AN INTERVENTIONIST STUDY OF COMPUTER APPLICATION BY CDT TEACHERS IN OXFORDSHIRE.

by

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ABSTRACT.

AN INTERVENTIONIST STUDY OF COMPUTER APPLICATION BY CDT TEACHERS IN OXFORDSHIRE.

by Anthony Parker, B.A. Cert. Ed. 1988.

This research attempted to clarify and intervene in the situation with regard to the use of microcomputers in Oxfordshire schools' Craft Design and Technology departments. It initially investigated and established the December 1986 position of computer use by CDT teachers within Oxfordshire LEA.

Data collection was accomplished by adopting the following techniques: Personal visits to schools; surveys by mail; a study of documents, articles, reports and a computer search; a study of books and papers in libraries; informal / formal talks with colleagues, Advisers and Heads of CDT; formal talks with Oxon Regional CDT Groups; observation of, and feedback responses from, teachers attending INSET courses both at national and local level. A review was undertaken of I.T. Education in the U.K., especially those aspects relating to CDT.

Case studies were undertaken of computer use in four Oxfordshire comprehensive schools.

Following the collection of initial data in the case studies, and the subsequent collation of the results, it was decided to undertake an Oxfordshire LEA County-wide survey of I.T. in CDT. It was initially necessary to discover how many schools and teachers were involved with CDT in Oxfordshire. Subsequently, a questionnaire was designed for use as the research instrument and distributed to all schools within the LEA.

Analysis of the data collected in the survey substantiated that there was both a requirement, and desire, for change amongst the survey population. Once the position was established, proposals were made to the LEA to increase CDT teachers' awareness and computer use. The suggested method of achieving this aim was by designing and employing an interventionist package, influenced by factors established in the research.

Problems of funding for both hardware and the development of course materials arose. An initial possible method of achieving this change was to devise a Distance Learning Package. This was to be used by teachers in conjunction with borrowed hardware. Subsequently, a taught course INSET package which could reach and affect more teachers was developed. This formed the basis of a secondary 'Action Research' programme into the method and effects of the training.

The INSET package concentrated on computer based Control Technology. Existing computer hardware, and course materials were investigated and evaluated; new course materials were developed, and then applied in the field.

Secondary research was undertaken which evaluated the effectiveness, and considerable success, of the teaching materials and training methods employed.

AUTHOR DECLARATIONS.

1. During the period of registered study in which this thesis was prepared, the author has not been registered for any other academic award or qualification.

2. The material included in this thesis has not been submitted wholly, or in part, for any academic award other than that for which it is now submitted.

A.G. Parker.

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Thanks and acknowledgements are due to numerous people who contributed to this interventionist research.

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INTRODUCTION AND OVERVIEW OF THE RESEARCH.

This research attempts to clarify and intervene in the situation with regard to the use of microcomputers in Craft Design and Technology departments in Oxfordshire Local Education Authority schools. It was instigated at the request of members of the Oxon LEA Technology Advisory Group following a proposal from, and discussions with, the author who has a personal interest in the field of microcomputing and CDT. The author has a total of 20 years teaching service in the LEA, and is an experienced senior CDT head of department, with 14 years experience working in this role in one of the largest CDT departments within the LEA.

A simplified description of the research project, is:

- That it initially endeavoured to investigate and establish the true position of a suspected situation within Oxfordshire LEA;

- that having established the situation proposals were made to change it by an interventionist approach;

- existing hardware and course materials were investigated and evaluated;

- new course materials were developed, and applied;

- secondary research was undertaken which evaluated the effectiveness of the resulting materials and methods used for raising the computer awareness and expertise of CDT teachers within Oxfordshire.

The majority of this research was undertaken on a full-time basis, over a years' leave of absence from teaching, between September 1986 and August 1987. However, some foundation work had been undertaken in the six months prior to this official starting date for the project.

With the increase in constraints on finance and resources for secondments, Oxfordshire have increasingly favoured those proposals which are able to give a 'return' to the LEA. 'Major' research projects are usually undertaken by attachment to a County Adviser. One of the parameters set for this research, was that it should be Oxfordshire based.

THE BASIS FOR CONCERN.

The concerns of the author, LEA CDT teaching and advisory staff, together with the Oxford Schools Science and Technology Co-ordinator, were categorised into the following:

(1) The apparent lack of interest concerning I.T. in CDT, both in schools and at LEA level.

(2) The apparent lack of computer equipment and its application in Oxfordshire CDT departments.

(3) The suspicion that Oxfordshire LEA was lagging behind other LEA's in CDT computer application. (Concern was already being expressed by CDT advisers and teachers within Oxfordshire; this increased following an I.T. paper resulting from an Advisers and HMI Conference - Matthews (1986) (1), and also the Design and Technology Exhibition held at Wembley in Autumn 1985, where computer use on the Birmingham schools Technical and Vocational Education Initiative stand, attracted the attention of many Oxfordshire CDT teachers).

(4) The perceived small-scale piecemeal I.T. developments in Oxfordshire LEA schools. (Those CDT teachers involved in I.T. appeared to be working on their own).

(5) An apparent shortage of specialist CDT staff with knowledge and expertise in the computing / I.T. area within the Oxfordshire LEA.

(6) Suspected underfunding in the I.T. area for CDT. (Evidenced by the apparent lack of hardware in CDT departments).

(7) Suspected deficiencies particularly covering Control Technology and Graphics / Computer Aided Design expertise amongst CDT teachers.

RESEARCH APPROACH & METHODS.

This section indicates the form that the research has taken. This form is:

1. Review of I.T. Education in the U.K., especially those aspects related to CDT.

The review includes materials from Schools and localised School Systems, In-Service Teacher Education, and new developments in the field of Information Technology Education. This was to provide an overview of I.T. education at national level, as a reference point for the level of I.T. education in Oxfordshire CDT departments.

The review approach would seem to be a particularly appropriate starting point. It attempts to clarify the use of the idea, and to show the breadth of usage. It gives valuable summaries of the intellectual area to which the topic belongs and can explore policy issues relevant to Information Technology education. Mullins (1977) claims that:

> "A review article gives an extensive detailed survey of a specific aspect of a science, usually for a specific period of time". (2).

Further support for the review approach can be evidenced by indicating examples which have been previously used in the UK and USA for surveys including the following diverse fields: A review of good practice in education; (3) a reader surveying a field; (4) for exploring policy issues related to communications. (5).(See references at end of this chapter for details).

2. COLLECTION OF DATA.

The collection of data was accomplished by use of the following:

- Personal visits to schools;
- a series of surveys by mail;
- a study of documents, articles, reports and a computer search;
- a study of books and papers in libraries;
- informal / formal talks with colleagues, Adviser and Heads of CDT;
- formal talks with Oxon Regional CDT Groups.
- observation of, and feedback responses from, teachers attending INSET courses, both at national and local level.

CASE STUDIES.

Introduction.

Case studies of four Oxfordshire Comprehensive schools were undertaken. This involved looking in particular at their CDT departments and teachers. Additionally, some of these teachers were studied on an existing computer control In-Service Training course. Other courses related to In-Service computer training for CDT and Science teachers were also studied both locally and nationally.

Use of the Case Study technique / approach is illustrated by Evans (1978) who asserts that the rationale for employing case studies is that when:

> 'used as part of a wider research project, case studies can provide material to illustrate a test or theory....'

and also that:

> 'research which has been reduced to mere statistics can seem very remote from the flesh and blood world we know, and case studies, judiciously used, can reclothe the bare bones...'(6)

As with most investigations, the collection of accurate data is crucial to the project. For this research the case study approach was considered to be the most appropriate method of collecting the required initial information and data.

SURVEY OF OXFORDSHIRE CDT DEPARTMENTS.

Following the collection of the initial data in the Case Studies, and the subsequent collation of the results, it was decided that an appropriate way forward was to undertake an Oxfordshire LEA County-wide survey of I.T. in C.D.T. A questionnaire was designed, for use as the research instrument, and distributed to all schools within the L.E.A. The Case Studies provided the necessary foundation, and a basis for pilot work; prior to a more extensive survey instrument being designed. Oppenheim (1973) writes:

> 'Pilot work can be of the greatest help in devising the actual wording of questions, and it operates as a healthy check, since fatal ambiguities may lurk in the most unexpected quarters. When a question is reworded after pilot work, it must be piloted again; the rewording may have introduced new difficulties or biases'.

In addition to the information gathered on the pilot studies, the prototype questionnaire forms were tested on co-operative teachers in schools; subsequent adjustments were made before the final format was adopted. Oppenheim also warns:

> 'It is important, at this point, to think well ahead toward the analysis stage'.(7)

This warning was heeded in the design of the questionnaire. A format was devised which allowed the information to be collated quickly and entered into a computer database ready for analysis.

Analysis of the data collected in the survey substantiated that there was a requirement, and desire, for change within the Oxfordshire L.E.A. With an awareness of problems of funding for both hardware and the development of course materials, an initial perception of a possible method of achieving this change was to devise a Distance Learning Package, which could be used by teachers in conjunction with borrowed hardware.

It was suspected that a limited amount of this hardware, which was already in use on a series of courses within the LEA, might become available as the funding for those courses finished. This did not prove to be the case; however, it was possible to make one, or occasionally two, sets of this equipment available for a limited amount of time to some teachers. Although this was useful for limited testing of development work, it was an unsatisfactory foundation for developing a distance learning package which would raise the awareness of numerous teachers.

However, subsequent discussions with the Oxfordshire Technology Advisory Group, following a set of proposals from the author, offered instead the opportunity of developing an INSET package which could reach and affect more teachers participating in tutored courses. The parameters of the work were widened at this point to include some science teachers together with the CDT teachers. This proposition formed the basis of an 'Action Research' programme.

ACTION RESEARCH.

Action Research, an interventionist approach, had successfully been used by the Oxford Educational Research Group Technology Project (8) in their four year study (1980-1984) of Technology in Oxfordshire CDT and Science departments.

Indications for the value of Action Research as an appropriate method to employ for this research in Oxfordshire, can be found in the work of Topping P. and Smith G. (1979):

> 'Action-research thus provided the researcher with a chance to make practical and useful findings, and a sure supply of resources from sponsors'.

As indicated above, the latter point regarding 'supplies of resources from sponsors', was crucial to the later aspects of the research. Further points made by Topping and Smith (1979) were also very valid for any progress to be made with increasing the I.T. awareness and ability of teachers from the levels which prevailed at the time of the research:

> 'However, there is another important technical strand. Conventional surveys and studies are almost bound to produce a static picture and, from this, causal relationships are hard to establish. one way forward, to try and determine the ordering of events, is complex statistical procedures. Another is to set up experiments which , by changing relationships, are likely to reveal causal links. Clearly, action-research projects could provide this experimental context and, importantly, the resources and legitimacy from introducing change.......Action-research projects naturally attract those who have strong commitment to change'.

A major intention of this research project from the outset, if the survey findings indicated and established the need for it, was to instigate a change in the CDT / I.T. situation within the county. The apparent constraints at the outset of the work indicated that an individual distance learning package may be the vehicle by which the intervention could be achieved. However, as the work progressed the opportunity of a course based approach arose. Topping and Smith (1979) later state:

> 'Action-research projects are based in particular areas and are inevitably drawn in to local commitments and relationships. Most, too, contain among their formal objectives the development of local involvement and participation and the notion of community'.(9)

Before the Action Research could take place it was necessary to develop the course and materials which would act as the research instruments.

THE DEVELOPMENT AND USE OF AN INTERVENTIONIST CONTROL TECHNOLOGY INSET TEACHING PACKAGE.

A parallel research investigating Computer Aided Design and Computer Graphics was being undertaken by another seconded CDT teacher within Oxfordshire L.E.A. Consequently, it was decided not to duplicate effort on these aspects of I.T. but to concentrate on the Field of Computer based Control Technology.

A requirement was established for the development of an interface, plus software and allied hardware, which could be used for INSET courses within the L.E.A.

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Following an extensive review of hardware, software, literature and other materials, an Interventionist INSET Package was devised, and applied, as a direct result of the findings of the above survey and subsequent deliberations.

Although a degree of finance for course materials had been established at this stage, it was insufficient to purchase hardware and other equipment which could taken away by the teachers and used for reinforcement at their leisure. (Following discussions in the case studies this principle was proffered as being of substantial value for teachers to reinforce at their leisure, what they had been taught during an intensive course).

Teachers attending the subsequent INSET courses were used as research subjects in order to investigate the effects of this newly developed interventionist package.

SUMMARY OF THE METHODOLOGY EMPLOYED IN THE RESEARCH.

Data collection was accomplished by adopting the following techniques: Personal visits to schools; surveys by mail; a study of documents, articles, reports and a computer search; a study of books and papers in libraries; informal / formal talks with colleagues, Adviser and Heads of CDT; formal talks with Oxon Regional CDT Groups; observation of, and feedback responses from, teachers attending INSET courses, both at national and local level. I.T. Education in the U.K. was reviewed, especially those aspects related to CDT.

Case studies of four Oxfordshire Comprehensive schools were undertaken. Collection of the initial data and the subsequent collation of the results from the case studies, suggested that an appropriate way forward was to undertake an Oxfordshire LEA County-wide survey of I.T. in CDT. A questionnaire was designed for use as the research instrument, and distributed to all schools within the LEA.

An initial possible method of achieving a change in the situation was to devise a Distance Learning Package, to be used by teachers in conjunction with borrowed hardware. Subsequently, because of an improved financial situation, a taught course INSET package which could reach and affect more teachers was developed. This formed the basis of an 'Action Research' programme.

Secondary research was undertaken which evaluated the effectiveness and success of the teaching materials and training methods developed and applied in the action research.

Chapter one describes some background and inter-relationships which existed within Oxfordshire LEA at the start of this research at the beginning of 1986.

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REFERENCES:

(1) MATTHEWS A. (1986) Report of the Cranfield Conference, Information Technology Implications for Craft, Design and Technology - held in December 1985. MEP & CET funded publication.

(2) MULLINS, C. J., (1977). - A Guide to writing and publishing in the Social and Behavioural Sciences. John Wiley & Sons, New York, USA,.

(3). Department of Education and Science - (1980) H.M. Inspectors of schools - publications: Craft, Design and Technology in Schools...Some Successful examples,

and:

D.E.S. - (1982) Technology in Schools... Developments in Craft, Design and Technology Departments,- both D.E.S. publications through HMSO London..

(4). MARSHALL A.R.(Editor) - Schools Technology in Action, Set Book, Open University, Technology for Teachers Course, O.U. Milton Keynes, UK.

(5). HAIGH R.W. GERVNER G.and BYRNE R. - Communications in the Twenty-First Century, John Wiley and Sons, New York, USA.

(6) EVANS K.M. (1978) - Planning Small Scale Research. (Revised Edition) - NFER Publishing Company Ltd.

(7) OPPENHEIM, A. N., (1973), - Questionnaire Design and Attitude Measurement, (Open University Set Book) Heinemann, London, UK.

(8) NASH M, ALLSOP T, & WOOLNOUGH B. (1984) - Factors Affecting the Uptake of TECHNOLOGY IN SCHOOLS - An OERG Research Project.

(9) HOWARTH J.T. (1979) - Community Involvement and Leisure. In the paper Ch. 13 'Action Research Perspectives and Strategies' - Lepus Books.

Searches were made in the following:

(10) E.R.I.C. (Educational Resources Information Centre) Booklets. The National Institute of Education, US Dept. of Education , Washington, USA.

(11) British Educational Index, 1981 - 86. The British Library, Bibliographic Services Division, UK.

CHAPTER 1.

CHAPTER 1.

This first chapter is included to give an understanding of the inter-relations between the Craft Design and Technology teachers, computers, schools and Oxfordshire Local Education Authority.

1.1. BACKGROUND TO CDT COMPUTING WITHIN OXFORDSHIRE.

The Oxfordshire Local Education Authority of today, administers an educational system which has as its foundation three distinctly different educational systems. The situation is compounded in its complexity by an amalgamation of two Counties. The original Oxfordshire LEA prior to 1974, comprised the City schools in the town of Oxford, and the mainly rural schools in the surrounding County area. Following the boundary reforms suggested by the Redcliffe - Maud report in 1974/5, the old North Berkshire educational area including the towns of Didcot, Wallingford, Henley, Wantage, Faringdon and Abingdon were incorporated into the 'new' Oxfordshire. The effect of this change was to increase the number of state secondary schools administered by the LEA, by 15; thus considerably increasing the workload of the administrators and County Advisers. As a bonus Oxfordshire now incorporated some of the more innovative Technical Studies Departments formerly under the control of Berkshire. A few of these had been receiving wide attention for their successful work. "Project Technology", of the type propounded by Don Porter HMI, and later by the Schools Council Project, was well advanced in some of these schools by the late 1960's. The foundations for the nationally recognised 'Technology' courses which were to follow, were already firmly established in some of these schools.

The Oxford City schools operated a three tier educational system of Lower, Middle and Upper schools, while the outer county area worked to the more conventional primary and secondary school system. The old North Berkshire area also predominantly followed this latter scheme, but had started to amalgamate schools for some sixth form courses in the small towns. A joint Sixth Form on a separate site was established in Wantage, to serve that catchment area. The 'Eleven Plus' examinations had been abolished in the middle 1960's and comprehensive schools were established as soon as the government bill was approved by Parliament.

1.2. THE ADVISERS FOR CDT.

The original Oxfordshire LEA prior to boundary reform, employed one full time County Adviser for Craft and Technical Studies and also a part time Teacher Adviser. The latter progressively became more fully employed because of the rising numbers of pupils entering the schools at that time; plus the 'Raising of the School Leaving Age' and the advent of 'Comprehensive Reorganisation'. After the boundary change took effect, the net increase in the workload was such that the LEA employed both advisers full time. A tacit agreement was reached between these individuals whereby the total LEA area was divided into zones of responsibility.

When one of the Technical Studies advisers took early retirement at the end of the 1970's, he was not replaced, (along with several other advisory posts). The remaining County Advisers were given an increased brief and subsequent workload, which gave them less time to concentrate fully on their specialist areas. In 1985 the LEA appointed an assistant adviser with responsibility in the Design area. Both of the existing CDT advisers readily admit to having little knowledge of computing, but have substantial craft and design backgrounds.

An adviser with responsibility for computing was appointed in 1982. This appointment establishing a new post within the LEA. His background is essentially within the mathematics area, but he also had well established links and experience with a local company which manufactured computers.

The CDT, Computing and Science Advisers, together with the Director of the Oxford Schools Science and Technology Centre, meet together as the "Technology Advisers Group."

Oxfordshire was one of the 'Shire towns,' whose County Council took the view in the early seventies, "that it would be prudent to do some 'good housekeeping' with the rates and finances" (Councillor John Francis), and thus started to cut back on educational spending. This political decision was to have far reaching effects on the state of finances for education in Oxfordshire for all years since that time. When central government finally imposed their own rate restraints, Oxfordshire was assessed on a much lower baseline than was necessary; which served to further restrain educational spending. Consequently, Oxfordshire LEA has been consistently in the lower half; and often near the bottom, of the LEA 'league table' for staffing and capitation. This list appears periodically in the "Times Educational Supplement" and professional association literature. (Author's observation).

1.3. LINKS WITH OXFORD UNIVERSITY.

Oxford University is recognised worldwide as one of the premier educational institutions. The University developed links with the LEA schools in the 1960's. A resources unit was established c.1971 titled "The Oxford Schools Science and Technology Centre" (OSSTC), based in the University at the Clarendon Laboratories. The OSSTC has played a significant role in establishing wide and helpful links with schools throughout the Counties of Oxfordshire, Berkshire and Buckinghamshire; and has been instrumental in developing early links between Craft and Science departments. Some of the early technology teaching within the LEA was certainly encouraged by this centre.

Attempts to increase the computer awareness of Science teachers in particular, were made at the Oxford Schools Science and Technology Centre, Oxford University, in the early 1980's. Courses were organised for electronics and computing within Oxford University, which were also attended by a few teachers who specialised in CDT / Technology. OSSTC had fairly close links with the Chiltern Regional Centre at this time. As a result of these links a few interfaces / buffer boxes were built to work with the RML 380Z machines. When related to the general lack of information regarding interfacing techniques in the early days of schools computing; the independently funded OSSTC had done much to provide information and help for those teachers who perceived the possibilities for this line of development of computer use. Information sheets and booklets were also produced which provided information and ideas for interfacing stepper motors and a number of mainly scientific experiments.

Oxford University employs the OSSTC director; who therefore has a degree of independence from the LEA, although he normally works very closely with the LEA advisers and in effect on many occasions acts as an adviser himself. The Schools Science and Technology Centre also acts as a Science and Technology Regional Office (SATRO), for the above area and including Berkshire and Buckingham. All subsequent directors of this centre have actively encouraged the co-operation between Science, Craft and Technology and have helped considerably with new developments in this field of teaching. This centre is regarded by many CDT teachers within Oxfordshire as being of significant importance for resources, help and training.

1.4. THE CDT TEACHERS WITHIN OXFORDSHIRE LEA.

In the 1960's, Craft teachers; who had also received some Design training; emerged from the established Training Colleges which traditionally had produced these specialist teachers. Prior to this time nearly all teachers teaching Woodwork and Metalwork were specifically trained in one of these subjects, together with Technical Drawing. A competent teacher in both Wood and Metalwork was relatively unusual. Some of the teachers teaching these subjects were not teacher trained at all, but were craftsmen who had entered the profession with City and Guilds qualifications, when entry requirements were less stringent. Some may have undertaken a one year 'Emergency Training' course. The specialist knowledge base of these teachers was quite adequate for the demands of the 1950's and early 1960's. However, during the 1970's, Woodwork and Metalwork started to give way to Technical Studies, Craft Design and Technology, Graphics rather than Technical Drawing; and a subject which resided uneasily between the science and craft departments in many schools, called 'Technology'. To teach these subjects adequately today (1987), it is no longer possible to have a sound knowledge of one subject only. The CDT teacher today must have a reasonable knowledge of the traditional crafts of woodwork and metalwork, plastics, graphics, art and design, electronics, pneumatics, mechanics - and now, computers. It would be difficult to find any other subject within the curriculum which has expected so much change of its tutors. Those teachers who have adapted to meet the new requirements, appear to have done so, in the majority of cases, without receiving any, or at best, inadequate retraining.

In view of the above comments it would be relevant here to consider the quality of the CDT teachers employed in Oxfordshire schools. A well publicised shortage of CDT teachers for the last 20 years should exhibit some effects on CDT departments in any LEA. In recent years, it appears that very few graduates have been produced by Training Colleges who have subsequently entered the teaching profession to take CDT posts. Amongst a variety of reasons, a contributory factor for this position arising could be the governments' demand for Colleges to produce an all graduate profession. The extra degree qualification has in many cases led to jobs in industry rather than teaching; where low pay and poor morale have been a known problem for many years.

Oxfordshire in common with many other counties has undoubtedly suffered from a shortage of trained and skilled CDT teachers. The schools have responded to the shortage in variety of ways. One Abingdon school, visited in the case studies, which had seven fully trained craft teachers in 1973, has closed workshops and now only employs four CDT teachers; two of whom teach in other subject areas in addition to the workshop subjects. Another school visited in the South of the county currently has seven teachers teaching CDT; only four of these seven were trained for craft teaching. Of the others, one was an Art / Drama trained teacher, another came from the building trade with City and Guilds qualifications, and the last member of the group has a Textiles Art College training. The situation is similar in many schools within Oxfordshire and tends to hide the true position regarding the shortage of fully trained CDT / Technology teachers. On paper, the county does not have a shortage! Many of these non-specialist trained teachers perform admirably in a workshop situation and some of these people bring valuable skills of their own to their classes. However, some find it difficult to adequately overcome the limitations which are inherently placed on them by their lack of specialist training in materials, tools and equipment use. It was widely reported in interviews for this study that it has been almost impossible to employ trained CDT teachers with electronics or computer skills within this time. Advertising for a scale one post has in many cases elicited a nil response in schools throughout the LEA.

1.5. CLASS SIZES AND TIMETABLED TIME.

In the late 1960's and early 1970's in Oxfordshire, a class size of 13 or 14 was not uncommon for all school years. It was with groups of this size that schools started to teach "Project Technology" (as advocated by D. Porter), with all the implicit individual attention for pupils which is inherent with this type of approach. Today it is not uncommon for groups undertaking similar work to contain 20 pupils; often working to a greater depth of knowledge than their predecessors. To exacerbate the situation even further, many schools have found it impossible to timetable the half day, or even double period time slots for design based subjects. These once common time allocations were not only regarded as necessary, but essential, by most CDT teachers. The advent of the 'Equal Opportunities Act', in many instances caused a reduction of time spent in the workshops for many pupils; because of the demand for greater use of the resources by the whole school population. Time also had to be found within the timetable to accommodate home economics subjects not previously commonly undertaken by boys. The resulting 'circus' arrangements often proved unsatisfactory. The results of staffing constraints and falling rolls in recent years have effected radical changes on demands and accepted practices for CDT within the LEA.

1.6. THE SUBJECTS TAUGHT IN WORKSHOPS.

While not denigrating the excellent quality of craftsmanship and skills still to be found in schools taking the traditional Woodwork and Metalwork examinations; undoubtedly some of the most spectacular and interesting work has been undertaken by schools entering pupils for the CDT and Technology examinations offered by the various examination boards in recent years. Over a period of fifteen years there has been a gradual move away from pure craft skills, towards design; and the written and graphic presentation of work becoming of paramount importance for examinations. Work in the CDT and Technology subject areas, has now to contain substantial evidence of thought and paperwork, as opposed to practical work, which nevertheless has to be executed with equal skill to that previously attained in traditional craft subjects. The precipitant implementation of GCSE has done little to help the situation of teachers still struggling to come to terms with Design and Technology in many schools within the LEA.

1.7. SPENDING ON COMPUTERS WITHIN OXFORDSHIRE LEA.

An indication of the expenditure levels of the Oxfordshire LEA on computing in schools, can be found in a newsletter distributed by the Microtechnology adviser in 1987. It States:

'During 1985/86, Oxfordshire County Council spent £400,000 on

> microcomputers in schools. This was a substantial sum which achieved a major breakthrough in the levels of microcomputer equipment in schools. Most Secondary schools got a five station network, while we were able to replace the cassette recorder that came with every Primary school's first microcomputer with a disk drive. In 1986/87 the Council spent £70,000. This allowed us to complete the job of installing networks in secondary schools, and to offer the cost of a disk drive to help primary schools with over 150 pupils to buy a second microcomputer'. (WALTON D. 1987).

With around 40 secondary schools within the LEA The £400,000 should have divided to around £9,000 per school in 1985/86, allowing for the Primary school disk drives. How much of this computing equipment had percolated into the hands of CDT teachers was a point to be investigated.

1.8. INTER-SCHOOL RELATIONSHIPS BETWEEN CDT TEACHERS.

The majority of CDT teachers throughout the LEA, have for many years co-operated with their colleagues in immediate neighbouring schools. They have also generally always been ready to offer help and support when approached by their colleagues.

The group identity of this collection of geographically scattered CDT teachers, is certainly recognisable and something to be experienced at any large meeting which they attend. One of the CDT advisers regularly warns his guest speakers to 'Watch this lot, they'll eat you'. Years of underfunding, staffing shortages and dealing with other adversities, have probably had the unconscious effect of drawing the CDT teachers together as a fairly close group. It was therefore perhaps surprising that this group had not apparently done more for themselves with regard to computers. Numerous questions could be asked to try to account for this situation:

- Was it a question of computers not being seen as part of the everyday tools of craft and design teachers?

- Could it be the result of a lack of equipment in the schools?

- Was it lack of computer and software awareness?

- Was the use of computers officially discouraged within the LEA, or the institutions themselves?

- Did the CDT teachers know how to use computers?

- Was any help with computing required, or even felt to be necessary by the majority of CDT teachers?

- How could help be given if it was desired?

- Is it the true situation that computers are not being used by the majority of CDT teachers?

- How could computer use be established?

- Should computers be used by CDT teachers?

- How could computers be incorporated into CDT lessons?

-etc. etc.

1.9. A POINT FOR CAREFUL CONSIDERATION.

Forthright teachers, overburdened with the precipitant introduction of new examinations systems and continuing industrial disputes, could be justly regarded as a potentially difficult population for research. A regrettable experience of a previous major research project within the LEA had also alienated many CDT teachers to contributing towards new projects.

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It is then, against this background of radical changes, hidden staff shortages, lack of trained CDT teachers liberally supported with non-specialist trained - or ex-craftsmen approaching retirement; that we have to consider why, and if, computers should have been, or should be introduced into CDT within the LEA. It is also at this stage that very careful consideration has to be given to possible strategies for determining the extent of the problem of computing and CDT; if it exists at all, and also to methods of achieving improvement if deemed necessary.

Chapter two looks at the relatively recent development of computer use in schools, and also considers whether this should form part of the CDT domain. It appeared that some of the CDT teachers within Oxfordshire already accepted that it should; but how general this view was, and whether it was well founded, needed verifying.

CHAPTER 2.

Chapter 2.

CHAPTER 2 - COMPUTERS INTO THE CLASSROOM.

This chapter considers the introduction of computers into the classrooms of schools. One of the instigators of the 'micros in schools scheme', Dr. Eric Bates, head of the Industry Education Liaison Unit within the Department of Trade and Industry; was interviewed during a visit to Oxford University Schools Science and Technology Centre in May 1987. The discussions with Dr. Bates helped achieve a greater understanding of the background to this unique project. The following paragraphs illustrate the development and progress made with computers within education in recent years.

2.1. HISTORY OF COMPUTERS IN THE CLASSROOM.

The history of computers and their use in British schools can be traced back much further than the joint government / DOI 'micros in schools initiative' of 1981. Although they were admittedly few in number, some schools were already using computers for teaching computer studies as an adjunct to mathematics in the early seventies. Most of those involved with this teaching were managing to introduce the subject under the flexibility offered by the Mode 3 Certificate of Secondary Education syllabuses. At the end of the seventies decade and the beginning of the 1980's, magazines promoting technology education, such as "NCST News", were including articles reporting the use in technology projects of microcomputers such as the PET Commodore. P.F. Nicholls, then at Belper High School, Derbyshire, wrote an article (March 1981) specifically concerned with 'Microprocessor control in CSE electronics.' (1) . Ron Denny a Bedfordshire adviser, later to become leader of the Bedfordshire branch of 'British Schools Technology;' wrote an article (December 1981) describing the use of Acorn Atom computers on a specially equipped bus. (2). The Bedfordshire technology buses subsequently became a very well known method of promoting technology in schools.

At least two schools within Oxfordshire LEA were offering computer studies on their curriculum in 1972. These were initially made possible by using telephone linked, school based terminals of computers based in Culham Laboratories and at Reading University.

In common with much of the rest of the country, computing was initially introduced into the Oxfordshire schools curriculum by those teachers with an interest or a degree of previous computing experience gained outside teaching. The mathematics departments in many schools were the first to find a use for the 'new technology'; but in at least two of the major secondary schools within Oxfordshire LEA, it was members of CDT departments who first exploited the potential of computers for administration and teaching. In these latter two cases, both teachers have since become increasingly involved with "computing" and could be described as 'computer expert'. Both of them now spend less time teaching CDT; and have virtually taken charge of computing within their schools.

However, it is not until the beginning of the 1980's and the Government / Department of Industry initiative to place a microcomputer in all schools, that the debates and controversies regarding computers and their use in schools can be regarded as becoming a major issue for the state education system.

2.2. USE OF COMPUTERS IN LEARNING.

With their astonishing rate of development, microelectronics and related technologies have had an incredible effect on our world. Becoming progressively cheaper, and hence more accessible, the 'new technologies' are encroaching on all aspects of our western lifestyle.

> Dr. Christopher Evans, of the National Physics Laboratory, calculated that if the automobile industry had been as successful in developing its product as the computer industry, it would now be possible to buy a Rolls Royce for £1.35; to get three million miles to the gallon and to fit six of them on a pinhead!(3)

Although this analogy is not very practical, it does serve to illustrate the phenomenal progress which has been made with computers in ten years. Schools, like all other sections of society are open to their influence and are not only being called upon to teach children about the 'new technologies', but also to incorporate them as an aid to teaching. There can be little doubt that schools cannot ignore a technology which has the potential to impose social change on a scale as great as that seen during the industrial revolution. An article in the Times Educational Supplement stated:

> 'It is clear that the exceptionally rapid advances in the field of information technology that we are currently experiencing, need radical responses from the teaching profession if we are to remain part of the real world in which children will live and work.' (4).
> (ASTON M. 24.10.'86)

2.3. GOVERNMENT and INDUSTRY INTERVENTION.

The foundations for computers becoming a major issue in schools, can be traced back to the Autumn of 1976 when the Prime Minister James Callaghan made the Ruskin College speech at Oxford which started "The Great Debate". This speech was made after an internal DES report known as the 'Yellow Book,' had drawn some sharply critical conclusions regarding the standards of education in some schools, and had recommended that the DES take a more active role in the design of the curriculum. Callaghan argued that rather than suffering a severe decline in educational standards, (which was being suggested by the Conservatives), 'today's world demanded higher standards than were required yesterday and there are simply fewer jobs for those without skill. Therefore we demand more from our schools than did our grandparents.' He then went on to call for 'a more technological bias in science teaching that will lead towards more practical applications in industry rather than towards more academic studies.' (5).

In 1979 Neil Mcfarlane told the autumn conference of the SCSST that the 'central issue to the United Kingdom at the moment is economic survival' and that a contributory factor of the economic decline was 'a mismatch between educational content and industrial / economic need,' and further that there was a 'crucial relationship between education and industry.' (6).

The DES in "The School Curriculum" (1981) argued a strong case for CDT and science as essential components for the education of all pupils in the 11 to 16 age range. In relation to CDT the paper states that 'when it is taught imaginatively, this work helps pupils to understand that the practical application of discoveries and inventions is as vital to our society as scientific research.' (7).

The concern of departments outside of the DES regarding the standards of education for Science and Technology was being strongly felt by government and the schools by 1980; and by 1982 the Industry Education Liaison Unit led by Dr. Eric Bates was spending £5,500,000 a year on education / industry links projects for schools. (8). As an initial incentive to schools to equip with the 'new technology'; the DTI in conjunction with Kenneth Baker, then government minister responsible for Information Technology, announced a scheme where the government and DTI offered 50% of the cost of one computer for every state maintained school, and for selected teacher-training institutions. The short-term subsidy ensured that the selected equipment was all British manufactured and thus precluded schools buying the industry standard IBM type computers; or those machines already in some schools such as PET and Apple. During an interview for this research, Dr. Bates reported that the figure eventually amounted to over £26 million for the equipment which he managed to place in schools under the scheme before his retirement in July 1987.

With unemployment approaching the 4 million mark, concern for the futures of young people became a central issue for the government. Against this background, and with the activities of the Manpower

Services' Technical and Vocational Education Initiative (TVEI), the merits of gearing secondary education to the 'world of work' became an important issue for those who had a say in, and indeed also for many of those who wanted to influence educational provision.

The Manpower Services Commission established in 1973 with general responsibility for training and employment; was asked by Margaret Thatcher as Prime Minister in 1982 to form the Technical and Vocational Educational Initiative scheme. (9). This action demonstrated that government concern with technological activity in schools, or perhaps lack of it, was causing them to challenge many of the preconceptions which had dictated the politics of schools science and technology since the second world war. Government intervention of this type was certainly a departure from the previous norm of the DES undertaking the introduction of new initiatives into the state schools. Ostensibly the origins of TVEI were explicitly vocational. However, many of the schools which piloted the TVEI schemes took the opportunity offered to review their curriculum and to develop what they viewed as more relevant courses for their pupils, but which also fulfilled the requirements of the new providers, the MSC. The effect on the state schools which piloted the scheme, was to give them unprecedented funding; which had not previously been available, to use for buildings and equipment. Many of the schools used significant amounts of TVEI funding to acquire microcomputers and ancillary equipment.

The 1983 Alvey Report on Advanced Information Technology makes frequent mention of the manpower implications of work in advanced information technology, and of the need for an extensive programme of education and training at all levels. 'The Alvey Report and Government regard British success in information technology as essential for a sound economic future. However, Government cuts in education provision have reduced the number of computer science and other technology graduates since 1981.' (10). This latter statement was not the only cautionary note the report made for the government, it later states:

> 'Action must start in the Schools. We support the moves which are now putting computing in the curriculum. But it is no good just providing schools with microcomputers. This will merely produce a generation of remedial education to entrants with "A" level computer science. Teachers must be properly trained, and the languages chosen with an eye to the future. Uncorrected, the explosion in home computing with its 1950's and 1960's programming style will make this problem even worse.' (11).

Further evidence for a change of emphasis within the education system was to be found in July 1984. Two hundred government education officials and experts from industry, converged at an international conference held at the Paris headquarters of the Organisation for Economic Co-operation and Development (OECD). The subject for discussion was that 'The Western Nations must get their act together and ensure that education keeps in line with the needs of society.' (12).

2.4. EXAMINATIONS.

The precipitative introduction of GCSE, against severe opposition, the background of the teachers disputes and the new 16+ examination system, as well as the Technical and Vocational Education Initiative, have all demonstrated the present government's desire to see ' education for relevance' within schools. It would be difficult to identify a period of similar radical educational changes, which have taken place in such a short space of time, in the history of British state education.

2.5. SUPPORT.

To support the deployment of hardware, the Departments of Education and Science of England, Wales and Northern Ireland, funded the Microelectronics Education Programme starting in 1981. Designed as a five year pump-priming operation, the MEP's brief was to 'investigate the most appropriate ways of using the computer as an aid to teaching and learning, as a guide to the individual child, as a learning aid for small groups of children, or as a system which involves the whole class.' (13). The Microelectronics Education Programme played a major role in 'supporting the school micro' and also contributed much to the development of educational software and in-service teacher training. The successor organisation, the Microelectronics Education Support Unit (MESU), (Feb. 1987) has yet to make much impact on the provision and support for schools.

2.6. FINANCIAL CONSIDERATIONS.

Coming at a time when educational budgets are constrained, the running costs of microcomputers; the initial cost of hardware and the ongoing costs of software and repair; represent a substantial investment not only for central government, but also at school level.

With some schools reported to be unable to find money to replace books, some teachers questioned the 'cost effectiveness' of the microcomputer as an educational tool. There is a misconception in some quarters that it is only the initial cost of hardware which poses a problem for schools. At present it is mainly software costs which account for recurrent expenditure. Another factor to be considered in the equation is that microcomputers used in school today have a limited life, both in mechanical terms and also in terms of simply becoming obsolete. Schools will then be expected to re-equip with the latest affordable 'state of the art' machines, hence it is reasonable to expect that the initial 'capital investment' in microcomputers will become part of a recurrent expenditure. It is to be hoped that advancing technology and better manufacturing methods will lower the equipment costs for schools in the future. However, it is interesting to note in Oxfordshire, that many of the schools are attempting to raise funds which will allow the purchase of second-hand BBC model "B" computers for use in science and CDT departments. This move against the 'logical' trend may suggest that the biggest, newest and best are not always what is required in the classroom. (Although this could equally indicate a severe shortage of funding). It may well be more important to the end user that significant quantities of useful software are available; which can be used without further modification, or which can be readily adapted to the particular school situation. The latter situation would parallel that in industry where it is the software which is important and the hardware to run it is predominantly an incidental consideration.

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2.7. COMPUTERS AS PART OF THE CURRICULUM?

Kenneth Baker made a statement in 1984 which perhaps indicates the degree of importance he and the government attach to computer use in schools:

> 'The challenge is now to achieve the widespread application of computers as a support for teaching and learning across the curriculum.' (14).

Perhaps it would be pertinent to also state here the cautionary note which Chandler (1982) wrote regarding school adoption of computer technology:

> 'the time it is taking for the pocket calculator to achieve such a revolution in attitudes in schools does not encourage one to be particularly optimistic about the short-term effects of the routine use of computer databases.' (15).

Perhaps Chandler was too pessimistic!

An HMI study (Wilce, H 1984), reported that schools were not thinking seriously about the use of their computers 'across the curriculum.' (16).

Since these statements were made, the GCSE has brought about a number of changes in computer use within Oxfordshire schools. Most no longer just teach 'computer studies' with its heavy emphasis on programming and history of computers, but are attempting to get all subject areas involved with computing. David Smith and Morley Sage

(1984) (17) recognised that problems existed and claimed that the introduction of the school microcomputer to date has been characterised by 'innovation without research' and that very little, if any, work has been done to research the possible implications of microcomputers in the school curriculum. This statement would certainly appear to apply to the Oxfordshire computing scene in many schools.

Computer studies had become part of the curriculum of a very large number of secondary schools. Most courses were directed towards external examinations and all examination boards had developed examinations in computer studies or computer science. These syllabuses were all revised with the implementation of the new GCSE examinations. As such, computer studies represented one of the largest growth areas of curriculum development in recent years. Under the new conditions offered by the GCSE examinations, it is perhaps possible that Kenneth Baker's 1984 statement regarding 'computing across the curriculum' will come nearer to fruition.

It is now widely suggested that the various curricular areas should reinforce and complement one another, so that the knowledge, concepts, skills and attitudes developed in one area, may be put to use and provide insight in another. The view is that this would help to increase the pupils' understanding, competence and confidence.

> 'We envisage that, rather than computer studies being a separate curriculum area, the use of technology should increasingly underlie the teaching and learning of each subject

area, offering a knowledge-based approach to computer literacy.' (18) (FEU 1985).

Computers have much to contribute in the achievement of these aims; particularly as the curriculum should be balanced in such a way that all pupils are brought into contact with a range of activities covering the agreed areas of learning and experience. The proposed 'National Curriculum' aired in the 1987 Conservative party manifesto, may well have the effect of breaking down some of the barriers of subject entrenchment and peculiarities inherent in some schools; (if it is implemented). Evidence and support for these changes can be found in an article in the "Times Educational Supplement:" (24.10.'86)

> 'This change in the new GCSE syllabuses now being taught in England and Wales involves a very significant reduction in the importance given to programming and concomitant increase in the study of computers as tools for human activity - applications in other words. There is a welcome move towards information technology and away from the technical ivory castle view of computers as machines in a vacuum. At the same time computers are (at last) spreading across the curriculum, so that programming opportunities will grow in other subject areas if that is what learners and teachers want. (19).

2.8. WHERE SHOULD COMPUTERS BE USED IN SCHOOL?

Apart from the more obvious contributions to linguistic, literary, mathematical, scientific and technological areas, computers can contribute to creative and even aesthetic areas. An understanding of the role which computers play in society today will contribute to the human and social awareness. Computers have a major part to play in Design and Technology courses in schools. The HMI paper on "The

Curriculum from 5 to 16" (1985) stresses the importance of design and technology within the curriculum. The paper states:

> 'At the secondary stage, the confidence to control things should be growing. There should be a change in the process of solving problems...The activity of designing should have become systematic...Designing should also include a more thorough analysis of the problem to be solved.' (20).

Although it is not necessary to have a computer to teach control technology, the use of a computer is certainly a major factor to be considered for control lessons. Similarly, the inclusion of computer aided design and manufacture must now be considered as highly relevant subject material for CDT courses. However, careful thought needs to be given to methods of implementing these topics into the courses if they are to be meaningful. As Deeson E. (1986) points out:

> '....How far can a class consider robots in an assembly plant, process control in a petrochemical unit, or computers in stock control when few, if any, of the pupils will know anything of those activities? (21).

2.9. IS CHANGE TAKING PLACE?

The reality of the situation is that changes in educational provision are painfully slow. It could however be considered that computers have impressed their presence on the British education system to a significant degree in six years. The previously autonomous nature of the British education system, has ensured that the content and implementation of teaching rests very much with the individual teacher. It is perhaps this very freedom which makes it difficult to effect general change, especially on a concerted basis. The implementation of the GCSE has ensured to some extent that standards and content will meet nationally agreed criteria, but it is becoming apparent that this change alone is not sufficient for the current government and Kenneth Baker is working towards a 'national curriculum.'

> '...I believe that, at least as far as England is concerned, we should now move quickly to a national curriculum. By that I mean a school curriculum governed by national criteria which are promulgated by the Secretary of State but in consultation with all concerned - inside and outside the education service......' (22)

One of the major barriers to the effective use of the microcomputer in British classrooms has been the absence of trained teaching staff; (FEU. 1985: SELF, J. 1985: MEP 1983 et. al.), and with the growing demand for the microcomputer to be applied 'across the curriculum', progressively more and more teachers will be forced into the situation of having to become 'computer literate'. Despite government and LEA efforts there remains a desperate shortage of in-service training. This deficiency is apparent at all levels of the education system; a report from the Further Education Unit (1985) stated,'most staff teaching CNC were themselves self-taught.' (23). A not untypical situation to be found in schools perhaps! However, it is possible that some improvement in this position will ensue for schools, as a result of the five in-service training days built into the 1987 pay award and conditions of service for teachers.

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2.10. SOFTWARE AND HARDWARE.

Good software, sufficient well trained teachers, and sufficient useful hardware for use by a full CDT class in schools, still appears to be a particular problem in Oxfordshire, (as it is elsewhere in some parts of the country). The problem with software, is not just the availability or otherwise of useful materials. To be able to use software successfully requires that the operator has time to learn how the programme works, and what it is capable of doing. This problem has been recognised by other commentators on the education system such as (THORNE, M. 1986):

> 'A related problem is what I call the "iceberg problem" for software. Many of the larger CAL packages are not being used because of the amount of teachers' time needed to find out just what pupils may get out of them and to gain enough confidence to use them.' (24).

A similar problem obviously exists for pupils learning how to use software. In many instances the problem is exacerbated by the input devices and software available for them to interact with the machinery. Substantial attempts have been made by various groups to make an easier input device to the computer. Tracker balls, mice, concept keyboards, Quinkey, touch screens and pads, have all been tried with varying degrees of success and there are reports of speech input developments taking place in American schools for the next generation of machines. Fortunately, in practice children soon learn how to use a keyboard, although not necessarily to the conventions expected by typing schools.

> 'There is now a definite trend away from programming and memorising commands in software, towards menu driven screens or command screens which lead the operator through the processes in simple stages without requiring an in-depth knowledge of the machine operation'. (ISMEC) (25).

This movement will inevitably make computers more accessible to all abilities rather than an interested few, or those with higher intelligence. Computers could be an everyday aid in a workshop situation for those children with writing and spelling difficulties. With suitable word processing and spelling check facilities fitted, a child may be more willing to produce a design folder, report or evaluation on a computer than he would otherwise. An ex-director of the MEP states in the TES 16.5.'86:

> '...Too often the neatness of the writing has seemed more important to the pupil than the content or imaginative, creative work. It should not be forgotten that correcting or re-drafting written work on a computer is often thought of as fun.' (26).

2.11. NUMBERS OF MICROCOMPUTERS IN SCHOOLS.

An indication of the numbers and types of microcomputers to be found in British schools generally, can be obtained from a survey released in November 1986:

"(1) The government subsidy from the Department of Trade and Industry has determined the models purchased. The BBC/IBA survey during the Autumn term 1985 showed the following picture:

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UK Schools equipped with micros.	Primary 95%	Secondary 99%
In equipped schools:		
Average no. of micros	1.9	13
Acorn/BBC B	85%	89%
RML	14%	59%
Spectrum	9%	23%
Under other models		
Commodore PET	15%	
Apple	11%	
ZX81	7%	
Electron	5%	
Commodore 64	4%	
RML Nimbus	3%	
Tandy TRS 80	2%	
Vic 20	2%	
IBM PC	1%	

The DTI grant was conditional on an element of teacher training being undertaken. This has been particularly critical in primary schools where the arrival of micros, and demands to use them, took place very rapidly, but the opportunities for training were very uneven.

This report commissioned by ITV and Channel 4 television goes on to say:

> (2) Parents in particular have been powerfully aware of the micro as a key to the future of employment for their children. They have made insistent demands on teachers and had often set about raising the funds to allow their own children's school to qualify for the DTI grant..........About one in five of UK homes has a micro, and of homes with children it's one in three.(27).

2.12. SUMMARY.

The British attempt to introduce 'educational computing' has seen a mixed degree of success. The 'here it is - find out what it can do' approach; which was typical of the way most schools were given a microcomputer, and for the most part, left to find out for themselves what it could be used for; has, in educational terms, been rather unusual. Considering that much of the funding for the scheme was derived from industry the approach is astonishing! Industry usually only buys what it needs, and even then only if it can see a return on the investment. It is usual in business to establish exactly what the use will be and then try to find equipment which will fulfil the task. The profligate approach taken with the 'micros in schools scheme' for education was revolutionary in industrial terms; whether it was the best one to take is arguable. There is no doubt that it has succeeded in making schools take notice of microcomputers. Whilst not all schools have been convinced that microcomputers are something they must come to terms with, the DOI - government 'pump priming' scheme has certainly aroused a computer interest in most schools. How far CDT departments have moved towards coming to terms with computers in Oxfordshire, is a subject open to debate.

The next sections of the study describe the attempt to discover the true position of computers and their use in CDT departments within the LEA. Preliminary case studies were undertaken with four schools and these are described in Chapter 3.

Chapter 2. REFERENCES.

(1). NICHOLLS, P.F. - (March 1981). School Technology - Page 30. 'Microprocessor control in CSE Electronics'.

(2). DENNY, R. - (December 1981). School Technology - Page 5. 'Technology goes mobile - the Bedfordshire bus'.

(3). EVANS C. Quoted by professor Tom Stonier in Science in Society - The Impact of the Micro-Processor on Society. (1987)

(4). ASTON, M. - (24.10.'86). Times Educational Supplement. - Page 36
para. 2.

(5). McCULLOCH, JENKINS and LAYTON. (1985) - Reporting a Times Educational Supplement article 22.10'76 - 'What the PM said'.

(6). MACFARLANE, N. MP - (November 1979)- Keynote address to the SCSST annual conference - 28.11.'79.

(7). DES (1981) - The school curriculum.

(8). Times Educational Supplement. (3.12'82) - 'DoI presses for practical exams.'

(9). Department of Employment, (March 1973) - 'Employment and Training, Government Proposals'. - Command 5250.

(10). JOHNSTONE, B. (24.7.84) - The Times.'World-wide explosion of school micros'.

(11). Further Education Unit - (1985) -Fifth Generation computers - 'Their implications for further Education'. page 12 para. 1

(12). ALVEY, J. (1983) The Alvey Report on Advanced Information Technology. - (Section on schools).

(13). FOTHERGILL, R. (1983) - Electronics and Control Technology. - (An information leaflet published by MEP).

(14). Report in the Times (24.7.84) - Kenneth Baker was speaking to the Organisation for Economic Co-operation and Development.

(15). CHANDLER, D. (1982) - Micro Primer - a foundation for teachers - Study Text. MEP - Techmedia.

(16). WILCE, H. (29.6.'84) The Times Educational Supplement.- 'HMI Concern over Computer Use'.

(17). HODGES (1984) - From a report produced for the Economics and Social Services Research Council.

(18). FEU (1985) - 'Fifth Generation Computers' - Curriculum Issues 20). Page 15 - para. 3.

(19). DEESON, E. The Times Educational Supplement.(24/10/86) - 'Wanted: Resources'. Para 2

(20). DES (1985) - HMI Curriculum Matters No. 2 "The Curriculum from 5 to 16"

(21). DEESON, E. The Times Educational Supplement.(24/10/86) - 'Wanted: Resources'. Para 3 Line 6.

(22). BAKER, K. MP - (23.1.87) - Secretary of State's speech to the SEO.

(23). FEU (1985) - "CNC in FHE"

(24). THORNE, M. (24.10.86) - The Times Educational Supplement. Extra - page 36 - para. 7.

(25). Independent Schools' Microelectronics Centre. (1986) - COMPUTERS - Their place in schools. - A policy statement.

(26). (16.5.'86) - Times Educational Supplement.

(27). "MICROS IN EDUCATION" - ITV/C4 NOV.'86

CHAPTER 3.

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3.1. CASE STUDIES AND INITIAL RESEARCH.

Potentially, there are many different approaches to an investigation. It was decided that the mini-case study approach would prove to be the most effective method of collecting initial information in this instance. Studies in four schools were carried out and the method used in each consisted of an informal or alternatively a semi-structured interview with CDT staff. In addition, both national and local In Service Training courses were visited, or attended, for the purposes of observation.

This chapter explains briefly why the case study approach was thought to be the most suitable method of investigation to adopt for this stage of the work. The chapter then goes on to describe how these case studies were conducted and developed.

Babbie (1973) suggests that;

> "Whereas most research aims directly at the generalised understanding, the case study is directed initially at the comprehensive understanding of a single, idiosyncratic case."

Further that:

> "Whereas most research attempts to limit the number of variables considered, the case study seeks to maximise them. Ultimately, the researcher executing a case study typically seeks insights that will have more generalised applicability beyond the single case under study, but the case study itself cannot assure this."(1)

It would seem then, that by carrying out case studies, and studying them in depth, features unique to each become apparent and common features may possibly be compared. The case study method, however, has a number of weaknesses. On the whole, it may not be possible to generalise from the results, and although observers in a case study have to be selective, their selectivity is not normally open to the checks which can be applied to systematic inquiries. The observer's selectivity often tends to be personal and subjective, and yet it is also flexible and thus may pick up answers to previously unthought-of questions.

The case study approach has been widely used, both in the UK and the USA, for many surveys, the subjects of which have included the following:

1) analysing innovation and educational change;(2)
2) a study of innovative schools;(3)
3) the relationship between a school and its wider environment;(4)
4) the transition from school to work.(5)

The required data from each school could have been collected simply by sending out written questionnaires, based on relevant factors common to each school. However, Nisbet and Watt (1980), warn that:

> "If something is not covered in the survey instruments, it will be missed, unless the respondent particularly wishes to supply extra information."(6)

This is a fairly fundamental limitation to the questionnaire approach, and there are of course others. Problems may arise from the way that individuals interpret questions, from careless responses and questionnaires not being returned. There may also be a difference between what is said to be done in a particular set of circumstances and what is actually done. This, of course, may only become apparent if personal visits are made.

The technique of Participant observation is seemingly used extensively during case studies because it allows close contact between the researcher and the subjects of the case study. This technique was adopted in this research for observing some of the national, and locally organised, INSET courses for teachers. The technique does not necessitate the adoption of a cool, clinical approach by the researcher, which may create a barrier between the researcher and the case study subjects. Although a biased viewpoint is seen as one of the limitations of Participant Observation, Sills comments that:

> "...it is precisely the 'bias' of the participants that the researcher wishes to become capable of assuming and understanding. The observer who establishes himself, and remains in a role external to the group being studied, it is not so much unbiased, as incompetent or unenterprising. The disciplined and reliable researcher is not a technical virtuoso, a machine, or a man without a viewpoint, but rather a trained person who enters the field with the expectation that he will be obliged to do many things in spite of his personal prejudices, or inclinations."(7)

So in general, the case study approach is not thought of as being very 'scientific', but its strength may lie in its insights or depth of focus, and its potential as a model for interpreting other similar situations. It is therefore hoped that although it may be difficult to arrive at generalisations from these case studies, it may be possible to clarify the important issues pertinent to this particular investigation.

3.2. THE CASE STUDIES.

In an attempt to establish the types of questions which could be asked in a wider research of CDT teachers, it was decided to undertake a mini-survey of a limited number of schools which appeared to be representative of the range of secondary schools within the intended research area of Oxfordshire LEA. Discussions with the CDT advisers and colleagues within the LEA suggested suitable schools.

After seeking and obtaining permission, four Oxfordshire schools were chosen and visited for the purposes of initial interviews and observation with regard to the use of microcomputers in CDT. Two of these schools were already known to make substantial use of micro-computers within the technical departments, and the third school was suspected of at least some involvement. The fourth school approached was found to have virtually no involvement with computer use in CDT. The CDT staff were asked to give reasons for the situation in their department.

A mainly informal interview technique was chosen to gain information from the CDT staff in the trial schools. Oppenheim (1977) (8) considered that this method would elicit a greater range of responses from the those interviewed, and would help to minimise any bias which could possibly have been introduced if a fully structured interview technique, as described by Wragg, (1980) (9) and Moser & Kalton (1971) (10) had been adopted at this stage. It was desired that teachers would freely state their observations and opinions about a number of matters which concerned them with regard to computing in their school situations.

However, a minor degree of structuring was used in the interviews, two basic lead questions were asked, which required teachers to state:

- whether and how they already used computers?
- and what, if any, would be their future plans for computer use?

Other questions which arose in the interviews involved trying to establish:

- how individual expertise had been gained?
- why the schools were using particular equipment and software?

An attempt was also made to try to poll opinion regarding whether help was required with computer use and if so what help would be of most value?

Several of these interviews were carried out within the schools during the free periods of the teachers involved, or during their lunch hour. One of the schools allowed the interviews to take place in two separate sessions of scheduled meeting time. However, some of the teachers involved preferred to be away from the school premises, and these interviews were carried out either at the Oxfordshire Schools Science and Technology Centre (OSSTC), or in a local hostelry over lunch. Two of the interviews were carried out in the teachers' homes during the evenings, at their own invitation.

This research was undertaken at a time of severe dispute and industrial unrest amongst teachers. This required a considerate and careful approach to many teachers and their schools. Because of problems encountered by CDT teachers in a previous major survey on another topic within the LEA, it was decided at the outset not to attempt to use a tape recorder to record the responses. This previous survey had created a lot of ill feeling amongst some CDT teachers, by recording verbatim attributable comments which had been made as asides. Therefore the responses for this research were written down as soon as possible after the interview was completed. Occasionally cryptic notes were taken during the interview. To ensure that minimal bias was created by the interviewer, checks on the accurate recording of the responses were made by an observer writing independent notes following one meeting at a venue outside school. A further verification was made in two other cases by allowing the teachers interviewed to see the points recorded. No changes were required in all three instances.

The case study schools were labelled A,B,C and D and the staff as A1, A2 etc. The numbers of pupils in these typical Oxfordshire comprehensive schools range between 750 and 1000. Brief profiles of teachers experience with computers are reported below:

COMPUTER EXPERIENCE OF CDT TEACHERS IN MINI-CASE STUDY SCHOOLS.

SCHOOL A:

The Department has seven full time staff. The teachers have a heavy commitment to teaching CDT and Technology. Four BBC computers are owned and used by the department. The school owns a variety of RML computers and has a 480Z network.

A1. Had no experience of computers and was not immediately interested in getting involved with them. He considered that they were too time consuming and that they were of little use to him.

A2. Had very little experience mainly gained on a RML 380Z introductory course and had not used computers in school. He had little opportunity or desire to be involved with them in school. Little time to learn how to use them was also a factor in this case.

A3. Had assembled a Sinclair ZX81 from a kit and had learnt at least a little Sinclair style Basic. Had also attended an early LEA computer course on RML 380Z machines and subsequently used a 380Z to sort the course choice within the school. No classroom application of computers mainly because he has little experience of BBC machines and can see little application of a 380Z in his own teaching.

A4. Attended an early RML 380Z course and subsequently bought a Commodore VIC 20 for home use. Had developed graphics demonstrations for classroom use on both machines and used them in school. Had learnt both Basic and some Assembly language programming at home. Has since bought an Amstrad word processor and uses this for substantial production of course material worksheets etc.

