic sense for the teacher, but of little use to the pupil doing a design and technology project. Both the diagrams identify several similar stages in the development of a solution to a problem but use different terminology. For example, Figure 1.1 includes "Implement the practical design" and Figure 1.2 refers to "Realisation", both referring to the making process which must be a vital element in both design and technology.

Similarly, "Identification of problem" appears in both.

At a time when these two projects were underway the Schools Council was also funding pilot schemes for common examinations at 16+ level to replace GCE "O" level and CSE. The Associated Examining Board (AEB) and The West Lindsey Regional Examining Board (TWYLREB) collaborated from 1972 to 1979 to produce a feasibility study, which included running a joint examination in "Design and Craft" for five years. The working party recognised the indistinct boundaries which exist between design, craft, art and science. They produced a diagram, reproduced in Figure 1.3, to illustrate this.

Figure 1.3

Diagram produced by the 16+ Working Party for 'Design and Craft'



The diagram identified the relationship between science on the one hand and art on the other. As described previously, Project Technology dealt with the science side of the curriculum through technology, and the Design and Craft project dealt with the more artistic element. The Working Party which developed this diagram recognised that there was a relationship between the two and produced an examination syllabus which encouraged them to come together.

To enable the examination to be implemented in the time scale available, the two Examination Boards provided a mechanism which required teachers to visit each other's schools, as well as attend a series of meetings to discuss the problems and the ways the examination could be developed. This activity covered the Yorkshire and Lincolnshire region and represented a considerable step forward in curriculum development in the schools involved. In summing up a description of the project Dutton (1976) concluded that:

> "..... this type of examination is an undoubted success. Several aspects will have to be changed in the light of experience, but the overall philosophy has been shown to be educationally viable."

In the 1970s the Schools Council funded another initiative: the development of modular courses in school technology. Schemes pioneered in Hertfordshire and Avon schools identified several elements of technology which could be taught as modules. Each scheme reinforced the teacher-taught technological knowledge with pupil project activity. The Avon scheme had mini design-and-make projects for each of the five modules, whereas the Hertfordshire scheme concentrated on three modules, plus an extended design and realisation project. The success of these schemes can be attributed to two factors. Firstly, the schemes were supported by high quality teaching materials in the form of pupil text books, pupil activity assignments and a teachers' hand book. Secondly, the schemes were disseminated throughout the country by members of the working parties who had been involved in formulating them. This was done by running a series of lectures and seminars.

By the time the political issues of the school curriculum were being discussed at a national level and calls made for designing, making and technology to be given a more important place in the school curriculum, considerable headway had already been made in developing design and technology in schools. However, several issues remained unresolved. Three of these were:

* the relationship between design and technology;
* the title of the discipline;
* the process pupils should follow to enable them to develop solutions to their design problems.

3. The Nature of School Design and Technology

As pointed out previously, confusion existed throughout the 1970s regarding the relationship between design and technological activity. The present DES title of the subject is Craft, Design and Technology (CDT). Using these words indicates that the discipline is some amalgam of three activities, which can be interpreted in many different ways. The word "Craft" has many connotations. Armstrong (1980) defined it in the following way:

> "CRAFT: A calling requiring special skill and knowledge, especially in manual art."

He goes on to say that the broadly educated CDT teacher must continue to develop "an appreciation of skills and a respect for the craftsman" in the pupils following CDT courses.

Craftwork has existed in schools since late last century when pupils did "craftwork" or in some instances "manual instruction". This work was seen as being useful for developing practical skills, which could be used in an apprenticeship when pupils left school. Very often the teachers were craftsmen with little or no formal teacher training. Craft apprenticeships involve training which is skill-based to enable people to do a particular job or operate a specific piece of equipment, for example, apprentice turners are trained to operate lathes. This word has caused confusion about the nature of CDT, as both educationalists, parents and pupils have linked the word with some form of skill training which is appropriate for industry. This perception existed until relatively recently. The Engineering Employers' Federation, however, produced the following statement in 1984 to indicate how they saw the subject:

> "The traditional image of CDT as a low status subject, unsuitable for the academically able, must be dispelled. The courses must be broadly based, not specialised in particular crafts, and all must include references to the underlying scientific principles and to a variety of real life applications. Design and make projects should provide opportunities for functional creativity, planning, costing, fashioning and evaluating, within known constraints, and learning to work in teams."

This was a clear statement that they did not see CDT as a material-based subject involving craft training, or one that was unsuitable for the more able pupils.

Schools have a long history of devaluing practical activity. Toft (1983) attributed this to the fact that the country was once the centre of an Empire with banking, insurance and commerce being of prime importance, requiring clerks not technologists. He suggested that it was "politically expedient" and "economically necessary" to develop grammar schools, rather than elementary and secondary education of a "scientific and technical kind". He went on to say that this has been damaging in the long run and that it has taken some time for this to be realised. He suggested that:

> "It is hardly surprising, in a meritocracy where schooling is an agent of job selection, that the status of school knowledge will be linked to an occupational hierarchy in which "capability" is of low regard."

Toft went on to say that the linking of disciplines to specific jobs must be broken down and that the progress of education for "capability" would be impeded unless this happened throughout society. It seems that the word "craft" has caused confusion in the past, and it must be used with caution in an educational context.

The title Craft, Design and Technology caused some difficulty for Carter (1983) when delivering the Stanley Lecture. Following his introduction, he found it necessary to clarify the terms he intended to use by saying:

> "As a point of procedure, I shall tend to use the term "design" generally - rather than "craft", "design" and "technology" separately - when I talk of the activities with which I am most familiar in this context. This does not imply I have less sympathy with, or enthusiasm for, craft and technology. It suggests, rather to me they are all indissolubly mixed into a single process of understanding, ordering, creating and manipulating - with skill and sensitivity and a lot of common sense. Separately used, "craft" - "design", "technology" are just a bunch of words - a mixture of verbs and nouns, which I find difficult to use collectively."

In this case, Carter, a professional designer, preferred to use the term "design" to describe what was known as CDT. Clearly, the title Craft, Design and Technology did not describe the activity in a concise way. Neither did the single words "design" or "technology". Four years later, the title Craft, Design and Technology came under scrutiny again, during the tenth annual Stanley Lecture. Nash (1987) reported the following comment by Dodd:

> "The more the DES and the HMI continue to insist on craft, design and technology as an unwieldy, divisive title, supported by the GCSE pattern of three courses, emphasizing the separate elements, the more difficulties teachers will have in the future in justifying the activity."

The article concluded with a call to the professional policy makers to make their starting point a working definition for the subject.

The development of the National Curriculum is likely to be a major opportunity for CDT teachers, in particular, and the education profession in general, to identify what the discipline is and how it should take its place in the education of young people. The National Curriculum Design and Technology Working Group Interim Report (1988) addresses the issue of a definition for the activity in its opening remarks.

The report stated:

> "We recognise that each of the terms "design" and "technology" can convey different meanings to different people. Furthermore, some of these meanings are deeply embedded through long usage, in different working communities. Even within a particular community, (eg designers or engineers; CDT teachers, IT teachers or science teachers) meanings may be contested."

It was in the first chapter of the report that the working party justified their adoption of the title "Design and Technology". The following points were made in the appendix to the chapter:

> "1. We have adopted the term "design and technology" to describe the area of the curriculum with which we are concerned. ......
>
> 2. It might be objected that a more appropriate title would be "Craft, Design and Technology" which is already widely used in secondary schools. However, while CDT has much to contribute, we are dealing with an activity broader than CDT which, to quote our terms of reference, "goes across the curriculum, drawing on and linking in with a wide range of subjects.
>
> 3. Our usage of the term "design and technology" is not intended to devalue "craft" - craft skills are essential means to the achievement of many design goals."

Clearly the working party (1988) had given some thought to this difficult task of definition and they expressed concern in the use of the dual term "design and technology". In an attempt to clarify the issue they stated:

> "Our understanding is that whereas most, but not all, design activities will generally include technology and most technology activities will include design, there is not always total correspondence."

It seems that considerable confusion still remains for those who are involved in the education profession, not to mention those people, such as parents, who do require a more concise definition of the activity.

It is clear, however, that the use of the word "Craft" as part of the title, is to be dropped. "Design and Technology" was adopted as a title for use throughout this research project as in the author's view it describes the activity adequately, but does not raise questions about links with the past nor have any connotation with training.

Clear definitions of the individual words "design" and "technology" have been used for many years in CDT documents. Lucas (1980) et al went to considerable lengths to produce a definition which could be used by educationalists.

Emphasising the breadth of design and the importance it has to a range of disciplines, including technology and science, they 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."

This definition has been the one adopted by the author as the most apt.

The word "technology" has been equally difficult to define. Lord (1987) emphasised the difficulty with the following statement:

> "Despite the enigmatic nature of technology, and probably because of it, there have been a number of studies which have attempted to illuminate or define the concept."

After pointing out that the studies have failed to reach firm conclusions, he attempted to highlight some of the alternative interpretations.

They include technology as:

- a purposeful activity intended to effect change in the environment;
- a distinct form of knowledge;
- a process;
- value and context determined.

Even with these descriptions, Lord fails to reach firm conclusions and define technology. He did, however, recognise that technology was located in CDT departments in the majority of the schools visited during his research. He found that CDT departments were:

> "..... utilising their experience of design work and had placed technology firmly within the framework of the design process."

Black and Harrison (1985) however, had a wider view of technology and who should teach it. They used the following School Technology Forum's definition:

> "Technology is a disciplined process using resources of materials, energy and natural phenomena to achieve human purpose."

They went on to identify three educational aims:

1. To give children an awareness of technology and its implications as a resource for the achievement of human purpose, and of its dependence on human involvement in judgemental issues;
2. To develop in children, through personal experience, the practical capability to engage in technological activities, and

3. To help children acquire the resources of knowledge and intellectual and physical skills which need to be called upon when carrying out technological activities.

While these aims gave a broad indication about the nature of technology there was considerable debate in schools about who should teach it. Some LEAs and Headteachers considered its place was in a science department, whereas others felt CDT could provide the most appropriate technology courses. Black and Harrison pointed out that both science and CDT departments had a role to play in the teaching and development of technology in schools, but admit that their definition and aims had not been totally accepted or understood. Clearly, a definition of technology was needed which described the activity more precisely.

HMI (1987) produced the following very simple statement, which is a basis on which to build something more comprehensive:

> "It [technology] is concerned with controlling things or making things work better."

The Examination Boards, of necessity, required a far more precise statement, particularly when GCSE syllabuses were being prepared. The National Criteria (1983) gave the following definition:

> "Technology is principally concerned with design and problem solving, leading to the making and evaluation of artefacts and systems. It draws upon scientific and technical knowledge, and requires an understanding of appropriate scientific principles. Technology also involves management of the environment, and familiarity with the concepts of materials, energy and control."

A similar definition appeared for the parallel Design and Realisation examinations:

> "Design and Realisation is principally concerned with design and problem solving processes, leading to the making and evaluation of artefacts. It draws upon imagination and understanding of materials and technologies. It demands active workshop experience, and leads to the appreciation and production of work of quality."

Both definitions use the words "design and problem solving" and state the activity leads to "the making and evaluation of artefacts". Clearly, design and technology are linked through the process of problem solving, making and evaluation. The Design Council (1980), use the word "designing" to describe such an activity. There is no parallel word to describe technology, which is perhaps fortunate, as "designing" can also be used in a technological context.

4. The Technical and Vocational Education Initiative (TVEI)

As described earlier, considerable development of design and technology took place, both in the schools and by Schools Council development projects throughout the 1970s. Prompted by calls for links with the world of work, the DES Further Education Unit (FEU) (1979) produced its own model of pre-vocational education in a document titled "A Basis for Choice" (ABC) which emphasised the need for a curriculum which provided an integrated educational experience, rather than the usual study of discrete disciplines. While ABC made some progress towards curriculum change, it was the Technical and Vocational Education Initiative (TVEI) which made the most significant move forward. TVEI was a complete departure from previous curriculum development projects, both in the way it was funded and in its stated aims. Announced by the Manpower Services Commission (MSC) in November 1982, the initiative gave Local Education Authorities the opportunity to bid for substantial funds for projects. Pring (1986) described the general aims of TVEI as interpreted by the participating LEAs as being to:

"(a) redirect the curriculum of schools more towards preparation for the world of real work - and other aspects of life.

(b) establish a greater central Government influence to ensure that this occurs

(c) rationalise a system of assessment and accreditation that

(i) is linked to agreed standards of performance at different levels and in different skill areas, and

(ii) enables, through the acquisition of credits, progress to be made through full-time and part-time courses to more advanced education and training."

He went on to give a ten point summary of the curriculum developments brought about by TVEI. Three of these were:

"(c) Changed styles of learning and teaching, reflected in the practice based assignments, negotiated curriculum objectives, stress on the processes of learning, rather than the product or content .....

(d) Use of technology, especially as the means through which resources can be made available and practical work engaged in - (although, in the emphasis upon processes of learning, rather than the product, there seems few signs of that progression in technological understanding, which surely is needed).

(f) Skills development, - "basic skills" in numeracy, communication, physical manipulation, keyboard skills, personal effectiveness - (although the concept of skill is used in such an elastic way as to confuse skills, knowledge, personal qualities and attitudes in a most alarming way.) ....."

They are particularly relevant to design and technology as they state some of the common aims, for example, the emphasis on "the process rather than the product", which has become a feature of design and technology teaching. Similarly, the "use of technology" involving "practical work" and "skill development" including "communication and physical manipulation" are key elements of design and technology. TVEI has brought many other changes to the school curriculum, particularly in developing new methods of teaching, as well as presenting greater opportunity for pupils in schools through work experience schemes. In many cases, the usual forms of examination have been abandoned in favour of assessments leading to vocational qualifications for example, those of the Business and Technician Education Council (BTEC) and City and Guilds.

5. The Process of Design and Technology

As outlined earlier, the Design and Craft Project and Project Technology produced diagrams (Figures 1.1 and 1.2) in an attempt to describe the process of designing. Also as discussed earlier, "designing" describes the activity which is found in schools. These diagrams provided a useful basis for teachers to discuss the activity, but did not in themselves provide any structure which could be used in teaching.

The diagrams shown in Figures 1.1 and 1.2 are fairly complex, so of little use to the pupil embarking on a design and technology project. The Examination Boards considered it necessary to produce simplified versions, which could be used in examination syllabuses. In some cases, they formed part of the rubric on an examination paper, so providing guidelines for the pupils. Figure 1.4 shows a diagram used by the Associated Examining Board (AEB) to help teachers when preparing pupils for their design and technology examinations.

Figure 1.4

Representation of the Design Process as used by the AEB 1978

NEED

(Design Brief)

INVESTIGATION

(a) Identify specific factors affecting problem

(b) Gather relevant information

(c) Identify technical factors including the CONSTRAINTS.

(d) Produce outline solutions

(e) Make selections from these alternatives and develop the most feasible.

(f) Plan for realisation

REALISATION

Quality of workmanship

EVALUATION

The majority of Examination Boards offering design-based CDT examinations represented the process in similar ways. Usually the rubric on the examination paper gave instructions as to what the candidates should produce as a design folio to support their practical project work. The Associated Examining Board (AEB) stated the sequence for design folios as part of the rubric as shown in Figure 1.5.

Figure 1.5

Part of the rubric from the 1980 AEB Design and Craft Examination

The folios should be set out in the following sequence. Marks allocated to each section are shown in brackets.

1.	Analysis of the problem and research.	(20)
2.	Preliminary ideas for solving the design problem.	(15)
3.	The development of the most suitable idea with the methods of construction, comments on materials, cost and feasibility.	(40)
4.	The dimensioned sketch or working drawing of the final solution, in sufficient detail to enable someone else to make it up.	(20)
5.	Materials list.	(5)

The teachers' coursework assessment sheet contained the same design process with the additional sections covering "realisation" and "evaluation" of the completed project. The Cambridge Local Examinations Board Modular Technology "O" level examinations from 1977 onwards had similar descriptions of the process candidates must use when presenting their design folios.

The Assessment of Performance Unit (APU) turned their attention to the process of designing in 1981. They suggested that further investigation into the activity was required, but they did come to the conclusion that the activity can be broken down into three main areas of skills, knowledge and values. Under the heading of skills they said:

> "The skills that are used in design and technological activity are distinctive and can be grouped into four categories:
>
> INVESTIGATION; INVENTION; IMPLEMENTATION; EVALUATION"

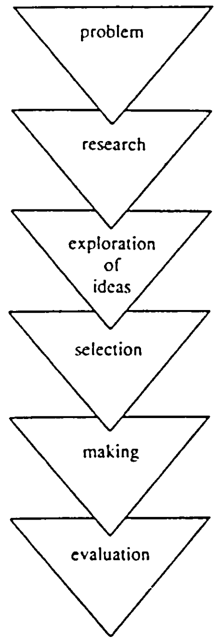
The words "investigation" and "evaluation" had been used by examination boards and CDT teachers for some time. The AEB had used the title "Design, Communication and Implementation", for one of its CDT examinations for many years and Festing (1981) reported that Professor Archer (1981) used the word "invention" to describe an important part of the activity. The APU (1981), however, found it essential to describe these activities, and the following description was used:

> "..... the skills of INVESTIGATION include the ability to recognise the existence of a problem which might be amenable to a solution through design and technological activity; the ability to perceive, or identify through investigation, how far a given thing or system meets the stated need; the ability to look for information and resources and generate information through observation or experiment and to judge how relevant, sufficient and reliable are the information and resources obtained; .....
>
> ..... the skills of INVENTION, includes the ability to initiate and develop ideas and images of proposed things or systems, ...
>
> ..... the skills of IMPLEMENTATION include the ability to plan a practical activity and to see it through, the ability to select from available resources, the most appropriate means for gaining the desired effects; the ability to use tools, instruments, materials, components, appliances and appropriate energy resources, ...
>
> ..... the skills of EVALUATION include the ability to discern the context within which the designed product or system is to be considered, and to identify the related criteria by which it should be judged, ..."

The initial work of the APU became a survey of design and technological activities in the school curriculum conducted by the National Centre for School Technology. The Centre conducted two studies: one looked at all the forms design and technological activity could take, and the second identified schools where design and technology was well developed. This initial work was extended to become a major research project at Goldsmiths College. By 1987 the APU had a clearer view of the design and technology activity and suggested that the linear model as shown in Figure 1.6 represents the simplest level.

Figure 1.6

Simple linear model of the design process used by the APU



This over-simplistic model has been used for several years by teachers and pupils because, as described earlier, it was included in the rubric of examination papers. The Secondary Examinations Council booklet "Craft, Design and Technology GCSE A Guide for Teachers" (1986) used the more detailed model shown in Figure 1.7. This gave details of the inter-relationships between each of the elements of the process.

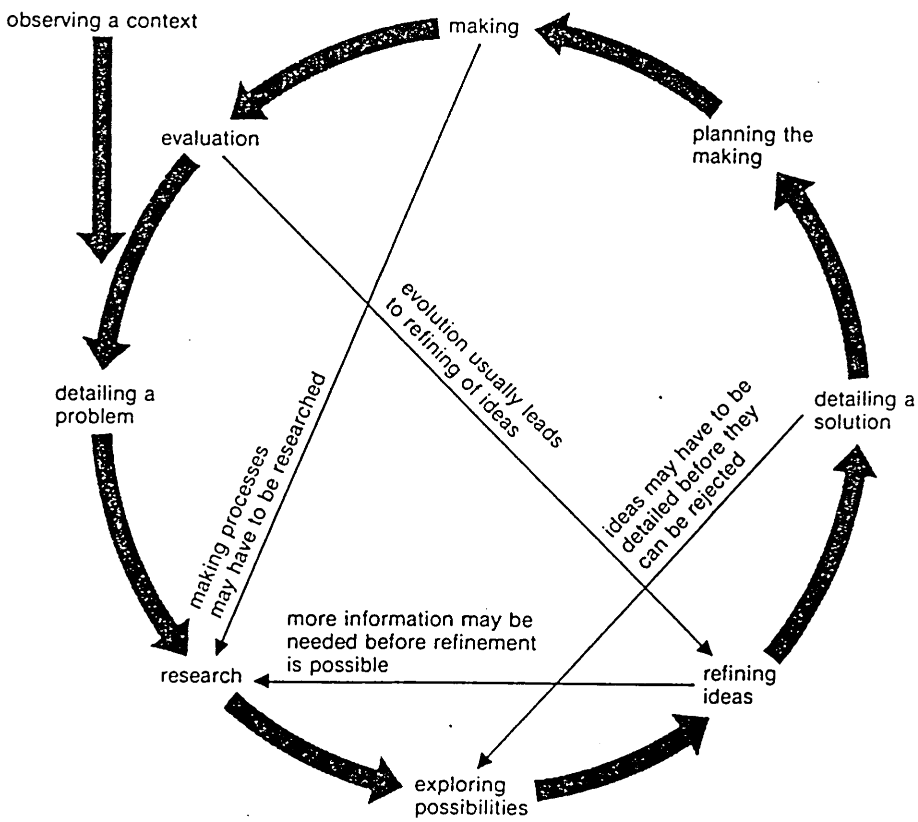
When describing this model, the authors point out:

> "It is also true that, while the phases of the procedure can be located at points around the loop, it does not follow that students have to mechanically work their way around it. Depending on the approach used by the designer, and in part on the nature of the design exercise itself, different elements around the loop will assume greater or lesser importance, and there may well have to be a great deal of jumping about across and around the loop before it is possible to arrive at a sound conclusion."

The "research" element of the model is highlighted by the fact that it has three arrows pointing to it. These are from the "making" element, the "refining ideas" element and the loop arrow from the "detailing a problem" element. The "research" element must, therefore, play a significant part in the process.

Figure 1.7

"The Design loop" model as shown in Craft, Design and Technology GCSE, A Guide for Teachers



Not only is the "research" element of the design process identified as important at GCSE level, but it also has a major role in design and technology work at "A" level. The Design Council (1980) described the design process in a linear way but they gave more details of each element. For example, when describing "research", they said students would be involved in:

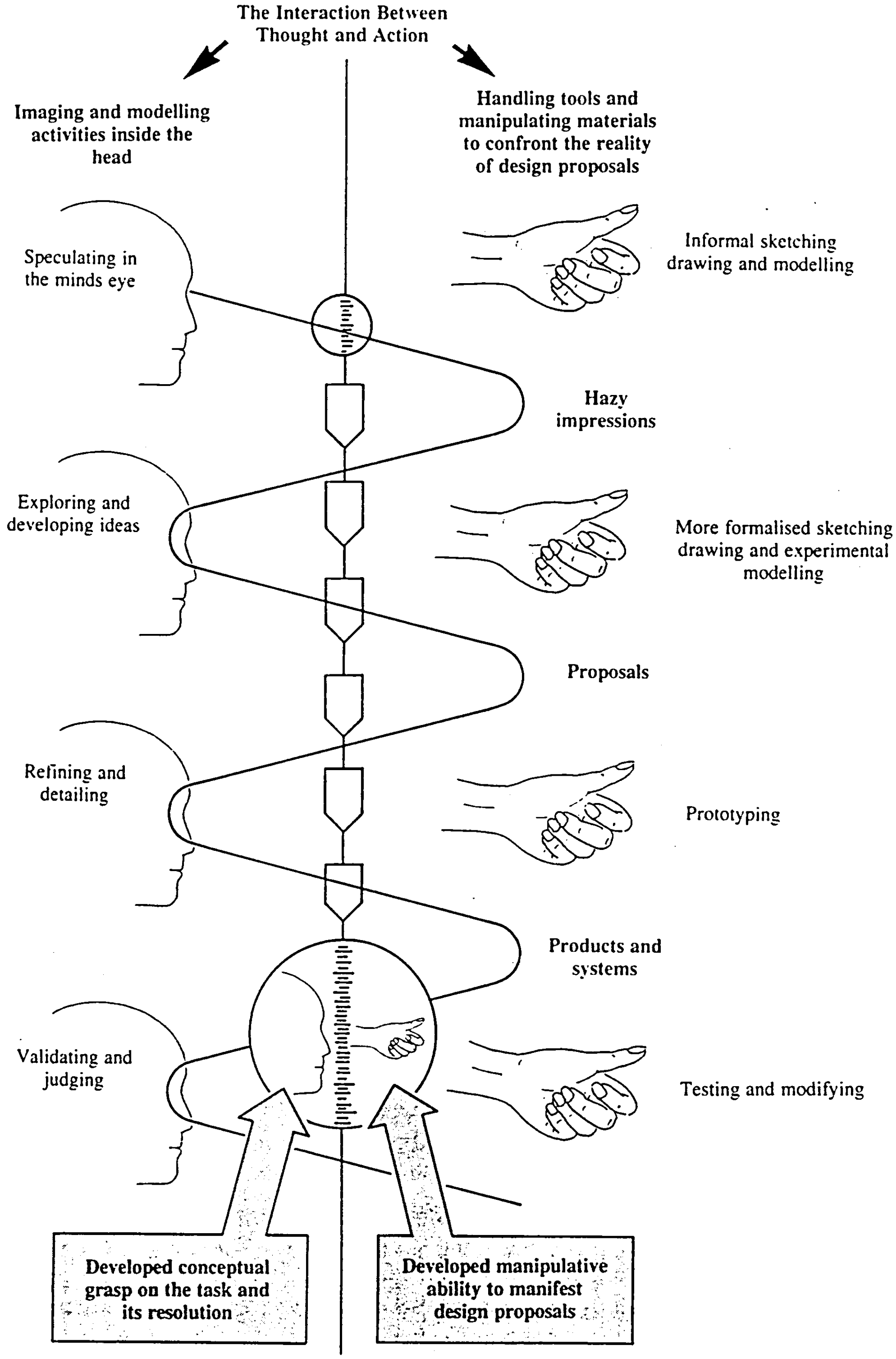
> "- undertaking research and compiling data on the problem or situation and the factors affecting it;
>
> - analysing the information gained."

While there has been a considerable amount of discussion and a great deal of information published about the design activity, only certain elements have been detailed in the form of content or teaching methods which may be used. Threlfall (1985) makes a brief reference to resources and knowledge when he suggested designing should be within a framework which includes "searching for and the ordering of information". He went on to say that students should be able to make appropriate use of communication skills, including "information technology".

A more recent model describing the process of designing was produced by the APU (1987). The diagram shown in Figure 1.8 illustrates the relationship between the intellectual activity and the manipulative ability required, through each stage of the design process. Although there was linearity, the model showed that intellectual activity was required at every stage of the process, including the "prototyping" when a design idea is actually realised.

Figure 1.8

The APU model of the "design process"



In the author's view the research activity, which is identified in many documents as being vital to the design process, is not particularly evident in schools. There are two areas of concern:

(a) the teacher's ability to teach the necessary research skills;

(b) the lack of resources for pupils to carry out meaningful research.

The author formed this view after working as an Examiner for the 16+ Design and Craft feasibility study, mentioned previously, and as the Chief Examiner for a Design and Technology "O" level examination for seven years. Both these examinations had a 50% coursework content and, therefore, pupils had ample opportunity to research their projects thoroughly. The research in the majority of pupils' coursework folios seen consisted of pictures cut out of magazines. Some pupils added comments which were usually superficial. Because the examination syllabus used a linear design process model, the research often consisted of one piece of paper in a folio with little evidence of continuous research as the project progressed. The use of research in the "making" or "refining ideas" shown in Figure 1.7 was not evident.

An analysis of six Design and Technology GCSE examination syllabuses (1989) shows that they all include references to the research component of the design process, but did not give examples of what could be done under this element. In each, the statement about research is virtually that included in the 16+ National Criteria for Craft, Design and Technology. The Northern Examining Association (NEA) CDT (Technology) Syllabus B (1989) has the most informative statement:

> "**Research** - The gathering and ordering of information which will stimulate ideas for possible solutions to the problems identified by the analysis. The information should come from a variety of sources and technologies and include practical experimentation where relevant."

The parallel NEA CDT (Design and Communication) (1989) has the following similar statement:

> "Research (the gathering and ordering of information)
> This concerns the candidate's ability to consult sources of technical information to obtain data upon which design solutions can be based; and the ability to recognise the need for such information whether or not it is provided. The candidate, as a designer, must accept responsibility for acquiring the necessary information."

These statements are made under the heading "Subject Content" which deals with the design skills in the minimum of space but specifies subject related skills in great detail. In the NEA CDT (Technology) Syllabus B, the syllabus includes one page dealing with design skills and ten pages of subject information, with helpful notes about teaching methods. The following illustrates the level of detail:

"Pneumatics

Component	Expected Knowledge/ Understanding	Possible Learning Experiences
Energy	Compressed air as a form of potential energy.	Use footpump to inflate car tyre or other pneumatic reservoir. Sense heat energy produced mechanical energy input. Use inflated tyre to operate a pneumatic cylinder."

As the design process features as a "Common Core Skill" in all GCSE CDT examinations, it was surprising that there were no detailed suggestions about the form or learning experiences the research could take. These could have been included to help teachers provide the resources to enable pupils to cover this aspect of their work more thoroughly.

6. **Project Work in Design and Technology**

The importance of practical project activity involving pupils in the design, make and test process, has been highlighted above. To get the maximum benefit from the time given to this activity, information to assist in the development and implementation of pupils' ideas is essential and, therefore, should be readily available. When the traditional material-based subjects of woodwork and metalwork were pursued, the effective management of project time was simple. Pupils were able to progress through a realisation project, devised by the teacher, who was able to give regular teaching inputs to ensure the whole group of pupils proceeded in an almost linear path through the work. This method of craft teaching could not be a feature of the new design and technology schemes of work as the educational benefits were limited, giving little credibility to the discipline. Genuine design and technology activity in schools encourages diversification in the way pupils apply their knowledge or skills to a particular problem. Teaching inputs on design method, technology, aesthetics, graphics and realisation skills in a well planned scheme of work should equip pupils with the ability to tackle project work. This requires a different style of teaching method. Hicks (1981), staff HMI for design and technology, expressed the view that:

> "Teaching facts is one thing; teaching pupils in such a way that they can apply facts, is another, but providing learning opportunities which encourage pupils to use information naturally, when handling uncertainty, in a manner which results in capability, is a challenge of a different kind."

Pupils must be taught to apply their past knowledge as well as seek out new knowledge, when required. The open-ended nature of the work inevitably means the teaching inputs must be on a more individual pupil/teacher basis. From the author's experience pupils are capable of great diversity of thought when working on projects, and often this can lead to situations where a pupil's solution to a design brief is in advance of the knowledge and realisation skills he or she possesses. In this situation, pupils require help and advice. There has been considerable development in both the content and methods of delivery for design and technology courses, particularly during the period when GCSE examinations were being formulated. This development has been supported by the availability of teaching materials in the form of text books, video tapes, new materials for projects, technological hardware and computer software.

7. Aims of the Study

The models used to describe the process of designing all feature "making" as an important aspect of design and technology and, as mentioned previously (page 29), the "research" activity should be supporting pupils' practical activity in design and technology workshops. The traditional craft teaching style encouraged pupils to rely almost exclusively on the teacher's help whenever decisions had to be made or problems solved.

As the discipline changed from materials-based crafts to design and technology, pupils needed to search out information for themselves. The author's impression from teaching in schools was that pupils began to ask for more individual help and a major part of the teacher's role became one of answering questions covering a much broader range of design and technology activity. Although the discipline was changing, pupils still tended to regard the teacher as the primary source of information.

An attempt was made by the author in his school to change this situation by providing an information resource to which pupils could refer. This was in the form of text books and printed information sheets stored as a workshop library. Although this provided an alternative to asking the teacher for help, pupils found that searching for information was time consuming and also on many occasions the information obtained was incorrect. Many pupils still showed a reluctance to search for themselves and preferred to wait for the teacher's assistance, even though this meant a delay.

During the period reviewed in this chapter, significant developments in educational technology took place, particularly in microcomputer applications. Many design and technology teachers adopted microcomputers for a variety of uses including computer control, Computer Aided Learning (CAL), Computer Aided Design (CAD), Computer Aided Manufacturer (CAM) and graphics. Furthermore, the microcomputer with its ability to store and retrieve large amounts of information appeared to be an attractive way of providing an information resource for use by pupils.

The present feasibility study was prompted by what appeared to be a need to provide pupils with a resource of design and technology information which they could use during their design and technology project work. By making routine factual information readily accessible by using a microcomputer, it was hoped that pupils would be able to progress more quickly with their project work, and enable teachers to spend more time with individual pupils working on other areas of the design and technology activity such as generating and refining ideas.

Regular visits by the author to a large number of schools over a three-year period strengthened the impression that pupils engaged in design and technology projects had difficulty in getting the help required for them to proceed. The impression gained was that pupils rarely had any information resource available to them, and teachers were having difficulty coping with the number of questions being posed by pupils anxious to get on with their work.

The purpose of this feasibility study was therefore to:

* investigate the methods used by pupils in school design and technology project work and to gather information on the way pupils select components, materials and appropriate processes of manufacture before and during the realisation of a proposed solution to a design problem;

* observe how teachers manage design and technology practical sessions regarding the correct use of components, materials, tools and equipment;

* evaluate the information obtained with regard to the ease with which pupils proceed with the design development stage to realisation of a solution to a design problem;

* use the information gathered to develop a microcomputer database which can be used to supplement and so enhance, the teaching of of project work in school design and technology;

* trial in schools the microcomputer database produced;

* draw tentative conclusions about the usefulness of the microcomputer database when used during design and technology project work and make suggestions about further development.

Chapter 2

USE OF MICROCOMPUTERS IN DESIGN AND TECHNOLOGY

Summary

After reviewing the published statistics about the use of microcomputers in schools, the influence of several major initiatives is assessed. Examples of microcomputer use in design and technology are given, showing the range of applications which have been developed and how they are integrated into project work.

The previous chapter outlined the rapid developments which took place in design and technology education during the 1980s. During the same period, the use of microcomputers as a new teaching resource developed very quickly. Teachers in every discipline in the curriculum considered the application of microcomputers, but this new form of educational technology was significantly different from previous developments. Slide/tape presentations and videos, for example, were usually set up and used by teachers under their control. Similarly, language laboratories required teachers to operate the system. The microcomputer, however, could be wholly under the control of individual pupils. Couple this with its versatility and range of uses, and it can be considered the most significant item of educational technology yet produced.

1. The Extent of Microcomputer Use in Schools

The implementation of new technology in schools became a regular topic for discussion and comment by politicians in the 1980s, especially the use of microcomputers. In fact, throughout this decade several Government initiatives were taken to encourage computer education and Information Technology (IT) to develop in schools. Irvine Smith and Campbell (1981) in their review of the development of Information Technology, reproduced the text of an article from "The Guardian" (31 December 1980), in which Kenneth Baker MP forecast that "within a year or 18 months, every secondary school should have a microcomputer." At the time, he was the chairman of, and industrial consultant for, the Computer Agency Council. The Department of Trade and Industry (DTI) encouraged the development of microcomputer use in schools by a variety of schemes, notably the pound-for-pound scheme, which enabled schools to buy microcomputer hardware at half price, the DTI paying the other half. Wellington and Macdonald (1989) reported that £16m had been provided by the DTI for this scheme.

They commented that:

> "The scale of investment in the microcomputer during the Eighties has been on a level which no other item of educational technology has ever equalled or is ever likely to match."

By Autumn 1985 there were on average 13.4 microcomputers per secondary school (DES 1986), giving an average of one microcomputer to 60 pupils. According to a recent survey published by "The Times Education Supplement" (17 March 1989), this ratio improved from 39:1 in 1987 to 28:1 in 1988. The survey went on to say that even this figure fell short of the 10:1 ratio often regarded as ideal, and only 7 per cent of schools in the survey had achieved that target.

Many TVEI schools have, since 1983, improved their microcomputing facilities. Wellington and Macdonald indicated that some TVEI schools had as many as 50 or 60 micros and that on average they had twice as many microcomputers as non-TVEI schools.

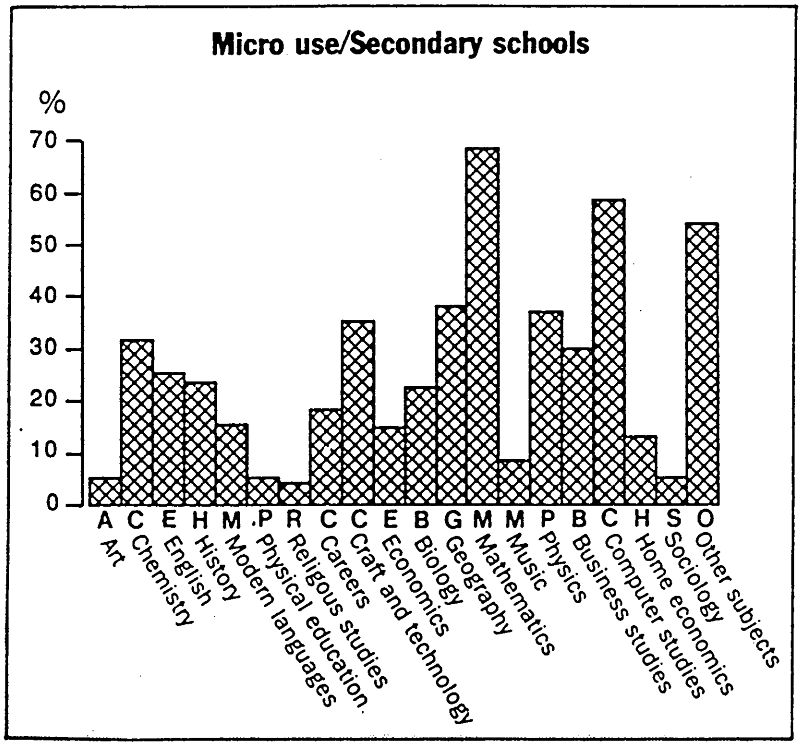
The implementation of microcomputer use in secondary schools has not been without problems. The author experienced difficulties in the early 1980s when working in a comprehensive school, where the computer provision was confined to one room, so giving limited access for both staff and pupils. Mead (1983) identified a similar problem when working as a Microelectronics Education Programme (MEP) co-ordinator. He made the following comments when describing the difficulties of implementing this new technology in the school curriculum:

> "Further complication is introduced in the shape of the Maths department, who are usually assigned as keepers of the computers, so the attempts by either CDT or Science to use them is forestalled by screwing down the machinery, gluing on the lids and issuing of a firm dictat that under no circumstances is anything resembling an interface to be plugged in, lest the valuable machine be driven mad to the extent that it can no longer do sums."