A5. Had used a Sinclair ZX81 at home and then learnt how to use a BBC "B" for word processing, (Wordwise). Produces substantial amounts of information and worksheets for school.

A6. (Second in Department). Sinclair ZX81 at home and subsequently bought two BBC "B" computers. Makes substantial use of 'View' for word processing both for school and home use. Uses 'Stardatabase' for record keeping, school administration and timetable sorting.

A7. (Head of Department). Had an Oric Atmos and quickly exchanged it for a BBC "B" three and a half years ago. Makes substantial use of 'Wordwise' and 'Stardatabase' to produce school worksheets, records, timetables and general administration. Has used a BBC for teaching control applications in school. Also owns a BBC Master at home.

SCHOOL B.

The CDT department has four full time staff and teaches Technology to "A" level. Has access to three BBC computers. The school has a 480Z network.

B1. Has not got a home computer and has not had any computer training within the LEA. Uses a computer within the department for keeping form records.

B2. Has a Sinclair ZX81 at home and regularly borrows a BBC "B" machine for word processing. Produces substantial amounts of worksheets, schemes of work etc. for school.

B3. Has an Amstrad word processor which is used for producing school worksheets etc.

B4. (Head of Department). Initially started computing with Sinclair ZX81 computers at home but burnt out four attempting to do school work. (They were apparently unable to cope with being used for long periods without being switched off). At considerable personal sacrifice bought a BBC "B" computer and had an official "Torch" Z80 computer upgrade added. Virtually all of his considerable computing expertise is self taught at home. Widely regarded by his professional colleagues as one of the most competant people in the LEA with regard to computers and their practical application. Makes considerable use of the "Perfect" range of software supplied with the Torch package. Applications include school examination statistics, sorting the fourth year course choice, worksheets, timetables, pupil record keeping, minibus accounts and numerous other administration tasks. Uses the 'Nova Systems' software packages for school administration. Has included substantial computer applications and projects into technology lessons. Has greatly influenced the whole school policy so that 'Torch' Z80 based computers are used for administration throughout the school.

SCHOOL C.

The department has five CDT staff and has mainly concentrated its efforts in teaching the traditional subjects of technical drawing, woodwork and metalwork. A number of various RML computers are reported to be in the school.

C1. No experience with computers.

C2. No experience of using computers in school, but has attempted to apply an RML 380Z for a complex private database application with limited success.

C3. (Head of Faculty). Has very little experience with computers, but prefers the BBC microcomputer and is occasionally borrowing one for use at home and in school. Wishes to apply a computer in school for computer aided graphics and control purposes.

C4. No information available. (Staff change in process).

C5. (Head of CDT). Runs a private business outside of school and uses a "Pet Commodore" for the accounts and administration. Has had little experience of computers and software for school use but states a possible preference for the BBC range of machines due to the amount of software already available.

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SCHOOL D.

Comprehensive school well known for traditional craftsmanship with a well established experienced staff. A 380Z available within the department. Numerous RML machines elsewhere in school.

D1. (Head of Department). Has not applied a computer to his normal school lessons but states an interest in acquiring a BBC "B". Comments that he will learn to use a computer when one is available at all times in the workshops. He reasons that when he has a few spare moments he is more likely to attempt to use it if it is readily available, than if he has to go across to the other side of school to find one. He feels that there is a lot of potential for children to do their design folders and reports on a workshop based word processor, and also that there is potential for applying some CAD and control applications to his teaching.

D2. Not using computers. (Leaving teaching to set up his own business).

D3. Has his own BBC computer and uses it for both word processing and graphics demonstrations in school. Has borrowed a 'Bitstik' graphics package and used it in school for demonstration in Design and Communication lessons.

D4. Has his own BBC micro at home and uses it for developing software for use in school as well as word processing. Has attended various county courses on the use of RML machines. Has applied the RML 380Z to control problems with children in the workshops. Has also tutored control courses for teachers with BBC machines.

3.3. The snowball effect suggested several other teachers within the LEA who should be interviewed about the computing situation in their schools. Several of these teachers, (approximately 20, of whom some were science teachers involved with technology teaching), were subsequently approached, again by adopting a mainly informal or semi-structured interview technique for the reasons given above. The views expressed by this group substantially agreed with those teachers already interviewed in the four schools. Formal notes or tape-recordings were again not taken in these interviews in order to eliminate the possibilities of disjointed conversations; or the perception of the respondent that he may be being questioned officially for some ulterior motive. (At this stage it was apparent to some teachers, that there was a substantial interest in this research by advisers within the LEA). Brief notes of the major points of the interviews were made shortly afterwards to establish the salient points.

Opinions and views expressed during these interviews were very revealing, and suggested areas of investigation for further research. An amalgamation of the 'results' and observations of these initial interviews suggested that there were a number of questions which could be included in a wider survey:

(1). How many CDT departments have ready access to computers and ancillary equipment within Oxfordshire, and in what quantities?

(2). The quantities and makes of computers and ancillary equipment perceived as being available to the Oxon. CDT teachers.

(3). How computers are being used in Oxon. CDT departments, (if at all)?

(4). The level of expertise, awareness and literacy of Oxon. CDT staff in relation to computers, and how this was acquired?

(5). Past and current INSET with regard to computers and CDT /Technology. Have Oxon. CDT teachers received computer training? Has the training been of specific value for CDT subjects?

(6). Whether there is a wide desire or demand from CDT teachers within Oxfordshire for further training or help with computers in relation to CDT?

(7). The perceptions of teachers towards computers. Do they wish to increase their own computer literacy? Are fear of the unknown; lack of time; lack of equipment etc. major factors?

(8). Possible methods of modifying computing capabilities of CDT / Technology teachers.

(9) Why is there a disparity in computer use between various CDT departments?

3.4. The informal school interviews, although undertaken with a restricted sample of CDT teachers, also confirmed the previous observations by the writer that a considerable amount of disquiet and opinion was being voiced regarding the situation of computing in CDT departments within the County. When related to the teachers' perceived view of the National situation, the Oxfordshire case study teachers' considered the development of computers in CDT in their authority to be at a much slower rate. However, it was also clear that a relatively small number of teachers within the LEA appeared to be attempting to apply and develop computer use for CDT on an individual basis. The computers mainly desired and chosen by these case study teachers for workshop use in their schools were the Acorn BBC range; which were unsupported by Oxfordshire LEA in all aspects relating to purchase, repair or software.

It was also clear from these initial interviews that the teachers who were already using computers in Oxfordshire CDT departments, had a distinct perception of apparently falling behind teachers in other areas with regard to the use of computers. This perception by the CDT teachers may, or may not have been well founded; however, several theories were suggested to formulate reasons for this position:

1. Lack of training in the use of computers for CDT teachers.

2. Lack of knowledge and publicity about software and equipment available for use in CDT.

3. That the RML machines supported by Oxfordshire were largely unsuitable for adoption in CDT departments due to the lack of readily available software and peripheral equipment for them; and the high cost of the latter when it was available.

4. Lack of funding to buy equipment.

5. Lack of time to learn how to use equipment and software even when it was available.

The statement that "Oxfordshire is a desert area with regard to computers in CDT", was vehemently expressed by one of the teachers interviewed.

3.5. FINDINGS FROM THE SCHOOLS CASE STUDY.

The findings suggested by the initial case study surveys of the four schools, and also the teachers from other schools contacted as a result of those interviews, suggested:

- Those case study teachers making use of computers in the schools chosen for interview, already appeared to have an home and school based commitment to the Acorn series of machines. They would therefore prefer to use equipment with which they were already familiar. Because of the difficulties of obtaining the use of any computer in school, some teachers used their own BBC computers at school. (See Ch.5).

- There is a large quantity of existing software which has been developed for educational use, both by commercial groups and also the government sponsored Microelectronics Project. (The MEP appeared to produce more software for the BBC than the RML although it provided for both).

- Until very recently (Autumn 1986) Oxfordshire has had a policy of supporting only RML machines for its schools. Very few of these computers appear to have come near CDT departments.

- Several of the teachers interviewed, commented adversely on the wisdom of networking computers elsewhere in school.

- It appeared that a number of CDT teachers have bought their own BBC micros and thus familiarised themselves with their use. As a result, these machines seemed to have been preferentially acquired by those teachers when the opportunity has arisen in school. (See Ch.5).

- The teachers interviewed had the perception that there are more 'add-ons' available for the Acorn range of machines than any others on the market. These peripherals and software also appeared relatively inexpensive in comparison to those offered for the RML range. The cost of adding a disc drive to an RML 480Z was an often quoted example; this being approximately twice the cost of adding a similar peripheral to a BBC machine.

- The opinion was given that the large number of Acorn machines already in the education system throughout the country, should ensure their use for many years to come. They will still satisfy the demand for a "simple" machine which is readily expandable.

- Case study teachers also expected that BBC computers will possibly become more available to the CDT departments as second-hand equipment, when others 'upgrade' to new machines.

- Not all CDT use for computers is based on the requirement for a large memory, such as that desirable in Graphics applications. Staffordshire LEA have settled on IBM 'clone' equipment for graphics; Oxfordshire have the Nimbus computers which would be suitable for this application. However, for teaching simple control applications or word processing letters etc. the BBC computer is seen as more than adequate for most school CDT based uses.

- There was a demand, from the teachers interviewed at least, for in service training with regard to computer use in CDT.

- A request had also been made for some way of simplifying the manuals and user guides which accompanied each piece of equipment and software. With the heavy commitment most teachers already have on their time, many felt that they could not, or were unwilling, to find time to try to read all the manuals available in order to learn how to use the equipment.

- Several teachers stated that it was not worth bothering to learn how to use equipment which was not available to them anyway. This tended to indicate that in some schools at least, a protectionist attitude was prevalent in the Computer Studies department.

- There appeared to be general dissatisfaction with the lack of computers directly available to the CDT departments, (this was even stated in those departments who had already acquired some equipment).

- The county had not provided BBC computers for CDT departments and yet some teachers had managed to acquire them for themselves; often in the face of heavy criticism and at best lack of help and support from those in the LEA with responsibility for this area of the curriculum.

- A problem for CDT teachers is that the RML machines which are in their schools, do not appear to have enough support in terms of software and indeed hardware for CDT. Cheap robot arms, interfaces etc. for use in control technology applications were often cited.

- The RML machines are seen by many CDT teachers, possibly unfairly, as not being upwardly compatible in software terms. (This can also be a problem with the Acorn machines if the software has been protected).

- The message coming from some CDT teachers appeared to be that there is a place for both types of machine in their departments; and that the RML range should not necessarily take precedence over BBC computers or vice versa.

- The RML Nimbus computers definitely appear to be desired for CAD applications, providing that the software can be obtained by the schools.

- One of the teachers interviewed, suggested that he would like to make use of a mainframe computer system for printed circuit board design with full auto-routing features, and computer aided design.

He quoted the programmes 'Pafec' and 'Autocad' which could be used on IBM PC machines with Winchester disc drives.

3.6. In many respects Oxfordshire's policy of only buying and supporting one range of computers makes sense. It saves duplication of software, equipment spares and expertise. It also attempts to ensure that teachers become familiar with one type of machine, rather than use a wide range of machines at a possibly lower level of understanding and probably with less expertise. In theory at least, the RML machines should have a greater capability for computer aided drawing and design, because of their larger user memories. At least two CDT teachers reported asking the LEA computing adviser to state three packages available which could be used for CDT on RML machines. His response at that time was unhelpful, because the software had not been developed or was not available within the county.

Because Oxfordshire already has an overwhelming commitment to the use of RML machines, and also mainly restricts its in-service training to these micros; it was surprising to find so many teachers reported to be using and wishing to use BBC micros in the workshops. It was therefore of interest to find out how widely the Acorn BBC range of micro-computers were being used in Oxfordshire CDT departments. The choice of the BBC micro by teachers at the 'chalk face' appears to differ greatly from the apparent policy and advice offered within the LEA.

3.7. OBSERVATION OF INSET COURSES.

A second set of case studies were undertaken in order to gain some insight into In-Service training already available to CDT teachers for improving their computer capabilities, which was taking place at both local and national level. Visits were made to several courses; in addition a course was attended as a student. Two of these courses were nationally based, one at British Schools Technology, Bedford; and the other under the auspices of Microtechnology Inset Team at the National Electronics and Microtechnology Centre based at Southampton University.

Informal observations had already been made of teachers involved in TVEI related INSET, based at the Oxford Schools Science and Technology Centre. Elements of Design, basic electronics and computer aided design had been viewed over several days.

To gain a full insight into what was involved in an INSET course, the author joined a group of teachers participating in an existing Oxfordshire TVEI related INSET course for the purposes of a case study.

Permission was granted to attend an existing TRIST 'computer control' course based at another centre within the LEA. A participant research technique was adopted to gain an insight into the training methods already available to a limited group of teachers chosen by the advisers. The group of teachers joined had already been observed on the other stages of their twenty day training. Some of the CDT teachers attending this course were well known to the author; as a result it was possible to gain some uninhibited feedback on their views regarding the course. The following notes were made as a result of attending the course using a participant / observer role.

The TRIST course was provided as a part of a 20 day In-service training programme for Oxfordshire Science and CDT teachers. The work was undertaken in October 1986 at various educational establishments within Oxfordshire LEA. The teachers involved were drawn from three schools who had made a commitment to release two CDT and two Science teachers for the duration of the 20 days of the training. The days were dispersed in small blocks over a two to three month period. The control technology course was observed using a participant research technique. It was blocked over five consecutive days at a College of Further Education within the LEA. The college was equipped with Acorn BBC "B" and "B+" computers, as well as RML Nimbus networks. The Acorn machines were chosen by the course organisers as the most appropriate equipment to teach the elements of control technology to this group of teachers. The LEA microcomputing adviser had recommended the use of "Logo" as the computer language appropriate for the course.

The tutors had an unenviable task in view of the wide disparity of computer awareness previously experienced by the teachers within the group. Five of the twelve teachers could be regarded for practical purposes as having no prior computer experience at all; whereas at the top of the ability range was a teacher who had substantial experience of teaching 'computer studies'. At least three of those present on the course were unable to use a keyboard and had never used typewriters.

"Logo" was the language chosen as a vehicle to teach the basis of control. Only one member of the course was familiar with "Logo" and this experience was with the RML Nimbus version. The small percentage of those in the group with an elementary or working knowledge of "Basic", were occasionally noticeably frustrated when trying to use "Logo". This became especially evident in the latter part of the course when they were attempting to build their own control routines. Often these failed to do what was expected and the message, "Logo doesn't understand how to....," became less than amusing to these teachers. As a result of this observation it was later suggested that the tutors include a glossary of routines at the beginning of the course manual, and further, that these be kept on a disc to help those students frustrated by typing errors when trying to include these routines in a programme.

In reality the course was intensive enough for those lacking previous computing experience without them being disadvantaged by a lack of typing ability. Following discussions with the group some students recommended the inclusion of some prepared "Basic" language routines for reading and outputting to some of the numerous input / output ports on the Acorn machines. A major consideration was that BBC Basic is already included within the machine and "Logo" costs another £60. It is debatable whether one language is superior to another at this level of experience, but funding within a school situation could be a critical factor.

Because of its potential speed and the lower memory requirements, machine code / assembly language is probably the best method of interrogating and adressing ports, although this is a more complex language to understand and is not easy for computer naive, or even experienced computer users to master.

The 'Pilot 1' interface boxes used on the course, although relatively simple in construction, tend to look complicated and mysterious, as well as being quite expensive in school terms. (This is generally true of most interface boxes). The aura of mystery may well be a contributory factor in inhibiting teachers attempting to take the work further when left to their own devices.

It was found that some of the hardware used on the course was temperamental, especially the D.C. motors in the 'Pilot 1' cars, and also unfortunately, a Lego brick/plug unit from the same source. This caused difficulty with one experiment, for an hour, before the real cause of the problem was discovered. Again it must be stated that time on the course overall was already at a premium and this type of delay only caused frustration.

When interviewed and invited to comment, all of those participating in the course were apparently pleased with the content and claimed to have gained quite a lot from the experience. Their awareness of computer use and interest in further developing their own skills was certainly increased as a result of the course. Several participants commented that they would like to have the equipment made available to them in their own school departments in order to reinforce what they had been taught and also to gain further time to evaluate its use.

An 'Alfred' robot was made available but not fully integrated into the control course. This device had been bought especially, together with a small 'Feedback Control' milling / drilling CNC demonstration machine. Those people who had a chance to experiment with Alfred were favourably impressed with its performance, ease of use and cost. The latter considerations were especially highlighted when related to the 'Armdroid' robots also used, which were not very favourably received. The latter robot arms proved awkward and unfriendly when used for experiments. They were notorious for the problems which ensued from the use of strings to operate the various arm movements.

It would have been helpful if the importance of the blackboard routines had been stressed at the beginning of the course. These routines played a major role when trying to solve the control problems which were set in the last two days. Several students had 'lost' the programs or had not realised their significance and were consequently hindered in their progression through the work.

On the first afternoon of the course the group was taken to a room equipped with a 'Nimbus' network. Regrettably the network was giving problems; the keyboards and Logo syntax were also different from those which had been used in the morning session. This caused considerable confusion amongst the teachers on the course, and was especially unhelpful to those with no previous computing experience. Although the intention was to show the use of a different and more powerful system, many of those present were demoralised by the amount of information which they were required to assimilate simply to get the equipment to respond. Some students commented that they had not found this session particularly relevant or helpful.

After participating in this "control" course, a suggestion for integrating some of the previously attended electronics course was proposed to the Oxfordshire Technology Advisory Group and programme organisers. The proposal was to give the students a specially designed PCB to make an interface board, together with a set of instructions and components, which they could solder together on the first day of a shortened combined electronics computing course.

Many of the teachers had found soldering difficult when attempting the electronics section of the course, (also attended by the author in an informal capacity), and had also experienced difficulty relating the work they had undertaken to their school situation. It was suggested that the proposed interface board should incorporate integrated circuits rather than large numbers of discrete components. These could be inserted into sockets rather than be soldered directly to the board, thus to some degree eliminating component destruction from lack of soldering expertise. It was suggested that students having an interface to take away with them, may well be more likely to experiment with interfacing projects at home or in school. (At this stage of the research it was not realised how significant this suggestion was to prove).

3.8. NATIONAL TRAINING COURSES.

To gain an impression of better resourced, nationally organised training, a visit was made to a Microtechnology In-service Training (MIT) session based at Southampton University. Three groups of teachers were observed working on a series of projects and problems concerned with electronics and computing. Observation indicated that the course tutors were either exceptionally good, (they were), or the teachers were already experienced in some aspects of the work. The complexity of some of the projects appeared to be very high for beginners.

The teachers participating on these MIT courses appeared to have greater familiarity with computers than those observed on Oxfordshire TRIST courses. This point was raised when interviewing Graham Bevis, Mike Whittaker and Mike Shaw, (Director and tutors of the Southampton course), when they were at Oxford University some months later. They reported - 'it was not our experience to find teachers who are unable to use keyboards'. This would indicate that the teachers they were attracting, already had some basic experience of computer use, and further, that they were not totally computer naive in the same way that some of the targeted Oxfordshire teachers would be.

These MIT courses also made extensive use of various 'systems electronics' units, such as the MFA and Unilab modules, to aid their teaching. One of the tutors had been involved with designing a series of modular 'control technology' boards which were being tested on this course. These boards appeared to be very well designed and constructed.

The professional finish inspired confidence in the ability of the equipment to perform its task. One interesting application was the use of an optical link for transmitting messages between two BBC micros.

Another course visited on two occasions was based in Oxfordshire, and was being taught by BST Trent from one of their purpose built trailers. BST Trent had been contracted to provide one of the first microtechnology training courses within Oxfordshire which was specifically aimed at CDT and Science teachers. These courses were just established at the start of this research in 1986. The computers used were BBC micros. Simple interfaces incorporating discrete transistors were being built on vero-board by the teachers involved. Some apparent consternation was exhibited by some teachers having to write their own software routines to make the interface operate.

The course visited at BST Bedford employed the commercially produced Deltronics interface. The teachers attending were using the interface in a problem solving situation and obviously enjoying their work. Few of this group of teachers could be safely described as computer naive. BST Bedford were later contracted to deliver Computer Aided Design and Graphics courses at the Oxford Schools Science and Technology Centre.

Participating teachers were informally interviewed at all of these venues.

Chapter 3.

Many of the teachers attending the courses expressed a desire for BBC microcomputers in their workshops. The teachers in the TRIST course case studies were particularly frustrated by having to return to a situation where they had no equipment to reinforce their learning. The observation of the various courses had left the author with the impression that a very carefully structured course was essential if teachers were to gain full benefit from the experience. Many teachers encountering difficulties 'took a break' and waited for somebody else to solve the problem. A good course would have eliminated this problem by working in small well documented steps.

The amount of concern and interest being expressed by the limited sample of teachers involved in the case studies within Oxfordshire LEA, merited wider investigation. Support for an extended survey was given by the CDT advisers and other members of the Oxfordshire Technology Advisory Group. Chapter 4 discusses the design and administration of a questionnaire to gather further information.

REFERENCES - Chapter 3.

(1). BABBIE, (1973) - 'Survey Research Methods', Wadworth Publishing Co, Inc, Belmont, California, USA.

(2). GROSS, N., GIAGGIUNTA, J.B., BERNSTEIN M. (1970) - 'Implementing Organisational Innovation' - A sociological analysis of Planned Educational Change, Harper and Row, New York, USA.

(3). BERNBAUM B. (1972) - Countesthorpe College UKL, - centre for educational research and innovation. 'Case Studies of Educational Innovation', (Vol. 5) at the School level. OECD, Paris, France. Harvard Educational Review.

(4). BARTH, R.S. 'Open Education and the American School.' Agathon Press, New York, USA.

(5). WILLIS, P. 'The class significance of school counter-culture.' In a book by HAMMERSLEY, M., and WOODS, P. (Eds.) 'The Process of Schooling: A Sociological Reader', Routledge, Kegan and Paul, UK.

(6). NISBET, J., and WATT, J. (1980) - 'Rediguide 26 - Case Study', Nottingham University School of Education. Oxford: T.R.C. Rediguides Ltd.

(7). SILLS, D.L., 'Participant Observation International Encyclopaedia of Social Science', (Vol. 11). MACMillan and Co. new York, USA.

(8). OPPENHEIM, A. N., (1973) - Questionnaire Design and Attitude Measurement, (Open University Set Book) Heinemann, London, UK.

(9). WRAGG, E.C. (1980) - Rediguide 11 - Conducting and Analysing Interviews. Nottingham University School of Education. Oxford: T.R.C. Rediguides Ltd.

(10). MOSER & KALTON. (1971) - Survey Methods in Social Investigation. Heinemann.

CHAPTER 4.

4.1. Research - Survey & sample.
4.2. The survey instrument.
4.3. Trials and Testing.
4.4. Administration of the survey.
4.5. Distribution of the questionnaire.
4.6. Findings from the follow-up.
4.7. Editing and coding of data.

CHAPTER 4.

In an attempt to establish whether the suggestions and initial findings in Chapter 3 above were common across all schools within Oxfordshire, a research technique and method needed to be developed and applied.

For internal reasons within Oxfordshire, the research parameters were restricted to the investigation of CDT/Technology departments. However, it was fully realised at the outset that many of the questions and findings may be applicable and relevant to other sections of the curriculum, especially science.

4.1. RESEARCH - SURVEY AND SAMPLE.

The published works of Oppenheim (1973)(1), Cohen and Manion (1983)(2) and Evans (1978)(3) relating to research methods and techniques, were further studied in an attempt to establish the most practicable methods of undertaking the proposed research. The adoption of further informal or structured interviews was eliminated because of the impractical nature of the amount of travelling and time which would be involved. It had already proved difficult to arrange meetings with teachers during the initial research. This was both because of their heavy teaching commitments; and also due to their involvement in industrial action with the government over pay and conditions of service. The latter action made it very difficult to find time outside school hours where teachers were willing to be interviewed. The potential costs of undertaking these interviews in the more sociable surroundings of a public house, at lunch time or in the evenings eliminated this possibility. These factors combined, required that a quicker, cheaper and more viable alternative for the research was considered and adopted. A survey by questionnaire appeared to be the best solution and most cost effective method of eliciting a response from a suitable number of the population to form a viable sample.

4.2. THE SURVEY INSTRUMENT.

Accordingly the work and recommendations of Hoinville and Jowell (1977) (4) was studied, in conjunction with that of Oppenheim (1973), to establish a method of designing and administering the questionnaire.

A major problem highlighted by Hoinville and Jowell (1977) was the proximity to Christmas, when the proposed questionnaire was likely to be distributed. They reported that responses to questionnaires were likely to be substantially lower at this time of year. This factor determined that the questionnaire be designed relatively quickly, so that distribution could occur after half term in October 1986; (holidays and ends of the week are also reported to affect the return rates adversely). The questionnaire was structured to largely comply with the requirements suggested by Hoinville and Jowell (1977).

Permission was sought, and granted, to give a brief explanatory talk and distribute the questionnaires to a gathering of all Oxfordshire heads of CDT departments and their representatives attending a meeting at Westminster college at the end of October 1986. All questionnaires to a school were accompanied by an addressed return envelope. Permission had been given for returns to come via the internal county 'bag mail', thus eliminating the cost of the first class stamp suggested by Hoinville and Jowell.

As an aid to subsequent editing and coding, it was decided at the outset to use a format which could be easily read from the sheets, and yet not appear to the subject filling in the questionnaire as a column of potentially worrying statistics. The coding was to be done with a computer and a database.

4.3. TRIALS & TESTING.

The questionnaire was tried out in two of the four schools initially interviewed above. The sheets were divided into the following sections:

(a) equipment perceived as available to CDT departments;

(b) what the equipment was being used for and with what software?

(c) whether there was a demand for training or help from CDT teachers?

(d) what self perceived expertise existed and what training had already taken place for CDT teachers?

(e) what computers were desired for use in CDT if any?

When the questionnaire was tested in school "B," it was found that one question was open to misinterpretation and suggestions were made to alter the wording in two others. The format of ticking a box rather than writing an answer was appreciated. It was suggested that the yes /

no responses at the end of the questionnaire should also include the alternatives of 'possibly' and 'sometimes'. These latter questions were also altered so that some of them were reversed to prevent the subject going down the list and ticking the same box without reading them, (a feature noted by observation of the trial group).

In view of the difficulties encountered in schools with the industrial action being taken by teachers, it was also decided to limit the questionnaire to appear as short as possible. This is contrary to the advice of Oppenehim (1973) and others, that the length of a questionnaire does not elicit a smaller response if it runs into many pages. From observation during the first trial in school "B", it was noted that the four sheets of questions printed in a 'Courier 10' pitch daisywheel, although very easy to read, were the cause of some reluctance by teachers to complete the task of filling them in. Subjects flipped through the pages and commented that there appeared to be a lot to do, and that perhaps they would need more time than they were able to find at that moment. Subsequently, before the second trial, a 15 pitch 'Letter Gothic' printwheel was used at 120 characters to the line. The visual effect on the questionnaire was to shorten it by a page and still give the impression of a lot of white space on the paper. The further expedient of printing page two on the reverse of page one gave the overall impression of a much smaller document.

When the revised version was tested in school "A" no complaints were made regarding the length of the questionnaire. This second trial took place in a timetabled departmental meeting attended by all the staff in the department. It was noted that the questions took between seven and thirteen minutes to answer; depending on the individuals involvement with computers, whether he was a Head of Department or in charge of the computing equipment.

4.4. ADMINISTRATION OF THE SURVEY.

The intended population for the survey, (from which the sample was to be drawn), was all teachers concerned with CDT / Technology in middle, secondary and upper schools, within the Oxfordshire LEA area.

An initial problem was to establish how many CDT departments and staff there are within the LEA. Oxfordshire has a variety of different schools serving children in the 11-18 age group. These range from Middle and Upper schools in Oxford City, to 11-16 and 11-18 Comprehensive Schools, including some single sex schools, in the outer county areas. Information obtained from the County Advisers with immediate responsibilities for CDT indicated that 40 schools in the maintained education sector could fall within these categories and may have elements of CDT established in their curriculum. However one of the Advisers also indicated that,

> 'It often cannot be readily recognised which of these schools are formally involved with CDT activities, and furthermore at what level the involvement takes. It is also difficult to establish a clear line between CDT and Technology, and similarly Art and Graphic Communication. Delineation of departmental responsibilities for teaching Technology and Graphic Communications is confused in many schools'.

In consultations with the advisers concerned with Technology, Design and CDT, a fairly accurate list of schools and these specialist teachers was compiled for the LEA area. Surprisingly, there did not appear to be a means of obtaining this information from a computer within the LEA.

4.5. DISTRIBUTION OF THE QUESTIONNAIRE.

Each school represented at the Westminster College meeting was given enough questionnaires for their whole department, and any spares which they thought may be required by teachers involved with teaching technology in the science departments of their schools. It was hoped that some of these extras would have elicited a response giving a different viewpoint. (In the event no questionnaires were returned from science teachers). Those schools not represented at the meeting, were identified from a check list, and questionnaires were sent by post to a named individual in the CDT department; usually the head of department. Oppenheim (1973) states that 'it does not improve the response to personalise the literature sent out with questionnaires'; however, local experience has previously shown that named individuals are more likely to respond. This expedient also does much to ensure that the questionnaire reached the intended audience within the school.

Fifteen days after the questionnaires had been distributed, a follow-up telephone call was made to those schools which had not responded. In each case a named member of the CDT department was contacted, or a message left for him to return the questionnaires. A second follow-up was made again fifteen days later; however this elicited a very disappointing response and follows the pattern reported by Cohen and Mannion (1983). A contributory factor for many schools, was definitely the proximity to Christmas and the consequent involvement in school productions, (despite involvement in industrial action), already recognised as a potential problem. At the end of term in December, 82 completed returns had been received together with 5 letters and 11 uncompleted forms.

As stated in the introduction, at the time of the survey, it was of interest to find out whether there was a demand from teachers for a loan package of equipment which could be borrowed from a central distribution point and used in school. If a demand was proven, the intention was to possibly provide distance learning equipment for those teachers who wished to become involved in computing; but who did not have access to the required hardware. This was envisaged both as a positive contribution towards improving the CDT / computing situation, if it was found to be necessary, and also the implied package acted as an incentive to reply to the questionnaire. Both Oppenheim (1973) and Cohen and Manion (1983) recommend that an incentive be given to the respondents in order to achieve a higher return for the survey. The envisaged limitations of available funding at the time of the survey, made the loan package option the most feasible proposition for any positive contribution which could be made to the teachers involved, if the demand was proven.

4.6. OTHER FINDINGS FROM THE FOLLOW-UP.

Subsequent investigations revealed a variety of reasons for the non-return of outstanding questionnaires. The teachers dispute with Kenneth Baker and the government, made several teachers very militant, and therefore reluctant to fill in anything that looked in the least 'official'. Some failures to return could be attributed to 'normal lethargy' in these matters; or to pressure of work. In some cases the blame could definitely be stated to be the inefficiency of the head of department in distributing, collecting or returning forms. One head of department was subsequently found to be in hospital undergoing a serious operation. It was however interesting to note the subsequent applications for places on computer training or other INSET courses, from staff in schools who did not reply to the questionnaires. Some schools did not reply because the technical departments feel they are underfunded and unlikely ever to be given computer equipment; one HOD wrote and replied to this effect. The numbers of teachers in each school and numbers which replied can be seen in Ch.5 Fig. 1.

4.7. EDITING AND CODING OF DATA.

The returned questionnaires were edited and the data was entered into a BBC microcomputer using "Stardatabase."

Although the questionnaire appeared to be fairly short in its final format, in reality there were potentially 145 pieces of data which had been requested and which needed to be allowed for in the database. The database utilised allows only one screen of information and a maximum of 70 fields. Other databases were inspected for their suitability, but several of them allowed many fewer fields of information. As a consequence of these limitations, it was decided to split the data into two sections. Section 1 included the responses to questions 1 to 5, and section 2 accommodated those from the rest of the questionnaire. A third data disc was already in existence, having been made for this research as a result of identifying the CDT teachers within the county.

By the expedient of printing the surname field on each of the three discs, it was possible to cross check to ensure that no duplication of entries had taken place and also to establish which schools and teachers had responded to the survey. In the interests of data security the discs are locked and a password is required for entry to the files; they are also registered for the purposes of the data-protection act. To allow fast entry of data, each field was restricted to the minimum feasible size, so that only one or two key strokes were required to input the information.

To speed up access to the database, a sideways RAM was utilised within the BBC computer to act as a silicon disc. All data was therefore sorted and coded within the memory area of the computer. This expedient dramatically increased speed and consequently reduced the time wasted waiting for disc drives to yield information. Once established, this method of coding would appear to be substantially easier and than the punch cards and other systems recommended by Oppenheim (1973), Evans (1978) and others. The design and screen layout of the three input cards, and printout of the field list for each disc, can be seen in the listings in the appendices.

Following the editing, coding and sorting of data, the results were listed and recorded. The major findings are listed in the next chapter. The results from the database sorting were incorporated into a spreadsheet, (Inter-Sheet), to readily effect a means of tabulation and any calculations required. Some of the charts to visually illustrate the findings, were produced with Inter-Chart both programmes marketed by Computer Concepts for the BBC micro.

A photo-reduced example of the questionnaire can be found in Appendix 1.

REFERENCES - Chapter 4.

(1). HOINVILLE G., JOWELL R. & Associates (1977) - Survey Research and Practice, Heinemann.

(2). OPPENHEIM A.N. (1973) - Questionnaire Design and Attitude Measurement, Heinemann Educational Books Ltd.

(3). COHEN L. & MANION. (1983) - Research Methods in Education.

(4). EVANS K.M. (1978) - Planning Small Scale Research.- NFER Publishing Company.

CHAPTER 5.

Research findings & statistics.

5.1. Population surveyed.
5.2. Networks.
5.3. Word processing.
5.4. Database Use.
5.5. Other uses made of computers.
5.6. How are computers used in CDT?
5.7. Comparative use of RML & BBC computers for CDT applications.
5.8. Use of home & school micros by CDT teachers.
5.9. Teachers Perceptions.
5.10. Training and ability.
5.11. BBC computer use.
5.12. Computer ownership by the sample.
5.13. Conclusions.

CHAPTER 5 - RESEARCH STATISTICS.

When the findings of the survey were analysed, a substantial amount of interesting information was revealed. In common with the case in many surveys, it could be claimed that some findings were obviously going to be established and that people had been saying 'x' or 'y' was the situation for ages; therefore why was it necessary to undertake research to establish what was obvious? One answer to this question is that very often what may appear to be obvious is not necessarily the case. Speculation and conjecture may not be the best foundation for any future attempt at intervening in a given situation. What this survey established for the first time, was a set of results for a sample of the population of craft design and technology teachers within Oxfordshire. As a consequence of the survey it was possible for arguments and discussions to be based on factual information as opposed to conjecture or possible biased opinions.

A brief description of some of the major and more interesting findings is set out below. Tables and charts have been used together, wherever possible, to illustrate the points. Written descriptions have been deliberately restricted because much of the evidence can be established by reference to the illustrations.

Areas of the survey findings which were not clearly established have been omitted in the interests of brevity and clarity.

Chapter 5.

5.1. POPULATION SURVEYED.

There were eight middle schools included in the survey. Two all girls schools were not included because they were known not to be involved with CDT or Technology as an examinable subject. Both of the girls schools subsequently sent science teachers to the computer and control courses which were organised following the survey. In the case of the middle schools, the teachers who were likely to have been involved to some degree with CDT work, were established using a 'snowball' technique and with assistance from the county advisers. In the final analysis the response from the middle schools generally indicated that they did not perceive themselves to be involved with CDT and that any computing was done as part of their 'normal' curriculum in the schools. Three of these eight schools responded with completed questionnaires and / or letters; a further three were subsequently contacted by telephone and their response was noted. Only those who fully completed questionnaires are included in the total number of 82 who responded below and who formed the sample.

The projected staff numbers within comprehensive schools in some cases include teachers who are part-time, or those who normally teach other subjects and are co-opted to teach CDT for reasons concerned with timetable exigencies. The majority of these teachers did not respond to the questionnaire because they did not feel that it concerned them. The schools listed in fig 5.1a overleaf are numbered in the interests of confidentiality. The table indicates whether a school was an 11-18 comprehensive (COMP), or a middle school (MIDD).

SCHOOL	TYPE	STAFF	REPLY	CDT COMPUTING	COURSE
1.	MIDD	1.00	1.00	NONE	**
2.	COMP	6.00	6.00		
3.	COMP	3.00	0.00	NONE	
4.	MIDD	1.00	1.00	NONE	
5.	COMP	3.00	3.00		
6.	COMP	2.00	2.00	NONE	*
7.	COMP	4.00	1.00		
8.	COMP	3.00	0.00		
9.	COMP	3.00	0.00		
10.	COMP	4.00	4.00		
11.	COMP	3.00	1.00	NONE	*
12.	COMP	4.00	3.00		
13.	COMP	3.00	3.00		
14.	COMP	3.00	3.00	NONE	*
15.	MIDD	1.00	1.00		
16.	COMP	3.00	0.00		*
17.	COMP	5.00	0.00		
18.	MIDD	1.00	1.00	NONE	**
19.	COMP	4.00	4.00		
20.	COMP	4.00	4.00		
21.	COMP	3.00	3.00		
22.	COMP	2.00	2.00		
23.	COMP	3.00	0.00		
24.	MIDD	1.00	0.00		
25.	COMP	4.00	0.00		*
26.	COMP	3.00	2.00		
27.	COMP	3.00	0.00		*
28.	MIDD	1.00	1.00		
29.	COMP	5.00	2.00		
30.	COMP	7.00	4.00		
31.	COMP	3.00	0.00		*
32.	MIDD	3.00	0.00		
33.	COMP	4.00	2.00		
34.	COMP	4.00	4.00		
35.	COMP	2.00	1.00		
36.	COMP	4.00	2.00		
37.	COMP	7.00	7.00		
38.	MIDD	2.00	1.00		
39.	COMP	4.00	4.00		
40.	COMP	5.00	3.00		
41.	COMP	5.00	5.00		
42.	COMP	4.00	1.00		
	42.00	140.00	82.00	RESPONDED	
			58.57%	REPLIED	
fig. 5.1.		11 Schools - NO REPLY			

Seven schools marked with an * subsequently applied for, and received, places on TVEI Related in Service Training (TRIST) or Grant Related in-service training (GRIST) courses based at the Oxford Schools Science and Technology Centre (OSSTC). The two middle schools marked with ** sent children on a computer / control technology course which was based at OSSTC. It was interesting to note how many teachers from the eleven schools which did not respond, subsequently applied for places on the courses organised following this initial research; despite apparently not having strong enough views on the matter to complete the questionnaires. The conclusion which can be drawn from this observation, is that there was a definite interest in computers, and a demand for help from some CDT teachers in those schools which did not respond to the questionnaires; for whatever reason. This would tend to indicate that many of the figures below would have been even more remarkable if a greater response from CDT teachers had been achieved.

The final sample (N) amounted to 82 CDT teachers from 31 schools within Oxfordshire LEA. This figure represents 58 57% of a liberally projected total of ALL teachers possibly involved with CDT teaching within the LEA. This figure is probably nearer to 75% of all true CDT teachers involved in full-time Design and Technology work. 73.8% of the schools replied and were included in the sample.

Chapter 5.

SURVEY FINDINGS.

5.2.NETWORKS.

The question 'Does your department use a computer network?' elicited an interesting response. Twenty five schools claimed to have a network either of RML 480Z's or RML Nimbus computers. Only six of these schools reported that the CDT teachers rarely or sometimes used the networks. The reasons for this were subsequently further investigated using a structured interview technique. Responses indicate that a combination of a number of factors can be attributed to this under-utilisation of resources:

a. The network is too far away from the workshops;

b. the network is not seen as part of the workshop domain;

c. it is difficult to book the network when required;

d. what use is a network without software for CDT?

e. often only one or two children from a practical lesson require the use of a computer; are they sent to use the equipment on their own? - what happens to the rest of the class if the teacher accompanies them?

f. often a computer may only be required for part of a lesson and it wastes time and causes disruption to move a class into the network room for part of a period; assuming that you can book it!

g. another class is timetabled into the network room when we need it!

SOME	NO	N	%SOME	%NO
6.00	17.00	25.00	24.00	68.00

fig. 5.2a. CDT NETWORK USE BY THOSE SCHOOLS HAVING NETWORKS.

In the above table two schools reporting networks failed to state whether they used them, this explains the discrepancy between the sample of N=25 and the sum of "NO & SOME USE" = 23.

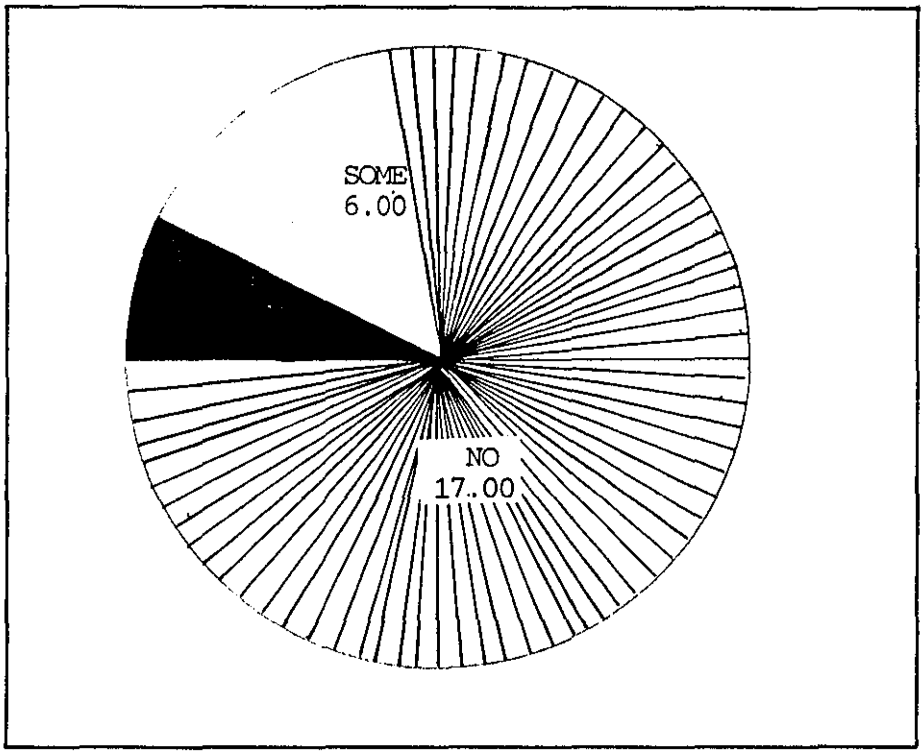

fig. 5.2b. CDT NETWORK USE BY THOSE SCHOOLS WITH NETWORKS.

Only two of the six schools reporting some use, claimed to make more than very occasional use of the network. These two schools used it for computer aided drawing or design as part of their graphics courses.

5.3. WORD PROCESSING.

At the outset of the research it was expected that those CDT teachers making use of a computer for their administration would be using it predominantly for word processing. 26.8% of the sample reported that they used a word-processor. The survey concentrated on the DOI supported micros; it was therefore of interest to establish which word processing programs were being used. As an RML based LEA it would be reasonable to expect that the predominant word processors would be RML based. The percentile of those in the sample claiming to use RML word processors amounts to 12.1%, while the BBC based programs account for 32.93%. This figure to some extent reflects the greater number of different programs available for the BBC machines, but is nevertheless an indication of the inroads made by the BBC micros into officially unwelcoming territory. The most popular software in use is "Wordwise" from Computer Concepts. "Inter-Word" produced by the same company had just been released at the time of the survey; yet three of the sample reported its use. Subsequent reports have indicated that the latter is in wider use and gaining in popularity.

	Word Processor	Users	Percentile
RML	Wordstar	5	6.10%
	Write	4	4.88%
	Word	1	1.22%
BBC	Wordwise	14	17.07%
	View	6	7.32%
	Perfect Writer	3	3.66%
	Inter-Word	3	3.66%
	Edword	1	1.22%

fig. 5.3a. NUMBER AND PERCENTILES OF WORDPROCESSORS IN CDT USE.

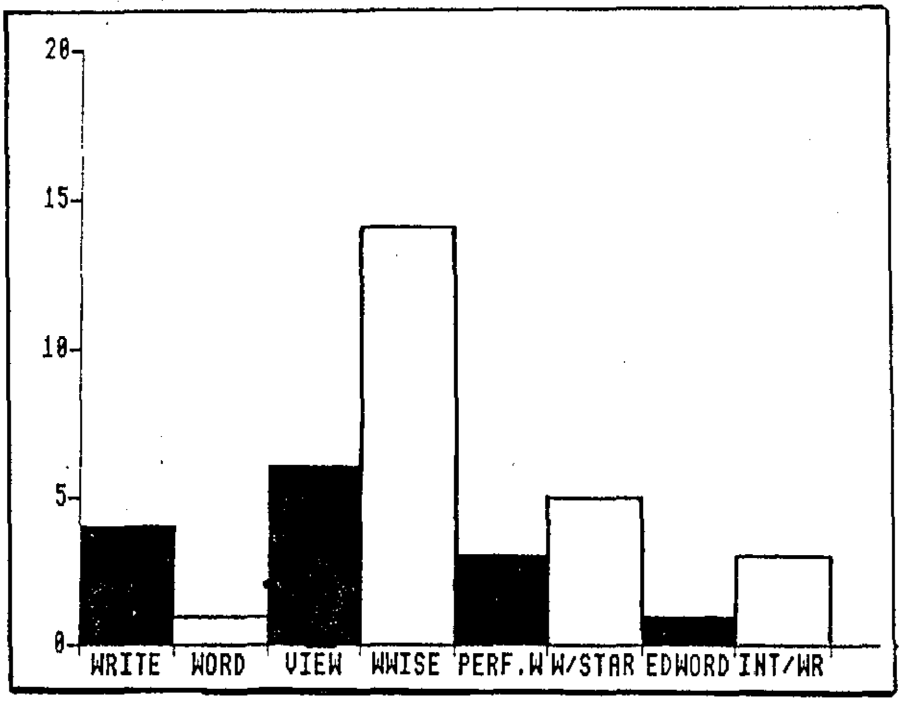

fig 3.b. Word processors in use in CDT departments. (Nov. 1986)

5.4. DATABASES

It was also expected that databases for record keeping, design research for materials components etc, statistics and general administration, would figure in the administration application of computers by CDT teachers. "Quest" has been readily available within the LEA for a long time; both BBC and RML versions are in many schools because of the method of packaging originally employed to distribute the programme. Some of the early Oxfordshire training courses were specifically designed to train teachers in the use of this program. A revised 16 bit version is also available within the LEA for the RML Nimbus computers. Expectations might be of a preference and wide application of this program where a database is used. A 10.98% percentile is surprisingly low and perhaps indicates the lack of database use by CDT teachers rather than suitability or otherwise of particular software. The less well known "Perfect-Filer" based on a

"Torch" Z80 extension to the BBC, was in use in two schools in preference to "Quest," although their figures are also included in the 10.98% figure for Quest above indicating a use of both programmes.

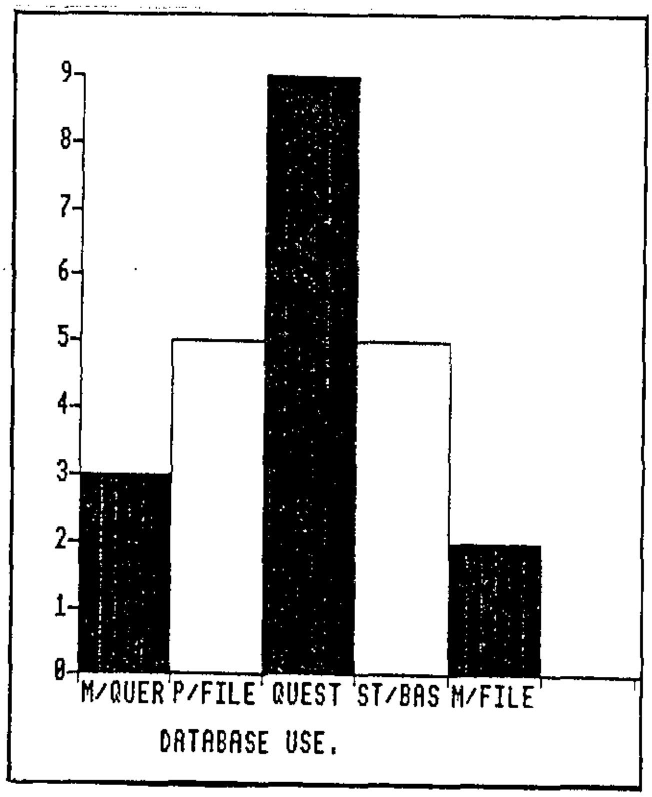

fig. 5.4a. Database use by CDT departments (Nov. 1986).

MICRO-QUERY	PERF-FILER	QUEST	STARBASE	MULTIFILE	N
3.00	5.00	9.00	5.00	2.00	82.00
3.66%	6.10%	10.98%	6.10%	2.44%	

fig. 5.4b. CDT DATABASE USE - NUMBERS AND PERCENTILES.

5.5. OTHER USES MADE OF COMPUTERS.

Those using computers for administration other than producing worksheets; indicated that record keeping of marks and profiles were their major concern. Examination statistics and timetable applications also enter the types of use. However, it can be seen from the figures that very few CDT teachers are exploiting the power of computers to help in their time consuming administration tasks.

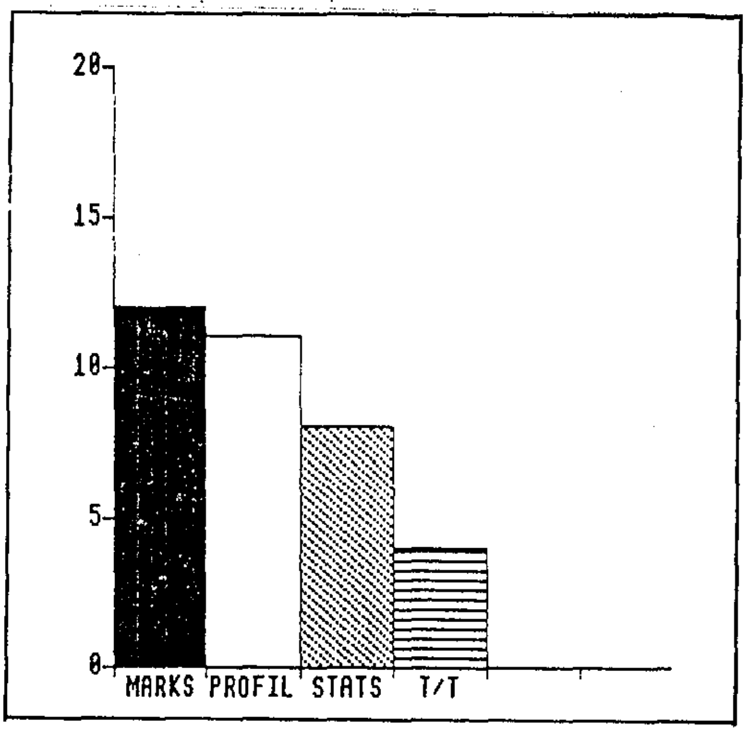

fig. 5.5a. Computer Use other than Word processing in CDT (Nov. 1986).

MARKS	PROFILES	EXAM-STATS	T/TABLE	N
12.00	11.00	8.00	4.00	82.00
14.63	13.41	9.76	4.88	% OF N

fig. 5.5b. (Percentiles on lower row).

5.6. HOW ARE COMPUTERS USED IN CDT?

The survey attempted to establish whether the suspected lack of the wider applications of computers amongst CDT teachers, both for administration and teaching purposes, was a reality. Subsidiary questions requiring answers which were anticipated by the questionnaire are:

a. Are CDT teachers uninterested in computers?

b. Are they aware of computers and their uses?

c. Do CDT teachers desire help with any computer uses?

d. What is the cause of the lack of application of computers in CDT.

Question 8 of the survey attempted to establish whether a demand for help and awareness of computer applications existed in the sample. The diagram and table below, shows that significant numbers of the sample desired help to learn how to use computers for a variety of applications which could be incorporated under the auspices of CDT / Technology.

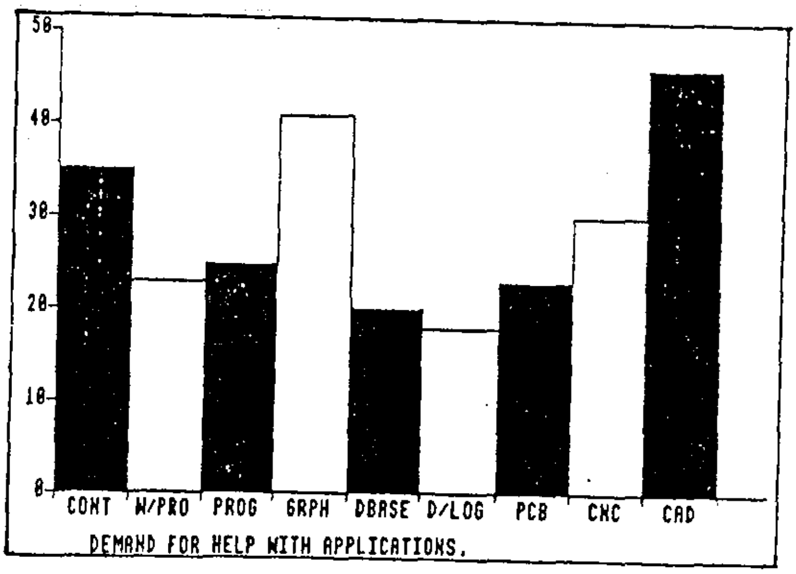

fig. 5.6a. (Refer to 5.6b. for abbreviations + percentiles).

ABBREV.		APPLICATION	HELP	% OF N
CAD	=	COMPUTER AIDED DESIGN	46.00	56.10
GRPH	=	GRAPHICS	41.00	50.00
CONT	=	CONTROL APPLICATIONS	35.00	42.68
CNC	=	CNC CONTROL	30.00	36.59
PROG	=	PROGRAMMING	25.00	30.49
PCB	=	P.C.B. DESIGN	23.00	28.05
W/PRO	=	WORD PROCESSING	23.00	28.05
DBASE	=	DATABASE ACCESSING	20.00	24.39
D/LOG	=	DATA LOGGING	18.00	21.95

fig. 5.6b. Demand from CDT teachers for help with computing applications in rank order (Nov. 1986).

It can be seen from the table fig. 5.6b. that there is a high interest in the computer aided design and graphics applications for computers from those who requested help. These areas are closely followed with a request for help with control and CNC uses. More than a third of the sample requested help in one or more of these four computing areas; therefore it would appear that the lack of computing applications in Oxfordshire schools CDT departments is not derived from unwillingness on the part of the teachers. It would also appear that between a third and a half of the sample at least, are aware of the potential uses of a computer for CDT. These figures would also indicate that there is a significant demand for considerable in-service training for CDT teachers with regard to computers. Even the lowest recorded number from the sample, consisting of the 18 teachers who requested help with data-logging, could be formed into a viable INSET group.

5.7. COMPARATIVE USES OF RML & BBC MICROS FOR CDT APPLICATIONS.

It was known that some schools were already making some use of computers for applications other than administration and word-processing within the CDT departments. It was of interest to establish what type of computers were being used for the various major applications likely to be found in a CDT / Technology room. The scaled bar graphs in 5.7a. and 5.7b. below show a surprising result for an RML based system. At the time of the survey in October / November 1986, the County were not advertising support for, or encouraging BBC micros in any schools; yet these results clearly show that where departments are making use of microcomputers, BBC micros are being used to a greater degree in all aspects than the RML machines. In the following tables 5.7a. and 5.7b. the key for the descriptor at the bottom of the bars is as follows:

CNT/R	=	CONTROL WITH RML MACHINES
CNT/B	=	CONTROL WITH BBC MACHINES
W.P/R	=	WORD PROCESSING WITH RML MACHINES
W.P/B	=	WORD PROCESSING WITH BBC MACHINES
PRG/R	=	PROGRAMMING WITH RML MACHINES
PRG/B	=	PROGRAMMING WITH BBC MACHINES
GR/RM	=	GRAPHICS WITH RML MACHINES
GR/BB	=	GRAPHICS WITH BBC MACHINES
DB/RM	=	DATABASE USE WITH RML MACHINES
DB/BB	=	DATABASE USE WITH BBC MACHINES
DL/RM	=	DATA-LOGGING WITH RML MACHINES
DL/BB	=	DATA-LOGGING WITH BBC MACHINES
PCB/RM	=	PRINTED CIRCUIT DESIGN WITH RML MACHINES
PCB/BB	=	PRINTED CIRCUIT DESIGN WITH BBC MACHINES
CNC/RM	=	COMPUTER NUMERICAL CONTROL WITH RML MACHINES
CNC/BB	=	COMPUTER NUMERICAL CONTROL WITH BBC MACHINES
CAD/RM	=	COMPUTER AIDED DESIGN WITH RML MACHINES
CAD/BB	=	COMPUTER AIDED DESIGN WITH BBC MACHINES

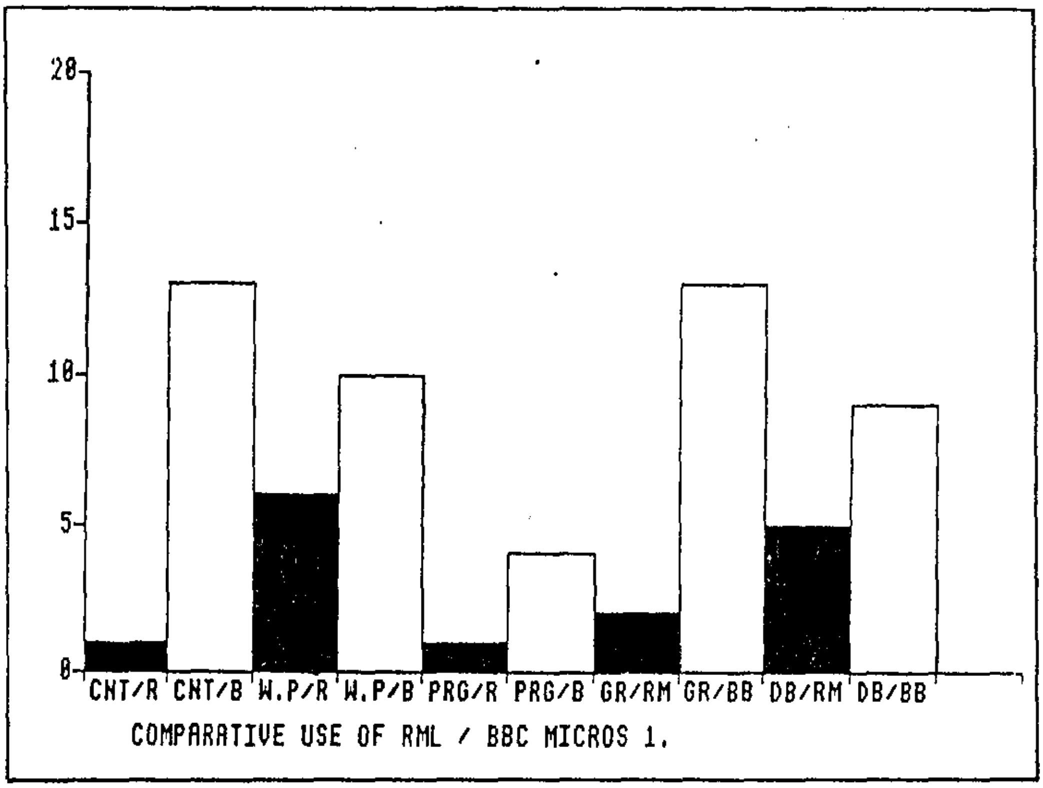

fig. 5.7a.

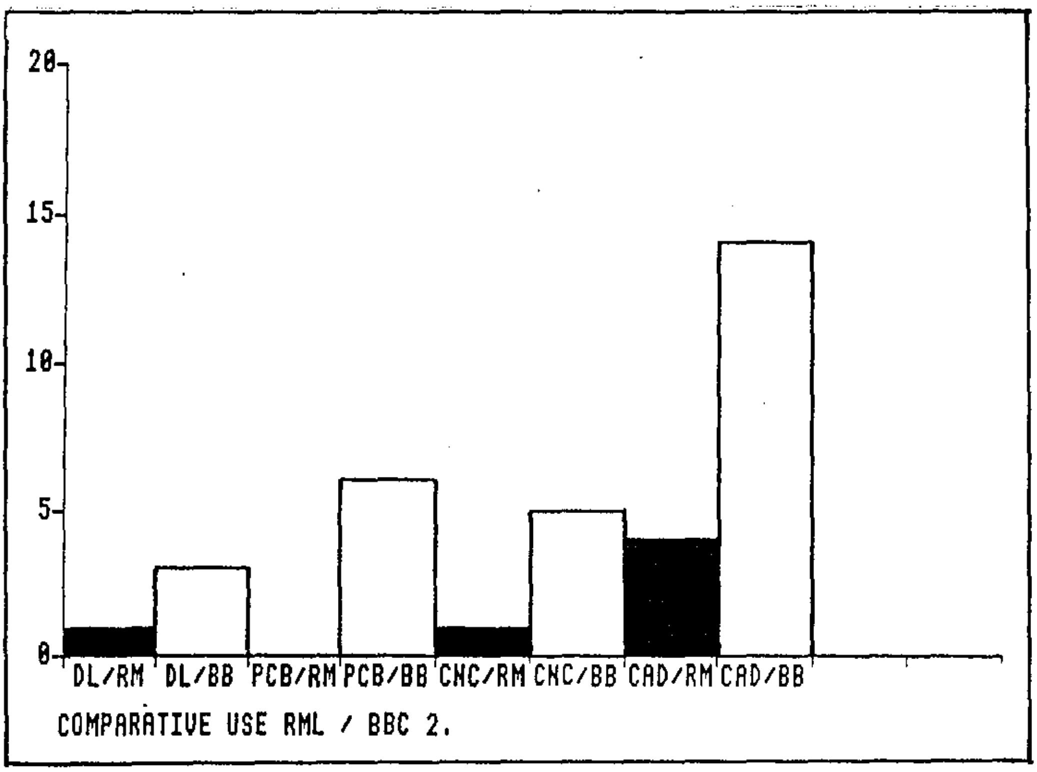

fig. 5.7b.

5.8. USE OF HOME AND SCHOOL MICROS BY CDT TEACHERS.

The bar graph in figs. 5.8b. & 5.8c. show that there are very few CDT teachers in the sample who desire or have RML machines at home; either borrowed or their own property. Of the sample only 1.2% owned an RML machine and a further 12.1% borrowed one. The picture is quite different for the Acorn BBC microcomputers; 18.3% of the sample owned a BBC and 20.7% borrowed a BBC machine for use at home. (Some of the BBC owners also borrowed a BBC computer). Only 1 teacher reported borrowing a Spectrum, (the other DOI supported machine), for home use. The Amstrad computers were also popular at home, and some of the sample wished to adopt them for school use. When the Amstrad PC was released after the survey, even more demand for Amstrad machines was voiced in the follow-up interviews and conversations with CDT teachers.

RML OWN	BBC OWN	RML BORROW	BBC BORROW	TOTAL % RML	TOTAL % BBC
1.00	15.00	10.00	17.00	11.00	32.00
1.22%	18.29%	12.20%	20.73%	13.41%	39.02%

fig. 5.8a. (Sample N = 82 Percentiles on lower row).

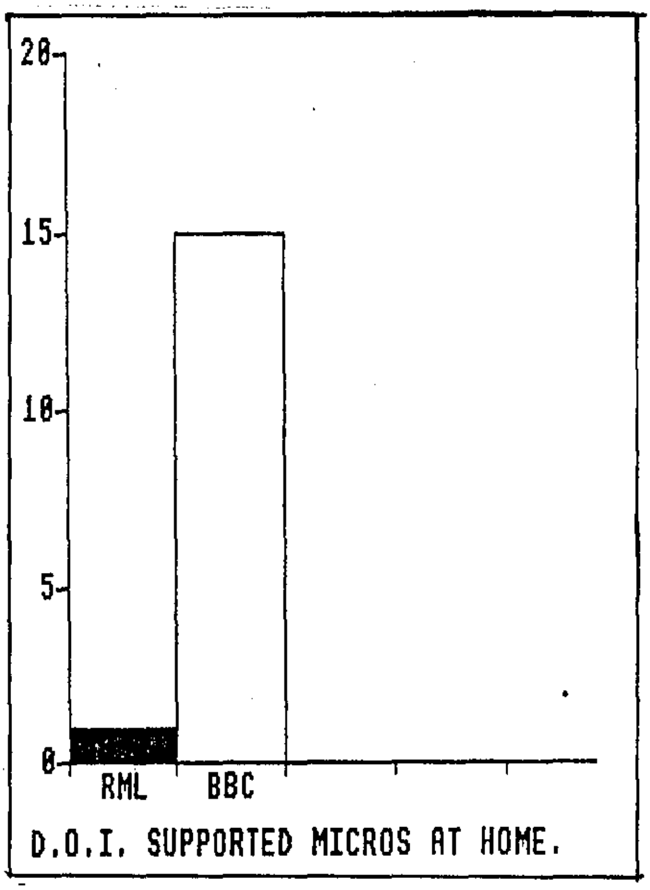

fig. 5.8b. DOI supported micros owned at home.(Nov. '86)

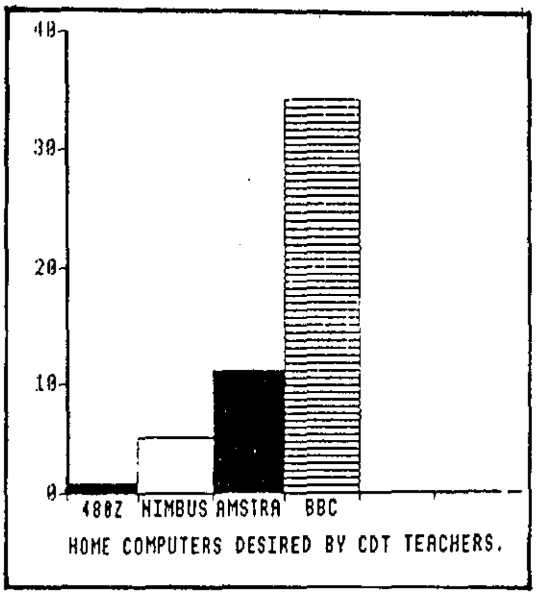

fig. 5.8c. Computers desired by CDT teachers for home (Nov '86).

9. TEACHERS PERCEPTIONS.

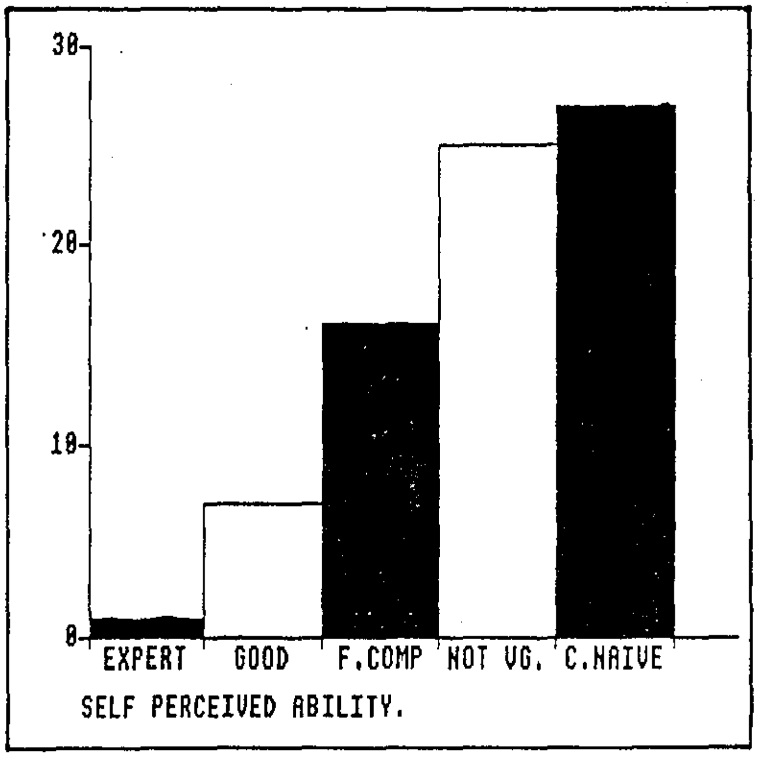

fig. 5.9a.

The diagram fig. 5.9a. shows a progression of the self perception of the CDT teachers in the sample, with regard to computers and their own ability. Of the group, 29.2% rated themselves 'fairly competent' or better; 63.4% rated themselves as 'computer naive' or 'not very good.' 7.4% did not reply to the question.

The responses to this question should not be regarded as anything other than a general indication of ability with computers. One respondent who claimed to be 'expert,' was subsequently observed using computers over a seven day period; he was patently not as good as another respondent who only claimed to be 'fairly competent', but who was justly regarded as 'expert' by his peers and others in authority within the LEA.

The table below fig. 5.9b. gives an indication of the desires, abilities and perceptions of CDT teachers with regard to computers and their present and anticipated uses.

Of the sample 54.55% believed that they could program a computer in 'Basic' language to some extent. This figure is surprising when compared to the 63.4% above who regarded themselves as 'computer naive' or 'not very good.' Whether the ability to program a computer is regarded as a yardstick of ability, is open to debate. There are those who never learn to program to a great extent, but who nevertheless are extremely competent computer users; if given the required software. An ability to write at least some programs would be useful in a situation where the computer is used in experiments or control; however, most writers on these topics consider that 'assembly' language is required to do more than very elementary work. Only 3.9% of the sample claimed to be able to write assembly language programs and another 3.9% claimed some ability.

QUEST.		YES	NO	SOME	N	% YES	% NO	%SOME
10.a.	PROGRAM IN BASIC?	17.00	35.00	25.00	77.00	22.08	45.45	32.47
10.b.	PROGRAM IN ASSEMBLER?	3.00	71.00	3.00	77.00	3.90	92.21	3.90
11.	ENJOY USING COMPUTERS?	43.00	11.00	18.00	72.00	59.72	15.28	25.00
11.a.	ARE COMPUTERS USEFUL?	62.00	3.00	8.00	73.00	84.93	4.11	10.96
11.b.	ARE THEY A WASTE OF TIME?	4.00	66.00		70.00	5.71	94.29	
11.c.	LIKE TO USE COMPUTERS?	68.00	2.00		70.00	97.14	2.86	

fig. 5.9b.

In response to question 11 "do you enjoy using computers?", 15.28% of the 73 who replied said that they did not like using them. Nearly 60% replied positively to this question. When asked whether a computer was equipment they would like to be able to use better than at present, 97.14% of the 70 who replied stated that they would. This indicate that there is at least interest in improving their abilities amongst many of those who do not enjoy using computers at present. Those who already considered themselves 'very good' or 'expert' generally did not respond to this question. 5.71% of the responses indicated that they thought learning how to use computers was a waste of time.

QUEST.		YES	NO	SOME	N	% YES	% NO	%SOME
13.a.	USE FOR INSTRCT. GUIDE?	63.00	4.00	9.00	76.00	82.89	5.26	11.84
13.b.	BORROW A LOAN PACK?	55.00	2.00	19.00	76.00	72.37	2.63	25.00
14.a.	INCREASE YOUR AWARENESS?	57.00	4.00	11.00	72.00	79.17	5.56	15.28
14.b.	GIVE INCENTIVE TO LEARN?	54.00	7.00	12.00	73.00	73.97	9.59	16.44
14.c.	STIMULATE PUPIL INTEREST?	52.00	4.00	15.00	71.00	73.24	5.63	21.13
14.d.	WASTE OF TIME TO ASSEMBLE?	3.00	61.00	7.00	71.00	4.23	85.92	9.86

fig. 5.9c.

The section of the survey relating to a loan package elicited very positive responses. Less than 10% of responses on all 6 questions were negative. Only 4.23% regarded it a waste of time to assemble a package of loan equipment. (Two teachers responding to the survey had a very negative attitude with regard to computing and were subsequently found to be influenced by problems within their school). The need for a very simple guide to the use of computers and peripheral equipment was very definitely highlighted; even by those members of the sample who already regarded themselves as fairly proficient in the use of computers.

Three quarters of the sample, thought that a loan package would increase their awareness of computing, as well as give them incentive to learn more about the subject. It was also felt that the equipment could be applied in the classroom to stimulate the interest of pupils.

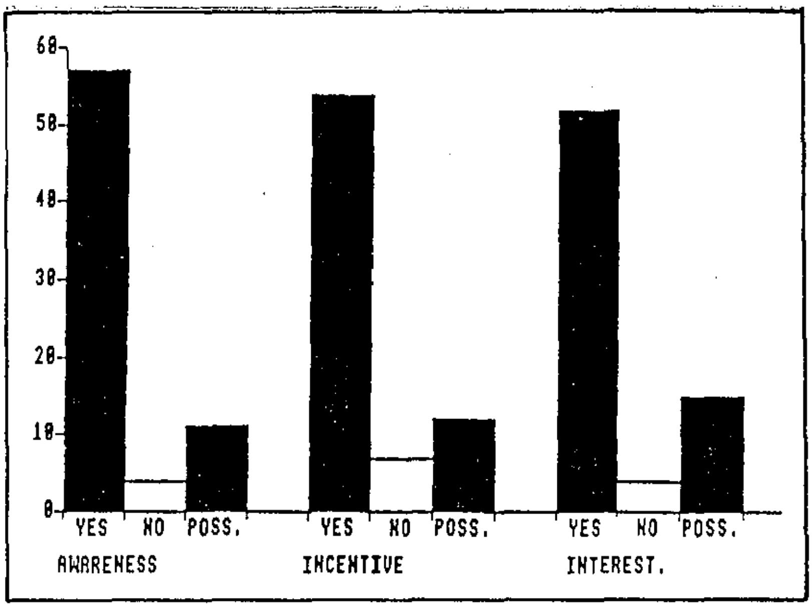

fig. 5.9d. Would a loan package raise your computer awareness / incentive to learn / increase interest in computers?

10. TRAINING AND ABILITY.

A surprisingly high number, amounting to 57.3% of the total sample of CDT teachers, claim to have received at least some computer training within the LEA. 12.1% of the total sample had received more than 20 hours training but only 3.6% had received more than 30 hours. It is not until the latter figure is realised that the extent of the training for CDT teachers can be established. Many of the teachers interviewed, claim to have gained most of their computing skills at home using their own, or borrowed, equipment.

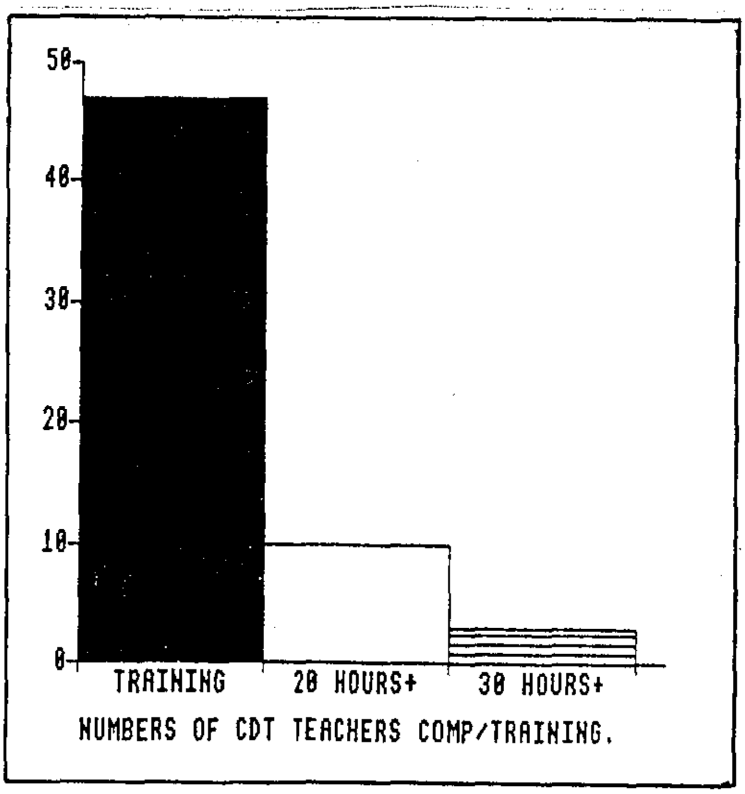

fig. 5.10a.

11. BBC COMPUTER USE.

The bar-graphs in figs. 5.7a. and 5.7b. above show that CDT teachers are making more use of BBC micros than they are of RML machines. This was a surprising discovery - especially for the uses of graphics and computer aided design. The greater memory capabilities of the RML machines and the Nimbus in particular, would have suggested that there would have been a greater application of these computers for these applications. Software is also fairly readily available for the RML computers within the LEA.

A cross-correlation revealed that of the 22 teachers claiming to use computers for school administration; eight, or just over a third of these, own and use their own BBC's at home. A further six of these borrowed BBC's for school administration use. Four others using computers for school administration use different computers; - (two Amstrads a Spectrum and a borrowed RML-380Z). Therefore 63.63% of those attempting to undertake administration tasks were using a non - LEA recommended BBC microcomputer.

Of the fifteen BBC owners, six stated they have not received any computer training.

All except one of the BBC owners used their computer for some use related to school; mainly graphics and design other than word processing. Those who borrowed BBC computers were using them in a similar manner, and in addition three teachers reported using them for control purposes.

Fourteen of the fifteen BBC owners are included in those forty seven who would like BBC computers for use in school. (The fifteenth owner did not reply to this question). The only privately owned RML machine, (a 380Z) was owned by a teacher who was also a BBC owner.

12. COMPUTER OWNERSHIP BY THE SAMPLE.

Forty seven of the eighty two CDT teachers responding to the questionnaire, either owned or borrowed computers for use at home; thirty nine were owned by CDT teachers, including nine Amstrad machines. Several teachers borrowed computers other than the make of machine which they owned; some BBC owners borrowed RML micros for design or administration work. It can be concluded from this information that 47.5% of CDT teachers in the sample were already interested enough in computers to purchase one for use at home. The comments section on some of the returns indicated that in other cases teachers would have been prepared to purchase their own equipment if they could afford it.

13. CONCLUSIONS.

The survey had demonstrated that CDT teachers within Oxfordshire were generally very willing to increase their use of computers provided that the necessary help and equipment were made available. Comments written on some returns indicated that the help was required at a basic level, which substantiated the findings of the preliminary case studies.

It appears that CDT teachers within the LEA were less than satisfied with the computer provision provided by the LEA within their schools, especially for the use of control technology and allied applications. 'Stand alone' computers were required IN the workshops NOT at a remote area of the school.

The number of CDT teachers who had applied independently to receive some computer training, was a surprise to the author and other interested parties. The numbers of BBC micros owned and borrowed or desired and admitted to in the survey, was also surprising in an LEA which had fairly actively discouraged their acquisition.

Some of the results of this survey were revealed to the Oxfordshire Technology Advisory Group for their consideration and possible remedial action for the CDT teachers within the LEA.

The next chapter discusses whether there is a need for CDT teachers to be trained in the use of computers. Proposals for possible ways forward to intervene in, and change the situation if it is shown to be desirable are also given there.

CHAPTER 6.

6.1. The need for teacher training.
6.2. National computer training provision for teachers.
6.3. The trainers.
6.4. The Microelectronics Project (MEP).
6.5. Microtechnology Inset Team. (MIT).
6.6. Microelectronics Support Unit. (MESU).
6.7. Training Provision for Computer use within Oxfordshire LEA since 1981.
6.8. British schools Technology.
6.9. The Manpower Services Commision (MSC).
6.10. Consequences of losing TVEI.
6.11. Future Developments.
6.12. Towards more training.
6.13. Projected future opportunities for retraining teachers.
6.14. Education Techniques which could be employed to retrain teachers.

CHAPTER 6.

This chapter provides an overview of the need for, and provision of, computer training for CDT teachers, both nationally and within Oxfordshire LEA.

6.1. THE NEED FOR TEACHER TRAINING.

There is little doubt that teachers involved in teaching CDT and Technology today, should be aware of computers and their use and also that they should be familiar with computer deployment as part of their normal teaching. Government, and some educationalists, have been expressing this requirement over recent years. Evidence for this demand from 'the top' can be found in 'The School Curriculum' (1981) where it specifically says:

> 'The Secretaries of State consider it important that pupils should become familiar, with the use and application of computers, particularly through direct experience in the course of their studies'. In addition the Secretaries of State 'attach special importance to CDT as a part of the preparation for living and working in modern industrial society'.(1)

The logical conclusion to be drawn, is that if children are going to be taught how to use and apply computers as an integrated part of their CDT coursework, then their teachers will require at least some familiarity and expertise with the equipment and its capabilities.

Questions which require an answer if this premis is accepted; are what is it that the CDT teachers should need to know and teach? Matthews (1986), reporting on the Cranfield meeting, indicated that they certainly accepted that the area of 'control' should be explored and be part of the CDT domain; a suggestion for the initial implementation of this topic is included in the report:

> 'The work should include the use of simple consumable materials, components and simple control systems. Initial work should involve children in designing, making and using devices which offer direct and obvious experiences. Examples of progression include the use of batteries and switches with bulbs, proceeding to Light Emitting Diodes and seven segment display devices or the control of small electric motors operating a device produced as the solution to a perceived need'.(2).(MATTHEWS, A)

Computers must be at least considered as an essential topic to be covered in the teaching of control technology. The same report also considers the need for computer aided design and manufacture. Teachers imparting their knowledge in the 'design and realisation' aspects of CDT courses would be foolish to ignore the potential of computers and their effects for this area of society and the curriculum. Computers are widely encroaching on design and manufacture in industry. A striking example is their recent extensive use and deployment in the motor industry; which previously has been notoriously slow to change its ways. Pupils should at least receive some basic awareness of these developments if their work is concerned with design and making; indeed if their intended future employment is to be in this field, then it should be considered an essential. It therefore follows that teachers will have to be able to cope with transmitting this awareness to the pupils. The fast changing role and problems of the CDT teacher is illustrated by Harrison and Black (1985)in their statement on the subject of CDT:

> 'CDT teaching has developed many new ideas which have brought with them a widening of purpose, sometimes at the cost of confusing some teachers, undermining both their confidence and integrity of the old disciplines which formed the basis of craft teaching. Teachers have felt themselves to be under criticism for not being sufficiently concerned about 'design' and 'technology' as well as 'craft'. (3).

These two writers later discuss the subject matter to be contained within the curriculum for Technology and state:

> It is hard to develop understanding of the relevant principles e.g. of properties of materials, of statics and of control, within the traditional curricula of (say) woodwork or metalwork. (4).

This statement plainly makes the point that traditional skills are no longer enough in isolation for a competent CDT or technology teacher. A much wider base knowledge and understanding is now required to teach these subjects. The Cranfield meeting of Advisers, HMI's and others stated under the heading of 'Professional Development' with regard to computers:

> 'Awareness must be kept short and sharp and aimed at all CDT teachers. A smaller number should undertake high level courses leading to understanding and capability'.

and elswhere in the same document:

> 'There is a need for professional development ranging from awareness to a high level of capability. In all areas the need to understand the "why" must precede the "how"'. (5).(MATTHEWS, A)

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It would appear that those closest to the top of the educational pyramid, namely advisers and HMI's, have long accepted that there is a need for ALL CDT teachers to come to terms with computers. However, it would also appear that there are some teachers at the bottom of the pyramid who have yet to be convinced of the need for such a radical departure from their previous ways. Self J. (1985) writes:

> 'Many educationalists will begin to rebel (if they have not done so already) at the suggestion that computers should be considered responsible for making decisions about teaching strategies. Using computers to reinforce the prevalent teacher-centred culture is bad enough: creating a computer controlled culture is going too far, they will say'.(6).(SELF, J.).

This demonstrates at the very least that computers are having an identifiable effect on the education system and that they are a force to be reckoned with by all teachers; even if some are heavily against their adoption. It would be wrong for any teacher to dismiss computers on grounds of uninformed prejudice, therefore it could be argued that this reason alone would be sufficient to demand that all CDT teachers be trained in computer use.

To return to the question what do CDT teachers need to know? The answer could be a very wide variety of knowledge relating to computers and computing. It would be extremely difficult to generate a course and base of knowledge which could cope with all the possibilities and demands that a CDT teacher could find arising for a computer during the normal lessons which he teaches. Some of the uses would be word-processing, database access (including that to a remote terminal), computer aided design and drawing, computer aided manufacture, control technology (including the use of CNC machinery), and possibly the ability to write programs for the computer. At this point it can be readily realised that to achieve this extensive base of computer knowledge would require very extensive training over a long period of time. Any and all of the above topics could be encountered by a teacher deploying computers as an integrated part of a CDT course, and they do not comprise an exhaustive list.

It is perhaps worth considering at this point how astonishing the rate of development of computing has been in schools during essentially six years. At the onset of the 'micros in schools scheme' very few CDT teachers saw the need for a computer in their lessons; only a very small minority teaching technology were making use of computing equipment. Now, six years later, government and others are implicitly requiring that all CDT teachers have at least some training in their use, and further, that they can make use of computers in lessons. What provisions have been made by both government and local education authorities to achieve this training?

From the results of the survey by questionnaire, it was apparent that there was a demand by CDT teachers within Oxfordshire for computer training in several areas of computer application. Despite the relatively high number of CDT teachers in the sample having received some computer training; it was apparent that out of the teachers who were using computers in lessons, very few had received any training in the particular applications which they were attempting to apply to their teaching. Provision for specialist applications training, such as that required by technology or design departments, had undoubtedly been neglected in Oxfordshire prior to 1986. Very few teachers had been deliberately exposed to, or instructed in the use of, packages specifically relating to CDT. During the preliminary interviews before the questionnaire was designed, at least three teachers in the limited sample complained bitterly of the lack of specialist CDT software available for the RML machines; they had also approached the computing adviser about this problem. This apparent paucity of software could be one explanation for the lack of any training having been provided within the LEA. At this juncture it would be pertinent to try to discover the background, range and effects of training which has been, and is still available for Oxfordshire CDT teachers.

6.2. NATIONAL COMPUTER TRAINING PROVISION FOR TEACHERS.

Many of the commentators and writers who have discussed the introduction and use of computers in schools, (Self, Thorne, Aston et.al.), have remarked on the lack of trained teachers in the school system capable of maximising the use of this new equipment. There has been a constant demand from schools and LEA's for in-service training, and consequent funding, since the inception of the 'micros in schools project' in 1981. To qualify for the original subsidies on the equipment, LEA's were required to provide training for teachers. Much of this early training was of necessity at a very low level. A two day, or even a weeks course, could not be regarded as sufficient to ensure that it produced competent operatives at the end of this limited time. Many LEA's produced statistics showing how many of their teachers had received training on computers; although these figures undoubtedly qualified the LEA concerned for the government / DOI grant, they could not be regarded as a reflection of the numbers of fully competent 'computer literate' teachers.

Traditionally, a number of agencies such as teacher training institutions, polytechnics and colleges of higher education offer longer courses, sometimes award bearing, such as Diplomas in Computer Education and the RSA awards. These courses last up to two years, perhaps on a day/evening a week basis. Long courses do give teachers time to come to terms with the larger software packages, control systems, communications, networks, peripheral devices and to develop their curriculum materials with real groups of children. However, with the reduction of long term secondments and the growing emphasis on school directed county based INSET in Oxfordshire, it is unlikely that many Oxfordshire CDT teachers would be attending courses of this type in the immediate future.

6.3. THE TRAINERS.

John Self (1985) reports that many of the teachers who became computer literate, and later expert; became so often by working in their own time and were driven by self-interest and motivation. (6). Subsequently many of these teachers were able to carve a new niche for themselves in the internal school promotion system. Some of these people also worked later for the 'Regional Centres' established under the 'Microelectronics Project' or gained other promotion outside the classroom. It would certainly appear that teachers writing articles on electronics and computing in the early 'eighties' later appeared as tutors on MEP and DES courses; others moved into higher education institutions. Many of these people would have had to have been highly self motivated, greatly interested in computers and self-taught because virtually no training courses were available at that time. Undoubtedly small informal interest groups arose which allowed those interested to exchange information and ideas at this early stage of computing in CDT and Technology. Some of these informal groups later developed into the core of much larger organisations. In view of these assertions, it is worth considering just how much training provision has been available to teachers, and how this has been implemented.

6.4. THE MICROELECTRONICS EDUCATION PROGRAMME.

This organisation resulted from a government initiative announced in Parliament in March 1980. To give an indication of its role, many MEP documents included the following statement inside their front covers:

"The aim of the Programme is to help schools to prepare children for life and society in which devices and systems based upon microelectronics are commonplace and pervasive". (7).

The parameters within which MEP was to function were defined in a document titled, 'National Strategy for Government's Microelectronics Education Programme for England and Wales and Northern Ireland'. (8). The paper accepted, in principle, the possibility of developing software for computer based learning across the curriculum, but gave priority to applications in mathematics, the sciences, craft/design technology, geography and courses related to business or clerical occupations. These were to include; microelectronics in control technology; electronics and its applications in particular systems; computer studies; computer-linked studies; including computer aided design, data logging and data processing; word-processing and other 'electronic office' techniques.

The MEP had to respond very quickly to the demands placed upon it by the Department of Industry 'Micros in Secondary Schools Scheme'. A number of regional centres were set up; each with a considerable degree of autonomy. The coordination of projects and liaison with the LEA's was undertaken by regional coordinators.

The MEP strived to establish courses in the four "domains" - Communications and Information Systems - Computer Education and - Computer Based Learning - Electronics and Control Technology.

Joint meetings to discuss INSET were regularly held between the regional coordinators and the four national coordinators in each of the domains. In some regions this strategy worked reasonably well; but as in any pyramid structure, there were reported weaknesses.

One of the criticisms of MEP's INSET was that it only reached teachers who were already interested in computing. This may have been true in other areas of the country, but from the results of the interviews and the writers other conversations with CDT colleagues, it never apparently reached even those CDT teachers within Oxfordshire. A major factor affecting the MEP work was the quality and quantity of support offered by LEA's in determining whether teachers were encouraged to make use of the considerable range of hardware and software packages eventually on offer. Very little of this material appears to have percolated into the Oxfordshire schools; although some knowledge of the resources was certainly available within the advisory service.

An indication of the effectiveness and efficiency of the MEP can be found in a comment from Mike Aston (1986) in the report:

> 'The box of resources produced to support the teachers and the L.E.A's. was remarkable in that they were made available in an extraordinary short space of time...... Software generally worked on two very different micros (the Research Machines 380Z and the BBC Acorn Model B) and teachers were actually able to take materials home which include software samples and easy-to-use machine tutorial guide. (9).(ASTON, M. 1986).

The report, 'Aspects of the work of the Microelectronics Education programme', looked at how far the MEP succeeded in its aim to 'help schools to prepare children for life in a society in which devices and systems based on microelectronics are commonplace and pervasive'.(HMI 1987) (10). It concludes that:

> 'the regionally based, triple strategy of information distribution, curriculum development and in-service training, (INSET) was broadly successful, thanks to the dedication and creativity of the MEP staff and the teachers involved'. However the report also states that 'poor Communication dogged MEP'. (DES 1987)

During this research in the Oxfordshire CDT departments, little evidence was discovered amongst CDT teachers of extensive knowledge of the MEP work. It is perhaps surprising that much of the good work undertaken by the Microelectronics Education Programme was virtually unknown within the Oxfordshire schools until the final stages of the project. However, this problem was not confined to Oxfordshire but has been recognised nationally by HMI who state:

> "...and many schools remained largely unaware of the range of MEP teaching materials available to them, until the last year of the programme."(11).

The value of the prolific output of the various groups working for the MEP cannot be underestimated for promoting some of the wider aspects of computer use, including "control".

6.5. MICROTECHNOLOGY INSET TEAM.

MIT was essentially a short term organisation to allow the new government sponsored Microelectronics Support Unit to become established for 1987. However, much of the MIT INSET work will be taken on board by the National Electronics and Microtechnology Centre (NEMEC) based at Southampton University; who have recruited new staff to support the few remaining MEP personnel.The National co-ordinator was Graham Bevis previously of the MEP. Much of the MEP printed material for the Electronics and Control Technology continues to be available through Beth Bevis.

The MEP managed to develop good working relationships between MEP Directors and relevant advisors in Local Authorities including Science and Technology Regional Offices, (SATRO's). At the end of the project in March 1986 some of the work of the MEP in the electronics and control technology domain was continued by a successor organisation comprising some of the MEP staff from that domain, with the acronym MIT. This organisation operated from a SATRO based at Southampton University under the auspices of the NEMEC with regional staff at Loughborough University and in Northern Ireland.

MIT devised INSET resource packs for particular technology topics. each of these packs outlined possible strategies for the possible organisation and implementation of INSET and described the required and available resources.

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6.6. MICROELECTRONICS SUPPORT UNIT.

The official government sponsored organisation formed to continue the work started by the MEP is the Microelectronics Education Support Unit (MESU). The brief for MESU was the 'consolidation and dissemination of MEP's work'. However this is a more limited operation and is taking a long time to make an impact on the teaching profession in certain areas of the country. Regrettably, at the time of writing (1987), once again they are almost unheard of in Oxfordshire amongst the CDT teachers.

The DES report quoted above says of MESU:

> '...the new challenge for MESU, is to improve the communication of knowledge between the people and other teachers. Particular stress is laid on introducing more IT into initial training for teachers, on INSET, and giving advice on the practical applications of IT in schools'.

6.7. TRAINING PROVISION FOR COMPUTER USE WITHIN OXFORDSHIRE LEA SINCE 1981.

Since the government / DOI initiative to place computers in schools, Oxfordshire LEA has provided computer awareness training for many of the teachers within the county. A decision to buy RML machines was made at a very early stage of the initiative and this policy has been largely maintained since 1982. Hence most of the teachers who have received training from the microcomputing centre, now based at Wheatley; have to a certain degree become familiar with the RML 380Z or 480Z machines and more recently, the Nimbus microcomputer.

Training was not initially targeted at any one group of teachers, but was open to those who wished to apply for places on the courses offered. These courses allowed the LEA to comply with the requirements of DOI support for partial funding of equipment by the provision of computer training for teachers.

Many of the initial training courses were two day awareness sessions and concentrated on basic use of the machine, word processing or the use of databases such as "Quest". Variations of these awareness courses and the use of software specific to RML machines has continued to the present time. A recent departure, has been to train teachers and office staff from schools which are using Nimbus computers to operate an office management / accounting and pupil record card system, which is now being introduced into pilot schools.

Regrettably little, if any, computer training has been specifically aimed at CDT teachers by the major computing provider within Oxfordshire LEA. The requirements of CDT departments could possibly have been one of the major areas requiring help during the last five or six years. The first courses to be specifically targeted at CDT teachers were organised by advisory staff not directly connected with the microtechnology centre at Wheatley. These courses established under the TVEI related in service training scheme in 1986 appear to have been the first substantial input of training for this group of teachers.

In the middle 1986 amidst growing concern from CDT teachers and their advisors, the computer centre at Wheatley were beginning to acknowledge the problems of computing in CDT. Another concurrent research project based at that centre, was being undertaken by a CDT graphics specialist. This research was specifically looking at the subject of computer aided drawing; with special emphasis on applications for RML machines. Further evidence of a response to representations from CDT teachers requests for help with hardware, were to be found in the centre publication where it was recognised that, 'there may be a need for a separate computer in CDT departments.'(12). (WALTON, D.). It is perhaps pertinent to note the reference to a single computer.

6.8. BRITISH SCHOOLS TECHNOLOGY.

British Schools' Technology (BST) was another government 'pump priming' operation which had two distinct branches, BST Trent and BST Bedford. The aim of these organisations was to promote technology education in schools. At the end of their three year official funding from government in 1987, BST had to become independent and self supporting.

British Schools Technology from Trent Polytechnic were contracted by Oxfordshire to provide courses relating to electronics, control and microcomputing for Science and CDT teachers in 1985. These courses were undertaken from the large purpose designed trailers developed by BST Trent, which were brought to strategic points within the county. These courses were visited and observed for this research. Teachers attending these courses were also interviewed.

The computers chosen by BST for their training, were the Acorn BBC microcomputers. This was a radical departure from previous county policy for many of the teachers who attended the courses. It was discovered in the research interviews that some of the teachers attending these courses already personally owned BBC micros and some others bought, or stated an interest in buying them, following their training. These BST courses appear to have been a significant influence in establishing some demand, at least from technology teachers, for Oxfordshire to change its policy and allow the purchase of Acorn machines where they were requested. A few technology teachers had already voiced this preference unsuccessfully, and some had managed to acquire Acorn machines for their schools through independent sources.

More recently in 1986, BST Bedford have been employed to teach aspects of computer aided drawing and design, to the teachers selected for the TVEI Related In-Service Training (TRIST) funded courses. This work has been based at the Oxford Schools Science and Technology Centre (OSSTC). Both RML Nimbus and BBC "B" or Master computers have been used on these courses. TRIST courses were specifically targeted at combined groups of science and CDT teachers from a small number of selected schools. The courses were established just before the start of this research.

6.9. THE MANPOWER SERVICES COMMISSION.

Oxfordshire had twice been unsuccessful in consecutive years with its applications to the Manpower Services Commission for the Technical and Vocational Educational Initiative.

In 1985-6 Oxfordshire finally had a TVEI project accepted for a group of six city schools. More significant for the teachers throughout the County, was a grant of funding for a TVEI Related In-Service Training programme (TRIST). The TRIST training was initially offered to six schools who had to commit themselves to releasing two science and two CDT teachers for a twenty day period; which was divided into two to five day blocks of time. The courses involved basic electronics, design and substantial elements of computer training; consisting of computer aided design and drawing and also a five day session on computer control. This represented the most significant computer training for any CDT teachers within the LEA since the advent of the Microcomputers In schools initiative six years previous to this time.

It was subsequently possible in the Spring of 1987 to extend a reduced, but broadly similar program of training, to 20 teachers selected from applicants from non-TVEI schools within the county. (Elements of this research were undertaken with this latter group of teachers). Much of the TRIST training has been undertaken at the Oxford Schools Science and Technology Centre and at a College of Further Education within the LEA. BST Bedford have undertaken some of the CAD aspects of the TRIST training and have been based at the OSSTC.

The TRIST programme has been superseded by the Grant Related In-Service Training (GRIST) scheme within the LEA. The GRIST scheme is currently working to a similar model to the modified TRIST programme mentioned above; with the difference that the schools taking part are nominated by the Technology Advisory group. (Elements of this research were also undertaken with GRIST sponsored teachers).

Other minor short courses have been undertaken by teachers within the LEA to train their colleagues in the 1981-87 period. One of the two 'computer expert' CDT teachers identified above, has also tutored a weeks residential course on computer control for the DES.

6.10. CONSEQUENCES OF LOSING TVEI.

An identifiable perceived effect of the rejection of the TVEI submissions, was for the Technology departments within Oxfordshire, to start to fall behind the developments apparently happening elsewhere in the country in CDT departments where TVEI money had been granted.

Chapter 6.

Many of the TVEI schools bought computers in significant numbers and embarked on INSET courses for their teachers. Subsequent courses for TVEI pupils involving "Information Technology" and computer control were consequently developed by these teachers. Inevitably the use of computer equipment spilled over into the non-TVEI curriculum in these areas and their schools.

Startling evidence for this lack of progress in computing and technology in Oxfordshire, was to be found at the Design and Technology Exhibition at Wembley in 1985. A display of work undertaken in some Birmingham TVEI project schools was on show, including pupils at work. This large exhibit incorporated elements of computer aided design and drawing, computer control, and the use of computer numerically controlled lathes and milling machines. Although it was realised that the exhibition of the Birmingham TVEI work was probably not the norm throughout the country, it demonstrated what was happening in an area where funding and sympathetic support were available to the schools. (The author and two colleagues spent a considerable amount of time viewing, investigating and discussing this work at that exhibition).

It was also obvious even at a casual glance, how much of the rest of the trade exhibition was related to computers and 'new technology', which marked a significant departure from the previous exhibitions. Many Oxfordshire teachers who attended the 1985 DES-TECH conference remarked on the changes taking place both in their subject areas and also the lack of enabling equipment which they had in their own workshops to attempt to keep pace with this change.

6.11. FUTURE DEVELOPMENTS.

It will not be long before there are a number of significant new developments. The use of electronic mail and access to national databases will increase. These developments are being actively encouraged by the Government, and the DOI have placed a 'modem' in most schools. The advent of the Times Network and NERIS based at the Open University will enable schools having suitable telephone lines to communicate with these remote databases.

The meeting of HMI's and advisers at Cranfield in December 1985 also suggested that the possibilities of a CDT database be explored, which would be able to answer "what if" type questions regarding materials structures etc. This same conference recommended the development of a 'design processor' to work as easily as word processors:

> 'A national CDT data base should be established. This data base should be accessed by means of a 'modem', via a telephone line........
>
> 'A design processor. This relative of the word processor will assist in the development of design solutions. It would not be subject specific and would allow the design of any item to be processed. The software should be able to answer "What if" questions such as 'What if a different material were used'?
>
> 'The combined use of a computer operating as a CAL machine with a video disc player would mean that a very large amount of visual information and digital data could be available in one CAL or CET system'.(13). (MATTHEWS, A).

Interactive video is already a reality with the 'Domesday project' being the first of many proposed projects. Those who have experienced its use are understandably impressed by the potential of such a system. Following a personal request, John Simmett, from Kingston on Thames demonstrated the system admirably at the OSSTC, Oxford during this research. If a means of accessing these video-discs by telephone or local networking can be devised (or there is a severe drop in their price and the price of the hardware) then the possibilities for information access by both teachers and pupils will be vastly increased. Teachers will of course require training and time to learn how to maximise the efficiency of these new and projected systems. With the astonishing rate of development already achieved by computers in schools in six years, who can forsee what will be happening in another six years time?

6.12. TOWARDS MORE TRAINING.

It can seen from the above that there are a number of national and local opportunities for CDT teachers to acquire CDT / Technology specific computer training. However, both of these avenues have had restricted access for teachers within the Oxfordshire LEA. Very few have received any specifically CDT orientated national computer training; of those teachers interviewed only two claimed training from this source. Although moves are currently being made to increase this training at local level under the auspices of 'grant related in service training' (GRIST), access to courses is largely restricted to those teachers from schools chosen by advisers. This means that some teachers receiving training may have been sent by their schools rather than having applied for the courses out of their own interest. This is however evidence of the concern being shown by some of the Technology Group advisers and headmasters regarding an unsatisfactory situation.

6.13. PROJECTED FURTHER OPPORTUNITIES FOR RETRAINING TEACHERS.

The government backed and MSC based 'Joint Support Activities' announced in May '87,(14) are an opportunity for groups of Authorities, working collaboratively, to build on the experiences of the TVEI pilot projects, the TRIST scheme and existing support mechanisms (eg SSCR, SATRO, SCIP). They are intended to focus on unmet needs, particularly in the areas of applied science and technology where there is 'a considerable and urgent demand for both expertise and equipment'. It is intended that they should give all teachers the opportunity to widen their experience and should concentrate particularly on 'supporting technological approaches within curriculum and staff development'.

The areas of activity recommended include the development of learning materials, including educational software and supported self study programmes. These would be complemented with 'development of active learning approaches across the curriculum both in the classroom and in INSET'.

The funding for these activities comes from the MSC and may be used for staffing, equipment, materials (and software) and exceptionally, premises. Those LEA's who can comply with the conditions attached to this scheme could benefit from the increased funding for training their teachers in the use of computers!

Aston (1986) reports in the Times Educational Supplement (15) that during 1985, two booklets were published, provoking considerable discussion among school staff. "Change in Perspective", intended for secondary staff and the "Time to Reflect" for primary. Both publications ask a lot of questions and neither provide any of the answers. Questions like who should primarily support staff development: a colleague or an outsider? Where would you prefer INSET activities to take place? In school or elsewhere? If you were head, what would you do to ensure support for those members of staff who showed interest in using a computer in their teaching? When teachers attend courses, what arrangements are made for them to share their new knowledge and skills with colleagues?

These are fundamental questions which require answers. The publications do not provide the answers. Local experience with TRIST courses shows that schools can suffer severe problems if releasing CDT or science teachers for extended periods of time. These problems include disruption to classes through inadequate teaching by supply teachers, or in some cases the impossible task of finding suitably qualified supply teachers. However, support for the principle of releasing teachers fully from their normal duties can be found from Lewis R. (1983) writing on a related computer / teacher subject, he states:

> 'It must be stressed that if teachers in the CAI courseware role are to make a real impact, there is no way that this can be achieved without providing them with uninterrupted free time. This is certainly costly, but two, or possibly three, full days per week are necessary. Care is also needed to ensure that this really is time free from the perpetual day-to-day pressures, such as marking, cover from absent colleagues and so on, which are notorious in eating into "free" time'.(16).

Reports from independent sources and advisers referring to a school in the South of the county, show that they had attempted to overcome the problems of releasing teachers, by utilising a teacher returning into school full of enthusiasm for the work she had undertaken on a course. She was instrumental in giving some voluntary basic training within her school for both colleagues and pupils. This initiative provoked other members of staff to apply for places on future courses. This latter experience perhaps highlights the need to set up self-help networks for those teachers with similar needs. This could be considered as a high priority for LEA subject advisers who could act as catalysts, even in those schools which are apparently uninterested in what their colleagues have been taught.

With the advent of the INSET days built into the new conditions of service for teachers, the possibility of increased school based INSET materialises. It could even be possible for teachers trained in aspects of computer use elsewhere, to return to school and become a 'local trainer' for their colleagues. The cost efficiency of this method for an LEA will probably not have escaped the notice of those it concerns. However, another factor enters the equation at this juncture which could provoke severe difficulties; should the teacher already employed by the LEA; who is undertaking local training of his colleagues, be paid extra for his services? Is it perhaps invidious to expect him / her to put in many hours of preparation on behalf of colleagues and receive nothing but the 'glory' in return? This and other allied problems may be looming on the horizon for those LEA's who have a rigidly parsimonious approach to their teachers.

Mention was made in chapter 4 of the possibility of designing and assembling a 'Distance Learning' package to put into schools; (if the results of the research demonstrated a need). As stated there, the funding or equipment for this package was not available at that time. However, the TRIST courses were coming to the end of their funding, and it was tentatively suggested by the writer that some of the equipment used on those courses could be incorporated into a package of this type. The development of this possibility for further research was therefore dependent on third party funding. The next section describes the progression of the research into its secondary stages.

6.14. EDUCATION TECHNIQUES WHICH COULD BE EMPLOYED TO RETRAIN TEACHERS.

The pressing need for financial assistance to take the research to a logical extension, prompted the production of a proposal to the advisers and organisers in charge of CDT and TRIST courses, a body known as the (Oxfordshire Technology Advisory Group). To allow the reader to see the context of the later development of this project, the contents of this proposal are set out below:

Initial analysis of the results of the questionnaire have substantiated the early premis that there is a need (and demand), in the survey area, for some low level computer awareness and training amongst CDT teachers. It is suspected that this need would be applicable to a wider group of teachers in other subjects, especially science; and to other areas of the country. However, that is outside the parameters of this research.

The findings show that there is little significant general use of computers within the CDT workshops for control technology or CAD. Although, a demand for equipment and software to fulfil these needs was identified from many schools.

A common request from teachers was for information on computing materials and equipment available for the CDT area of the curriculum; especially with relation to RML computers. Oxfordshire has had a policy of supporting only RML machines, which have proved excellent for computer studies and CAL in some classroom subjects, but, which up to now have been sadly lacking in widely available control materials for the workshop situation. It is understood that steps are being taken by the Wheatley Centre to help remedy this situation within Oxfordshire. However there is still much work to be done before general application of this equipment will be seen in workshops.

The overwhelming response from CDT teachers stating a preference for a workshop computer, was a desire for the BBC range of machines. The main reasons given when following up this response, were the wide range of software, peripheral hardware, expansion ports and mass of information already available for these machines. Indeed, one difficulty is selecting what is best from the wide range available for the Acorn machines.

A very high demand was placed on the need for a simple guide to the use of a computer and its peripherals. An equally high response was returned for the opportunity to have a 'package' of equipment for a loan period within the school situation to allow the individual teachers the opportunity to familiarise themselves with the materials at their own pace.

An interesting response noted in the comments section of the questionnaire, was from some teachers who indicated, in various ways, that they were unable to afford their own computer equipment, or that their chance of obtaining it in school was very low at this time.

Possible methods suggested to increase CDT / Technology teacher awareness of computers within Oxfordshire are:-

METHOD 1.

To provide the teachers identified, with INSET courses in an established training centre; this should be away from their school to allow them opportunity to concentrate on uninterrupted study. Periods of between two and five days, (continuous), should be sufficient initially, depending on course content. The Oxfordshire Schools Science & Technology Centre is suggested as a suitable venue, because it already administers some of the equipment required.

Disadvantages with this method are cost; the availability of supply teachers, and the interruption to class teaching if the course is held during normal school time.

With the advent of the revised Oxfordshire provision for INSET; the above method could be funded by schools cooperating and agreeing their teacher upgrading / retraining requirements. The £90 GRIST INSET money available for each teacher, could be pooled to buy the course expertise etc. This training could also be held, (less satisfactorily in the current conditions of service), outside school hours in the evenings or at weekends. A further possibility would be to hold the courses in the proposed five days INSET provision built into the new pay proposals. Funding could also be available from the TVEI extension scheme, and the TRIST money obtainable from the MSC.

METHOD 2.

The training could be undertaken within the school by a peripatetic instructor, who would adapt the course materials to a particular situation or requirement.

An enhanced but ideal solution for this method would be for Oxfordshire, (or a cooperative of Counties), to acquire a technology bus / vehicle similar to the BST system, and then undertake local area training. This would help minimise travelling costs for teachers and yet allow them the uninterrupted training inherent in 1 above.

METHOD 3.

To provide a 'package' of computing equipment and materials for teachers to borrow and use as a distance learning package within school or home as time permits.

The advantage of this centralised unit, is that the relatively high costs of computers and some peripheral equipment such as small CNC machinery, robot arms, turtles etc. would not fall on one school, but would be made available to many, thus maximising their use and investment.

By providing different types of equipment within the kits for loan, a variety of differing skills could be taught. Control equipment may not be required by teachers concentrating on CDT design and communication; but they may well require information and help with computer aided design or drawing, and the opportunity to learn word processing. The differing contents of the kits would allow a 'programmed learning' situation for the teachers, while allowing more than one school access to equipment which may otherwise be unused.

A further advantage of this system would be to overcome the reticence of some CDT teachers to attempt to familiarise themselves with a computer - 'until there is one in my workshop which I can use when I feel like it, and can find the time in odd moments'. This phrase or something similar was often heard, in both interviews and casual conversation, during the research.

Most of the teachers responding to the question on the use of a loan package, suggested that they would also use it to increase pupils computer awareness while it was in their possession.

A possible disadvantage could be wear and tear on equipment being moved around and constantly having the peripherals plugged in and out by teachers lacking expertise; consequently causing some damage.

METHOD 4.

In an ideal situation some combination of the above methods would be helpful in increasing computer awareness in teachers. i.e. A teacher having undertaken a five day course; could reinforce the experience at his leisure with a distance learning pack and perhaps adapt the work he has undertaken to enhance a project with the pupils he is teaching. Alternatively a teacher having a distance learning package may require some help from an understanding visiting tutor. (Possibly a reversion to the long lost role of Teacher Adviser?).

AIMS OF THE LEARNING MATERIALS.

1. To increase the computer awareness of computer naive CDT / Technology teachers.

2. To offer practical "hands on" experience of programmable systems to CDT / Technology teachers.

3. To encourage these teachers to apply the computer to their normal working and workshop situation, thus enhancing the range and quality of education they can offer pupils.

4. To help diminish the possible perception the computer as a 'box of

mystery' and encourage it to be regarded as a 'tool' or resource to be used as a natural choice when necessary.

5. To offer and promote some possible uses for the computer in a workshop situation.

Some Objectives - (assuming the use of the BBC machines currently based at OSSTC):-

-Identification of the major components in a BBC micro and their use;
-introduce and familiarise the use of jargon related to computers;
-keyboard familiarity;
-the concept and methods of communicating with a micro;
-use of disc drives, tapes, ROM's and RAM's etc.
-identification of the input output ports and their use on a BBC micro;
-connecting peripherals to the various input output ports;
-the use of interfaces for control;
-using the machine to control external equipment;
-the design, building and application of simple control interfaces;
-use of the micro for word processing;
-use of the micro for computer aided design / drawing;
-use of the micro for communication, teletext access, database access, satellite downloading etc.
-setting up and using a database for record keeping / profiling;
-etc. etc.

These proposals were duly considered. At this stage a negative response to the proposal could have totally restricted the research to a theoretical 'distance learning' package with little chance of extensive field testing.

Permission for the research had been granted by the advisers for CDT and Design; who in addition to their watching brief, had also expressed great interest in the findings. The proposal above was followed by an invitation to join their meetings. Some of the initial findings of the survey were made available to these members of the

Oxfordshire Technology Advisory group. A request was made to members of this group for both funding and loan of hardware, to assemble a proposed distance learning package; similar in structure to that suggested in the questionnaire. The CDT teachers interviewed as a result of the questionnaires had shown significant interest in the interfacing and control technology applications of computers. The intention was to provide a package which could be placed in schools with selected teachers who agreed to participate in further research.

It was hoped that this follow-up research would serve the dual role of investigating the potential of this method of training the teachers and also make available to the teachers equipment which was otherwise unattainable.

A second meeting of the Technology Advisory Group, offered instead the opportunity to undertake participative / action research with mixed groups of science and CDT teachers working on computer control courses. Course funding would be provided, and it would offer the opportunity of a larger sample of teachers for the research. The possibility for research of this scale had not been envisaged as feasible within the initially constrained parameters of the project. The invitation of working with two groups of teachers was readily accepted.

The findings of the survey by questionnaire and the subsequent decisions to offer 'centre-based' retraining, considerably affected the early intention to solely develop a 'distance learning' package for teachers. The requirements and parameters for the secondary research, had radically changed following the 'Technology Advisory Group' meetings.

The opportunities for research were now much wider. The development of a package for training CDT teachers was in some respects narrowed down, to a 'computer control' teaching module which would incorporate elements of basic electronics and circuit building. However, it was decided to try to develop a course which could fulfil the requirements of both a centre based taught course and an effective, but possibly limited, distance learning module.

Further research was undertaken to try to elicit the guidance and advice, as well as the experience, of other persons and institutions having been involved in teacher or similar adult education, involving computers. Information on this subject could prove invaluable for the development of a proposed interventionist course package. Chapter 7 describes elements of this further research.

REFERENCES - Chapter 6.

(1). DES (1981) - The school Curriculum.

(2). MATTHEWS, A. (1986) - Report on the meeting of Advisers, HMI's and others at Cranfield Institute of Technology - December 1985.

(3) & (4). BLACK, P & HARRISON, G. (1985) - In Place of Confusion.

(5). MATTHEWS, A. (1986) - Report on the meeting of Advisers, HMI's and others at Cranfield Institute of Technology - December 1985.

(6). SELF, J. (1985) - MICROCOMPUTERS IN EDUCATION. - A critical appraisal of educational software. - The Harvester Press.

(7). FOTHERGILL, R. (1983)

(8). DES (1980) Microelectronics Education Programme - The Strategy. DES for England and Wales and Northern Ireland'.

(9). ASTON, M. (24.10.'86). The Times Educational Supplement. Page 36.

(10) and (11). HMI (1987) - Aspects of the work of the Microelectronics Education programme. Department of Education and Science.

(12). WALTON, D. (November 1986). Hexagon. Oxfordshire computing centre publication.

(12). SELF, J. (1985) - MICROCOMPUTERS IN EDUCATION. - A critical appraisal of educational software. - The Harvester Press.

(13). MATTHEWS, A. (1986) - Report on the meeting of Advisers, HMI's and others at Cranfield Institute of Technology - December 1985.

(14). Manpower Services Commission, (March 1987) - Letter to Chief Education Officers in England and Wales referring to TVEI Joint Support Activities.

(15). ASTON M. (1986) - The Times Educational Supplement - 24.10.86 - PG36.

(16). LEWIS, R. (1983), "Teachers, Pupils, Microcomputers." TECHNOLOGICAL HORIZONS IN EDUCATIONAL JOURNAL, February '83.

CHAPTER 7.

7.1. Learning!
7.2. Distance Learning.
7.3. Learning with the help of the computer.
7.4. Summary.

CHAPTER 7.

This chapter describes the research both into learning and the techniques which can be employed to help maximise the efficiency of a teaching package. Very little evidence of research related specifically to training teachers with the help of computers was discovered. There would not appear to have been any significant research work undertaken with a group as specific as CDT teachers. Much of the available published research on teaching and training with computers is American based; and in many respects their results and conclusions are now outdated by more modern, faster and larger memory capacity equipment.

Bearing in mind an original concept of the project, mentioned previously, the feasibility of designing a course capable of being taught at a central venue, and yet still be capable of serving the parallel role of a distance learning package, was still a prevalent consideration while undertaking this section of the work. Points for and against each type of learning situation were explored in the literature searches. Some of the more relevant and salient features are set out below.

7.1. LEARNING.

It would appear logical that before any desired learning can take place on a course intending to convey a body of knowledge to a student, then that body of knowledge should have been carefully decided. It should also be capable of meeting the specific aims and objectives which have been decided upon before the interaction at the tutor / student interface is established. Hirst (1971) states that the two conditions which a teaching activity must meet are:

> (a). The activity must, either implicitly or explicitly, express or embody the X to be learnt, so that this X is clearly indicated to the pupil as what he is to learn.
>
> (b). The second condition is that the activity 'must take place at a level where the pupil can take on what is intended he should learn'.(1). (HIRST)

Self J. (1985) writing about the same subject states:

> 'a teaching activity is the activity of a person, A (the teacher), the intention of which is to bring about the activity (learning), by a person, B (the pupil), the intention of which is to achieve some end state (e.g. knowing, appreciating) whose object is X (e.g. a belief, attitude or skill)'. (2). (SELF, J).