Despite such difficulties, many enlightened design and technology teachers incorporated the use of microcomputers into their teaching. Meakin (1987) when commenting on the DES Statistical Bulletin, "Results of the Survey of Microcomputers etc in Schools" (Autumn 1985), produced the bar chart shown in Figure 2.1. This demonstrates the extent of microcomputer use by each discipline in secondary schools. The chart shows that 36 per cent of design and technology departments were using microcomputers, which is similar to the 37 per cent of physics departments and 32 per cent for chemistry.

Figure 2.1

The extent of computer use in
the various departments of secondary schools.



Meakin (1987)

2 Microelectronics Education Programme (MEP)

As discussed in the previous section, the DTI gave considerable financial support to schools for the purchase of microcomputer hardware. The DES also provided support in the form of in-service education for teachers, to enable them to incorporate the use of microcomputers into their teaching. The Microelectronics Education Programme (MEP) and now its successor, the Microelectronics Education Support Unit (MESU), have been particularly active in this work.

MEP was financed by the DES and administered by the Council for Educational Technology (CET). The organisation was on a regional basis and the areas of activity were divided into "domains". The Electronics and Control Domain was of particular significance to the design and technology teacher. When describing this domain, the MEP Information File (1983) stated:

> "Electronics also appears as a single subject at all levels of the examined curriculum and is included as part of many syllabuses, such as Control Technology, Craft, Design and Technology, Engineering Science, Physics, Computer Studies."

It is interesting that in the Electronics and Control Technology Domain in the MEP Northern Region the Steering Committee was largely composed of CDT Advisers and this resulted in an intensive INSET programme to introduce technology courses, including the use of microcomputers, into the schools of the region. This INSET programme had a specific course dedicated to computer control. The MEP Information File (1983), described the course in the following way:

> "This course is to introduce the elements of the BASIC language and will allow teachers to produce their own programs, while also giving some appreciation of the applications of the computer to control situations. This area of effort is seen as essential as the use of microcomputers in CDT is likely to become more common in the near future."

It was clear, therefore, that the microcomputer had a place in design and technology teaching and this was recognised by MEP and the LEA CDT advisory service.

3. The Computer Enhanced Design and Realisation (CEDAR) Project

The Computer Enhanced Design and Realisation (CEDAR) project was jointly funded by the DTI and the University of Cambridge Local Examinations Syndicate from September 1985 to September 1987. The original project title was "CAD/CAM in Secondary Schools", but this was changed because of the strong engineering bias and the need to look at the use of microcomputers in a wider context. The project involved a number of Local Authority Design and Technology Advisers in discussions concerning the implementation of microcomputer uses in the subject, followed by a questionnaire circulated to schools to assess the extent of computer use in design and technology. Table 2.1 shows the results of a question asking staff in schools the extent of computer draughting, computer graphics and Computer Numerical Control (CNC) machining expertise. 107 questionnaires were sent out and the table below represents the data from 37 returns.

Table 2.1

The extent of expertise in computer draughting, computer graphics and Computer Numerical Control (CNC) in secondary schools.

Computer draughting expertise							
None	3	Little	11	Some	19	Lot	4
CNC expertise							
None	6	Little	13	Some	17	Lot	1

Based on a table by Powell (1986)

At first sight, the results look healthy regarding the use of microcomputers. For example, the research shows that 62 percent of the teachers responding to the questionnaire were using computer draughting some or a lot of the time and 48 per cent were using CNC machines. This indicates far greater usage than that suggested by the DES (1986) which reported that only 36 percent of CDT teachers made use of microcomputers. However, the CEDAR questionnaire was confined to a small number of schools nominated by LEAs, so it is highly likely that the nominated schools would have a higher proportion of use in design and technology than a random selection of schools. Powell (1986) at about the same time made some critical comments about the level and methods of implementation being used in schools. He based his information on reports from the LEA's Advisory Service and visits to a number of schools which had been nominated as wishing to be involved in some aspect of Computer Aided Design (CAD). For example, he reported:

> "At no time during the research period was any element of design, other than draughting or CNC (Computer Numerical Control) mentioned. All attempts at implementation revolved around creating and storing an orthographic set of views of an object."

Very little comment appeared in the CEDAR research report (1986) which contained the data collected by the questionnaire. The emphasis of the findings centred on the fact that very few design and technology teachers were using microcomputers effectively in their teaching because:

* the equipment and software had been adapted for school use, but was based on industrial practice; therefore, pupils were spending time learning to operate the system, rather than use it creatively;
* the design and technology teachers lacked the expertise to use computers effectively in their teaching.

Powell (1986) reinforced these points by giving the following example of his experience when visiting a school:

> "One head of department in Burnley admitted that his CNC machine was usually covered up, because he did not feel it had any sound educational value. Many teachers fail to admit this, and embark on a course centred around skills based on Computer Aided Engineering. This is contrary to the aims of Design education, of encouraging creation and realisation of solutions to self determined problems."

The CEDAR project identified many difficulties associated with the use of microcomputers in design and technology, but in the author's view, failed to identify and give credit to, commendable work which was going on at the time. Nor did they suggest ways that this work could be built on and disseminated throughout the country. The report did recommend the establishment of a centre to promote development, but then tended to suggest ideas which were, in the author's view, rather remote from the reality of the school teaching situation. For example, the report suggested the writing of a whole suite of software using hardware rarely found in schools. A more realistic approach may have been to suggest greater liaison with companies selling in the education market and influence them to develop the appropriate hardware and software using their company resources. Co-ordinating this type of activity could have resulted in more rapid development of both hardware and software. The CEDAR project failed to attract funding for its continuation.

4. The use of Microcomputers in Design and Technology

4.1 Computer Control

As mentioned earlier in section 2, computer control was one use of the microcomputer which has been developed by Government agencies and has been incorporated into design and technology teaching. However, MEP publications and courses have not been the only sources of support for this type of activity; several of the monthly electronics and computing magazines have included articles which have been used by teachers in developing understanding and expertise. Adams and Feather (1983-1984), for example, produced a series of articles in "Everyday Electronics and Computer Projects" which were particularly useful to design and technology teachers. Each article was accompanied by interface circuit diagrams and notes on how to use the equipment and write appropriate program code in BASIC. The printed circuit boards for constructing the interface hardware were readily available, making it easy for teachers to develop the necessary understanding. A similar series of articles was published in "The Micro User" and supported by kits of electronic components for the hardware.

By the time MEP was discontinued, its contribution to computer control was impressive. The "Sunderland file: Interfacing the BBC Microcomputer" (1985) and "The Book" (1985) have been extremely useful resources for both pupils and teachers. The information was detailed, the published hardware circuits worked well and construction was straight-forward.

Design and technology teachers with a strong technological bias have been able to develop programming skills, particularly for control applications. Sparkes (1986) suggested that it has been customary to assume that mathematics teachers were best equipped to do this. However, Sparkes suggested:

> "It would be much better if programming were taught by someone who has real problems to solve - for example, technologists and chemists trying to take measurements in a laboratory. I would also argue for an emphasis upon the electronics of computers - bits, bytes, NAND gates and microprocessors - not just to know about them, but to use them to make something useful.
>
> There can be little doubt that most Physics teachers and some CDT teachers are happiest in this realm."

To enable pupils to write control programs, MEP produced "MEP Control Basic". Control programs can be written in BASIC, but they tend to be rather complicated, particularly for the 11 to 14 age phase pupils. Control BASIC was developed so pupils could use very simple commands such as:

```
MAKE 3, OUT              (sets line 3 of the user
                          port as an output)
```

The BBC BASIC equivalent of the above command would be:

```
?&FE62=?&FE62 OR 8       (sets line 3 of the user
                          port as an output)
```

The lines of the user port of a microcomputer are numbered 0 to 7, therefore line 3 is actually the fourth line with a decimal value of 8, when programming.

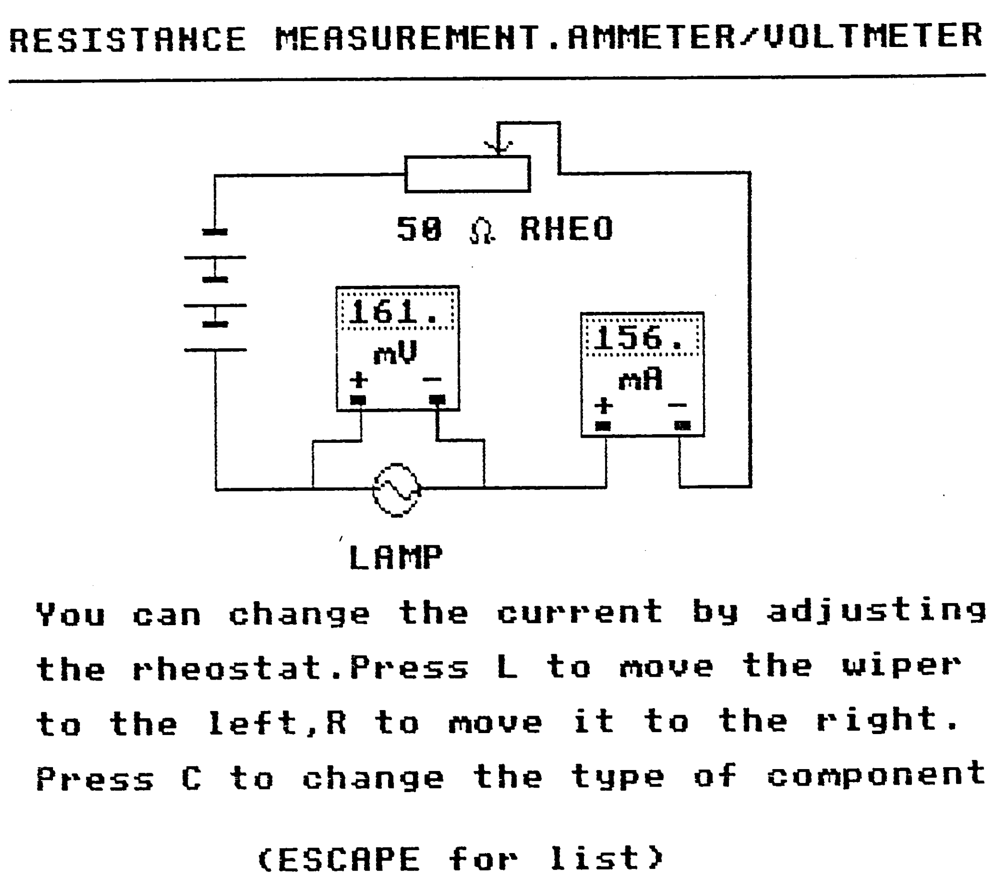
Particularly successful examples of computer control work can be found in the technology work done by pupils following GCSE Design and Technology examination syllabuses, but using the facilities provided by the Bedfordshire LEA technology buses instead of the usual school facilities. These buses have been equipped with an extensive range of technology teaching equipment, including microcomputers complete with interfaces for control applications. By providing a mobile technology facility, Bedfordshire LEA has been able to provide technological equipment and teaching expertise on a wide scale throughout the county.

4.2 **Computer Aided Learning (CAL)**

Computer aided learning for design and technology, has been confined to the technological aspects of the work, very often using software developed for science teaching. Electronics teaching lends itself particularly well to CAL. The author has found the MEgaCyCAL series of software particularly useful for teaching basic electrical, electronic and microelectronic theory. The software uses animated diagrams to describe particular topics. Revision questions are used to reinforce the learning and self tests can be used for pupils to assess their progress. Figure 2.2 shows an explanation screen from "DC", a CAL package in the MEgaCyCAL series, dealing with some of the elementary principles of current electricity. Options available to the pupil when using this screen include such exercises as: changing the lamp for a different component, for example, a fixed resistor; and adjusting the current flow by altering the rheostat. The readings on the two instruments measuring the current flow and the voltage drop across the lamp are updated when changes are made to the rheostat, so showing the relationship between current and voltage.

Figure 2.2

Teaching screen from "DC", a CAL program in the MEgaCyCAL series

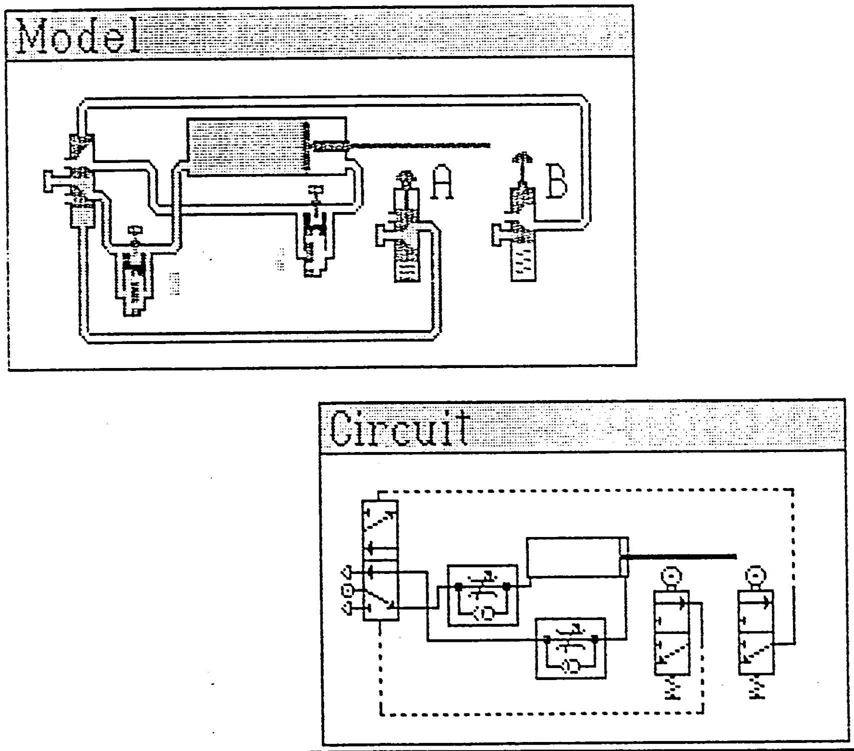


One of the most effective examples of CAL software for design and technology has been the BBC's "Technology and Design". The CAL software was designed as part of a more comprehensive learning system comprising radio broadcasts, television programmes, a slide pack and Computer Synchronised Audio (CSA). CSA is a method of linking an audio tape with what goes on in a microcomputer program in a way that one may be used to enhance the other. The system requires a cassette tape player, which is used in conjunction with the microcomputer. There are no interconnections, the tape player and the microcomputer software being entirely under the control of the pupil.

In addition, the package provides copyright-free pages of information to be used as back-up notes. The programs cover structures, gearing and linkages, motors, pneumatics and electronic systems. The software makes use of animated sequences to illustrate how various parts of a system work. For example, the pneumatics section has diagrams of the various valves and cylinders which can be made to operate using animation techniques, brought into action by inputs from the computer keyboard. The program guides the user through a series of stages showing how systems can be assembled and operated. Figure 2.3 shows a sample screen from the software, showing how a pneumatic system can be constructed for opening and closing a door. The diagram marked "Model" shows the operation of the system when keys <A> or <B> on the computer keyboard are used to simulate the operation of valves "A" or "B" of the animation. As the system goes through its cycle, the changes are also shown on the theoretical diagram marked "Circuit".

Figure 2.3

Example screen from the pneumatics section of the CAL software "Technology and Design"



Similar methods have been used in the most fascinating part of the program, the electronic systems. A theatrical scenario of a haunted stage is used, the student being given the task of designing a system to control the various effects such as the lights and a trap-door. When reviewing the package, Drange and Evans (1988) commented:

> ""Technology and Design" is one of the most ambitious and comprehensive sets of materials to cover the teaching of design skills across a broad range of ages. Its strength lies in its modularity, its use of several media and its inventiveness, which makes it a lively, interesting and entertaining tool, for both pupil and teacher alike."

The author has discussed the use of this example of software with the Advisory Teacher responsible for an Upper-School Bedfordshire technology bus, where it has been in use since publication. His view was that the system used readily available equipment very effectively, the success being due to the way the software and tape commentary have been integrated together by careful use of audio and visual prompts. He also pointed out that the teaching method adopted in the pneumatics section of the software was for pupils to assemble the various valves and cylinders from pneumatics teaching kits into the systems shown on the screen, and connect them to a compressed air supply. In this way they were able to see a system in action as well as the simulation.

A second package of "Technology and Design" used the same CSA system. Three separate topics were covered, the first dealing with the design of bus timetable systems, the second, the use of technology in an adventure game and the third, a packaging problem. Flanagan (1989), when reviewing the software, said it was suitable for "upper school range, especially GCSE students taking design and technology courses". He went on to suggest that it was also suitable for use by pupils doing other courses of a more advanced nature, such as retail and management.

The CSA system has enabled CAL materials to be used in design and technology courses, with considerable success. Part of the success was due to the use of readily available, relatively cheap hardware found in schools, coupled with very carefully designed and expertly implemented software. Clearly, such teaching materials would benefit if technology such as interactive video were used, but this would require considerable investment in hardware and software development. The "Technology and Design" packages could be seen as paving the way for much more sophisticated systems in the future.

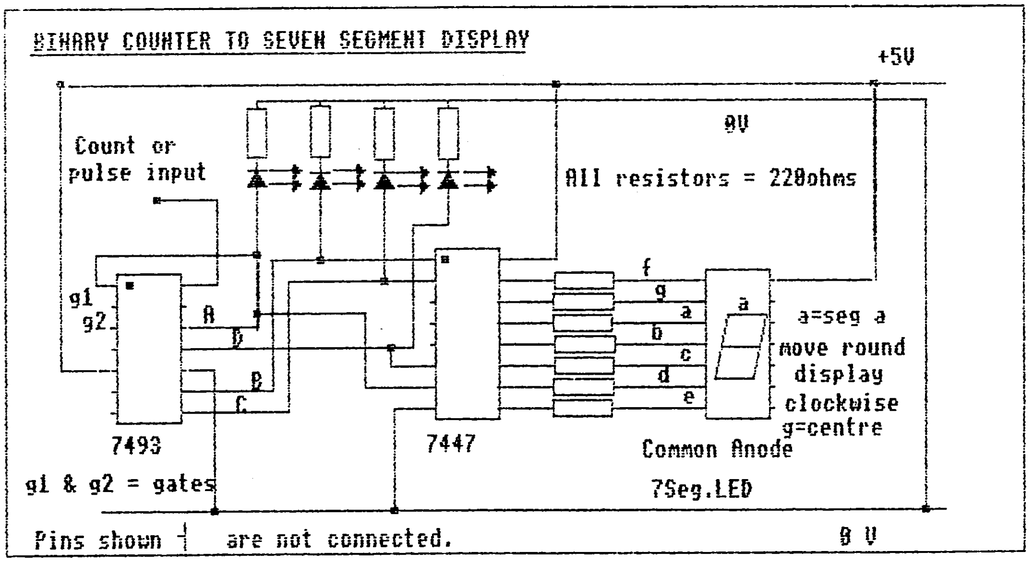
4.3 **Computer Graphics**

The versatility of the microcomputer allowed it to become an electronic drawing board or artist's canvas, but this has led to confusion in defining the various titles which have been used to describe these activities, particularly in schools. Computer graphics can be used to describe the activity of representing three dimensional objects or diagrams on a visual display unit (VDU) screen, very often using the microcomputer's ability to readily modify or even animate the diagrams. Computer aided design (CAD), however, uses the processing power of the computer to help the user make decisions from the range of options the computer is able to present. These may be visual representations in sophisticated three dimensional form, or mathematical information, or both.

Many schools have invested in computer graphics software, which enables pupils to create a picture on the VDU screen. A graphics software package named AMX Super Art, was developed with a particularly user-friendly format. It has, therefore, been used extensively in design and technology for creating pictures as part of project work. The AMX software included a set of electronics symbols, which many teachers have used to illustrate circuit diagrams on project sheets. User-friendly electronic draughting software has become common and well used in the schools. Figure 2.4 shows an example produced using DCIRC+, an electronic draughting package produced by the author, who has noted an increase in the use of circuit diagrams produced in this, or similar ways, submitted in pupils' design and technology examination folios.

Figure 2.4

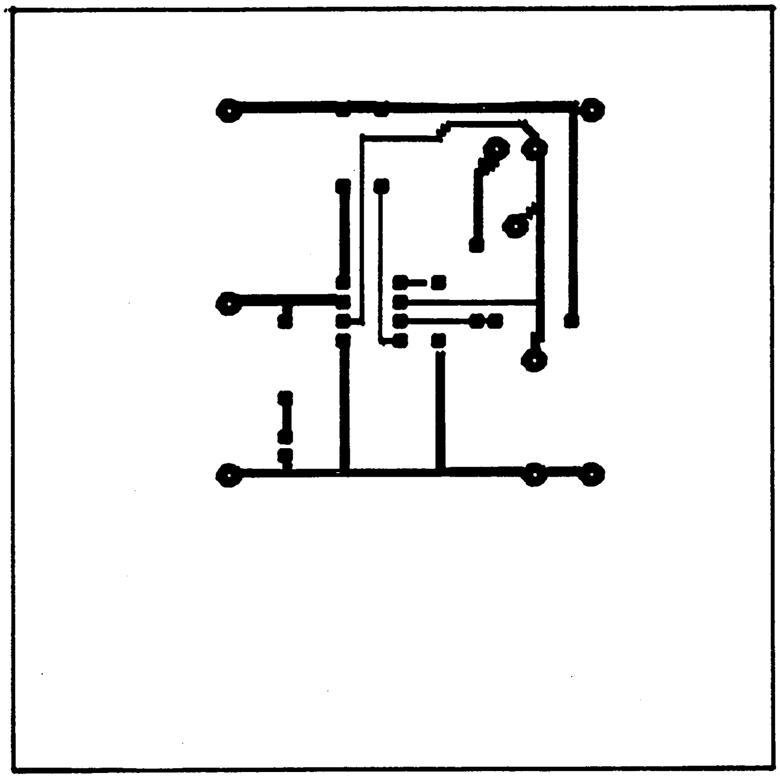
Circuit diagram produced using DCIRC+ electronic circuit draughting software



Another example of the microcomputer being used as a draughting tool in design and technology is the generation of printed circuit board (PCB) layouts used in electronic project work. Pineapple Software's PCB was developed with a particularly user-friendly operating system. The usual way of laying out PCBs has been to rub down pad and track transfers onto tracing paper, which was time consuming and often inaccurate. The Bedfordshire Design and Technology Advisory Teacher mentioned previously, considered the Pineapple PCB software to be an essential part of any school's technological resources as it enabled pupils to produce high quality work quickly and accurately. An example printout of circuit layout produced by Pineapple PCB is shown in Figure 2.5.

Figure 2.5

Printed Circuit Board layout, generated by
Pineapple PCB software



4.4 **Computer Aided Design (CAD), Computer Aided Manufacture (CAM) and Computer Numerical Control (CNC)**

These aspects of computer use in school design and technology have been the most controversial.

Powell (1986) commented:

> "A major fear expressed during the research was that the children might lose the opportunity to create an artefact. The problem is retaining the satisfaction, while ensuring educationally valid activities. It is not felt that the use of draughting and CNC in the way it is currently used allows this to be achieved."

Many TVEI schools, in the rush to spend the money available to them, invested in equipment before the applications had been considered in an educational context. This may be a case of the technology becoming available before the teachers and pupils were ready to use it. The result has been that in some schools design and technology has become "equipment" or "hardware" led. The worry has been that the approach used by some teachers to such new technological equipment is similar to the traditional craftwork discussed in the previous chapter, that is, the prime objective was learning to use the equipment only. The difficulty in using CNC equipment has been one of writing complicated program code to operate the machines. The result has been that pupils have spent much of their time attempting to program the machine, rather than use it to help them realise the artefact they have designed.

Powell (1986) gave the following example to illustrate this point:

> "In one school, female pupils were given the task of designing a badge and making it on a CNC mill, using G-code programming. At no time were they encouraged to consider the most important aspect of a badge, that it should be visually distinctive. There was no use of lamination, or filling the cavities created with pigmented resin. The task was simply one of part programming. This does not provide any aesthetic training, transferable skills, or insight into the industrial process."

It would appear that time and thought need to be given to the integration of new technology into schemes of work. Some design and technology teachers have not been able to do this. There are schools, however, where this type of equipment has been put to sound educational use by imaginative design and technology teaching, with considerable success.

Rkaina and Hawkins (1989) gave the following example:

> "Cost conscious: At Stevenage Girl's School, Hertfordshire, pupils have designed and made vases out of a bar of perspex using a computer controlled lathe. Says Sorubi Pathmanabhan, 15 ...: "With CDT you're not only learning to think things out logically, but there's a lot of imagination and creativity which goes into the planning. The cost of the project is important: my vase cost between £4 & £5.""

Recently, there has been considerable improvement in educational CAD/CAM software to make it more useful as a tool to be used, rather than a system to be learned.

The British Thornton COMPAS system was designed and developed as an integrated suite of CAD software. It was the first system available to schools to operate in a similar way to the more sophisticated main frame computer CAD packages. The software allowed complex shapes to be drawn, extruded into three dimensional shapes, and edited. The system also allowed shapes to be viewed from different points. Frazer (1986) has used the system extensively and concluded that:

> "All microprocessor based systems are at the moment limited to what are generally referred to as "architectural" type forms. That is, they are largely made of flat planes and straight lines or simple cylindrical forms which occur in one plane at a time, and are often treated in fact as a large number of small, flat planes. It might be argued that this limitation at the CDT level is in fact a considerable advantage in that dealing with twisted and sculptured surfaces might be an unnecessary complication."

The author has used the COMPAS ADVANCED software and found it particularly difficult to operate and achieve any form of three-dimensional model which can be easily interpreted by children.

The problem seems to be that the wire frame drawings produced do not always give an indication of what a real object would look like, without the user exercising some imagination. In a sense, this defeats the object of using the system.

The major step forward with the COMPAS system was COMPAS CAM which uses elements of the COMPAS ADVANCED system to enable

G-codes to be produced for a CNC machine. This can enable a pupil to draw a shape on the VDU screen as a profile: the software then produces the G-codes ready for transfer directly into a CNC lathe's memory. The system eliminates the need for pupils to produce code for a machine. Figure 2.6 shows the representation of an object which was drawn as a profile on a VDU screen using COMPAS CAM: the software built up the three dimensional representation shown. Figure 2.7 shows the software producing the G-code in preparation for machining. The software actually simulates the action of a cutting tool, moving along the work; its path is shown as the series of dotted lines. The part program code is shown as a series of numbers below the drawing. These numbers are recorded on disk, ready for transfer to a CNC lathe which can then make the component.

It is this type of development which will put CAD/CAM work into a school design and technology context. The benefits are that the shape shown in Figure 2.6 would require considerable machining expertise, outside the scope of a pupil using a conventional machine, yet such a component could be made by a pupil using a CNC lathe. This provides the pupil with a greater degree of sophistication when producing solutions to design projects. In fact, such equipment provides a solution to a problem which design and technology teachers face regularly, that is, pupils designing components which they do not have the time or skills to realise. The CNC machine and CAD/CAM software become another tool, rather than a technology to be learned.

Figure 2.6

Three dimensional representation of a turned component drawn as a profile using COMPAS CAM

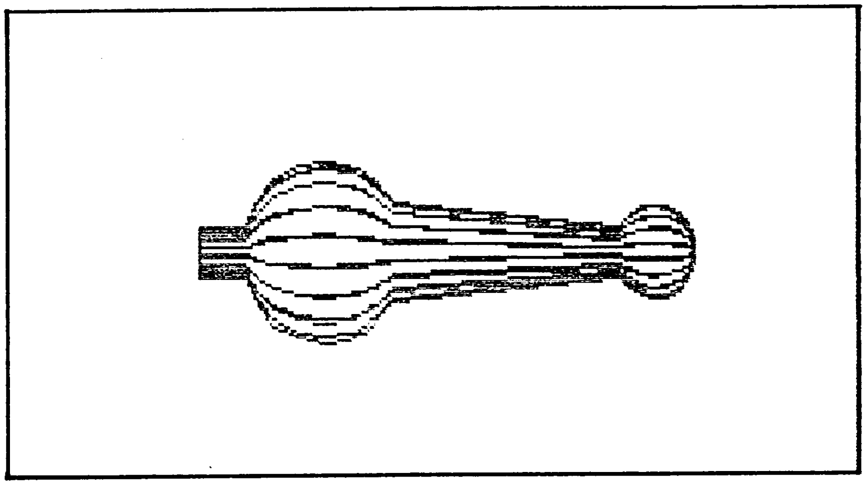
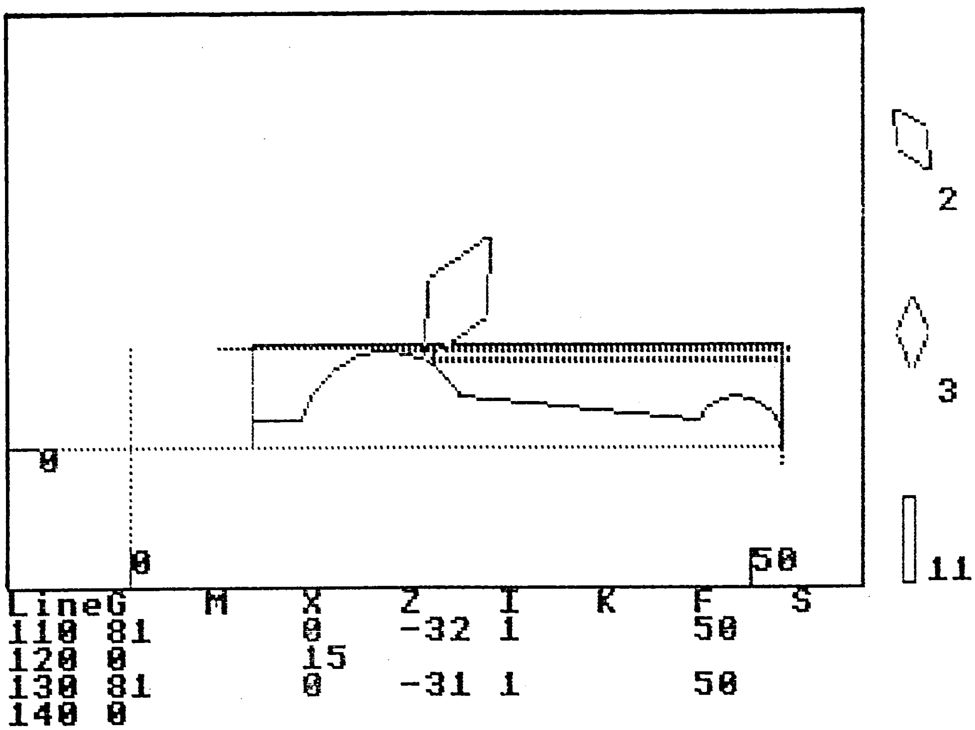


Figure 2.7

COMPAS CAM in the process of generating G-codes for machining the component shown in Fig. 2.6



Several other systems similar to COMPAS CAM, but giving a greater degree of flexibility, have become available, making it possible for design and technology teachers to integrate this type of work into their teaching without subjecting pupils to the drudgery of writing the code. It is becoming clear that design and technology teachers and pupils will become users of microcomputers in an increasing variety of roles as the software becomes more sophisticated and hardware more readily available.

Widespread use of microcomputers has major implications for methods of teaching and learning.

Chapter 3

PRELIMINARY INVESTIGATION

Summary

The two methods of assessing the difficulties pupils have in obtaining information when working on design and technology projects are described. The first is the development and use of an observation schedule and the second is the preparation of a list of questions used when interviewing pupils working on projects. Also included are details of a teacher questionnaire used to gather information on possible topics to be included in an information system. Finally, the results of these three forms of investigation are tabulated and analysed.

1. Background to the Research

The rapid development of design and technology in schools was prompted by several external factors, as discussed in Chapter 1. Although teachers were attempting to provide a genuine design and technology experience, particularly with the examination groups, visits to schools left the author with the impression that pupils were not progressing through their project work in a confident manner. Teachers were still encouraging pupils to use a linear design process to pursue open-ended project work. Progress towards the final realisation was, in many cases, slow. The author's experience of teaching design and technology in schools at a time when rapid development was taking place, seemed to indicate that open-ended project work leads to situations where pupils need more individual help.

Such help was identified as being related to three distinct aspects of the work:

(a) representation of a pupil's ideas in a design folio;

(b) the development of a solution to the design brief being tackled;

(c) provision of routine information about tools, processes, materials, machines and the use of technological equipment during the realisation part of a project.

The impression that pupils were demanding more teacher help was confirmed when visiting schools to supervise student teachers on teaching practice. Observing lessons rather than being part of them, gave the opportunity to see more precisely how pupils progressed with their work. It was clear that in many cases progress was haphazard and the pupils were wasting time waiting for the teacher to give out routine information to enable them to proceed.

Sykes (1987), an English teacher studying the use of language in technology teaching as a member of the St. William's Foundation Technology Education Project research team, noted the following:

> "Instead of reading books and worksheets, the pupils ask one another what to do, which can lead to prolonged periods of inactivity."

Wasted pupil time was not the only problem identified in design and technology project sessions. The workload on teachers was sometimes considerable as they faced a regular stream of questions which were often of a divergent nature. Sykes also commented:

> "However, further problems arise, relating to the pupils' response to projects. The pupils I observed tended to see their teacher as the sole source of information during project work, putting impossible demands on the teacher, and leading to uninvolvement on the part of the pupils waiting for his or her attention."

All the models used to describe the design process have included a section on "research" or "investigation" yet pupils did not appear to be able to carry out this activity in a confident way. As already pointed out in Chapter 1, this particular aspect of designing is an on-going process. Research must be done at the start of a project, but as work proceeds, further research may be necessary. This was made clear by the "GCSE A Guide for Teachers" in Figure 1.7 where the making process is joined by an arrow to the research heading. If, as Sykes pointed out, pupils were relying on the teacher for constant support in providing routine information, the teacher would not be able to provide as much help in developing project ideas or to assist with new areas of work.

The three aspects of work of help identified by the author for which help is needed as outlined in (a), (b) and (c) above were also identified by other researchers involved in the St William's Project. For example, Lord (1987) commented on the influence of graphics teaching on project work. He observed that CDT departments with a graphics teacher, or organised as part of a creative studies faculty with co-operation between art and CDT, had overcome some of the problems pupils had with representing their ideas.

Sykes (1987), however, noted pupils had difficulties during the early stages of project development work. He commented that pupils tended to "skate over the preparatory thinking and designing stages, showing a strong urge to begin making as soon as possible." Bolton (1987), another researcher in the Project team, highlighted the importance of pupils having a capability in the use of tools and equipment. He argued that these two aspects of design and technology were inseparable, and went on to say that technological competence is achieved by "developing understanding through the use of tools, instruments and apparatus" and this understanding should consist of both "knowing how and self expression".

The problems outlined in (a) above concerned with the effective teaching of graphic skills and the ability of pupils to transfer their ideas on to paper are rather different to those associated with obtaining information when developing or realising an idea. An extensive national study for the APU entitled "The Design and Technology Project" conducted by Goldsmiths College, underway at the time of writing, is concerned with aspects of how pupils develop design and technological capability. When this research is completed in August 1990, more should be known about the imaging and representation of ideas in design and technology.

It was therefore decided, for the purposes of this feasibility study, to limit the investigation to an examination of the difficulties which pupils had with the development of solutions to a design problem (b) and the realisation (c) aspects of their work.

2. **Aims of the Preliminary Investigation**

With reference to the purpose of the feasibility study (see page 36) the preliminary investigation was intended to check the author's impression that pupils required more help with their design and technology project work outlined in (b) and (c) in the previous section, and also to gather information which could be used in the production of the proposed database.

The aims of the preliminary investigation were therefore, to obtain information on:

(a) the methods used by pupils during their design and technology project work to acquire information, concerning the selection of components, materials, and appropriate processes of manufacture before and during the realisation phase of a project;

(b) the work load on the teacher when dealing with the questions about the selection and use of components, materials, tools and equipment during project sessions;

(c) the tools, equipment (including microcomputers), components and materials currently in use in design and technology;

(d) current workshop practices in design and technology.