It therefore follows from the above that both participants involved in the interaction will have some premeditated ideas of what they wish to achieve from the process. The pupil, because he is naive and inexperienced in the body of knowledge offered by the teacher, may well have an alternative preconception of the course content and what it is he will achieve, or is required to achieve. Conversely the pupil may well have very firmly established ideas about what it is he wishes to learn. Self goes on to state:

> If the aim of education is to aid the 'self-realisation of the individual' then education must be a learner centred activity, and from this it will be argued that overtly didactic teaching and receptive learning is not to be encouraged. Instead learners

should be responsible for their own decisions about educational gaols and learn 'by discovery'...(3).

It could be argued that teachers volunteering to attend places on a course could certainly be trying to develop their 'self realisation', and that those requesting help with the aid of distance learning packages will certainly be responsible for making many of their own decisions. Learning 'by discovery' has been one of the major foundations of 'progressive' educationalists for many years. (4). (KERSH, B.Y. & WITTROCK M.C. et. al).(1962) This philosophy could be inherent in a teaching package to develop computer awareness or skills; providing that the 'discovery' can ensure that the objectives are met. Retraining courses for teachers in most LEA's are intensive and generally very constrained for time, so the limitations for extended discovery learning become apparent. This limitation has also been recognised by Self J. (1985) who states:

'...designing a successful environment for discovery learning involves considerable technical skill........This is because the whole point of the exercise is to encourage free exploration. As a result it is difficult to anticipate just what a pupil will decide to do...... (SELF, J).

In an attempt to circumvent these problems, a learning strategy requires to be developed by, or for, the pupil. A learning strategy has been defined by Elliot (1976) as 'a pattern of use of learner-control features which results from decisions made on the part of the learner as to how to proceed through a learning episode'.(5). (Elliott,1976) If a course has been pre-programmed in suitably defined stages and constricted to carefully predetermined parameters, then any advantages inherent in the discovery learning process could be incorporated into a substantially directed course. The pupil could still be allowed freedom to explore and the opportunities of developing their own learning strategies; and to a limited extent on a taught course, depending on its structure, of developing at a rate which they feel suits them.

7.2. DISTANCE LEARNING.

Considerable experience of 'distance learning' has been achieved by the Open University in Britain. A measure of their success can be evidenced by the many thousands of people now having degrees, who would have otherwise found this an unattainable objective for a variety of reasons. Many teachers number amongst the successful past students, thus giving hope for a distance learning package as a successful method of in-service training. This very success, can in itself be used as evidence that well designed distance learning is effective. However, there are many inherent problems and other implications with open learning systems such as that adopted by the Open University - David Tinsley writes:

> 'To remove the teacher as the all-knowing purveyor of knowledge it is necessary to provide a block of material that can carefully progress the study, eliciting regular responses from the student to ensure that knowledge leads to understanding; understanding leads to comprehension, and comprehension gives sufficient confidence to proceed to the next level. The tutor is necessary only when the process breaks down or when an in-depth analysis and assessment of a package unit is required. Alternatively, a tutor can be used as an organiser of a group of individual

learners or a personal contact with the administration of the programme.(6).

Tinsley, as director of the MSC's open learning unit, could possibly have more insight than most into the problems faced by students working remotely from their tutors. A student working in isolation has to devise his own method of learning; generally recognised as a 'learning strategy'. Watson (1983) reports that:

> 'a number of studies contain evidence that adult students, when given control of their instruction, selected different learning strategies. Further, it appeared that some strategies were more successful than others. It was also reported that achievement and efficiency were not generally affected by allowing students to control the sequence or amount of their instructional components'. (7). (WATSON & DERRYN).

Distance learning systems can however also have definite advantages for the student; they can develop their own method of individual study and can negotiate the whole process including: time of study, place of study, length of study, continuity of study and range of study. These courses are however still most effective when they are under the control of a supervisor or tutor. Tinsley also reports:

> '....Many attempts have been made to provide wholly self-instructional courses but large drop-out clearly demonstrates that a relatively minute proportion of the adult population can cope without some support'.
>
> '......To achieve these new goals institutions will need to increase the roles of counselling and advisory staff...' (TINSLEY, David).

Huntley, Mangles & Slater, (1985) have also recognised the same problem which can be faced by students interacting with a computer based learning package:

> '.....However, the full timer derives great advantages from his contact with staff and other students, and so the micro assumes a much more important role for the DL student than is first apparent......However, the increasing awareness of IT, and the consequent increase of computer usage in full-time courses, has not been properly reflected in the provision for the distance learning student'.(8).

Tinsley's assertions would obviously indicate a possible problem for any distance learning package developed as a result of this research. Where would the tutorial or supervisory back-up come from? This would not be an insurmountable problem, but would definitely have to be considered for the future if a distance learning course is to be adopted and fully effective. In addition Mangles et.al. (1985) also appear to suggest that it would not be easy to find a worthwhile model to use as an ideal starting point.

Distance learning courses would usually consist of a study guide and a series of notes and exercises, coupled with other forms of reinforcement to guide the student through a series of textbooks. This is regarded as the cheapest and most personal form of open learning as both student and tutor can identify the source of the exercise and work more closely together. This is basically a text-based learning system where all the material and the response to that material is based on the written word. However, some of the Open University courses incorporated quite extensive practical sections involving home based equipment and also evening or weekend tutorials at an area centre. Although this latter feature would probably be desirable, the funding for premises and a tutor would probably prove to be an impractical barrier within Oxfordshire LEA for the small numbers of teachers who could have access to the limited loan equipment. A method of increasing access to course materials would be to base them around equipment which the teachers would be required to find for themselves; however some had already indicated in their questionnaire responses that their personal and school finances ruled out this alternative.

The computer is of course the other factor involved in any proposed distance learning package resulting from this project. The package would be concerned with teaching a teacher how to use a computer, or increasing his awareness of using a microcomputer for control. However, the computer in this instance could, and probably would, be used as a vehicle for the teaching materials themselves. How well do computers work as 'teachers'? Bracey (1982) reports that:

> 'Recent research has shown that students learn more when using computers than when using conventional classroom instruction.......the computer through CAI programs keeps students actively involved and lets them progress at their own pace while providing infinite patience and attention to each student; the student's answers are judged promptly and responded to with helpful feedback'. (9). (BRACEY,1982).

Implicit in Bracey's comment is the understanding that well written interactive learning software has been provided for the student. Where would this software come from? It is doubtful whether an 'off the shelf' package could be found to meet the requirements. Consequently a package would need to be specially written if it was decided to go for a full 'computer aided instruction' implementation. This then raises the question of who is going to write the package? Reports discussing this subject in "Computer Education" state:

'...Training the average teacher to write worthwhile CAI not only is time consuming but also is very costly; furthermore, it is doubtful that such an investment will eventually pay off'.

And later:

'Before teachers are expected to produce worthwhile courseware, they should go through some extensive training. The training should include, in the introductory level, a computer awareness and computer literacy course. The course gives instruction and practice in the use of one or more hardware systems. It shows the teacher how to write simple computer programs, and how to use and possible modify existing software. It also helps the teacher to locate information on sources of software, educational organisations, literature, and periodicals. It is recommended that such a computer awareness and computer literacy course be attended by every teacher......'(10).

Although the latter statement supports the premis for all teachers to receive computer training, discussed in chapter 6, it is hardly encouraging for the individually based production of a full CAI program which would support a distance learning package. Some of the aims described in the 'course' above would certainly be applicable to the computer naive CDT teachers it is intended to train. On the basis of the time involved alone, this alternative would appear to be impractical, except for an extended or joint research project.

Burke (1982) studied some of the characteristics of 'Quality CAI Authors' and 'Quality Software' he writes:

'A careful study of the special characteristics of CAI courseware authors, reveals that three main areas of knowledge are required - knowledge of the contents to be taught, knowledge of instructional system design, and knowledge of computer programming.' (11). (BURKE,1982)

Financial considerations rule out the sub-contracting of such an instruction package; the time factor involved in gaining the necessary expertise and writing one of the required standard, would eliminate the prospect of such a proposed course.

Gardner (1984) reporting on research into the effectiveness of Computer Aided Learning (CAL) indicated that 'very little is known of the effectiveness of CAL in-service training'. His report later shows the results of research work undertaken with teachers undergoing CAL-INSET. These results are of interest because it may be possible to draw conclusions from them which would be of relevance to any packages proposed for retraining teachers locally. It is always possible however that CDT and science teachers will not react in the same way. Gardner found that teachers actually attending courses 'i.e. those with practical experience and discussion', achieved a higher satisfaction level. Practical sessions, discussions and the distribution of 'hand-outs' imparting information appeared to be well received.

> '... the main themes of the courses were also appreciated, with the handouts receiving four/five or better from 68.2 per cent and the discussion sessions four/five or better from 69.9 per cent. The practical sessions were the most popular aspect of the courses with a rating of four/five or better from 86.4 per cent of the teacher population'.

Under the conclusions section of his report Gardner makes two interesting statements:

> '.....Teachers are beginning to seek assistance in learning the new techniques and the results would indicate that the most

> effective method of giving them this assistance is through in-service courses which give them the opportunity to come to grips with the microcomputer through hands-on experience of the machine and its software.
>
> ......The question 'How best can I incorporate this piece of software into my teaching?' was a common discussion point in most of the courses, indicating that teachers do not need to be convinced of the potential of the new techniques but do need to be given guidance in moulding it into their teaching as part of their normal resources'.(12)
> (GARDNER, J.R.)

The majority of CDT teachers participating in the Oxfordshire survey also did not appear to require convincing of the potential of computers, and perhaps significantly, in addition they asked for help with applications which could be incorporated into their teaching. 'Hands-on' experience was definitely a major component for any course developed from this research. Guidance would be implicit in any materials developed and it would only remain for the teacher to assimilate the information and practice the techniques and skills he has been taught. However, Huntley (1985) et.al, reporting the findings in their research give a word of caution:

> ....Very often students feel that repeated drill and practice is rather beneath them, although this is exactly what they need to aid their understanding. The micro provides a neutral, non-hostile environment for such learning. (13). (HUNTLEY, MANGLES & SLATER).

Realistic consideration of time and limited finances, indicate that a text based course combined with a simple linked set of computer programs might be a viable alternative to a full Computer Aided Instruction course. Some educationalists writing about CAI have indicated that the average home micro is limited by lack of memory for this purpose in any case.

'Computer based training still exposes the limitations of home computers too quickly while more sophisticated packages are, as yet, slow'. TINSLEY, D.

It seems from the evidence of those above that there are points for and against distance learning packages; while the major problem for a taught course, would appear to be to give the student enough latitude to develop and explore at his/her own pace. Despite the problems of time and scale of the package for this project, it was decided that if a course could be designed to incorporate the advantageous elements of both styles of teaching, this would hopefully maximise the advantages and potential for the student. Constraints of time, expertise and finance all have to be considered for any course design; in this case they were of paramount importance.

A more realistic approach to the problem of designing a distance learning package was called for, if it was to be produced in the limited time scale of a few months.

7.3. LEARNING WITH THE HELP OF THE COMPUTER.

The computer itself can play a major and advantageous part in the education process if, as mentioned above, the software is correctly written. However, local and personal experience has shown that computers can also be a significant source of severe frustration for those attempting to use them for the first time, or for the application of previously unknown software. Due mainly to poor software, the supposedly helpful messages built into the operating systems and languages of many computers, which appear on the screen following an inappropriate action by the user, are often the cause of deep frustration. Teachers on TRIST courses had already been observed having problems with typing and running programmes. The message 'at line 210' or whatever, does not always indicate the source of the fault to a non-programmer and the problem could be elsewhere in a programme. It must be borne in mind that any teacher involved in a course, may not have experienced the use of a computer before or may have very limited keyboard skills. Many now competent computer users, can still remember the feeling of total hopelessness when confronted with the equipment for the first time. It is known to the would-be user, that the machine he faces is both useful and powerful, but what do they have to do to get it to work for them? Is it perhaps this all too easy dismissal of their first experiences, that prompts competent computer users to later write the jargon filled, technical and incomprehensible manuals, which are all too common and destroy the confidence of those who wish to follow in their footsteps?

A very high demand had been placed on the production of simple manuals by the teachers in the sample; even by those who were already fairly competent in computer use and who were aware of much of the terminology involved. A mystique appears to have grown up with computers about their capabilities and use. Many would-be users are discouraged because they cannot programme the machine; which they have been led to believe is essential. It is then, perhaps necessary to develop software and a very elementary written guide to its use, which will overcome these difficulties for the newcomer. Inevitably some aspects of computer use are difficult, but should these concern or discourage potential equipment users? Is it necessary to know how a motor car works before you can drive one? If it is, then there would be far fewer drivers on the roads than there are today!

To learn to use a computer it is necessary to have the incentive or need to start. Once this is established then it is perhaps a matter of constant practice and developing the skills by easy stages as the requirements arise. A major problem is taking the first steps. Once this is overcome, it is proposed that the rest will follow, for most people, as their need or curiosity dictates. Teachers on courses had been observed as reluctant to take the first step for fear of looking silly in front of their peers. In most cases a few minutes quiet individual instruction was all that was necessary to get them started. It was also apparent, however, that the help of an understanding tutor was instrumental in developing those skills much faster than would have been the case for an individual working on their own without support. The technique involved was for the tutor to know when to ask a relevant question rather than feed all the answers to the student; this eliminated rote learning from the interaction.

7.4. SUMMARY.

Whatever type of course is developed the guidance must be simple and relevant to the needs of the learner. In being simple it must not be overly 'pedestrian' in its approach. Support for the student should be available for the occasions when they become stuck; a tutor is the obvious answer, but in an unsupported distance learning package some other method will need to be devised. The computer could be incorporated as an essential part of the learning scheme. Ideally the computer should be able to interact with the student and give him/her 'feedback' or correct the mistakes. This aspect is not easy to achieve with limited machine memory and simple software. Experience of the case studies and survey above, shows that teachers will probably not require convincing of the potential of the equipment, and that by giving them ideas and a lead, they will try to develop the application to suit their situation. It also appears, from observation and the work of Gardner set out above, that teachers on courses like to have something to take away with them which they can use or refer to at a later date. Evidence for this 'cargo cult' was given in the individual interviews with teachers. A further consideration for the course design is that instruction manuals for any package developed must be kept simple. England E. (1984)(14) had highlighted the desirability and need for colour presentation to be used in computer aided learning materials. However, it was remembered at this point that many of the subjects this package was aimed at, may only have access to monochrome monitors; although factors highlighted by England were carefully considered.

The development of the course package is described in Chapter 8.

REFERENCES - Chapter 7.

(1). HIRST, P.H. (1971) - "Journal of Curriculum Studies" - What is Teaching?

(2). SELF, J. (1985) - MICROCOMPUTERS IN EDUCATION. - A critical appraisal of educational software. - The Harvester Press.

(3). SELF, J. (1985) - Microcomputers in Education. - A critical appraisal of educational software. The Harvester Press.

(4) KERSH, B.Y. & WITTROCK M.C. (1962) Learning by Discovery: An Interpretation of Recent Research - "Journal of Teacher Education"

(5). Elliott, P.H.(1975) An Exploratory Study of Learning Styles. Doctoral dissertation, University of Illinios at Urbana-Champaign, University Microfilms No. DAH 76-06757.

(6). TINSLEY, D. - Director of MSC's Open Tech Unit - "Digest-Open learning systems".

(7). WATSON, DERYN M. (1983) - A Model For The Production of CAL Material. - "COMPUTERS AND EDUCATION", Vol 7, No.3, 1983. Training the Teacher; Problems and Suggestions.

(8). HUNTLEY, I. MANGLES, T. & SLATER, G. (1985) - "Using micros with distance-learning students" -
INT. J. MATH. EDUC. SCI. TECHNOL. VOL. 16, NO. 3, 373-378

(9). BRACEY, G.W. (November / December 1982) - "ELECTRONIC LEARNING" - Computers In Education: What The Research Shows. - Factors for CAI Effectiveness.

(10). "COMPUTER EDUCATION". (February 1985) - Some Commonly used Methods for CAI Production.

(11). BURKE, R. V. (December 1982) - "ELECTRONIC EDUCATION" - If You're Thinking About Developing Your Own Software, Consider This.

(12). GARDNER, J.R. (October 1984) - "British Journal of Educational Technology". No. 3 Vol. 15.

(13). HUNTLEY, MANGLES & SLATER. (1985) - Using micros with distance-learning students. INT. J. MATH. EDUC. SCI. TECHNOL. VOL. 16, NO. 3, 373-378.

(14). ENGLAND E. (1984) "Colour and Layout Considerations in CAL Materials". - Computer Education Vol 8 No. 3.

CHAPTER 8.

CHAPTER 8.

This chapter traces the development of a teaching package designed to increase Oxfordshire CDT teachers' awareness of computers and their application in a workshop situation.

Following the literature searches and associated reading, some of which is discussed in chapter 7, it was decided that the approach to a teaching package had to be realistically curtailed to a narrow specific field, which would be of use to teachers both for increasing their own awareness and for application in their teaching situation if they wished. The limited time available for the development of this package by one person, was a major factor influencing this decision. It has already been stated earlier, that the development of a control technology package was also heavily influenced by the requirements of the Oxfordshire Technology Advisory Group. Again however, it must be remembered here that any package developed, was to serve the dual role of both teaching, and an instrument for further research into the effectiveness of an In-Service Training programme, specifically designed to increase computer awareness and use by CDT teachers.

8.1. THE DEVELOPMENT OF AN INTERFACE AS A RESEARCH INSTRUMENT.

The employment of an interface as a research instrument and composite part of a training package, appeared to be a logical development of the opportunities offered by the Oxfordshire Technology Advisory Group. The computers to be used on any courses developed were all Acorn machines, consisting of BBC Masters and BBC model 'B' micros. These had already been purchased by the LEA, and were in use at the Oxford Schools Science and Technology Centre at the Clarendon Laboratories.

The survey had identified the interest and demand from many CDT teachers, for elementary computer training. A sample of twenty of the teachers returning questionnaires were subsequently interviewed in an attempt to establish some common factors for their requirements. Most of those interviewed expressed a desire to interface small d.c. motors in preference to stepper motors; mainly because of the difference in costs involved. However, some teachers also asked about the possibility of a stepper motor driver board for constructing plotters, or three axis machinery, which could be built in a school workshop.

A number of desirable interface features were identified following the interviews:-

(1). low cost - (less than £25);

(2). be easy to understand by teachers and pupils;

(3). be easy to use;

(4). minimise the possibility of injury for the user;

(5). be capable of driving at least 3 d.c. motors bi-directionally;

(6). preferably have some indication of what is happening to the signal lines;

(7). the interface must have some programs ready written and tested, so that non-programmers would to be able to use the board;

(8). minimise possibilities of damage to the computer.

In an attempt to reduce the workload, an attempt was made to discover an existing interface, or parts of other teaching packages, which could be utilised within the parameters imposed on this project within the LEA. Consequently a hardware search was undertaken.

8.2.EXISTING INTERFACES.

As stated above, it appeared logical to attempt to locate a unit which would meet the requirements of the teachers interviewed and which could be used to investigate the effects of their training. By the process of an hardware review, it was also hoped to establish which were the best features of ready made units. It is not the intention here to review every interface in existence for the BBC micro, there are so many that this task would be difficult to achieve. However, there are a vast variety of designs from both commercial sources, as well as those produced by individuals or various educational institutions, which could be employed for training courses. Some representative examples of this large range were acquired and inspected. Wherever possible the interfaces were used and tested with teachers or children and the results were observed. The testing either took place in schools with co-operative teachers; or was undertaken as an adjunct to other courses which were taking place in the OSSTC at the time of investigation.

Of the wide variety of interfaces already in existence and on the market, for the BBC microcomputer range, some are designed to meet a specific requirement for operating with other equipment produced by the company marketing them. The "Beasty" interface marketed by Commotion falls into this category and is primarily designed to work with small model aircraft type servo motors. Many educational institutions and establishments have also developed interfaces for their own requirements and several of these were also studied.

A common approach to the interfacing problem for use in educational institutions; are simple modules built for a specific purpose which will work in conjunction with systems electronics kits. The module can be expanded to a more complex unit with additional boards, e.g. a module incorporating a light emitting diode display can be added to one with relays to control an external motor. Some of these boards are built into short lengths of plastic electric cable 'trunking'. Unilab market products of this type and there are at least some variations on the theme produced by teachers in Berkshire.

The various interfaces used by the British Schools Technology Establishments at Trent and Bedford, differ widely in their construction. However, both establishments appear to prefer the use of a large number of discrete components. BST Trent supply vero-stripboard and transistor type simple interface designs for use on the in-service training trailers.

On their home constructed boards BST Bedford appears to prefer the use of solid state outputs to relays. They initially used the "Bedford" interface for teacher training courses; however, the commercially produced "Deltronics" interface is now used as a standard unit for the courses at BST Bedford. Although there was little opportunity for extensive testing in this research, the Deltronics interface appears to be a well designed and constructed unit; but at a reported cost of £85 was too expensive for adoption.

The NCST, based at Trent Polytechnic, have produced a very versatile design for an interface, which can be connected to the 1 mhz. bus of the BBC. Described as a 'decoder' in their literature, circuit diagrams and PCB overlays are available from Trent Polytechnic for this design. A slight criticism would be regarding the 28 wire links necessary above the board to construct this circuit.

The "Banana" interface meets the demand for a unit which is virtually foolproof and indestructable. This interface is well designed and makes use of opto-coupling to avoid damaging the computer. It was widely advertised to schools by the manufacturer, but has not sold in large numbers. Paul Riley, one of the designers, admits that it is too expensive for most schools to consider buying in quantity. This interface was designed by teachers who started from the position of trying to establish what hardware problems could arise with inexperienced users. Having established a worst case situation, the designers then attempted to make equipment which was totally indestructable in normal use.

The Danish firm of LEGO have recently entered the area of computer control and have produced an interface in conjunction with some ex-members of the MEP team. This unit is designed to operate with their Technical Lego sets through a 'front panel' type of software package called "LEGO Lines". During a visit to the factory in Denmark, this interface was very impressively demonstrated by Ole Moller of the LEGO educational section. Anthony Lucas, who previously worked for the MEP, is working for LEGO, writing and adapting the "LEGO Lines" software for a wide range of computers including IBM PC machines. Lego obviously envisage a wide market for this product. This interest may be an indication of their view of the importance of interfacing for educating children. The 'Lego Lines' control program is part of a teaching package, which has to be bought in addition to the interface, thus making a very expensive total initial outlay for a school. The teaching package is quite comprehensive, including copyright free worksheets and ten pupil guides, in addition to the more comprehensive teachers manual. The expense of the teaching package would only be incurred once, and the additional interfaces could be added as requirements dictate. The Lego interface is restricted to six output lines and two inputs, but incorporates opto-coupling in an attempt to alleviate any possibility of user or hardware damage. Children are generally fairly familiar with Lego and have few inhibitions about assembling structures from these materials. There are already a wide range of gears, mechanisms, light bricks and opto-sensors available in the Lego range of products. When these various components are used in conjunction with their small d.c. motors and battery units, a wide range of constructional and control options are possible.

Fischertechnik have been in the computer control area of education for a relatively long time. Possibly their best known educational product is the "BBC Buggy" which works in conjunction with the BBC Microcomputer. The Buggy is fitted with a variety of sensors and can be used together with a suite of programs to demonstrate principles of 'feedback' as well as direct computer control. Impressive demonstrations of extensive layouts made of Fischertechnik consisting of computer controlled conveyor belts, robot arms and other equipment, can usually be viewed on display stands manned by Economatics staff at exhibitions such as the Design and Technology exhibition mentioned above. It is probably only worth considering the high initial costs of this product if extensive supplies of Fischertechnik components are already available within the institution. The addition of a stepper motor unit, designed to be built into the constructions, may offer some advantages over the Lego system.

Austin Taylor have produced an interface which has eight relatively heavy duty relay outputs at 36 volts - 3 amps capacity each. The relays and LED indicators are mounted above the circuit board on the outside of the case and can be seen in operation. A programme disk titled "Connect 8", is supplied with the interface, which allows the user to control equipment from an on-screen, front panel display. This pictorially indicates the options available and those already selected as well as providing a window for the user to write a simple program routine. The software provided offers a relatively simple programming language and also sets up the BBC function keys to allow single key input for the most used commands. It is also possible to obtain a printed program listing. The interface is connected to the BBC micros 1Mhz. bus and analogue ports via an intermediate buffer box. This interface is one of the few marketed which offers a fairly simple package of an interface complete with programs for the user.

A fairly well known interface, the "Interbeeb", was marketed to educational establishments by Griffin and George, amongst others. This was one of a family of interfaces made by DCP Microdevelopments, some of which were designed to work in conjunction with the DOI funded school micros and even Sinclair ZX 81 computers. This range of interfaces incorporates some novel features, including the possibility of replacing an inter-card specific to a particular machine; thus allowing a user to change computers and not have to buy a complete new interface. The small terminal blocks arranged along the outside edges of the PCB make connections to peripheral equipment very easy. The whole unit is very compact and is cased in a standard plastic component case available form most electronics components suppliers. The case has some artwork on the lid which indicates the major components and pathways through the interface. The terminal blocks protrude neatly from the sides of the box; and the ribbon cables and connectors to other interface modules are positioned at the ends. The worst features of this product are the instruction manual, which requires considerable computing experience before it would be possible to use the interface; and the fairly complex nature of the electronics inside. It is a pity that this interface was not marketed with some software. If the latter factors are ignored, then this product is quite good value for money.

The Microelectronics Project (MEP), have published several designs for interfaces, notably in "The Book" (1) and "Interfacing The BBC Computer".(2). Some of these designs were assembled and tested for evaluation. One of the major findings to emerge from this part of the study, was that constructors wishing to follow this course of action, should be aware that problems exist with the MEP literature. In view of the generally good work and efforts of the MEP, it was perhaps surprising to find minor errors and omissions in their literature. One difficulty encountered, was that some diagrams omit to mention which pin is No.1 on the user port connections to the interface boards. This problem would be of a relatively insignificant nature for those teachers and others already familiar with electronics and computer port pinouts, but it was the cause of some consternation for a capable technical teacher, with no previous experience in these matters, trying to assemble the interface. The software listings also suffer from being printed with daisy-wheels which do not accurately copy the characters required in the programme. Although the MEP work is generally very useful, some experience of both programming and electronics would be required to avoid difficulties if working in isolation. It was also noted that many of the MEP circuits were built on unnecessarily large circuit boards, which affected the cost of production, and to some extent could be a problem to store. Conversely a point in favour of using the larger board was the slightly decreased chance of bridging across the tracks when soldering or etching the PCB. When assembled, the MEP designs proved to work well and were generally relatively inexpensive to produce.

Some interfaces, although commendable in their flexibility, are very complicated to use and require the user manual to be constantly available.

Most of the commercially produced interfaces are totally encased, which can contribute to a "magic box of mystery" syndrome. The otherwise excellent but expensive interface from LEGO, amongst others, suffers from the problem of the intelligent user not being able to see inside the unit to gain an understanding of the workings. Interfaces such as Pilot 1 and Lego, have some artwork on the outside to give an elementary indication of pathways.

Large numbers of interface designs have appeared in books within the last five or six years. However, most of the constructions are built on 'veroboard', or matrix board and are consequently quite difficult to understand without a circuit diagram. Although they are very effective when correctly constructed, this sytem of building interfaces could present problems with fault finding or teaching logic pathways etc.

The ubiquitous 4mm banana plug, or its smaller relatives, appears to be the most common method of making connections to the interface, or box. In extreme cases this can lead to a complex system looking like a badly dishevelled rats nest. The resultant wiring may possibly be fully understood by the person who assembled it, but not by others trying to understand what is being demonstrated. This is a particular problem when a large number of sensors are connected to the interface. The DCP interface uses sets of PCB mounted screw terminal blocks, which give a more compact and sturdy connection.

There are very few interfaces available to drive stepper motors. Probably the most successful product reviewed was part of the "Feedback Instruments" CNC drill / milling machine package costing around £850; which is beyond the realms of most departmental funding for a demonstration machine. At the lower end of the market is a single motor driver board from "Magenta Electronics" costing about £15.

Surprisingly, all the interfaces reviewed were found to be unsuitable for the specific needs of the research. The main discriminating factor was because of their cost, however some were dismissed for other reasons concerned with their use, or construction which are indicated above.

Many of the commercial products are versatile, although some are specifically designed to be used in conjunction with specialist equipment sold by the individual firm. Nearly all commercial interfaces are expensive, when related as a percentage of an average Oxfordshire CDT department's capitation. The cost of equipment has long been a problem for teachers. Many of the interfaces on the market could be regarded as reasonably priced in commercial terms, especially when factors related to design royalties, production and marketing costs are accounted for; but they are still beyond the resources of many CDT departments. An entrepeneurial effort has been made by two Brighton based ex-teachers who have recognised this problem of funding, and are producing a range of kits costing less than £10 each. One of their packages will drive two relays and these kits can be added to, as funding and requirements dictate.

8.3. SPECIFICATIONS WHICH EMERGED FOR THE TRAINING INTERFACE.

Having searched unsuccessfully for an affordable and suitable interface for initial training, and possible inclusion in a distance learning package, it became necessary to investigate an alternative method of meeting the requirements; particularly in view of the decision made by the author and advisers at this stage, that teachers should be able to take the interface away from the course with them.

After participating in the TRIST "control" course previously described above, and bearing in mind some of the results of the survey, a further suggestion was proposed to the Technology Advisery Group and

TRIST programme organisers. This was to link the electronics and computing sections of the courses. The proposal was to give teachers a specially designed interface board PCB package for them to assemble. This would be issued together with a set of instructions and components. It was envisaged that an interface could be assembled on the first day or so of a shortened combined electronics / computing course.

Many of the group of teachers observed above, had found soldering difficult when attempting the electronics section of their course; in addition they had also experienced difficulty relating the work which they had undertaken, to their school situation. It was proposed that the interface board should incorporate integrated circuits instead of large numbers of discrete components; these could be inserted into good quality sockets to minimise contact problems, rather than be soldered directly to the board; thus to some degree eliminating component destruction from lack of soldering expertise.

As mentioned above, it was suggested that students having an interface to take away with them, may well be more likely to experiment with interfacing projects at home, or in school, thus offering an opportunity for learning reinforcement.

The interfaces and subsidiary boards described in the following pages have been designed to meet the demands of low cost, simple, flexible and understandable, initial control training units.

Although primarily designed as a research instrument they are also capable of integration into both 'Distance Learning Packages' and taught courses for teachers and pupils.

8.4. THE RESEARCH INSTRUMENT.

The development of an interface for 'computer control' courses was not undertaken lightly. However, after the 'hardware' search, it was apparent that there were very few commercially made products which would meet the requirements of the TRIST courses on the basis of cost alone. The decision to integrate the basic electronics and control aspects of the courses was the ultimate guiding factor in a solution to the problem. Although the interface was to be used in conjunction with course materials primarily as a research instrument; it was hoped at the outset of this project to be able to produce a unit which, once assembled, could be used both on the course as an educational aid and then taken away by the teachers to be used at home or in their own schools. This expedient not only ensured that the teachers would have at least some opportunity to further develop their skills after they had been made aware of the possibilities of using a computer for control, but also that they owned some enabling equipment for use in their lessons at school.

A further literature search was undertaken on the subject of interfacing. This proved to be another substantial subject in its own right. A considerable number of books have been written during the last five years on this topic. Therefore, because the course machines were already chosen as previously described, it was decided to deliberately restrict the field to those which were primarily concerned with the BBC micro. The BBC computer users magazines, "Acorn User" and "Micro User", have also contained information on interfacing. Mike Cook has published a series of articles on interfacing in the "Micro User" magazine under the 'Body Building' heading.(3) These articles even included a device for checking radioactivity after the Chernobyl disaster. Each of these articles refers to a piece of equipment dedicated for a task or purpose.

It was soon evident that regular contributors to two of the three major BBC dedicated computer magazines had also written books on interfacing. Bruce Smith has been particularly prolific on a number of topics related to the BBC micro, and his work includes a very clearly written book on interfacing.(4). Smith's book proved extremely difficult to acquire and would now appear to be out of print. This book contains much of the basic information necessary for interfacing the BBC micro. A very much easier book for the beginner has been written by Joe Telford, which takes the topic through very simple stages to the production of a 'buggy' at the end.(5) John Billingsly (6) has also produced a readable text with a series of projects for the beginner; however, this book is characterised by some appalling artwork and diagrams. Penfold (7), and also Bishop (8), have written at least two books each on the subject. The common factor found in all of these books is that construction of the circuits are based on 'vero-board' copper strip matrix, or more crudely, by component to component direct wiring. This expedient was probably chosen because the general public would have limited access to facilities for etching printed circuit boards.

The major problem with matrix board, is that producing a circuit by co-ordinate numbers and ensuring that all the tracks have been broken at the appropriate places underneath, is a very exacting task. Any slight oversight could at worst cause severe damage to both the components on the circuit and any equipment, such as a computer, which may be connected to it. It is also very awkward to trace a faulty component or failure in the circuit with this method of construction. One of the excellent Usborne series of books describes the construction of an interface for a robot arm which is built on vero-board. At least two examples of this circuit known to have been constructed, have not worked because of a fault which has proved impossible to trace without extensive amounts of time and 'head-scratching'.(9). It would not appear to be sensible to use this method of construction for anything other than very basic circuits. To employ this technique with teachers inexperienced in electronics work could be both time consuming and frustrating.

The preferred method chosen by Mike Cook in his body building series is to produce a printed circuit board. With the adoption of this method, providing the circuit has been correctly drawn, there can be few problems. A worst case could be a hairline crack in a track, which can be readily tested for with a multimeter or piece of wire to 'short across' the gap. Another alternative method of construction is to use a wire wrapping technique around the extended legs of components which have been positioned through a plain matrix board. This method again suffers from the problem of very exact connections being made manually from pin to pin. The purpose designed PCB would appear to be the best method to adopt for a course which could include complete novices.

'Interfacing and Robotics on the BBC Micro' (10) contains a printed circuit design for a stepper motor driver board. This is a well written and informative publication, although expensive, costing just under fifteen pounds. It should be possible to construct an X,Y plotter by following the information given in various parts of the text.

Several 'Green Files' have been produced by the MEP on the topic of interfacing. 'The Book' (11) contains a number of very useful diagrams and information on basic circuits. There are problems with some of this information, and especially the programme listings, which have been referred to elsewhere in this text. 'The Sunderland File - Interfacing the BBC Micro'(12) is equally informative; however, many of the program listings are written in assembly language which is not easy to understand even by experienced computer users. 'Teaching About Computer Control With the BBC Micro Computer' (13) is an excellent basic guide to the subject and could be heavily utilised for any course on this topic. A library disc of 'procedures' written in Basic is included with the book; these could be readily utilised by teachers wishing to write their own programmes. This publication would be well worth including in a distance learning package. 'Control by BBC Microcomputer Using Machine

Code' (14), is another in the MEP Electronics and Control Technology Domain series; and although it is well written and again includes a disc, the information at the front of this file clearly states that it is not intended as a self-instruction guide. With their vast experience in designing and providing courses for teachers it would be hard to dismiss the work published by the MEP. It would not be difficult to delve into a variety of their publications and to utilise some of their software to form the core of a wide range of new courses for INSET. The MEP 'Analogue Sensor Manual' (15) is yet another invaluable reference source for anything concerning the analogue port on the BBC micro.

Many of the publications studied appeared to indicate that they feel a display to indicate the state of the computer bits on the port control lines, is essential to aid understanding. This is almost self evident and it is not a big step for a tutor to explain what the computer is doing if the condition of the signals can be seen. An indicator made from light emitting diodes is the normal method of producing the desired result. When controlling motors from the computer a variety of means are encountered, but the majority method appears to be the use of relays as a means of isolation from the computer. Relays will allow heavier currents and higher voltages to be controlled by the computer than it could otherwise manage.

'A Science Teachers Companion to thep BBC Microcomputer' by Philip Hawthorne (16) is a very useful reference book on a number of interfacing topics and contains numerous programs which could be utilised by teachers. A particularly good program in this publication is the 'ADC' listing which works in conjunction with the analogue port and will allow a variety of screen displays and recording of experimental data. All the programmes contained in the book can be obtained on a cassette to save typing. This publication is one of the few produced by a person who is both conversant with programming professionally, and teaching.

Most of the publications encountered, offered some programmes as listings which would work with the equipment they were inviting the reader to construct. Bains (17) and others, included machine code routines without explaining in great detail how they worked. Undoubtedly Telford's simple, guided approach which consisted of building up a more complex programme from a series of much smaller procedures, was very helpful and good for beginners. Most listings however failed to include any screen display so that the user could be informed of what was happening or gain extra information from the VDU.

Bishop and Telford both describe a system of building a series of modules which can be coupled together to form a much larger unit. The advantage of this is that individual circuits can be less complicated, but the problem comes when finding a positive method of joining the modules together. Penfold designs individual circuits dedicated to a particular task. This latter approach undoubtedly has much to recommend it if a circuit is to be used for one specific purpose; production costs would be minimised because only the components necessary would be used in the circuit. However, there is also a very good case on a training interface to include a number of possible alternatives which can be utilised for a series of experiments on a course. This eliminates the need to build a lot of circuits and also saves duplication of some circuitry or components such as the Darlington drivers. A general purpose, versatile interface could also be readily applied to a number of situations, which may later be encountered in a school, without the delay of designing and building dedicated circuits.

8.5. THE PCB TRACK DIAGRAM.

The initial layouts for the interface prototype PCB's were drawn by hand, using the traditional methods of indian ink and drawing pens. The utilisation of PCB 'rub-down' transfers for the spots and integrated circuit pads decreased the problems of accurate spacing.

However, it was hoped to include an element of computer aided design into any courses developed. A variety of software packages were acquired and assessed for their suitability. One of these packages proved to be very interesting and relatively low priced. This software "PCB" by Vinderen Associates of Northern Ireland (18), proved to be the answer to the inclusion of a relevant and integrated computer aided design and drawing package for use in the course. It was just possible to draw out the printed circuit for the interface with this software before the BBC computer ran out of memory. There would not appear to be a similar piece of software available for RML computers at a similar cost.

A decision to produce a printed circuit board for the construction was made because this method looks more professional and also equates with the ideal current practice for producing electronic circuit modules in a workshop or classroom. The production process was to be demonstrated as an important integral component of the course.

One of the aims of the interface is to allow the constructor to see the pathways to the various components, and with the application of a little thought, understand their relationship. It had already been noticed that CDT teachers in particular, have an insatiable appetite to get inside a sealed unit; often in the face of extreme difficulties, in order to find out what happens inside. 'Let's have the guts out and find out how it ticks', appears to be their standard maxim. It apparently matters not whether they fully understand what they are viewing; even a little extra knowledge appears to satisfy their curiosity.

8.6. THE INTERFACE PARAMETERS.

The interface board has been deliberately designed for construction as a compact, single board, open unit for the purposes of initial training. The printed circuit board can be accommodated on one half of a standard 220mm X 110mm photo-etch PCB board, which is obtainable from a variety of electronics component suppliers - (Rapid Electronics in this instance). A construction guide has been produced (see Appendix

3) consisting largely of diagrams to accompany the kit of components. On a taught course this would be allied with a verbal explanation and overhead projector sheets.

It is possible to modify the board to fit into purpose built boxes which will give it more protection. A suggested method is that the container be given a clear acrylic base so that the track layout can still be seen. An alternative suggestion is to "pot" the underside of the base in a clear resin; this protects the tracks from inadvertent 'shorting out' on metal objects. (e.g. Screwdrivers on bench tops etc.) A disadvantage of this method will be encountered if components need to be removed and re-soldered. (CDT teachers should however need little instruction on how to make boxes). The underside of the prototype boards were protected by fitting them into a vacuum formed polystyrene tray, especially moulded for the purpose.

PCB mounted terminal blocks have been chosen for the interface because they offer a neater, compact and positive connection, at a greatly reduced cost when compared to 4mm plugs and sockets. If it is desired to use the 4mm sockets, the constructor can easily take the connections to the interface board by soldering a length of wire between them. An alternative solution is to use 2mm banana type plugs or 'plockets', which will fit directly into the terminal blocks.

It was decided to limit the options available on the interface to a normal configuration of six outputs and two inputs, or alternatively eight outputs. This unit is intended to be used for introducing the principles of control and although an attempt was made to make it as versatile as possible, a deliberate decision was made to keep it simple. The interface was primarily designed to operate from the user port of the BBC micro. The eight data lines from the 6522 versatile interface adapter (VIA), inside the computer have been connected, but the two lines CB1 and CB2 have not been implemented. (See Bray Dickens & Holmes pages 425-6 for connection details) (19). When users become both more competent and confident, these two lines are worthy of further investigation, but could cause unnecessary complication on an initial training interface. Provision has been made to allow two lines to become either inputs or outputs. Ten lines have also been brought from the analogue port at the back of the BBC micro to the edge of the interface board for convenience. It is quite easy to assemble a few simple components into the relevant terminals and undertake sensing experiments; both on the board and also from remote units. The analogue lines can be used to sense and the user port, (or printer port), lines can be used to react to the input while the VDU displays instructions. No protection has been added to the analogue lines, however a simple zener diode based circuit could be used as an exercise on the course if given a circuit diagram. (A suitable circuit can be found on page 61 of "BBC Hardware Projects" by Don Thomasson) (20).

A Ten way Molex connector has been deliberately chosen in preference to an Insulation Displacement Connector (IDC) transition connector or direct soldering of the input cable which joins the board to the computer. This allows the possibility of connection to other ports on the BBC micro, or to other micros; especially those with a standard parallel printer port. It was remembered that most Oxfordshire teachers would have access to RML machines - hopefully either 380z or 480z computers with In / Out ports on the rear. All that is required, is for the user to connect the appropriate lines to a Molex socket and send the correct address instructions from the computer. It is of course also possible with a board dedicated to one machine, to solder and clamp the cables directly to the circuit board and eliminate any possible problems with the cables breaking off the Molex connector. An alternative solution would be to bring the cable to an intermediate switch box designed to allow selection of various lines to be readily interchanged between different machines. (This would form an interesting design problem in itself).

The interface has been successfully connected to the RML 480Z computers I.O. port simply by making a different cable. It will not of course be possible to use a printer port as an input from the interface board when connected to a BBC micro, because this is an output only device. This method of construction does however allow the possibility of using two boards side by side; one from the printer port and one from the user port; thus giving a potential for driving sixteen output lines, or 8 d.c. motors bi-directionally!

The 5 volt line from the BBC or RML computer has been connected to allow the LED display to be driven without the necessity for external power supplies. The computer should be quite capable of supplying this power, which makes the demonstration of binary counting, traffic light sequences, program problems etc. very easy to implement. The computer can also drive the relay coils without problem. However, the computer MUST NOT be expected to supply the power to drive D.C. motors, as this can lead to problems. (One reported result of this unwise action, was of the tracks on a computers main printed circuit board burning out, thus forming a very expensive fuse)!

A variety of differing methods of construction were encountered when surveying the interfaces available to schools. Many used transistors as discrete components, rather than Darlington driver integrated circuits for the initial signal line amplification. With todays lower price for these integrated circuits, the economics of this method are questionable when constructing an interface. The possibilities of "dry" joints, or damaged transistors, are increased by the larger number of connections to be made. Subject to the considerations mentioned in the instructions for building this interface, an octal Darlington driver such as the ULN 2803A is a much easier solution to the problem of amplifying 3 mA. line signals, typically found on the BBC micros. As a bonus, the "A" version of this i.c. also contains the necessary diode protection and resistor buffering networks. (See diagram in Appendix 3).

Resistors have been added to the circuit before the LED display, either as an I.C. block, or individually. The advantage to this interface of using discrete components is to allow a larger opening for taking tracks out to the 8 pin DIP switch and jump connector. This allows the addition of a secondary or sub-board if desired. The resistors can be in the range of 270, 330, 470 or 680 ohms. 270 ohms will give a brighter light in daylight, but 470 or 680 ohms should be used if a 12v external power supply is to be utilised, because they give greater protection to the light emitting diodes. The typical current through the LED should be no greater than 20 mA although there is some latitude; the red versions are more sensitive than the yellow or green. It would also be necessary to disconnect the computer 5V line completely and to use 12V relays if a constant requirement for 12V operation is envisaged.

The LED display has been built up from individual components because it is cheaper than buying a bar display, and these are also normally encapsulated as blocks of 10. It is also much easier to see whether a 5mm LED is switched on under normal lighting conditions. The cost of any repair is also minimised with this method. No provision has been made to switch out the LED display because this is regarded as a training interface, and it has been assumed that greater understanding of what is happening will be gained from observing the state of the lines. The inclusion of the red, amber and green LED's allows the interface to be used for elementary programming problems, such as the well known, but nevertheless useful, traffic light and "Pelican" crossing sequences.

Relays are regarded by many as being too clumsy and slow for control circuit operation. However, they offer some advantages over other methods of switching D.C. motors. One of the major advantages is the total isolation of the computer from the motor power supply line. A diode, included inside the ULN 2803A, is used in the signal line circuit to the relay coil to prevent excessive back e.m.f. reaching the computer when the relay coil is switched off. The relays used on this board are rated for 5v operation, which is particularly suited to the 5v computer logic signals. Although more expensive than some other relays on the market, they have proved to be reliable and have been extensively used in past MEP projects. It is also easier to see if a relay has failed than to check out a solid state device. The diagram of the relay in the accompanying notes (Appendix 3) has been deliberately drawn from the top view, rather than following the normal underview convention. It has been found that this expedient aids understanding of the relationship of the various component connections when the board is viewed from the top. It was noted that teachers, if they were inexperienced with electronics, had difficulty working out the connections when viewed normally from the underside.

8.7. MORE ADVANCED USE OF THE INTERFACE.

After an initial understanding of the interface has been acquired it is possible to configure the board for voltages greater than 5V. However, when any external power source greater than 5v is used to drive the board, the computer power supply MUST BE SWITCHED OFF FROM THE BOARD WITH SWITCH 1-4. If higher voltage work is envisaged, THE RELAYS MUST BE SWITCHED OFF WITH SW2 (the package of 8 dual in line switches), because their coils are rated at 6 volts maximum. A higher resistance of at least 470 ohms must also be placed before the LED's. The Darlington driver I.C. can be satisfactorily driven with any voltage between the ranges of 4V to 18V which should be regarded as the limits of this interface.

To use the interface to drive a stepper motor sub-board, a supply of 12 volts should normally be used. This would require that the computer supply switch to the board is off and the external power supply is on. The double pole double throw switch fitted to the issue 6 interface will effectively achieve this configuration automatically. (The issue 6 board was designed after an initial trial course with teachers had confirmed the suspected problem). However to avoid any chance of a 'flashover' it is wise to place the switch into this position before connecting the external power supply. If the board is only to be used for controlling d.c. motors via the relay output side, a voltage greater than 5 volts could be applied to the board. This is because the power from the external PSU should only go to the output side of the relay. (See relay diagram Appendix 3). The relay will switch 24 volts or more, depending on the current.

NEGATIVE VOLTAGES MUST NOT BE APPLIED TO THE BOARD OR SEVERE DAMAGE TO THE COMPUTER COULD BE THE RESULT.

DO NOT CONNECT MAINS ELECTRICITY TO THE INTERFACE.

Every effort has been made to test and ensure that the interface design works without problems. The design progressed through six stages of minor alterations to the circuit board. The switches next to the darlington driver i.c. were originally a block of four dual in line package; this was changed to a pair of double pole - double throw switches to eliminate the possibility of an external power supply trying to feed power to the computer. This modification was made following observation of CDT teachers using a trial board in a school. They were working on the principle that 'if all else fails, read the instructions'. The DPDT switches would be better mounted remotely from the board and connected with flying leads in circumstances where extensive use is envisaged.

8.8.

COMPONENTS LIST FOR INTERFACE 1.

1	PCB + ETCHING	1.60	R
1	D type 15 way plug	.50	R
1	20 way IDC cable mounted socket	.75	J
4	Diodes 1N4001	.08	J
2	Yellow 5mm standard LED's	.16	J
2	Green 5mm standard LED's	.16	J
4	Red 5mm standard LED's	.32	J
8	Resistors 270 or 470 ohm	.08	J
2	Resistors 100k	.02	J
6	Relays RS348-526	6.60	RS
1	Darlington Driver ULN 2803A	1.30	R

2	2 Way DPDT switch	.96	J
1	8 Way DIP switch	.65	J
2	Molex PCB plugs 10 way	.40	RS
1	Molex 10 way socket	.35	RS
4	4 way PCB terminals	1.04	J
3	2 way PCB terminals	.42	J
1	Ribbon cable	.65	J
1	10 track veroboard	.26	R
1	18 pin DIL socket	.09	J

TOTAL£16.39 + VAT

The above prices reflect the best prices available at the time of writing (June '87) for items from 3 firms:-

J.P.R. Electronics. = J
Rapid Electronics. = R
R.S. Components. = RS

8.9.THE INSTRUCTION GUIDE.

It had already been discovered from the survey that teachers were finding difficulties with the manuals provided with computers and the majority of software. Even if the language was understandable the length of the literature was often regarded as too long. One notable exception and example of a firm which has a very high reputation for some of its manuals is Computer Concepts; the "Wordwise Plus" (21) manual being particularly well received by those who used this software. The "Wordwise Plus" manual is set out in easy clear stages and the information under each heading is succinct and readable by the non-expert. This could be a good model to follow if designing a tutor and user guide, although there are doubtless other examples which could be cited.

Chapter 8.

It was decided to produce an instruction guide for assembling the interface. The intention was for this literature to be brief and to the point, and to miss out all unnecessary technical detail, while at the same time giving enough information for both construction and use of the board. A decision was taken to try and illustrate the guide so that much of the work could be undertaken in easy visual steps. The limitations of black and white reproduction had to be taken into account and this restricted the drawings to a longer series than would have been necessary if several colours could have been used. The production of a set of additional 'build-up' transparency overlays was considered for the overhead projector, but this was eventually rejected in favour of a single multi-coloured sheet with a key included. A flow diagram was produced to indicate how the interface worked; and a circuit diagram was drawn to help the electronics enthusiasts to trace faults if they occurred.

Additional drawings and schematic drawings were made of the major components included on the interface. The intention was to allow little excuse for not understanding the basic layout or principles of operation. Examples of this series of drawings and instructions can be seen in Appendix 3.

Details and examples of the functions of the interface switches will be found in the diagrams following the construction guide examples in Appendix 3.

8.10. SOFTWARE FOR THE INTERFACE.

An interface and computer in isolation are of limited value, therefore it was decided to give the students a disc of simple programmes to use in conjunction with their newly acquired interface.

A disc of menu-driven simple basic programs is used in conjunction with the interface to allow use by inexpert programmers and computer naive students. The programmes can be readily altered by those with knowledge of programming. (see Appendix 4 for examples). The disc of programs are intended to have a very fast 'learning curve' for the user, thus increasing their familiarity and confidence with the equipment. Although the programs are simple, they can be adapted and expanded to more complex requirements or used in conjunction with each other.

The readily available Nottinghamshire 'Bits' programme and 'Lego Lines' software will both operate with the interface without modification.

The programmes on the disc include one for working out the values of resistors and their colour codes. This at least serves as a check for teachers unfamiliar with working out these values, and to ensure that they inserted the correct components into the right holes on the interface. This expedient would also introduce the computer, and one of its uses, to those who had never used one before. The disc is menu-driven, therefore it is only necessary to teach the student how to 'boot' the disc and then to follow instructions on the screen. The disc also includes the program which tests whether the interface works properly. No implementation of a fault finding programme was established, but this was considered. Fault finding of a circuit was considered by the TRIST organisers to be an important part of a basic electronics course. Programmes for converting binary and hexadecimal numbers are considered an essential aid to understanding and are used when these principles need to be established.

Several demonstrations and very simple experiments were included amongst the programmes provided for the teachers. The information for these was displayed on the screen so that subjects had to learn how to make use of the computer before they moved to the next step.

8.11. PROGRAMMING.

In view of the experience gained with the group of teachers on the TRIST 'control technology' course which had been observed earlier in the case studies; it was decided to make the programs work in 'Basic' for some of the reasons stated in the report of that observation (See Chapter 3). A secondary important reason for this decision was that a substantial number of CDT teachers already appeared to have at least some experience of this language; which was established by their responses to the questionnaire. It was decided to include a variety of methods of achieving similar tasks. e.g. Some programs require a key to be pressed before they jump to the next screen; to illustrate the point, others incorporated a time delay which will scroll or jump automatically. This series of small routines is intended to give basic guidance so that they can be incorporated into a teachers own programmes at a later date when they have found the need for them.

It was considered that at least some simple knowledge of the ability to write a programme could prove useful to a CDT or Science teacher attempting to interface an experiment or to control equipment. The alternative method of interaction between the operator and the equipment, is via a 'front panel' type screen display such as the Nottinghamshire 'Bits' software or Austin Taylors 'Connect 8'. However, both of these incorporate a simple programming language so there would not appear to be a significant advantage in their adoption at this level.

The development of programmes to demonstrate the use of both the user and analogue ports of the BBC micro became the priority activity at this stage. Over half of the teachers responding to the question of which computer they would prefer, had stated the BBC micro. The microcomputers to be utilised on the OSSTC courses were also BBC micros. This computer has the advantage of a built-in analogue to digital converter which could to be utilised. The process of measuring light, temperature or other 'data logging', would appear to be useful knowledge for teachers involved with technology projects.

8.12. SUMMARY.

The research and investigation of hardware and software and subsequent decision to design a totally new package consumed a vast amount of time during this research project. A considerable pressure and impetus was placed on the work because of the deadline imposed by the TVEI related INSET course which was already allocated.

It can be seen from the above that numerous considerations were taken into account when developing the package, which was to be used as a research instrument for raising computer awareness and capability in CDT teachers. Undoubtedly others may have approached the problem in a different way; however constraints of time and finance were substantial considerations in this area of the work. Feedback from interested parties and observers during the development stages of the package was very encouraging. Considerable interest in the project was exhibited by teachers attending other courses at the OSSTC, where some of the development work was undertaken.

Following the hardware and extended literature search, the interface and software had been produced in time for the next stage of the research project, and were ready for testing. Chapter 9 describes this stage of the research. The application of the package to a course of teachers followed shortly after the testing and is described in chapter 10.

REFERENCES - Chapter 8.

LITERATURE REFERENCES FOR CHAPTER 8.

(1) & (11). S.E.D.C. Team for MEP (1985) - The Book. Electronics and Control Technology Domain. The Romsey Printing Co.

(2) & (12). MEAD T. for MEP (1984) Sunderland File -Interfacing the BBC Microcomputer. Electronics and Control Technology Domain. The Romsey Printing Co.

(3). COOK M. (1984 >) - Micro User. Magazine published monthly by Database Publications Ltd.

(4). SMITH B. (1983) - Interfacing Projects for the BBC Micro. Addison Wesley Publishing Co.

(5). TELFORD J. (1985) - Practical Hardware Projects for the BBC Micro. Century Communications Ltd.

(6). BILLINGSLEY J. (Reprinted 1984) - D.I.Y. Robotics and Sensors with the BBC Computer - Projects for Control Applications - Sunshine Books.

(7). PENFOLD R.A. (1984) - Micro Interfacing Circuits - Books 1 & 2. Bernard Babani publishing Ltd.

(8). BISHOP O. (1982) - Interfacing to Microprocessors and Microcomputers.Newnes Technical Books published by Butterworth & Co.

and:

(1985) - Easy Add-On Projects for Commodore 64, Vic-20, BBC Micro & Acorn Electron. Bernard Babani Publishing Ltd.

(9). POTTER T. (1984) - How to make Computer Controlled Robots. Usborne Publishing Ltd.

(10). BRADLEY R. (1985) Interfacing and Robotics on the BBC Micro - Micro Press.

(13). TROTTER M. - Teaching About Computer Control With The BBC Micro Computer. MEP Electronics and Control Technology Domain. The Romsey Printing Co.

(14). GHEE B, MILLS R, & NICHOLLS P. for MEP - Control by BBC Microcomputer Using Machine Code. Electronics and Control Technology Domain. The Romsey Printing Co.

(15). S.E.D.C. Team for MEP - The MEP Analogue Sensor Manual. (Second Edition). Electronics and Control Technology Domain. The Romsey

Printing Co.

(16). HAWTHORN P.A (1985) Science Teacher's Companion to the BBC Microcomputer - Macmillan.

(17). BAINS G. (1986) Practical Interfacing with the BBC Micro - Chapman Hall/Methuen

(18). PCB. (1986) - Vinderen Associates, Northern Ireland. (Software package).

(19). BRAY A, DICKENS A, & HOLMES M. (1983) - The Advanced User Guide For The BBC Micro. The Cambridge Microcomputer Centre.

(20). THOMASSON D. (1984) - BBC Hardware Projects. Melbourne House Publishers.

(21). COLL J, & MYERS A. (1984) - Wordwise Plus Reference Manual. Computer Concepts.

INTERFACE HARDWARE INSPECTED.

Alfred Robot - Available from John Simnett, Kingston on Thames, Surrey.

Pilot 1 interfaces.

Austin Taylor communications Ltd. Bethesda, Bangor, N.Wales, LL57 3BX. - Interfaces, Connect 8, Pneucad and Electrocad, (CAD software).

LEGO interface. Inspected at LEGO Factory, Billund, Denmark - together with LEGO Lines software. Available from LEGO UK, Wrexham, Clwydd.

DCP interfaces - Griffin and George.

Banana Interface - Information from Paul Riley at Lancaster University.

Fisher Technic interface and BBC Buggy.

Cambridge Micro Systems - Control It.

Deltronics Interface - Inspected at British Schools Technology, Bedford.

Feedback Control - CNC drilling / milling machine.

Magenta Electronics - 1 stepper motor interface.

Trent Polytechnic - Decoder from 1mhz bus.

Three MEP interface board designs were constructed.

CHAPTER 9.

9.1. Testing the in-service teaching package.

CHAPTER 9.

TESTING THE IN-SERVICE TEACHING PACKAGE.

Following the design of the research instrument described in chapter 8; which now consisted of an interface, plus a disc of programmes and associated teaching materials; it was decided to trial the package with serving CDT teachers. This was subsequently attempted. However, most CDT teachers at this stage of their teaching year, were heavily involved with examination work. Those approached indicated that they were unable to expend very much time and effort on this aspect of the project. Regardless of this potential problem, three sets of materials were left with colleagues already known to be interested; one of whom was not very conversant with computers or their use. The other two individuals were known to be reasonably competent in computer use, but had no experience of computer control.

The feedback from these experimental packages was encouraging although limited in its scope. There appeared to be general satisfaction with the compact design and construction of the interface itself, and it was further stated that it would not be difficult to build or use from the materials they were shown. Subsequently three more boards were placed in schools for teachers who had expressed a willingness to construct them into interfaces. The rigours of school life defeated all three of these latter teachers from completing the experimental interfaces in the time available before the courses;

although they all gave positive indications that they felt there would be little difficulty for them to have done so if given enough time.

Following the cessation of the formal teachers dispute with the government, which came at this stage of the research, headteachers had apparently redoubled their efforts to make teachers produce reports and to attend parents evenings. This, coupled with the already heavy examination loads defeated those teachers chosen as control subjects. (All of the interfaces were subsequently constructed by the chosen teachers and worked without problems. Regrettably this information was not available before the major trial with a course of teachers at OSSTC).

Although not fully successful in experimental terms; enough was learnt from these teachers, and those of their colleagues interested enough to comment, to know that they were optimistic for the success of the package. Even at this early stage, it appeared that considerable interest was being expressed by teachers having seen the materials in schools, but who were not themselves directly involved in the testing. (This reinforces the observations made by teachers at the OSSTC mentioned elsewhere). Within a few days of these boards being released for trial, the OSSTC began to receive telephone calls enquiring about the interface and its availability.

During the period of time which was required for the development of the interface and course materials, approximately thirty teachers attending OSSTC for courses, and other reasons, were given the opportunity to see the development work. This opportunity was sometimes extended formally in a specially convened session of their course, or more usually informally, during lunch hours or before and after their course. After interest had been aroused in the formally convened sessions, it was often difficult to escape further attention and having to explain exactly what was involved in the research and why. Following the explanation, a common response would be - 'it's about time somebody attempted to do something about it', or some similar statement. These teachers were invited to comment adversely or otherwise on what they saw. Remarkably little adverse comment was received; the worst case coming from an electronics expert who insisted that a circuit diagram should be included with the materials. (It had not been formally drawn at that stage). He was however at the same time being very complimentary about the layout of the circuit board. Feedback of this nature helped to determine the possible reception of the course materials, as well as indicating areas of deficiency as forseen by practising teachers. Most of those teachers viewing the interface board were very keen to try to obtain at least one for themselves or school; a substantial number of these requests were from science teachers in addition to those from CDT.

In order to establish whether the instructions and teaching materials were suitable for computer and electronically naive teachers, the package was given to a twelve year old boy. He assembled the interface with little trouble and was fascinated with the potential when he coupled it to the computer. It was not long before he was building a series of Lego models to use in conjunction with the computer and interface. It was perhaps a rash assumption that a teacher should be able to cope with the materials if they were sufficiently clear for a twelve year old; however, this appeared to be a reasonable conclusion to make. With a constraints on both time and finance, little other potential opportunity was immediately available for testing the package.

The secondary research attempting to investigate the possibilities for, and effects of, retraining computer naive CDT teachers was undertaken from this limited base of trials. The 'computer awareness and control' course resulting from the Technology Advisory Group meetings and devised for the research, was based at the Oxford Schools Science and Technology Centre, and all course administration was handled there. When the course was advertised to all non-TVEI schools, little difficulty was expected in filling the ten course places available. The only forseen problem that could have arisen was because of the stipulations for TRIST funding, schools were being circulated in both CDT and science departments. If an extreme situation arose, this could have resulted in a science teacher only group. In the event the applications for places exceeded all expectations. The course information sheet which was included with the application forms, is set out in Appendix 5 to indicate the intended range of the training.

Within fourteen days of the letter advertising the course leaving

OSSTC, over forty requests for places were returned and applications were then closed. At this point the telephone calls requesting information about the interface and course materials became a regular feature of daily life. Several schools even attempted various devious ploys to gain extra places for their staff. Undoubtedly if the previously proposed distance learning packages could have been made available at this point, the lack of equipment materials and funding would have created distinct problems with both administration and distribution. It is worth remembering that at this stage no teachers had actually been trained with the materials. The demand which had arisen is perhaps indicative of the wide interest in the subject of interfacing in schools. Another reason to explain the demand could also be the efficiency of the informal 'bush telegraph' which was operating between some of the teachers, who had seen the development of the 'research instrument', and their colleagues; some of whom would have now realised the significance of the survey by questionnaire three months earlier.

The research tool had been developed and tested, (although not as fully tested as originally intended). It was realised that there was possibly room for further refinement of both the interface and literature, but at this stage it was deemed more important to apply the instrument for its intended purpose of testing the potential for training, and increasing the computer awareness of teachers.

The first course which effectively acted as both an in depth trial for the research instrument and also for the second stage of the research, is described in the next section.

CHAPTER 10.

- The retraining courses.

10.1. Course one.
10.2. Questionnaire employed for further research.
10.3. Description of the course.
10.4. The second course.
10.5. Description of course two.

CHAPTER 10 - THE RETRAINING COURSES.

Following the development and limited testing of the research instrument package, it was applied to two courses of teachers in to establish its effectiveness. It was also of interest to discover how possible it was to intervene in an established situation of 'teacher / computer deprivation'.

These courses were held under the auspices of the MSC TVEI related In-Service Training programme. Documentation to satisfy the MSC report requirements was already established within Oxfordshire and the major format had to be substantially adhered to. This created a problem for administering formal questionnaires directly related to this research. Descriptions of what took place on the courses are given below.

10.1. COURSE ONE.

The course took place over five consecutive working days in March, during a normal school working week. An even distribution of science and CDT teachers had been achieved. Only one of the teachers attending was female. It was soon apparent that some of the science teachers were not computer naive, but had previous computing experience. Only one of the five CDT teachers in this group claimed any competence with computers. Two of the chosen CDT teachers were from two of the four schools initially chosen for preliminary case study work and interviews. Both of these individuals could be fairly stated to be strongly outspoken personalities and very good at the traditional aspects of craft teaching. One of them was notable for his outspoken comments in the preliminary interviews, and for indicating that he 'would not bother about computers until he had one in his workshop'. One of the physics teachers had no previous craft, electronics or computing experience. Most of the science teachers had little practical skill, except for one, who was exceptionally good with his hands and outstanding with electronics. He was also very good with computers but paradoxically, had never been involved with control technology incorporating computers. This teacher was very able with radio control models and is one of the few acknowledged experts in the country regarding satellite downloading with microcomputers. It can be seen from this description that the range of ability within the group was enormous. The common factor was a lack of familiarity with BBC computers, although some of the CDT teachers had already expressed their interest in the questionnaire for acquiring BBC micros. Those who were using computers were using RML, Commodore and Amstrad machines.

10.2. QUESTIONNAIRE EMPLOYED FOR FURTHER RESEARCH.

Remembering that the course members were not all CDT teachers, it appeared reasonable to attempt to ascertain the past experience of the delegates and also establish what they expected to gain from the course. The ten people chosen were the lucky applicants and were chosen by the TRIST director. No bias or influence was allowed in selecting teachers who were potentially good research subjects. The group can be regarded as probably representative of science and CDT teachers within Oxfordshire. The only factor which may have set them slightly apart from some of their peers was that they had chosen to attend the course. It could possibly be unkindly speculated that some may have applied for places simply to get out of the pressure of school for a week.

Three of the five CDT teachers were already known. Two of these had been involved in pre-research interviews, and their involvement in the course was entirely fortitous. They were not aware of each others involvement in this aspect of the work. From the knowledge gained of these individuals in the previous interviews, it was a surprise to find they had applied and were attending the course. A third CDT teacher was completely computer naive and again a surprising applicant based on past knowledge. All of the science teachers, except one, were unknown quantities. The science teacher who was already known was acknowledged to be very expert in the field of electronics.

Keeping in mind the constraint mentioned in the opening paragraph above, a questionnaire was designed jointly with the TRIST director to gain some basic information from the teachers. A subsidiary ulterior motive for administering this questionnaire was to focus their minds on what they expected to achieve from the work ahead. An area of immediate interest for the research, was what the teachers expected of the course and how they intended to apply any expertise which they may gain. The questionnaire had to be designed to elicit information required for both the TRIST organisers and for this research. The TRIST director was interested in background to experience, whereas this research was satisfied to be advised about knowledge which was already possessed by the teachers present. The questions are listed in appendix 2; however, the answer areas have been eliminated to save space.

The questions of major interest to this research are 1,2,6, and 7. The answers to questions 4 and 5 are of interest for planning future taught courses.

Responses to question 1. What are your hopes/expectations for the course? are reproduced in full below. The first five responses are from CDT teachers:

> 'To START using a computer for all CDT areas including recording assessment of students work over 5 years'.
>
> '1. Use the BBC in respect of control.
> 2. How to look at and UNDERSTAND interfaces.
> 3. How to set up control. What is needed?
> 4. An insight into the electronics part of interfaces.'
>
> 'To overcome my own / departments shortcomings in computer applications re technology. Presently no knowledge of resources within control aspects of technology'.
>
> 'To become familiar with the use of computers - to know what to buy for the workshops - what courses to set up for various levels'.

'Applications for computers in control technology. Very basic electronics - computer graphics'.

'Become more confident in the use of computers in the classroom. Learn to use interfaces. Increase knowledge of electronics through hands-on experience'.

'I should like to learn how computers can be incorporated into school science lessons. We have computers at school but I have no idea what they can be used for'.

'Greater awareness of computer - its use in technology and greater knowledge of how to teach this'.

'Construction of an interface and how to use it to interface experiments in science with computers, and, if possible, control of robot type devices'.

'To be able to use a BBC in all aspects of control technology, and to have the knowledge to make/mend/maintain/develop interfaces to that end. I have a particular interest in robotics and satellite receiving systems but no specific experience'.

(The scientist interested in satellite systems was granted his request for information; another science teacher was an acknowledged expert on this topic and equipment for downloading was already at the OSSTC. All members of the course were shown how to use this equipment as part of their training).

The first five responses from CDT teachers are a confirmation of the findings of the survey. It can be easily deduced how much computer and control equipment exists and is available in these five different schools; and yet all of those teachers wanted to learn more about computers and their applications.

Question 2 was set to gain an insight into the self assessed previous experience of those present. Little purpose would be served here by listing the individual responses, the information is intended to give a general guide to the previous abilities of the group. The responses from the ten participants appear as totals in the grid below:

	None/Little	Fair	Good	Very Good
a. Electricity / Electronics.	5	2	3	
b. Microcomputing in Technology Area.	7	3		
c. Control Technology.	8	1	1	
d. Computer Aided Design	8	2		
e. Computer Aided Manufacturing	9	1		
f. Problem-Solving.	2	3	3	2
g. Graphic Communication.	4	2	2	2
h. Product Design.	2	4	1	2
i. Curriculum Development.	4	4		2
j. High Tech Areas of Industry.	7	2	1	

It can be readily seen from the above that the vast majority of those attending were inexperienced with any of the four major computer areas in questions 2.b,c,d, & e. although three rated themselves good at electronics and one said he was good at control. (This was later found to be a correct assessment - but not in conjunction with computers). Five of those present claimed some expertise in electronics.

The responses to question 6 which asked how do you intend to use the expertise gained on the course? are listed below:

> 'In school to operate Control Tech. as part of GCSE Technology if possible'.
>
> 'Within my teaching at ***** school'.
>
> 'Hopefully to develop the most appropriate aspects into the workshops'.
>
> 'To initiate the introduction of computers into the relevant areas of the CDT curriculum'.
>
> 'Developing new physics courses and technology courses within my own department. Probably set up a workshop for my own dept. and CDT dept. - but will feed back info. to them anyway'.
>
> 'Involving computers in Physics GCSE and "A" level practicals??'
>
> 'Ask when I find out when any expertise has been gained'.
>
> 'If **** survives we will need to introduce more control / technology as part of our TVEI course'.

One science and one CDT teacher failed to respond, possibly indicating that they had little clear idea of what they were hoping to apply their knowledge to. One of the CDT teachers did not state it under this question, but elsewhere on the paper indicated that he wished to use a computer for record keeping. (He was totally computer naive at this stage and only had fairly vague ideas of the capabilities of the equipment, with no practical experience of its use). One of the science teachers was similarly reticent to state a use, because he did not feel that he would gain enough experience during a week to be able to use a computer in the classroom. It could be reasonably stated that six of those present had a directed motive for their attendance at the course and wished to gain expertise which they could immediately apply to their teaching. Again it was apparent that some of the CDT teachers had the will to incorporate computers into their teaching but had received little advice or equipment to enable this to be achieved. The physics teacher stating that he was going to set up a technology workshop is an interesting case; it was subsequently discovered that the headmaster in the school had refused to allow technology to come under the auspices of CDT where there was a definite will to implement a technology course. The situation was even more notable for the fact that a CDT teacher was originally offered a course place; his headmaster refused to let him attend and transferred the place to the science teacher responding above. This gives another small indication that the lack of implementation of technology in schools, is not always the result of a slow or negative response from CDT teachers. The problem often lies elsewhere in the system!

The only two comments worthy of note gained from question 7 were: 'Looking forward to the week!' and 'I hope it is basic enough for me'.

10.3. DESCRIPTION OF THE COURSE.

After the introductory session during the morning of day one, representative examples of various makes and issues of the Acorn computers were shown, described and demonstrated. The internal arrangements and constituent parts were explained, together with guidance about potential faults and what to look for in second-hand machines. The normal jargon terms encountered were introduced naturally as part of this session. Information sheets were distributed to reinforce the points made. This session was generally well received and relevant questions were asked by the group. Following the coffee-break the interface was introduced and some of its potential described. The basic electronic principles were described and the Vinderen Associates "PCB" computer aided design package demonstrated. The link was immediately made with the interface and its design by demonstrating the "PCB" layout build up.

A large colour monitor was arranged to face the group. A second green screen monitor was running off the video socket of the same computer, which allowed the tutor to face the course members and still operate a keyboard successfully. This arrangement of computer and two monitors was employed where necessary throughout the week. When used in conjunction with "Wordwise", the forty character screen display was easily read by the audience and was used instead of a blackboard or overhead projector for explanation, jargon etc. This arrangement formed a very low level system of computer aided instruction, the use of which was recognised and appreciated by the teachers in the group.

The kits of parts and circuit boards were issued. To help describe the construction of the circuit, a series of overhead projector sheets were used to accompany the set of diagrams and instructions issued with the kit. All but one teacher claimed to be able to solder and arrangements were made for the process to be demonstrated to her. With this, the participants in the course were told to go and construct the interface. For some unexplained reason, this appeared to come as a severe shock to some of the teachers; while the majority were able to cope quite adequately, three teachers staged a minor rebellion. Two of them were CDT specialists and one a science teacher. They argued that they could not see the relevance of building a circuit each, and that some would work and some would not by the end of the week. It was quietly pointed out that they were attending a course which entailed simple electronics, and that this was in the information which had been sent to them. The further point was gently made that far from the end of the week, all circuits would be working by Tuesday lunchtime. They were not convinced (neither was the author at this stage), but agreed to work on after lunch. It was interesting to note that all the other CDT teachers rushed through to the construction area and made a start without fuss. The science teacher who was totally craft and electronics inexperienced, went with them. One of the lessons learned from watching previous courses was that science and CDT teachers have complimentary skills in this type of situation. The requirements of TRIST funding demanded that they work in the same groups, presumably to highlight this and encourage cooperation in future. Usually, but not always, the craftsmans sense of caring for the appearance of his work, ensures a neatly made construction with components carefully lined up and neat bends in wires etc. It had been noticed that often some of the science teachers lack this pride in their work, and are only interested in whether the result functions. A craftsman working quickly appears to unconsciously assemble items in a careful and logical sequence. In the case of the three who rebelled, the science teacher was used to having technicians produce equipment for him and was rarely required to do anything practical for himself. It was strongly suspected later, that all of three of them did not wish to have any of their practical difficulties or inexperience highlighted. This situation was unforseen and unexpected. These three eventually went on to produce working circuits within the required time, (to their own astonishment and satisfaction). One of the CDT teachers was a slow and meticulous worker who arrived an hour before the start of the course, and stayed an hour after the end each day to continue with his work.

It was undoubtedly a mistake to accept the assurances from the teachers that they could solder. A ten minute demonstration would have been well worthwhile. Soldering faults caused problems on several boards. The important process of fault finding in circuits was an integral feature of the course, and it was suspected that one or two boards resulting from what was basically a discovery learning process, would require some extra work. In the event the process of fault finding was demonstrated with a vengeance. A rewarding experience for all concerned was when the science teacher who had never done anything of a practical nature before, brought a beautifully made board for testing. It worked first time!

Following a careful visual check the interfaces were attached to a computer, and the test programme on the previously prepared disc was run. At this point it was possible to make the detached observation that it was obviously an exciting or rewarding experience for the teachers to see their interfaces working correctly. Their sense of achievement and obvious wish to use the interface was immediately exploited. This need for using the newly acquired equipment, had been correctly anticipated prior to the course. A disc of programmes, together with some extra components, was issued to those who had successfully assembled their circuit. They were then instructed to work through the demonstrations to discover what each did. Help was given where necessary, but most of the extra information required was displayed on the screen of their computer system. At this point the diversity of computer experience became apparent. The anticipated and hoped for ability of the course materials to allow a student to work at their own pace, was largely realised.

Teachers unfamiliar with binary counting, were quickly able to see the relationships between the different computer lines by sending numbers from the keyboard and observing which LED's switched on. This system was known to work as it had been tested with a nine year old; who predicted the sequence after four attempts at sending numbers. An astonishing experience! Teachers unfamiliar with binary counting took much longer to realise the relationship. The problem of simple programming was introduced by the expedient of altering time delays and light sequences on a series of traffic light programmes.

Familiarisation with the techniques of listing and editing programmes was almost unconsciously assimilated after an initial demonstration. The teachers were now beginning to use computers with confidence, the simple process of 'cause and effect' when a program was slightly altered fascinated them. It was not long before some of the more competent users were adding lines of their own to the programmes. A degree of 'monitorial' teaching entered the course at this stage. The cooperation between all the members of the course was evident. Nobody left, or wanted to leave at the appointed time in the afternoon; several had to be persuaded to leave an hour and a half later! The fixation of computers when learning something new, and things are going well, was now also apparent. The majority of the course members were in attendance at least thirty minutes early the next morning in order to experiment further. This situation prevailed for the rest of the week.

A design problem was posed, which made use of minimum materials. These consisted of card glue and 'corriflute' plastic sheet, together with two three volt d.c. model motors. This was the next surprise for some of the teachers present. The facilities within OSSTC for extensive practical work are limited; exigencies of time and cost dictated that any design problem must have carefully restricted parameters. The simple set problem was 'to produce a vehicle which can be operated from the computer within a three metre radius; it must also be steered and reversed'. The consternation amongst some of the science teachers was immediately seen. They had probably never been placed in the situation where they had been asked to design, draw and construct something with minimal materials and information. Some of the CDT teachers were also in trouble, not because they could not think of ideas, but simply because the tooling and materials available to them in their own workshops were now missing. Any objections were muted and not made within hearing. One of the original aims of this process was to introduce a degree of computer aided drawing and design to the course. However, this was abandoned in favour of drawings on paper because of the time involved. It was eventually pointed out to the group that they were now facing a similar situation to those which they unthinkingly give children every day. This was a deliberate ploy to illustrate this fundamental process to the teachers, and was a lesson well taken.

When completed, the buggies and vehicles; which included a nine hundred millimetre long 'Concorde' aircraft, had to be connected to the computer. Some had included the interface in the vehicle and the others used the interface at the computer end. The immediate problem to be solved, was how to get the vehicle to move and stop. Some experimentation was allowed before further information sheets explaining how to use two relays for motor direction were issued. The need to write a program now became a desperate issue. Some of the students who quickly reached this decision, were given a simple buggy program written in Joe Telford's previously mentioned interfacing book. This was quickly typed in by the science teacher without previous craft or computing experience; and also the CDT teacher from the trial school who had been adamant that there would have to be a computer in his room before he would be interested. On completion of the typing, the program was tested. It did not achieve the expected results. Forwards became a right turn and so on; this was a surprise for those who had not thought about the principles involved. The need for binary counting was now fully realised and the program was listed and altered to accept the correct numbers in the relevant lines. The CDT teacher now insisted on a screen display to give him information; at this point he was totally 'hooked'! The menu and screen headers on his disc were listed and the various mode seven screen displays which had been utilised were explained. He then sat down and wrote a screen header and display. The science teacher had meanwhile added several lines to the middle of the program to make the vehicle turn in various ways, including a spin on the spot.

A discussion of the effects and 'results' of this course can be found in chapter 11.

The next section describes the course and research involving the second group of teachers. Differences in organisation made this group a very different proposition to the one described above.

10.4. THE SECOND COURSE.

The second group of teachers participating in this section of the research, were composed in a number of different ways to the former group already described. The teachers came from three selected schools, and were participating in an element of a fourteen day training session, which was split into several single day and multiple day blocks of time. Five of these days were set aside for the 'Basic Electronics, Computers and Control Technology' course, which forms part of this research. The course was organised in a three day block and then two separate single days widely spaced afterwards.

The administration for this group was not directly handled by the OSSTC. Funding was obtained from 'Grant Related INSET' rather than TRIST. The newly appointed Science adviser handled much of the administration, working in conjunction with the 'Technology Advisers Group' to choose the schools and teachers who would attend. This group was therefore 'targeted' by the advisers rather than formed from potentially interested teachers applying for places on a free choice basis. This situation led to an interesting aberration, where three members of the second group had already attended the first course. The reasons for this strange position arising, have their foundations in the odd situation which arose in group one, where a headmaster refused to let the CDT teacher attend that course. On this occasion it was strongly suggested by the advisers that two CDT, and two science teachers, be given places; it was not expected that he would send the science teacher who had previously attended course one! The other two teachers also came from a school where the science and CDT advisers were particularly concerned about the lack of development in the design and technology areas of the curriculum. The head of department for CDT was selected. This school was possibly chosen again to raise the awareness of the headmaster, and other members of his staff, to recent developments in the field of technology teaching. These two returning teachers were notable on the first day of course one, for their outspoken comments which are mentioned in the assessment section for that course. Indications for the success of the first course can be gauged when it is realised that they had requested places on this second course! Twelve teachers attended the course, consisting of two science and two from CDT, from each of the three chosen schools. Some of these were definitely 'pressed men'.

Some members of this group were very familiar with the range of RML computers and were reasonably competent programmers; at the opposite end of the scale were two CDT teachers who had virtually never touched a computer and apparently had little wish to do so! This group was therefore quite different in a number of respects to the one which preceded it. While not necessarily openly antagonistic, some of the teachers were not unduly enthusiastic about the course either. In many respects this group were a true test for the effectiveness of the research instrument and allied materials.

The pre-course questionnaire described above, was administered to the participants. The responses are listed in a similar manner below; with the exception that in this instance they are coded so that some comparisons can be made with a post course questionnaire. The school is identified by a letter and the teacher with a number. The demarcation for science and CDT is made with the suffix "S" for science and "C" for CDT.

Responses to question 1 What are your hopes / expectations for the course?

A1-C. 'A better understanding of how computers can be used in the school situation to aid and back up present design. Simple ways computers can be used in school projects to control various things'.

A2-C. 'To gain a greater insight and personal knowledge of computer control applications and maybe some electronics'.

A3-S. To provide me with a link between science and CDT. I would hope to develop the control side to some extent - particularly the computer control'.

A4-S. '(1). Look at low technology ideas to be built into 1st. - 3rd. year work.
(2). Analysis of syllabuses on offer.
(3). Structure discussions of links between craft and science.
(4). Software for problem solving / CAD / Circuit Design.
(5). Finally - High Tech. Technology'.

B1-C. 'To gain methods / techniques to use computers in the CDT rooms. To increase own awareness of scope in technological application in industry and school'.

B2-C. 'To improve my knowledge and to be able to teach simple microcomputing'.

B3-S. 'To become more aware of subject area concerned in technology courses. To improve skills especially on electronics. To learn new skills - CAD. Members of **** on course more able to work together as a team and more inclined to think positively together about future plans'.

B4-S. To have the opportunity to get up to date on current developments. To learn more about the educational aspects of areas fo technology I am familiar with from academic study. To have an opportunity to work with colleagues, particularly from my own school and to have time to discuss common issues'.

C1-C. 'To gain insight into setting up a technology course in school - particularly GCSE'.

C2-C. 'An overview - have some idea about using a word processor - a little knowledge in electricity'.

No comments were received from the science teachers in school C.

The responses from eleven of the twelve participants appear as totals in the grid below, (the twelfth did not complete a form):

	None/Little	Fair	Good	Very Good
a. Electricity / Electronics.	6	2	3	
b. Microcomputing in Technology Area.	8	3		
c. Control Technology.	7	3	1	
d. Computer Aided Design	9	1	1	
e. Computer Aided Manufacturing	10	1		
f. Problem-Solving.	2	7	1	1
g. Graphic Communication.	7	4		
h. Product Design.	5	2	4	
i. Curriculum Development.	5	4	2	
j. High Tech Areas of Industry.	8	2	1	

The figures above do not indicate the good to exceptional computing skills which were readily apparent when watching three of the science teachers. One of these three was also in charge of computing within his school. One of the CDT teachers was also very conversant with the Nimbus computer and CAD software. However, once again this group of teachers had little knowledge of 'control' using computers. Three of the group were very good at electronics.

The responses to question 6 asking how the knowledge gained on the course would be applied - followed a similar pattern to those of the first group. It was however remarkable to note that seven teachers wrote that they hoped to set up technology courses in school. Five of these seven specifically mentioned links between CDT and science. This desire to form linked courses was mentioned by teachers from all three of the schools involved. This perhaps gives an indication of the desire from below within the schools, to get the system to change towards technology. Computers were regarded as an essential component of this movement.

Seven of the eleven teachers completing the pre-course questionnaire reported in response to question 4 that they had been sent on the course by their headmaster, head of department or an adviser! No comments were received in answer to question 7.

10.5. DESCRIPTION OF COURSE TWO.

The format for the course was broadly similar to that followed by course one for the first three days. It was interesting to note that the three teachers who had attended the previous course were very keen to repeat the work which they had already largely covered. The interface part of the research instrument, had been slightly modified to eliminate possibilities of computer and external power supplies being switched on at the same time. Two of the CDT teachers were found to be very reticent to learn about computers and computing. One of these eventually completed all that was asked of him but looked for opportunity to complain wherever possible. The other could be fairly described as a prime example of an untrained CDT teacher who was totally out of his depth in the subject; nevertheless he eventually completed the interface and most of the set tasks. This experience proved the ability of the materials to give enough basic information for construction and use of the interface and computer equipment. The problem of soldering was once more highlighted, even after a demonstration had been given.

Both course groups were exposed to demonstrations of an RML 480Z computer, complete with another very recent Oxfordshire interface development; which was different in the respect of operation through an 'on screen front panel'. This program works in a similar manner to the Nottinghamshire 'Bits' control software and has been developed by the micro-technology adviser at Wheatley.

An interesting difference was noted between the two groups of teachers; very few of the first group were interested in the software system which should theoretically be easier to operate than Basic programming. The second group contained more teachers already having access to, and expertise with, RML machines. This may have influenced their interest in the software as an 'off the shelf' package available to them through the county system; a secondary reason for the interest may have been that they were shown the package at an earlier stage of the course, before they had very much opportunity to experiment with the software already available to them as part of the research package.

A further development implemented with this second group was the construction of a small seven-segment display interface 'sub-board', which was used in conjunction with the research-tool interface. A problem was set to the group to find a method of making the display show the figures 0 through to 9 and then write a program to demonstrate the sequence. This problem solving project appeared to raise the level of enthusiasm demonstrated by one or two of the slower members. This mini-project was a less hectic way of teaching the process of sending the correct binary signals down to the interface from the computer. The subsequent problem of designing a vehicle control program was therefore much easier to understand.

Three quarters of the members of this group worked well and showed interest in what they were doing, despite several of them having been told to attend the training. Informal interviews during the training sessions indicated that they were generally pleased with what had been done; some were extremely positive in their feedback.

This second group of teachers was given a questionnaire intended to elicit some less inhibited feedback, and also to give a self perceived indication of success or failure of the training.

The results of the questionnaire, and an overall discussion and assessment of the success or failure of the courses as a method of raising the computer awareness of CDT teachers, is given in chapter 11.

CHAPTER 11.

An assessment of the effects of the courses.

CHAPTER 11.

AN EVALUATION OF THE COURSES.

Although there was a degree of background disparity between the research subjects on the two courses, the overall end results were remarkably similar for both groups. The following paragraphs give an indication of the direct and indirect effects which the research package and accompanying course materials had on the teachers participating in the research.

11.1. COURSE ONE.

On the fourth morning of course one, the most outspoken CDT teacher, who was previously reluctant to get involved with microcomputers, proudly arrived at the course with a second-hand BBC "B" computer, complete with disc interface and an 'APTL ROM board' full of ROMS. He openly admitted that he had gone out and bought this computer under the influence of his newly found enthusiasm, which had been gained as a result of the work on the course over the previous days.

Two of the teachers involved in the first day minor rebellion, had returned to school and found two unused BBC computers in somebody elses cupboard; they promptly appropriated them and used them in class with their software and interfaces!

The physics teacher who was totally inexperienced with craftwork or computers before the course, went back to school and organised a mini-course on interfacing for teachers within the school. Pupils were also introduced to control technology with computers by the same teacher.

The other strong minded and outspoken CDT teacher, went back to his school and demanded from his head of department, a BBC computer for his own room. (He was given one, and is now developing software and demonstrations of his own).

Another CDT teacher is known to have ordered at least one BBC Master for control purposes in his school; and openly states this is a direct result of the experience gained on the course.

11.2. Further indications of the effectiveness of this attempt at raising computer awareness in CDT teachers, and also of course organisation, can be gauged from the two independently produced sets of notes / minutes taken by course members in the plenary session discussion at the end of the last day. These are reproduced verbatim except for the removal of individuals names:

ELECTRONICS, MICROCOMPUTER AND CONTROL INSET.

23RD TO 27TH MARCH 1987.

1. Appreciated when letters are addressed personally, this helped to ensure that they reached the right people.

Appreciated the full course details sent with letter this helped to attract interest for the course.

Supply cover is essential.

Chapter 11.

Literature should make clear lunch arrangements and travelling expenses.

2. Comparisons between BBC and Nimbus made clear.

Experience and information to help teachers buy second hand equipment.

Possibly pair teachers. One experienced teacher with a less experienced teacher or science with CDT teacher.

A lot of computer jargon at the beginning, possibly too much for the teachers with little experience.

Teachers have reached different levels at the end of the course.

Learnt a lot, not always realising that it was actually happening.

Gained a lot by being able to make obvious mistakes and correcting them ourselves i.e. soldering.

The small bank of programs was very useful to start with - programming skills learnt quickly as there was a need for them. BUT, most still would not be able to program from scratch.

Allowed to find own levels and learn at our own pace with help from **** or ****, someone in group with more experience or a colleague who had just learnt him/her self.

Excellent to have an interface and a buggy to go away with. Also the literature and disc.

All have a good insight but basic knowledge is a bit sketchy.

Possibly take one day and split it into two groups - electronics/computing for those who need it.

Time table was operated flexibly to allow for outside visits and for items to be slotted in.

Paperwork has been good many snippets available.

People thinking up their own ideas for projects using the skills that were learnt.

Went straight into BASIC which was useful. Can now look at other programs and understand what the program is 'getting' at.

Appreciated the look at commercial equipment.

Feedback to **** on interfaces in school.

Two week course condensed into one week course - teachers were unlikely to attend a two week course.

Grateful for lack of homework.

11.3. THE SECOND SET OF MINUTES.

(These minutes / notes were taken by another teacher in the group sitting at the opposite end of the table).

Name of individual on letter ensured that info. reaches the person concerned.
Full mailing lists needed for Science Depts. in Oxon.

Details of course helped attract interest.

Availability of supply cover is essential.

Literature should indicate travelling expenses, supply etc.

Travelling expenses form to centre.

Some frustrated by differences in experience between course members, but perseverance seems to have bound some fruit among the less experienced.

Time Table was operated flexibly to allow outside visits to slot in, and for items to be inserted and deleted as experiences dictated through week.

Some needed more time on electronics some more time on computing.

There is no more money for further courses.

Aim of course was to make teachers more aware of developments.

Paperwork has been good. Much useful advice available.

Younger teachers will be more familiar with computers. Learn from them.

Grateful for the lack of set homework.

Some early literature might of been sent out before the course? - Not a good idea as it tends to be ignored or lost & does not seem relevant. Much better to be assimilated on course.

11.4. EXTRACTS FROM A LETTER WRITTEN BY ONE OF THE CDT TEACHERS.

'Hands on experience' always found of vital importance for teachers. Schools rarely give this opportunity to get to grips with important developments in CDT.

Course gave expert help and equipment which will be of vital importance in CDT re. G.C.S.E.

Found introduction clear and what to look for in second-hand BBC for the under-funded Departments. The explanation of computer language could have been clearer.

Electronics work clearly laid - I found no difficulty.

To look at computer hardware was very good as usually the only insight into this is through catalogues or by random chance.

I found design of buggy a relatively easy task but science teachers found it more difficult due to lack of experience.

The course as a whole has given me an insight what is needed in my school situation for the C.D.T. Dept. if we start any control.

The CDT advisers reported that they also independently received positive feedback and complimentary comments from the teachers involved.

Sending information directly to named teachers appeared to have been greatly appreciated. One of the major discussion points in the plenary sessions for both courses, (see below), was the difficulty in obtaining supply teachers and also the disruption caused to examination classes back in school. It was interesting to note that the two sets of minutes above, only once referred to the necessity of adequate supply cover.

11.5. FOLLOW-UP.

It was possible to do follow up interviews with six of the ten teachers participating in the course. All stated that they were pleased with what they had been taught and that the interface, literature and programs had subsequently proved useful in school. In at least two of the schools; other staff had experimented with the interface and programmes, and had incorporated them into their teaching.

One teacher, not attending the course, had claimed the course materials when his colleague returned to school. He had taken them home and used them on his own computer in the evenings and at weekends; thus unwittingly testing them as a distance learning package. On returning the interface to school, he had incorporated his new knowledge into his lessons. He was quite happily teaching control problems, using d.c. model motors, to fourth and fifth year pupils; in addition he was also implementing binary counting problems with first year classes. This 'accidental' or chance testing, was sufficiently encouraging to give an indication of the potential success of the package if it was employed for distance learning. This same teacher has since acquired enough materials to build four extra interfaces, and would like more if funding can be found. His use of the interface in a classroom situation also indicated two extra factors. The first was that children found no problems with its use. The second observation was that there could be a problem with wires snapping off the 'Molex' cable socket, if the board was extensively used with children. The course members had been advised to 'pot' the cables on the back of the socket with epoxy resin, so that flexing and consequent possible stress fractures of the fine wires in the ribbon cable, would be minimised. This had not been done on the cable used in this instance. An easier solution to this problem was later devised which involved encapsulating the cables with the flexible 'plastic' glue dispensed with a glue gun. This appears to eliminate any fractures at this vulnerable joint and at the same time insulates the soldered connections.

11.6. FEEDBACK FROM GROUP TWO.

This group of twelve teachers was issued with a questionnaire intended to elicit some less inhibited feedback and to give a self appraised indication of success or failure of their training. It is fully realised that it would be invidious to attempt to fully quantify and draw general conclusions from such a small sample; however, it is suggested that the trend can be demonstrated from these figures. A condensed form of the questionnaire is shown below and the results from the nine forms returned are inserted under each question heading.

POST COURSE RETURN FROM COURSE TWO.

NAME...SCHOOL..School Tel.No.....

1. What subject area do you teach? Science or CDT
(3) (6)

2. Did you use computers in your normal teaching before attending the Microcomputers and Control course? yes / no / sometimes
(7) (2)

3. Since attending the Microcomputers and Control course are you:-
(Tick as many boxes as you feel are appropriate).

(a) Making more use of computers for your normal teaching? (0)
(b) Using computers the same as before attending the course? (1)
(c) Strongly considering using computers for your normal teaching? (8)
(d) Not using computers in your normal teaching? (4)
(e) Not going to bother with computers for teaching? (0)

Comments:-

'Main problem is that the course is tailored to the BBC micro and we only have 480Z's'.

'Waiting for a CDT department to be formed and resourced'. (This comment was from a Head of CDT department)!

'Investigating the possibilities'.

4. Are you now:- (Tick the most appropriate comment box).

(a) Very confident in the use of computers:- (0)
(b) More confident with computers than before attending the course:- (5)
(c) About the same ability with computers as before attending the course:- (3)
(d) Still worried by computers:- (4)
(e) No better with computers than you were before attending the course:- (0)

5. On a scale of 1 to 5 (with 5 as the highest mark), circle the most appropriate number.
(Give a mark for each of a,b & c).

It is best to teach control technology by:-

(a) Using a program for control via a screen based input program such as Oxfordshire / RML "Control" or "Lego Lines".

1	2	3	4	5
(2)	(1)	(2)		

(b) Using a disc of pre-prepared mini programs to operate an interface with a number of examples /worksheets.

1	2	3	4	5
(1)	(3)	(1)	(1)	

(c) Having an interface and writing your own programs.

1	2	3	4	5
		(4)		(2)

6. Has the course:-

(a) Increased your awareness of the potential of computers for teaching?

ENORMOUSLY	QUITE A LOT	A LITTLE	NO
(1)	(4)	(4)	

(b) Given you more confidence in the use of computers?

ENORMOUSLY (1)   QUITE A LOT (3)   A LITTLE (3)   NO (1)

(c) Assuming you have the equipment available in school, how would you now feel about teaching control technology with computers?

CONFIDENT (2) : REASONABLY HAPPY (3) : WORRIED BUT WOULD TRY (3) : WORRIED/DARE NOT TRY (1)

7. How would you now regard yourself in terms of computer use? (Tick a box and be honest).

EXPERT   GOOD (1)   FAIRLY COMPETENT (3)   NOT VERY GOOD (5)   COMPUTER NAIVE

8. Do you enjoy using computers?   yes (6) / no / sometimes (1)

Do you regard computers as 'tools' which you think are:-

(a) a useful piece of equipment,   yes (8) / no / possibly

(b) a waste of time to bother to learn how to use,   yes / no (8)

(c) something you would like to be able to use better than at present,
yes (9) / NO

9. State what you feel are the most suitable computers for use in your school and give reasons for your choice. (If you wish you can recommend different makes of machine for the different tasks you wish to undertake).

'BBC for interfacing'.

'BBC this computer appears to offer all that is necessary for the teaching of technology'.

'BEEB - availability of software and hardware'.

'BBC'

'Have very little choice because we have network of RML - if we were planning a system now - would use BBC'.

'BBC primarily because of the parts available and the large quantity of software available'.

Chapter 11.

ANY COMMENTS ON ANY ASPECT(S) OF THE COURSE:-

A1-C. 'I found the start of the course, taking the top off a computer and naming or coding parts - utterly confusing. It did not help me to understand in simple terms how the computer worked.

Would have been better to issue the terms sheet at the start of the course because computer jargon was used despite the group being computer naive ?!

Good experience to solder PCB for first time.

But as most Oxfordshire schools have RML it would have been better if the interface was designed specifically for the RML'.

A2-C. 'That the interface be further developed for the RML'.

A3-S. 'The production of a buffer board was very valuable and this will continue to be of use in school. The use of the board with the computer needed to be a little more specifically directed'.

B3-S. 'Good. - Has made me more aware of the aspects involved in teaching 'technology' courses and of the problems that are going to be involved introducing them. I wish headteachers and heirarchy could also be made aware of the demands that are being made on CDT and Science teachers'.

C2-C. 'I feel I have a better overview of the direction CDT is now taking. However I am by inclination and training craft and arts orientated and this is the area I wish to work and remain in namely to set up Craft Design & Realisation - especially plastics and wood and if possible silversmithing.
However, I do intend in my spare time to try my hand at word processing. - I hope I have the aptitude'.

C3-S. 'Longer time was needed for those with little experience of computers to grasp the fundamentals of instruction / programming. Interface will be useful in the future'.

As stated above, the two courses were quite different because some of the teachers attending the second course were there because they had been told to attend. This to some extent affected their attitude to the work which they were asked to do. The first group of teachers were all volunteers and theoretically desperate to gain this type of training. However, it can be seen from above, that both groups had members who were to some extent reluctant to undertake what was asked of them; this came as a surprise in the first group but was not unexpected with the second course. The informal interviews during and after the courses, led to the conclusion that some of this resistance had a basis of the teachers not wishing to show their ignorance or inability with computers. In the final analysis all of those who were 'difficult', except for one (C2-C), achieved most of what was required of them.

The CDT teacher identified as A1-C above, looked for difficulties where there were none, his attitude had generally been noted as 'anti' by independent observers. His interface worked satisfactorily and he was given the information for making up the cable for an RML computer. In reality his science colleague, (who unfortunately did not return a questionnaire), was extremely enthusiastic about the interface and course materials. He immediately set about adapting them for the RML machines, (which were obviously readily accessible to these teachers within their school). This same science teacher, at great personal inconvenience, went to the trouble of further investigating the interface originating from the Wheatley centre. His unsolicited comments were that he thought the interface which they had built on the course was more useful, versatile and better designed. This teacher was obviously prepared to look at what was on offer and adapt it to his own requirements. As a school, they were given the four interfaces, information and course materials which in themselves were a substantial input of equipment and source materials for teaching. In reality it was irrelevant which computer they were going to employ to use them. The CDT teacher A1-C and his colleague from this school were definitely exhibiting some inclination of preference for RML machines because they already had them available, but it was interesting to note that he commented he would acquire BBC computers if equipping again now. Irrespective of which interface and computer system they would use, all four of these teachers would now be capable of undertaking at least some control technology with computers, and responded that they were prepared to at least try to teach it if required to do so. It was interesting to note that the three teachers from this one school who responded to the questionnaire were the least enthusiastic about the improvement which they considered they had made resulting from the course. At least one of these three was already known to be quite capable with computers; and was using one quite extensively four years ago for teaching computer aided design with large numbers of children. One of the science teachers also had responsibilities for the RML network in his school, therefore this response is not surprising.

11.7. INFERENCES AND SUMMARY.

The figures in brackets on the form above demonstrate that the training was largely successful. Eight of the nine teachers responded that they were now considering using computers in their teaching. However, because the sample is so small, there is little point here in producing extensive tables and graphs; although it is suggested that some general inferences can be made from these figures.

Another indication of the overall success of the course can be seen in the responses to the question 6.a. where one respondent claimed he had had his awareness increased enormously, four others claimed 'quite a lot' and the other four claimed 'a little'.

The teacher who responded 'no' to the question 6.b. whether his 'confidence in the use of computers had increased', was already a very competent and confident user of RML equipment for CAD in school; therefore this response is not unexpected.

The least promising of all the course members was the CDT teacher who bitterly resented the lack of funding available to him within his school. He is identified as C2-C above. He responded by letter to the original survey of all CDT teachers, indicating that there was no point in him learning about computers because he would never be able to acquire any. This negative or defeatist attitude, certainly caused him to exhibit tendencies of minimal effort in responding to the set tasks on occasions during the course. (His reading the 'Times' newspaper during a short demonstration of binary counting to the group, is a notable example). When the Vinderen Associates "PCB" software was given to all teachers to test for themselves, this teacher just drew a tangled mass of random lines and spots all over the VDU screen. Other teachers who were not familiar with electronic circuits and components before the course, made valiant attempts to produce some form of circuit layout, and appeared to gain satisfaction from their efforts. It may be possible to deduce from this observation that there needs to be at least some incentive from within the school for teachers to fully involve themselves on training courses.

The fact that both courses took place out of school appeared to be appreciated by the teachers attending. However, professional feelings of how their attendance would affect the children they normally taught, were foremost in some minds. Nearly all of those questioned, responded that they thought they had learnt more as a part of a group than they would have on their own. The uninterrupted block of time allowing full concentration was also stated to be of immense value. The five days consecutive course, appeared to be more effective than the three days and two single days. The unbroken span of time allowed continuous learning, wheras the break after the first block of time in the second course required a period of re-orientation for the teachers. It also put in false 'cut-off' points where they would not have been made in the continuous course. Both groups however agreed that it was better to have had a clean break from the school for the concentrated period of the course, and further, that they thought they had learnt a lot more as a consequence of this. This problem of teachers attending courses in term time affecting their school work, already identified by previous researchers and discussed earlier, was again highlighted in this work.

The second course was organised in a different way, partially to attempt to alleviate some of the problems of continuous disruption in school. However, there appeared to be little benefit to be accrued from the split sessions; indeed, there would appear to have been some disadvantage to the participating teachers resulting from this split session method. The author and a University colleague, observed that many of the subjects obviously found it difficult to collect their thoughts, when returning for the single day sessions, after being back in school had disrupted their concentration.

It is suggested that the continuous five day session was a more beneficial training system to employ. The learning curve for the students was very fast. They were immediately reinforcing what they had earlier learnt, without other thoughts or interruptions disrupting their concentration and thought patterns. During the second course a degree of recapitulation had to be undertaken. Although there was technically some time for the teachers to work on their own back in school between the sessions of the second course, not many took the opportunity to do so, despite having the equipment available, (in some cases).

It would appear from the results observed in these two courses, that teachers previously unfamiliar with computers and their potential, can become almost fiendishly enthusiastic about their future adoption and use; once the initial breakthrough has been made. Most appear to have an avaricious appetite to acquire equipment, by almost any means, once they have been given confidence in the use of computers.

Familiarity with one make of computer does not necessarily mean competence with another. The different versions of 'Basic' language on RML and BBC machines is confusing, although not a difficult problem to solve for a competent programmer. The availability of programmes or routines which can be readily adapted to a science or CDT teachers particular situation, would appear to be essential. Few teachers have the time, ability or inclination to write programmes from 'scratch'. Even a few simple routines offer immense opportunities to teachers with little technical computing ability. The realisation that you do not need to be able to program to operate a computer, came as an obvious relief to many of those on the courses. However, once they were using the equipment, many subjects wanted to know how and why certain things happened, and thus gained the incentive to at least alter a programme slightly.

The research has shown that there is a definite desire from both science and CDT teachers within Oxfordshire to increase their computer awareness, and a high degree of interest in attempting to do so, providing the courses can be made simple enough to be easily understood.

Chapter 12 considers some final conclusions and recommendations which can be made as a result of this research.

CHAPTER 12.

12.1. Conclusions.
12.2. The Trial Groups.
12.3. Recommendations.
12.4. Independent indications of the effectiveness of the package.

CHAPTER 12.

When attempting to summarise the results of this intensive, 'double-edged' research project undertaken by one individual, it is perhaps difficult to draw 'hard and fast' conclusions; although it is quite possible to use the information to make recommendations based on the experience gained. It is proposed that the samples of teachers used in the secondary research into the methods and effects of training teachers in computer use, although larger than envisaged at the beginning of the research, are still too small in statistical terms, to make viable definitive statements.

It is perhaps surprising that apparently very little research into aspects of training teachers in computer use in the CDT and Science / Technology areas of the curriculum has been undertaken; especially when one considers that since 1981 many eminent individuals and institutions have been heavily involved with this work. It would appear that the expertise gained has been retained by a select few; who have possibly been so involved in the massive task of providing the training, that they have had little time to undertake scientific research which would have allowed them to pass on their experience to others.

This modest research project has been able to substantiate the broad findings of Gardner (1984), who also worked with small groups of teachers in Ireland. Although perhaps a rash conclusion, it could be argued on this basis that there are some simple ground rules which can be made for training teachers in the use of computers. Some of these are indicated below.

The results of this research have certainly had some effect on CDT, and some science teachers, within the LEA area participating in the project. A more open approach to computers and their adoption by these specialist teachers has been noted from the LEA itself. Both the author and the Director of the OSSTC, now regularly receive requests for help with computer applications in science and CDT, thus indicating both an increased awareness and usage amongst these teachers.

It is suspected that the broad findings of the research would be applicable to any non-computing CDT or Science teachers within in any local education authority, and possibly also to other groups of teachers.

12.1. CONCLUSIONS.

A part of this research has been an attempt to establish what the position was regarding computers and their use by CDT teachers in Oxfordshire. It was of interest to determine whether the position was actually as bad as had been suspected by some teachers and advisers. The survey by questionnaire substantiated that some of the allegations were largely correct.

Once the situation was established, an attempt was made to produce an instrument for training and raising the computer awareness of CDT teachers. What then are the conclusions that can be drawn from these efforts?

There was, and still is, a definite need for training and raising the level of computer awareness for a substantial number of the CDT teachers in the area researched. Many of the teachers responding to the questionnaire requested training in specific uses for computers with regard to CDT. It would appear that the training required is not a 'once only' situation, but that substantial efforts to update and teach new information will have to be made, if teachers are to stay fully abreast of current developments in the field of computing and Information Technology.

The research established that 57% of the CDT teachers responding to the survey had received at least some computer training by that time (December 1986). This group represents approximately forty percent of all known possible CDT teachers within the LEA. This figure would have increased by the end of July 1987 because of the in-service training offered under the TVEI Related In-service Training and Grant Related In-service Training schemes. The training offered by these latter two methods was the first sustained and substantial attempt within the LEA for organised computer based INSET directly aimed at CDT teachers. It is perhaps interesting to note that the funding for these schemes was essentially government directed, and not provided from local sources. The advantages of the TRIST and GRIST training have been the duration of the courses involving computer use; effectively eight days of control technology and computer aided design.

There are advantages and disadvantages within the existing training schemes offered by the LEA. A major advantage is that teachers are removed from the school situation for their training, and can therefore concentrate fully on the work before them without interruptions. This can be counter-balanced, to some extent, by the disruption caused to the school and the classes which they would normally teach. Some teachers have been reluctant to miss examination groups, especially those involved in "A" level work. A further disadvantage for some schools is the time it will take for them to gain places on training courses if the schools are 'targeted by the advisers'.

An internal problem within the LEA sensed at the beginning of the research, is caused by the hitherto rigid policy of only supplying and supporting RML computers in the secondary schools within the LEA. In terms of use and reliability, there is little to choose between the RML and BBC computers. However, there is definitely more software and peripheral equipment available for the latter machine which is of use to CDT teachers. Undoubtedly the RML Nimbus computer is potentially very useful for graphics and computer aided drawing / design; although in a further study undertaken by T. Gordon (1986), (County Inspector for CDT) in Staffordshire, he came to the conclusion that IBM PC and AT computers and their close clones were the best machines for this application. Gordon also highlights the potential of the thirty two bit machines; both RML and Acorn now have these machines on the market.

Oxfordshires computing centre are reported to have refused to take up the option on an Acorn Archimedes, which perhaps is indicative of the future plans for the LEA. There is a definite demand from CDT / Technology teachers for the BBC micros; the research interviews highlighted that there is positive resentment amongst some of those interviewed, that they have not been given BBC microcomputers to use in the workshops. Many CDT teachers view the computer as a piece of capital equipment or 'tool' to be used when required, in a similar manner to any other machine in the workshops.

The policy of networking computers in a room away from the workshops, has had positive disadvantages for those CDT teachers wishing to naturally incorporate computers into their teaching. This problem has at last been acknowledged within the LEA, but little has yet been done to alleviate the situation. Some CDT departments are now laying claim to RML 380Z's, discarded by others, in a desperate attempt to get started with computing; others are adopting a cavalier attitude and buying BBC machines, regardless of the consequences. The RML network does however have advantages for CAD drawing applications for class use in Design and Communication lessons, (providing the software is made available). The conclusion which can be drawn from this, is that there is a place in schools for both networks and remote computers, and additionally, that no one make of computer should take exclusive precedence over another. As in industry, surely it should be the application, software availability and cost effectiveness, which determines the hardware. A rigid policy of buying one make of machine within Oxfordshire has certainly appeared to have a deleterious effect on computing in CDT departments; in terms of control and sensing technology at the very least.

This research established that it has been lack of equipment, or suitable equipment, rather than lack of intention by the CDT teachers, which has been the cause of delay in CDT microcomputer developments in some schools.

It is very regrettable that the foundation work of the MEP was not, and is still not, widely known and available within the LEA. Undoubtedly if access had been readily available to some of the electronics domain, computer control and sensing 'Green Files', several teachers would have moved ahead much faster than they have already managed. Teachers on the research courses seeing these publications for the first time are very keen to borrow or buy them. At least one set of these publications should be made centrally available within the LEA.

The courses will inherantly have had an effect on increasing the awareness of teachers regarding available literature, hardware and software. Attempts were made to introduce both RML and BBC machines, peripheral devices and programs to the teachers on the courses.

The time factor involved in learning how to use a computer and its allied software, must not be underestimated. Many teachers would be prepared to attempt to use a computer if they had one readily available for them to use at odd moments of peace and calm. Some of the CDT teachers who are now fairly competent with computers, reported in discussions and interviews that they taught themselves at home with their own, or borrowed, equipment. It is interesting to note that some of these competent users would not regard themselves as such; it appears that as soon as knowledge is gained, the realisation develops that there is much more to learn. It also appears that constant practise is required in the use of software if skills are not to be fairly quickly forgotten. As a result of this observation, it would appear that there is a substantial argument in favour of only learning to use a few carefully selected software packages. The problem then arises as to who will decide which packages should be adopted within an LEA.

12.2. THE TRIAL GROUPS.

Of the twenty two teachers attending the two courses, the vast majority appear to have gained a lot from the experience.

The original concept of taking computer naive teachers and raising their awareness through 'hands on' experience and an engineered 'need', appears to work effectively if given the support materials and self-incentive from the teacher. The experimental groups were not ideal for research in the respect of the differing abilities and experiences of the teachers which they contained; additionally, half of the group comprised of science teachers, whose needs may possibly be different to those of CDT teachers. To be realistic however, it is unlikely that any 'large' group will be homogeneous in ability. It is suspected that it is more likely that individual distance learning packages would be able to reach a specific target level. It was however, noticed that a positive influence on the training resulted from this very diversity of experience and backgrounds.

A considerable amount of self-help and support was given by members of the group to their colleagues. It was heartening to see some teachers who had just mastered a technique, demonstrating it to their less fortunate colleagues. The old style 'monitorial system' of education was therefore unwittingly revived and employed effectively. The system of the 'blind leading the blind', on occasions led to a very positive group spirit. The fact that science and CDT teachers were forced by circumstances to work together, resulted in both groups gaining a greater insight into the problems and abilities of their colleagues. In the majority of cases, this at least resulted in them talking to each other, and in many instances, of positive discussions for cooperation in the future. The differing skills of each are possibly complementary to the other. These characteristics must be maximised and exploited in the schools, if technology is to be taught fully effectively for the children.

The carefully structured courses demonstrated that teachers can be trained reasonably quickly in the basics of fairly complex new techniques. The factors which appear to be important to this process are:

- That they have the will and incentive to learn;

- that they have the necessary equipment readily available to them when they require it;

- the course materials must be at a very basic level and not accompanied by complex manuals;

- where possible instructions should be pictorial rather than in the form of extensive written scripts;

- instructions, information sheeets and notes are probably better given out in small sections, adopting a 'drip feed' technique, rather than presenting the subject with a possibly overwhelming full course manual;

- the course materials will work if the teachers can perceive the need for the current and next stage;

- that some understanding back-up is available when difficulties are encountered;

- the time to undertake the training is made available;

- the possibility of uninterrupted concentration on the training, over a continuous period, appears to help the process;

- that there is financial and equipment support in their teaching situation within school;

- the computer is used as a tool to aid the learning, rather than presented as an obstacle to be overcome;

- the software is totally 'user friendly' and help messages etc. are carefully implemented;

- that learning should take place in small progressive steps building on what has gone before;

- the subjects are exposed to new materials at a low enough level to build their confidence in their success; (positive feedback either self perceived or from others would appear of enormous value to the process);

- teachers like something 'useful' (preferably an object rather than literature), to take away from the course with them.

12.3. RECOMMENDATIONS.

A series of four methods for training CDT teachers in the use of computers was put to the 'Technology Advisers Group' and stated in chapter six. These recommendations are still valid here.

There would not appear to be an inexpensive method of training all those who desire, or need it, over a relatively short period of time. The distance learning packages for particular computing applications would appear to have much to offer. A slight disadvantage of this method would be the lack of tutorial back-up. This would perhaps require the establishment of a self-help group or some similar support organisation. A distinct advantage of this method for those teachers already having equipment, would be that they could have previously prepared materials at minimal cost; the costs consisting of duplicating, postage and perhaps minimal amounts of centrally owned equipment on short-term loan. If the loan packages were to contain full systems of computer equipment, then this method dramatically increases in cost. It would still however, be comparable to the annual cost of the GRIST programme, and would possibly eventually reach a larger number of teachers, but over a longer time scale. It is suspected however, that the training would not be as effective as the concentrated courses which were a feature of the TRIST training.

The training courses which take place over a five day period have a definite effect on increasing computer awareness, and consequent incentive for teachers to use them. It must be remembered here, that the second part of this research was enabled by an invitation to participate in a part of a much wider training programme.

The current Oxfordshire GRIST schemes take place over fourteen days (1987). It would be possible to gain greater integration of the course content, if the tutors were given time to work and plan the courses together before the training started. Each tutor currently prepares his own work independently. There would certainly be possibilities for integrating the 'computer control technology' and 'computer aided design' aspects of the courses, in the same way that 'electronics' and 'computer control technology' have already been amalgamated in the interventionist package designed for the research purposes above.

It would be sensible to set up a computerised record bank within the LEA to keep track of the training which each CDT teacher has received. If the advisers had control of these records, a useful database of CDT teachers and other information could also result. A mailing list label for each individual teacher could be just one small advantage of this system. This record bank would help eliminate the duplication of teachers attending the same or similar courses; places which could possibly have been better used by other teachers.

12.4. INDEPENDENT INDICATIONS OF THE EFFECTIVENESS OF THE PACKAGE.

Since the two courses described above took place, the package developed for INSET and research has been used by two other groups of teachers within Oxfordshire LEA. It has also been partially used with teachers on other courses within the Authority. The Director of the OSSTC, (where the courses have been based), estimates that between 75 and 100 teachers have now been exposed to this work. He reports that the LEA are intending to use it again in 1989. No scientific long term follow-up has been undertaken, however, indications are that the courses have increased the adoption of computers by teachers in CDT and science in the schools.

It is now apparent that the core of this work will also be used to form a module on a proposed joint Diploma course with a local academic institution.

A subsequent course to those described above, was attended by an Australian computer 'expert', Lou Endean from the University of Queensland. She participated in the course as a student, but was also undertaking research into the effects of the training programmes offered at the Oxford Schools Science and Technology Centre, under the various controlling bodies which financed and provided these courses. Although totally unfamiliar with BBC microcomputers and electronics assembly, she successfully completed both the construction of the interface and the computer control course. Positive comments on both aspects of the authors work have been made in a joint paper titled "Bridging the Gap" - Developing an INSET model for science and technology teachers. (1988 - unpublished at this time), written with

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James Fisher, Director of the OSSTC.

An American 'computer researcher', also visited the OSSTC to look at the work being undertaken with this package. The author was very surprised to learn from him, that little, if any, work was being undertaken in America along similar lines for their teachers. This visit resulted in an invitation to present a paper on the INSET work at a conference in America in March 1988. As a result of the author having heavy teaching commitments at this time, James Fisher (Director of the OSSTC) subsequently attended this conference and presented a paper.

A further formal invitation was received, (in addition to a similar informal invitation from another source), for the author to undertake a workshop for Australian teachers, at the Australian Bicentennial celebrations in Canberra during July 1988.

A publisher is also actively pursuing the author to produce a commercial version of the INSET package for publication in this country.

It is suggested that these independent sources must see at least some value in the work resulting from this research. However, as with any work of this type, the package could be developed further if given the time. A new full-time teaching commitment precludes further development by the author in the immediate future. It is perhaps this constant pressure on teachers, which makes them receptive to a simple and easily understood, completely integrated, learning package. When in full-time teaching there is little time for teachers to develop their talents for themselves. Trainers should be aware how easy it is to overestimate what is required by teachers and what they are able to assimilate in a short time.