The information gathered in response to aims (a) and (b) above was to be used to identify more clearly those areas of difficulty experienced by pupils and to examine how they overcame them.

Information obtained from (c) and (d) was required to ensure that the proposed database met with current design and technology practice in schools. After analysing all the information the objective was to produce a database as a supplementary source of help for use in school design and technology workshops. In the light of the discussion in Chapter 2, a microcomputer database was considered to be an appropriate way to provide help for pupils.

3. Investigation Strategy

The preliminary investigation was planned in three stages:

(a) observation of design and technology lessons;

(b) pupil interviews;

(c) a teacher questionnaire.

Observation seemed an appropriate strategy to obtain preliminary first-hand information on pupil and teacher behaviour in the workshop. Non-participant observation as outlined by Cohen and Manion (1985, i) using a structured observation schedule was considered an appropriate method. The purpose of the observation (a) was to gain an insight into the ways pupils were gathering information during their lessons, particularly the extent of their reliance on the teacher. Additionally, it was hoped to obtain greater knowledge of the areas of realisation activity where pupils needed most help.

The pupil interviews (b) were planned to follow the lesson observation and provide more detail of the help required by pupils. Powney and Watts (1987, i) suggested that interviews could follow initial field work, for example observation, to clarify particular details of a study. They also considered interviewing pupils, a most appropriate research tool for collecting data as "it requires no other ability on the part of the interviewee than to think and talk." They found answers to written tasks they had given to pupils could contain "interesting comments but they were clumsily or vaguely expressed, or only half articulated." As well as providing useful data, it was anticipated that the pupil interviews would provide a cross check on the data obtained during the observations.

Bell (1987, i) pointed out the need to ensure the "reliability and validity" of the methods used for collecting data. She pointed out that it was necessary to ensure that if another researcher were to use the same research instrument, the results obtained should be similar. Furthermore, if only one researcher was involved in a study over a period of time, it was essential to guard against possible changes in that person's perception of events. As the observation and interviews were planned to be conducted over a period of about one school term, it was essential that the research instruments to be used were designed and structured with care.

Both Bell (1987, ii) and Powney and Watts (1987, ii) commented on the dangers of the researcher's bias creeping into a study, particularly when using interview techniques. As the author was the sole researcher in the study, it was necessary to use at least two methods of collecting data to minimise the effects of bias. Cohen and Manion (1985, ii) referred to the use of at least two different methods of collecting data as a form of triangulation. One set of data can then confirm or clarify data collected in a different way. As pointed out by Burgess (1985), "triangulation is one of the most frequently cited tactics to ensure some cross reference between one research instrument and another in order to provide greater validity and reliability."

To ensure the proposed database contained up to date information about components, materials and processes available in school workshops a questionnaire (c) was distributed to a large number of schools. Bell (1987, iii) referred to these as surveys. She pointed out that "when all respondents are asked the same questions in, as far as possible, the same circumstances", useful answers to questions such as "What? Where? When and How?" can be obtained. In this case the questionnaire concentrated on asking for factual information (What? and How?), including the details of microcomputer provision in the schools. This was necessary in order to ensure that it would be possible to trial the database adequately when produced. Also, the questionnaire aimed to obtain information from teachers about current working practices in schools to ensure the proposed database reflected current health and safety regulations.

3.1 Observation of Design and Technology Lessons

The aim of observing lessons was to:

(a) study the way pupils obtained information in design and technology lessons, particularly from the teacher;

(b) assess the number of questions initiated by pupils which a design and technology teacher has to deal with in project lessons;

(c) obtain information about the areas of difficulty which prompted pupils to ask questions.

Following an initial period observing fourth and fifth year groups working on design and technology project work, the author concluded that the development of an observation schedule appeared to be an appropriate method to obtain numerical data about the number of pupil enquiries the teacher was dealing with during lessons.

Initial observation revealed that, broadly speaking, there were two sorts of question. Firstly, there were pupil-initiated questions, for example, "How can I join these two parts together?". Secondly, there were teacher-initiated questions, posed by the teacher during a discussion, for example, "Have you decided what material you are going to use?". The teacher-initiated questions were also part of a conversation generated by the pupils' enquiry. Three mid-career, experienced teachers were observed and each had different teaching methods. On some occasions, teachers turned a pupil request for help into a question and answer session with a view to encouraging the pupil to think around the problem for themselves. On other occasions a direct answer was given.

Following the initial observation, a schedule was devised with the types of question categorized. The intention was to obtain quantitative data about the questions being asked and at the same time identify the areas of activity pupils found most difficult. The observation schedule was designed to study pupils' own design and technology project work and not specific teaching or demonstrations given by the teacher.

The observation schedule devised (Appendix 1), used the following system of categorising the questions:

DESIGN	Questions dealing with the development of a design idea. Includes such aspects as presentation and folio organisation.
MATERIALS	Questions about the selection of materials and their working properties.
FABRICATING METHODS	Questions dealing with processes such as adhesives, joining processes using heat, project assembly.
HAND TOOLS Selection and correct use	Example questions are "Which saw do I use?" A teacher initiated question in this category is "Do you know how to use that saw?"
MACHINE TOOLS/ EQUIPMENT	Questions dealing with the setting up and correct use of machinery and equipment, eg "How do I fit the drill in the machine?" A second type of statement eg "I don't know how to use a multi-meter" was interpreted as a request for a demonstration.

FINISHING Selection, abrasives, correct use.	Questions about the correct selection of an appropriate finish and the preparation of materials using abrasives.
TECHNOLOGY Electronics, component selection and recognition, assembly, testing and fault finding.	Questions about electronics, regarding the practical aspects of designing and making circuits rather than the theory.

Two groups of pupils were selected from the same school (school 1) each working on a different aspect of design and technology activity. The school was an 11 to 18 age comprehensive school, housed in modern buildings in a suburb of Sheffield. The facilities for design and technology work were good and the staff had several years of teaching experience in that school. The school had developed design-based courses over a number of years and had participated in the 16+ Design and Craft feasibility study mentioned in Chapter 1. Technological courses were being developed, but at the time of the observation were in their infancy.

The two groups were:

> Group A - a fifth year group of thirteen boys and one girl working on their own pupil-generated design brief. Their projects were to be assessed as part of their "O" level coursework.
>
> Group B - a fourth year group of thirteen boys and six girls working on a teacher-set design brief with a technological content. The brief encouraged pupils to make individual responses.

A third group from a different school (school 2) was also observed. This school served a council housing estate. The pupils' design and technology experience had been limited to craft work, but a recent change of Head of Department had brought a new, more up-to-date approach to the work. This 11 to 16 comprehensive school was housed in 1950s buildings, with traditional woodwork, metalwork and technical drawing rooms. The Head of Department was trying to update the work in the department and had recently introduced technological courses.

This group was:

Group C - a third year group of fourteen pupils of which approximately half were girls working on a teacher-set design brief, with a strong element of technological teaching, delivered in a structured way.

The procedure adopted was to observe complete lessons and record the number and types of pupil- and teacher-initiated questions asked during the project part of the lesson. Questions which were part of a demonstration or other teaching input to the whole or part of the group were not recorded, as they were considered to be part of the teachers' input to the group.

3.2 **Pupil Interviews**

The aim of the pupil interviews was to gain further insight into the ways pupils obtain information before and during the realisation stage of projects. The interview schedule developed was centred on the design and realisation activity and targeted some practical activities by identifying points where decisions must be made. In addition, questions in the final part of the schedule were formulated to obtain pupils' ideas about the methods which could be adopted to enable them to obtain information and help more quickly.

The first draft schedule was modified in two stages to obtain the final schedule of twenty three questions (Appendix 3). The first stage of the development was to trial the initial draft with three fifth-year pupils. Following this it was necessary to modify the wording of the questions extensively to make them more precise.

For example question 1 was originally:

1. When do you select the materials for your project?

It was expected that pupils would state the stage in their projects. Instead pupils tried to remember the particular time when they chose materials, for example February, and not the stage in the design process.

The question was modified to:

1. When working on a project, at what stage do you select the materials?

Pupils answered this question in the manner expected, stating the appropriate stage of the design process.

Also it was found necessary to extend the interview schedule to include questions designed to collect data on how pupils made decisions. The questions used in the initial schedule produced many "yes/no" answers and did not encourage the pupils to give further information. The modifications were designed to enable interviewees to expand on these answers, giving further detail. For example, the first draft schedule had the following "closed" question:

7. Is there a range of glues available in the workshop for you to use?

The modified schedule used the same closed question with the addition of two other questions on the same topic to enable pupils to be more specific.

8. How do you choose a glue for a particular material, for example, wood?
9. What other ways do you use to join materials together?

The areas of questioning were designed and developed with reference to the data obtained from the workshop observations carried out previously, the results of which are shown in Table 3.2 (page 78). For example questions 1 to 4 of the interview schedule (Appendix 3) corresponded to "materials/working method" category of question shown in Table 3.2. Similarly questions 5 to 12 of the interview schedule were designed to clarify the "fabricating methods" category of question of the observation schedule. By designing the interview schedule in this way, an element of triangulation was introduced as mentioned in section 3 of this chapter (page 65).

Wragg (1978, i) stressed the importance of explaining the purpose of the interview to the interviewees. A standard introduction preamble (Appendix 2) was written to prepare pupils for the interview. This was regarded as important for the sake of consistency, and also as the interviewees were following examination courses, it was essential to allay any fears that the interview was a part of an examination.

The second stage of development was to include two final questions in the schedule to obtain pupils' ideas about the methods which could be adopted to enable them to obtain information and help more quickly (Appendix 3 questions 22 and 23).

Following these modifications the "improved" schedule (Appendix 3) was used with a further three pupils and found to provide more detail as expected. The pupils still gave "yes/no" answers to questions such as question 7, but were able to expand on their answer when asked questions 8 and 9.

The interviews were conducted in school 1 used for the observation and in school 3, not used previously. The intention was to include pupils for interview who had not been subject to observation or interviewed during the development of the schedule. School 1 could provide only one such group of pupils and school 2 were unable to provide enough pupils, therefore it was necessary to use a further school, school 3. This was a purpose built comprehensive school serving owner-occupied housing in a recently developed outer city suburb. Both schools 1 and 3 had sound reputations for using good design and technology teaching methods. Staff in both schools had considerable experience of teaching design and technology, using extensive open-ended project work.

Wragg (1978 ii) has pointed out the importance of carrying out interviews at a time and place close to the related event. The interviews, therefore, were carried out during pupils' design and technology lessons as they worked on their projects. This enabled pupils to refer to their present project work to illustrate their answers if necessary. All pupils interviewed were in years four and five following the same Northern Examining Association CDT: Design and Realisation GCSE course.

The method adopted was for the author to read the preamble (Appendix 2) and then ask each question in turn. For consistency, discussion of the answers with each pupil was kept to the minimum. A total of twenty nine pupils were interviewed using the final schedule, but poor tape-recordings because of background noise in the CDT workshops rendered two interviews unusable.

3.3 **Teacher Questionnaire**

The possible design and development of an information system for use by pupils in their design and technology project work required information which reflected current practice in schools. To date, many examples of software for use in design and technology schemes of work have been produced with little reference to the actual requirements of the pupils or to current practice. The author considered it essential to consult teachers about the content of an information system so that it reflected the requirements of pupils and teachers. As the intention was to gather information about materials, equipment and facilities, a descriptive survey using a questionnaire, as outlined by Ary, Cheser Jacobs and Razavieh (1985), was considered to be appropriate.

The information to be collected by the teacher questionnaire (Appendix 4) was categorised in the following way:

> Category A - the materials, equipment, tools and components currently in use in school design and technology.

Category B - the extent of computer provision in design and technology departments in the region.

Category C - working practices and methods being used by pupils with particular reference to the use of machinery.

The teacher questionnaire (Appendix 4) had the same format for categories A and B. This was to present lists of materials etc and ask the teachers to indicate if that item was available to fourth and fifth year pupils during their design and technology lessons. Teachers were also given the opportunity to add any further items they had available which were not on the list.

Questions in Category C (Appendix 4 questions 8a to 8i) were designed with "yes/no" answers. The section was used to collect two distinct types of information. Five questions, 8a to 8e, were used to obtain a numerical assessment of the availability of information displays and text books which could be used by pupils when working on practical projects. These questions were prompted by the result of the pupil interviews which indicated that pupils did not make much use of text books as a source of information during their project work (Table 3.4 page 94). Similarly, very few pupils referred to using charts or information sheets. The objective was to ascertain if books, charts and displays were indeed provided for pupils.

A further four questions, 8f to 8i, concentrated on the issues of setting up and using machinery. When designing these questions, attention was given to the results of question 14 (page 88) of the pupil interview schedule. The indication was that pupils were setting machines themselves before using them. However, the results of question 16 (page 89) clearly showed that in the schools used for the interviews, setting machine speeds was not usually done by the pupil. These answers left some doubt about what pupils were allowed to do in this respect, therefore questions 8f to 8i concentrated on the issues of setting up and using machinery. As pointed out previously, it was vital that information in the proposed database reflected current health and safety regulations.

Questionnaires (Appendix 4) with an accompanying letter (Appendix 5) were distributed to 104 comprehensive schools in the following Local Education Authorities - Derbyshire, Sheffield, Rotherham, Doncaster, Barnsley, Leeds and North Yorkshire. The schools were selected on a random basis.

4. Results and Conclusions of the Preliminary Investigation

4.1 Observation Results

The time spent observing pupils working and recording the questions asked was 19.3 hours. In that time a total of 521 questions were asked. (Table 3.1)

Table 3.1

Observation Results

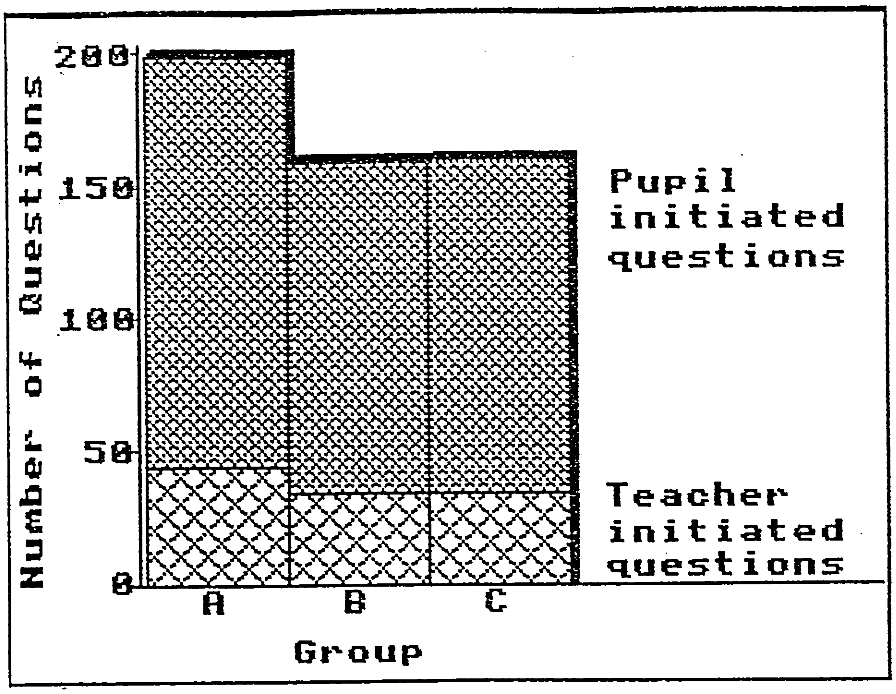
	Group A	Group B	Group C
Number of lessons observed	6	4	5
Number of pupils in group	14	19	14
Working time in hours	7	4	8.3
Number of teacher-initiated questions	45	35	35
Number of pupil-initiated questions	155	125	126
Total number of questions	200	160	161
Percentage of questions initiated by pupils	77.5%	78.1%	78.2%
Average questions per hour per pupil	1.6	1.6	1.1

Total number of teacher-initiated questions	115
Total number of pupil-initiated questions	406
Total number of questions	521

There was a consistency in the number of pupil-initiated questions to those initiated by the teacher in each of the three groups. Of every five questions asked, four were initiated by the pupil (Figure 3.1). This could be an indication that the pupils were uncertain in many areas of their project work. The teacher had to deal with, on average, 27 questions per hour, or one approximately every 2 minutes when working with an average group size of 15 pupils. This was a high rate of questioning and confirmed the author's view that there was considerable uncertainty when pupils were working on their project work.
Some questions could be dealt with in less time than others, for example, telling a pupil the size of a wood screw, but those requiring practical help and, perhaps, a demonstration took a long time to deal with. This represented a considerable work load on the teacher, bearing in mind the wide range of activity covered. Group A were fifth year pupils, working on projects derived from their own design briefs, and it is clear that this type of open-ended project generates the most problems requiring teacher help.

Figure 3.1

The relationship between questions initiated by pupils and those initiated by the teacher



The bar chart shown in Figure 3.2 showed that Group C, working on a structured technology project, did not generate the same number of pupil questions per hour as the other two groups. It is reasonable to assume, therefore, that the more teachers structure the work, the less pressure they have to face in the form of pupil enquiries.

Figure 3.2

The rate of questioning from different groups

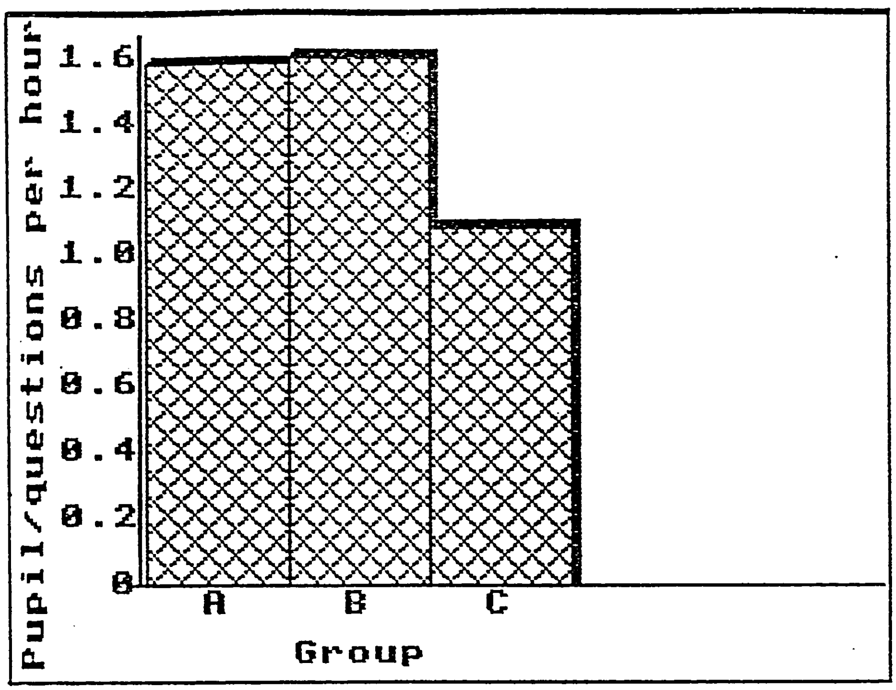


Table 3.2

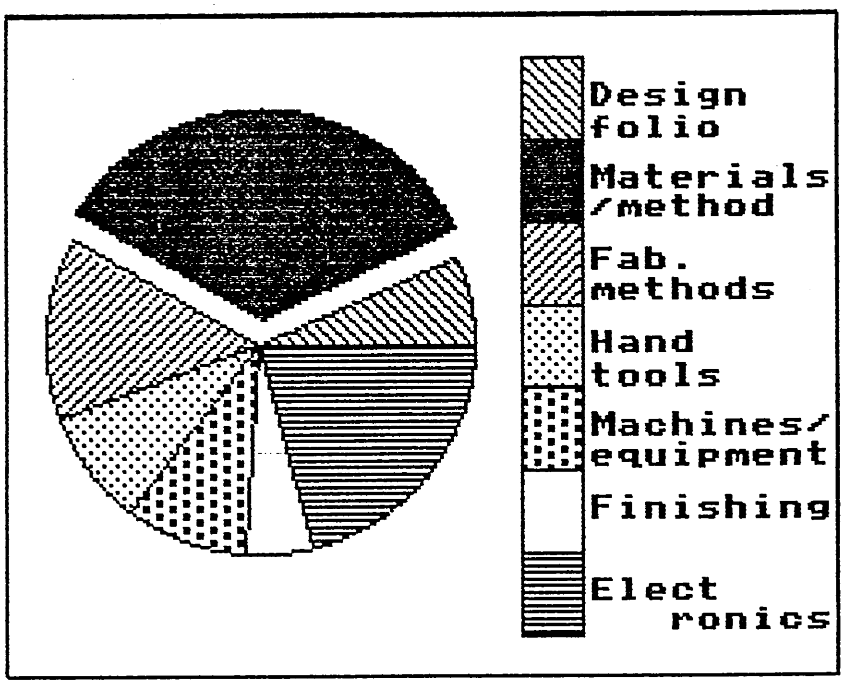
The distribution of question types for observation

Category of Question	Total	Percentage of total (pupil and teacher initiated)
Design folio	36	7
Materials/working methods	182	35
Hand tools	46	9
Fabricating methods	73	14
Machine tools/equipment	48	9
Finishing	26	5
Electronics	109	21
	Total	100%

The distribution of question types is shown in Table 3.2. The largest number of questions dealt with was in the materials/working method section, indicating there was considerable uncertainty in this area. Figure 3.3 shows that approximately one third of the questions were under this heading.

Figure 3.3

The number of questions asked under each of the headings on the observation schedule



It was apparent that these problems about materials and the way they are worked were being left by the pupils until the realisation had started, instead of being sorted out at the design stage. It seemed the pupils were relying on the teacher to solve problems as realisation progressed. Obviously this was going to happen to some extent, but if pupils had considered these problems at an earlier stage of the development of a solution to a problem, progress through a realisation would have been more rapid. It is possible that pupils were not given the opportunity to select materials and working methods when lower down the school, and therefore they were not prepared for this task in fourth and fifth year project work.

The use of hand tools and machine tools appeared to be giving the minimum of trouble. Perhaps this could be accounted for by the fact that pupils had received effective teaching in this area lower down the school. From both the teachers' and pupils' point of view, getting the balance of design and technology courses right lower down the school could have an effect on the way pupils tackle project work in the upper years. It seems that if this balance was correct teachers could find themselves spending more time helping pupils with design problems, rather than just giving out information.

The small number of questions dealing with the design stage of a project was rather surprising and tends to confirm that pupils rely on their teacher to solve many of the problems. All the sessions observed were practical project work, during which time the teacher was kept busy dealing with realisation problems, giving little attention to smaller groups of pupils working on the design of their next project. Ideally, there should be a balance between the two. If the teacher were able to give time to the "designers", perhaps the realisation work would proceed more smoothly.

The observation sessions were valuable in obtaining data about the teachers' work load during the lessons. The data obtained about the actual problems pupils had as they worked through their projects indicate that the area of greatest uncertainty is the use and working of materials. While useful data were obtained, the observation sessions did not take into account help given by one pupil to another and it was possible that questions were missed by the author during the observation sessions. Also, it was possible that when pupils asked questions in rapid succession, an answer given to one pupil could be heard by another and provided the answer to his or her question.

4.2 Pupil Interview Results

Two schools were used for this part of the investigation (school 1 used previously, and school 3). All the pupils interviewed were in the fourth year, working on projects as part of a GCSE course. The interviews varied in length between 10 and 14 minutes. The longer interviews involved pupils who tended to give a more explanatory answer to a question. Of the twenty seven pupils interviewed, five had no experience of electronics. Questions 19, 20 and 21 (Appendix 3) were not used with these pupils.

The tape recordings were analysed by:

(a) playing back each recorded interview and noting the range of answers;

(b) re-playing each interview and writing down the results against the range of answers noted previously.

In many cases the pupils gave more than one response to a question, in some cases as many as three. The responses were noted as first, second and third response. For example, there were two responses to question 5 (Table 3.3), these were:

the design stage, or the realisation stage.

Sixteen pupils responded that they decided on a joining method during the "design stage". One pupil went on to say that sometimes he left the decision until the "realisation stage". This was recorded as a first response of "design stage" and a second response of "realisation stage". The first response was seen as the most significant. Eleven pupils responded that they left decisions about joining until they had to actually join pieces of material together, when the realisation was well underway. This method of recording the results was used throughout the analysis.

In Table 3.3 each question used in the interview schedule is stated, followed by the answers and the number of pupils giving that answer. Interesting quotes from some pupil responses are included.

Table 3.3

Pupil interview results and comments

	Response 1st	2nd	3rd
		N = 27	
1. When working on a project, at what stage do you select the materials?			
Design stage	25	0	0
Realisation stage	2	0	0

The answers given were a clear indication that in the two schools used for the interviews, pupils were following sound design practice by considering material selection during the design stage of the project.

	1st	2nd	3rd
		N = 27	
2. How do you select appropriate materials for your projects?			
Previous experience	14	0	0
Help from the teacher	9	1	0
Help from books	0	0	1
Help from wall charts/displays	0	0	1
Don't know	4	0	0

More than 50 per cent of the pupils stated that previous experience was used when selecting materials. If pupils were indeed using their previous experience, then the implications are that design and technology courses offered lower down the school must have provided an adequate experience.

Answers such as "The teacher tells me", given by 33 per cent of the pupils and the 15 per cent answering "Don't know", are clear indications of uncertainty and a reliance on the teacher for basic information.

	Response 1st	2nd	3rd
		N = 27	
3. What sorts of things do you take into account when selecting materials for a project?			
Depends on the project	3	0	0
Appearance	7	3	0
Weight	1	0	1
Cost	0	1	0
Corrosion	1	1	0
Ease of working	5	1	0
Strength	7	0	0
Don't know	3	0	0

Appearance (25 per cent) and strength (25 per cent) feature as important criteria when selecting materials, but it is significant that only seven pupils stated they selected materials using more than one criterion. Clearly pupils were limited in their knowledge of material selection.

		N = 27	
4. If you are making a part of your project and are uncertain of the correct method of working the material you are using, for example, cutting acrylic, how would you find out the correct way to do it?			
Ask the teacher	27	0	0
Ask another member of the group	0	3	0
Ask the technician	0	1	0
Consult books	0	0	2

The 100 per cent response "ask the teacher" is a clear indication of the difficulties these pupils had in knowing how to use the wide range of tools and equipment available. If a teacher's response to a request for help results in a one-to-one demonstration, this must be time consuming for the teacher. It may be that this aspect of design and technology teaching makes a significant contribution to the time wasted by pupils.

The 7 per cent recording of "consult books" as the third response, indicates a reluctance of pupils to use this source of information. Perhaps text books do not provide adequate or well illustrated descriptions of how to work materials, or it is possible that using books takes longer than asking the teacher.

	Response 1st	2nd	3rd
		N = 27	
5. At what stage do you decide on the method you intend to use for joining different parts of your project together?			
Design stage	16	1	0
Realisation stage	11	1	0

The 60 per cent recording of the "design stage" illustrates that correct design methods were being applied by more than half of the pupils. The other 40 per cent were leaving decisions far too late. One, obviously able pupil, responded with "When I'm designing". He then went on to say "It depends, sometimes I change my mind when I've started it." This was a pleasing response, indicating the pupil was prepared to make a decision, but then reconsider as he progressed through the project.

	1st	Response 2nd	3rd
		N = 27	
6. How do you select a method of joining the parts of your project together?			
Help from books	6	0	0
Past experience	4	1	0
Advice from the teacher	8	2	0
Don't know	9	0	0

The 33 per cent response "Don't know" and 27 per cent response "Advice from the teacher" is an indication of uncertainty in this area. The 22 per cent who were prepared to look in books shows a willingness to search for information.

	1st	2nd	3rd
		N = 27	
7. Is there a range of glues available in the workshop for you to use?			
Yes	18	0	0
No	6	0	0
Don't know	3	0	0

Some pupils answered with descriptions of the containers used to dispense the adhesive, eg one pupil's response was "There's some in a grey tin for plastic and some in a Fairy Liquid bottle for wood". The pupil knew of two adhesives, but did not know their names. 33 per cent of the pupils were unaware of the selection of adhesives available. The results of the teacher questionnaire (Table 3.5, Question 2) indicates that all the schools responding had a range of adhesives available, but clearly many pupils (33 per cent) interviewed were not aware of this.

	1st	2nd	3rd
		Response	
		N = 27	
8. How do you choose a glue for a particular material, for example, wood?			
Previous experience	9	1	0
Ask another member of the group	5	1	0
Ask the teacher	3	0	0
Don't know	8	0	0
Read instructions on package	2	0	0

This question produced an interesting result, as "ask the teacher" accounts for only 11 per cent of the answers, yet "ask another member of the group" had the greater number, 19 per cent, of the responses. "Read instructions on package" indicates resourceful thinking by 2 of the pupils, but very often the adhesives are not displayed. The issue of displaying adhesives in the workshop was discussed with the two teachers running the workshops. They both highlighted the problems of some adhesives being "sniffable", therefore it was necessary to keep them locked away.

	1st	2nd	3rd
		N = 27	
9. What other ways do you use to join materials together?			
Nails	10	1	0
Joints	11	2	0
Weld	2	0	0
Glue	1	2	0
Wood screws	2	7	0
Rivets	0	1	0
Don't know	1	0	0

The range of responses to this question was disappointing, the majority of pupils stating methods used to join timber. This may be a reflection of the previous coursework done by the pupils. Clearly this would be a useful area to develop as part of an information system, particularly if good illustrations could be included with the text.

	Response 1st	2nd	3rd
		N = 27	
10. Are nuts, bolts and wood screws available in the workshop for you to use?			
Yes	26	0	0
No	0	0	0
Don't know	1	0	0

The result is a clear indication that the pupils were aware that a range of fasteners was available.

	1st	2nd	3rd
		N = 27	
11. How do you choose the correct size of wood screw to use when you require them?			
See what is available	5	0	0
Ask another member of the group	0	1	0
Ask the teacher	15	0	0
Common sense/judge for myself	7	0	0

"Ask the teacher" accounts for 60 per cent of the answers to this question, indicating there was uncertainty in the majority of the pupils' minds as to how to make a choice. It was interesting that none of the pupils suggested that they could refer to a table or a book, which would have been an appropriate course of action. This represents another situation where the majority of pupils rely on the teacher. However, the 18 per cent who answered "Common sense/judge for myself" indicated that some of the pupils were prepared to make decisions for themselves, when given the opportunity. One pupil in this category was confused, suggesting that "It's common sense really, it depends on the hole I've drilled," Clearly he misunderstood the procedure for using wood screws.

	Response 1st	2nd	3rd
	N = 27		
12. How do you choose the correct size of nuts and bolts to use when you require them?			
See what is available	3	0	0
Ask the teacher	14	2	0
Common sense/judge for myself	10	0	0

This was a similar result to the previous question, with the teacher featuring as the main source of information. One pupil answered that she would "Ask the teacher", but then added, "I wouldn't use nuts and bolts." It appeared that she had not used these fastenings previously in a project, therefore she was not prepared to consider them until she had been shown what they could be used for.

	1st	2nd	3rd
	N = 27		
13. If you cannot use a particular tool, what ways do you use to find out the correct method of use?			
Experiment/trial and error	1	2	0
Ask another member of the group	2	3	0
Ask the teacher	23	2	0
Look in a book	1	3	0

Clearly the teacher featured as the main source of information, yet both the schools had a well illustrated range of new text books, which pupils could have used to help in this area.

	1st	2nd	3rd
	N = 27		
14. When using machines in the workshop, do you set the machine up yourself?			
Yes	22	0	0
No	1	0	0
Some machines	4	0	0

This result does not seem to tally with the results of question 8 from the teacher questionnaire (Table 3.6, question 8f page 103) where approximately 50 per cent of teachers said the pupils can set up machines. Actually the teachers in the schools used for the pupil interviews, indicated in the teachers' questionnaire (Table 3.6) that they would allow pupils to set up their own machines. Pupils in these schools, therefore, demonstrated confidence in this aspect of their work.

	Response 1st	2nd	3rd
		N = 27	
15. What sorts of things are important when setting up a machine, for example, a drilling machine?			
Safety	18	3	0
Set correct speed	0	1	0
Tighten chuck	8	4	0
Support/hold work correctly	1	0	0

Safety (66 per cent) was clearly a significant response to this question, indicating pupils were aware of its importance. Nevertheless, the 30 per cent responding "tighten chuck" were relating to what must have been a limited experience of using either drilling machines or lathes. While their answer was specific to particular machines, they were safety conscious.

		N = 27	
16. Would you set the speed of a machine yourself?			
Yes	4	0	0
No	23	0	0

This result indicated an area of doubt. 49 per cent of teachers (Table 3.6, question 8g page 104), said they would allow pupils to change a drilling machine's speed, whereas in the two schools used for the pupil interviews, very few pupils were prepared to do this. Machine speeds could have been an interesting development as part of a microcomputer information system, but as there is doubt in the schools regarding pupils carrying out this operation, it was not included in the microviewdata system developed.

	Response 1st	2nd	3rd
		N = 27	
17. What sorts of finishes are normally available in the workshop for you to use?			
Paint	3	6	1
Varnish	17	2	1
Polishes	1	1	1
Aerosol paint spray	2	6	1
Several	4	1	1

Pupils appeared to be unaware of the range of finishes available to them. The teachers' questionnaire showed that a far wider range of finishes were available in the schools.

Teachers' questionnaire - 12 finishes available

Pupil interviews - 4 finishes stated

Obviously this may have been a reflection on what was available in the schools used for the pupil interviews. This was borne out by the fact that several pupils said they used aerosol spray paint. In fact, one pupil stated "I buy my own paint spray instead of using school's paint."

	1st	2nd	3rd
		Response	
		N = 27	
18. How do you choose a finish for your projects?			
See what is available	1	0	0
Decide for myself	24	0	0
Look at other projects	1	0	0
Ask the teacher	1	1	0

Pupils were making decisions about finishes, but in a limited way as they were not aware of the range available (question 17). Information about finishes appeared to be a useful part of a design and technology information system.

	1st	2nd	3rd
		N = 22	
19. Do you choose the electronic components for projects?			
Yes	2	0	0
No	17	0	0
Sometimes	3	0	0

Note: Some pupils had not attempted any electronic work.

Very few pupils were selecting their own components for electronic circuits. Twenty two of the pupils had done some electronic construction work, but they had been given the components as a kit.

	1st	2nd	3rd
		N = 22	
20. If you are unable to recognise an electronic component, where would you find the information?			
Ask the teacher	13	3	2
Ask someone in the group	2	0	0
Look in a book	5	5	0
Look on a wall chart	1	0	0
Look in marked boxes in store	1	0	1

This question was the second which prompted a significant number of answers "Look in a book" (22 per cent) (Question 6 had a similar result). This may have been a result of the pupils using the excellent electronic text and work books which have become available. One pupil said that ".... if the teacher doesn't know, I look in a book". It is interesting to compare the results of this question with those of question 4. That question prompted two third responses related to books, yet this similar question gave five first and five second responses of "look in a book". This may be because high quality electronic textbooks were available, whereas similar quality books for "working materials" were not available in the two schools. The recognition of

components could be an ideal area of development for a microcomputer based information system.

	Response 1st	2nd	3rd
		N = 22	
21. What would you do if an electronic circuit you have built did not work?			
Test it myself	15	0	0
Ask someone in group to help	0	1	0
Ask teacher to test it	7	7	0

The 55 per cent of pupils who replied "test it myself" had a confidence which was pleasing, but a third of the answers still indicated the teacher was used to solve most of the problems.

	1st	2nd	3rd
		N = 27	
22. If your teacher is busy helping someone else with a project and you have a problem, what would you do?			
Wait	13	4	0
Ask a member of the group to help	11	2	0
Ask the technician	1	1	0
Look in a book	1	3	0
Go to library	1	0	0

One resourceful pupil responded "I usually wait, but sometimes I find another teacher and if he can't help me, I wait". "Wait" accounted for more than half the answers and must represent a considerable waste of a pupil's time. The 40 per cent who "ask members of the group" were at least attempting to overcome their difficulties. However, they were in danger of getting incorrect information from their friends. Surprisingly only one pupil responded "Look in book" as a first response.

	Response 1st	2nd	3rd
		N = 27	
23. What sources of information could be consulted other than your teacher, when designing or making your project?			
Books	13	1	0
Library	1	3	0
Information sheets	5	1	0
Computers	2	0	0
None	6	0	0

The 48 per cent who suggested books shows an awareness that they can be useful, but answers to the previous question did not give an indication that there was an automatic acceptance that they can be a source of help. The five pupils suggesting that "information sheets" could be consulted clearly would try alternative sources of information, if they had been available. Only two pupils suggested that computers could be of any help.

In one of the schools, the pupils had completed an Information Technology course which had, in part, consisted of exercises in the use of a database, but this had not involved any practical uses.

Question numbers 4, 6, 8, 11, 12, 13, 18, 20, 21, 22 and 23 attempted to find out where or how the pupils found information or obtained help. An analysis of the answers to these questions is shown in Table 3.4.