The foundation researches, undertaken before developing the interventionist training package for this project, proved essential for giving the author a firm picture of what the students (teachers) thought they required, and further, what they would find acceptable.

The final accolade must come from an outspoken, traditional craft teacher, with no computer experience, who attended one of the research courses. He was overheard at the end of his course saying - "If I had known how easy it was to use a computer I would have bought one years ago. In over thirty years of teaching, this is the first time that any secondment within the authority has given anything back to me personally, - and my-word hasn't it been useful!" This came from a man well known to the author, over a period of twenty years. He has little time for modern developments which interfere with his craft teaching! He walked out of the door with a newly acquired computer under one arm, and a large computer controllable model he had made on the course, under the other arm.

It is perhaps this simple example and others like it, which indicate the success of this research and subsequent interventionist training!

BIBLIOGRAPHY.

(1). A & B Computing Magazine(s). (1984-'87 various). Argus Specialist Publications.

(2). Acorn User Magazine(s). (1983-'87 various) - Redwood Publishing Ltd.

(3). ALVEY, J. (1983) - "The Alvey Report on Advanced Information Technology". - (Section on schools).

(4). ASTON, M. (24.10.'86). - Times Educational Supplement. - Page 36 para. 2.

(5). BABBIE, (1973) - "Survey Research Methods", Wadworth Publishing Co, Inc, Belmont, California, USA.

(6). BAKER, K. MP - (23.1.87) - Secretary of State's speech to the SEO.

(7). BAINS G. (1986) - "Practical Interfacing with the BBC Micro" - Chapman Hall/Methuen

(8). BAINS G. (1984) - "The Better Guide To The BBC Micro". Zomba Books.

(9). BARTH, R.S. - "Open Education and the American School." Agathon Press, New York, USA.

(10). "BBC User Guide". - (1982). BBC Publications.

(11). BERNBAUM B. (1972) - Countesthorpe College UKL, - centre for educational research and innovation. "Case Studies of Educational Innovation", (Vol. 5) at the School level. OECD, Paris, France. Harvard Educational Review.

(12). BEVIS G. (1984) - "New perspectives". Computer Education 7.11.'84.

(13). BILLINGSLEY J. (Reprinted 1984) - "D.I.Y. Robotics and Sensors with the BBC Computer". - Projects for Control Applications - Sunshine Books.

(14). BIRNBAUM I. (1984 Ed.) - "Assembly Language Programming For The BBC Microcomputer". MacMillan.

(15). BISHOP A. & BISHOP O. - "Handbook of Procedures and Functions for the BBC Micro". Granada.

(16). BISHOP O. (1982) - "Interfacing to Microprocessors and Microcomputers". Newnes Technical Books published by Butterworth & Co.

Bibliography.

(17). BISHOP O.(1985) - "Easy Add-On Projects for Commodore 64, Vic-20, BBC Micro & Acorn Electron". Bernard Babani Publishing Ltd.

(18). BLACK, P & HARRISON, G. (1985) - "In Place of Confusion". Nuffield Chelsea Curriculum Trust / Trent Polytechnic.

(19). BLACKIE E. & SIMPSON I. (1985) - "Evaluating the Effectiveness of a Distance Learning Course". Bulletin of Educational Development and Research. Part 29 Spring Ed.

(20). BLY R.W. (1984 Ed.) - "The Puffin Dictionary of Computer Words". Puffin Books.

(21). BOND A M et al. (1978 Ed.) - "Understanding Solid-State Electronics". Texas Instruments Learning Center.

(22). BOSTOCK S.J. & SEIFERT R.V. (1986) - "Microcomputers in Adult Education". Croom Helm.

(23). BRACEY, G.W. (November / December 1982) - "ELECTRONIC LEARNING" - Computers In Education: What The Research Shows. - Factors for CAI Effectiveness.

(24). BRADLEY R. (1985) - "Interfacing and Robotics on the BBC Micro". - Micro Press.

(25). BRAY A, DICKENS A, & HOLMES M. (1983) - "The Advanced User Guide For The BBC Micro". The Cambridge Microcomputer Centre.

(26). BRITISH JOURNAL OF EDUCATIONAL TECHNOLOGY - No. 3. Vol 15. Oct. '84.

(22). BURKE, R. V. (December 1982) - "ELECTRONIC EDUCATION" - If You're Thinking About Developing Your Own Software, Consider This.

(27). CARPENTER I. & WILLIAMS A. (1984) - "Control Technology for All". Electronics Systems News 22-23.

(28). CHANDLER, D. (1982) - "Micro Primer - a foundation for teachers" - Study Text. MEP - Techmedia.

(29). COATS R B. (1983) - "BBC Basic". Edward Arnold Ltd.

(30). COHEN L. & HOLLIDAY M. (1979 Ed.) - "Statistics for Education and Physical Education". Harper and Row.

(31). COHEN L. & MANION. (1982 Ed.) - "Research Methods in Education". Croom Helm.

(32). COLL J, & MYERS A. (1984) - "Wordwise Plus Reference Manual."

Bibliography.

Computer Concepts.

(33). COOK M. (1984-'86) - "Micro User". Magazine published monthly by Database Publications Ltd.

(34). "COMPUTER EDUCATION". (February 1985) - Some Commonly used Methods for CAI Production.

(35). CURRAN S. & CURNOW R. (1983) - "First Steps In Basic". Windward.

(36). DEAN & WHITLOCK. (1983) - "A Handbook of Computer Based Training".

(37). DEESON, E. - The Times Educational Supplement.(24/10/86) - "Wanted: Resources".

(38). DENNY, R. - (December 1981). - School Technology - "Technology goes mobile - the Bedfordshire bus".

(39). Department of Employment, (March 1973) - "Employment and Training, Government Proposals". - Command 5250.

(40). DES (1980) Microelectronics Education Programme - "The Strategy". DES for England and Wales and Northern Ireland".

(41). DES (1981) - "The School Curriculum".

(42). DES (1985) - HMI Curriculum Matters No. 2 "The Curriculum from 5 to 16".

(43). DES (1985) - "Science 5-16: A statement of Policy". DES & Welsh Office.

(44). DES (1982) - HMI "Technology in Schools.

(45). DODD J. (1981) - "The Credibility of Distance Education". Open University Pres

(46). DODD W.P. (1985) - "Computer Conferencing Aided Learning: Some Initial Experiences." Computer Education Feb. '85.

(47). DUNN W.R. & HAMILTON D.D. (1985) - "Competencee-Based Education and Distance Learning: A Tandem for Professional Continuing Education?" Studies in Higher Education Vol 10 No. 3.

(48). Electronics Systems News - Various Editions (1983-87)

(49). ELLIOT C.R. (1985) - "Starting From Scratch - A Critical Appraisal of Microcomputers in British Schools"

Bibliography.

(50). ELLIOTT P.H. (1975) - "An Exploratory Study of Learning Styles." Doctoral dissertation, University of Illinios at Urbana-Champaign, University Microfilms No. DAH 76-06757.

(51). ENGLAND E. (1984) - "Colour and Layout Considerations in CAL Materials". Computer Education Vol. 8 No.3

(52). ENTWHISTLE N.J. & NISBETT J.D. (1973) - "Educational Research in Action". University of London Press.

(53). EVANS C. (1987) - "Science in Society". - The Impact of the Micro-Processor on Society.

(54). EVANS K.M. (1978) - "Planning Small Scale Research". NFER Publishing Co.

(55). FERGUSON J. & SHAW T. (1983) - "Assembly Language Programming On The Electron". Addison-Wesley Publishing Company.

(56). FISHER J. & ENDEAN L. (1988) - "Bridging The Gap" - Developing an INSET Model for Science & Technology Teachers. (Academic Paper OSSTC).

(57). FLEETWOOD-WALKER P. (1985) - "Distance Learning Through Tutored Video Instruction". Media in Education and Development. June 1985.

(58). FLYNN SASSCER M. & MOORE D.M. (1984) - "A study of the relationship between Learner- Control Patterns and Course Completion in Computer Assisted Instruction". PLET, Vol 21 No.1.

(59). FOTHERGILL, R. (1983) - "Electronics and Control Technology". - (An information leaflet published by MEP).

(60). FOTHERGILL R. & ANDERSON J.S.A. (1983) - "Microelectronics Education Programme Policy and Guidelines". Council for Educational Tchnology.

(61). FREEMAN R. (1983) - "Step by Step Basic". Lifelong Learning Ltd.

(62). FRIEDMAN D. (1983) - "What Is Educational Computing?". Educational Computing Nov/Dec '83.

(63). Further Education Unit (1984) - "A Framework for Action in IT - A Policy Statement".

(64). Further Education Unit (1985) - "CNC in FHE"

(65). Further Education Unit (1983) - "Computer Literacy Parts 1 & 2".

(66). Further Education Unit (1982) - "Computer Aided design In FE".

Bibliography.

(67). Further Education Unit (1983) - "Computer Aided Profiling".

(68). Further Education Unit (1984) - "I.T. Bulletins". (various issues

(69). Further Education Unit (1985) - "Taking IT With You".

(70). Further Education Unit (1985) - Fifth Generation computers - "Their implications for Further Education".

(71). Further Education Unit (1984) - "Robotic Arms - A Contribution to the Curriculum".

(72). Further Education Unit (1985) - "Supporting IT in CPVE".

(73). GARDNER, J.R. (October 1984) - "Computer Assisted Learning and In-Service Teacher Training". British Journal of Educational Technology No. 3 Vol. 15.

(74). GERVER E. (1984) - "Computers and Adult Learning". Open University Press.

(75). GILLHAM B. (1980) - "How to Write a Distance Learning Course:". (In parts 1 to 11 written with others). Council for Educational Technology.

(76). GHEE B, MILLS R, & NICHOLLS P. for MEP - "Control by BBC Microcomputer Using Machine Code". Electronics and Control Technology Domain. The Romsey Printing Co.

(77). GORDON A.T. (1985) - "Computing in Context".

(78). GOODMAN A. (1984 Ed.) - "The Colour Coded Guide To Microcomputers. MacDonald.

(79). GREENACRE L. (1982) - "Supporting Adult Learners in a Practical Environment: A 'Low Tech' Approach". Construction Industry Training Board, Open Tech Project, Kings Lynn. PLET,22,1 Educational and Training Technologies.

(80). GROSS, N., GIAGGIUNTA, J.B., BERNSTEIN M. (1970) - "Implementing Organisational Innovation" - A sociological analysis of Planned Educational Change, Harper and Row, New York, USA.

(81). HARMAN C. (1982) - "Study Skills for the Correspondence Student". National Extension College. Cambridge.

(82). HAWTHORN P.A (1985) - "Science Teacher's Companion to the BBC Microcomputer". - Macmillan.

(83). HIRST, P.H. (1971) - "Journal of Curriculum Studies" - What is

Bibliography.

Teaching?

(84). HMI (1987) - "Aspects of the work of the Microelectronics Education programme". Department of Education and Science.

(85). HODGES (1984) - From a report produced for the Economics and Social Services Research Council.

(86). HOINVILLE G., JOWELL R. & Associates (1977) - "Survey Research and Practice", Heinemann.

(87). HOWARTH J.T. (1979) - "Community Involvement and Leisure". Lepus Books.

(88). HUGHES C. (1984) - "A Beginners Guide To Simple Programming - First Steps With Your BBC Micro". Fontanna Paperbacks.

(89). HUNTLEY, I. MANGLES, T. & SLATER, G. (1985) - "Using micros with distance-learning students" -
INT. J. MATH. EDUC. SCI. TECHNOL. VOL. 16, NO. 3, 373-378

(90). Independent Schools' Microelectronics Centre. (1986) - "COMPUTERS - Their place in schools". - A policy statement.

(91). JENKINS J. (1981) - "Materials For Learning How To Teach Adults at a Distance2. Routledge & Kegan Paul.

(92). JOHNSTONE, B. (24.7.84) - The Times."World-wide explosion of school micros".

(93). KERSH, B.Y. & WITTROCK M.C. (1962) - Learning by Discovery: An Interpretation of Recent Research - "Journal of Teacher Education"

(94). KONTOS G. (1985) - "INSTRUCTIONAL COMPUTING: In Search of Better Methods for the Production of CAI Lessons". Computer Education FEB. '85.

(95). LEES R. & SMITH G. (1975) - "Action Research in Community Development".G. Routledge & Kegan Paul, London.

(96). LEWIS, R. (1983) - "Teachers, Pupils, Microcomputers." TECHNOLOGICAL HORIZONS IN EDUCATIONAL JOURNAL, February '83.

(97). LEWIS, R. (1985) - "How to Develop and Manage an Open Learning Scheme". Open Learning Guide 5. Council for Educational Technology.

(98). MADDISON J. (1983) - "Education in the Microelectronics Era". Open University Press.

(99). "Maplin Catalogue" (1986 & 1987) - Maplin Electronics.

Bibliography.

(100). McCULLOCH, JENKINS and LAYTON. (1985) - "Technological Revolution - The Politics of School Science & Technology in England and Wales Since 1945". The Falmer Press.

(101). McFARLANE. J. (1984) - EEF NEWS (insert) - "Why Schools Should Heed Industry - The Federation Explains". Engineering Employers Federation.

(102). MACFARLANE, N. MP - (November 1979) - Keynote address to the SCSST Annual Conference - 28.11.'79.

(103). Manpower Services Commission, (March 1987) - Letter to Chief Education Officers in England and Wales referring to TVEI Joint Support Activities.

(104). MARKS T. - "I Wish I Knew About the BBC Micro". Pitman.

(105). MATTHEWS, A. (1986) - Report on the meeting of Advisers, HMI's and others at Cranfield Institute of Technology - December 1985.

(106). MEAD T. for MEP (1984) Sunderland File - "Interfacing the BBC Microcomputer". Electronics and Control Technology Domain. The Ramsey Printing Co.

(107). MEGARRY J. (1985) - "Inside Information". BBC Publications.

(108). "MICROS IN EDUCATION" - ITV/C4 NOV.'86

(109). "Micro User Magazine(s)" (1983-'87) - Database Publications Ltd.

(110). MOSER & KALTON. (1971) - "Survey Methods in Social Investigation". Heinemann.

(111). MYRING L. & GRAHAM I. - "The New Technology". Usborne Publishing.

(112). NASH M. ALLSOP T. & WOOLNOUGH B. (1984) - "Factors Affecting the Uptake of Technology in Schools". (OERG research report).

(113). "NCST NEWS" - (1981-86) - Trent Polytechnic.

(114). NICHOLLS, P.F. - (March 1981). "School Technology" - Page 30. "Microprocessor control in CSE Electronics".

(115). NISBET, J., and WATT, J. (1980) - "Rediguide 26 - Case Study", Nottingham University School of Education. Oxford: T.R.C. Rediguides Ltd.

(116). OLSEN G H. & BURDESS I. (1980) - "Computers and Microprocessors Made Simple". W.H. Allen & Company Ltd.

(117). OPEN UNIVERSITY (1984) - "The TICCIT and PLATO Projects" In Educational Reader of Micros in Schools Pack.

(118). OPEN UNIVERSITY (1984) - "Adult Learning: Individual, Group and Community; Commentary. E355 Education. Open University Press.

(119). OPPENHEIM, A. N., (1973) - "Questionnaire Design and Attitude Measurement". (Open University Set Book) Heinemann, London, UK.

(120). O'SHEA T. & SELF J. (1983) - "Learning and Teaching with Computers". Harvester Press.

(121). PAWSON R. (1985) - "The Robot Book". Windward.

(122). PCB. (1986) - Vinderen Associates, Northern Ireland. (Software package).

(123). PENFOLD R.A. (1984) - Micro Interfacing Circuits - Books 1 & 2. Bernard Babani publishing Ltd.

(124). PERCIVAL F. & ELLINGTON H. (1984) - "A Handbook of Educational Technology". Kogan Page.

(125). POTTER T. (1984) - "How to make Computer Controlled Robots". Usborne Publishing Ltd.

(126). PRIGMORE C. (1984 Ed.) - "30 Hour Basic". BBC/NEC.

(127). "R.S. Components Catalogue" (1984-'87) - Radio Spares, Corby.

(128). ROUSE S. & LEWIS R. (1984) - "Study Skills at a Distance - Ten Years On". British Journal of Educational Technology No.1 Vol. 15 Jan '84.

(129). SAGE M. & SMITH D. (1983) - "Microcomputers in Education: A Framework for Research". Social Sciences Research Council.

(130). School Technology Forum (1986) - "Working Paper No. 6, Technology Across the Curriculum", National centre for School Technology.

(131). SCRIVEN J. & HALL P. (1984 Ed.) - "Programming For Education On The BBC Computer". Sunshine Books.

(132). S.E.D.C. Team for MEP (1985) - "The Book". Electronics and Control Technology Domain. The Romsey Printing Co.

(133). S.E.D.C. Team for MEP - "The MEP Analogue Sensor Manual". (Second Edition). Electronics and Control Technology Domain. The Romsey Printing Co.

Bibliography.

(134). SELF, J. (1985) - "Microcomputers in Education". - A critical appraisal of educational software. - The Harvester Press.

(135). SILLS, D.L. - "Participant Observation International Encyclopaedia of Social Science", (Vol. 11). MACMillan and Co. new York, USA.

(136). SIMON. - "Quality Programs For The BBC Micro". Micro Press.

(137). SMITH B. (1983) - "Interfacing Projects for the BBC Micro". Addison Wesley Publishing Co.

(138). SMITH J. (1984) - "Micro Knowledge". Ladybird Computer Series.

(139). STANDING CONFERENCE ON SCHOOLS' SCIENCE AND TECHNOLOGY (1985) - "Technology in TVEI - Forum Conference Report 1985". NCST Trent.

(140). STEPHENSON A P. (1983) - " Discovering BBC Micro Machine Code". Granada Publishing.

(141). SUMMERS M.K. (1985) - "Electronics 11-18: A co-ordinated Programme for the School Physics Curriculum". Physics Education 20.

(142). TATCHELL J. & BENNETT B. (1982) - "Understanding the Micro - How it works and what it can do". Usborne Publishing.

(143). Technical and Vocational Education Initiative (1987) - Arrangement for Joint Support Activities (JSA) for TVEI Background. - Letter to Chief Education Officers. MSC.

(144). TELFORD J. (1985) - "Practical Hardware Projects for the BBC Micro". Century Communications Ltd.

(145). "Times Educational Supplement". (3.12.'82) - "DoI presses for practical exams."

(146). "Times Educational Supplement". (Various Editions) - Times Newspapers.

(147)."Times Newspaper" (24.7.'84) - Kenneth Baker was speaking to the Organisation for Economic Co-operation and Development.

(148). TINSLEY, D. - Director of MSC's Open Tech Unit - "Digest-Open learning systems".

(149). THOMASSON D. (1984) - "BBC Hardware Projects". Melbourne House Publishers.

(150). THORNE, M. (24.10.'86) - The Times Educational Supplement. Extra - page 36 - para. 7.

Bibliography.

(151). TROTTER M. - "Teaching About Computer Control With The BBC Micro Computer". MEP Electronics and Control Technology Domain. The Ramsey Printing Co.

(152). WALTON, D. (November 1986). - "Hexagon". Oxfordshire computing centre publication.

(153). WATSON J. (1983) - "Mastering Electronics". MacMillan.

(154). WATSON, DERYN M. (1983) - A Model For The Production of CAL Material. - "COMPUTERS AND EDUCATION", Vol 7, No.3, 1983. Training the Teacher; Problems and Suggestions.

(155). WELDMAN J. (1983) - "The Future of Computers in Education: What are the Right Questions?" T.H.E. Journal Sept. '83.

(156). WHITESIDE T. (1978) - "The Sociology of Educational Innovation". Methuen.

(157). WILCE, H. (29.6.'84) The Times Educational Supplement.- "HMI Concern over Computer Use".

(158). WILLIS, P. "The class significance of school counter-culture." In a book by HAMMERSLEY, M., and WOODS, P. (Eds.) "The Process of Schooling: A Sociological Reader", Routledge, Kegan and Paul, UK.

(159). WINDEKNECHT G T. (1983) - "6502 Systems Programming". Little, Brown & Company Ltd.

(160). WORCESTOR R. - (1981 Ed.) - "Electronics". Hamlyn.

(161). WRAGG, E.C. (1980) - "Rediguide 11 - Conducting and Analysing Interviews". Nottingham University School of Education. Oxford: T.R.C. Rediguides Ltd.

A 'Dialog' search was made of the abstracts and publications held on the Educational Resources Information Center of the U.S. Department of Education (ERIC). Numerous additional documents, magazines, newspapers and books were also 'sifted' in addition to those mentioned above.

The direction of the research also ensured that a considerable computer hardware and software review was also undertaken during the course of this work.

APPENDICES.

1.a. The survey questionnaire.
1.b. Printouts of the fields and screens used for the database files.

2.a. Pre-course questionnaire.
2.b. Post-course questionnaire for course two.

3. A reduced version of the course package materials.

4. Software included with the course materials.

5. Course Information for Research Subjects.

APPENDIX 1.

1.a. The survey questionnaire.

1.b. Printouts of the fields and screens used for the database files.

NAME.......................................SCHOOL...............................School Tel.No.........

ADMINISTRATION. QUESTIONS 1,2 & 3 TO BE FILLED IN BY HOD's OR PERSON I/C CDT COMPUTING.

1. How many computers does your department have regular access to? ....

2. Give the quantities of each make:-

(a) RML 380Z [ ] RML 480Z [ ] RML Nimbus [ ]
(b) BBC Model A [ ] BBC B [ ] BBC B+ [ ] BBC Master [ ] BBC Master compact [ ]
(c) Sinclair ZX81 [ ] Sinclair QL [ ] Sinclair Spectrum [ ] Sinclair Spectrum + [ ]
(d) State any other makes and quantities:-

3. How many of these were/are:-

(a) Partially funded by the Government/DOI scheme, (if known); .....
(b) Bought new, (excluding (3a) above); .....
(c) Acquired second hand; .....
(d) The personal property of staff. .....
(e) Does the school have a computer network? yes / no Make of machines networked ....
(f) Does your department use the network system in school? often / sometimes / no

Does your department own or use regularly, any of the following? (Please indicate how many).

Monochrome monitor	[ ]	Colour monitor	[ ]	Disc drive(s)	[ ]
Acorn Z80 2nd processor	[ ]	Torch Z80 2nd processor	[ ]	6502 2nd processor	[ ]
Dot matrix printer	[ ]	Daisy wheel printer	[ ]	Plotter	[ ]
Robot arm	[ ]	Turtles / Buggies	[ ]	CNC machinery	[ ]
Modem	[ ]	Teletext adapter	[ ]	Sideways ROM board	[ ]
Sideways RAM board	[ ]	RAM disk	[ ]	Graphics Tablets	[ ]

TO BE COMPLETED BY ALL CDT / TECHNOLOGY TEACHERS.

4. Do you use computers for paperwork or administration in CDT? yes/no (If NO go to Q.6).

5. If the answer to 4 is yes, do you:-

a. Use any of the following wordprocessors?

Write [ ] View [ ] Wordwise (+) [ ] Perfect Writer [ ]
Word [ ] Wordstar [ ] Edword [ ] Merlin Scribe [ ] Inter-word [ ]
State any others not listed?

b. Use any of the following databases?

Stardatabase [ ] Perfect filer [ ] Inter-base [ ] Beebbase [ ] Superfile [ ]
Solidisk D/base [ ] Gemini D/base [ ] Quest [ ] Micro query [ ] Fileplus [ ]
Masterfile [ ] Inform [ ]

State any others not listed?

c. Use any of the following spreadsheets?

Viscalc [ ] Inter-sheet [ ] Viewsheet [ ] Perfect calc [ ] Beebplot [ ]
Ultracalc [ ] Multiplan [ ]
State any others not listed?

6. Please give brief details of any other administration for which you use computers:-
i.e.:- pupils marks [ ] profiles/records [ ] examination statistics [ ] timetabling [ ] state other uses.

7. State the software and computer which you have used and found to be the most useful for school in 6 above.

The survey is mainly about computer use within CDT, but please feel free to include a brief description of interesting applications which are taking place elsewhere in school.

8. TEACHING APPLICATIONS IN CDT.
Do you use RML or BBC micros for teaching any of the following? (Tick box under relevant column).

	RML	BBC		RML	BBC		RML	BBC
Control Applications			Word processing			Programming		
Graphics			Database Access			Data-logging		
P.C.B. Design			CNC control			C.A.D.		

Others:-

Do you require help or support to enable you to incorporate any of these applications into your teaching programme? (If the answer is yes please indicate which applications).

Control Applications		Word processing		Programming	
Graphics		Database Access		Data-logging	
P.C.B. Design		CNC control		C.A.D.	

Others:-

9.HOME AND PERSONAL USE.

(a) Do you own any RML micros at home? yes / no
If the answer is yes, which RML model(s)?

(b) Do you own any of the Acorn range of BBC micros at home? yes / no
If the answer is yes, which BBC model(s)?

(c) Tick a box if you borrow a computer to use at home (from any source).
RML [ ] BBC [ ] SPECTRUM [ ] OTHER [ ] (State make)

(d) Name any other make of computer(s) you own or use at home:-

What do you use your home computer for?

School work	[ ]	Playing games	[ ]	Writing programs	[ ]
Control Applications	[ ]	Word processing	[ ]	Comms. Applications	[ ]
Graphics	[ ]	Database Access	[ ]	Data-logging	[ ]
P.C.B. Design	[ ]	CNC control	[ ]	C.A.D.	[ ]

Others:-

10. Can you:-
(a) program in basic? yes / no / some
(b) program in assembly language? yes / no / some

(c) How would you regard yourself in terms of computer use? (Tick a box and be honest).

EXPERT [ ] GOOD [ ] FAIRLY COMPETENT [ ] NOT VERY GOOD [ ] COMPUTER NAIVE [ ]

11. Do you enjoy using computers? yes / no / sometimes
Do you regard computers as 'tools' which you think are:-
(a) a useful piece of equipment, yes / no / possibly
(b) a waste of time to bother to learn how to use, yes / no
(c) something you would like to be able to use, yes / no.

12. GENERAL INFORMATION.

(a) Have you received any LEA or DES training on computers and their use? yes / no

(b) If yes approximately how many hours? ....

13.(a) Would you find a use for a very basic instruction guide to help teachers become more aware of computing applications in CDT. yes / no / possibly

(b) Assuming a 'package' could be assembled containing a BBC micro + leads, interface, items of equipment to control, such as a robot arm or demonstration CNC machine together with a very simple user guide and software reviews. Would you make use of such a 'package' if it was available for short term loan, (3-4 weeks)? yes / possibly / no.

14. Do you feel that a 'package' of this type would:-
(a) help you to increase your computer awareness, yes / possibly / no
(b) Give you incentive to learn more about the subject, yes / possibly / no
(c) Stimulate interest in the pupils you teach, yes / possibly / no
(d) Be a waste of time for someone to assemble, yes / possibly / no

15.(a) What model computer(s) do you feel would best suit your requirements in school?

(b) What model computer(s) would best suit your requirements, (if any), at home?

ANY COMMENTS:- (Use back of paper or attach a letter). i.e. Constructive criticism of any machine or software. Please feel free to promote here any non-DOI supported make of computer and software with which you are familiar.

```
SCHOOLS CDT TEACHERS    13/11/1986
----------------------------------------
FILE   LENGTH      183 records
FILE   USED        41 records
RECORD LENGTH      536 characters
----------------------------------------
*** FIELD NAME LIST ***

1         S    STAFF    N
2         S    TEL      S
3         S    TYPE     S
4         S
5         S
6         S
7         S
8         S
9         S
A         S
ADDRS     S
B         S
C         S
COMMENTS  S
D         S
E         S
F         S
FORMS     N
G         S
H         S
HM        S
I         S
SCHOOL    S
----------------------------------------
*** INPUT CARD ***

 SCHOOL ..............................

ADDRESS ...............................
.......................................

 TEL.No. ............. TYPE ...........

 STAFF ...    FORMS ...

 1 ................... A ..............
 2 ................... B ..............
 3 ................... C ..............
 4 ................... D ..............
 5 ................... E ..............
 6 ................... F ..............
 7 ................... G ..............
 8 ................... H ..............
 9 ................... I ..............

 HEADMASTER .........................

COMMENTS ..............................
.......................................
----------------------------------------
```

CDT COMPUTING DISC B   13/10/1986

FILE LENGTH   774 records
FILE USED   82 records
RECORD LENGTH   127 characters

*** FIELD NAME LIST ***

1	N	ED	S	PW	S
380	N	FP	S	Q	S
3A	N	GD	S	QL	N
3B	N	GT	N	RD	N
3C	N	IB	S	SB	S
3D	N	IN	S	SCL	S
3E	S	IS	S	SD	S
3F	S	IW	S	SF	S
4	S	MC	N	SP	N
480	N	MF	S	SRAM	N
650	N	MOD	N	SROM	N
A	N	MON	N	T8	N
A8	N	MP	S	TTX	N
ARM	N	MQ	S	TUR	N
B	N	MS	S	UC	S
BB	S	MST	N	VC	S
BP	N	NAME	S	VS	S
BPT	S	NET	S	VW	S
CNC	N	NIM	N	WD	S
COL	N	P	N	WR	S
DD	N	PC	S	WS	S
DMP	N	PF	S	WW	S
DWP	N	PL	N	Z81	N

*** INPUT CARD ***

NAME .... SCL ....
1 .. 380 .. 480 .. NIM .. A .. B .. BP
.. MST .. MC .. Z81 .. QL .. SP ..P ..
3A .. 3B .. 3C .. 3D .. 3E . NET......
3F . MON .. COL .. DD .. A8 . T8 . 650
. DMP .. DWP .. PL .. ARM .. TUR .. CNC
.. MOD .. TTX . SROM . SRAM . RD . GT .
4 . WR . VW . WW . PW . WD . WS . ED .
MS . IW . SB . PF . IB . BB . SF . SD .
GD . Q . MQ . FP . MF . IN . VC . IS .
VS . PC . BPT . UC . MP . 6A

CDT COMPUTING DISC C   13/10/1986

FILE LENGTH   169 records
FILE USED   81 records
RECORD LENGTH   580 characters

*** FIELD NAME LIST ***

10A	S	7B	S	9SW	S
10B	S	8A	S	9WP	S
10C	S	8B	S	9WPG	S
11	S	8C	S	BBC	S
11A	S	8D	S	CA	S
11B	S	8E	S	CAD	S
11C	S	8F	S	CNC	S
12	S	8G	S	COMMENTS	S
12B	N	8H	S	DA	S
13	S	8I	S	DL	S
13B	S	9A	S	GR	S
14	S	9B	S	HOME	S
14B	S	9C	S	NAME	S
14C	S	9CA	S	OT	S
14D	S	9CAD	S	OTH	S
15	S	9CNC	S	OTHER	S
15B	S	9COM	S	OTHR	S
6A	S	9D	S	PCB	S
6B	S	9DA	S	PG	S
6C	S	9DL	S	RML	S
6D	S	9GR	S	SCL	S
6E	S	9PCB	S	SPEC	S
7	S	9PG	S	WP	S

*** INPUT CARD ***

NAME .... SCL ....
OTHER ....
6A . 6B . 6C . 6D . 6E . 7 ....
....
7B ....
....
CA .. WP .. PG .. GR .. DA .. DL .. PCB
.. CNC .. CAD .. OTH ....
8A . 8B . 8C . 8D . 8E . 8F . 8G . 8H .
8I . OTHR ....
9A . 9B ....
9C . 9D ....
RML . BBC . SPEC . OT ....
HOME ....
9SW . 9PG . 9WPG . 9CA . 9WP . 9COM .
9GR . 9DA . 9DL . 9PCB . 9CNC . 9CAD .
10A . 10B . 10C ... 11 . 11A . 11B .
11C . 12 . 12B .. 13 . 13B . 14 . 14B .
14C . 14D . 15 ....
15B ....
COMMENTS ....
....
....

INITIAL STATISTICS FOR COMPUTERS IN CDT. OXFORDSHIRE. 2.12.86.

Number of records entered:-76 from 28 schools.

Do you have a network? 24
Does your department use it? 6 reported rarely or sometimes. 16 SAID NO

4. Do you use computers for CDT admin. No 55 yes 21

5. Of those 21:-

Write (3)	view (5)	WW (13)	PW (3)	
Word (0)	W/star (5)	Edword (1)	Mer.Sc.(0)	Int/wd (3)
St/base (5)	P/Filer (5)	Quest (8)	M/query(3)	M/File (2)
Multiplan (3)	Perf/calc (2)	Quick/calc (1)		

6. Marks (11) Profiles (11) Ex/stats (8) T/T (4)

8.

	RML	BBC		RML	BBC		RML	BBC
Cont/App	1	12	Word/proc	5	6	Progmng	1	3
Graphics	2	12	Dbase/Acc	5	5	Data-log	1	1
P.C.B. Dsn	0	5	CNC/cont	1	5	C.A.D.	4	12

Do you require help or support

Cont/Appl	33	Word/proc	22	Progng	24
Graphics	40	Data/Acc	19	Data-log	16
P.C.B. Dsn	20	CNC cont	29	C.A.D.	44

9.(a) Do you own any RML micros at home? yes (1)

(b) Do you own any of the Acorn range of BBC micros at home? yes (13)

(c) Tick a box if you borrow a computer to use at home (from any source).

RML (10) BBC (17) SPECTRUM (1)

10. Can you:-
(a) program in basic? yes (14) no (32) some (25)
(b) program in assembly language? yes (3) no (66) some (2)

(c) How would you regard yourself in terms of computer use?

EXPERT (1) GOOD (6) FAIRLY COMP. (15) NOT VERY GOOD (25) COMP. NAIVE (23)

11. Do you enjoy using computers? yes (40) no (9) sometimes (18)
Do you regard computers as 'tools':-
(a) a useful piece of equipment, yes (56) no (3) possibly (8)
(b) a waste of time to learn how to use yes (3) no(62)
(c) something you would like to be able to use, yes (63) no (2)

12.(a) Have you received any LEA or DES training? yes (44)

10 have received more than 20 hours training only 3 of those above 30 hours.

13.(a) Use for instruction guide yes (60) no (3) possibly (7)

(b) Assuming a 'package' for short term loan, yes (53) possibly (15) no (2)

14.(a) Increase your computer awareness yes (54) possibly (10) no (2)
(b) Give incentive to learn about the subject, yes (50) possibly (12) no (6)
(c) Stimulate interest in the pupils you teach. yes (48) possibly (14) no (4)
(d) Be a waste of time for someone to assemble, yes (3) possibly (7) no (56)

15.(a) What model computer(s) do you feel would best suit your requirements in school?

3 RML 480z + 6 Nimbus; of those some also wanted BBC's and are included with the 44 teachers who want BBC's.

(b) What model computer(s) would best suit your requirements, (if any), at home?

1 RML 480z + 3 Nimbus of these some also suggested BBC's (34), 10 also suggested Amstrads.

APPENDIX 2.

2.a. Pre-course questionnaire.

2.b. Post-course questionnaire for course two.

PRE-COURSE QUESTIONNAIRE FOR DELEGATES.

Name.... School.... Department....

1. What are your hopes/expectations for the course?

2. PLEASE TICK BOXES AS APPROPRIATE

AREAS Knowledge (K), Commercial(C), and Teaching Experience (T), of AREAS listed.

	None / Little	Fair	Good	Very Good
	K T C	K T C	K T C	K T C
a. Electricity / Electronics.				
b. Microcomputing in Technology Area.				
c. Control Technology.				
d. Computer Aided Design				
e. Computer Aided Manufacturing				
f. Problem-Solving.				
g. Graphic Communication.				
h. Product Design.				
i. Curriculum Development.				
j. High Tech Areas of Industry.				

3. Please expand on headings (a) to (j) in Question 2.

4. How did you come to be involved in the Course?

5. Please comment on the advantages / disadvantages of the way in which this course has been organised/timetabled?

6. How do you intend to use the expertise gained on this course?

7. Any other comments at this stage?

NAME..SCHOOL.................................School Tel.No.........

1. What subject area do you teach? Science or CDT

2. Did you use computers in your normal teaching before attending the Microcomputers and Control course? yes / no / sometimes

3. Since attending the Microcomputers and Control course are you:-
(Tick as many boxes as you feel are appropriate).

(a) Making more use of computers for your normal teaching? [ ]
(b) Using computers the same as before attending the course? [ ]
(c) Strongly considering using computers for your normal teaching? [ ]
(d) Not using computers in your normal teaching? [ ]
(e) Not going to bother with computers for teaching? [ ]

Comments:-

4. Are you now:- (Tick the most appropriate comment box).

(a) Very confident in the use of computers:- [ ]
(b) More confident with computers than before attending the course:- [ ]
(c) About the same ability with computers as before attending the course:- [ ]
(d) Still worried by computers:- [ ]
(e) No better with computers than you were before attending the course:- [ ]

5. On a scale of 1 to 5 (with 5 as the highest mark), circle the most appropriate number.
(Give a mark for each of a,b & c).

It is best to teach control technology by:-

(a) Using a program for control via a screen based input program such as Oxfordshire / RML "Control" or "Lego Lines". 1 2 3 4 5

(b) Using a disc of pre-prepared mini programs to operate an interface with a number of examples / worksheets. 1 2 3 4 5

(c) Having an interface and writing your own programs. 1 2 3 4 5

6. Has the course:-

(a) Increased your awareness of the potential of computers for teaching?

YES / ENORMOUSLY [ ] YES / QUITE A LOT [ ] YES / A LITTLE [ ] NO [ ]

(b) Given you more confidence in the use of computers?

YES / ENORMOUSLY [ ] YES / QUITE A LOT [ ] YES / A LITTLE [ ] NO [ ]

(c) Assuming you have the equipment available in school, how would you now feel about teaching control technology with computers?

CONFIDENT [ ] REASONABLY HAPPY [ ] WORRIED BUT WOULD TRY [ ] WORRIED AND DARE NOT TRY [ ]

7. How would you now regard yourself in terms of computer use? (Tick a box and be honest).

EXPERT [ ] GOOD [ ] FAIRLY COMPETENT [ ] NOT VERY GOOD [ ] COMPUTER NAIVE [ ]

8. Do you enjoy using computers? yes / no / sometimes

Do you regard computers as 'tools' which you think are:-

(a) a useful piece of equipment, yes / no / possibly

(b) a waste of time to bother to learn how to use, yes / no

(c) something you would like to be able to use better, yes / no.

9. State what you feel are the most suitable computers for use in your school and give reasons for your choice. (If you wish you can recommend different makes of machine for the different tasks you wish to undertake).

ANY COMMENTS ON ANY ASPECT(S) OF THE COURSE:-

APPENDIX 3.

A reduced version of the course package materials.

In the interests of brevity, much of the detailed project information has been left out of this section. Some of the course materials contained in this appendix were adapted from work published by others; notably the MEP for some of the information relating to BBC computer ports, and Dr. John Shaw in an OSSTC information sheet for some of the information on stepper motors. This expedient resulted from a severe restriction on development time when designing the training programme. All other work relating to the interface design, drawings and construction guide, emanate from the author of this thesis. These materials were specially designed and assembled as a research instrument package for training teachers; and for the ultimate purpose of evaluating the effects of that training in an interventionist action research programme.

These materials were used on tutored courses with the advantage of verbal explanations and immediate back-up for the participating students. However, there are at least two known successful cases of these materials being used independently by teachers, as 'distance learning' packages.

THE OXFORD INTERFACE & COURSE MATERIALS.

This low cost, simple interface, was initially developed for training and raising the computer awareness of Oxfordshire L.E.A. Science and C.D.T. teachers. It has been successfully deployed on INSET courses and in the classroom, at Oxford Schools' Science and Technology Centre in the Clarendon Laboratory at the University of Oxford. Development work was undertaken during the 1986 Academic Year. Today, after extensive trialling at Oxford, the interface could be made more widely available.

The basic philosophy behind the package, is to encourage the student to make an interface which can subsequently be taken away from a course and used in their own school, or at home, for reinforcing their learning. The package operates on the basis that learning will take place following the establishment of the need or curiosity of the student to want to know more. e.g. Once the student has constructed the interface and seen it tested, he will want to use it and then possibly improve the trial programme etc. The literature and accompanying software is deliberately designed at a simple level and is capable of leading the student through the course in small steps. These materials have been succesfully completed by a twelve year old child.

Primarily intended to be used with the BBC model 'B' and Master Microcomputers, the interface is supplied in kit form for construction by teachers of Science and C.D.T. and also competant school pupils having access to simple tools. Full details to allow construction and testing are enclosed, together with a Software starter pack.

In basic technical terms, the Oxford Interface is designed to be driven from the User Port of the BBC Microcomputer to give 6 relay driven outputs and 2 inputs, or alternatively 8 outputs to Light Emitting Diodes only. If employed in this latter configuration it could be used on any computer with an addressable parallel port such as a BBC printer port. Provision has been incorporated to take output lines to another board for driving Stepper Motors or other control or sensing devices. The two lines which can be configured as inputs to the user port can also be set up as outputs to another board. Additionally provision has been made: for fitting a Seven Segment, Light Emitting Diode Interface sub-board, and for Analogue

Interface Course.

Lines to be connected to the Interface.

Before commencing construction all but the most competant (electronically) are strongly advised to read the booklet 'How to build the Oxford Interface'. Constructors should also check the components supplied against the listing, and ensure that they have the basic tools necessary for construction.

The constructional and testing process has been designed to ensure that by the time the interface is built and tested, the user will have gained the confidence to go forward, extend the device, and use it within the classroom. Accordingly, basic details of simple extension devices and curriculum materials have been included in the booklet supplied.

Interface Course.

CONSTRUCTIONAL AND USER GUIDE.

INDEX

INTRODUCTION TO COMPUTERS AND MICROCOMPUTERS.

1. WHAT IS A COMPUTER?

Primarily it is a calculating machine which can store a vast amount of information. It is comprised of huge numbers of minute electrical switches (gates) which can either be set on or off.

2. WHAT CAN IT DO?

This calculating machine can be programmed to carry out 'logical' operations such as transferring information from one part to another, or it can perform arithmetic calculations.

MILESTONES IN COMPUTER DEVELOPMENT.

(1) 1st Mechanical Calculator developed and produced by Blaise Pascal in 1642.

(2) In 1801 a Frenchman called Jacquard invented a punch card system for controlling the threads in a weaving loom.

(3) Charles Babbage produced his 'Analytical Engine' in 1833. This device could perform calculations automatically using punched cards - this was the first true digital computer.

(4) In 1943 the British Army developed a computer to produce artillery firing charts - this was the first electronic computer.

(5) 6 years later this computer moved into the research environment of Cambridge University. The parallel lists below are provided for comparison of the efficiency of the machines:

1950's	1980's
32' x 8' x 4'	1/4" x 1/4" x 15 THOU
4000 Valves	7000 Components
6 miles of wire	Reliable
100,000 Joints	
27KW	5mW
Air Conditioned	-55 - +125 C
	100x More Powerful
500,000 Inst/Sec	2,000,000 Inst/Sec
£1,000,000	£1,000
£500,000 per annum software costs	£50 per annum software costs

3. WHAT IS IT COMPRISED OF?

Clearly there are many designs but all following the basic structure.

Each has: a Central Processing Unit (CPU);
an Input Unit;
a backing Unit;
an output Unit.

The C.P.U. comprises

1. A control unit - within which all the computer functions are carried out. It also interprets and carries out the instructions contained in a program.

2. A main store - which is an extremely fast access storage facility, typically it functions in nanoseconds (one thousand millionth of a second).

3. An arithmetic unit - which is the main centre of operations, here calculations are performed and the logical processes of selecting, sorting and comparing information take place.

Interface Course.

4. Registers - which are small stores that hold data to be worked on in a calculation. These stores only give up their information when instructed to do so. Data can be transferred from one register to another.

The Input Unit - reads the information to be stored and converts it into electrical impulses which can be used in arithmetical calculations.

The Backing Store - stores data permanently, usually in the form of recordings on magnetic material. It contains the vast majority of material (data) a computer can deal with.

The Output Unit - presents the result of computer operations. This may be in the form of; printed material, tape or disc, V.D.U. (television) display or card etc.

4. COMPUTERS HAVE THE FOLLOWING:

BULK MEMORY	INPUT	OUTPUT
MEMORY		MICROPROCESSOR

(Input is usually through such devices as keyboard, Disc Drives and Tape. Output is usually done through a V.D.U. or Printer.

The memory holds instructions and data, and the Microprocessor does all the arithmetic and logical work.

5. HOW DOES IT WORK?

Basically - Information is fed in; it is processed and the results are sent out to the appropriate display or store.

6. WHAT CAN IT BE USED FOR?

Individual Learning

Simulations and Models

Electronic Blackboard

"Number-Crunching"

Interface Course.

Information Retrieval

Games

Administration

Word Processing

Data Capture and Display

Control

Interactive Video Activities/Teaching

Computer Aided Design/Manufacturing

7. COMPUTER AIDED LEARNING.

ADVANTAGES	DISADVANTAGES
Own Pace	Isolation
Active Involvement	Cost
Motivation	Unfamiliarity
Extension of Lab Work	
Frees Teaching/Workshop Staff	
Computer Acceptance	
Distance Learning	

8. TODAYS MICROCOMPUTER.

The modern microcomputer is the result of technological development and scientific advances. It is effectively a miniaturised large computer whose whole comprises of all the basic components and functions described above. Typical of a modern microcomputer would be the BBC range described in the following section.

1.1. INTRODUCTION TO THE ACORN MICROCOMPUTERS.

The range of Acorn microcomputers has progressed from the Acorn Atom to the very successful range of machines generally known as the "BBC micros". These machines were developed by Acorn and sold under a licensing agreement with the British Broadcasting Corporation. These computers have been extensively used in educational programmes during the early 1980's.

The early BBC Model "A" machines had 16k of user RAM (which was a major advance at the time of release). They were fitted with "Basic 1 ROM's" and an operating system which generally would not allow control of the expansion ports: (these ports were not fitted to model "A" micros). Most of the later machines had an OS 1.0 or higher operating system, which would allow use of disc drives when the interface was added and also access the user port, 1 megahertz bus and tube. Most model "A" machines were fitted with an issue 2 or 3 board. Many of these machines were subsequently upgraded by their owners to 32k RAM machines almost identical to the model "B". The full upgrade required replacement of the operating system, the addition of RAM chips, port sockets and the replacement of the early linear power supplies with the much improved switched mode power supply. The linear supply was black in colour and did not have an auxiliary socket for driving peripheral equipment. The switched mode supplies have a gold coloured case.

The BBC model "B" machines when they wer launched, were justly regarded as the standard for judging all other micro-computers. It was fitted as standard, with a wide range of peripheral ports and was easily upgraded to take a disc drive. A considerable amount of forethought had gone into the design of the machine; although it was probably unforeseen that the Intel 8271 disc controller microchip would be so difficult to obtain in the quantities which were subsequently required. There were considerable shortages of these chips in 1984-85 which by the mechanism of supply and demand forced the price of a disc interface to the £120 level, (the same interface in 1986/87 costs around £45).

As a result of this development, there was a positive eruption of firms producing disc interfaces. Many of these also supplied disc drives and other peripherals from their own or other independent sources. Some of todays relatively large companies, started by selling 'add-ons' for the BBC "B" micro-computer, sometimes from a spare bedroom in a domestic house. It is perhaps a tribute to the original concept of this machine that many of these companies are still in business and have not had to diversify to other ranges of micro-computers. Watford Electronics and Solidisc are two examples of these companies. It is also interesting to note that competition has led to lower prices and a very wide range of equipment, software and firmware for the machine.

Some early BBC B's were fitted with an operating system on a 'butterfly' board which consisted of 2 x 8k eproms, these were mainly found on issue 3 boards. Acorn later offered an upgrade to an OS 1.2 which was conventionally blown in into a PROM. Issue 3 machines were fitted with Basic 1; this was also the case with some early issue 4 boards. In late 1983 virtually all machines were fitted with OS 1.2 and an upgraded version of the Basic ROM known as Basic 2, which cured a few minor 'bugs' identified in Basic 1. Some programs written for Basic 2 will not run properly on a machine fitted with Basic 1. The issue 7 board released in 1983 was subsequently very little altered and proved to be a very reliable computer.

In 1985 a new board was designed which had 32k. of user RAM and an additional 32k. sideways or shadow RAM. (Aries shadow RAM boards had been available for BBC B's from an independent source for a long time previous to this date). The shadow RAM could be used to take care of the screen handling, thus freeing more of the 32k. user RAM for programmes. This new machine was labelled the BBC B+ and was initially available as a 64k. machine. A 128k. version was released at the end of 1985 but was only produced for a very short time. Both versions of this machine were fitted as standard with Acorn 1770 ADFS (Advanced Disc Filing System). Both machines are reliable and well made but were only on the market for a relatively short time before the "Master 128" machines appeared in February 1986. Consequently, there is little specially written software available to take advantage of the extra capacity in these machines.

The "Master 128" machine then emerged. This machine is 'upwardly compatible' with the previous machines to a high degree. It had both ADFS and DFS built in as standard and contains a range of Acorn software built into a 128k. 'mega-rom', master chip, operating system. A battery backed memory is contained within the machine to maintain the preferred configuration of the user. Early machines incorporated a 3 volt lithium battery but because of reported fire hazard problems, Acorn subsequently upgraded all machines to employ an alkaline battery pack. In addition to the normal keyboard the "Master" has a numeric keypad on the East side and the BREAK key has been moved one space to the right of the red function keys.

As an additional precaution the break key was also fitted with a screwdriver operated lock. The cursor keys have also been repositioned in a diamond format.

All the components are soldered into the main computer board, thus making potential reliability very high. The machine makes use of nine custom built integrated circuits which reduces both the number of components used and the power consumed. Paradoxically the computer has a much larger capacity power supply, and will apparently happily run two disc drives, a co-processor and other peripherals, for many hours at a time without objection. The computer case has also been strengthened to allow a monitor to stand on it.

In August 1986 the "Master Compact" was launched. This computer was aimed at the education sector and home computer market. The machine has a separate keyboard / computer box. The power supply and a 3.1/2" disc drive are contained in a monitor stand / plinth arrangement. The machine uses an ADFS and has a configurable EEROM (Electrically Erasable Read Only Memory), which can be set up by the operator when the machine is switched on. The peripheral ports use continental style "D" sockets for most purposes and are probably a reflection of the influence Olivetti has had on the design of the machines since their amalgamation with Acorn. The lack of a user port was noted almost immediately by customers and today an add-on unit is available from a third party supplier. This unit gives the machine a User and Analogue Port.

The keyboard is a departure from the normal BBC machines; it uses a membrane 'bubblepad' rather than individual switch keys.

Against a background of great interest from many of those in the educational and computing world, Acorn finally released details of the "Archimedes" range of computers in June 1987. The initial release was limited; supplies being made available to computer dealers, press and educationalists. This new microcomputer is expected to be extremely powerful and incorporates a 32 bit processor. With this range of equipment, Acorn effectively leaped over the 16 bit computers and looked towards the future.

The Archimedes range incorporates a reduced instruction set chip (RISC), which gives an advertised effective increase of processing speed of between 20 and 70 times greater than that attained by the BBC "B". The computers have been designed with built in expansion possibilities. There are a set of sockets to contain extra RAM chips in the lower specification machines, and all are able to be fitted with newly designed 'podules'; which will give the familiar BBC output ports and allow different languages to be utilised. Several well respected companies are reported to be writing software to match the expected capabilities of the new machine.

The other machine produced by Acorn was the "Electron". This was aimed at the home market in competition to the Sinclair "Spectrum". Extensively advertised as a baby BBC, it never received the success it deserved. A few of these machines found their way into schools. With suitable expansion boxes (Slogger etc.), they can still be quite useful computers.

1.2. ROM SOCKETS.

One of the most useful features of the BBC range of computers is the built in ability to expand the Read Only Memory, referred to as "ROM" by plugging in pre-programmed integrated circuit chips. All Acorn manuals and technical literature refer to the machine in terms of the points of a compass e.g. the back of the machine where the output sockets for RGB, video, cassette etc. are positioned, is referred to as the North of the machine, the power side is West, the keyboard South when looking at the machine from the top of the computer with the keyboard in the normal working position.

There are normally five sockets on the early micros before the "Master" series of machines. Of these five sockets, one on the West of the bank always contains the operating system, (MOS ROM) in a standard machine. The ROM containing the Basic language is usually positioned next and then the Disc Filing System (DFS) ROM.

The normal practice is to remove the Basic ROM and position it into the right hand (East) socket when other ROM's are added, this is because the machine 'pages' or reads the memory bank starting from the East. If the ROM positioned in that socket is found to be a language, the machine will automatically start up in that language. Most users prefer this to be 'Basic'. If the machine is used only for word processing, then the word processor chip, i.e. View, Wordwise or Inter-Word etc. could be inserted in this position.

The differing layouts for ROM sockets on the various models of BBC microcomputers often cause beginners some confusion.

The configurations are as follows:-

1.2.2. The BBC model "A" & "B" machines have the ROM sockets positioned on the main computer board and underneath the top right hand (East) corner of the keyboard when looking at the machine in its normal working position. Gaining access to the sockets necessitates the removal of the top cover and keyboard.

1.2.3. The BBC "B+" 64k. & 128k. machines have their sockets positioned on the West of the computer board towards the rear of the machine. The advantage of this configuration is that nothing on the machine, other than the top of the case, needs to be removed when inserting a ROM. The two similar sockets, just to the South of the main bank, must NOT BE USED for ROM's, these are for a non-implemented speech system.

1.2.4. The BBC Master 128 machines, released in February 1986, differ quite radically from the earlier computers. They are designed to take advantage of the larger memory eproms which were developed during the lifetime of the BBC "B". These eproms can contain up to 128k. of information. The ,'mega-rom' inside the master holds all the built in software comprising the operating system, DFS, View, Terminal etc. Early machines can be identified by a 'tower block' or 'piggy-back' style ROM. Independent manufacturers have plans to take advantage of these larger ROMs for holding suites of software, the "Inter-" family from Computer Concepts is widely expected to be contained on a 128k. single eprom. This would save a lot of space inside the machines.

The normal procedure for inserting extra ROM's would entail inserting them into a cartridge or carrier which holds two chips. (Some independent manufacturers supply carriers capable of holding four ROM's). The memory capacities of the ROM's can be 8k. 16k. 32k. or 64k. However 'tower block' ROM's such as Computer Concepts' Interword will not fit into the machine if placed into a normal Acorn style cartridge. The cartridges are inserted into two slots having spring loaded covers, which are just above the keyboard to the East. The smooth face of the cartridge is normally positioned towards the front (South) of the computer. It is only necessary to remove the top cover if a tall ROM or a special ROM containing a different operating system, such as the 'Torch MCP ROM', is needed.

The three ROM sockets inside the machine are positioned on the East side of the computer and are orientated East to West, i.e. the top of the ROM must face West. It is normal to use the centre socket as this does not effect any of the sideways RAM banks. If either of the other two sockets are to be utilised, then it is necessary to reset the links adjacent to these sockets. When these links are reset the sideways RAM area is reallocated and an appropriate number of banks will be lost for this use.

The BBC Master 128 also allows a ROM image to be transferred from disc into the sideways RAM area with the command:-

*SRLOAD "ROMFRED" 8000 W Q. (The W could be X, Y or Z depending on how many images you have already loaded).

The computer must be reset with a CONTROL + BREAK 'hard' reset before the ROM can be initialised.

Because manufacturers are rightly concerned about copyright being infringed on their products, many ROM's contain a few bytes of code which stop them operating as an image.

1.2.5. The BBC Master Compact, released in August 1986, has five ROM sockets positioned on the East of the main computer board. The separate keyboard module of these machines also houses the computer board. The sockets are aligned East to West in a similar manner to the Master 128, however, depending on the specification of the particular machine, one or more of the four 'spare' ROM sockets may already be occupied. The fifth socket contains the 'mega-rom' operating system which should not be removed.

1.3.1. INTERFACING THE BBC MICRO.

The BBC Micro was designed with a large amount of inbuilt input/output control capability. It is used for a wide variety of measurement and control applications and it is often employed in institutions, such as the Clarendon Laboratory at Oxford University, as an inexpensive means of controlling and monitoring experiments or logging data. Numerous variations of commercial interfaces and buffer boxes are available, (with or without software), which will allow the computer to be used for a wide range of applications and also protect the machine from accidental connection to high voltages; but the majority are home grown and have been designed for a specific purpose. Clearly all users need to have a knowledge of the ports and their usage.

Port is the term used in computing parlance to describe a plug or socket, which can onnect the computer to various devices, allowing it to read or send small electrical signals to and from peripheral equipment. Some of the ports on the BBC micro are general purpose, others are very specialised. Although it is possible to connect some devices directly to the computer, it is inadvisable to connect home made equipment having d.c. motors or mains voltages present, without using an intermediate buffering device. Interface boxes should be carefully designed to isolate the computer from "feedback" which could be generated by external devices.

1.3.2. THE PARALLEL PRINTER AND USER PORTS.

The printer port is primarily designed for connection to a 'Centronics' type printer. The computer automatically defaults to this port when instructed to address a printer. (This in effect being the *FX5,1 call available from the keyboard. Serial printers can also be connected to the RS 423 port on the rear of the machine, but have to be addressed to output there with the command *FX5,2 etc.).

The printer port can however be utilised as an eight bit output only device. The necessary memory locations can be addressed with &FE61 and &FE63 hex. the latter location being the Data Direction Register (DDRA). It can be used in conjunction with the user port, which can be configured either as an input or output, to allow control of eight inputs and eight outputs.

The printer and user ports are sections of the 6522 versatile interface adaptor (VIA) i.c. situated South of the 6502 Central Processor Unit inside the BBC "B". The user port is known as port B and the printer port is known as port A. The 6522 VIA has two sets of eight I/O lines - the User Port is connected to lines PB0 to PB7 and these lines are characterised by increased output compared to the A side. They are designed to give an output current of at least 3mA before the output voltage falls below 1.4v. which is the base/emitter voltage of a Darlington pair of transistors. These devices have a current gain of at least 1000, therefore single stage current amplification from 3mA to 3A is straightforward. In theory, loads of up to 100VA can be controlled with just a single buffer on each output line.

External power supplies are required and it is very important that their outputs are suitably earthed external to the computer to prevent the BBC 0V line becng overloaded.

The group of eight general purpose I/O lines referred to as PB0 to 7 which make up the user port, correspond to the state of binary digits in a specific memory location (&FE60). Use is straightforward, the only problems being avoidance of overloading outputs and the conditioning of input voltages to the range 0-5V.

The computer board connector is a 20-way IDC (Insulation Displacement Connector plug). To add to confusion, the normal mains electricity convention of the wall fixture being called a socket and the cable mounted device being called a plug, is not followed. Interface cables can be made up with a 20-way IDC line socket, a female connector and a length of ribbon cable. Pin 1 of the socket is normally marked by a small triangle moulded into the plastic. The outside conductor will become connected to pin 1, irrespective of the direction the cable is inserted. Always make sure that the cable leaves the connector on the opposite side to pin 1 so that when the connector is inserted the cable hangs downwards. When fitting sockets to both ends of a cable ensure that these triangular marks are both on the side of the cable which connects to pin 1 and not pin 20.