Table 3.4

Analysis of the pupil interview questions related to where and how pupils obtained information

Answer	Number of answers	Per cent
Ask the teacher	124	48
Decide for myself	67	26
Ask someone else in the group	20	8
Look in a book	14	5
Don't know	17	6.5
Other answers	17	6.5
Technicians	1	0
Total number of answers	260	100

Clearly the pupils in the two schools used for the interviews relied heavily on teachers for information, although they were prepared to make decisions for themselves in aspects of their work such as selecting a finish for a project. Very often such decisions were based on previous experience or their own judgement, rather than searching out information for themselves. Few pupils were prepared to use books as sources of information, even though both the schools had a supply of recent design and technology text books.

The importance of research as an element of the process used in tackling a design and technology project, was discussed in Chapter 1, yet the conclusions drawn from the pupil interviews were that:

* the pupils were mainly relying on the teacher for information;

* some pupils were able to make decisions;
* although books were available, the pupils did not make much use of them.

If design and technology project work has research as an integral part of the process, then it is vital that pupils are taught to seek out information for themselves from a variety of sources. To enable pupils to be successful in this teachers need to have information available which pupils can access quickly and easily. While books are a useful source of information, searching for the right book and then the appropriate section of the book can be time consuming, as well as unreliable.

4.3 Teacher Questionnaire Results

The results of the teacher questionnaire (Appendix 4) are shown in Table 3.5. Eighty five of the questionnaires were returned, representing a response rate of 82 per cent. The information gathered in questions one to seven was intended to help in the design of the information system to be developed as part of this feasibility study. For example, question 1 dealt with materials available for use by pupils in their project work. The results showed there was a good range available including some unexpected examples such as sheet silver. Materials such as this, however, were only available in a small number of schools. Therefore when preparing the microviewdata system, any material reported by less than four schools was not included. Similar action was taken with data from responses to the other questions. The opportunity was taken to gather a considerable range of information to ensure a comprehensive information system could be developed.

Table 3.5

Results of the teacher questionnaire, questions 1-7

No of Questionnaires Returned = 85

QUESTION No 1a

MATERIALS Metals

NUMBER OF CATEGORIES (20)	Number of Responses
Al. alloy (casting)	77
Al. alloy (rod etc)	72
Al. alloy tube (round)	42
Steel (rod etc)	85
Steel tube (round)	77
Brass (rod etc)	70
Sheet Al. alloy	81
Al. alloy tube (square)	14
Zinc casting alloy	2
Sheet steel	84
Steel tube (square)	80
Sheet brass	73
Sheet copper	24
Sheet nickel silver	5
Tinplate	6
Sheet gilding metal	12
Sheet stainless steel	7
Sheet silver	3
Silver steel (tool steel)	3
Phosphor bronze	2

QUESTION No 1b

MATERIALS Plastics

NUMBER OF CATEGORIES (18)	
Sheet acrylic	84
Polyester resins	37
ABS sheet	19
Expanded polystyrene	38
Acrylic rod	34
Polystyrene sheet	42
Polycarbonate sheet	8
Corex	8
Coroflute	11
Polyurethane foam	1
Formica	1
UPVC preformed sections	3
Nylon rod	3

PVC sheet	2
Polypropylene sheet	1
Polypenco rod	1
Structural foam (models)	2

NUMBER OF QUESTIONNAIRES PROCESSED 85

End of the record

QUESTION No 1c

MATERIALS Timber

NUMBER OF CATEGORIES 18

Redwood (Pine)	84
Beech	58
Ash	33
Meranti	34
Jelutong	37
Ramin	23
Balsawood	51
Parana Pine	26
Mahogany	33
Teak	7
Oak	19
Elm	12
Yew	3
Chestnut	7
Sycamore	3
African Walnut	10
Canary White wood	7
Freigo	3

NUMBER OF QUESTIONNAIRES PROCESSED 85

End of the record

QUESTION No 1d

MATERIALS Man-made boards

NUMBER OF CATEGORIES 9

Plywood (Utile or similar)	80
Contiboard (or equivalent)	59
Chipboard	65
Hardboard	73
Blockboard	40
Birch plywood	63
High density fibre board	3
Plywood (oak faced)	2

Plywood (teak faced)	2

QUESTION No 1e

MATERIALS Modelling materials

NUMBER OF CATEGORIES (11)

Card for models	83
Art straws	57
Plasticine	43
Clay for models	35
Plawco rods and joints	7
Modelling foam	12
Balsawood (also recorded in 1c)	3
Meccano	6
Lego	4
Fischer Technic	1
Welding rods	1

QUESTION No 2

ADHESIVES

NUMBER OF CATEGORIES 19

PVA glue	85
Balsa cement	49
Loctite (metals)	21
Contact adhesive	77
Aerosol adhesive	32
Polystyrene cement	20
Tensol cement	83
Epoxy resin	79
Double sided tape	53
Copydex	36
Hot melt glue (card)	15
Hot melt glue (wood)	15
Cascamite	14
PVC solvent cement	3
Glue sticks	5
Aerolite	1
Cow gum	3
Loctite super glue	1
Gloy	1

Table 3.5 (continued)

QUESTION No 3a

FINISHING MATERIALS Abrasives

NUMBER OF CATEGORIES (14)

Emery cloth	82
Glass paper	80
Garnet paper	64
Wet or dry paper	72
Buffing compounds	7
Brasso	6
Steel wool	7
Pumice powder	4
Water of ayr stone	3
Abrasive flap wheels	1
Aluminium oxide discs	4
Carborundum powder	1
Tripoli	1
Crocus powder	1

QUESTION No 3b

FINISHING MATERIALS Finishes

NUMBER OF CATEGORIES (12)

Aerosol paint	46
Aerosol primer	32
Cellulose sanding sealer	64
Standard oil based paint	71
Polyurethane varnish	82
Plastic wood type filler	45
Hammerite paint	69
Polyester filler	23
Plastic dip coating	5
Emulsion paint	2
White polish	2
Bees wax	4

Table 3.5 (continued)

QUESTION No 4

ELECTRONIC COMPONENTS

NUMBER OF CATEGORIES (25)

Resistors	71
Capacitors (other types)	68
Relays	61
Light emitting diodes	67
Light dependent resistors	65
555 timers	51
Transformers	46
7 segment displays	26
Electrolytic capacitors	57
Transistors	68
Diodes	64
Low voltage bulbs	67
Thermistors	57
Integrated circuit logic gates	37
Loudspeakers	54
741 operational amplifiers	45
Potentiometers	6
PCB	5
Reed switches	7
Slide switches	7
Buzzers	7
Vero board	3
Battery connectors	3
Pre-set potentiometers	3
Micro-switches	3

QUESTION No 5

FASTENING DEVICES

NUMBER OF CATEGORIES (17)

BA nuts and bolts	60
Metric nuts and bolts	80
Wood screws (brass)	68
Wood screws (steel)	85
Pozi-drive screws	41
Self tapping screws	67

Table 3.5 (continued)

Rivets	83
Pop rivets	82
Star lock washers	27
Panel pins	84
Oval nails	81
Round wire nails	72
Tension lock rolled steel pins	6
Hinges	2
Split pins	1
Knock down fittings	4
Staples	2

QUESTION No 6

EQUIPMENT

NUMBER OF CATEGORIES (19)

Metal turning lathe	83
Vacuum forming machine	52
Bandsaw (small Burgess type)	58
Jig saw	49
CNC lathe	5
Belt sander	56
Signal generator	20
Wood turning lathes	85
Drilling machines	85
Vibrating saw	26
Injection moulding machine	4
Sanding disc	83
Line bender (for plastics)	81
Oscilloscope	34
Variable low voltage power supply	55
Vertical milling machine	63
Multi-meters	58
Batteries	57
Horizontal milling machine	62

QUESTION No 6 additional

EQUIPMENT additional information

NUMBER OF CATEGORIES (14)

Brazing hearth	4
Kiln	6

Table 3.5 (continued)

Mortice machine	6
Forge	4
Portable drill	5
Portable router	4
Spot welder	1
Oxy-acetylene welding equipment	8
Shaping machine	10
Polishing machine	4
Power hacksaw	3
Sheet metal folding machine	1
Casting equipment	5
Photo-etch PCB equipment	1

QUESTION No 7

COMPUTER EQUIPMENT

NUMBER OF CATEGORIES (22)

BBC Master series	28
BBC Model B	45
RML 380Z computer	1
Mono-chrome monitor	11
Spectrum computer	3
Colour monitor	53
Disk drive (single)	44
Disk drive (double)	24
Cassette tape deck	17
Micro-drive	0
VIC 20 computer	2
Printer	14
Plotter	12
Input/output interfaces	9
British Thornton Compass 2D	3
Light pen	4
Robot arm	5
Graph pad	4
Mouse	8
Colour printer	1
Buggy	4
Digitiser	1

Question 8 was used to collect information about some of the working practices and obtain details of health and safety issues which could be an important consideration when describing workshop processes as part of the microviewdata system. Table 3.6 shows the analysis of the responses to question 8.

Table 3.6

Analysis of Question 8 of the teacher questionnaire

8. WORKING PRACTICES AND METHODS

Percentage Results

Total no returns 85
response 82%

		Yes %	No %	No Response %	
a.	Is the range of materials stocked clearly displayed in the CDT area?	37	63	-	
b.	Is the range of nuts, bolts woodscrews and other fastening devices stocked displayed in the CDT area?	24	76	-	
c.	Is the range of adhesives stocked displayed in the CDT area?	28	72	-	
d.	Is the range of electronic components stocked displayed in the CDT area?	27	65	8	This represents number of schools without electronic component stock in CDT
e.	Do pupils in the CDT area have easy access to a range of CDT text books?	88	12	-	
f.	Are pupils expected to set up a machine such as a lathe, unaided, before they use it?	47	47	6	Some replies gave an answer with a qualification ie not the less able.

g.	Are pupils permitted to change drilling machine speeds?	49	49	2	As above
h.	Are pupils permitted to change lathe speeds?	68	32	-	
i.	Are pupils allowed to use a small bandsaw similar to the "Burgess" type?	33	61	6	This represents schools without a small bandsaw

A third of the schools responding had a display of the materials available and one quarter displayed information about their nuts, bolts, woodscrews and adhesives. Both these figures indicate that the majority of pupils must have difficulty making decisions about using any of these items, as they cannot be aware of what is available for them to use. Similarly, electronic components stocked were not displayed in two thirds of the schools. The conclusion drawn from these results was that displays of materials to help pupils make choices were generally not available in school CDT departments. Perhaps teachers did not have time or space to display the large range of materials available. (Table 3.5, questions 1 to 5, pages 96 to 101)

The results from question 8e indicate that text books are accessible for use in design and technology lessons, yet the results of the pupil interview schedule indicated that pupils do not make use of them. It may be that the teaching methods adopted by many CDT teachers do not encourage reference to books. As pointed out previously, the research element has been identified as an important part of designing, therefore it could be necessary for CDT teachers to change their teaching strategies to ones which encourage pupils to be more resourceful and less reliant on the teacher.

The setting up and use of machinery by pupils was clearly a contentious issue, as only approximately half the teachers allowed pupils to do this for themselves. It was interesting, however that half the CDT teachers allowed pupils to change drilling machine speeds, but two thirds allowed pupils to change lathe speeds. This probably reflects the type of mechanism used on the different machines to change the speed. Drilling machines almost universally use a belt drive system, whereas lathes more commonly use gear shift mechanisms. Belt drive changes can be more hazardous. The use of small bandsaws by pupils was not allowed in the majority of schools. The results of these questions was of importance when writing the datapages for the microviewdata system, to ensure the information presented to pupils represented the current working practices used in most school CDT departments.

To summarise therefore, it was clear from both the pupil observations and interviews that pupils were not searching out information for themselves. Even though the three schools involved had good reputations for design and technology, the results indicated that pupils relied on the teacher for most of the help required during both the design and realisation stages of project work. As pointed out above, pupils rarely considered looking in text books even though they were available. While the teaching styles used in the schools may have been a significant factor, it could be that pupils found searching books for information was difficult. Firstly, they would need to select an appropriate book and then look in the index to see if the information needed was listed. If the information required was available it would probably be necessary to search through several paragraphs to find it. These stages were likely to be time consuming and could lead to pupils getting incorrect information. A microcomputer running carefully designed software could do the searching operation quickly and present only the most appropriate information for the pupil to read, so reducing error. By using the microcomputer's ability to store and process large amounts of data, it should be possible to provide information in one comprehensive, readily accessible source.

Chapter 4

COMPUTER BASED INFORMATION SYSTEMS

Summary

Following a discussion about the way information systems such as interactive video and Prestel can be used in schools, an analysis of several Teletext emulation software packages is made. The advantages and disadvantages of microcomputer database packages when used in schools are discussed, followed by examples of experimental design and technology databases assembled by the author using commercial software. Reasons are given for the development of a specialised system which combines a database with a Teletext system.

The breadth of design and technology activity in schools calls for a comprehensive information system which can be accessed by pupils at the design stage of project work, as well as during practical project sessions.

1. Interactive Video

As design and technology activity is predominantly dealing with three dimensional materials, tools, components and equipment, a video system could be a satisfactory way to present information. The observation sessions and pupil interviews indicated that many of the difficulties which prevent pupils progressing with their project work were related to uncertainties about practical skills. Videos of workshop processes, for example, soldering electronic components into a circuit, are feasible. However, in order to cover the breadth of design and technology activity, the library of such videos would need to be large. Pupils selecting the appropriate videotape or even searching the videotape for the section required would need to be guided by an index in some form.

The technology exists to enable a computer to search a videotape for a required section, but this can be a slow process as the video recordings are in a sequential format on the tape. To find a particular section on the tape, the "wind" and "rewind" would need to be operated by the computer. This could take a long time, particularly if many items of information were recorded on a long-play tape. Another disadvantage of the videotape is the difficulty of producing a freeze frame or video still. Most video equipment has this facility, but usually the picture quality is poor and it is possible to damage the videotape.

The Telesoft interactive video project, funded by the Manpower Services Commission (MSC) and based at Brighton Polytechnic, developed an interface to adapt a VHS format video recorder to operate under the control of a BBC Master microcomputer. The project involved the development of computer authoring software to enable schools and colleges to develop their own interactive video material at reasonable cost. The final report on this project (1988) stated that the Telesoft system is robust, reliable and low cost and provides a ready means of extending the use of microcomputers in schools.

The system was extensively trialled during 1987 and several TVEI centres developed their own interactive video material. One centre in the project, Crawley College of Technology, successfully converted existing video materials dealing with demonstrations of practical skills into an interactive video form. It would appear that the Telesoft system represents a useful resource for design and technology teaching, particularly when pupils require revision demonstrations of how to work materials and operate equipment.

The most attractive method of using a computer and video system is the technically advanced interactive video which uses video discs to store both the pictures and computer information. One example is the Domesday project produced by the BBC in partnership with Philips Electronics and Acorn Computers. Following its launch in late 1986, Leah (1987) commented that the Domesday Interactive Video was the equivalent of 300 weighty volumes on just two 12in videodiscs.

The system demonstrates how large amounts of information can be stored and accessed quickly. The Domesday project contains more than 50,000 photographic stills, 250,000 pages of text, 24,000 maps and an hour of video sequences with sound. The system developed allows 324 Megabytes of digital data to be stored on each disc as well as 54,000 analogue video frames. In addition, software was required with a complex indexing system to search the video disc.

Oxford University Press have used a similar system for their "Volcano" project. It takes full advantage of interactive video by using moving pictures and animated graphics to show the development of a volcano through to its eruption. However, moving pictures take up a considerable amount of video disc space, so that while the quality of the presentation is excellent, the quantity of information which can be accessed is reduced. Therefore, the Volcano project deals with only one topic.

The Council for Educational Technology (CET) has also developed interactive video material. They have developed eight interactive video discs including a "Design" disc. These packages run on the Acorn BBC Master IVIS (Interactive Video in Schools) system. The design disc contains a short film introducing a variety of examples of good design. The design process is shown through two pieces of film. One shows the design of the Coca-Cola can, the other is about the design of the Ford Scorpio car. A menu system gives access to examples illustrating different stages in the design process. These are supported by a databank of almost 2000 video stills. These packages started school trials in the 1987 summer term.

The advantages of the video disc are as follows:

* rapid access time to any part of the disc;
* ability to store both computer program data and video picture data;
* massive storage capacity;
* robustness compared with video tapes and the computer's "floppy" disk.

On the other hand, the disadvantages are as follows:

* initial cost of the equipment;
* cost of producing the video material and accompanying software;
* cost of manufacturing the video discs in relatively small quantities.

The high cost of interactive video appears to be decreasing as the technology develops and more schools start to use it. Threadway (1988) reporting on the Microvitec Cub system explained how it is capable of running the IVIS programs as well as those produced for the Videologic system used in industrial training centres. When discussing the cost of producing the video discs he pointed out that Microvitec would convert 36 minutes of videotape, of any format, into a video disc. The cost of the disc is £395 which would be less if a quantity were produced.

Macdonald (1988) reported a most promising development by Thorn EMI called "MIST", a new video disc player developed over a five-year period. The system is available on a rental scheme only, providing schools with the opportunity to use the system without fears of high expenditure and inbuilt obsolescence.

While such systems are attractive and ideal for use in design and technology, the reality is that few schools have such systems at present. Those schools which have interactive video systems can only make them available as a central resource, based, for example, in the library or computer room. To be effective, any information technology system must be available where pupils are working, so that it may be used regularly. The correct place must be the classroom, workshop or laboratory.

2. Videotex Systems

As Information Technology developed in the 1970s, the word "videotex" was used to describe systems which used a visual display unit (VDU) to display text. The VDU was either a television screen or a computer monitor. The data to build up the text on the screen could be transmitted either by telephone line, or by television broadcast signal. Thompson et al (1982) gave the following definitions:

> "Videotex includes both interactive and broadcast systems.
>
> Interactive videotex, or viewdata, is the generic term for such systems as British Telecom's PRESTEL.
>
> Broadcast videotex, or teletext, is the generic term for such systems as the BBC's Ceefax and ITV's Oracle."

The development of microcomputers with appropriate operating systems has enabled software developers to produce programs which emulate a viewdata system. Futcher (1986) describes these as "microviewdata". The Council for Educational Technology (1987) qualified this definition by pointing out that the development of sophisticated microcomputers has led to software that allowed very small videotex systems to run. These viewdata and teletext "emulation" programs were often known as microviewdata applications.

These have been used by organisations wishing to set up their own internal viewdata systems. Schools, particularly those with computer networks, have used microviewdata software and developed their own systems. The Council for Educational Technology (CET) (1987) was aware of more than 50 such systems being run by schools, colleges, Local Authorities or individuals.

The "Teletext" system of building up text and simple graphics screens has been used by many microviewdata program developers as a microcomputer's memory can be employed in an economical way. Information is presented in the same format as the screens seen on the television's Ceefax, Oracle and 4-Tel systems. CET (1987) described this as an international display format, giving a "page" with 40 columns, 25 lines and a possible seven colours.

3. **Viewdata and On-line Databases**

On-line databases have been used commercially for a number of years, and their use as a resource in schools has been suggested since the early 1980s. Bevis (1983) proposed an "Information Technology for all" syllabus which could include a section:

> "Communication of Information
>
> Introduction to the way digital representation enables new powerful communications techniques improving the availability of information and its consequent use. The central database, Oracle, Ceefax, Prestel, banking and commerce, broadcasting with feed back."

Another section could include the following examples, which could be used in the teaching:

> "Lessons backed up by videotapes illustrative of the use of new communications techniques. Use of database, Ceefax and Oracle and Prestel."

These on-line databases, such as Prestel Education, offer a comprehensive information service containing over 300,000 datapages. The development of this as an education resource has been supported by the Department of Trade and Industry (DTI) by the distribution of 12,000 modems to Local Education Authorities in 1986 for use in schools and colleges. The problems of cost and the difficulties of using school telephone lines, coupled with the lack of in-service courses for teachers in the use of such systems, have restricted their use. Andrews (1986) concluded:

> "When all these problems have been overcome, the initial costs and the running costs are evaluated, the modem offer seems a little hollow."

Askey (1987) shared this view stating:

> "Speculation about the value of the modem in school is rife at the moment. A variety of hardware and software has now been thrown at the feet of teachers and librarians who are expected to use it wisely and effectively - without prior experience or help."

While Askey (1987) points out the difficulties of implementing the use of on-line databases in schools, she recognises their value in helping pupils to learn information skills. One conclusion she reached is:

> "The process through which children go in accessing these databases, in locating and manipulating the information according to their needs is fundamental to the GCSE and primary curriculum."

As the on-line database requires the use of a telephone line as well as a modem and associated microcomputer equipment, costs are high. For example, the cost of operating a Prestel system is approximately £200 per year, plus the cost of each telephone call. The system allows datapages of information to be down loaded to a disk and stored for future use. This could enable a teacher to gather together a resource of suitable material for use in project work. Pupils, particularly those in the 14 to 18 age phase, can benefit from using such databases. They can be of great value in cross-curricular project work. Prestel also encourages pupils to become information providers (IP's), for example, schools can submit Teletext-style graphic pages for inclusion in a carousel of graphic design pages. Also schools are able to communicate with each other using the electronic mailbox facility. Prestel also allows access to the National Educational Resources and Information Service (NERIS) database.

NERIS was set up by the Industry Education Unit (IEU) of the Department of Trade and Industry (DTI) to provide a powerful and comprehensive database of curriculum materials and information for teachers. The initial aim of providing a single point of reference for teachers seeking information about learning materials and resources and delivering it by electronic means has been successfully met. Teacher groups, Local Education Authority curriculum and resource centres, examination boards, educational publishers, subject and professional associations and government departments have become information providers. To maintain the quality of the database, IP's have to meet set criteria and conform to a strict layout for the information. Validation of the data before inclusion in the system has been an important apsect of the NERIS development team's work.

While NERIS has provided a resource for teachers, it was not intended as a database which pupils could access for information. The use of on-line databases for teachers to obtain teaching material represents a major step forward in curriculum development, but again costs can be high.

The provision of a modem by the D T I for schools, did not take into account these running costs, therefore the implementation of this technology in schools has been restricted. Westacott and Pain (1988) conducted a survey of the use of TTNS (The Times Network for Schools) and Prestel in schools, during the summer of 1987. Unfortunately, the response rate to the questionnaire circulated via the system was poor. When reporting the results they concluded there was no clear pattern of the use of TTNS or Prestel in primary or secondary schools.

Their final comment about encouraging the use of on-line databases was:

> "...... it does seem evident that in the area of TTNS and Prestel there is a small number of innovative, active authorities in Britain. As to those who did not respond, it is possibly fair to assume that had they a record to be proud of, they would have responded."

This survey was conducted two years after the DTI distributed the modems to schools.

4. **Teletext**

The Teletext information system is an alternative to the on-line databases such as Prestel. Systems such as Ceefax, Oracle and 4-Tel, operated by the television broadcasting organisations, and transmitted as part of the television signal, can be of use in schools. Several companies have developed Teletext adapters which, when connected to a computer, enable the user to down-load the datapages. It is also possible to store the pages on disk and print them out on paper. The cost of the Teletext adapters and associated software is about £120. The information on the datapages has possible applications in some school subjects, for example, business studies.

These television data systems have the disadvantage of having little specific information which can be used by the teacher to support the day to day classroom, laboratory, or workshop teaching. It would be possible for the education service of the television organisations to produce a Teletext database specifically for schools. This could be an attractive proposition, as the equipment costs would be low and teachers could be involved in supplying the information.

5 Microviewdata

Several microviewdata systems have been developed to enable individual or groups of teachers to develop their own Teletext style databases. The Teletext format, 25 lines of text, each with 40 character spaces, is used. Futcher (1986) gave details of several microviewdata computer programs (Table 4.1) designed to enable a microviewdata system to be built up. He described how pupils collected appropriate data and designed the Teletext screens to display the information.

Table 4.1

Microviewdata computer software

Software title	Publisher	Micro computer
The CommunITel Viewdata system	CommunITel Ltd	BBC
Telefax	P J Barker	BBC
CET Educational Viewdata package	Council for Educational Technology	BBC & RML 480Z
Tele-Book	4Mation Educational Resources	BBC
Seafax	RESOURCE	BBC
School Text	GSN Educational Software	BBC
Mikefax	C Rowling	BBC
Edfax	Tecmedia Ltd	RML 480Z

Futcher (1986) continued by describing how a system, based on the CommunITel software, developed. He concluded:

> "Schools can now create their own viewdata systems, a sort of mini-Prestel. The CommunITel package allows a BBC micro to behave in this way. The system can be phoned up and searched in the same way as Prestel."

Barr (1987) described a similar viewdata system which was developed in a secondary school in Northern Ireland. In the first instance he had used the Edfax package, but as more datapages were added an improved package was looked for. His comments on teletext emulators and viewdata were as follows:

> "This experiment led us to investigate other teletext emulators, but we were disappointed at the limitations of the paging system, characteristic of the teletext systems. Viewdata, on the other hand, allowed the same textual and graphical expression of teletext, but with a superior search method. Page numbers were therefore abandoned in favour of routed pages."

The change to CommunITel 1 Viewdata also had the advantage of operating on the Econet system, installed throughout the school, as well as providing the routed pages.

The running of school-based microviewdata systems has attracted many teachers, particularly in schools where network systems have been installed. Case (1988) when reporting on the setting up of a network in his school said running a viewdata system was "potentially one of the most exciting aspects of the project".

One of the differences between the microviewdata systems available is the method used to access the datapages. The cheaper systems, for example Mikefax, enable the user to create datapages easily and store them on disk. The pages are accessed by entering a page number, the computer then finds that datapage and displays it. The alternative method of viewing the datapages is to start at the first datapage and, holding a key down, look at each datapage in turn until the one required is found. This represented a simple carousel system. An elementary package such as "School Text" was limited to storing 26 pages on a disk using the Acorn Disk Filing System (DFS).

More sophisticated systems, such as CommunITel 1 Viewdata, employ a free routing system similar to that used by Prestel. A greater number of pages can also be stored on a disk. Free routing is a flexible system, which allows the viewdata designer more freedom in the structuring of the system. It enables the user to see the numbers of the information pages which are associated with the one being viewed. To enable this to be done the system has to be designed with care, as it can be difficult to add and delete pages if the routing system is to be preserved. Also, menus used in the organisation of the system could be affected.

When exploring microviewdata packages, the author also tried those shown in Table 4.2 and found that selecting appropriate pages could be time consuming, as often it was necessary to pass through several menus to get to the information required. It was easy to get irrelevant pages of information.

Table 4.2

Additional microviewdata software assessed

Software title	Publisher	Micro computer
Rotaview	COIC Sales	BBC
DESFAX	Morley Electronics	BBC

It appears that to be of real service to pupils in the classroom, a microviewdata system should be built up so that teachers can include information which is useful in their teaching. To encourage the development of viewdata usage in the Greater Manchester area, teachers have assembled a viewdata system in conjunction with Salford University. The director of the project, Cox (1987), stated:

> "It is being tailored to meet the specific needs of the LEAs it will eventually serve. They are all being given the opportunity to contribute to what is at present, a very open-ended project."

The project has been funded by money available from the Government's Technical and Vocational Education Initiative. The system is to operate using local telephone calls to minimize the cost.

It would seem that the following elements of microviewdata systems for both pupils and teachers are desirable:

* the equipment must be readily available for use by pupils;
* the running costs must be minimal;
* teachers should be involved in assembling the information.

The school-operated microviewdata or the locally developed viewdata system appears to meet the needs of both teachers and pupils. The national databases such as Prestel have potential, but this cannot be fully realised until school budgets can cope with the costs.

6. Databases

The DES (1986), when assessing the use of computers in primary schools, reported that databases were being used by pupils in the 9 to 11 age phase. Davis (1985) emphasised their educational value, particularly for group work, by pointing out that whole classes can work together on building up files, for example on animals, trees or friends.

The DES (1986), however, showed that the main uses of microcomputers are in problem solving, simulations and mathematical work. The majority of this type of school software involves pupils working towards some specific objective. For example, the adventure game aims to develop powers of reasoning by putting pupils in a position of having to make decisions, the aim being to get to the end of the adventure. Databases have a different use. They can be considered as a tool by which pupils can assemble information and process it to produce facts. The software is a utility program used to produce the database in an organised way and provide a flexible method of accessing the information. The information can be used by others in different learning situations. Webster (1986) described databases on such topics as:

* weather surveys;
* class surveys of "ourselves" dealing with weight, height etc;
* historical surveys, dealing with names, occupations, numbers in families, ages in the family.

Several sophisticated database programs have been produced commercially for the microcomputers used in schools. These databases can be used for text only. It is not possible to display any form of graphic representation. The author has experimented with several of these in an attempt to assemble databases to support school design and technology activity. Those used are shown in Table 4.3.

Table 4.3
Database software

Database title	Publisher	Micro computer
Discdata	Watford Electronics	BBC
File-plus	Watford Electronics	BBC
Beebug	Masterfile	BBC
Mini Office 2	Database software	BBC

All these databases work in similar ways, the differences being confined to the presentation and the speed which data can be accessed. They all conform to the usual database functions of assembling datafiles as records, which are made of different fields. The first datafile assembled by the author dealt with the properties of materials. An example of a record is shown in Table 4.4.

Table 4.4

Example record from a materials database assembled using Discdata

Record 1	[Entry]
Field name	
Name	Acrylic
Type	Polymer
Class	Plastic
Compo	Not applic
Supply	Sheet/rod
Finish	Ready finished
Colour	Various
Cost	Expensive
Weight	Light
Tens/str	Fair
Comp/str	Good
Melt/pt	Low
Heat/tre	Can be annealed
Hand/wrk	Easy
Mach/wrk	Easy
Bending	Heat/use strip heat
Info/use	Works easily/attractive finish

This record, from a file constructed using "Discdata", has a limitation on the number of characters that can be contained in any one record. The databases tested had a character limit of 254 and in the case of "Discdata" a maximum of 20 fields. In this example 17 fields were used. The result of these limitations is the use of abbreviated words for field names, ie "Melt/pt" for melting point and simple phrases for the actual entry. The information stored is limited. For example, under the field name "Weight", words such as "light", "very light" or "heavy", had to be used to give a broad indication to the user rather than specific information, for example weight per square metre. This would have been satisfactory for sheet materials, but the weight of other materials can be expressed differently, for example, weight per linear metre for metal bar and rod.

Searching for information would therefore require some prior knowledge of the different systems used. However, all the databases tested could be searched easily using simple search words. For example, if the user wanted to look at all the materials which are light, entering the word "light" when prompted by the database, would show all those materials which had "light" or "very light" entered under the field "Weight".

When tested by groups of teachers on in-service courses, it became apparent that entering the correct search word was essential, in order to retrieve the records. For example, entering the word "easy" would show every record with the word "easy" in it. The difficulty therefore is assembling fields without duplication of the same word.

It was also clear that someone who had not previously used the database had difficulty in deciding what search words to use. In fact, unless some indication of appropriate search words is given, the database becomes difficult to operate. This difficulty was pointed out by Davis (1985) when discussing the use of "Quest", a database designed for use by pupils in schools. He comments:

> "The program is a powerful package, allowing quite complex questioning of the stores of information held by the computer. Even the closest friends of this program, however, would probably agree that some of the language the user has to employ, is somewhat stilted and tortuous."

Webster (1986) noted pupils using a database had difficulties with misspelt words. She explained:

> "...... a name, like Elisabeth, entered carelessly by a child with a misspelt letter, will not be found in a search."

The author had difficulties when both upper and lower case letters were used in records, leading to information not being presented. Beebugs "Masterfile" has mechanisms to overcome this problem, but it is more complex to use. The conclusion was that a database of this type is useful for the person assembling it, but requires considerable explanation and experimentation before other people can make use of it. Databases with these operating difficulties cannot be considered for storing information which is required quickly and without teacher assistance.

Following further experimentation, the author and a group of design and technology teachers concluded that it is possible to use these databases to record stocks of materials, tools and electronic components. An example from this type of file is shown in Table 4.5.

Table 4.5

Example record from materials stock database assembled using Discdata

Record 1

Field name	[Entry]
MATERIAL	ALUMINIUM ALLOY
SIZE	THICKNESS 16 SWG. 0.64 INCHES 1.6 MM
STKLEVEL	2 SHEETS
ACTSTOCK	1 SHEET
COST	0.30 PENCE PER 100 CENTIMETRE SQUARE

This information is useful to staff and technicians in schools, but the only field of use to pupils would be the "COST" which can be an important consideration when selecting materials.

The costing of projects and the consideration of economy in the use of materials, is a feature of many design and technology GCSE syllabuses. The Northern Examining Association's (NEA) CDT (Technology) Syllabus B 1988, states under the heading of knowledge:

"Materials and components

Selection related to characteristics, useful properties and performance. Awareness of source and relative cost."

A similar syllabus item is included in the Southern Examining Group's CDT: Design and Realisation 1988 syllabus:

"A consideration of economic factors should include:

- economy in the use of materials
- the basic cost of materials"

A stock database with the option of costing electronic components, has been developed by the author. Table 4.6 shows an example of a transistor datafile produced by the software. Table 4.7 shows a printout from the same software, but using an option which enables a circuit to be costed. The program was developed as a teaching aid to be used when teaching this GCSE syllabus topic. The database assigns part numbers to components in a way similar to that used by commercial suppliers.

Table 4.6

An example record from Electronics database using the author's software

File name is -- TRANSIS
Component -- Transistors

Part No.	Type/Value	Unit Cost
TR1	BC107	10
TR2	BC108	10
TR3	BC109	10
TR4	BC168	10
TR5	BFY51	27
TR6	ZTX300	14
TR7	ZTX500	13

Table 4.7

Example printout of a circuit costing

List of components costed

Part No.	Type/value	Component	Unit cost	No.	Cost
EC8	220 uF	Elec. capacitor	15	2	30
CN15	pp9 Bat clip	Connectors	12	1	12
01	Bulb 6v	Opto-electronics	18	2	36
R1	E12 Series	Resistors	1	4	4
P3	10K	Potentiometers	35	1	35
TR1	BC108	Transistors	10	2	20
CB7	PCB	Circuit board	40	1	40
SW3	Min slide switch DPDT	Switches	15	1	15
TOTAL COST OF COMPONENTS					£1.92

The activity of assembling a database using commercially available software presents an excellent secondary school design and technology activity. An example could be the development of an ergonomic database. Information could be obtained by practical measurement and experimentation, using equipment designed and made by pupils.

The activity of designing in schools embodies the principle of decision making. To make a decision, pupils need information, therefore any database used must present options from which they can make a choice. In some cases the options will be limited, in others a wide range can be considered. The microviewdata Teletext style datapages give the greatest scope for presenting information, but the routing systems can lead pupils along incorrect paths. When pupils obtain irrelevant information time is wasted. The Teletext system of building up text screens used in microviewdata also has a range of graphic characters which can be used to illustrate the text. These characters produce block graphics which limit the quality of the representations.

The author concluded that the database had considerable capacity for storing vast amounts of information of a similar type, for example, names and addresses, but information for design and technology covers considerable numbers of topics which are dissimilar, making it very difficult to organise in a way which could be accessed easily. Also, while the total capacity of a database is usually considerable, the amount of data which can be stored in an individual record is limited. The conclusion reached, after experimenting with microviewdata systems, was that the Teletext datapage format was the most suitable for use in design and technology, provided that an improved system of searching for appropriate pages could be developed. The system would need to combine the advantages of Teletext datapages with the ability of the database to hold information about page numbers. The user would be able to search the database for the page numbers required and then view those pages. For example, if a pupil required information about 'wood screws', he or she would search the database to find the appropriate pages, and then look at those pages only. Well designed software could be made to search for page numbers and then display those pages automatically. Using a Teletext format, graphic representations of the wood screws as well as text about their applications could be presented. In these ways, the advantages of different information systems could be combined and adapted to meet the needs of teachers and pupils involved in design and technology activity.

Chapter 5

DESIGN AND DEVELOPMENT OF THE MICROVIEWDATA SYSTEM

Summary

Reasons for the choice of microcomputer to run the information system are given. The specification adopted for the datapages is presented following details of research into the layout, colour and wording used in other computer information systems. The content selected for the microviewdata system to be used in trials is given and the design and development of the software code, including the filing system, is described.

1. Choice of Microcomputer

When designing educational software for microcomputers a decision about which machine is to be used is required before work can proceed. This is particularly important when the software is for use in schools because of the variety of microcomputers the schools have adopted. Industry and business have settled on International Business Machines Personal Computer (IBM PC) standards which use the Microsoft Disk Operating System (MS DOS) and more recently the PC2 with its OPS2 operating system. The adoption of a common standard makes the transferability of software from one machine to another easy. Sixty per cent of microcomputers in schools are in the Acorn BBC range (DES 1986). However, the rapid developments in computer technology are making these machines obsolete. The Government policy statement "New Technology for Better Schools" (1987) recommended that any new microcomputers should be able to offer:

> "Substantial potential for software portability;
>
> Compatibility with existing software and expertise;
>
> Compatibility with commercial software and systems in this and other countries."

The policy of trying to maintain compatibility of existing software with the new generation of computer hardware is controversial, but follows from the fact that schools have invested in software for the older eight-bit machines and still want to use it on the new generation of 16- and 32-bit machines. Very often the quality of this software is good and teachers have the expertise to use it in their teaching.

Black (1988) disagreed with this policy stating:

> "The trouble is, the more we try to leave open the window to the past, the more we will perpetuate the kitchen table software developers working in hand-crafted Basic within the limitations of a 32k eight-bit machine."

He supported his argument by citing the Government recommendation of the need to move rapidly to a 16- or 32-bit standard in secondary schools, particularly for hardware which can run industry standard software.

While the Government's policies are essential to ensure that computing provision in schools meets the needs of pupils in the 1990s, the reality is that many 8-bit microcomputers, particularly those in the Acorn BBC range, will be in use in secondary schools for some time. As computer provision in secondary schools is updated, the older machines could be dedicated to specific tasks such as operating a database or microviewdata system all the time, so improving the accessibility for pupils.

The survey of CDT departments (Table 5.1) carried out as part of this study, indicates that the Acorn BBC range of microcomputers is the most common in CDT departments in schools in the South Yorkshire region. It therefore seemed logical to produce software to operate on the Acorn BBC range of hardware as the trials were to be run in that region. It was essential, however, that the software designed could easily be recoded to run on alternative hardware, so that it could be developed further if successful.

Table 5.1

Microcomputers in school CDT departments. Data from teacher questionnaire (Table 3.5 question 7)

Microcomputer	No. of CDT departments using microcomputer
Acorn BBC Master series	28
Acorn BBC Model B	45
Sinclair Spectrum	3
RML 380Z	1
Commodore VIC 20	2

Number of schools responding = 85

While the operating system and the provision of the advanced BBC BASIC language made the Acorn BBC model B an extremely useful microcomputer for educational use, its Disk Filing system (DFS) was a disadvantage. The DFS was only able to store 31 file entries on each disk surface. For applications such as a microviewdata system this set a low limit on the number of records or datapage titles a disk was able to store. During the production life of the Acorn BBC model B microcomputer several companies attempted to overcome this limitation, for example, the Watford Electronics Double Density Disk Filing system (DDFS) enabled 62 files to be stored on each disk surface. A double sided single disk drive would, therefore, have a capacity of 124 files. Watford's DDFS was offered as a Read Only Memory (ROM) based system requiring the user to install a different chip set in the computer. This system could not be considered for a software application for schools as they would need to install the Watford DDFS chip set in their computer. Beebug produced a software solution to the problem as part of a suite of programs named "Discmaster". The system enabled 61 files to be stored on each disk surface by appending a utility program to the user's own program. When tested, the utility program operated well for storing individual files, but when embedded as part of a large program the system required the computer to write to the disk each time it was required to read the extra files. This was found to be unsatisfactory as it was possible for the actual program being used to be partly overwritten by the utility program. This caused the program in use to crash.

The limitations of the Acorn BBC model B microcomputer's DFS made it unsuitable for a "stand alone" microviewdata system which had a large number of pages to be held in a filing system. Several peripheral hardware manufacturers produced systems which attempted to overcome these limitations. Morley Electronics, for example, produced a RAM (Random Access Memory) Disk and Teletext ROM (Read Only Memory) which could produce a comprehensive microviewdata system. The price of £250 however, made this unsuitable for the development of educational software as users would be required to purchase the Morley Electronics system to enable the software to run. As explained earlier, developing software which required specialist hardware to enable it to operate was not considered suitable for a school application.

The Acorn BBC Master 128 microcomputer introduced in 1986 was provided with the Advanced Disk Filing System (ADFS) which overcame many of the limitations of its predecessor.

The Welcome Guide (1986) described the system as follows:

> "- a recording format which gives each surface of a 40-track disc a capacity of 163840 (160K) characters, and each surface of an 80-track disc a capacity of 327680 (320K) characters;
>
> - a hierarchical directory structure, which overcomes the limit of 31 files per disc surface in the DFS, and which therefore means that ADFS can make optimum use of alternative types of disc unit, for example Winchester hard discs;
>
> - the use (if possible) of both sides of a single disc as one entity."

One advantage of the ADFS is the number of file titles it can store. The system has a root directory which can hold 47 file titles which can be used to direct the computer to further directories each containing up to 47 files. The system's storage capacity limit is 640K bytes which can accept a theoretical maximum of 2162 file titles. The ADFS therefore appeared to be ideal for the development of an educational microviewdata system with a large number of datapages.

After experimenting with the software used to improve the Acorn BBC Model B's filing system, it became clear to the author that to produce a system capable of handling a large number of datapages for this computer was going to be difficult without additional hardware. As the Acorn BBC Master 128 microcomputer had the necessary filing system capacity, it was therefore decided to produce the software to operate on this latter machine only. This was not seen as a major problem as 33% of the schools responding to the teacher questionnaire (Table 5.1) already had Acorn BBC Master 128 microcomputers in CDT departments. At the time the questionnaire was sent to the schools, the Acorn BBC Model B microcomputer was no longer in production and, therefore, any departments extending their computer provision with Acorn BBC microcomputers would be getting the Master 128. Producing a microviewdata system for this microcomputer only would not unduly limit trials in schools, nor the subsequent development of the author's system.

The usual method of accessing datapages in microviewdata systems did not solve some of the problems identified in the research into the use of microviewdata and database systems outlined in Chapter 4. The routed pages and the carousel system in microviewdata can lead to pupils searching but not finding the information they require or, at least, not very quickly. Databases using search words can have similar problems, as well as placing limits on the amount of information an entry can hold. The author, therefore, decided to combine a microviewdata system with a database in an attempt to improve accessibility. The format chosen on was that of a microviewdata system, but with series of page numbers stored in a database type filing system. The intention was for the user to search the page number files using a limited range of "search words" and then the microcomputer would show pages relevant to the search word selected. Rather than asking the user to enter a "search word" it was considered more appropriate to present a list of "words" from which the user could make a choice. Finding a title for this "hybrid" system caused initial difficulty for the author, but it is best described as a "microviewdata system".

The design and development of the design and technology microviewdata system consisted of three distinct phases:

* researching, writing and presenting the datapages;
* designing and developing suitable filing systems for the datapages;
* designing and developing a flexible software system to access the datapages.

2. Researching, Writing and Presenting the Datapages

2.1 Introduction

When the BBC Model B and the BBC Master Series computers were designed, they were provided with the chip set enabling them to generate and use Teletext control codes. Coll (1982) described the system in the following way:

> "Mode 7 is a Teletext compatible display mode which is very economical in its use of memory. It can provide a full colour text display with limited, but full colour, graphics. This mode is strongly recommended for applications which do not require very fine graphic detail."

The method of building up the screen display was the same as that used by the television companies to produce datapages for their Teletext systems. The amount of computer memory required to produce a screen display on the BBC microcomputer varies with the Mode selected. The best resolution, Mode 0, requires 20K bytes of memory to store the information to produce a screen display. The Teletext Mode 7, however, requires only 999 bytes for each screen display. Using the ADFS of the Acorn BBC Master 128 microcomputer with an 80 track disk gained a theoretical maximum of 640 datapages. In reality the number would be less, as the same disk would also be required to store the program and filing system to select the pages the user wanted.

2.2 Screen Layout

The Teletext screen as used by the television companies has a maximum of 960 character positions which can be used to build up datapages. This is based on 40 characters per line and 24 lines. There are 25 lines available but the first line is used for transmission purposes to display the date, time and the carousel page number count. For a stand alone microviewdata system all 25 lines can be used giving a maximum of 1000 character positions on the screen. Some of these character positions are used by character codes which act on the text, for

for example, to change its colour or make it flash. This fixed grid of the Teletext display has important implications for the layout of text on the screen. Characters can only be displayed in a given number of positions. As invisible character codes are used to act on the text, it is possible that words on the screen are separated by one or more equal spaces. Usually text fonts produced by typesetting processes are allocated the correct area for each size of character: a narrow lower case letter takes up less space than a wide upper case letter. With Teletext each character occupies the same amount of space regardless of its size or shape. For example, the letter "i" takes up the same area of the screen as the letter "B", even though "B" is a tall, wide letter, whereas "i" is a short, narrow letter. This can result in the Teletext page having an uneven texture unless the text is constructed with care. Reynolds (1980) explained this problem in the following way:

> "This [the problem of uneven texture] is partly because each letter occupies the same amount of space regardless of width, which results in the apparent isolation of narrow letters such as i and l, and partly because strong vertical "rivers" are created where word spaces happen to occur in similar positions on successive lines."

Reynolds (1980) recommended that the text should be broken up using headings and line spaces between successive paragraphs to avoid what she describes as "a very daunting and indigestible appearance".

Alderson and DeWolf (1984) produced the following guidelines for displaying text on a Visual Display Unit (VDU):

> "Text should be divided into paragraphs of no more than three or four sentences and a space should be left between paragraphs.
>
> Blocks of text should be set in upper and lower case characters.
>
> Do not right justify blocks of text.
>
> Avoid scrolling text.

> Take care that line breaks do not interfere with reading and comprehension.
>
> Keep grammatical structures consistent."

Futcher (1986) described another phenomenon of reading from the VDU display, which needed to be taken into account:

> "With screen reading you don't start naturally to read a screen from the top left corner as with a book. The eye focuses somewhere in the middle of the screen and roams around looking for reference points."

To overcome this he recommended that a microviewdata screen should have reference points which draw attention to the top of the screen. He suggested this could be a title or heading which reminds the reader of the overall subject, and this could also include a well designed logo.

The professional Teletext screen designers have developed a high degree of sophistication as can be seen by looking at the Ceefax, Oracle and 4-Tel Teletext screens. Analysing these screens gave the author further guidance on screen layout. Counting the number of words on several screens produced an average number of 95 words per screen. The use of sub-headings in a different colour and indenting the body of the text by one character space were techniques adopted by the author as good practice in screen design.

The use of colour on the microviewdata screen can enhance the quality of the visual presentation of text, but if colour combinations are used indiscriminately this quality can be destroyed to the point that text becomes unreadable. The colours available on a VDU are the three primaries, red, blue and green. These colours are produced by three electron guns firing a stream of electrons at the phosphor coated screen. The complementary colours of cyan, yellow and magenta are a mix of the appropriate two primaries. White is a mixture of all three primaries.

Table 5.2 shows the relative luminance of the VDU colours.

Table 5.2

Relative luminance of VDU colours

White	100%
Yellow (green plus red)	98%
Cyan (green plus blue)	70%
Green	59%
Magenta (red plus blue)	41%
Red	30%
Blue	11%

(Reynolds, 1980)

With regard to the use of colour, Reynolds concluded that:

> "White is the most visually dominant colour, followed by yellow, cyan and green in that order. It would therefore seem sensible to use cyan and green as basic text colours and to use white and yellow for emphasis."

Red and blue text on a black screen do not stand out, but background colours can be used to enhance their use, providing care is taken in selecting the correct combination. Where red and blue characters are in close proximity, the effect can be disturbing. Reynolds suggested that red and blue should be reserved for graphic displays and decorative purposes. Table 5.3 (taken from Alderson and DeWolf, 1984) gives all possible colour combinations and recommended pairings.

Table 5.3

Colour pairings which give good and poor legibility on both colour and monochrome VDUs

BACKGROUND COLOUR	FOREGROUND COLOUR: White	Yellow	Cyan	Green	Magenta	Red	Blue	Black
White	o	o	o			+	+	+
Yellow	o	o	o	o		+	+	+
Cyan	o	o	o	o			+	+
Green			o	o	o			
Magenta				o	o	o		
Red	+				o	o	o	
Blue	+	+				o	o	o
Black	+	+	+	+			o	o

+ are RECOMMENDED pairings
o are pairings to AVOID

(Alderson and DeWolf, 1984)

Pointer et al (1985) suggested that software produced for schools should use colours which give a luminance which is readable on a monochrome monitor. This produces severe limits on the design of microviewdata pages. Responses to the teacher questionnaire (Table 3.5, question 7 page 102) indicated that the school CDT departments with microcomputers also had colour monitors. Therefore, the full range of recommended colour combinations was adopted by the author.

Following the research into microviewdata screen layout, the following specifications for the datapages were adopted:

* the first two lines to be reserved for the title consisting of the name of the database, the page number, the menu in use and the file;

* the last two lines to be used for operation messages to prompt the user;

* cyan text on a black screen to be reserved for text data pages with headings in yellow or white;

* no more than 95 words to appear on a text datapage;

* important information, for example safety messages, to be highlighted with a cyan background and red text;

* coloured background with appropriate foreground colour to be selected from Table 5.3 for graphics screens;

* "more" messages to be placed in the lower left corner of the text space to indicate when a page is part of a series, for example, when all the information on a particular subject cannot be accommodated on one datapage.

Figure 5.1 shows an example of text datapage and Figure 5.2 an example of a graphic datapage.

Figure 5.1

Example of a text datapage

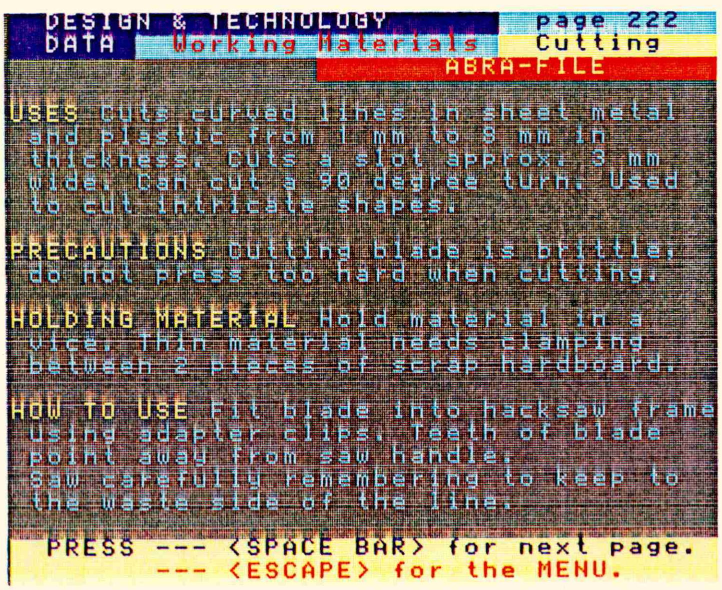
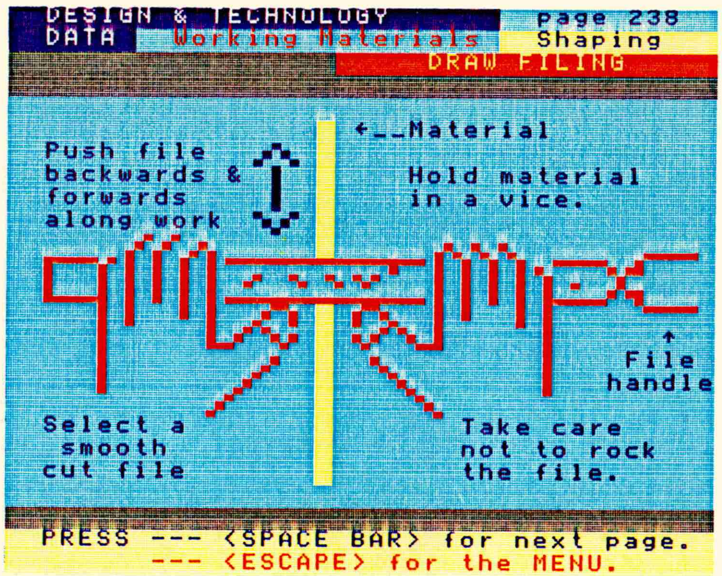


Figure 5.2

Example of a graphics datapage



Datapage identification was considered important to the user and in the operation of the computer program. Numbering pages or naming pages were the alternatives considered. The numerical system emulates the usual microviewdata systems such as Prestel. Adopting a numerical system allowed the computer to do mathematical operations on the page numbers, which proved useful when operating a carousel of pages. For example, by using a program loop and incrementing the page number by one each time the computer executes the loop, the pages could be shown in numerical order. Similarly, decrementing the page number by one each time the loop is executed enables the computer to move back through a series of pages. Storing page identification in data files as integer numbers also represented the best way to produce a reliable system.

To facilitate the development of the database the page numbers were set into series. For example, those pages dealing with adhesives were set in the series 100 to 199. The numbers 100 to

110 were reserved for instructions and information concerned with using the menu and files which contained information about adhesives. Similarly, page numbers 200 to 299 were reserved for the datapages dealing with working materials. Datapages 900 onwards were reserved for safety datapages. Adopting this method allowed room for future expansion of the system without making any alterations to the previous work.

2.3 Datapage Generation

Utility computer programs which make the generation of Teletext style datapages easier have recently become available. Several of the commercially available viewdata emulator programs such as CommunITel 1 contain the necessary page generation software as a menu option. According to Cooper (1987) the original Teletext pages were generated by Microfax, a program developed by the BBC. Since this was developed, several similar utility programs have become available to run on the Acorn BBC microcomputers. The utility program selected for the development of the author's datapages was Beebugsoft's "Teletext Pack" as it allowed the development of four screens or datapages at any one time, with a capability of copying between any of the screens. An added advantage was the software's option of saving the screens generated as screen images or as "procedures" in BASIC Code, complete with appropriate line numbers. Procedures developed in this way could be embedded in a BASIC program. This utility proved to be invaluable when developing the datapages, as well as the program which accesses them.

An important consideration was the choice of appropriate language on the datapages. It is inevitable that a design and technology microviewdata system includes technical expressions, and if these are not used with care and described adequately, the purpose of the system could be defeated. For example, if a word such as "facing off" with reference to a lathe operation is used without an explanation, the pupil may have to ask the teacher for the meaning. In such a case the microviewdata system would cause difficulties for both pupil and teacher rather than provide help On the other hand, if appropriate technical expressions were avoided, the educational value of the microviewdata system would be questionable. For example, it was decided to use the word "adhesive" in preference to "glue". Glue tends to describe a material with a sticky nature, but many of the modern adhesives are not sticky but join by chemical action. For example, some of the "Loctite" range of adhesives are anaerobic in their action.

At first, producing the datapages was found to be a slow task. Once the information to be included on a particular page was assembled and edited it had to be fitted into the very limited space available on a datapage. As well as typing the text into the computer, the appropriate character codes to change colours etc had to be included. It was found that a second stage of the editing process was required to ensure that an acceptable datapage layout was preserved. The graphics pages were particularly time consuming to produce as the block graphics required considerable manipulation of the characters to obtain reasonable representations of items such as a pair of goggles. With experience the production of datapages became easier as the author's skill in using the Beebug "Teletext Pack" increased. As indicated above, the four work screens were particularly useful, as different sections of a graphics datapage could be developed in isolation and then finally assembled to make the complete datapage.

2.4 Content Selected for the Trials

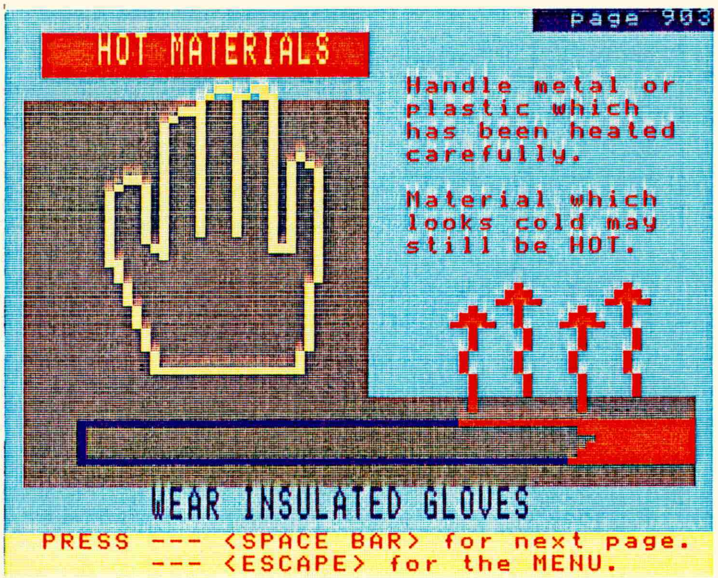
Even though the microviewdata system planned had considerable capacity, it was essential to select information which would be of particular use to the pupils in the schools used for the trials. The areas of design and technology with which pupils had the greatest difficulty had been identified by the pupil observations. Analysis of (Table 3.2 page 78) indicated that materials/working methods, fabrication methods and electronics were causing the most problems. As 24% of the schools were not involved with electronics, it seemed appropriate to concentrate on the other two aspects. As fabricating methods covers a vast range of information, the author decided to concentrate on mechanical methods, for example wood screws, in one section, and adhesives in another, together with appropriate cross references.

Information for the datapages was assembled from a variety of design and technology, woodwork, metalwork and plastics working text books, as well as from manufacturers' datasheets. The instructions given on the packaging used for materials such as adhesives was found to be a useful source of concise information.

As the content of the microviewdata system for the trials in schools included datapages about using machines and equipment, it was necessary to include safety datapages pointing out the associated hazards. Graphics datapages were considered the most appropriate medium so that the safety message was conveyed boldly in a visual way, without the user having to read a lot of text. Example safety datapages are shown in Figure 5.3.

Figure 5.3

Safety datapages



Before the software to access the datapages could be designed and developed, several user operations had to be considered. The aim was to make the software simple to operate so that pupils would require the minimum of teacher assistance or computing expertise to enable them to access the datapages. To be effective as an aid to both the teacher and pupil, it was considered essential that the software had attractive screen layouts and was also fool-proof in operation.

3. Design and Development of a Filing System

The filing system of the author's software is different from that in a usual microviewdata system and becomes more like a database. Two filing systems had to be developed. The first, called the "page number" files, hold the page numbers of a series of pages which would be shown when a particular topic was selected. Utility software was developed to build up these files (Appendix 7). Each file has a title, for example "CUTTING", with records consisting of a number which represents a material, followed by the numbers of the datapages which have the information for cutting that material. A printout of the "CUTTING" file is shown in Table 5.4. The first record in this file is for aluminium alloy bar which has been allocated the material number 1. This is followed by the numbers of the pages which have information about cutting aluminium alloy bar. Most of the page numbers are in the 200 series indicating they have information about working materials. Page number 902 is in the 900 series indicating it is a "safety" page. The 0 entries enable the computer to tell when there are no more datapages in that record.

The "CUTTING" file is relatively short with 36 records. Other files are longer, for example the "ADHESIVES" file has to store two material numbers in each record. For example, if aluminium alloy is to be glued to acrylic then the numbers representing these materials are stored as material one and material two.

The page numbers containing the information about suitable adhesives occupy the page positions as in the previous example. This file contains 580 records with all the possible matches of materials.

The second filing system holds the actual information which builds up the datapages. These files have titles such as "PAGES900" holding the datapages with numbers from 900 onwards. The 200 series of datapages extended to more than 47 entries which is the maximum, and so a second file had to be used. The system of numbering pages enabled a program routine to be developed which automatically changed from one file to another when required.

Table 5.4

Printout of the "CUTTING" file

FILE NAME - CUTTING

Material	Page	Page	Page	Page	Page	Page	Page
1	212	213	902	221	0	0	0
2	213	902	221	0	0	0	0
3	212	213	902	0	0	0	0
4	220	218	219	222	0	0	0
5	212	213	902	221	0	0	0
6	212	213	902	0	0	0	0
7	220	218	219	0	0	0	0
8	212	213	902	0	0	0	0
9	220	218	212	222	0	0	0
10	220	218	219	0	0	0	0
11	212	213	902	0	0	0	0
12	220	218	219	0	0	0	0
13	220	218	219	0	0	0	0
14	220	218	219	0	0	0	0
15	220	218	219	0	0	0	0
16	223	224	901	212	902	215	216
17	211	217	229	214	902	215	216
18	211	217	229	214	902	215	216
19	212	211	214	902	215	216	226
20	212	211	214	902	215	216	226
21	225	223	901	228	0	0	0
22	224	223	225	901	0	0	0
23	211	214	226	902	215	216	227
24	211	217	902	216	227	0	0
25	211	217	214	902	216	227	0
26	211	212	214	902	215	216	227
27	211	217	902	216	227	0	0
28	212	213	902	216	215	0	0
29	212	213	214	902	215	216	226
30	213	214	902	227	0	0	0
31	224	901	218	212	902	215	216
32	224	901	218	212	902	215	216
33	224	901	212	902	215	216	0
34	223	224	901	215	216	0	0
35	223	224	901	0	0	0	0
36	223	224	901	213	902	215	216

END OF CUTTING FILE

4. Design and Development of a Flexible System to Access the Datapages

4.1 Keys used to Operate the Microviewdata System

The keyboard has, hitherto, been the most common method of entering information into the microcomputer for the user, but the development of the "mouse" and "window environments" has resulted in more user friendly software. However, as the DES "Results of the Survey of Microcomputers Etc. in Schools" (1986) showed that only 18% of secondary schools had a mouse, using such an input device for the software trials could not be considered. Keyboard entry was adopted using the minimum of carefully selected, easily recognisable keys. This was considered important so pupils without keyboard skills would not need to spend time searching the keyboard. The keys selected were:-

- <CURSOR UP> and <CURSOR DOWN> to move up and down menus and lists;
- <CURSUR RIGHT> to move forward through the datapages;
- <CURSOR LEFT> to move back through the datapages;
- <SPACE BAR> to advance the program;
- number keys to key in datapage numbers;
- <RETURN> to enter a number keyed in;
- <ESCAPE> to return to the menu in use at any time.

The <BREAK> key was programmed to act as a function key so if accidentally pressed an "OLD" command is entered followed by a "RUN" command so recovering the program at the menu in use. The keys not used to operate the software were disabled, so it was not possible to make an incorrect entry.

Figures 5.4 and 5.5 show the instruction datapages giving details of the keys used to operate the microviewdata system. During the software development, experiments with external keypads plugged into the user port of the microcomputer proved satisfactory. Tactile membrane keypads could be used by pupils with dirty hands. These experiments were not pursued for the software trials, but could easily be incorporated into the software in the future.

Figure 5.4

Instruction datapage giving details of the keys used

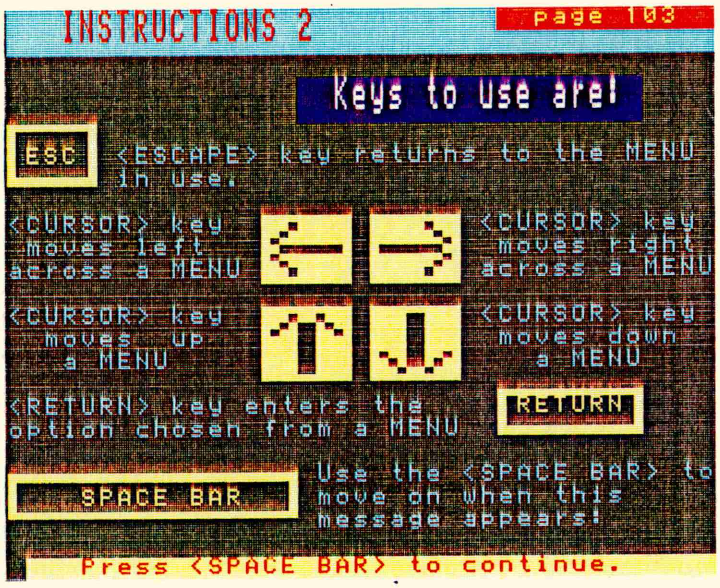
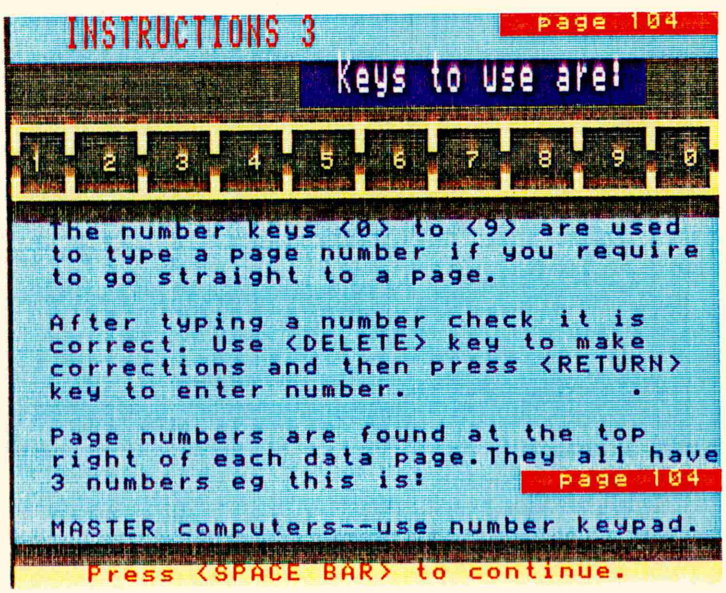


Figure 5.5

Instruction datapage giving details of the keys used



4.2 **User Instructions**

It has become usual practice to accompany computer software with an operating manual or instruction book. Very often a prompt sheet and sometimes a key strip are also included. In the school environment these often get misplaced. It appeared absurd to the author that a communication system should require these external aids, and therefore the information about the program and the operating instructions were embedded in the software. For the first-time user of the software these would be essential, but as users became more familiar with the system, constant interruptions of the instructions appearing on the screen could become an annoyance. To overcome this, the software was provided with an option which allowed the user to turn the information and instructions off. The situation of the user forgetting how to proceed was anticipated by providing a facility in the menus which enabled the instructions to be viewed, even if they had been turned off. Figure 5.6 shows an example of an information datapage. Figure 5.7 shows an example of an instruction datapage. The sideways RAM (Random Access Memory) of the Acorn BBC Master 128 is used to store the information and instruction datapages of the program. This gives virtually instant access to these pages by calling the appropriate sideways RAM memory locations and transferring the information directly into the screen memory map of the microcomputer.

Figure 5.6

Information datapage

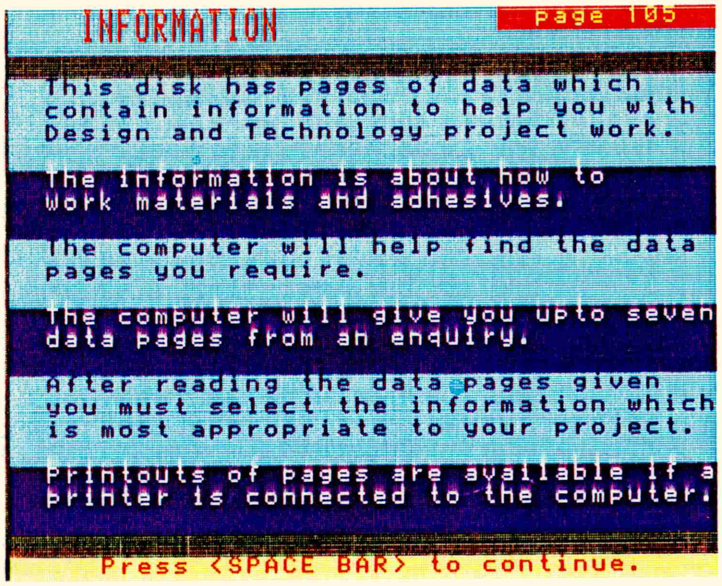
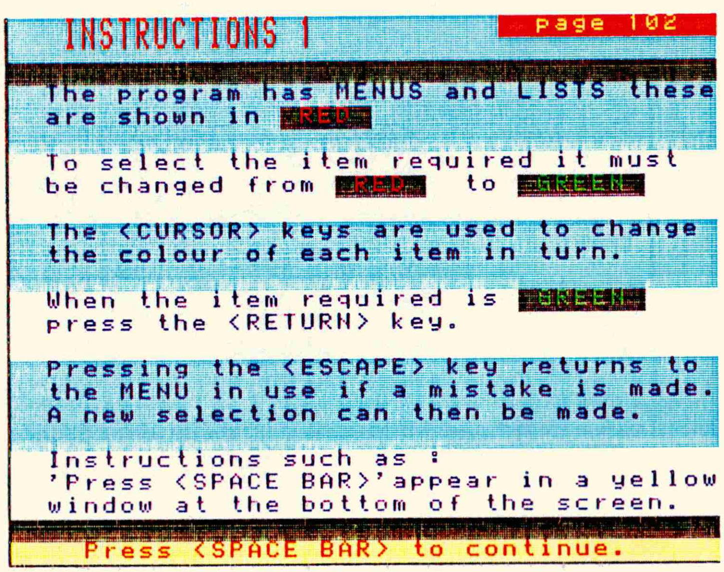


Figure 5.7

Instruction datapage



4.3 **Menus and Lists**

The software was designed around a system using menus and lists. Several menus were used to access various sections of the software. Software developers have adopted different methods of selecting an item from a computer program menu or list. The numbering of each item is one which was considered by the author, but rejected, because the number of items in the menus and lists used in the software could be as many as 36. The user would be required to enter a two digit number on some occasions which could result in errors. The method adopted was to use red characters for each menu or list item, the cursor keys being used to step through each item in turn, the current item changing from red to green. When the item required is green, pressing the <RETURN> key selects that item. The change from red to green is a well recognised indicator that a selection has been made. For consistency, this method was adopted throughout the software.

The problems with the use of search words identified in Chapter 4 (page 122) were eliminated by providing lists of words to choose from. In the case of the microviewdata system trialled, these were names of materials and processes. Selecting from these lists ensures the correct file is searched using a "search word" which is definitely in that file. In actual fact, the files are not searched with a "word" because when the name of a material is selected from a list, it is represented in the system by a number, as mentioned earlier. Using numbers which are stored as integers saves disk space and speeds up the search operation. Using this system ensures the user is presented with relevant information from each enquiry.

4.4 **Printouts of the Datapages**

When engaged on project work in design and technology pupils are usually requested to build up a folio as a record of their work.

When a pupil finds information in a microviewdata system it would be useful if the pupil could obtain a printout of that datapage. This could be included in the pupil's folio as part of the project research.

The Teletext format pages in Mode 7 cannot be printed directly as a screen dump. Special ROM (Read Only Memory) based software such as Watford Electronics "Dumpout 3" have been available for some time, but an integral printer dump for the software was essential so that teachers did not have to use a special ROM such as this. The method adopted was to convert the Mode 7 datapage into a monochrome Mode 4 screen and then use a conventional machine code screen dump to print this out. The conversion program is in BASIC so that it takes approximately one minute to complete, followed by about 45 seconds for the printout. The machine code for the printer dump was designed for use on any Epson compatible printer. An example printout of a datapage from an Epson printer is shown in Figure 5.8.

Figure 5.8

Example printout of a datapage

DESIGN & TECHNOLOGY page 314
DATA Working Materials Joining
WOOD SCREWS

WOOD SCREW DATA
Screw gauge: ie number 6, indicates the diameter of the screw.

Pilot hole: is a small hole a screw cuts a thread in.

Clearance hole: is a hole a screw will just slide through.

SCREW GAUGE	PILOT HOLE DRILL	CLEARANCE HOLE DRILL
4	2.0 mm	3.2 mm
6	2.2 mm	4.0 mm
8	2.5 mm	4.7 mm
10	3.2 mm	5.6 mm
12	3.6 mm	6.5 mm

PRESS --- <SPACE BAR> for next page.
--- <ESCAPE> for the the MENU.

An analysis of the responses to the teacher questionnaire (Table 3.5 question 7, page 102) showed that 14 out of the 85 design and technology departments had printers available. As it was inevitable that the software would be trialled in some schools which did not have printers, the software was developed so that the printout option could be cancelled. When the software is loaded into the computer this option is set during the routine used to set the information and instruction options. If printouts are selected at the start of the program a "Printout a Datapage" option appears in the menus. If "printouts" are **not** selected, then this menu item does not appear. This was designed to avoid the situation of a pupil attempting to obtain a printout of a datapage when a printer was not connected to the microcomputer.

4.5 **Program Code**

The program was written in BASIC taking full advantage of the procedures provided in BBC BASIC. Procedures can be considered as named building blocks of BASIC code which can be accessed from any part of a program by name. For example, the <SPACE BAR> is used throughout the software to advance the program to its next stage. The program code has a procedure named "PROCspacebar" which is called by this name whenever the routine is required. As outlined previously, many procedures used in the software were assembled using Beebug's Teletext Pack.

The software consists of several programs which are "CHAINed" from the disk when required. The programs of the software are similar. For example, the program which selects "joining methods" datapages is similar to the one which selects "adhesives" datapages. The only significant changes being the wording included in the menus and lists and the files which are accessed. Using this modular approach the software could be developed further with only minor alterations to the code. A printout of the program used to access the Adhesives datapage is shown in Appendix 8. The use of variables such as "sentence1$" and "sentence2$" (lines 100 and 110) make changing the program menus a simple operation. Similarly, the variable "material$(loop)" which holds information about the materials lists is held in "DATA" statements and "READ" by line number 40. Changing a "Material list" can be done by altering the information in the "DATA" statement. For example, if a list of electronic components was required, the names of electronic components would be substituted in lines 3000 and 3010. When line numbers 2020 to 2270 (Appendix 8) are printed, they contain characters which make little sense. These represent the Teletext character codes used to build up a screen. The procedure "PROCmenulayout" (line 2020) was produced using the Beebug Teletext Pack and then embedded into the program.

Extensive use of what Alcock (1986) described as "Backdoor Basic" ensured the software made full use of the special effects known as "FX" (mnemonic for effects) codes and the "VDU" (Visual Display Unit) codes provided by BBC BASIC. Access to the datapages which are stored in the filing system with numerical titles required the use of "OSCLI", the Operating System Command Line Interpreter. The usual method of loading a screen image into the screen memory map is by using the "*LOAD" command followed by the title of the screen to be loaded and the load address. This will only work if an alphanumerical title is used. The datapages are stored in the filing system with numeric titles. The solution to this problem was described by Whitmore (1987). The BASIC program line used is shown in Figure 5.9 where "pageno%" is the integer variable used throughout the software for the page numbers.