1.3.3. ADDRESSING THE PRINTER AND USER PORTS.

The eight user port lines are memory mapped into location &FE60, with &FE62 controlling the data direction on each line. A value of 1 in a bit &FE62 sets the line as output, and a LOW or HIGH voltage will appear on it depending on the state of the corresponding bit in &FE60.

Location &FE62 Hexadecimal - (65122 Decimal), is the location for all setting user port interface lines as inputs and outputs. &00 would make all lines inputs, &FF all outputs. Location &FE62 is often referred to as DDRB. (Data Direction Register B). The corresponding DDRA location is &FE63 hex. - (65123 decimal).

The input or output lines for the user port can be accessed after the Data Decimal register has been set, by writing to location &FE60 - (65120 decimal). Writing a 1 will cause the line to go high, (if it is set as an output), with a voltage of 4.5v-5v. Writing 1 to a line set as an output will have no effect. Writing an 0 will cause the line voltage to drop to a little above 0v.

Line state can be inspected on the VDU by typing - PRINT -?&FE60, (or P.?&FE61 for the printer port). The & sign must be included as it tells the computer that it must read a location in hexadecimal.

All user port lines set as outputs = &FF in &FE62, (or &FE63 for the printer port).

By placing a set of binary 1 or 0's in &FE60 or &FE61 the lines can be made to go high or low e.g. be switched on or off.

To find out which lines are high or low type P.~?&FE60, or ~?&FE61.

The 'squiggle' before the decimal number is the shifted character just below and to the left of the break key, it will appear as a divide sign in MODE 7.

1.3.4. THE CASSETTE PORT.

This is part of the section of the computer containing the RS423 circuitry, it is possible to use the relay in this circuit, to control a low power external device. It controls a tape recorder motor in normal use and can be instructed from a Basic program with the command *Motor 1 and *Motor 0, (an alternative way of making these calls is with *FX137,1 to turn the motor on and *FX137,0 to turn it off). This is an inexpensive way of directly controlling very light loads without the use of other interfacing buffer units.

A very simple and useful device in the form of a crossover or 'null' cable, (see below), can be made which will enable communications and transfers of ASCII text files between totally different types of computers, (providing the other machine also has a serial port). Terminal software is required. The BBC Master series has 'Terminal' built into the mega-ROM. These cables have ben used by the writer to connect machines as diverse as Apple MacIntosh, Olivetti M10 portables and RML Nimbus computers, to the BBC range for purposes of transferring text.

To address the serial port the command *FX5,2 is sent from the keyboard. This may need to be followed by other *FX calls to set baud rates or disable the keyboard etc. (See section 42 p.418, BBC "User Guide").

1.3.5. CROSSOVER CABLES etc.

Data transfer on the RS423 serial port only requires two cables, one for incoming data (Receive Data), and one for outgoing data (Transmit Data)d A common return line (ground) is provided. Two control lines are included in addition RTS and CTS each of these is held high and taken to a low state when the host unit is ready for data transmission. They would therefore be correctly termed "Not ready to send" and "Not clear to send".

1.3.6. THE ECONET INTERFACE AND THE TUBE.

These two ports are of little general interest for most home built equipment. The tube allows the attachment of second or co-processors such as the Acorn 6502 or Z80 range. (These co-processors, and the 16 bit 512 board, are fitted into the internal PCB mounted sockets on the Master 128 range of machines).

The econet interface is used for networking a number of machines in a room, or linking remote stations.

1.3.7. THE 1 MHz BUS.

This is a fast expansion bus capable of addressing a wide variety of complex devices. There are known problems with the select lines on this bus and external circuitry is required to clean them up. Refer to the Acorn application note on the subject and also to the 'Advanced User Guide' by Bray Dickens and Holmes. A very short ribbon cable connection should be employed when utilising this port.

1.3.8. ANALOGUE PORT.

The BBC micro has a built-in four channel analogue to digital converter. The normal application for this port is for accommodating up to two joysticks complete with fire buttons. Inputs are brought to a 15-pin D-type connector on the rear of the machine. Each analogue channel will accept a voltage in the range 0v to +1.8v. The port can be addressed from BASIC with the ADVAL(-) call, where the bracketed dash is a number between 1 and 4 which relates to the specific channel being read.

The analogue to digital conversion is relatively slow at 10ms per channel and the computer is unable to follow rapidly changing signals, however the port can be readily utilised for a number of differing interface experiments. The Port also implements a light pen interface and a games controller input. The light pen input could be configured to digitise areas of dark and light on pictures and thus act as a scanner input.

Pin number descriptions are as follows:-

"1: +5v allows power to be taken from the micro.

2: 0v The other power line out.

3: 0V similar to 2.

4: CH3 voltage input 0 -1.8v, read with ADVAL(4).

5: Analogue ground - Essentially a 0v outlet but it is used as the reference signal for all voltage inputs as it is connected to the 0v line close to the analogue to digital converter and so should minimise stray pickup.

6: 0V same as pin 2.

7: CH1 - same as pin 4 but is read with ADVAL(2).

8: Analogue ground - same as pin 5.

9: Light pen strobe - This input will latch the current state of the counters addressing the screen memory. After a pulse on this input you can look at the latched value in the CRT controller and work out where the spot was on the display screen when this input was pulsed.

10: PB1 - a digital input meant to be used for fire buttons on joysticks. To read ADVAL(0) and 2 will return the value of 0 if this line is connected to 0 volts or a value 2 if it is open circuit or connected to +5 volts.

11: Vref - All the voltage measurements on the Ch inputs are measured relative to this voltage. It is read about 1.8 volts.

12: CH2 - same as pin 4 but read with ADVAL(3).

13: PB0 - same as pin 10 but read with ADVAL(0) AND 1 it will return a value of 1 if open circuit or if 0 is connected to zero volts.

14: Vref - same as pin 11.

15: CH0 same as pin 4 but read with ADVAL(1)."

(Extracted from Micro User p.126 September '86).

Pin one is top right of the board socket as you look into the back of the machine. The pin numbers are moulded into the body of the plug in very small figures.

N.B. "Although full scale is reached with an input of +1.8v, no damage will occur if the applied voltage is kept within the range 0 to +5v, although this can cause an internal latch-up which requires the machine to be powered down to reset. Negative voltages can have lethal effects and if there is danger ot the input going outside the safe working area then a simple diode protection network can be inserted which for reasonably low impedance voltage sources need be no more complex than a single zener diode and 100ohm resistor - it will not provide immunity from direct connection to the mains but will resist 50V or so."

(Some of the above information was adapted from the MEP 1985 'Green File' titled - "Sunderland File - Interfacing the BBC Microcomputer").

GLOSSARY.

This glossary of computing terms is included to help the student understand some of the more commonly used 'jargon' terms which inevitably appears to accompany computers and their literature.

The list has been compiled for the BBC series of computers and some of the extra information given after the definition may not be applicable to other makes of machine.

Glossary.

LIST OF TERMS.

ADDRESS A numbered location in RAM which will contain one byte of information.

ALGORITHM A set of steps for performing a task.

ASCII American Standard Code for Information Interchange. A binary code to represent characters.

ASSEMBLER A coded form of instructions containing both alphabetic and numeric symbols. Can be translated into machine code before execution by a computer.

BCD Binary Coded Decimal. A method of storing numbers inside a computer memory. (See Binary).

BINARY A number system using only digits 0 and 1.

BIT A binary digit, 0 or 1.

BOOT The common term used for starting a disc. It is performed by pressing SHIFT + BREAK on the BBC micro. The derivation is from BOOTSTRAP, a short program which is held in ROM and devised for CPM computers to load their disc and operating system into the machine from a master disc before the machine can be fully used.

BREAK - Wipes out from memory if a number is entered immediately after pressing it. The program should be retained if 'OLD' is typed in followed by pressing return. Not to be pressed when a disc drive is writing or reading otherwise the disc could lose data. (Use ESCAPE where possible).

BYTE A set of eight bits.

CAPS-LOCK Upper case = capitals, on-off by touch. Light off - lower case.

CHANNEL The path along which data flows between one part of a computer and another.

CPU Central Processing Unit. The microprocessor itself. Controls all other parts and their operation.

CONTROL (CTRL) - A key which alters the function of other keys on the keyboard and sends the computer operating system messages. e.g. Pressing CONTROL + N before listing a basic program will stop the listing in screens, CONTROL + BREAK does a hard reset and clears the BBC computer memory completely. Also used to describe the operation of peripheral equipment by the utilising the computer.

DECIMAL (Denary) A number system using digits 0,1,2,3,4,5,6,7,8,9. (Base 10).

DISC (DISK) The BBC computer normally uses 5.1/4" or 3.1/2" floppy discs as a backing store. They are relatively compact and fast access devices in microcomputing terms.

DISC DRIVE A device for spinning floppy discs allowing data storage and access.

DISC INTERFACE The collection of integrated circuits within the computer which will allow it to access a disc drive. (Often confused with DFS).

DISC FILING SYSTEM (DFS) The firmware programme held in the BBC computer which contains the instructions for operating a disc drive. Machines with more memory load this into RAM from a disc when they are switched on. (See BOOT above).

EPROM Erasable Programmable Read Only Memory. A special form of ROM. It can be erased with Ultra Violet light and reprogrammed. Has a window in the top.

ESCAPE - Stops the computer if pressed but does not generally clear memory. A panic button with a less drastic action than break.

FIRMWARE Programs held in or on devices which are not readily alterable by the user. e.g. PROMS or EPROMS.

HARDWARE The machinery of a computer system.

HEXADECIMAL A number system based on the number 16.

HIGH LEVEL LANGUAGE A computer language written in such a way that it is easily understood by the programmer. Has to undergo a translation progress before providing the machine code which the computer understands. Basic, Cobal, Fortran.

INTERFACE A device enabling one piece of equipment to communicate with another.

KEYBOARD Typewriter pattern input device.

KILO A prefix denoting a thousand. In computing terms 1 Kilobyte is approx.)000 bytes. 1K = 1024 expressed in true computing calculations (2^10).

A KILOBYTE <> 1000 bytes. Because powers of 2 are useful numbers in computer systems, 1K actually = 2^10 = 1024. 32k = 32 * 1024 = 32768 bytes, or storage locations.

MACHINE CODE A numeric coded form of instructions capable of being interpreted directly by CPU.

MEGA A prefix denoting one million.

MEMORY Is measured in kilobytes. 32 K = 32 kilobytes. A byte is a single storage location.

MICROSECOND One millionth of a second (10 ^-(0.6)).

MIPS Million Instructions per Second.

NANOSECOND One thousand millionth of a second (10 ^-(0.9)).

NIBBLE Half a byte i.e. fours bits

OCTAL A numbers system using digits 0,1,2,3,4,5,6,7 - (sometimes called base 8).

PERIPHERAL A device connected to a microprocessor. Disc drives, printers etc.

PROM Programmable Read Only Memory. An integrated circuit which can be programmed once only by the manufacturer. It can be identified in relation to an eprom because it lacks the window on top.

SCREEN Characters - Letters, symbols, numbers. 40 characters on a line. Screen can hold 25 lines each of 40 characters. So a character may be placed in any of 25 * 40 = 1000 positions on screen. Screen automatically scrolls after filling up.

SHIFT LOCK Light on all letters in capitals. Numbers/Symbols appear.

PROGRAM(ME) A logical sequence of instructions executed by a computer in order to solve a problem.

RAM Random Access Memory. (Possibly better called 'Read Access Memory'). A memory module which can have coded information both written to it or read from it. Any location within it can be accessed directly and very quickly. Usually loses its information when the computer is turned off unless the machine has a battery.

RETURN KEY - Entering = press return key.

ROM Read Only Memory. A memory module which has coded information "burned" into it, permanently, (the BBC basic and operating system i.c's for example). It can only have data read from it. (See PROM).

SOFTWARE The programs used by a computer.

Glossary.

VDU Visual Display Unit. A television or monitor usually attached to a computer or terminal. Displays whatever is typed in, together with computer output.

WORD A unit of computer information. Generally, one word consists of eight bits. Some micro/mini computers use a 16 bit word. Mainframes use a 24 or 32 bit word.

ASSEMBLY TOOLS AND MATERIALS.

1 small soldering iron with a small chisel bit - in the range 12 to 17 watts.

1 pair of wire strippers.

1 pair of small sidecutting pliers.

1 small screwdriver.

1 Third Hand - (Magnifying glass for those with poor eyesight) - (Optional).

1 small vice.

1 pair scissors.

1 desoldering pump (optional).

1 scalpel or craft knife.

Resin Cored Solder -preferably 22 s.w.g.

1 small multimeter tester - analogue or digital.

2 A.A. size Batteries.

Insulated Electrical Wire - 22 s.w.g.

COMPONENTS LIST FOR INTERFACE.

1	PCB + ETCHING 100 X 220
1	D type 15 way plug
1	20 way IDC cable mounted socket
4	Diodes 1N4001
2	Yellow 5mm standard LED's
2	Green 5mm standard LED's
4	Red 5mm standard LED's
8	Resistors 270 or 470 ohm
2	Resistors 100k
6	Relays RS348-526
1	Darlington Driver ULN 2803A
1	4 Way DIP switch
1	8 Way DIP switch
2	Molex PCB plugs 10 way
1	Molex 10 way socket
4	4 way PCB terminals
3	2 way PCB terminals
1	Ribbon Cable
1	10 track veroboard
1	18 pin DIL socket

PRODUCING PRINTED CIRCUIT BOARDS (PCB's) BY THE PHOTO-ETCH PROCESS.

Printed circuit boards can be made with a process called photo-etching. This is accomplished by drawing out a circuit diagram and then making a transparency from the drawing, (sometimes called a foil). The transparency can be made photographically, or more commonly by passing an acetate sheet through a photocopier. Tracing paper also photocopies quite well for this purpose. For those without acetate sheets, the expedient of putting thin cutting oil on a photocopy of the circuit will effectively make it transparent to U.V. light.

It is best to try and arrange a reversal of the circuit drawing, so that the printed side of the foil is in close contact with the photo-sensitive copper layer. This gives a denser line with less chance of the light diffracting around the edges. PCB design software programs for the BBC micro, such as Vinderen Associates "PCB", make this reversal automatically at the plotting stage.

The foil and circuit board are exposed under an ultra violet light for a time recommended by the manufacturer, (on average 6 to 8 minutes at normal room temperature). Care must be taken to protect the eyes from the U.V. light source because it can damage eyesight. A professionally made U.V. light box from Rapid Electronics, R.S. Components etc. is an effective answer to this problem. Following U.V. exposure the PCB is developed in sodium hydroxide and then thoroughly washed. The unwanted copper is etched away by immersing the developed board in ferric chloride solution, which requires constant agitation. A bubble tank is the best method of achieving this.

The PCB is now removed from the ferric chloride solution and thoroughly washed in clean running water. Ideally, it would now be advisable to tin the surface of the copper track with a proprietary tinning solution, as this helps to avoid oxidation of the copper surface. After final washing the board can be air dried ready for use.

After initial sketching and hand drawing for the prototypes, the final PCB transparencies for these interfaces were produced with:-

Vinderen Associates "PCB" - for Interface 1. (Cost approx. £22).

Pineapple Software "PCB" - for the Stepper motor interface and the Analogue port sensor boards. (Cost approx. £95).

ASSEMBLING THE INTERFACE.

The instructions for assembling the interface are uncomplicated and success is assured if the instructions are adhered to in the order listed below.

1. Check the components against the list provided.

2. Ensure that you have the tools and materials indicated in the list provided.

3. Drill holes in P.C.B. Use a .8mm drill for the smaller components, terminal sockets and Molex plugs require 1mm or possibly 1.2mm holes. (See Interface assembly stages Figs. 1 & 2).

4. Clean the PCB tracks with fine abrasive or methylated spirits and try to keep your fingers off them. (Sweaty fingers deposit a greasy layer onto the surface which may prevent the solder adhering).

5. Cut the wire links to length and strip the covering off the ends with wire strippers if available, or a penknife if they are not. Solder the links into the board, also solder in the analogue ribbon cable connections. (See Fig 3. Interface Assembly stages, & Diagram labelled Connections).

6. Fit any non polarised passive components such as resistors, sockets, plugs, switches etc. (See Figs. 4, 5, & 6 Interface Assembly Stages).

7. Fit polarised components such as diodes; take care, some capacitors and LED's are heat sensitive. (Use a heat shunt on the legs of the latter to prevent the heat from the soldering iron destroying them). (See Fig. 7. Interface Asssembly Stages).

8. Solder in the very heat sensitive components, such as transistors and small integrated circuits; ensuring that a proprietary heat shunt or a pair of pliers are clamped to the leg above the circuit board. With integrated circuits, it is also a good idea to earth yourself and the soldering iron, before touching them. This is because it is just possible that a static discharge could destroy them. (See Fig. 7. Interface Assembly Stages).

9. Insert any integrated circuits into their DIL sockets and be careful to ensure that all the legs are positioned correctly before pushing the chip home. It is also essential to check that the chip is inserted with the spot, or U shaped notch, adjacent to the intended pin 1 on the circuit board. (See Fig. 8. Interface Assembly Stages).

When soldering it is essential to heat the track to temperature before touching the component leg and solder together. The tracks radiate the heat quite quickly and it is possible to overheat a component before a track reaches soldering temperature. A 12 or 15 watt soldering iron with a very fine chisel tip is more than adequate for most electronic work. Use resin cored solder, preferably fine wire (22s.w.g.) whenever possible, as it helps to prevent excess solder joining across tracks. Before each soldering operation, the tip of the soldering iron should be cleaned on a damp sponge to eliminate oxides etc. Tin the ends of multi-strand wires to keep them together when pushing them through the holes in the PCB. This also helps to ensure a good soldered joint. The appearance of a good joint is bright and shiny, and is readily seen adhering to both track and component.

The positioning of the various components can be seen in the series of diagrams Figs. 1 - 8 'Interface Assembly Stages' which follow this section.

Upon completion of this process and after reading the Safety Advice/Warning, and the following section with the computer, the interface may be tested. The disc of programmes supplied with the interface kit, contains a 'binary test' programme A on menu 1.

USE WITH OTHER MICROCOMPUTERS.

Technically the Oxford Interface will function with any microcomputer that has a parallel printer port. However, the degree to which it will function will depend upon the individual machines. The interface has already been run in conjunction with RML 380Z & 480Z microcomputers. All that is necessary, is to make up the cable as per the connections shown in Fig. ?

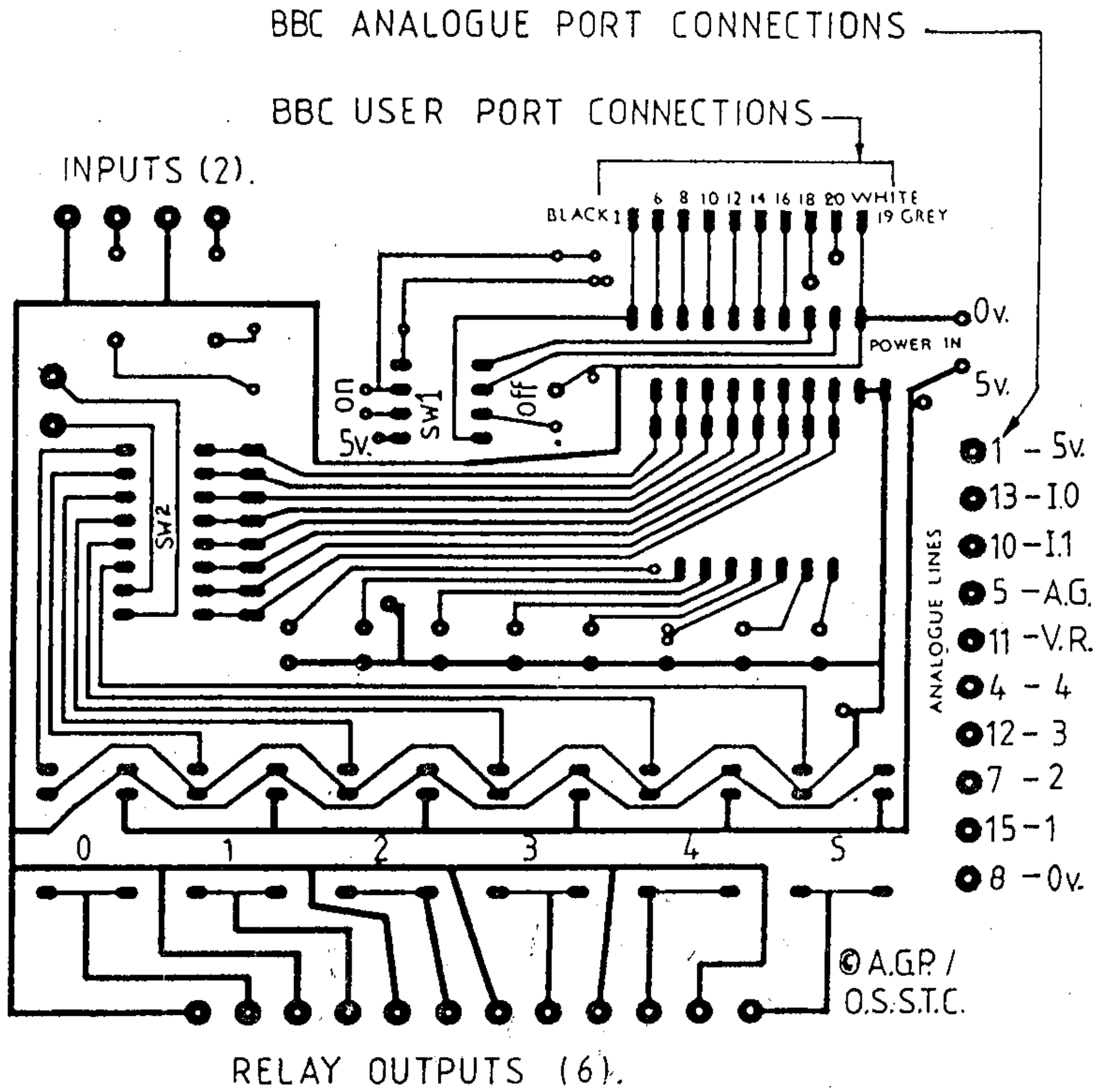
It is suggested that a suitable software driver such as the Nottingham 'Bits' or 'Lego Lines' (see App. 1 for details) is used in conjunction with the BBC machines. Other programmes may be available for other computers. Oxfordshire have developed a package called "Control" for use with RML 480Z computers.

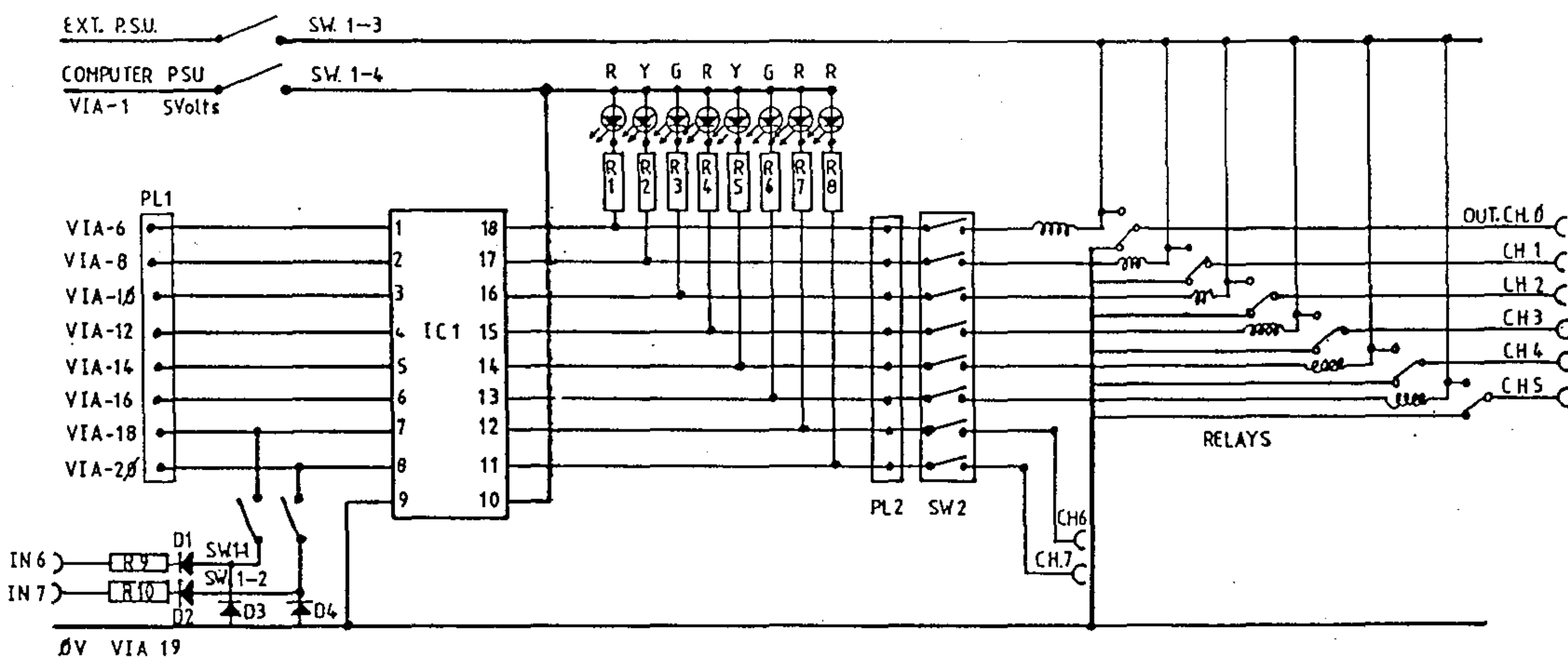
The interface may also be used with an RM Nimbus if a parallel port is fitted and suitable software is available.

Connection to the 'Apple' range of computers is also possible if a parallel port is fitted and appropriate Control Language is acquired.

N.B. In all cases the manufacturers manuals should be consulted for full details of connections and limitations.

PCB CONNECTIONS. (View from underside).





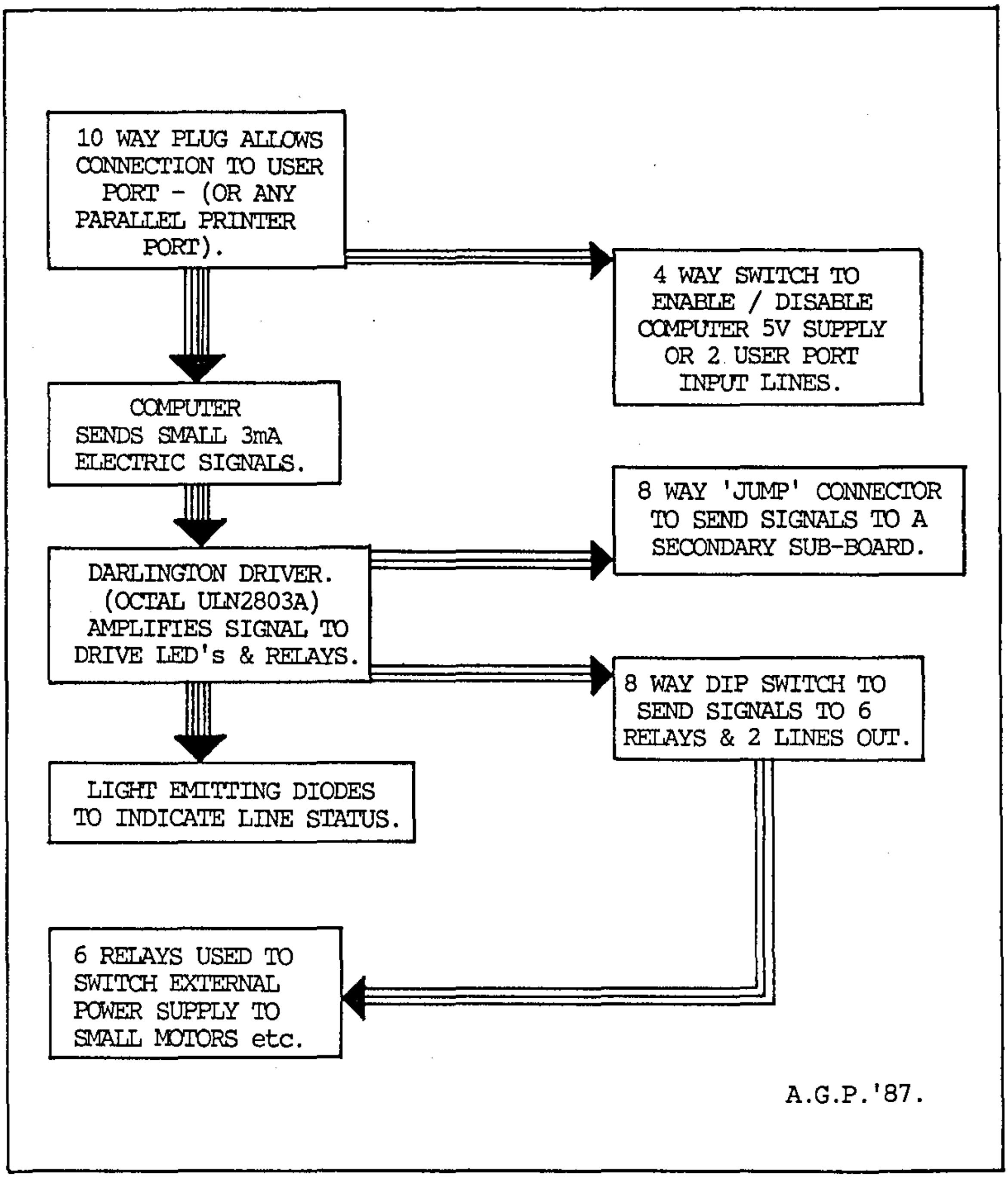
RESISTORS 1 to 8 270 or 470 ohms.
" 9 & 10 100 ohms
I.C. 1. – ULN 2803A
L.E.D's. 1,4,7 & 8. – RED 5mm std.
" 2 & 5 — YELLOW " "
" 3 & 6 — GREEN " "

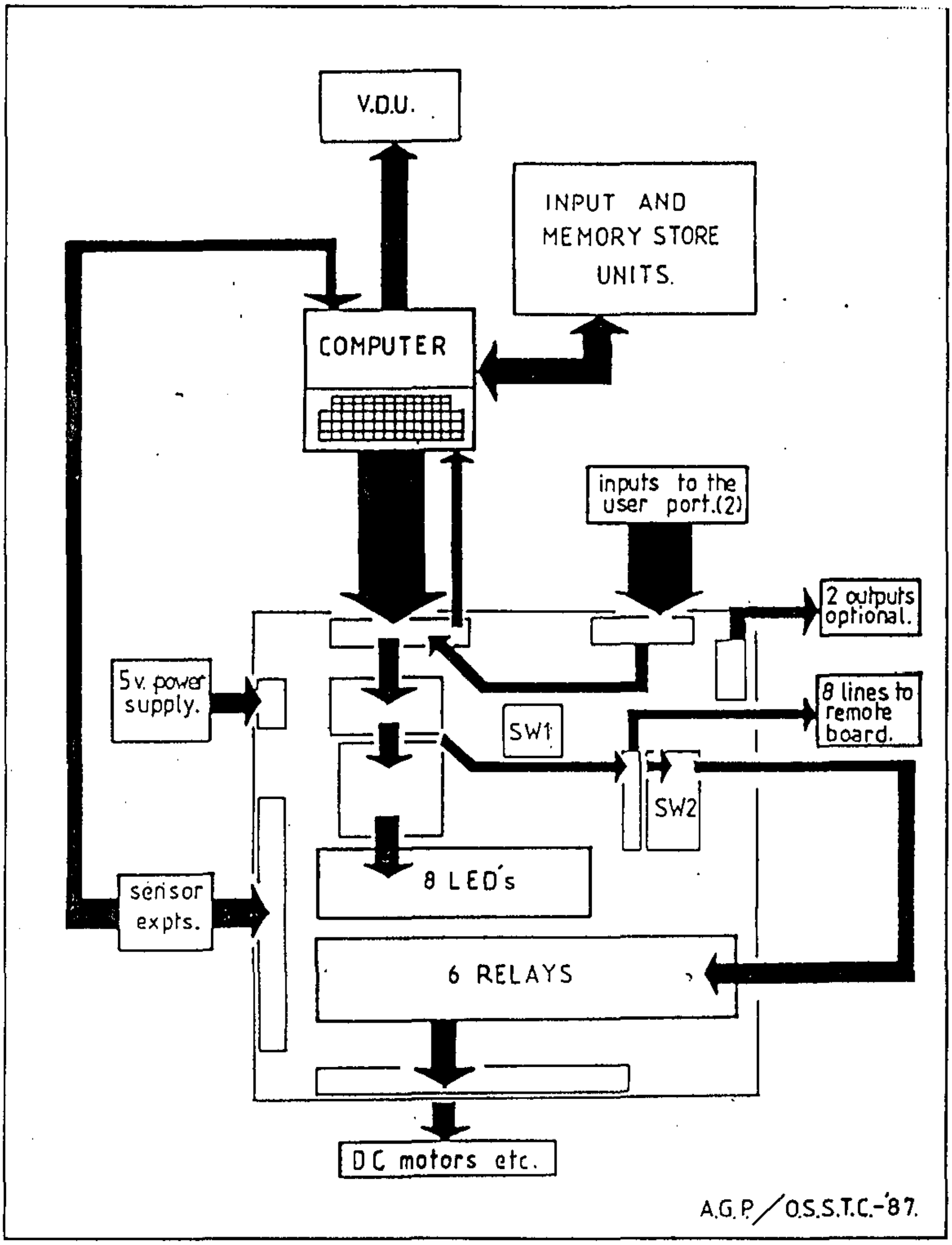
SWITCH 1– 4 DIL
" 2– 8 DIL
DIODES 1 to 4 – 1N 4001

RELAYS – 5v S.P.S.C.
PLUG 1 – MOLEX 10 WAY
" 2 – " 8 "

CIRCUIT DIAGRAM

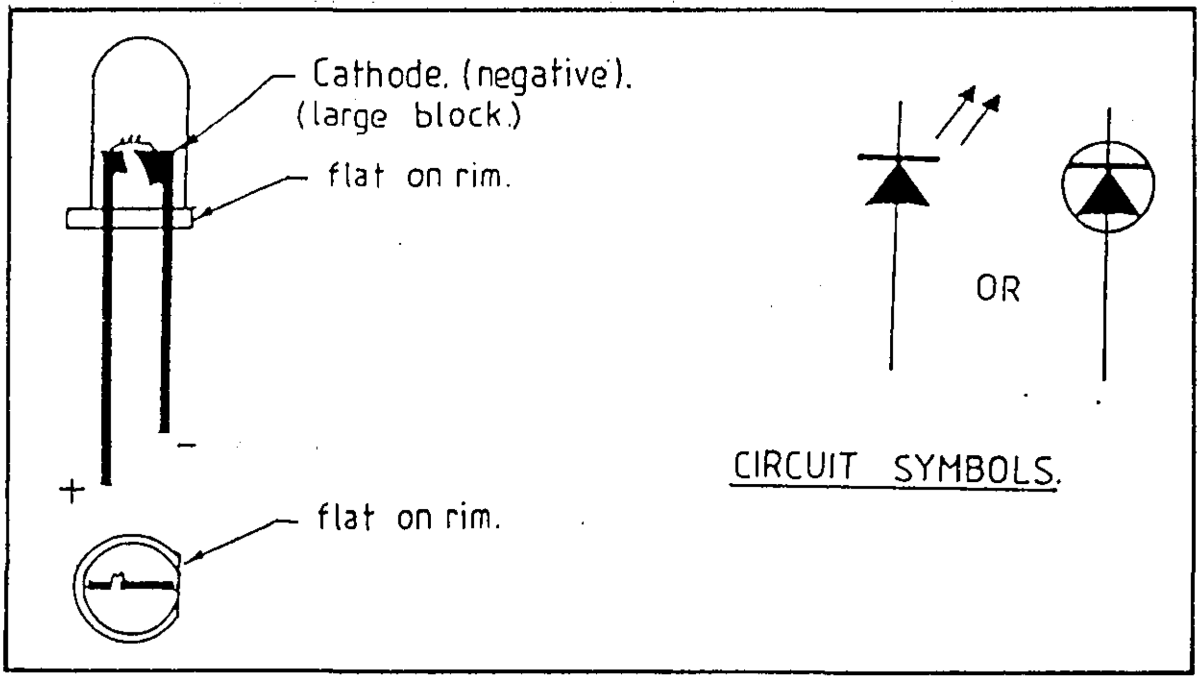
FLOWCHART - INDICATING PATHWAYS THROUGH THE INTERFACE.



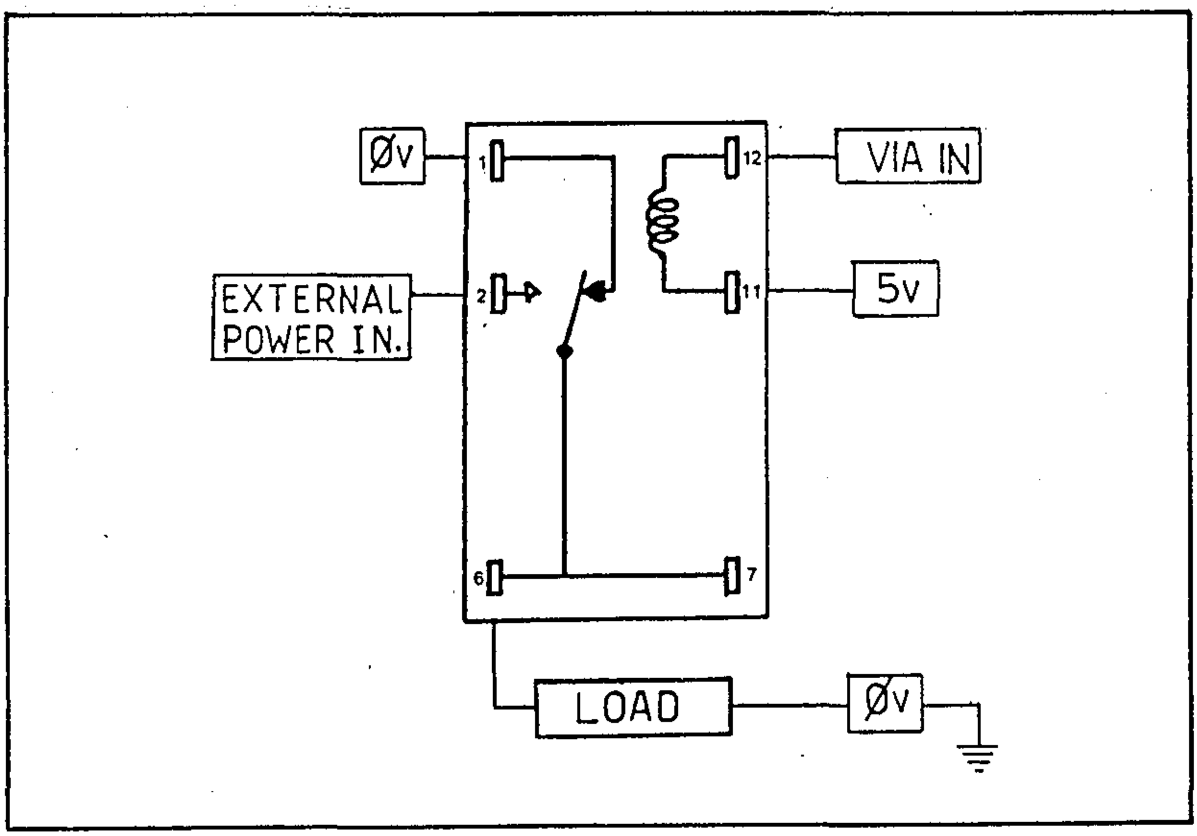

V.D.U.
INPUT AND MEMORY STORE UNITS.
COMPUTER
inputs to the user port.(2)
2 outputs optional.
5v. power supply.
SW1
8 lines to remote board.
SW2
sensor expts.
8 LED's
6 RELAYS
DC motors etc.
A.G.P./O.S.S.T.C.-'87.

Interface literature.

LIGHT EMITTING DIODE.

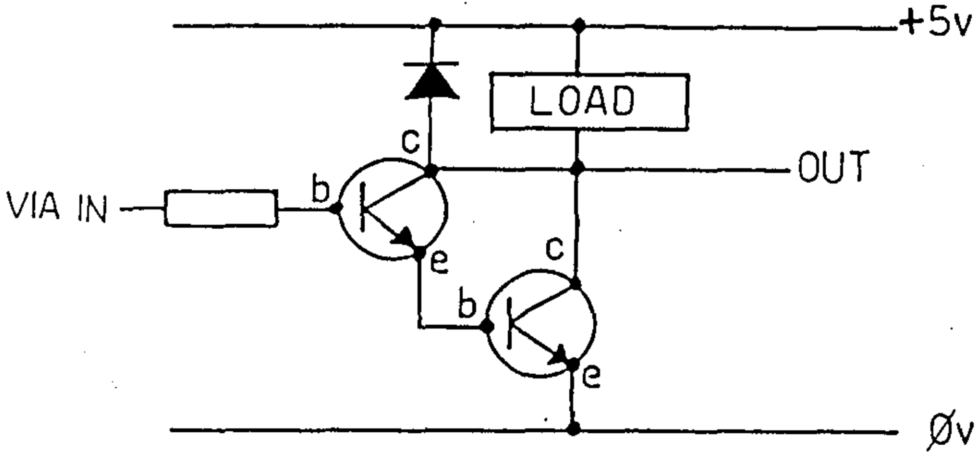


SINGLE POLE, SINGLE CHANGEOVER, RELAY. (Top view).

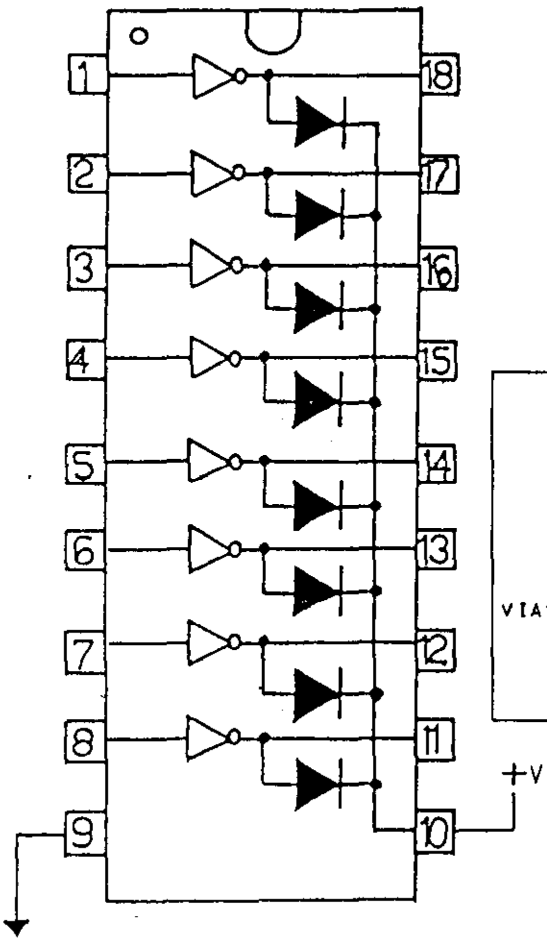


Interface literature.

DARLINGTON DRIVER - Signal Line Amplification systems.

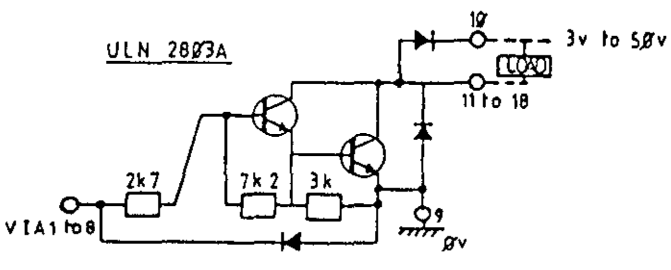


2 TRANSISTORS - 1 RESISTOR - 1 DIODE. (Amplifies 1 line only).



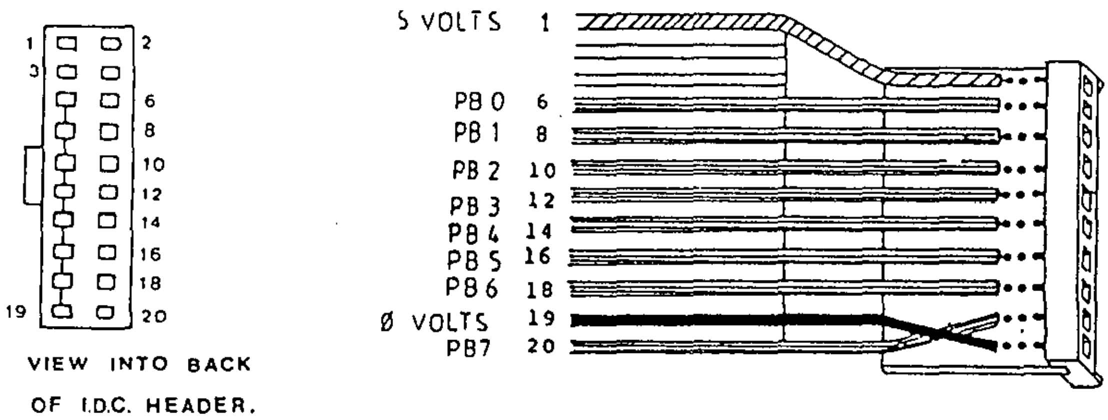
ULN 28Ø3A OCTAL DRIVER.

Includes resistor & diode buffer network.

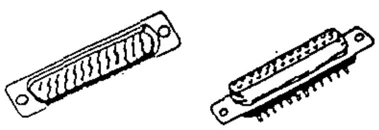


ONE CHANNEL - (INTERIOR LAYOUT).

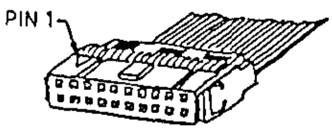
CONNECTIONS.



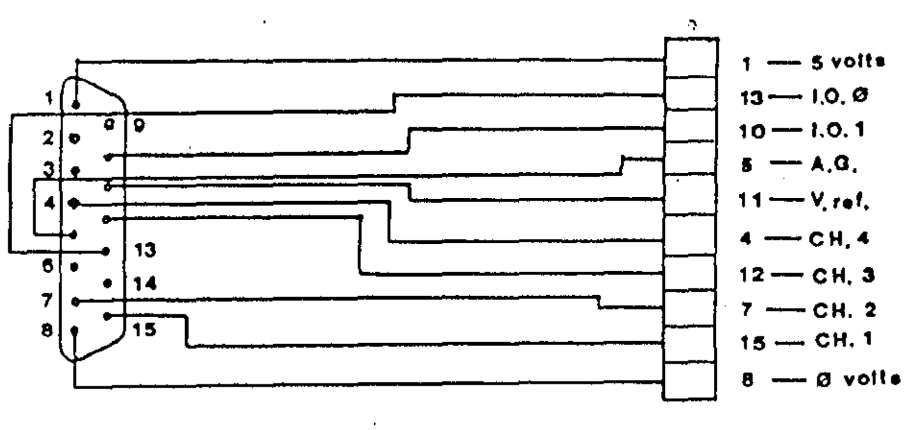
USER PORT / INTERFACE CABLE.



'D' TYPE PLUG AND SOCKET

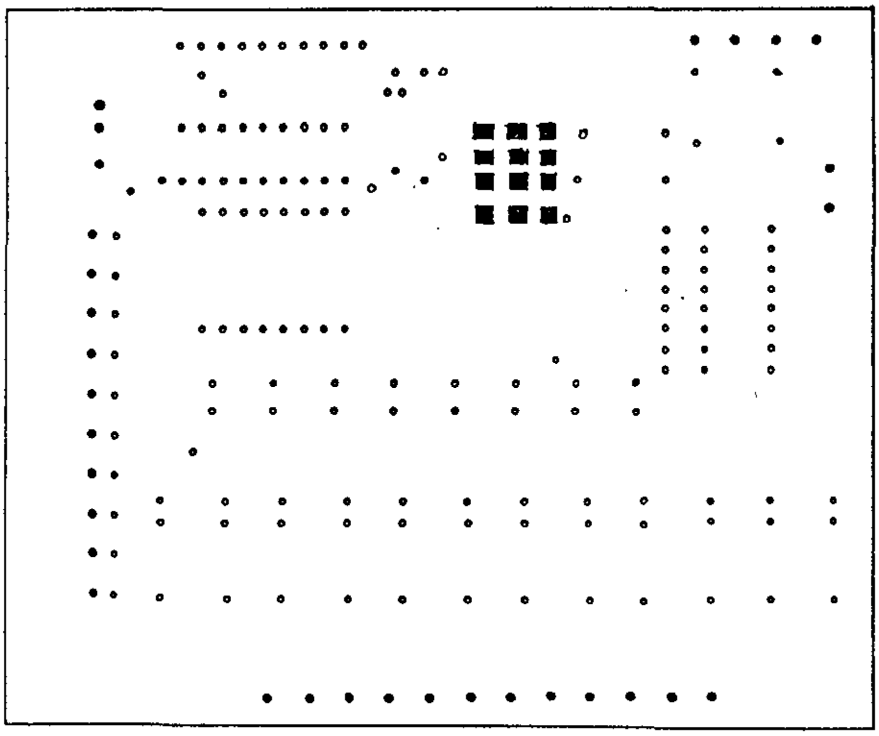


20 PIN CABLE MOUNTED I.D.C. SOCKET.



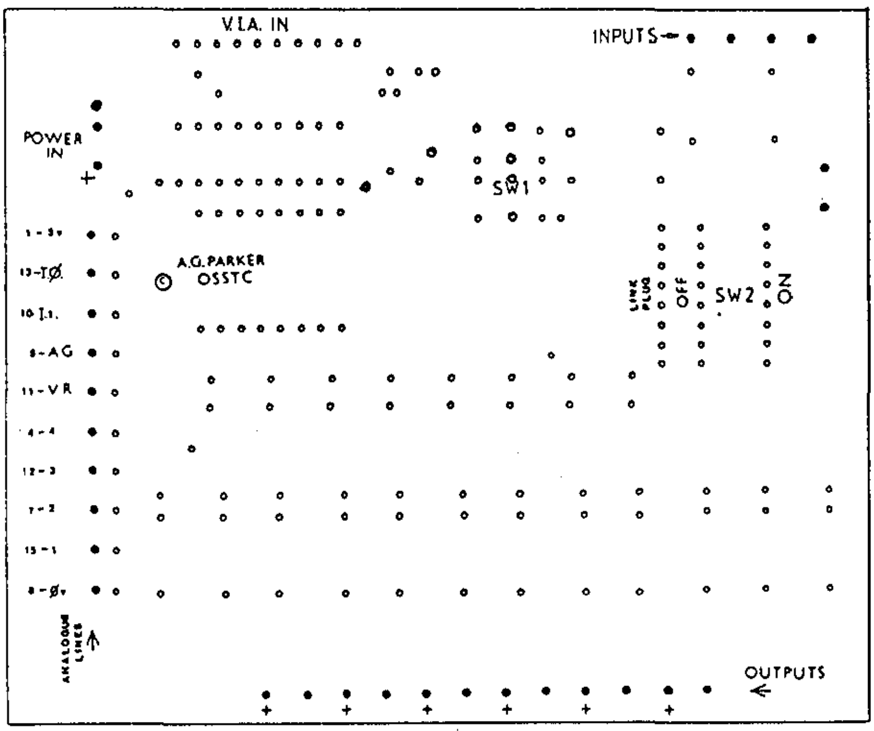
ANALOGUE PORT CONNECTIONS.

INTERFACE ASSEMBLY STAGES - (Component side of board).



(1)

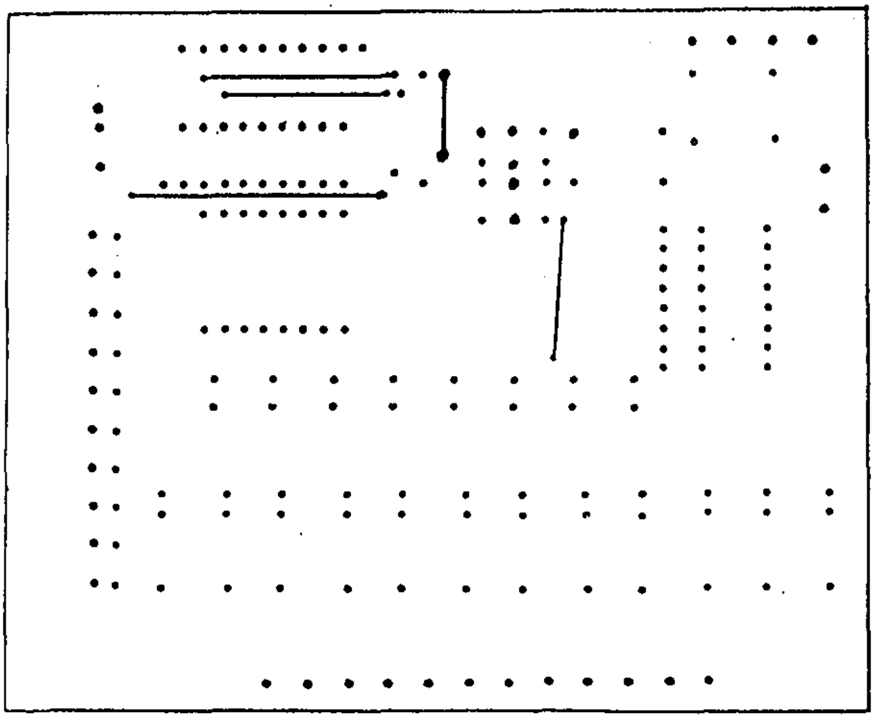
DRILL HOLES. [o=0·8 or 1mm ●= 1·2mm ■ 1·8mm]



(2)

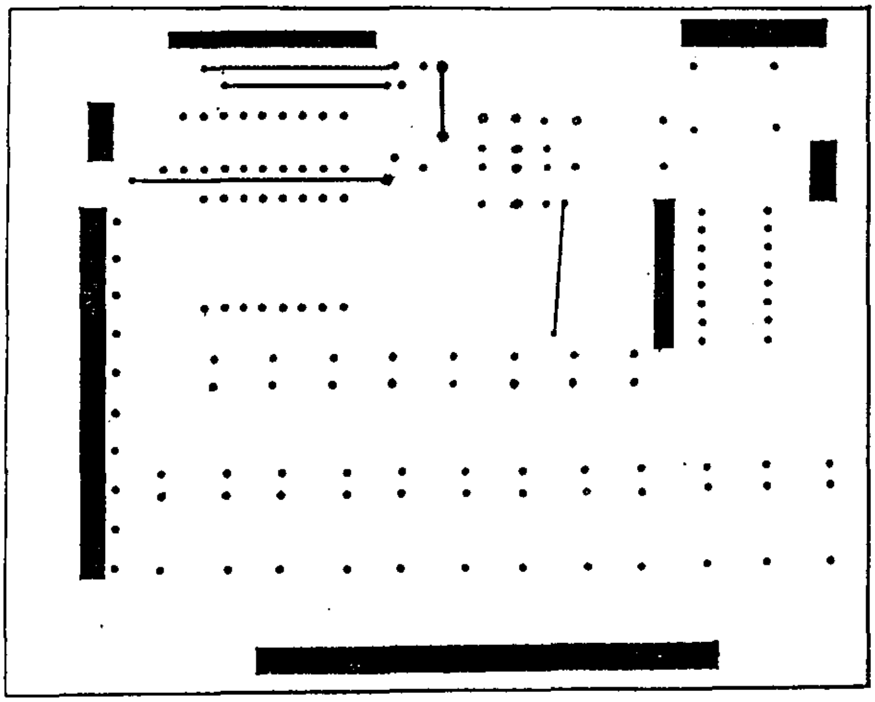
BOARD ORIENTATION

INTERFACE ASSEMBLY STAGES - (Component side of board).



(3)

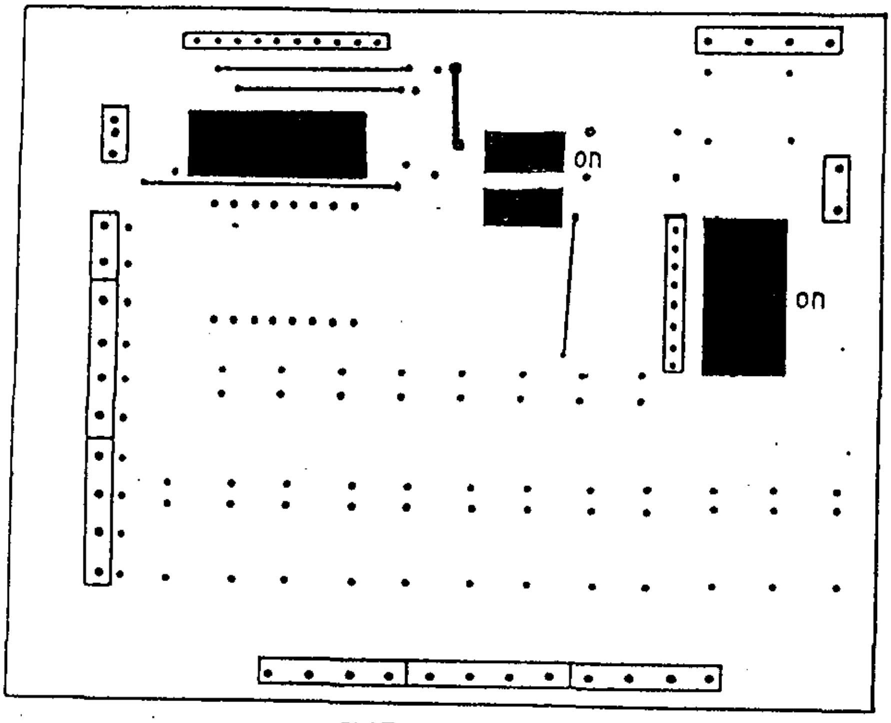
LINKS.



(4)

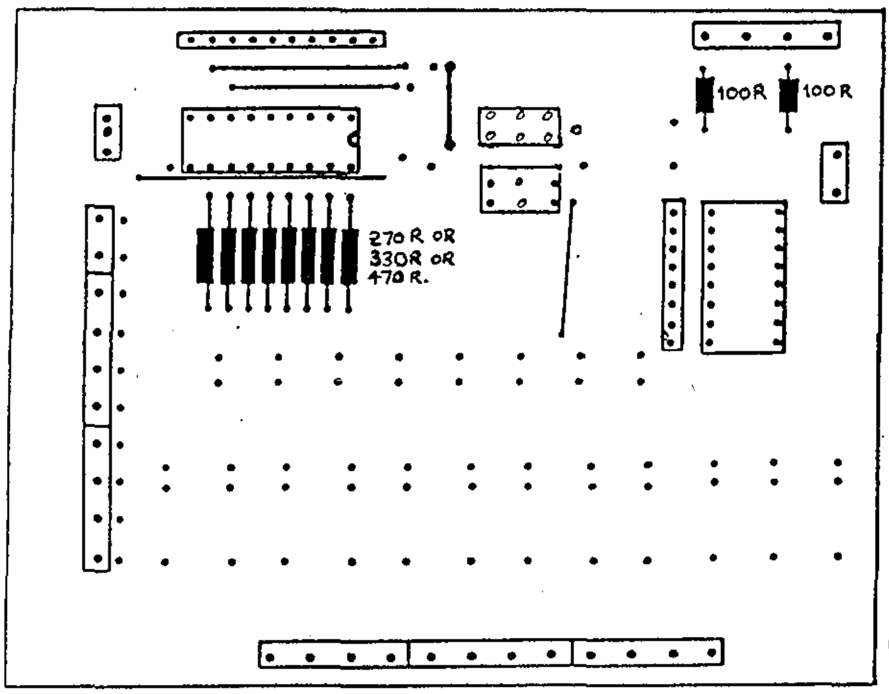
PLUGS + SOCKETS.