Figure 5.9

Program line using OSCLI to access a numeric page title

```
OSCLI "LOAD "+STR$(pageno%)+" 7C00"
```

This routine uses a machine code sub-routine (OSCLI) built into the computer's operating system which enables a numeric variable (pageno%) to be treated in the same way as string variable which is usually in the alphanumeric form.

4.6 **Operation of the Software**

Figure 5.10 shows the flow diagram of the software. The following is a description of the software's operation. A complete set of the teacher's notes is shown in Appendix 9 describing how the software is used. A disk with the software is attached to the last page of this thesis.

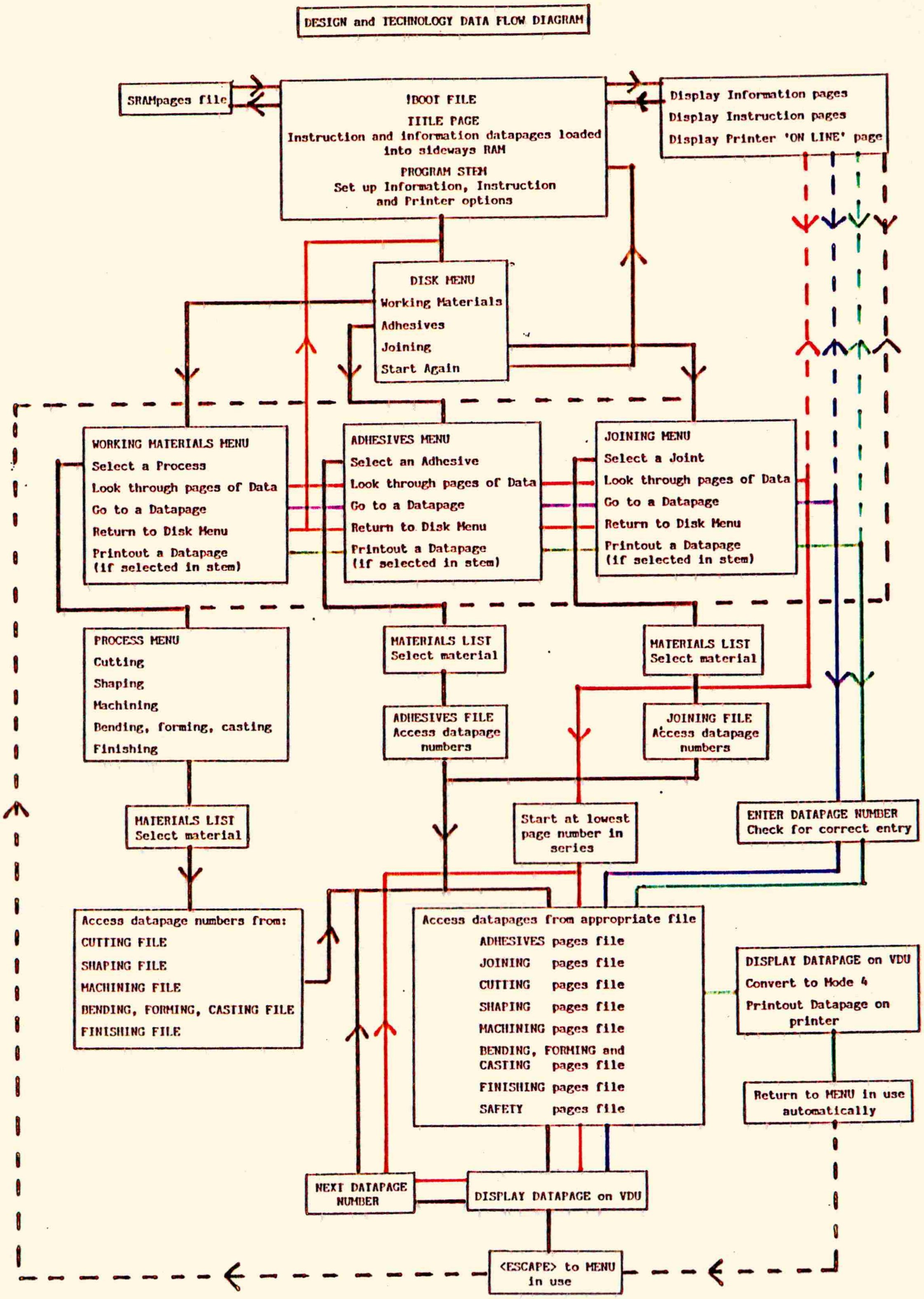
Before the software can be run, the computer must be configured for the Advanced Disk Filing System (ADFS). The Acorn BBC Master 128 computer can be set up to default to this configuration if it is to be dedicated to the task of operating the author's software. However, for computers used in the normal Disk Filing System (DFS) default mode, it is necessary to place the program disk in the disk drive, check it is switched to 80 track and type in:

*ADFS <RETURN>

The disk drive runs for a short time and then a screen message indicates the filing system has switched to ADFS.

The software is "Auto booted" into the computer in the usual way by holding the <SHIFT> key down and tapping the <BREAK> key. A title page indicates the software is loading correctly. As several datapages are loaded into sideways Random Access Memory (RAM) the loading takes approximately 30 seconds.

Prompts and instructions on how to proceed have been provided using a yellow display window at the bottom of each screen. these messages have been confined to instructions such as **<Press the SPACE BAR>**. The yellow window has been used consistently throughout the software to convey such messages.


DESIGN and TECHNOLOGY DATA FLOW DIAGRAM
SRAMpages file
!BOOT FILE
TITLE PAGE
Instruction and information datapages loaded into sideways RAM
PROGRAM STEM
Set up Information, Instruction and Printer options
Display Information pages
Display Instruction pages
Display Printer 'ON LINE' page
DISK MENU
Working Materials
Adhesives
Joining
Start Again
WORKING MATERIALS MENU
Select a Process
Look through pages of Data
Go to a Datapage
Return to Disk Menu
Printout a Datapage (if selected in stem)
ADHESIVES MENU
Select an Adhesive
Look through pages of Data
Go to a Datapage
Return to Disk Menu
Printout a Datapage (if selected in stem)
JOINING MENU
Select a Joint
Look through pages of Data
Go to a Datapage
Return to Disk Menu
Printout a Datapage (if selected in stem)
PROCESS MENU
Cutting
Shaping
Machining
Bending, forming, casting
Finishing
MATERIALS LIST
Select material
MATERIALS LIST
Select material
ADHESIVES FILE
Access datapage numbers
JOINING FILE
Access datapage numbers
MATERIALS LIST
Select material
Start at lowest page number in series
ENTER DATAPAGE NUMBER
Check for correct entry
Access datapage numbers from:
CUTTING FILE
SHAPING FILE
MACHINING FILE
BENDING, FORMING, CASTING FILE
FINISHING FILE
Access datapages from appropriate file
ADHESIVES pages file
JOINING pages file
CUTTING pages file
SHAPING pages file
MACHINING pages file
BENDING, FORMING and CASTING pages file
FINISHING pages file
SAFETY pages file
DISPLAY DATAPAGE on VDU
Convert to Mode 4
Printout Datapage on printer
Return to MENU in use automatically
NEXT DATAPAGE NUMBER
DISPLAY DATAPAGE on VDU
<ESCAPE> to MENU in use

A standard menu system of:

Select ....
Look through pages of Data
Go to a Datapage
See Instructions
Return to Disk Menu
Printout a Datapage

has been used in the software. When the menu for Adhesives is being used the first item reads **"Select an Adhesive"**. Similarly **"Select a Joint"** appears when the joining processes menu is used. In all menus consistency has been preserved to ensure ease of operation.

The **Select ....** option of each menu takes the user to lists of processes and/or materials where further selections can be made. The microcomputer then accesses the correct file and reads in appropriate datapage numbers, control is then moved to the page files and datapages with those numbers are displayed.

The **Look through pages of Data** has been provided for the user who wants to browse through the datapages in a similar way to looking through pages of a book. The <CURSOR RIGHT> key moves to the next datapage and the <CURSOR LEFT> key moves back a datapage.

The user has the option of using **Go to a Datapage** to access a particular page they may want to look at. This by-passes the software's filing system. A number checking routine was incorporated in the software to block any incorrectly entered or silly numbers.

See Instructions was incorporated on the menus for users who have cancelled the instruction option in the stem of the software (Figure 5.10) but have forgotten how to proceed. Also a novice user can obtain help quickly. Using the sideways RAM of the microcomputer gives virtual instant access to the instructions, so instilling confidence. **Return to Disk Menu** enables a user to select different branches of the software.

As described in 4.4 of this chapter, the **Printout a Datapage** option enables the user to take hardcopy of a datapage. The **Go to a Datapage** routine described previously, checks page number entries made by the user after which a printout is produced automatically.

4.7 Preparation for the Trials

Before the software was trialled a "truth table", Table 5.5, of all possible combinations of the options was prepared. The options were then set in turn and each menu and list of the software tested to check it functioned correctly. The test consisted of selecting each menu item to check its function; for example, the filing system was checked by selecting each pair of materials in turn to see if the correct pages were presented. The printer options were tested using two Epson printers.

Table 5.5

Truth table used to test all program options

Instructions selected	Information selected	Printer selected
0	0	0
1	0	0
1	1	0
1	1	1
0	1	0
0	1	1
0	0	1

0 = option NOT selected

1 = option selected

In addition to the above test, a short program (Appendix 11) was prepared to print out each of the files holding the information about the material numbers and the page number combinations. Table 5.4 was prepared using this program. Each file was printed and checked for accuracy.

To test the reliability of the software during the trials, line numbers 2955 to 2957 (Appendix 8) were included. The action of this routine ensures that if an error in the program code occurred during the trial the user was asked to report the error line number to the author. The author's name and telephone number were included to expedite correction of the error.

The presentation of the software package was kept simple for the software trials. It was given the title "Design and Technology Data". The cover design reflected the nature of the software's use by using a stylized illustration of a microcomputer, monitor and a selection of design and technology equipment. This was produced on a BBC Master 128 microcomputer using "AMX Super Art", giving a reasonable result when the printouts of the illustrations were reduced by photocopying to improve the resolution. The cover is shown in Appendix 10.

After testing the software using several different Acorn BBC Master 128 computers, disk drives and printers, no errors could be found. To test it in a working situation, an extended trial in schools was organised.

Chapter 6

SOFTWARE TRIALS

Summary

The aims of the software trials are given, together with information about the procedures adopted. Teacher and pupil questionnaire design is outlined, followed by presentation of the data collected. The results are analysed, with particular regard to the free-response comments of the teachers and pupils involved in the trials.

1. Organisation of the Trials

Trials of the "Design and Technology Data" microviewdata system were organised using a number of schools. The aims were to:

(a) enable teachers to introduce a design and technology computer microviewdata system into their teaching and give their opinion about its effectiveness;

(b) enable pupils to use a computer microviewdata system in design and technology lessons and give their opinions about its usefulness;

(c) evaluate the effectiveness of the embedded operating instructions;

(d) compare teacher and pupil reactions to the system devised and the layout of the information screens adopted;

(e) test the software in a design and technology environment and check the technical reliability;

(f) obtain suggestions from teachers about the development of this type of teaching resource.

The trial was planned to take place over one term, giving teachers the opportunity to introduce the system and the pupils time to become accustomed to using it.

Selection of the schools to take part in the trial was based on information received in response to the teachers' survey questionnaire, used in the preliminary investigation. Question 7 of this questionnaire (Appendix 4), asked for information about computer provision in the school CDT department. As the system had been developed to take advantage of the Acorn Advanced Disk Filing system (ADFS), the schools reporting they had a BBC Master 128 computer, disk drive and colour monitor available provided a suitable sample for the trials.

A letter (Appendix 12) setting out details of the trial, and inviting the head of the CDT department in each school to participate, was circulated. The letter pointed out that the "Design and Technology Data" system was to be made available for use by 4th and 5th year pupils in their design and technology lessons during the summer term 1988. It also informed the heads of department that questionnaires would be used to collect information from both staff and pupils using the system. A reply slip (Appendix 13) was included for heads of department to make their reply.

Of the 27 schools contacted, 25 agreed to join the trial. Three of the schools agreeing to participate indicated on their reply slips that they would need to borrow some of the hardware required, as it was not available within their department. Several heads of CDT departments telephoned, asking if it were possible to use the system with pupils in the younger age phase of 11 to 14. This decision was left to individual teachers after they had inspected the contents of the Design and Technology Data system themselves.

The software and teachers' notes were sent to the participating schools in time for the start of the summer term, together with a letter (Appendix 14) indicating that pupil and teacher questionnaires were to follow.

Early in the trials, four heads of department reported the software would not operate satisfactorily. On visiting the schools concerned, three of the faults were due to the disk drive not being set up to be used with the BBC Master computer Advanced Disk Filing system (ADFS). Re-configuring the microcomputer to receive information from the disk drive, solved the problem. The fourth fault was concerned with a school which was operating an Econet system under the guidance of a computer technician. The head of the CDT department had been unable to use any commercial software suitable for use in his lessons and expressed concern about the difficulties in using microcomputers in his department. As the software could not be modified easily to operate on the Econet system this school was unable to continue with the trial.

2. Design of the Questionnaires

The pupil questionnaire used in the software trials (Appendix 15) was designed to gather information in four areas. The first was about the pupil, concentrating on his/her age and if he/she was following an examination GCSE course. The second concentrated on aspects of using the software and its usefulness. The third section was designed to assess the reaction to using a computer microviewdata system during individual project work. Closed questions were considered appropriate for most of the questionnaire (Appendix 15 questions 1 to 5) so that numerical data could be assembled from the responses. Question 6 (Appendix 15) was carefully designed as a closed question with several possible responses. The objective was to test by an internal check, the reliability of the answers. The question asked:

What did you like about the database?

Pupils could give up to six answers from a list. Two items on the list ask a similar question but in different ways. They were:

Not always relying on my teacher for help

and

Finding information for myself

Oppenheim (1966) suggested that asking two questions in this way should give an indication of the consistency of the interviewees' responses.

A final free-response question was included to enable pupils to have the opportunity to comment on "Design and Technology Data".

The teacher questionnaire used in the software trials (Appendix 16) had a similar format of closed questions. Youngman (1978) considered the first stage of a questionnaire to be crucial in establishing the respondents' interest in completing it. Questions 1 and 2 were, therefore, included to collect biographical details of the respondents, particularly the period of time they had used microcomputers in their teaching. The second section, questions 3 to 9, concentrated on the teachers' impressions of the software and its use in their teaching. Several of the questions are similar to those in the pupil questionnaire. For example, question 9 "How easy do you think the pupils found the datapages to understand?" deliberately corresponded to question 5 of the pupil questionnaire, which was "How easy are the datapages to understand?" Similarly, question 7 of the teacher questionnaire corresponded to question 1 of the pupil questionnaire, dealing with the usage of the system. The third section, questions 10 to 12, was included to obtain the teachers' views on the usefulness of the microviewdata system for pupils in the 11 to 14 age phase. Finally, the respondent was given the opportunity to comment and make suggestions for the development of the "Design and Technology Data" software. It was expected that any operating or technical errors would be reported in this section.

The questionnaires were forwarded to the 25 participating schools four weeks after the trials had started. A letter was included, setting out how the questionnaires should be completed (Appendix 17). The timing was planned so that any 5th year pupils who had used the system would be able to respond, as well as any of the other pupils.

3. Questionnaire Returns

Of the 25 schools agreeing to participate in the trials, one failed to get the software to operate as noted earlier, therefore 24 schools were expected to return the questionnaires and the software. Initially 15 schools did this by the date requested in the letter sent out with the questionnaires (Appendix 17).

Telephone calls to each of the schools who had not returned the questionnaires resulted in one more set of completed questionnaires being received. A reminder letter (Appendix 18) resulted in the return of the outstanding software, but the questionnaires had not been completed. Heads of CDT departments in three of these schools explained that they had been unable to try the software with pupils because the department's microcomputer equipment had failed. In one case, the head of department had unsuccessfully tried to borrow a replacement disk drive from within the school. Another head of department had not been able to borrow the necessary hardware from the computer studies department in his school. Staff absence in another school, had made it very difficult for the head of department to find the time to trial the software.

4. Pupil Questionnaire Results

The results of the questionnaire are set out in Table 6.1. The total number of pupil respondents was 168. The majority of the pupils (108) were in the 15 to 16 year age phase, of whom 94 were following GCSE courses. Seventeen 14 year old pupils also indicated they were following GCSE courses. 53% of the pupils had used "Design and Technology Data" sometimes, or many times, during the term, with a smaller percentage of 43% using it rarely. Only 4.8% of the pupils had not used it, but since they had completed the questionnaires, they must have been instructed in how to use it, or they had browsed through it at some time during their lessons.

The majority of pupils (158) claimed to have found the instructions easy to follow and a similar number claimed to have found it easy to use. The response to question 4, indicated "Design and Technology Data" had been useful to 71% of the pupils during their project work. The 29% of pupils who did not get any information of use to them, probably could not find information relevant to their project.

Table 6.1

Pupil questionnaire results from software trials: questions 1-6

Total number of questionnaires completed 168

Age of pupils	13 yrs	14 yrs	15 yrs	16 yrs
number	16	44	90	18
%	9.5	26.2	53.6	10.7

Number following GCSE course

number	111	Number in 15 to 16 yr age phase	94
%	66		

1) **How often did you use the database?**

	Many times	Sometimes	Rarely	Not at all
number	16	71	73	8
%	9.5	42.3	43.4	4.8

2) **How easy did you find the instructions to follow?**

	Very easy	Fairly easy	Fairly difficult	Very difficult
number	55	103	6	4
%	32.7	61.3	3.6	2.4

3) **How easy did you find the database to use?**

	Very easy	Fairly easy	Fairly difficult	Very difficult
number	50	110	5	3
%	29.8	65.5	3.0	1.7

4) **How useful was the database in helping with your project work?**

	Very useful	Fairly useful	Not very useful	No help at all
number	40	79	30	19
%	23.8	47.0	17.9	11.3

Table 6.1 (Continued)

5) **How easy were the datapages to understand?**

	Very easy	Fairly easy	Fairly difficult	Very difficult
number	59	94	10	5
%	35.1	56.0	6.0	2.9

6) **What do you like about the database?** Please tick as many boxes as necessary.

		%
Using the computer	111	66
Not always relying on my teacher for help	91	54.2
Able to get on with my project work quickly	79	47
Getting printouts of the datapages for my folio	40	23.8
Finding information for myself	106	63.1
Nothing	6	3.6

This is indicated by such comments (Table 6.2) as:

> "I found that joints I will need for my major project were few and far between." (comment 10)
>
> and
>
> "The database was not really useful to my project, because it didn't tell you which joints to use." (comment 26)

These comments and others indicate that several pupils were looking for woodwork joints. Obviously, they were following a traditional woodwork course, which "Design and Technology Data" does not cater for.

Most of the pupils found the datapages very easy (59) or fairly easy to understand, with only 15 pupils experiencing difficulties. Several pupils made comments about the datapages. Two indicated the level was too low:

> "It was OK, some people may find it too easy, like me." (comment 33)
>
> and
>
> "The database seemed to have been designed for a younger age group." (comment 43)

Ten of the pupils made comments about the graphics on the datapages. One pupil commented favourably:

> "Easy to understand and well presented. Good graphics. Covers everything you need to know." (comment 45)

Another pupil disapproved of the graphics, making the following comment:

> "I could do without the pretty pictures." (comment 28)

Nine other pupils suggested that more graphics should be used on the datapages.

The results of question 6 are shown in Figure 6.1. 66% of the pupils recorded that they liked using the computer as a source of information. A similar number, 63%, indicated that they liked

Table 6.2

Pupil questionnaire results from software trials: question 7

Responses to Question 7 unedited, except for correcting spelling mistakes.

Pupil Comments

1. The database would be better with a few more diagrams.
2. Interesting to use and very useful and quick.
3. Fairly interesting.
4. It would be better if there were more diagrams.
5. Slow printout, but very good quality.
6. It means that you can work at your own speed.
7. It was too slow between pages.
8. When it says pick a page number, you don't know what is on the pages.
9. Clear instructions, so it was simple to understand.
10. I found that joints I will need for my major project were few and far between. I only found one single joint for chipboard to chipboard.
11. Very good.
12. I like lots of different methods of doing things.
13. There was not enough information on woods.
14. The only problem with the database is, all the page numbers have to be found by us.
15. Limited uses - not all pages were available.
16. Limited practicality - arrived too late.
17. Did not have very large range.
18. Some relevant material is missing.
19. Not enough on certain topics.
20. It was very useful
21. Did not show all information wanted.
22. The information is easy to understand.
23. More explanations required on certain joints.
24. It didn't show you how to use it properly and clearly.

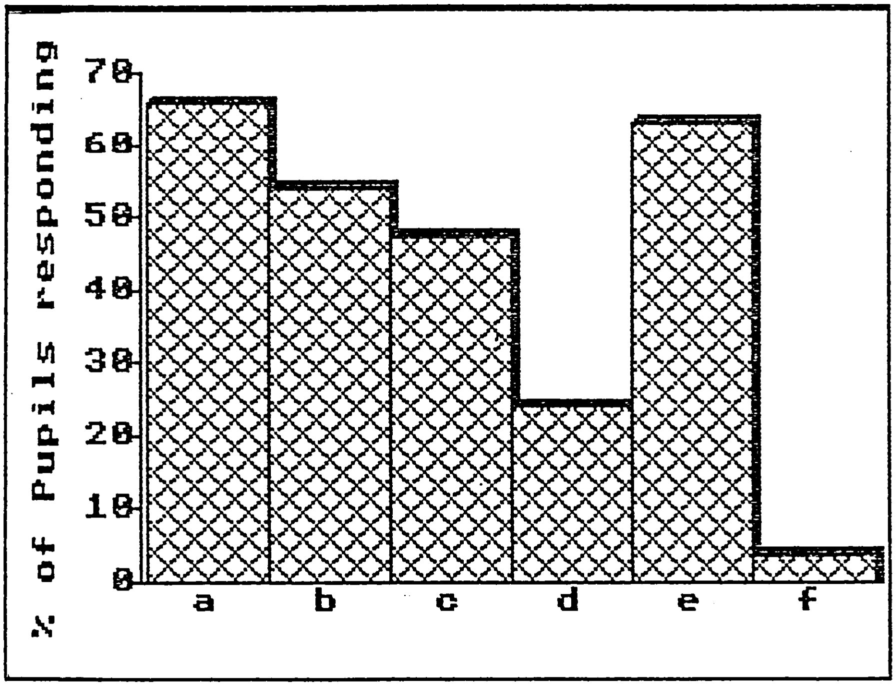
Table 6.2 (Continued)

25. When programming the computer to get joints and show you how to make them, it doesn't.
26. The database was not really useful to my project because it didn't tell you which joints to use.
27. More detailed pictures to show the instructions.
28. I could do without the pretty pictures.
29. It should have more useful pages to choose from.
30. There could be more information about different things, but I thought it was straight forward, more or less.
31. Sometimes it can be easy for other people.
32. It was a bit boring just reading, you could make it better by having to draw or design ideas.
33. It was OK, some people may find it too easy, like me.
34. It was OK, but didn't always give you the information you wanted.
35. I found it very useful. I used it while doing my project, it helped me and I got it done very quickly.
36. Instructions may not be too clear, but otherwise I found it pretty good.
37. Slow and boring.
38. Slow and very boring.
39. It was good to use and quite useful.
40. The database could have more diagrams to make it more interesting.
41. The database could do with more pictures.
42. More pictures. Printout bigger.
43. The database seemed to have been designed for a younger age group.
44. Didn't help my knowledge at all.
45. Easy to understand and well presented. Good graphics. Covers everything you need to know.
46. A bit complicated to get adhesives.
47. The only problem is that you'd need at least 2 systems per class, otherwise you'd get queues.
48. It made my course much more fun. More graphics would have improved the program.

"Finding information for myself". The 47% who liked getting on with their project work quickly, had benefited from having the "Design and Technology Data" available. The reliability check designed into question 6 provided evidence that respondents were replying consistently. Of the 63 percent of pupils recording that they liked "Finding information for myself" 89 percent also answered that they liked "Not always relying on my teacher for help".

Figure 6.1

Pupils' reasons for liking "Design and Technology Data" : question 6 of the pupil questionnaire



a = Using the computer

b = Not always relying on my teacher for help

c = Able to get on with my project work quickly

d = Getting printouts of the datapages for my folio

e = Finding information for myself

f = Nothing

Two pupils made the following comments about the usefulness of "Design and Technology Data":

> "I found it very useful. I used it when doing my project. It helped me and I got it done very quickly." (comment 35)

and

> "It means you can work at your own speed." (comment 6)

Only 25% of the pupils found the printout facility useful, but it is not known whether a printer was available for use by the pupils at the time the software was in use. One pupil commented:

> "More pictures. Bigger printout." (comment 42)

48 pupils made additional comments about "Design and Technology Data". A quarter of these comments related to the lack of information pages about topics the pupil was researching for. Eleven pupils made positive comments about the usefulness of the system, one pupil commenting:

> "It made my course much more fun." (comment 48)

5. **Teacher Questionnaire Results**

31 teacher questionnaires were returned. Some heads of departments had involved other members of staff in the trial, in one case four teachers, while others had used the software only with their own pupils. Two of the heads of department returned their completed questionnaires, but had not asked pupils to complete theirs. In one case, the head of department commented that the pupils required more time to use the system. The results of the questionnaire are shown in Table 6.3.

A diagramatic representation of responses to questions 1 and 2 is given in Figures 6.2 and 6.3.

Table 6.3

Teacher questionnaire results from software trials: questions 1-11

Total number of questionnaires completed 31

1) **How many years have you been teaching?**

more than 10	5 to 10	2 to 5	less than 2
22	6	2	1

2) **How long have you been using computers in your teaching?**

more than 5 years	2 to 5 years	less than 2 years	not at all
1	12	16	2

3) **How useful did you find the teachers' notes?**

very useful	fairly useful	not very useful	no use at all
7	20	2	2

4) **How easy was it to introduce the database to pupils?**

very easy	fairly easy	fairly difficult	very difficult
12	18	1	0

5) **How easy do you think the database is to operate?**

very easy	fairly easy	fairly difficult	very difficult
18	12	1	0

6) **How did pupils react to the introduction of the database?**

enthusiastically	interested	little interest	no interest at all
9	21	1	0

Table 6.3 (Continued)

7) **How often did the pupils use the database?**

many times	sometimes	rarely	not at all
2	27	2	0

8) **How attractive did you find the layout and presentation of the datapages?**

very attractive	attractive	mediocre	boring
10	16	5	0

9) **How easy do you think the pupils found the datapages to understand?**

very easy	fairly easy	fairly difficult	very difficult
9	20	2	0

10) **Did you use the database with pupils in the 11 to 14 age phase?**

yes	no
21	10

11) **How useful do you think the database is for pupils in the 11 to 14 age phase?**

very useful	useful	can be used with modifications	no use at all
9	7	5	0

Figure 6.2

Teacher Experience
Question 1 of the teacher questionnaire

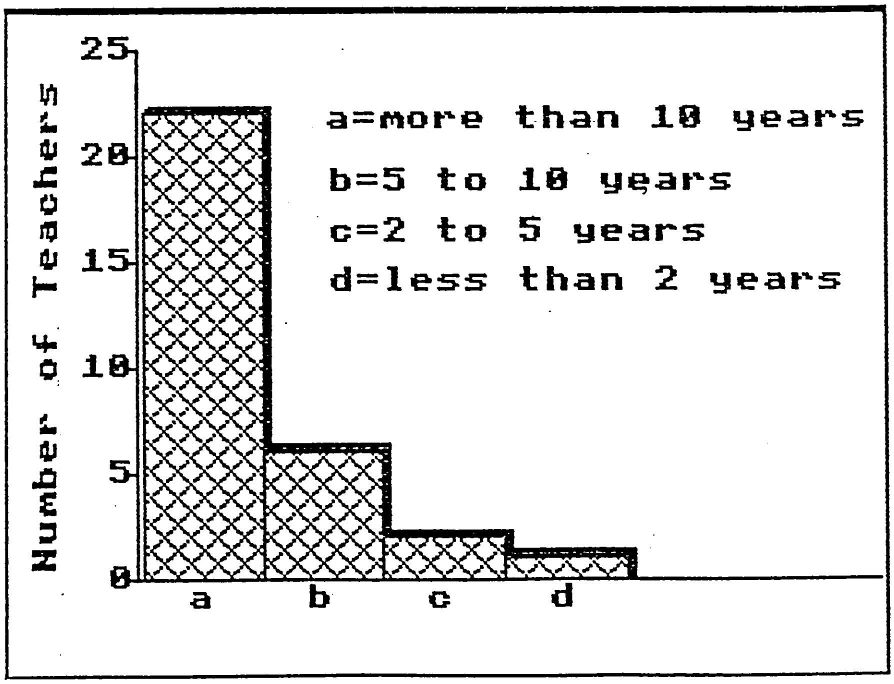
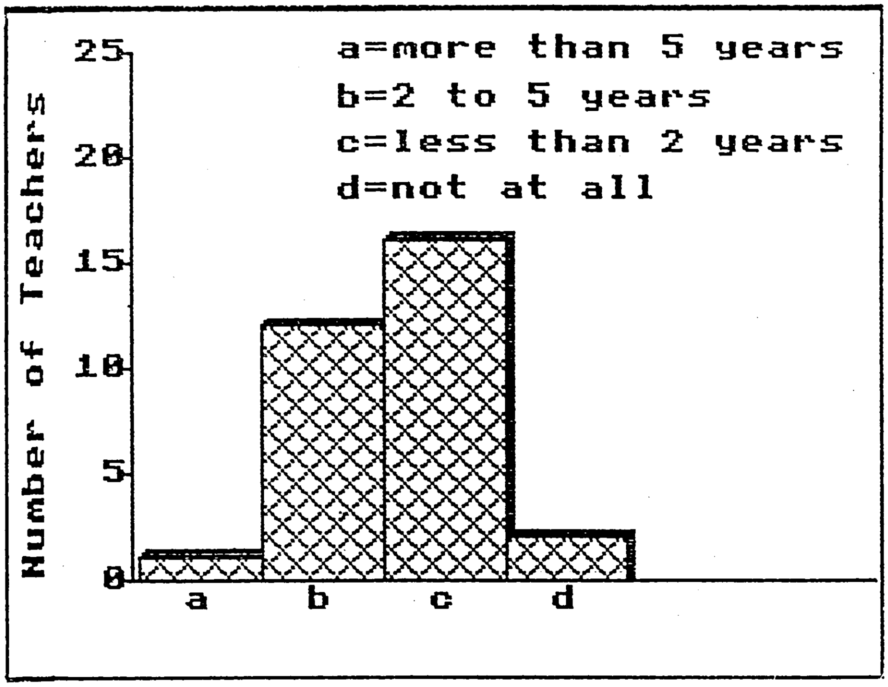


Figure 6.3

Teachers' experience of using computers:
Question 2 of the teacher questionnaire



The majority of the teachers had been teaching for more that 10 years. (Figure 6.2) However, the results of question 2 indicate that they had not been using microcomputers in their teaching for very long. Sixteen teachers recorded less than 2 years and 12 teachers 2 to 5 years. (Figure 6.3) As computers have been in use in design and technology since the early 1980s, the group of teachers trialling the database did not have as much experience with microcomputers as might be expected. In fact, only 1 teacher recorded more than 5 years of microcomputer use in his teaching.

Table 6.4 is a list of the teachers' comments. The ID Number, that is 15 in the first record, was allocated to each school when the teacher questionnaires (Appendix 4) were returned. The second number identifies members of staff in the same school, therefore ID No 15/2 is school 15 member of staff 2.

The teachers' notes were found useful or very useful by 27 of the teachers, but one teacher suggested they were not necessary, commenting:

> "I found that the teachers notes weren't really needed. The program was self-explanatory, hence the response to question 3." (Table 6.4 ID No 56/1/15)

The majority of the teachers found "Design and Technology Data" "very easy" or "fairly easy" to introduce to the pupils and the same number found its operation "very easy" or "easy". Teachers recorded that the pupil reaction to the introduction was satisfactory (question 6) with 9 recording that it had been received "enthusiastically" and 21 "interested". Four teachers commented that it would have been better to introduce the system in the autumn term. In fact, these teachers requested the software to be returned to their schools for more extensive trials when new projects are being started. These teachers felt that the software would have greater use at the beginning of a project, when pupils were more likely to be searching for information.

Teachers recorded that the software had been used "sometimes" (87%) or "many times" (6%) indicating that, in their opinion, it had been used adequately during the trial.

Table 6.4

Teacher questionnaire results from software trials: questions 12-15

ID No	Quest. No	Comment
15/1	13	Some information on graphics to be used in Craft, Design and Communication lessons. Methods of drawing etc.
	15	I would like to use it with lower school groups more. Also the fifth years would find it more useful in the Autumn term when they are further on with their projects.
15/2	13	Further information on fastenings. Accessories - handles, catches etc.
19/1	12	It does not always seem possible to escape to menu from a datapage.
	14	The database is very slow to operate, perhaps this is a fault of the filing system.
19/2	13	Design and Communication data B.S.S. spec. etc.
	14	Speed of printout.
22/1	12	Index
29/1	13	Electronics (simple basic stuff). Then another database dedicated to electronics up to A level. Please note that I only had chance to use it with a few classes due to it being the usual end of project work chaos. I would like to borrow it again in September, when the new work gets underway. The real value of the system could be put to the test, and pupils could fill in their questionnaires from a position of familiarity rather than the odd lesson input.
40/1	12	A book of information to be covered or a simple index of the information covered on each page.
	13	Circuit diagrams and mechanisms for GCSE groups.

Table 6.4 (Continued)

	14	Greater use of visual illustrations for lower school groups.
40/1	15	The summer term is not the best of occasions to introduce the package. The Autumn term would have seen greater use of the program within GCSE groups.
40/2	14	I would like to see greater use of visual illustrations eg diagrams, as examples to the text.
	15	Due to the fact that the summer term has been broken up with a number of activities not concerned with CDT, I would wish to continue the use of this software in the Autumn term.
43/1	13	Costing materials.
	14	Faster to use - more on the screen at once.
46/1	12	More data.
54/1	13	Would like to see both general and specific anthropometric data as BSI PP7310 and Dreyfuss-converted of course, and other BSI standards relating to design. Sources of resource info - national bodies willing to help etc. Materials information functions.
	15	I am only sorry that time and equipment have meant a limited use. (Only one Master in Department which is for Plotmate and Boxford 125 TCL). Nevertheless, this is an excellent start in such a vastly developing field.
54/2	13	Anthropometric data. Materials, uses and characteristics. Electronic info / techniques / principles. Mechanisms / structures.
56/1	13	None. There appeared to be sufficient for the needs of my pupils at this stage.
	14	The screens were difficult to read unless used on a colour monitor.
	15	I found that the teachers' notes weren't really needed. The program was self explanatory hence the responses to question 3.

Table 6.4 (Continued)

		Pupils found the screens difficult to follow on a green screen monitor, hence the response to question 8 and question 9. Due to the stage that the pupils were at with their design work, it was rarely used. I would have used it lower down the school though, if given the chance.
56/1	15	The poor response to the questionnaire is due to the external and internal exams, Trident etc, which the pupils were involved in.
	Note	Many thanks for letting me look at and use this package and please do not hesitate to send any further software of this nature if you require it to be trialed.
71/2	13	Less written information, it assumes the level of reading age.
	14	More diagrams. More information.
71/3	12	More detail on the procedure for joining material. Concentrate on the simple joining techniques. Relate to common usage materials.
	13	Applications of materials. Shaping/forming techniques need expanding.
	14	Electronic input. (Timing circuits and comparison circuits).
73/1	13	Properties of materials. Identification of materials.
	14	Would it be possible to have names of selected materials displayed on datapages?
73/2	13	Electronics. Hammerite data chart. Science related technology. Conversion charts eg inch - mm, ft/lb - Newtons.
	14	A version for Archimedes.
74/1	12	Better and more detailed graphics if possible
	13	Explanation of graphical terms and techniques More diagrams. Various wood joints increased.
	14	General all round increase in knowledge.

Table 6.4 (Continued)

	Note	The CDT Dept would like to purchase a copy of this data disc as soon as possible. Please keep me informed of the progress.
74/2	13	Stages in Design. Definitions of names and terms, in Research, Analysis as applied to GCSE.
	14	Depth of information ie wood joints. Different types of joints, reasons for choice. Properties of materials.
77/1	13	The showing (diagrams and notes) of techniques eg cutting a through housing joint.
79/1	13	Heat treatment of metals eg annealing, case hardening and tempering.
	14	Inclusion of page index. (Brazing torches - most schools now equipped with single rotary gas/air control valve)
	15	Some notable omissions - nothing on soft soldering; use of compound slide for taper turning; colour coding of silver solder; rivet allowance. Might be simpler to refer to borax flux rather than trade names.
82/1	12	Printing needs to be quicker and search method for preparation for printing. Needs an index of all pages.
	13	Carcase and frame joints. Electronic data and components. Information on structures, gears, pulleys etc. Material qualities ie ply, hardwoods, softwoods, acrylic, PVC, etc.
	14	When page is located, one or two keys ought to be pressed for printout.
	15	Very good database which I would like to have available - will miss it while you are updating it.
	Note	We only have the one computer and therefore it is required by other staff for other uses. Apologies for few returns but database has good potential.

Table 6.4 (Continued)

99/1	Comments attached to questionnaire	
	a	It should tell the user that ADFS is necessary.
	b	When you move down the menu the cursor scrolls back to the top option. The opposite does not apply.
	c	Instructions are very good and self explanatory.
	d	Good printer information.
	e	Slow printout but high quality print set.
99/1	f	The text is well arranged and complemented with nice graphics. However, colours could be cut down to make foreground text easier to read. Double height characters in Mode 7 would be advantageous on some headings.
	g	The printing excellent and well used. Would benefit from the harnessing of the bi-directional printing facility.

The datapages were considered to be "very attractive" (10) or "attractive" (16) by the teachers. One teacher commented:

> "The text is well arranged and complemented with nice graphics. However, colours could be cut down to make foreground text easier to read." (comment 99/1/f)

Another teacher, however, had experienced difficulties with the equipment he was using, commenting:

> "The screens were difficult to read, unless used on a colour monitor." (ID 56/1/14)

This school did indicate in the earlier teacher questionnaire, (Table 3.5 question 7), used in the preliminary investigation, that the CDT department had the equipment available. It would appear they had not been able to use it in the trial.

Most teachers considered the datapages "very easy" (9) or "fairly easy" (20) to understand. Four teachers commented that more graphics should be used on the datapages.

Two thirds (21) of the teachers had tried the system with 11 to 14 year age phase pupils, and of these, 9 felt it was "very useful" and 7 "useful". Five teachers recorded it could be used with modifications. The most common modification suggested was the inclusion of an index of some type. One suggestion was that this could be in the form of a book.

22 teachers responded to the request for comments in questions 13, 14 and 15. Question 13, the request for suggestions for information to be included in any future developments of the "Design and Technology Data", produced 10 categories of suggestions. The categories and the number of teachers making suggestions in each category is shown in Table 6.5. Electronics

Table 6.5

Suggestions for additional information in the database (Question 13)

Teachers' suggestions	Number of teachers making suggestion
Graphics	3
Electronics, including circuit diagrams	5
Costing materials	1
Heat treatment of metals	1
Anthropometric data	2
Expansion of the joining materials section to include other fastening devices	3
Properties and identification of materials	3
Technological conversion charts	1
Technological information on gears, mechanisms and structures	3
Stages in the design process	1

Table 6.6

Suggestions for improvements to the database (Question 14)

Teachers' suggestions	Number of teachers making suggestion
Increase speed of operation	2
Improve the operation and speed of printout	2
More visual illustrations	2
More information	3
Suitable for use with monochrome monitor	1
Materials displayed on datapages	1
Index	1
Version for the Archimedes microcomputer	1

data is the most common suggestion. Graphic techniques, properties of materials and an expansion of the joining section, occur equally. Question 14, dealing with suggested improvements to the system, received fewer responses (Table 6.6). The notable points were:

further calls for more visual illustrations,

an increase in the speed of operation of the system,

improvements to the speed of producing a printout of a datapage,

the inclusion of more information.

The request for further comments, question 15, brought 7 varied comments of a more general nature. Two teachers commented favourably:

> "Very good database, which I would like to have available - will miss it while you are updating it." (ID 82/1/15)

and

> "I am only sorry that time and equipment have meant a limited use. ..... Nevertheless, this is an excellent start in such a vastly developing field."

One teacher used the opportunity to record what he thought were notable omissions. (ID 79/1/15). These omissions were about traditional metalwork topics, which had not been included in "Design and Technology Data" because it had been developed for use in schools following design and technology courses.

The teachers' questionnaire did not contain any reports of the software failing to operate correctly, and no telephone calls were received by the author to report any error messages. It is assumed, therefore, that the error message embedded in the program, (Appendix 8 lines 2955 to 2957), was not seen by any of the teachers or reported by the pupils using the software.

Chapter 7

CONCLUSION

1. The Feasibility Study

This feasibility study was prompted by the change from material-based craftwork in schools to project-based design and technology which required pupils to be more independent learners, able to search out information for themselves. From early observation it appeared that teachers were acting as information providers rather than managing project sessions in ways which encouraged pupils to be more self-sufficient learners. Clearly there was a need to provide an alternative source of routine factual information for pupils.

The overall aim of this feasibility study, as pointed out in Chapter 1 pages 36 and 37, was to produce and trial a microcomputer database for pupils to use during their design and technology project work. By providing such a resource it was hoped that pupils would be able to work more independently and so make better progress with their project work.

A preliminary investigation was carried out to:

study the methods used by pupils to gather information;

observe how teachers managed project sessions in design and technology.

To help in compiling the database, a survey of school design and technology departments was carried out to investigate:

materials, equipment and resources (including microcomputer provision);

current working practices.

After reviewing a range of database and microviewdata utility software, both software and information datapages for a hybrid microviewdata system were written. The system developed was trialled in a number of schools to evaluate its usefulness and check its reliability.

This chapter presents the main conclusions of the feasibility study and offers suggestions for further development and investigation.

2. Results of the Preliminary Investigation

2.1 Observation of Lessons

Three groups of pupils were observed, two working on individual design and technology projects, the third working to a design brief structured by the teacher. It was evident from the author's observations of these groups that pupils did not search out information for themselves. As a result, the teachers were kept very busy handing out routine information mainly concerned with the selection and use of appropriate materials, tools and processes. In fact the rate of questioning of approximately one question every two minutes (page 75) represented a heavy work load for the teacher, particularly onerous when the wide range of activity encompassed by design and technology is taken into account.

Two further findings emerged. Regardless of the type of project, approximately four out of five questions (Table 3.1 page 74) were initiated by the pupils, thus indicating their need for information. But in the case of more structured project work, fewer questions overall were asked by both pupils and teachers, indicating less information was required. It seems therefore, the more open-ended the project work the greater the need for pupils to have access to information. As open-ended project work is becoming more widespread in design and technology, providing pupils with a source of information other than the teacher, appeared to be a sensible proposition.

The observation schedule devised was useful in gaining an overview of the way pupils worked during their lessons, particularly with respect to the selection of tools, materials and processes. It also provided numerical data about the areas of practical project work where pupils appeared to be having most difficulty (Table 3.2 page 78). This information was particularly helpful when developing the subsequent interview schedule.

Noisy workshops with pupils moving around specialist facilities was a difficult environment for trying to focus on the discussion between teacher and pupil with regard to questions being asked. Data collected, however, proved to be useful when triangulated with the subsequent pupil interviews, so giving a measure of verification to the preliminary investigation.

2.2 **The Pupil Interviews**

Pupil interviews shed more light on the findings of the observations discussed above. Namely, they confirmed that pupils were relying mainly on the teacher for information (Table 3.4 page 94). There was some evidence, however, that pupils could make decisions for themselves, provided they had some previous experience or knowledge, for example, selecting from a limited range of materials and finishes (Table 3.3 No 2 and No 18 pages 82 and 91 respectively). Significantly, the interviews showed pupils were aware that books and information sheets could be a source of help (Table 3.3 No 23 page 93), but rarely did they consider using them. This was despite the fact that the schools used for observation and pupil interviews had good reputations for design and technology. There could be two possible reasons for this. Firstly, the schools where pupils were interviewed did not appear to have a supply of books and information sheets readily available for pupils to consult. Text books were not seen to be used by any pupils during practical sessions. Secondly the pupils may not have been encouraged to search out information during the earlier years of their design and technology education.

The interviews revealed that pupils did, in fact, have difficulty when making decisions concerning the selection of tools, components and processes during their project work. Clearly this was one aspect of design and technology where pupils needed help. This information provided a focus for the preparation of the proposed database. In accordance with Wragg's (1978, ii) recommendations on timing and location, all interviews were conducted while pupils were working on their projects. This was a useful strategy as several pupils referred to their project work during the interviews. CDT departments, however, were difficult environments in which to conduct interviews because of noise and activity.

If the ability to make decisions, particularly those related to designing and making, feature as an aim of design and technology education, pupils should be put in situations which encourage them to be more independent learners. This involves providing sources of help other than the teacher, and encouraging pupils to use them. The preliminary investigation confirmed that many pupils were not gathering information for themselves but were relying mainly on the teacher. But as the number of lessons observed and pupils interviewed was small, the results can provide only a tentative indication of what may be the general position.

2.3 The Teacher Questionnaire

The survey questionnaire circulated to 104 comprehensive schools in the Yorkshire/North Derbyshire region had an excellent response rate (82%). As pointed out in Chapter 3 (page 72) the questionnaire was designed to gather three categories of information. The first was factual information for inclusion in the database: a large quantity of data was gathered about the materials, equipment and resources used for teaching design and technology. This was used when composing the datapages incorporated in the software, but it was impossible to use all the information received, as writing the datapages proved to be very time consuming. Information not used is of course available to extend the database at a later date.

The second category was data about microcomputer provision in school design and technology. The results confirmed the author's impression that the Acorn BBC range of microcomputers predominate in the region (Table 3.5 Question 7 page 102). This information was essential both when writing the software for a specific microcomputer and also for ensuring that the microcomputer was available in sufficient numbers to run software trials in the schools. The survey questionnaire results showed the disappointing fact that 27% of the teachers responding did not have a microcomputer available for use in their workshop.

The third category of information was more complex as it dealt with working practices. Table 3.6 (page 103) shows that only approximately 30% of the schools had displays of materials and components. In the majority of schools, therefore, pupils had little or no opportunity to see the range of materials available, and therefore select what they required. With the benefit of hindsight a further question inviting teachers to state if other information resources were available to pupils could have explored this more fully. Similarly, while the question about text books gave an indication of availability, it was not clear if pupils actually used them during lessons. An additional question on this issue might have clarified this. The majority of teachers responding to the questionnaire (88%) said pupils **did** have access to text books during lessons. In one of the schools used for observation, several sets of text books were stored in glass fronted cupboards in the workshops but, as pointed out previously, pupils did not attempt to make use of them. Almost half the pupils (13) interviewed said that books could be consulted (question 23 page 93) but only four pupils said they would look in a book for help when their teacher was busy with another pupil (question 22 page 92). One can conclude therefore, that although books were available as mentioned previously, pupils may not have been taught to use them for reference purposes. It is also possible that the books did not contain information dealing with the required routine workshop matters.

The results of questions 8f to 8i (Table 3.6 page 103) dealing with health and safety issues, provided limited guidance for the preparation of datapages. In two cases (8f and 8g) the results were inconclusive as equal numbers of teachers responded "yes" and "no". Half the teachers would let pupils set up machines in general and drilling machines in particular. The responses to questions 8h and 8i gave a clearer indication of current practice when using lathes and bandsaws. More than two-thirds of the teachers would allow a pupil to set up a lathe. Clearly teachers considered the belt shifting operation required to change the speed of a drilling machine was hazardous, yet most considered shifting the gears on a lathe was a suitable task for pupils. Two-thirds of the teachers felt pupils should not use small bandsaws.

The overall results of these four questions left doubts about current workshop practice as it appeared that teachers' opinions varied considerably regarding the use of machinery. It was thought wise, therefore, to include concise warnings about using machinery safely on several datapages to warn pupils of possible dangers, and ensure the software met with teachers' approval.

3. Software Survey and Design

The investigation into suitable utility software centred on databases and microviewdata systems. There was an abundance of database software suitable for school use but as pointed out by Davis (1985) and Webster (1986) pupils can have difficulties using search words. The author concluded that the database software surveyed can be useful for carefully organised text and numerical data but was less suitable for an information system.

Microviewdata software which emulates an on-line viewdata system on a microcomputer was also readily available and had been used successfully in several schools. Of the software evaluated CommunITel and Seafax were found to be the most satisfactory. However, both had the same disadvantages, namely a limited number of pages and a difficult routed pages system which meant that it was not possible to search for specific information. The author considered a search system similar, but simplified, to that used in the NERIS database, should be an essential feature of the planned microviewdata system. The intention was to enable pupils to access relevant datapages quickly and accurately.

As pointed out on page 132, the software developed was a hybrid system combining the search advantages of a database with the economical datapage layout of a microviewdata system. Recommendations from the research of Reynolds (1980) into text screen layout and colour combinations proved useful when designing datapage layouts. However, the task of preparing and editing datapages to meet published guidelines (Alderson and DeWolf 1984) proved to be very time consuming, thus the microviewdata software was deliberately limited to selected aspects of design and technology. As mentioned in 2.4 above, the teachers' survey questionnaire provided more information than could be incorporated in the system in the time available.

The Acorn BBC Master microcomputer with the Advanced Disk Filing System (ADFS) proved ideal for operating the microviewdata software developed. The ADFS provided considerable flexibility for the operation of both page number and datapage files. As a storage medium, 80 track disks and ADFS have potential for further development for use in school microviewdata systems. Each design and technology workshop and studio could have its own dedicated microviewdata work station using readily available, relatively cheap, microcomputer hardware.

4. Results of Trials

Trials of the "Design and Technology Data" software were carried out in 25 schools, the basis for selection being the availability of an Acorn BBC Master 128 microcomputer as reported by teachers in the survey questionnaire (Table 3.5 question 7 page 102). Overall the software was well received by both pupils and teachers, even though it did not purport to be a fully comprehensive source of information.

While teachers and pupils generally reported that they liked using the software, considerable pressure was on them to complete examination projects. In hindsight it appeared that the Summer Term was not the ideal time to conduct software trials. As pointed out by one teacher, the Autumn Term would have been more appropriate as GCSE pupils would then be fully engaged on individual project work (Table 6.4 page 182 identity 40/1).

Although the number of questionnaires (168) completed by pupils was not as high as expected, enough data was obtained to indicate that the software had generally been useful during their project work. There was clear evidence that pupils were prepared to find information from the "Design and Technology Data" software. The reliability of the questionnaire was verified by the results of question 6 outlined on pages 170 and 173.

The response rate to the teachers' questionnaire was higher (31 teachers in 24 schools) and the overall response to the software was positive. The majority of teachers had been using microcomputers for only a short time (Figure 6.3 page 176) yet apparently they found no difficulty in incorporating the package into their teaching. Although the software had been designed for 4th and 5th year pupils, 21 teachers had used it with pupils in the 11 to 14 age phase and found it helpful. Teachers' comments were particularly valuable as a means of assessing the usefulness of the software, as they could provide the basis for future development. Overall it seemed that a microviewdata system could be a valuable resource for pupils throughout the secondary age phase.

5. Future Developments

5.1 Development of the Present Microviewdata System

During the trials, no program errors were reported by teachers, nor were any faults reported when answering the questionnaire. It is reasonable to assume, therefore, that the software performed well and was fault free. However, there is considerable scope for improvement and expansion. The software trialled had a total of 161 datapages plus the datafiles and program code, yet it used only approximately half the available disk space. The program code was written with the minimum number of multi-command lines to aid development. Compressing the code into multi-command lines would release further disk space for datapages and also reduce the time taken to access them. Further improvements could be achieved by holding the datafile information in dimensioned arrays. This would speed up the access time considerably as the microcomputer would not be required to search the disk each time an enquiry was made. With these improvements the datapage capacity would be in excess of 400 pages, which would represent a considerable improvement over systems such as CommunITel and Seafax.

As reported on page 164, four schools required assistance with the configuration of their disk drives to enable them to operate the ADFS system. Additional information to enable teachers to do this needs to be incorporated in the instructions.

The inclusion of the printout option proved to be worthwhile. Forty pupils indicated they liked getting printouts of the datapages for use in their design folios (Table 6.1 Question 6 page 169). The time taken to convert and print a datapage could be reduced considerably with refinement of the code. Also, as colour printers become more common in schools, an option to print out datapages in colour needs to be incorporated. The Integrex colour printer is particularly well suited to this task as the machine contains a Teletext character set which produces good results. The sample datapages in this thesis were produced in this way and then colour photocopied.

A further important development of the software would be to provide an option for teachers to prepare their own datapages and integrate them into the filing system. This would enable them to add information pertinent to their own courses. The process of producing datapages could itself be an ideal pupil design project, as described by Futcher (1986).

5.2 **Hardware Developments**

As explained earlier, the software was developed for the BBC Master microcomputer as this was a popular computer in school design and technology departments when the feasibility study was carried out. However, at the time of writing, the eight-bit microcomputer was rapidly being replaced by more advanced 16-32 bit technology of a new generation of machines. Personal Computers (PCs) as used in industry and business were also finding a place in schools. Newer machines, such as the Acorn Archimedes, appeared to be following, and improving on, the Apple Macintosh by providing an easy-to-use desktop environment featuring windows, icons, menus and pointers (WIMP). Such machines also have a vastly improved graphics capability as well as greater processing power than the previous generation of microcomputers. It could be possible that these attributes make electronically stored "textbooks" a reality.

The proliferation of different microcomputer systems in schools produces problems for software developers. Several microcomputer hardware manufacturers have produced emulation programs aimed at solving problems of portability of software from one machine to another. For example, Commodore produced a BBC Basic emulator for their Amiga. This was tested by the author but it was only able to emulate the simplest of BBC BASIC programs. It would not run the software produced for this feasibility study. The Acorn Archimedes, however, was able to run the software after minor changes had been made to the memory locations used for the instruction datapages. The capability of this microcomputer could be exploited to improve the quality of datapages which rely on graphics to convey information. The relatively crude Teletext graphics used in "Design and Technology Data" to describe, for example, metal and plastic turning (Software datapage 244) could be vastly improved.

While the software was successful, it was rather limited in the way it could deal with some aspects of design and technology. Fabricating methods, an area of difficulty highlighted in the preliminary research was such a topic. For example, the software uses two graphics and one text datapage to describe how a pop-rivet is used (Software datapages 320, 321 and 322). The description of the operation could be far more effective, however, if shown as a sequence of moving pictures with commentary. This could be stored on video disc but accessed from the microviewdata system. Also this could be done using video tape as pointed out on page 107, but the sequential search necessary for a tape system would be rather slow compared with the more advanced video discs.

However, making videos of a range of workshop processes would require professional expertise and equipment, as well as being expensive. Producing video discs in relatively small numbers for the education market is also expensive. Nevertheless in the author's opinion interactive video systems, as discussed in Chapter 4 (page 108), represent the most attractive information system for use in schools at the time of writing. The recently developed compact disk read only memory (CD ROM) has considerable potential for development of interactive information systems. Unfortunately, the development of such technologically advanced systems for use in education has been slow. In the author's opinion two problems exist. Firstly, when technologically advanced hardware becomes available, strategies for developing appropriate educational software appear haphazard. Secondly, schools rarely have the financial resources to invest in sufficient equipment and software to make a new learning resource readily available to pupils. As discussed in Chapter 2 (pages 39 and 40) the DTI have provided considerable funds to promote the use of microcomputers in schools, but such financial support needs to be increased if pupils are to be given access to new educational technology such as interactive video.

5.3 **Educational Developments**

As identified in Chapter 1 the "research" aspect of design and technology has considerable educational value, yet as the preliminary investigation of this study has shown, pupils were not fully engaged in finding information for themselves. A further more comprehensive investigation, confined to the "research" activity in design and technology could provide more conclusive evidence that this is a weak aspect of the discipline. Monitoring individual pupils' progress as they work through their projects could be a useful investigation strategy. This study has also highlighted the need for more focussed development of possible methods teachers can use to develop research and information gathering skills as part of pupils' design and technology courses.*

Meanwhile, to enable pupils to develop research skills, a comprehensive design and technology microviewdata system could be developed. Provision of such a system in a large number of schools could give design and technology teachers the opportunity to develop different teaching styles. This could, in turn, encourage pupils to become more independent learners.

In the author's opinion, the most successful scheme for promoting the development of microcomputer software was the Microelectronics Education Program (MEP). This was instrumental in enabling software to be designed for the majority of school disciplines, including design and technology.

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* This study was carried out before and during the development of Technology in the National Curriculum (1990). Throughout this development it became apparent that informtion gathering skills, including the use of Information Technology (IT), would permeate the Attainment Targets and Programmes of Study. For example, Attainment Target 2: Generating a design, level 7a states:

> "systematically seek out, appraise, organise and use information from different sources to develop and combine ideas and judge how realistic they might be".

Possibly its successor, the Microelectronics Education Support Unit (MESU) will be able to co-ordinate interested parties in the development of subject-specific software, so ensuring that good quality software continues to be made.

This study clearly indicated that pupils need a design and technology resource to provide routine information, and if available, they would use it. NERIS is perhaps in a good position to develop a comprehensive design and technology microviewdata system quickly as it has already established systems for obtaining information from teachers. Teachers could write suitable datapages which, after editing, could be incorporated into a filing system. Distribution could be by telephone line and modem or by floppy disks with a regular update service.

It is suggested that should a more comprehensive microviewdata system be developed for design and technology, it would require intensive trials over a longer period of time in a larger number of schools. Also, while questionnaires were an appropriate method of collecting data about pupil and teacher reactions to the "Design and Technology Data" software, development of a more comprehensive system would require different research instruments. Strategies such as observation and pupil interviews, as used in the preliminary investigation of this study, could be appropriate ways to evaluate such a system and could check whether in fact such a resource was affecting pupils' learning.

6. Conclusion

Within the limitations of this feasibility study it is concluded that, with an increase in content and refinement, the microviewdata system developed could provide a useful source of routine information to help pupils with design and technology research and decision-making processes. Such a system could also enable teachers to manage project work more effectively. However, in the author's view, long term success in using microcomputer based information systems for resource-based design and technology learning depends on at least five factors:

(a) teaching the pupils from an early age that it is necessary for them to search for information themselves using a variety of sources, including microviewdata;

(b) making a microviewdata system available during every design and technology lesson;

(c) making available well-designed and reliable software for the range of microcomputers used in schools;

(d) ensuring the microviewdata system used contains information which provides adequate answers to pupils' enquiries;

(e) educating design and technology teachers to adopt teaching styles which encourage pupils to be more independent learners.

The "Design and Technology Data" software can be viewed as a useful step in the right direction. Developing it further and making it widely available to schools could make the "research" element of designing more meaningful to pupils. Teachers could also find themselves in a position to spend more time with individual pupils, engaged in the creative aspects of the discipline instead of being mainly the providers of routine information. To do this some teachers might need in-service training to enable them to take advantage of technological advances.

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Appendix 1

Observation Schedule

Design and Technology Database

Observation Schedule

Observer

School	Date
Group	Age range
Number in group	Length of Lesson

Project description

Lesson subject - Design and Technology/Design & Realisation

Type of Question	Teacher initiated	Pupil initiated
Design Folio		
- interpretation		
- presentation		
- organisation		
Materials / working method		
- suitability (properties)		
- working method - man made timber		
- working method - plastics		
- working method - metals		
- working method - natural timber		
- working method - card		
Fabricating methods - adhesives		
- mechanical		
- heat processes		
- project assembly		
Hand tools - selection		
- correct use		
Machine tools/equipment - setting up		
- operation/correct use		
Finishing - selection		
- abrasives		
- correct use		

Electronics Technology		
- component selection		
- component recognition		
- assembly techniques		
- testing/fault finding		

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Appendix 2

Preamble for the Pupil Interviews

Pupil Interview Schedule

Preamble

What is your name and which year are you in?

I am going to ask you a series of questions about how you design and make your CDT projects. The questions are not connected in any way with your examination work and are not part of any assessment. They are to help me with a research project which involves finding out the ways used by pupils to design and make solutions to design briefs.

I am going to tape record the answers you give to the questions, so I can analyse the results later.

TIM LEWIS

Appendix 3

Pupil Interview Schedule

Design and Technology Interactive Databases

Pupil Interview Schedule

School ________________________ Date ____________

Group ________________________ Age ____________

Length of interview ________________________

Lesson Subject - Design & Technology/Design & Realisation

1. When working on a project, at what stage do you select the materials?
2. How do you select appropriate materials for your projects?
3. What sorts of things do you take into account when selecting materials for a project?
4. If you are making a part of your project and are uncertain of the correct method of working the material you are using, for example cutting acrylic, how would you find out the correct way to do it?
5. At what stage do you decide on the method you intend to use for joining different parts of your project together?
6. How do you select a method of joining the parts of your project together?
7. Is there a range of glues available in the workshop for you to use?
8. How do you choose a glue for a particular material, for example, wood?
9. What other ways do you use to join materials together?
10. Are nuts, bolts and wood screws available in the workshop for you to use?
11. How do you choose the correct size of wood screw to use when you require them?
12. How do you choose the correct size of nuts and bolts to use when you require them?
13. If you cannot use a particular tool, what ways do you use to find out the correct method of use?
14. When using machines in the workshop, do you set the machine up yourself?
15. What sorts of things are important when setting up a machine, for example, a drilling machine?
16. Would you set the speed of a machine yourself?

17. What sorts of finishes are normally available in the workshop for you to use?
18. How do you choose a finish for your projects?
19. Do you choose the electronic components for projects?
20. If you are unable to recognise an electronic component, where would you find the information to help?
21. What would you do if an electronic circuit you have built did not work?
22. If your teacher is busy helping someone else with a project and you have a problem, what would you do?
23. What sources of information could be consulted, other than your teacher, when designing or making your projects?

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1. MATERIALS

Please put a tick in the appropriate box if the material is normally available for use by 4th and 5th Year pupils in your department.

a. Metals

Aluminium alloy (casting)	☐	Sheet aluminium alloy	☐
Aluminium alloy (rod, bar, strip, etc.)	☐	Aluminium alloy tube (square)	☐
Aluminium alloy tube (round)	☐	Zinc casting alloy (Mazak)	☐
Steel (rod, strip, bar, etc.)	☐	Sheet steel	☐
Steel tube (round)	☐	Steel tube (square)	☐
Brass (rod, strip, bar, etc.)	☐	Sheet brass	☐

Other metals ---- please state ----

b. Plastics

Sheet acrylic	☐	Acrylic (rod, strip, bar, etc.)	☐
Polyester resin (for GRP work)	☐	Polystyrene sheet	☐
ABS sheet	☐	Polycarbonate sheet	☐
Expanded polystyrene	☐	Corex	☐
		Coroflute	☐

Other Plastic materials ---- please state ----

c. Natural Timber

Redwood (pine-softwood)	☐	Jelutong	☐
Beech	☐	Ramin	☐
Ash	☐	Balsawood	☐
Meranti	☐	Parana pine	☐

Other natural timbers ---- please state ----

d. Man-made boards

Plywood (utile or similar)	☐	Hardboard	☐
Contiboard (or equivalent)	☐	Blockboard	☐
Chipboard	☐	Birch plywood	☐

Other manufactured boards ---- please state ----

e. Modelling materials

Card for models	☐	Clay for models	☐
Art straws	☐	Plawco rods & joints	☐
Plasticine	☐	Modelling foam	☐

Any other materials ---- please state ----

2. ADHESIVES

PVA glue	☐	Polystyrene cement	☐
Balsa cement	☐	Tensol cement (acrylic adhesive)	☐
Loctite adhesives for metals	☐	Epoxy resin (Araldite etc.)	☐
Contact adhesive (Evostick etc.)	☐	Double sided adhesive tape (Sellotape etc.)	☐
Aerosol/spray adhesive	☐	Copydex	☐

Other adhesives ---- please state ----

3. FINISHING MATERIALS

Please put a tick in the appropriate box if the finishing material is available for use by 4th and 5th Year pupils in your department.

a. Abrasives

Emery cloth	☐	Garnet paper	☐
Glass paper	☐	Wet or dry paper	☐

Other abrasives ---- please state ----

b. Finishes

Aerosol paint	☐	Polyurethane varnish	☐
Aerosol primer	☐	Plastic wood type filler	☐
Cellulose sanding sealer	☐	Hammerite paint	☐
Standard oii based paint	☐	Polyester filler	☐

Other finishes ---- please state ----

4. ELECTRONIC COMPONENTS

Please tick in the appropriate box if the component is available for use by the 4th and 5th Year pupils during project work.

Resistors	☐	Electrolytic capacitors	☐
Capacitors (other types)	☐	Transistors	☐
Relays	☐	Diodes	☐
Light emitting diodes	☐	Low voltage bulbs	☐
Light dependent resistors	☐	Thermistors	☐
555 timers	☐	Integrated circuit logic gates	☐
Transformers	☐	Loudspeakers	☐
7 segment displays	☐	741 operational amplifiers	☐

Other components ---- please state ----

5. FASTENING DEVICES

Please tick in the appropriate box if the fastening device is available for use by 4th and 5th Year pupils during project work.

BA nuts and bolts	☐	Rivets	☐
Metric nuts and bolts	☐	Pop rivets	☐
Wood screws (brass)	☐	Star lock washers	☐
Wood screws (steel)	☐	Panel pins	☐
Pozi-drive screws	☐	Oval nails	☐
Self tapping screws	☐	Round wire nails	☐
		Tension lock rolled steel pins	☐

Other fastening devices ---- please state ----

6. EQUIPMENT

Please tick in the appropriate box if the equipment is available for use by 4th and 5th Year pupils during project work.

Metal turning lathes	☐	Wood turning lathes	☐
Vacuum forming machine	☐	Drilling machines	☐
Bandsaws (small, similar to Burgess)	☐	Vibrating saw	☐
Jig saw	☐	Injection moulding machine	☐
Computer Numerical Controlled lathe	☐	Sanding disc	☐
Belt sander	☐	Line bender (for plastics)	☐
Signal generator	☐	Oscilloscope	☐

Equipment (Continued)

Variable low voltage power supply	☐	Batteries	☐
Vertical milling machine	☐	Horizontal milling machine	☐
Multi-meters	☐		

Other equipment ---- please state ----

7. COMPUTER EQUIPMENT

Please tick in the appropriate box if you have any of the following available for use by 4th and 5th Year pupils during Design and Technology lessons.

BBC Master series	☐	Colour monitor	☐
BBC model B computer	☐	Disk Drive (single)	☐
RML 380Z computer	☐	Disk drive (double)	☐
Mono-chrome monitor	☐	Cassette tape deck	☐
Spectrum computer	☐	Micro drive	☐

Other computer equipment ---- please state ----

8. WORKING PRACTICES AND METHODS

All the following questions are related to the working practices and methods followed by 4th and 5th Year pupils. Please give your answer by ticking in the appropriate box.

		Yes	No
a.	Is the range of materials stocked clearly displayed in the CDT area?	☐	☐
b.	Is the range of nuts, bolts, wood-screws and other fastening devices stocked displayed in the CDT area?	☐	☐
c.	Is the range of adhesives stocked displayed in the CDT area?	☐	☐
d.	Is the range of electronic components stocked displayed in the CDT area?	☐	☐
e.	Do pupils in the CDT area have easy access to a range of CDT text books?	☐	☐
f.	Are pupils expected to set up a machine such as a lathe, unaided, before they use it?	☐	☐
g.	Are pupils permitted to change drilling machine speeds?	☐	☐
h.	Are pupils permitted to change lathe speeds?	☐	☐
i.	Are pupils allowed to use a small bandsaw similar to the 'Burgess' type?	☐	☐

Thank you for completing the questionnaire.

Sheffield City Polytechnic

Brincliffe, Psalter Lane, Sheffield S11 8UZ
Telephone Sheffield 556101 (STD Code 0742)

Department of Design
Head of Department K Tyssen DesRCA

To: The Head of the Craft, Design and Technology Department

Enquiry into the materials, equipment and working methods used by 4th and 5th Year pupils during open ended Design and Technology project work.

Dear Colleague

I would like to ask you for information about the materials, tools, equipment and working practices in the CDT department of your school. The information is to be used as part of a research project to assess the difficulties pupils have in selecting materials, tools and processes as they are designing and realising their solutions to design and technology problems.

Any information made available will be treated in the strictest confidence and no individual or school will be identified without express permission. If you wish to sign your name and give the address of your school in the space provided, I will be pleased to supply you with the result of the enquiry and keep you informed of any further developments of the project.

From the information gathered it is hoped to assemble a data base of information for use by 4th and 5th Year pupils working on design and technology projects.

Please return the completed enquiry form in the stamped addressed envelope, if possible by 5 June 1987.

Thank you in advance for giving your time to complete the questionnaire.

Yours faithfully

Tim Lewis.

TIM LEWIS
Department of Design

*Name: ....

School address: ....

....

....

* Only give your name and school address if you are interested in receiving the results of this enquiry.

Sheffield City Polytechnic

Brincliffe, Psalter Lane, Sheffield S11 8UZ
Telephone Sheffield 556101 (STD Code 0742)

Department of Design
Head of Department K Tyssen DesRCA

JTL/EMJ

10 June 1987

To: The Head of the Craft, Design & Technology Department

Dear Colleague

Recently I circulated a copy of an enquiry into the materials, equipment and working methods used in Design and Technology project work. The purpose of the enquiry is to obtain information for the assembly of a data base for use by pupils in school. I am sure you will agree that the introduction of new working methods and examinations, particularly GCSE, has brought many changes in our subject area, making it essential to have up to date resources.

The data base will be a resource designed to assist activities currently taking place in Design and Technology. I would appreciate your assistance in gathering the relevant data to ensure this is possible.

Enclosed is a further copy of the enquiry and a stamped, addressed envelope. It would be very helpful if you could return it by 19 June 1987.

Thank you in advance for your assistance.

Yours faithfully

Tim Lewis

TIM LEWIS
Department of Design

Appendix 7

Example of Utility Software used to generate "Page Number" Files

```
 10 REM MATERIAL/PAGE NUMBER FILE CREATOR M.PHIL J T LEWIS  16 3 88
 20DIM pageno%(20)
 25 DIM mn%(2)
 26 recordno%=1
 30 CLS
 40 INPUT"ENTER FILE NAME",filename$
 50 A=1:X=0:Y=1
 60 A=OPENOUTfilename$
 70 PRINT"FILE OPEN"
 80 REPEAT
 85 PRINT"Record number ";recordno%
 90 INPUT"Material No.",mn%(1)
 95 INPUT"Material No.",mn%(2)
110 INPUT"Page No.",pageno%(1)
120INPUT"Page No.",pageno%(2)
130INPUT"Page No.",pageno%(3)
140INPUT"Page No.",pageno%(4)
145INPUT"Page No.",pageno%(5)
146INPUT"Page No.",pageno%(6)
147INPUT"Page no.",pageno%(7)
150PRINT#A,mn%(1),mn%(2),pageno%(1),pageno%(2),pageno%(3),pageno%(4),pageno%(5
),pageno%(6),pageno%(7)
160 PRINT"Another record <Y>=yes <N>=no"
170 K=GET
175recordno%=recordno%+1
180 UNTIL K=&4E
190 CLOSE#A
200 PRINT"FILE CLOSED"
```

```
10 REM ADRIV21 M.PHIL. J T LEWIS 13 / 12 /87 ADHESIVE SELECTOR
15 *KEY 10 OLDöM RUNöM
20 A=1:matsel%=1
30 DIMmaterial$(32):DIM materialchoice$(2):DIM mn%(2):DIM matno%(2):DIM selpa
geno%(4)
40 FOR loop=1TO32:READ material$(loop):NEXT loop
100 sentence1$="Select an Adhesive":sentence2$="Look through pages of data":se
ntence3$="---pieces of the same material?":sentence4$="---pieces of different ma
terial?"
110 sentence5$="Go to a data page":sentence6$="See instructions":sentence7$="R
eturn to Disk Menu":sentence8$="Print out a data page"
120 MODE7
130ON ERROR GOTO2910
140VDU 23;8202;0;0;0;:*FX11,0
150 *FX4,1
160 REM MENU
170 R%=129:G%=130:Y%=131:B%=132:M%=133:C%=134:W%=135:NB%=157:DH%=141:select%=1
:pageno%=111
180 IF F%=1 THEN PROCsrinformation:PROCspacebar
190 IF I%=1 THEN PROCsrinstructions:PROCspacebar
200PROCmenulayout
210pageno%=111
220 REPEAT
230 IF select%=1THEN col%=130ELSE col%=129
240 PRINTTAB(4,9);CHR$(col%);sentence1$
250IF select%=2THEN col%=130ELSE col%=129
260PRINTTAB(4,11);CHR$(col%);sentence2$
270IF select%=3 THEN col%=130ELSE col%=129
280PRINTTAB(4,13);CHR$(col%);sentence5$
290IF select%=4THEN col%=130ELSE col%=129
300PRINTTAB(4,15);CHR$(col%);sentence6$
310IF select%=5THEN col%=130ELSE col%=129
320PRINTTAB(4,17);CHR$(col%);sentence7$
330IF select%=6THEN col%=130ELSE col%=129
340PRINTTAB(4,19);CHR$(col%);sentence8$
350 PROCcursorkey
360 IF select%>6OR select%<1THEN select%=1
370 UNTIL K=&0D
380 IF select%=1 AND I%=1 THENPROCsrinstruction107
390IF select%=1 AND I%=0THENPROCselectadhesive
400 IF select%=2 AND I%=1 THENPROCsrinstruction109a
410IF select%=2 AND I%=0PROCbrowse
420 IF select%=3 AND I%=1 THEN PROCsrinstruction109b
430IF select%=3 AND I%=0 THEN PROCenterno:PROCbrowse
440 IF select%=4 THEN PROCsrinstructions:PROCspacebar:GOTO 200
450IF select%=5THEN CHAIN"$.BASIC.DISMEN3"
460IF select%=6THEN PROCenterno:PROCload:L%=0:CHAIN"$.BASIC.M7M4CDP"
470 DEFPROCload
480*DIR$.PAGES
490OSCLI "LOAD "+STR$(pageno%)+" 7C00":ENDPROC
500 END
510 DEFPROCbrowse
520*DIR $.PAGES
530 REPEAT
540CLS
550 PROCsearchmessage
560OSCLI "LOAD "+STR$(pageno%)+" 7C00"
570 PROCbk_fw
580UNTIL FALSE
590 ENDPROC
600 DEFPROCbk_fw
610PRINTTAB(0,23)CHR$(131);CHR$(157);CHR$(132)"PRESS <ü>=forward page <Ä>=back
 page"
620 K=GET:IF K<&88 OR K>&89 THEN 620
630 IF K=&89THEN pageno%=pageno%+1:GOTO 650
640 IF K=&88THEN pageno%=pageno%-1:GOTO650
650 IF pageno%=131 THEN pageno%=111
660IFpageno%=110 THEN pageno%=111
670 ENDPROC
680PRINTTAB(0,23)CHR$(131);CHR$(157);CHR$(132)"PRESS key <F>=forward  KEY<B>=b
ack  "
690 K=GET:IF K=&46 OR K=&66 THEN pageno%=pageno%+1:GOTO 720
700 IF K=&42 OR K=&62 THEN pageno%=pageno%-1:GOTO720
710 GOTO690
720 IF pageno%=130 THEN pageno%=111
730IFpageno%=110 THEN pageno%=111
740 ENDPROC
750 DEFPROCspacebar
760VDU31,0,0
770 K=GET:IF K=&20 THEN ENDPROC ELSE 770
```

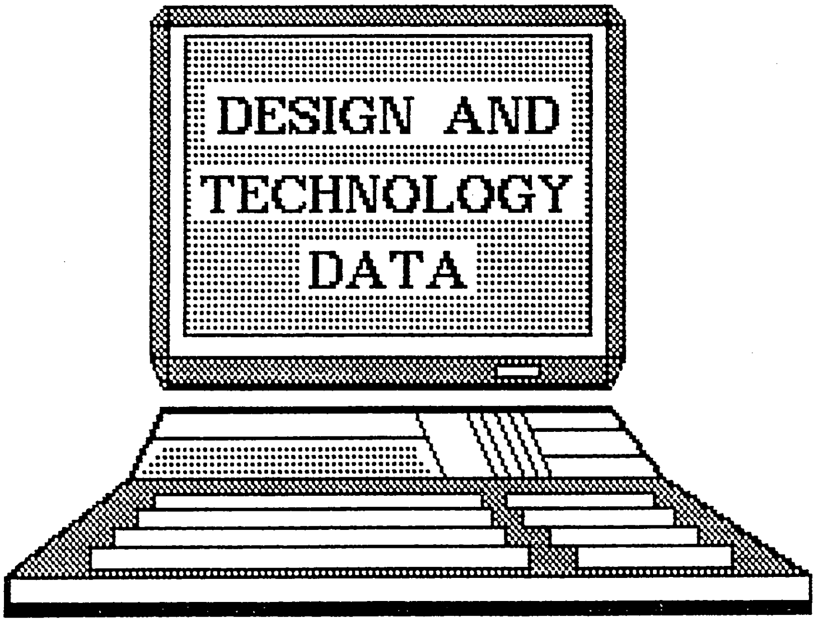
```
780 DEFPROCsame_different
790 REPEAT
800PRINTTAB(3,10)CHR$(C%);"Do you want to join---"
810 IF select%=1THEN col%=130ELSE col%=129
820 PRINTTAB(3,12);CHR$(col%);sentence3$
830IF select%=2THEN col%=130ELSE col%=129
840PRINTTAB(3,14);CHR$(col%);sentence4$
850 PROCcursorkey
860 IF select%=3THEN select%=1
870 UNTIL K=&0D
880 ENDPROC
890DEFPROCcursorkey
900 K=INKEY(10)
910IF K=&8ATHEN select%=select%+1
920IF K=&8B THEN select%=select%-1
930ENDPROC
940DEFPROCenterno
950CLS
960 PROCselector1
970 REPEAT
980INPUTTAB(30,11)pageno%
990IFpageno%<111 OR pageno%>130 THEN PRINTTAB(4,12)CHR$(R%)"This page number i
s not available":delay=INKEY(200);PRINTTAB(4,12)CHR$(W%)"     Enter Page number a
gain       ":PRINTTAB(30,11)"       "
1000 UNTIL pageno%>110 AND pageno%<131
1010ENDPROC
1020 DEFPROCselectadhesive
1030 REM MATSEL8FOR ADRIV11 9 10 87 M.PHIL J T LEWIS
1040VDU23,1;0;0;0;0
1050matsel%=1
1060 A=1:B=1
1070*FX4,1
1080flag=0
1090X=0:Y=0:matsel%=0:mc%=1
1100T=1
1110 CLS
1120PRINTTAB(1,0)CHR$(B%);CHR$(NB%);CHR$(Y%);SPC(9)"MATERIAL LIST            "CH
R$(156)
1130 PRINTTAB(0,1)CHR$(129)"wood (inside)":PRINTTAB(20,1)CHR$(129)"acrylic (per
spex)"
1140PRINTTAB(0,2)CHR$(129)"wood (outside)":PRINTTAB(20,2)CHR$(129)"fibre glass
(GRP)"
1150PRINTTAB(0,3)CHR$(129)"plywood":PRINTTAB(20,3)CHR$(129)"sheet polystyrene"
1160PRINTTAB(0,4)CHR$(129)"contiboard":PRINTTAB(20,4)CHR$(129)"sheet ABS"
1170PRINTTAB(0,5)CHR$(129)"hardboard":PRINTTAB(20,5)CHR$(129)"sheet polycarbona
te"
1180PRINTTAB(0,6)CHR$(129)"fibre board":PRINTTAB(20,6)CHR$(129)"corex"
1190PRINTTAB(0,7)CHR$(129)"chipboard":PRINTTAB(20,7)CHR$(129)"coroflute"
1200PRINTTAB(0,8)CHR$(129)"blockboard":PRINTTAB(20,8)CHR$(129)"PVC section(pipe
)"
1210PRINTTAB(0,9)CHR$(129)"balsawood":PRINTTAB(20,9)CHR$(129)"aluminium alloy"
1220PRINTTAB(0,10)CHR$(129)"ramin (models)":PRINTTAB(20,10)CHR$(129)"steel"
1230PRINTTAB(0,11)CHR$(129)"jelutong (models)":PRINTTAB(20,11)CHR$(129)"brass"
1240PRINTTAB(0,12)CHR$(129)"card":PRINTTAB(20,12)CHR$(129)"nickel silver"
1250PRINTTAB(0,13)CHR$(129)"cardboard":PRINTTAB(20,13)CHR$(129)"tinplate"
1260PRINTTAB(0,14)CHR$(129)"modelling foam":PRINTTAB(20,14)CHR$(129)"gilding me
tal"
1270PRINTTAB(0,15)CHR$(129)"paper":PRINTTAB(20,15)CHR$(129)"stainless steel"
1280PRINTTAB(0,16)CHR$(129)"expanded styrene":PRINTTAB(20,16)CHR$(129)"copper"
1290PRINTTAB(0,21)CHR$(B%);CHR$(NB%);CHR$(Y%)"Use the <CURSOR> keys to move up,
down"
1300PRINTTAB(0,22)CHR$(B%);CHR$(NB%);CHR$(Y%)"and across the material list"
1310PRINTTAB(0,23)CHR$(B%);CHR$(NB%);CHR$(Y%)"   Press <RETURN> to select."
1320 VDU 31,0,17,B%,NB%,Y%,31,0,18,B%,NB%,Y%,31,0,19,B%,NB%,Y%,31,0,20,B%,NB%,Y
%
1330 PRINTTAB(3,18)CHR$(156)"MATERIAL 1"CHR$(B%);CHR$(NB%);CHR$(156)CHR$(Y%)SPC
20CHR$(B%);CHR$(NB%)
1340PRINTTAB(3,20)CHR$(156)"MATERIAL 2"CHR$(B%);CHR$(NB%);CHR$(156)CHR$(Y%)SPC2
0CHR$(B%);CHR$(NB%)
1350PRINTTAB(6,17)"Press"CHR$(136)"<CURSOR DOWN>"CHR$(137)"to start."
1360 REPEAT:K=GET:UNTIL K=&8A
1370 PROCXdown:PRINTTAB(18,18)material$(matsel%)
1380PRINTTAB(4,17)"                                        "
1390 FOR loop=1TO2
1400 REPEAT
1410 K=GET
1420 IF K=&8ATHEN PROCXdown:GOTO1460
1430 IF K=&8B THEN PROCXup:GOTO1460
1440IF K=&89THEN PROCYright:GOTO1460
1450IF K=&88THEN PROCYleft:GOTO1460
1460IFmc%=1PRINTTAB(18,18)"                      "
1470IFmc%=1PRINTTAB(18,18)material$(matsel%)
1480IFmc%=2PRINTTAB(18,20)"                      "
1490IFmc%=2PRINTTAB(18,20)material$(matsel%)
1500UNTIL K=&0D
```

```
 1510 materialchoice$(mc%)=material$(matsel%):mc%=mc%+1
 1520 mn%(loop)=matsel%
 1530 NEXTloop
 1540 PRINTTAB(0,23)CHR$(129);CHR$(157);CHR$(131);CHR$(136)" Press <SPACE BAR> t
o continue"
 1550 K=GET
 1560 IF K=&20 THEN 1570ELSE 1550
 1570 PRINTTAB(4,23)"Please wait.Searching for data     "
 1580 *DIR $.FILES
 1590 B=OPENIN"SELPG"
 1600 REPEAT
 1610 INPUT#B,matno%(1),matno%(2),selpageno%(1),selpageno%(2),selpageno%(3),selp
ageno%(4)
 1620 UNTIL matno%(1)=mn%(1) AND matno%(2)=mn%(2) OR matno%(1)=mn%(2) AND matno%
(2)=mn%(1)
 1630 FOR loop=1 TO 4:IF selpageno%(loop)=0 THEN 1680
 1640*DIR $.PAGES
 1650 OSCLI "LOAD "+STR$(selpageno%(loop))+" 7C00"
 1660 K=GET:IF K=&20 THEN 1670 ELSE 1660
 1670 NEXT loop
 1680 PRINTTAB(3,23)"There are no more suitable adhesives"
 1690 PROCdelay5
 1700REPEAT
 1710PRINTTAB(3,23)CHR$(136)"Press---                                 "
 1720UNTIL FALSE
 1730ENDPROC
 1740DEFPROCXdown
 1750 PRINTTAB(X,Y)CHR$(129):Y=Y+1
 1760 IF Y>16 THEN Y=16
 1770PRINTTAB(X,Y)CHR$(G%)
 1780matsel%=matsel%+1
 1790 IF matsel%>16 AND flag=0 THEN matsel%=16
 1800 IF matsel%>32 AND flag=1 THEN matsel%=32
 1810ENDPROC
 1820 DEFPROCXup
 1830PRINTTAB(X,Y)CHR$(129):Y=Y-1
 1840IF Y<1THEN Y=1
 1850PRINTTAB(X,Y)CHR$(G%)
 1860IF matsel%<=1 THEN matsel%=1
 1870 matsel%=matsel%-1:IFmatsel%<1 THEN matsel%=1
 1880 IFmatsel%<17AND flag=1THEN matsel%=17
 1890 ENDPROC
 1900DEFPROCYright
 1910 IF flag=1 THEN ENDPROC
 1920PRINTTAB(X,Y)CHR$(129):PRINTTAB(20,Y)CHR$(130):X=20:matsel%=matsel%+16
 1930 flag=1
 1940 ENDPROC
 1950 DEFPROCYleft
 1960IF flag=0 ENDPROC
 1970PRINTTAB(X,Y)CHR$(129):PRINTTAB(0,Y)CHR$(130):X=0:matsel%=matsel%-16
 1980flag=0
 1990 ENDPROC
 2000 DEFPROCdelay5
 2010 delay=INKEY(500):ENDPROC
 2020DEFPROCmenulayout
 2030CLS
 2040PRINT'"";
 2050PRINT"
DESIGN & TECHNOLOGY";
 2060PRINT"
DESIGN & TECHNOLOGY";
 2070PRINT"
DATAMENU";
 2080PRINT"
DATAMENU";
 2090PRINT" ";
 2100PRINT"
 S
 ADHESIVES/";
 2110PRINT"
 S
  ADHESIVES";
 2120PRINT"
```

```
";
2130PRINT" 5                                    j";
2140PRINT"  5                                   j";
2150PRINT"  5                                   j";
2160PRINT"  5                                   j";
2170PRINT"  5                                   j";
2180PRINT"  5                                   j";
2190PRINT"  5                                   j";
2200PRINT"  5                                   j";
2210PRINT"  5                                   j";
2220PRINT"  5                                   j";
2230PRINT"  uppppppppppppppppppppppppppppppppppppz";
2240PRINT" <CURSOR DOWN>--to move DOWN MENU9";
2250PRINT"  <CURSOR UP>----to move UP MENU  9";
2260PRINT"  <RETURN>-------to select        5";
2270ENDPROC
2280 DEFPROCsearchmessage
2290PRINT" ";
2300PRINT"
DESIGN & TECHNOLOGY";
2310PRINT"
DESIGN & TECHNOLOGY";
2320PRINT"
DATA";
2330PRINT"
DATA";
2340PRINT" ";
2350PRINT"
                    ADHESIVES//";
2360PRINT"

                     ADHESIVES";
2370PRINT"                         ";
2380PRINT" ";
2390PRINT"
///Searching for page ";pageno%CHR$(145)"";
2400PRINT"
Searching for page ";pageno%CHR$(145)"";
2410PRINT" ";
2420PRINT"                                      "
2430PRINT''''''''"
2440ENDPROC
2450 DEFPROCsrinformation
2460 *SRREAD 7C00 7FE7 8000
2470 ENDPROC
2480 DEFPROCsrinstructions
2490 *SRREAD 7C00 7FE7 9383
2500 PROCspacebar
2510 *SRREAD 7C00 7FE7 976A
2520 ENDPROC
2530 DEFPROCsrinstruction107
2540 *SRREAD 7C00 7FE7 9383
2550 PROCspacebar
2560 PROCselectadhesive:ENDPROC
2570 DEFPROCsrinstruction109a
2580 *SRREAD 7C00 7FE7 976A
2590 PROCspacebar
2600 PROCbrowse:ENDPROC
2610  DEFPROCsrinstruction109b
2620 *SRREAD 7C00 7FE7 976A
2630 PROCspacebar
2640 PROCenterno:PROCbrowse:ENDPROC
2650DEFPROCselector1
2660CLS
2670PRINT"
```

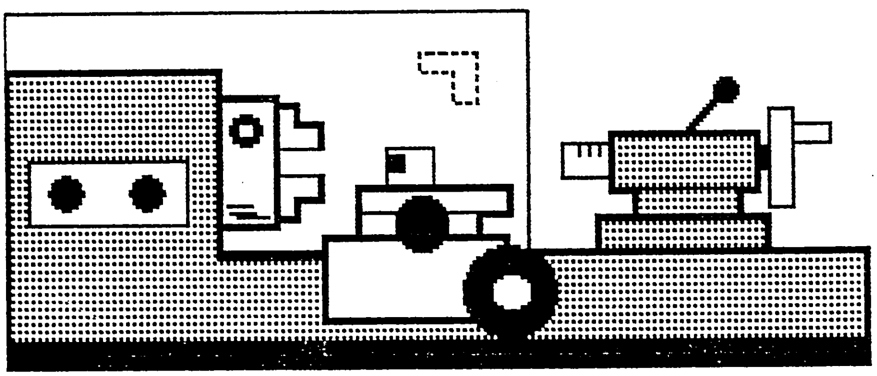
```
 2680PRINT" ";
 2690PRINT"
DESIGN & TECHNOLOGY";
 2700PRINT"
DESIGN & TECHNOLOGY";
 2710PRINT"
DATASELECTOR";
 2720PRINT"
DATASELECTOR";
 2730PRINT" ";
 2740PRINT"
5                  ADHESIVES//";
 2750PRINT"
5                   ADHESIVES";
 2760PRINT"  5                       ";
 2770PRINT"  5                               j";
 2780PRINT"  5       Enter page number:     j";
 2790PRINT"  5                               j";
 2800PRINT"  7###################################k";
 2810PRINT" 5   The page numbers available    j";
 2820PRINT" 5   are between 111 and 130.      j";
 2830PRINT"  uppppppppppppppppppppppppppppppppppz";
 2840PRINT'" Use number keys <0> to <9> to type"
 2850PRINT" a page number"
 2860PRINT" "
 2870PRINT" Use <DELETE> key to correct errors.";
 2880PRINT" "
 2890PRINT" Press <RETURN> key to enter number.";
 2900ENDPROC
 2910 CLOSE#0
 2920 *DIR $.BASIC
 2930 IF ERR=17 THEN GOTO200
 2935 CLS
 2940REPORT
 2950PRINTCHR$(R%)"Line number ";ERL
 2955PRINT"This is a trial program. If a fault"'"occurs please record the error
line"'"number and telephone:"'
 2956PRINTSPC(5)"Tim Lewis"
 2957PRINTSPC(5)"0742 556101 Ext.5098"'
 2958PRINT"Press <BREAK> to restart program."
 2960END
 3000DATA wood (inside),wood (outside),plywood,contiboard,hardboard,fibreboard,c
hipboard,blockboard,balsawood,ramin (models),jelutong (models),card,cardboard,mo
delling foam,paper,expanded polystyrene
 3010 DATA acrylic (perspex),fibre glass (GRP),sheet polystyrene,sheet ABS,sheet
 polycarbonate,corex,coroflute,PVC section (pipe),aluminium alloy,steel,brass,ni
ckel silver,tinplate,gilding metal,stainless steel,copper
```



by
TIM LEWIS

TEACHERS NOTES

TRIAL MATERIAL



SHEFFIELD CITY POLYTECHNIC
DEPARTMENT OF DESIGN

TRIAL MATERIAL

TEACHERS NOTES

DESIGN and TECHNOLOGY DATA

by Tim Lewis

For the BBC Master 128 Computer

INTRODUCTION

Design and Technology Data is a specialized computer data base with over 100 pages of information. It is designed to help 4th and 5th year pupils with their design and technology project work. The pages of data are in a Teletext format and are accessed through menus and lists. A filing system ensures only relevant information to an enquiry is presented. This ensures pupils do not waste time searching through irrelevant data.

EQUIPMENT

BBC Master micro computer
40/80 track disk drive
Colour monitor
Epson or Epson compatible printer. This is not essential but is useful if the user requires to take a hard copy of the pages of information.

USING THE SOFTWARE

Design and Technology Data needs to be available for use during ALL design and technology lessons for 4th and 5th year pupils. The program should be loaded into the computer at the beginning of a lesson and the pupils encouraged to use it as a source of information instead of the usual practice of approaching the teacher on most occasions when help is required. The program has been designed to make it easy for people to use.

The information pages are useful:

> During the design stage of a project when decisions are being made about manufacturing a solution to a problem - a hard copy of the information pages can be a useful addition to a project folio;
>
> During the actual realisation when pupils may require information about the use of specific tools, equipment or processes - pupils should be encouraged to consult the pages of data instead of asking the teacher;
>
> As revision following a teacher demonstration of a process.

The computer's response to an enquiry for information always gives several options so the final decision is still left to the pupil.

The pupil's decision is made after reading the information presented. Therefore it is an informed decision.

Example: If the user asks for information about gluing balsawood to plywood several options will be given. The user must read the data pages presented and make the final choice of adhesive.

DATA PAGES

Data pages are all provided with a page number. This is displayed in the top right corner of each page. Several specialized pages are provided, eg, safety information. Printouts of these pages are not available.

Each page has a similar layout. Variations are in the sub-titles used on the pages. When the information on a particular subject requires more than one page, the message 'more' appears in the bottom left corner of the screen. This indicates there is more information about that subject on the next page.

A yellow window appears at the bottom of each page. Various prompts and instructions appear in this window.

OPERATION

The program is operated with the minimum of keys so avoiding the situation of pupils making false entries or spending time scanning a keyboard.

The keys used are:

four <CURSOR KEYS> (arrow keys).
<RETURN> key.
<SPACE BAR>
<ESCAPE> key.
number keys <0> to <9>

Menus, lists and 'YES' 'NO' answers are all operated by using the <CURSOR KEYS> and the <RETURN> key. The menus, lists and 'YES' 'NO' answers are presented in RED. The <CURSOR KEYS> are used to change the colour of each item in turn. The colour of the items can be changed from RED to GREEN. When the item required is GREEN pressing the <RETURN> key will select that item. The <ESCAPE> key can be used at any time to return to the MENU in use.

LOADING THE PROGRAM

Locate the 40/80 track switch on the disk drive. Set the switch to 80 track. Connect the printer, if available, and switch on. Check the printer is 'on line'.

Switch the monitor, computer and disk drive on.

Type *ADFS <RETURN>

The disk drive will run for a short time. When it has stopped:

Hold the <SHIFT> key down and tap the <BREAK> key.

The program title page will appear and the program will load into the computer. The disk must be left in the disk drive.

The program starts with a leader which is used to set the computer up. Three questions are asked:

Do you require information about the program?

Do you require instructions?

Do you require print outs of the data pages?

Information

A 'YES' response to "Do you require information about the program?" presents the user with information. This can only be accessed at this point. It is provided for first-time users.

Instructions

The instructions for operating the program are embedded in it so avoiding any reference book or prompt sheet. The first time user will require instructions, therefore a 'YES' response to the question "Do you require instructions?" gives operating instructions throughout the search for data pages. A 'NO' response is provided for those users who have operated the system previously so they can access the data pages more quickly.

For users who select the 'NO' option for instructions and later find they need help, selecting the SEE INSTRUCTIONS option from the MENU in operation will show the instruction pages.

Printer Option

The leader to the program asks the question "Do you require printouts of the data pages?". A 'NO' response cancels the 'PRINTOUT' option on the MENUS. A 'YES' response provides the 'PRINTOUT' option. A reminder to check the printer is turned ON and ON LINE is given. An EPSON or EPSON compatible printer is required.

THE DISK MENU

This has three options:

Working Materials

Adhesives

Joining

Start Again

Working Materials has approximately 80 pages of information about the tools and processes used in design and technology.

Adhesives selects the appropriate adhesives to join some 580 combinations of common materials used in design and technology.

Joining gives pages of information about different ways pairs of materials can be joined.

Start Again enables the user to return to the beginning of the program and reset the information, instruction and printout options.

PROGRAM MENUS

The headings are:

Select an Adhesive

Look through pages of Data

Go to a Data Page

See Instructions

Return to Disk Menu

Printout a Data Page

NB When **Working Materials** is selected from the DISK MENU: **Select a Process** appears instead of **Select an Adhesive.**

When **Joining** is selected from the DISK MENU: **Select a Joint** appears instead of **Select an Adhesive.** All other options are the same.

The **Select** option enables the computer to give information about materials and then present the appropriate pages of data for the user to read.

The **Look through pages of Data** option gives the user the opportunity to browse through the pages of data.

The **Go to a Data Page** is provided for the user who knows the page number and wants to look at the information again. It gives rapid access to the appropriate data page.

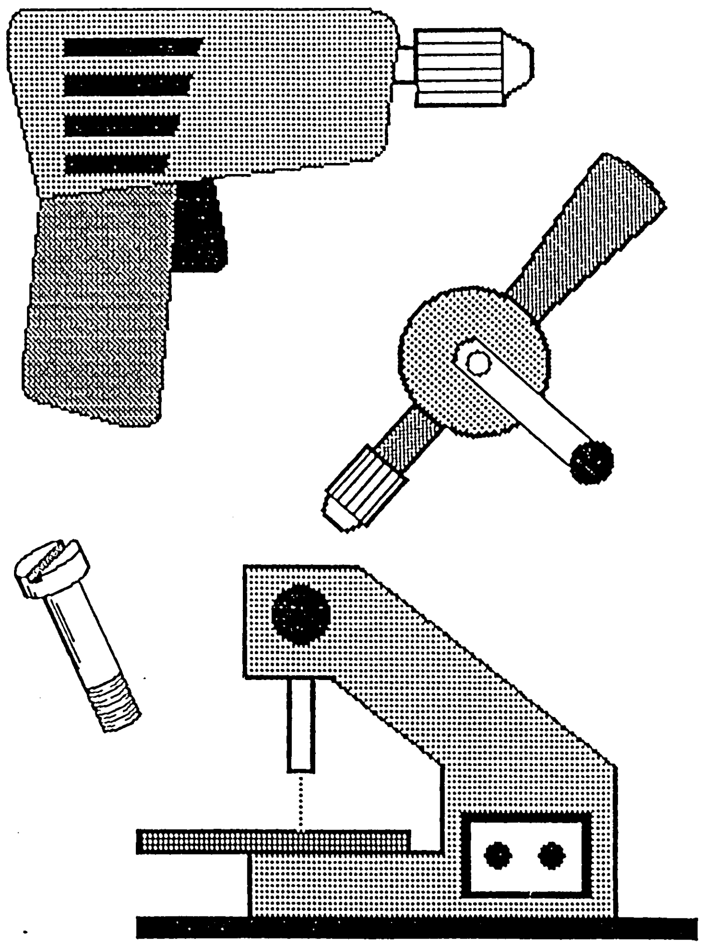
The **See Instructions** option is provided to enable the user to access the instructions subsequently if a 'NO' answer was given to the question "Do you want to see the instructions?" in the leader to the program.

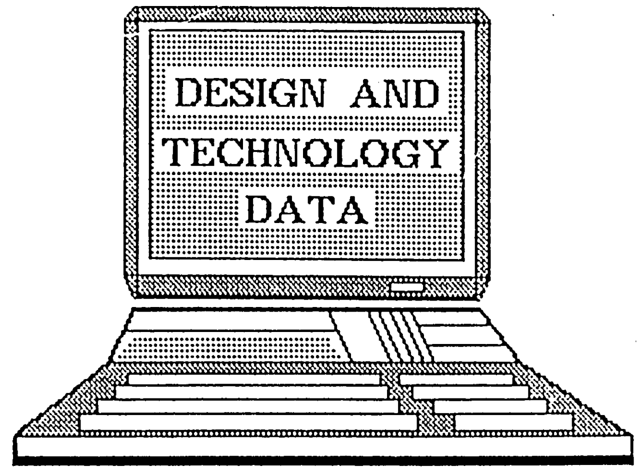
Return to Disk Menu enables the user to access pages of information in other branches of the program.

Printout a Data Page only appears if a 'YES' answer is given to the question "Do you want printouts of the pages of data?" in the leader to the program. When this option is selected the computer asks for the page number required and then displays that page. The coloured display is converted to monochrome and the page is dumped to the printer. The conversion and printing takes about 2 minutes. When printing is completed the MENU in use is reselected.

Appendix 10

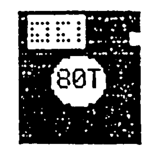
Cover for Program Disk Wallet used for the Software Trials



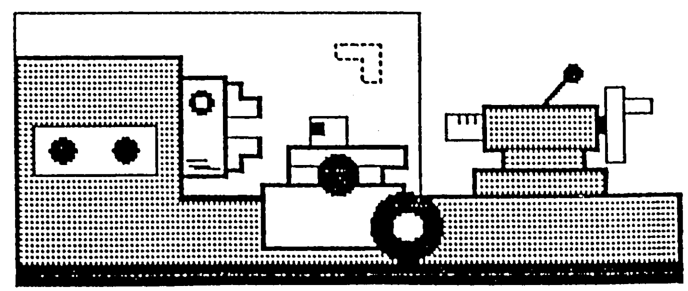


by
TIM LEWIS

For the BBC MASTER 128
microcomputer



TRIAL MATERIAL



Appendix 11

Utility program used to print out data held in page number files

```
10 REM FILE PRINTOUT FOR USE WITH FILCOR3 M.PHIL J T LEWIS 20 2  88
12 DIM pageno%(7)
13 CLS
15A=1
20 INPUT"ENTER FILE NAME",filename$
22VDU2:PRINTfilename$:VDU3
25 REPEAT
30 INPUT"ENTER RECORD NUMBER",recordno%
40 A=OPENINfilename$
50 PTR#A=(recordno%-1)*40
60 INPUT#A,mn%
70 INPUT#A,pageno%(1),pageno%(2),pageno%(3),pageno%(4),pageno%(5),pageno%(6),
'pageno%(7)
75 VDU 2
80 PRINTmn%
90PRINTpageno%(1),pageno%(2),pageno%(3),pageno%(4),pageno%(5),pageno%(6),page
no%(7)
100 CLOSE#0
210 VDU3
220 UNTIL recordno%=36
```

Appendix 12

Letter inviting Schools to participate in the Software Trials

Appendix 12

Letter inviting schools to participate in the software trials

JTL/EMJ

Dear

You may remember responding to my questionnaire in June 1987. The questionnaire was concerned with materials, equipment and working methods in design and technology.

The information gathered has been used in the design and development of a specialized computer database for use by 4th and 5th year pupils working on design and technology projects.

The software, titled Design and Technology Data, is now ready to be trialled in schools. I would like to ask you and your CDT colleagues to participate in the trials. The software runs on a BBC MASTER 128 computer with a colour monitor and 80 track disk drive. An Epson or Epson compatible printer can be used to get a hard copy of information, but this is not essential.

The trial consists of:

1. having the appropriate computer equipment available for use by 4th and 5th year pupils during their lessons for the summer term 1988;
2. arranging for the 4th and 5th year pupils to complete a questionnaire;
3. the CDT staff completing a questionnaire;
4. returning the questionnaire to me.

I hope to be able to visit as many schools as possible during the trials to obtain the reactions of both CDT staff and pupils to the computer software.

Any information gathered will be treated in the strictest confidence and no individual or school will be identified without express permission.

Please return the enclosed reply slip in the stamped addressed envelope. A reply by 15 March 1988 will be greatly appreciated so I can arrange for distribution of the software promptly.

Yours sincerely

TIM LEWIS
CDT Section Leader, Department of Design

Sheffield City Polytechnic

Brincliffe, Psalter Lane, Sheffield S11 8UZ
Telephone Sheffield 556101 (STD Code 0742)

Department of Design
Head of Department K Tyssen DesRCA

DESIGN and TECHNOLOGY DATA computer software trials.

I will participate in the software trial ☐

I am unable to participate in the software trial ☐

I have available:		Name ....
BBC Master 128 computer	☐	School ....
80 track 5.25 disk drive	☐	Address ....
Colour monitor	☐	....
		....

Sheffield City Polytechnic

JTL/CMC

21 April 1988

Dear Colleague

Thank you for agreeing to trial the Design and Technology Data software. Enclosed is a computer disk and the teachers' notes.

To obtain the maximum benefit from this type of software, it must be available for pupil to use during all their Design and Technology lessons. Several teachers agreeing to trial this material have asked if it can be used by pupils in the 11 to 14 age phase as well as by 15 and 16 year olds. It would be appreciated if you could try using the database with younger pupils to test their reactions to it.

During this term I hope to visit as many schools as possible involved in the trials to observe pupils using the database and discuss teachers' reactions to the development of this type of teaching support material.

After the Spring Bank Holiday, I will be circulating questionnaires for pupils to complete. When completed, they will enable me to make an assessment of the database's effectiveness. A teacher questionnaire will be included to obtain your views.

Thank you for your co-operation.

Yours sincerely

TIM LEWIS
CDT Section Leader

Faculty of Cultural Studies

Psalter Lane, Sheffield S11 8UZ
Telephone (0742) 556101
Telex 54680 SHPOLY G Fax 758019
Department of Design

SHEFFIELD CITY POLYTECHNIC DEPARTMENT OF DESIGN

DESIGN AND TECHNOLOGY DATA
A database for the BBC MASTER 128 computer

Pupil questionnaire

Name of your school	Your age

Please tick here if you are following a GCSE Design & Technology course ☐

1) How often did you use the database?

many times	sometimes	rarely	not at all
☐	☐	☐	☐

If you did use the database, please answer the following questions.

2) How easy did you find the instructions to follow?

very easy	fairly easy	fairly difficult	very difficult
☐	☐	☐	☐

3) How easy did you find the database to use?

very easy	fairly easy	fairly difficult	very difficult
☐	☐	☐	☐

4) How useful was the database in helping with your project work?

very useful	fairly useful	not very useful	no help at all
☐	☐	☐	☐

5) How easy were the pages of data to understand?

very easy	fairly easy	fairly difficult	very difficult
☐	☐	☐	☐

6) What did you like about the database? Please tick as many boxes as necessary.

- Using the computer ☐
- Not always relying on my teacher for help ☐
- Able to get on with my project work quickly ☐
- Getting printouts of the data pages for my folio ☐
- Finding information for myself ☐
- Nothing ☐

7) Please write down here any further comments you wish to make about using the database.

Please write on the other side of the paper if necessary.

Thank you for completing this questionnaire.

DESIGN AND TECHNOLOGY DATA

A database for the BBC MASTER 128 computer

Teacher Questionnaire

Name of School

Please tick in the boxes

1. How many years have you been teaching?

more than 10 ☐ 5 to 10 ☐ 2 to 5 ☐ less than 2 ☐

2. How long have you been using computers in your teaching?

more than 5 years ☐ 2 to 5 years ☐ less than 2 years ☐ not at all ☐

3. How useful did you find the teachers' notes?

very useful ☐ fairly useful ☐ not very useful ☐ no use at all ☐

4. How easy was it to introduce the database to pupils?

very easy ☐ fairly easy ☐ fairly difficult ☐ very difficult ☐

5. How easy do you think the database is to operate?

very easy ☐ fairly easy ☐ fairly difficult ☐ very difficult ☐

6. How did pupils react to the introduction of the database?

enthusiastically ☐ interested ☐ little interest ☐ no interest at all ☐

7. How often did the pupils use the database?

many times ☐ sometimes ☐ rarely ☐ not at all ☐

8. How attractive did you find the layout and presentation of the data pages?

very attractive ☐ attractive ☐ mediocre ☐ boring ☐

9. How easy do you think the pupils found the data pages to understand?

very easy ☐ fairly easy ☐ fairly difficult ☐ very difficult ☐

10. Did you use the database with pupils in the 11 to 14 age phase?

yes ☐ no ☐

If the answer is 'yes', please answer question 11. If the answer is 'no', then please go to question 13.

11. How useful do you think the database is for pupils in the 11 to 14 age phase?

very useful	useful	can be used with modifications	no use at all
☐	☐	☐	☐

12. If you ticked 'can be used with modifications', please state the modifications you think necessary.

13. The capacity of this database can be increased. What further design and technology information would you like to see included?

14. Write down any improvements you would like to see made to the database.

15. Write down any further comments.

Thank you for completing this questionnaire.

Please return the completed Teacher Questionnaire and the completed Pupil Questionnaires in the envelope provided.

Appendix 17

Letter accompanying Questionnaires
during Software trials

Sheffield City Polytechnic

JTL/EMJ

May 1988

DESIGN AND TECHNOLOGY DATA
A database for the BBC MASTER 128 computer

Dear Colleague

I hope you have received your copy of Design and Technology Data and pupils are using it. The next stage of the trials is to collect information about how pupils and teachers have reacted to the use of this type of teaching support material.

I enclose 40 copies of a pupil questionnaire and 4 copies of a teacher questionnaire.

Pupil Questionnaire

I would be most grateful if this questionnaire could be completed by each member of the groups who have had the opportunity to use the database. To enable 5th year pupils to respond, the questionnaire will need to be distributed before the start of the examination period in June. It will be satisfactory for 4th year pupils to complete their questionnaire later in June.

Teacher Questionnaire

As individual teachers' views are essential in assessing new teaching materials, it would be helpful if each member of staff using the database with pupils could complete this questionnaire. Teachers' comments will be particularly valuable.

Enclosed are two stamped addressed envelopes. One is for the return of the pupil and teacher questionnaires. The second is for the return of the computer disk. To enable me to analyse the questionnaires, it would be appreciated if these items could be returned by 4 July 1988.

Following the analysis of the questionnaires, the software will be modified and updated, paying particular attention to teachers' suggestions.

Thank you again for agreeing to participate in these trials.

Yours sincerely

Tom Lewis

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Department of Design
Head of Department
K Tyssen DesRCA

Appendix 18

Letter reminding Teachers to return Software and Questionnaires

Sheffield City Polytechnic

TL/CMC

6 July 1988

Dear Colleague

I hope you have had some success with the trial of the Design and Technology database but I'm sure you will have some comments about its content and operation. I would be pleased if you could return the questionnaires and the computer disk as soon as possible.

During the next few weeks I will be analysing the questionnaires and improving the database. Improvements will be based on the comments of both pupils and teachers.

An updated version of the database should be completed by the end of this year and available to schools during 1989.

Thank you for your co-operation.

Yours sincerely

TIM LEWIS
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