INTERFACE ASSEMBLY STAGES - (Component side of board).



5

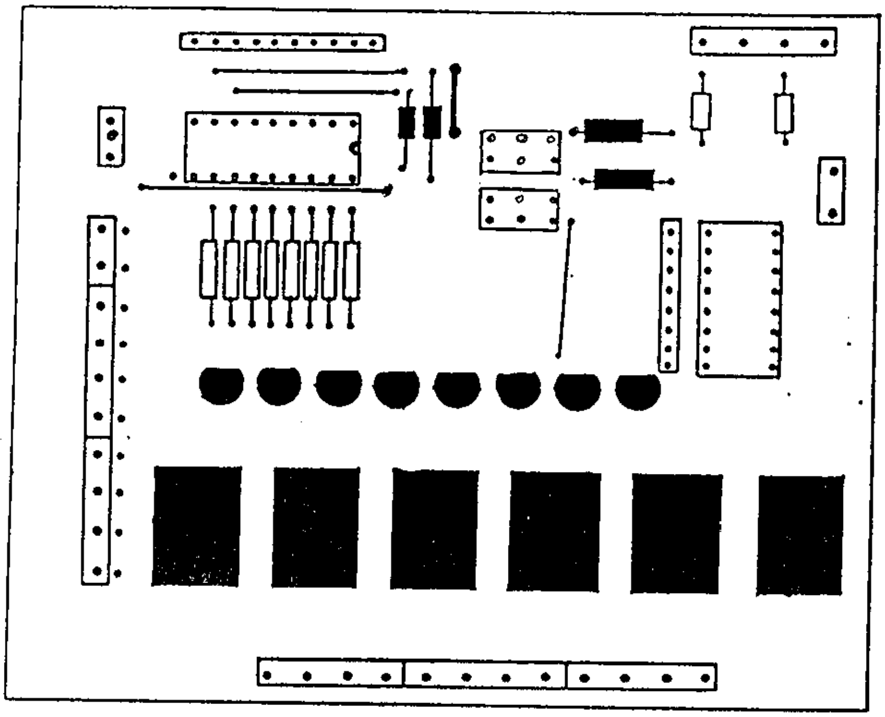
SWITCHES + I.C SOCKET.



6

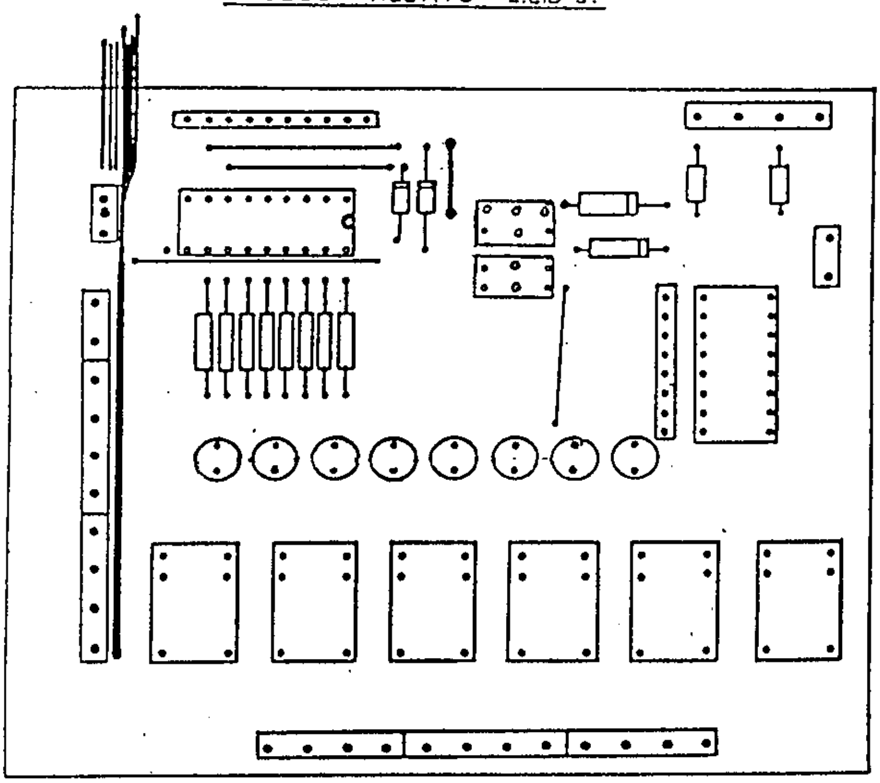
RESISTORS.

INTERFACE ASSEMBLY STAGES - (Component side of board).



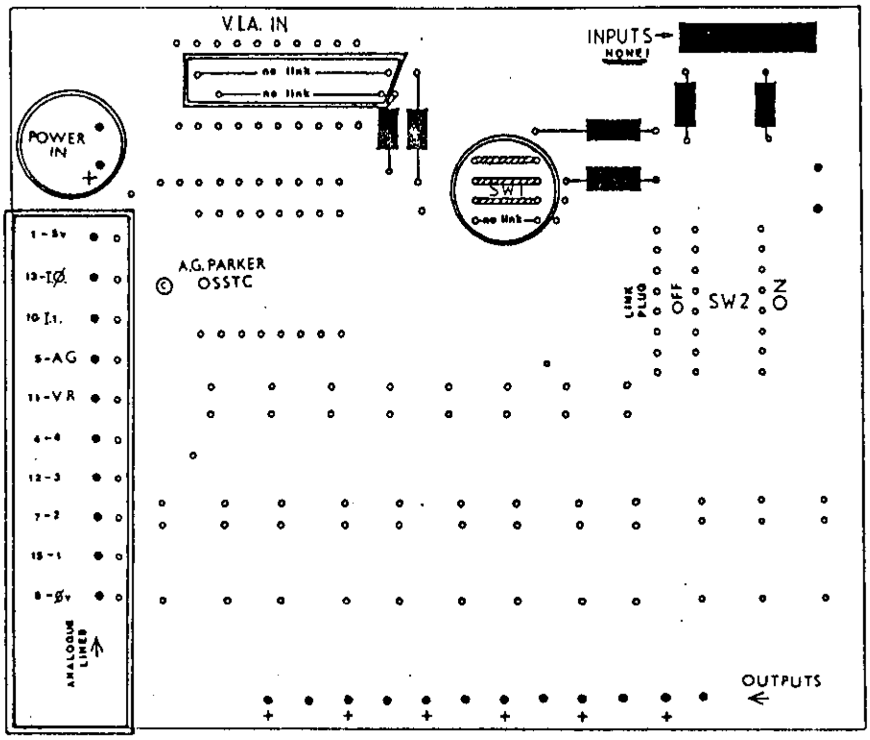
(7)

DIODES – RELAYS – L.E.D's.



(8)

SOLDER ANALOGUE CABLES.



(9)

The drawing No. 9 above illustrates the changes which can be made to the interface board if it is going to operate ONLY on the BBC PRINTER port. These changes may also be applicable to some other computers which have ports containing output only lines. The major change to the board requires the constructor to miss out the components highlighted in black on drawing No. 9 above. The areas of the board surrounded by a double line are areas which could be optionally changed if required:-

-the power input terminals could be replaced with a battery connection soldered into the board and terminating at a suitable battery e.g. (4-1/2 volt cycle lamp type etc.);

-switch 1 could be replaced with links permanently soldered into positions 1,2 and 3, the fourth connection is not required because it is not possible to pick up a 5 volt supply from the printer port socket of the BBC micro. (A flying lead could be taken to another suitable port but is hardly worthwhile in terms of cost effectiveness);

-the links highlighted directly under the 'VIA IN' molex connector are not required because they only allow lines PB6 and PB7 to be connected back to the BBC user ports when configured as inputs;

-the analogue lines may or may not be required depending on the individual users requirements or what computer is used.

It should be possible to readily adapt this interface board to work with RML 380Z and 480Z machines by making up a suitable lead to connect to the relevant I/O port.

WARNING !

DO NOT :—

1. PLACE LIQUIDS ON OR NEAR COMPUTER EQUIPMENT e.g. Cups of drink.

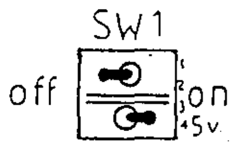
2. UNPLUG OR CONNECT PERIPHERALS WHEN THE COMPUTER IS SWITCHED ON.

3. CONNECT MAINS CURRENT TO THIS INTERFACE.

4. TRY TO POWER THE INTERFACE FROM AN EXTERNAL P.S.U. WHEN sw. 1-4 IS ON!

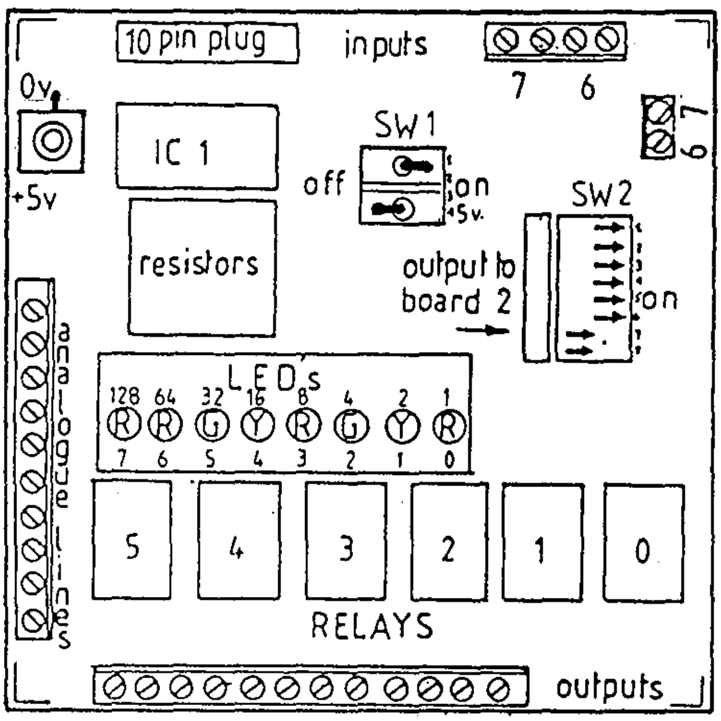
5. UNPLUG OR CONNECT ROM CARTRIDGES WHEN THE COMPUTER IS SWITCHED ON.

D.I.P. SWITCH SETTING.



switch	off	on	
1	input	output	input line
2	input	output	" "
3	off	power on	external power to IC.1.
4	off	on	computer supply in use.

switch	off	on	
1	×	✓	relay 0 control
2	×	✓	1
3	×	✓	2
4	×	✓	3
5	×	✓	4
6	×	✓	5
7	×	✓	output from SW1/ch.6
8	×	✓	" " " ch.7



EXAMPLE 1.

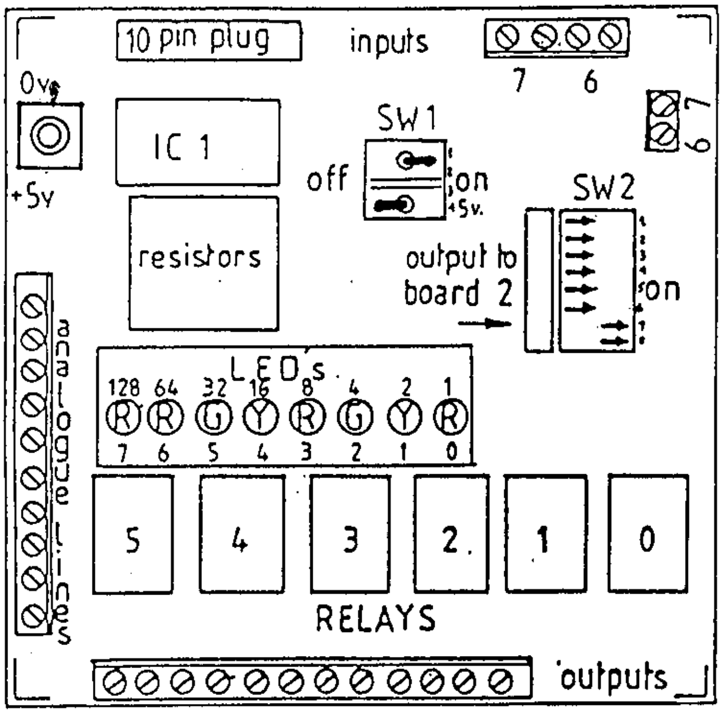
Normal settings.

SW1-3 off. SW1-4 on, - supplying power from the computer.

SW2-1 to 6 on - allowing computer power through to relay coils.

SW1-1 & 2 on - allowing data lines 6 & 7 to become outputs.

SW2-7 & 8 off - no signal to terminal block.

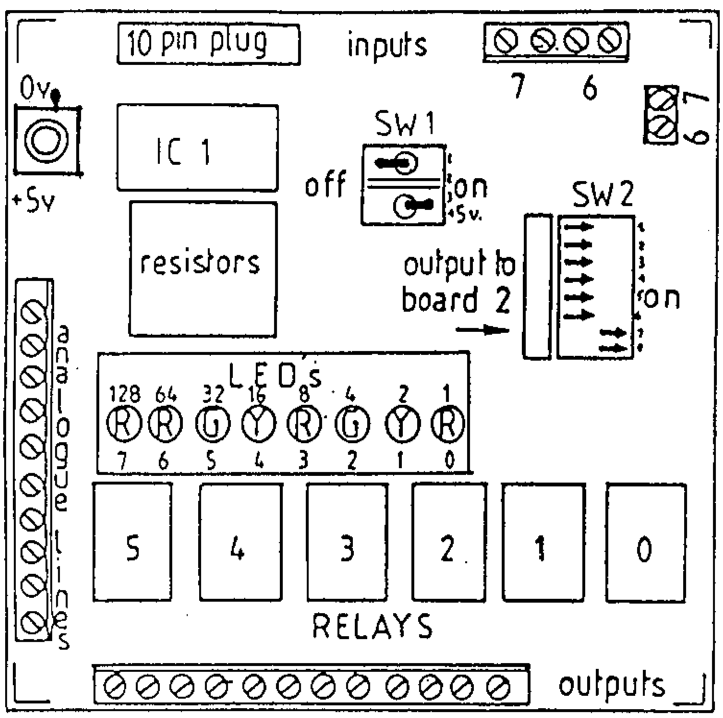


EXAMPLE 2.

SW1 set as above.

SW2-1 to 6 off - no power to relay coils.

SW2-7 & 8 on - allowing data lines 6 & 7 to act as outputs to terminal block positioned N-S above SW2.



EXAMPLE 3.

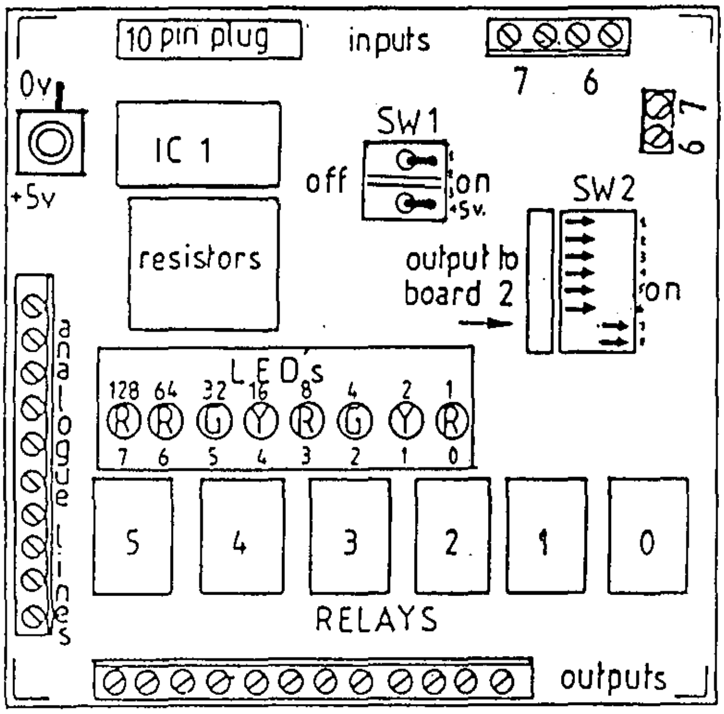
SW1-3 on. - supplying power from external power supply.

SW1-4 off. - computer supply MUST be switched off when external supply is used.

SW2-1 to 6 off - no power through to relay coils.

SW1-1 & 2 off - allowing data lines 6 & 7 to become inputs through 4 pin terminal block positioned E-W above SW2.

SW2-7 & 8 on - no signal to 2 pin terminal block positioned N-S above SW2.



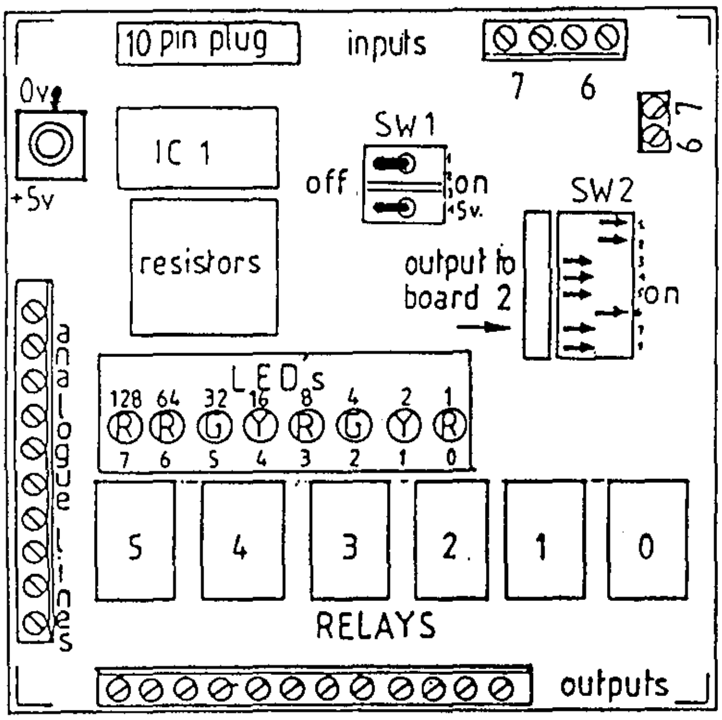
EXAMPLE 4.

SW1-1 & 2 on. - set as outputs.

SW1-3 & 4 set as in example 3. (Please note instruction above).

SW2-1 to 6 off - no power to relay coils.

SW2-7 & 8 on - allowing data lines 6 & 7 to act as outputs to terminal block positioned N-S above SW2.



EXAMPLE 5.

SW1-3 off. - no power from external power supply.

SW1-4 on. - computer supplying power.

SW2-1, 2 & 6 on - power through to relay coils 0,1 & 5.

SW1-1 & 2 off - allowing data lines 6 & 7 to become inputs through 4 pin terminal block positioned E-W above SW2.

SW2-7 & 8 off - no signal to 2 pin terminal block positioned N-S above SW2.

STEPPER MOTORS.

Some Background Notes.

3.1. INTRODUCTION:

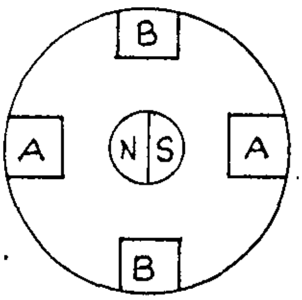
Stepping motors are DC motors which are driven by a series of pulses. Each pulse causes the motor to rotate through a fixed step. The size of the step varies but may be anything from 90 degrees to a fraction of a degree.

By controlling the number of pulses sent to the motor and their frequency, the total angular rotation and the speed of the rotation can be simply controlled. Stepper motors find numerous uses in mechanisms such as printers (paper feed and print head movement), automatic machine tools etc. They vary in size from power consumption of a few watts up to kilowatts.

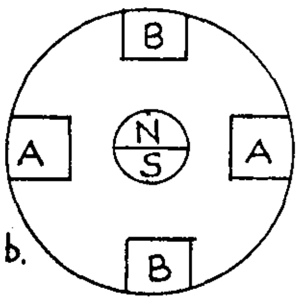
3.2. TYPES OF STEPPER MOTOR AND THEIR OPERATION:

All stepper motors have several sets of stator windings, and a rotor which may or may not be permanently magnetised.

Probably the simplest type to start with is the Hybrid Permanent magnet motor:



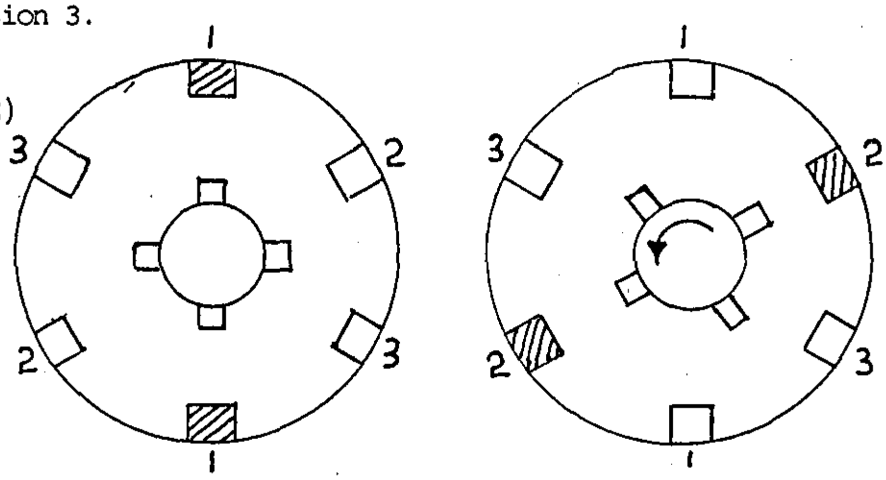
1a.



1b.

A permanently magnetised rotor lies between two pairs of electromagnets. WHen current flows through the coils of Pair A, the rotor will align itself as shown in Fig. 1(a). If pair A is now switched off, and pair B switched on, the rotor will turn clockwise through 90 degrees. Energising pair A again in the opposite direction will cause another 90 degree step and so on. More poles will give smaller steps, but such motors are usually restricted to small sizes and steps of 3 degrees - 90 degrees.

The Single stack Variable Reluctance motor is superficially similar, but the rotor is not permanently magnetised, and has a number of "teeth." (Fig. 2)



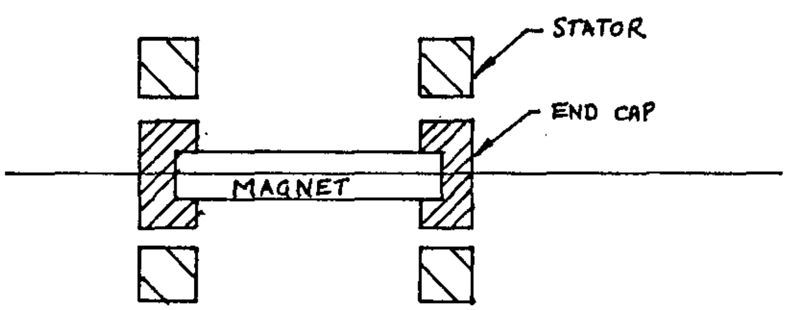
As before, opposite pairs of stator poles form pairs, with their windings connected together. Stable positions of the rotor occur when a pair of rotor teeth are opposite a pair of magnetised stator poles. Fig. 2 shows how the rotor will step round when the stator poles are magnetised in the sequence 1, 2,3,1,2,3 etc. (Note that the rotation of the rotor is in the opposite direction from the rotation of the magnetic field!)

$$\text{The Step Angle} = \frac{360}{(\text{No of stator teeth}) \times (\text{No of rotor teeth})}$$

More complex types of motors are the Hybrid and the Multi-Stack Variable reluctance types:

3.3. HYBRID:

A permanent magnet on the motor shaft has two iron end-caps, which have teeth and act as rotors. Each rotor is inside a separate stator. The poles of the two stators are lines up with one another, while the teeth on the two rotors are exactly out of step. (See Fig. 3)



In the example, with eight stator poles, windings on corresponding poles are connected together. The motor operates as a two-phase motor, with poles 1,3,5 and 7 forming one phase and poles 2,4,6, and

8 the other. When these two phases are energised alternately, the rotor will move in steps of "half a tooth-spacing." As with other motors with permanently magnetised rotors, the direction of current through the windings is important. In fact, since the currents have to flow in opposite directions during different parts of the cycle of operations, the driving circuitry is more complex than it is for the variable reluctance motors.

3.4. MULTI-STACK VARIABLE RELUCTANCE MOTORS:

Several rotor and slator sets (usually 3 to 7) are stacked on one shaft. The rotor teeth are all aligned with one another, while the stator poles are staggered. The stators are energised in sequence, all the poles on one stator being energised at a time. Because of the staggering of the poles, the rotor moves round one step at a time.

$$\text{The step Angle} = \frac{360}{(\text{No. of stacks}) \times (\text{No. of rotor teeth})}$$

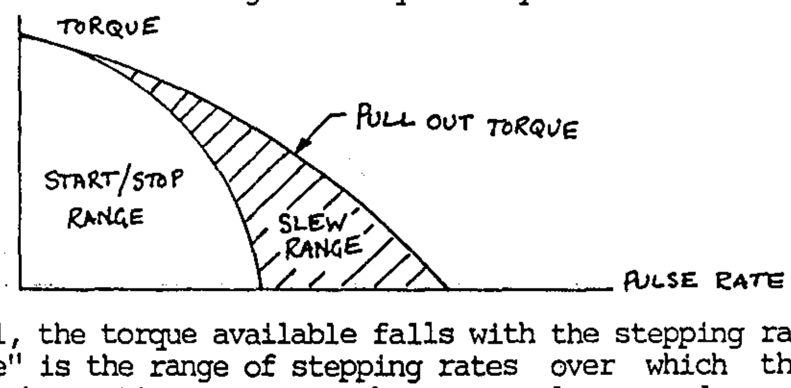
Characteristics of the Two Types:

Generally speaking, hybrid motors have small step angles (typically 1.8 degrees) and high torque. Because of the magnetised rotor, there is a small torque holding the rotor in position when it is not energised.

Variable Reluctance motors tend to have larger steps (typically 15 degrees) and low rota inertia.

Pull-in and Pull-out Characteristics

Curves such as those in Fig. 4 are quoted by the manufacturers.



In general, the torque available falls with the stepping rate. The "slew range" is the range of stepping rates over which the motor does not have time to stop between pulses, and so rotates continuously. The pull-out curve shows the maximum stepping rate possible for different torques. The pull-in curve shows the maximum stepping rate at which the motor will start and stop, for different torques. At higher rates it will either not start from rest, or, if already running, will not stop instantly.

Real systems sometimes show "resonance dips" in the curve which upset operation at certain stepping rates.

3.5. DRIVING STEPPER MOTORS:

There are basically two approaches, the software and the hardware approaches.

In both, output stages capable of supplying the required current are needed; the difference arises in the way those stages are switched in the required sequence.

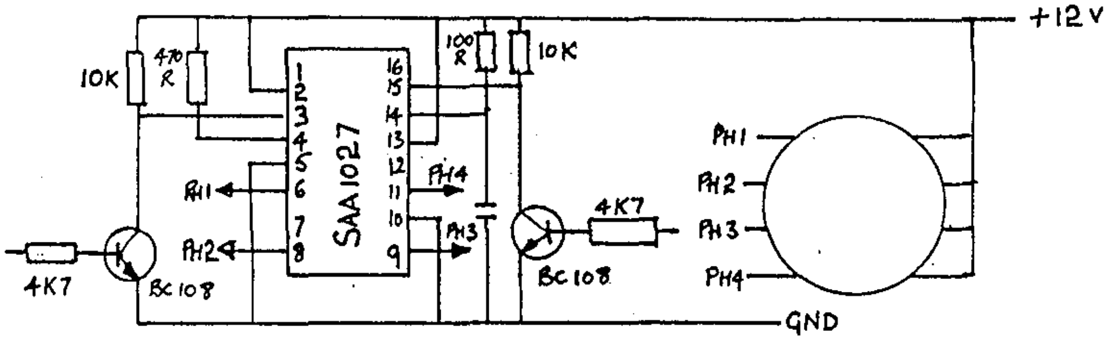
a) Software:

The driver stages are connected to four output lines from the computer, and software takes the output lines high or low as required. It is possible to drive a small motor at say 5 to 10 steps per second from BASIC, but if higher speeds are required, machine code has to be used. A sample BASIC program (RML BASIC):

```
10  N = 1
20 POKE 64511,N
30 N = 2*N
40 IF N>8 THEN N = 1
50 GOTO 20
```

b) Hardware

Circuits can be built, or obtained in integrated form, which, when fed with a pulsed input, produce the correct number of outputs switched in the correct sequence. Some of the integrated circuits include output stages suitable for driving small motors. For example the SAA1027 I.C.:



The input marked F/R controls whether the motor is driven forwards or backwards. Using this I.C., a small motor can be driven quite fast from BASIC.

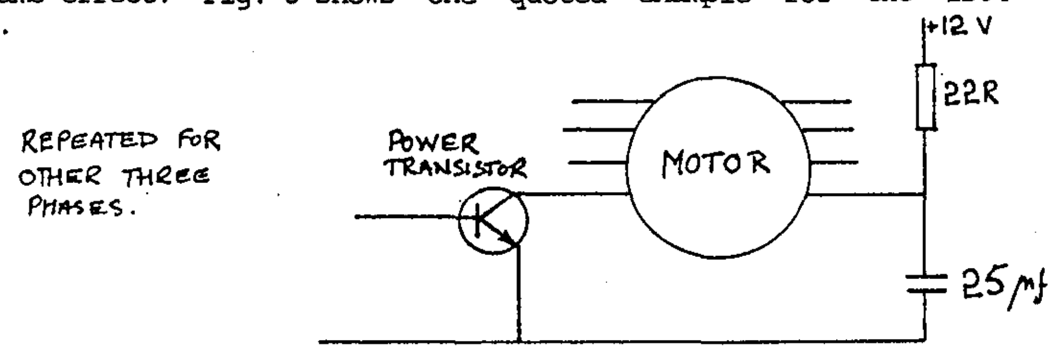
The inputs to the circuit are not at normal TTL levels, hence the need for transistors Tr1 and Tr2 to translate from TTL levels to the 0 to 12 volts needed by the I.C.

3.6. MISCELLANEOUS POINTS:

a) Forcing Resistance and Flywheel Resistance:

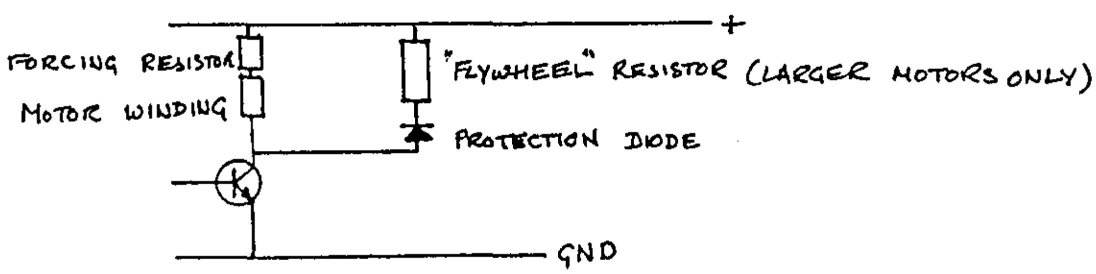
One of the problems at high stepping rates is that self-inductance of the motor windings tends to slow down the rate of rise of current in the winding at the beginning of a pulse. Thus the current may not have risen to its maximum value before the end of the pulse, with consequent loss of torque. This effect can be reduced by including a resistor in series with the winding (see Fig.5 470R), and increasing the supply voltage accordingly.

A so-called "current-forcing" network is sometimes used to obtain the same effect. Fig. 6 shows one quoted example for the ID04 motor.



At the end of a current pulse, a considerable reverse EMF may be induced in the winding, and the output transistor may be destroyed. The usual technique is to include a protection diode as shown in Fig. 7. With larger motors, when the amount of power is to be dissipated is considerable, a resistor is often connected in series with the diode as shown. (The "flywheel" resistor).

Protection diodes are built into the SAA1027, they are connected up by connecting pin 13 to the supply voltage.



b) Half-Stepping:

A common pattern of excitation of the phases for a small four-phase motor might be:

1 and 2, 1 and 4, 3 and 4, 2 and 3 etc.

(The reason for exciting two phases at once is probably to increase the torque.)

The motor can be driven in half-steps by using this pattern:

1 and 2, 1, 1 and 4, 4, 3 and 4, 3, 2 and 3, 2 etc.

(It is possible to "mini-step" a motor by exciting several windings at once. By varying the proportion of the currents in the different windings, the normal step angle can be sub-divided into as many as twenty mini-steps. This is a considerable problem in electronic control!)

Ramping:

A stepper motor will run at higher pulse rates than those at which it will start up from the rest (see Fig. 4). Consequently, for the highest speeds, the pulse rate has to be ramped up when the motor is started from rest, and ramped down again when it has to be stopped. If this is not done, and the maximum pulse rate is applied instantly, either the motor will not start at all, or it will "miss" several pulses. Since the control system has no means of "knowing" that the motor has missed some pulses, it will "think" that the motor has turned further than it actually has, with consequent loss of position accuracy. (In very accurate systems, some form of position feedback is added.)

There are also other tricks which are used: refer to the reference given.

3.7. SOME REFERENCES AND ADDRESSES:

"Stepping Motors - A Guide To Modern Theory", by P. A. Acarnley (I.E.E. Control Engineering Series No. 19, published by Peter Peregrinus for the I.E.E.; ISBN 0906948 75 3)

Low cost stepper motors suitable for use in schools with the Oxford Interface Extension Stepper Motor Board are available from - The Southern Science and Technology Forum, Surplus Buying Stores or from Proops, Tottenham Court Rd. London.

Interface extension 3.

STEPPER MOTOR INTERFACE.

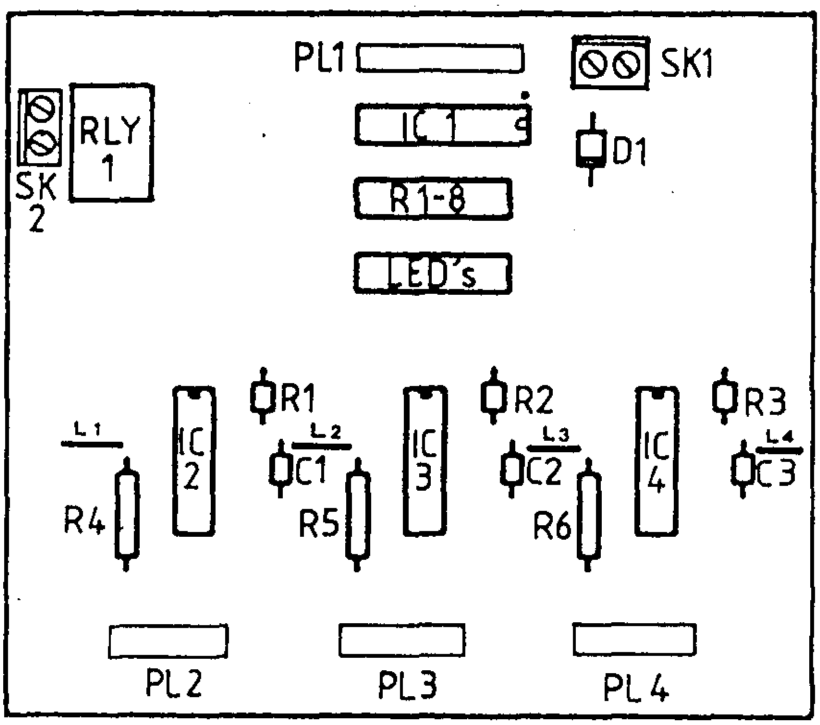
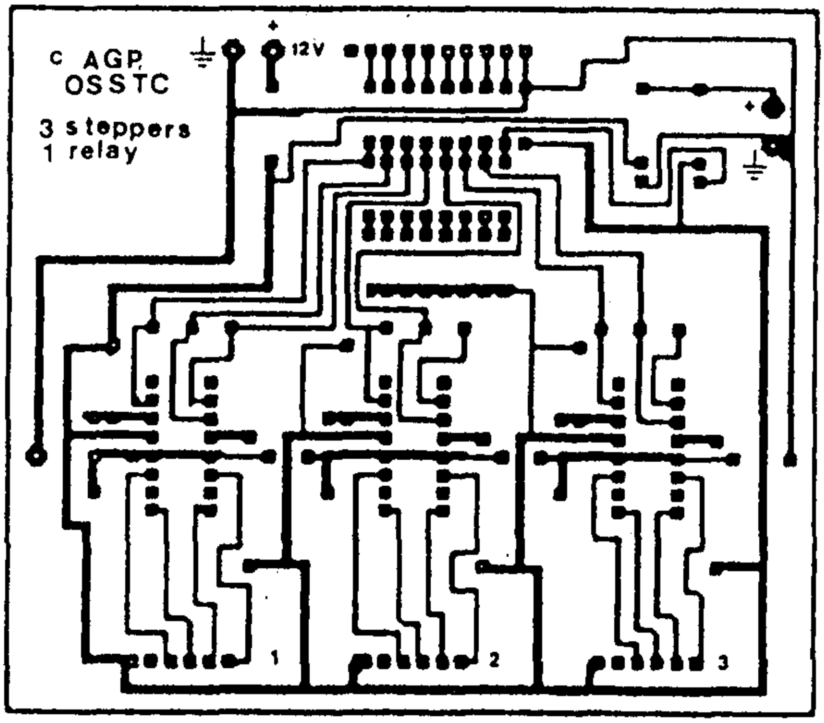


fig 3.2.1. Component Layout for Stepper Motor Interface.
COMPONENTS FOR STEPPER MOTOR INTERFACE.

Part	Quant.	Description
PL1	1	Molex 10 way PCB plug.
PL2,3,4	3	Molex 6 way PCB plugs.
SK1,2	2	2 way pcb mounted terminal blocks.
IC1	1	ULN 2803A Darlinton Driver Array.
D1	1	1N4005 Diode.
D2-9	8	3mm Red LED's.
IC2,3,4	3	SAA 1027 Stepper Motor driver I.C's.
C1,2,3	3	100 nanofarad capacitors.
R7-14	8	470R resistors.
R4,5,6	3	220R X 1/2 watt Resistors.
R1,2,3	3	100 Resistors.
RLY1	1	12v 320ohm Relay R.S. 348-510

Interface extension 3.

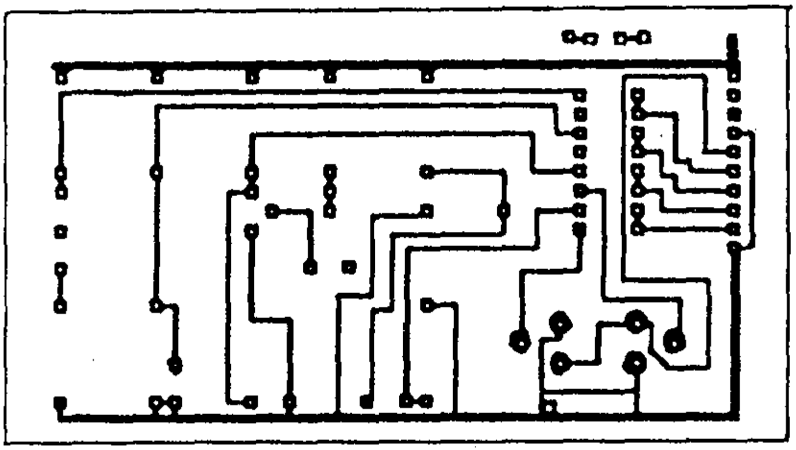
STEPPER MOTOR INTERFACE PRINTED CIRCUIT BOARD. - fig 3.2.2.



The stepper motor controller circuit above has been designed as a low cost unit capable of driving 3 small stepper motors and 1 relay switched d.c. motor or solenoid. The obvious use for a board of this type is for driving 3 axis machinery, plotters, turtles or robot arms. If only two stepper motors are required, it is only necessary to fit the components into the first two circuits on the circuit board and leave the third circuit bare. (Each of the motors is driven by an identical circuit; there are three of these in parallel on the interface board). The board is small enough to be contained within the base of most well designed equipment and can be connected to the computer by an umbilical ribbon cable. A separate power supply of between 12 and 18 volts is required to drive the board and stepper motors. (The computer power supply is not connected). This interface will run equally well on the user or printer port, (there are no input lines), therefore two boards could be incorporated into projects thus allowing the possibility for 6 stepper motors to be driven by one BBC computer. Two ancillaries can also be operated via the relays on the interfaces.

The stepper motor control logic is determined by the SAA1027 integrated circuits.

DEMONSTRATION ANALOGUE SENSING CIRCUIT. - fig. 3.2.3.



The circuit above has been designed to conveniently demonstrate very simple analogue sensing circuits. This circuit will work in conjunction with the supplied disc of programmes to illustrate the use of the following sensors:-

- push switch;
- reed switch;
- thermistor;
- photo-transistor or light dependent resistor;
- 2 potentiometers configured as drawing "paddles".

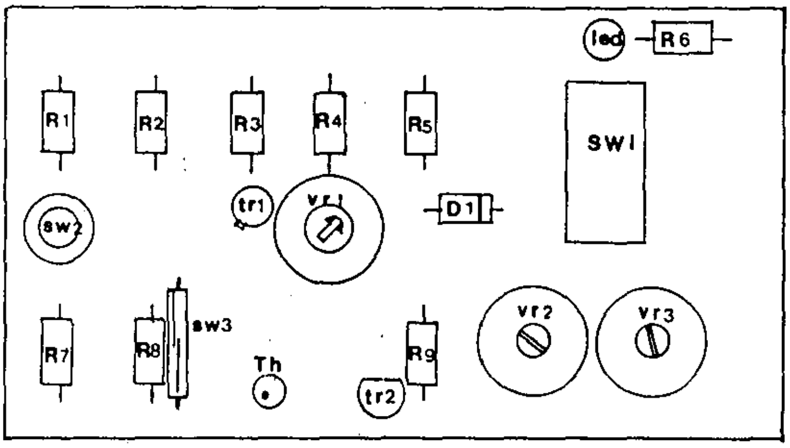
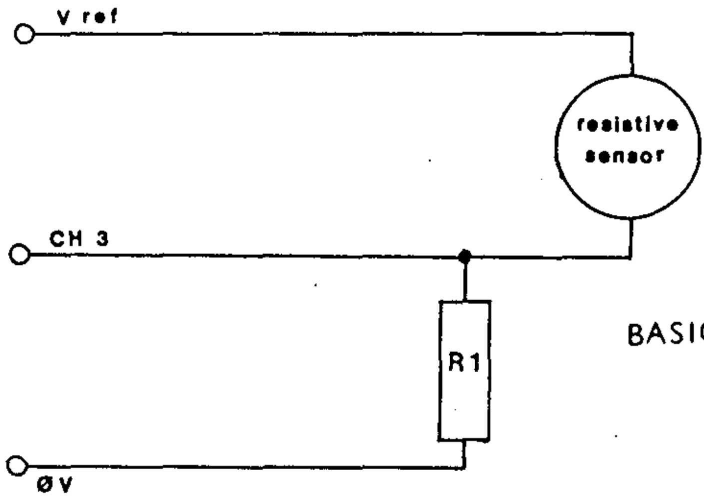


fig. 3.2.4. Component layout for analogue sensing circuit.

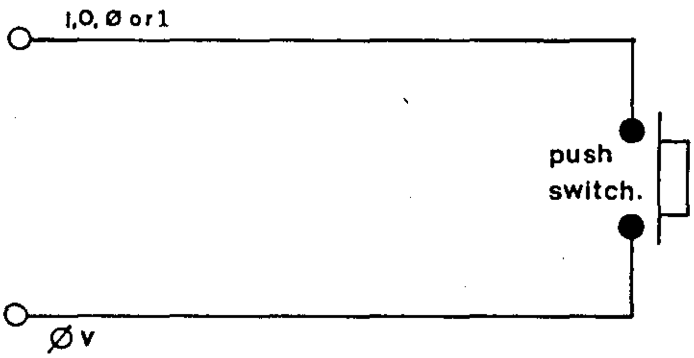
Each of the above sensors can be made on separate circuit boards.

ANALOGUE PORT CIRCUITS.



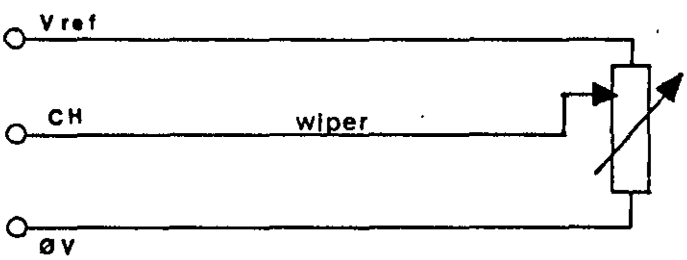
BASIC SENSING CIRCUIT.

1



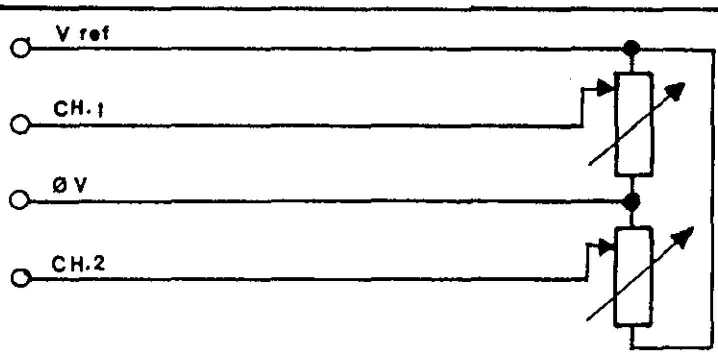
"FIRE" BUTTON.

2



POTENTIOMETER (PADDLE).

3



JOYSTICK.

4

DIRECTIONAL CONTROL OF SMALL D.C. MOTORS.

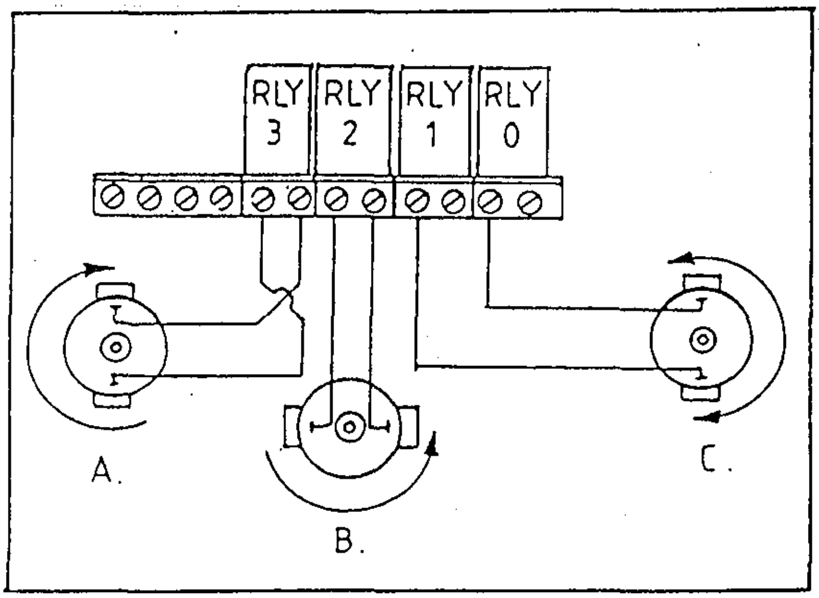
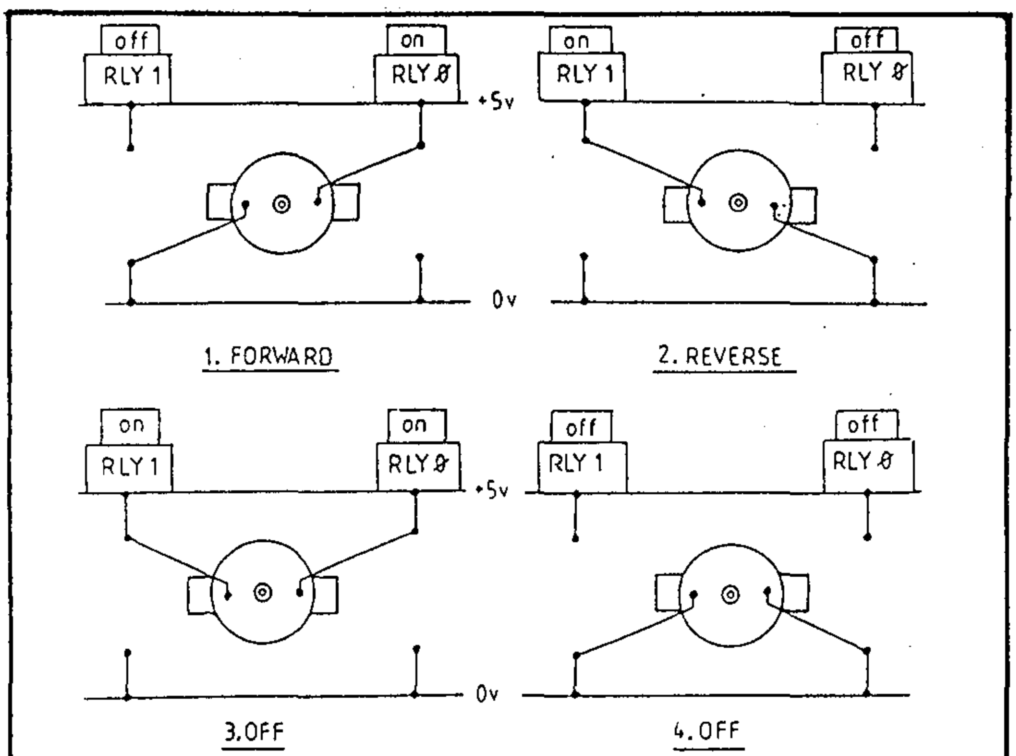


fig. 3.5.1.

A. Rotates clockwise - wires are reversed in relay connectors.

B. Rotates anti-clockwise.

C. Bi-Directional rotation. (See diagram fig. 3.5.2. below).



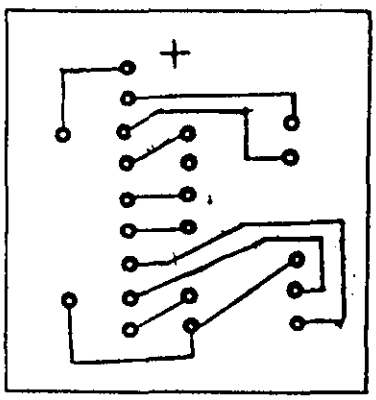
MOTOR CONTROL USING 2 RELAYS

Interface extension 3.

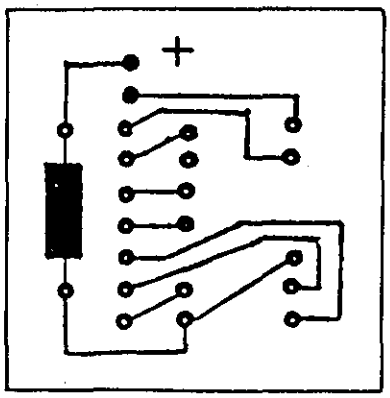
ASSEMBLING THE SEVEN SEGMENT LED SUB-INTERFACE.

This small sub-board is designed to fit on the jump plug connection positioned just to the West of DIP switch two on the training interface.

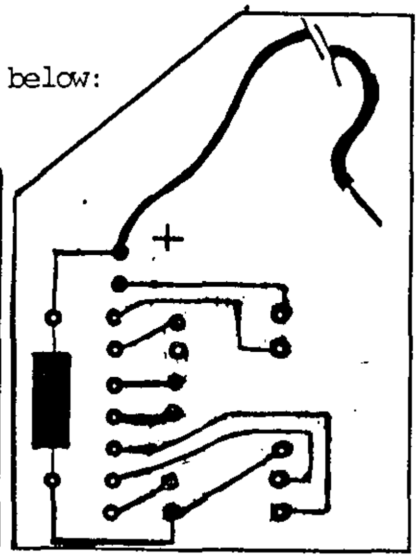
Construction is very simple, see the diagrams below:



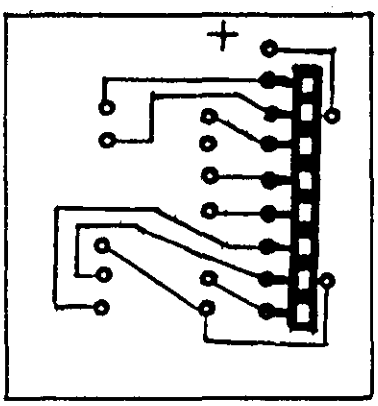
1. Circuit (comp. side).



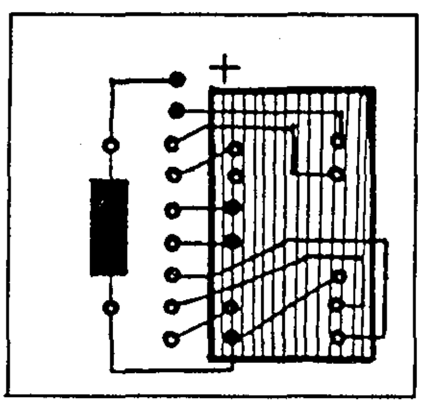
2. 22R Resistor.



3.Fix flying lead.



4. Solder on Socket.



5. Fit 7 segment display.

All views, (except No. 4), are from above the board i.e. the component side away from the copper tracks.

(a) Solder in the 22R resistor and then the flying lead, both are positioned above the board on the plain surface.

(b) Clip approximately 2.5mm off the angled legs of the molex socket and then solder it into position on the copper track side of the

ETC...

APPENDIX 4.

4. Software included with the course materials.

INTERFACE SOFTWARE.

The disc of short basic programmes which accompany the interface, are accessed by the simple shift + break 'boot' procedure used on the BBC micro. If the user is operating a colour monitor system, a colourful Mode 7 screen will appear, which displays a copyright notice and an invitation to select either menu one, or menu two, by pressing the appropriate number key. When the menu is selected, the user again views a multi-coloured screen and is prompted by a flashing message to select the program which he or she wishes to use. This is achieved by pressing the relevant letter key. The program will load and run when the letter is pressed. Some of the programs then put up further on-screen messages and instructions; or alternatively they will operate the interface directly. The flashing message is also very obvious when used with monochrome monitors. (See diagrams).

The programs are divided into user port procedures selected in menu one; and utilities such as resistor colour codes and binary / hexadecimal conversion, plus analogue port and cassette port programs, in menu 2. When the program is selected, the title is found in two-colour, double height lettering at the top of the screen. If action is required from the user, such as connecting components to the interface or checking switch settings, the on-screen commands usually wait for the space bar to be pressed before a program will run.

In several instances the user is encouraged to 'escape' out of a program and list it. An example listing is given below; a slight variation of this program invites the operator to alter a line in the program via an on-screen message. When the program is run again the user can see the effect of the changes made. Many users like the diesel engine effect heard when the time delay is altered in this binary test program. (See fig. 4.3). This triggers each line in turn and will switch each relay accordingly, (providing they are switched on by the bank of eight DIP switches on the interface). This also very simply illustrates the principle of a time delay alteration in a program.

At this stage users are not encouraged to save their alterations back to the master disc, but to keep to memory only changes. However, as the confidence to make simple and effective alterations to a program increases, the user will eventually wish to save their own versions. This can be done on a spare disc; or onto the master disc if they are certain this is what they require. The menu system is explained, and new programs can be added to the existing menu; or entered into a third menu which can be accessed from the initial front panel. The front panel program will of course need another line added which will demonstrate a 'knock-on' effect.

The object of these exercises is to increase the confidence of the

Software.

user in very simple program alteration and eventually program writing. Much of this confidence will arise as a result of the instant feedback from the machine when something is changed, or eventually, from the basis of need when the user wishes to do something different. Control problems are set on the taught courses; which eventually require the user to use the keyboard to 'drive' equipment which they have made. Most students at this stage wish to add their own screen messages, even if they are adapting an existing main program.

CONTROL PROGRAMS MENU 1.

A BINARY TEST PROGRAMME
B BINARY COUNTING
C TRAFFIC LIGHTS 1
D TRAFFIC LIGHTS 2
E BURGLAR ALARM (USER PORT)
F BUGGY CONTROL
G BUGGY + ACCELERATION
H MASTER KEYPAD CONTROL PANEL
I PELICAN CROSSING
J ROBOT CONTROL 1
K ADVANCED BUGGY CONTROL
L PELICAN CROSSING
M ROBOT CONTROL WITH MEMORY

PRESS A LETTER TO SELECT.

4.1. Menu one screen display.

CONTROL PROGRAMS 2

A 1 STEPPER MOTOR TEST
B ANALOGUE PADDLE DRAWING
C JOYSTICK DRAWING ROUTINE
D THERMISTOR GRAPH
E ANALOGUE SWITCH
F CASSETTE MOTOR CONTROL
G RESISTOR COLOUR CODES
H LDR TEST PROGRAMME
I DECIMAL TO BINARY CONVERSION
J BINARY TO DECIMAL CONVERSION
K ANALOGUE DISPLAY / LOGGER PROGRAMME

PRESS LETTER TO SELECT.

4.2. Menu two screen display.

Software.

4.3. An example program listing, (MODE 7 colour characters removed).

```
10CLS
20 PROCsetout
30MODE7
40PRINT:PRINT:PRINT
50PRINTTAB(5);CHR$141"BINARY TEST PROGRAMME"
60PRINTTAB(5);CHR$141"BINARY TEST PROGRAMME"
70PRINT:PRINT
80PRINT"This programme will test the outputs"
90PRINT"of your interface board by turning"
100PRINT"the L.E.D.'s on and off in sequence."
110PRINT:PRINT
120PRINT"Make sure that switch 1 / 1 & 2 are"
130PRINT"in theON position, 1 / 3 should be"
140PRINT"OFFand 1 / 4 must be on if you are"
150PRINT"powering the interface from the"
160PRINT"COMPUTER."
170PRINT:PRINT
180PRINT"Switch the relays toOFFwith the"
190PRINT"switches 1 to 6 on DIP switch 2."
200 REPEAT
210 FOR n=0 TO 7
220 PROCoutput(2^n)
230 TIME=0:REPEAT UNTIL TIME>100
240 NEXT
250 UNTIL FALSE
260DEFPROCsetout:?&FE62=&FF:ENDPROC
270DEFPROCoutput(value):?&FE60=value:ENDPROC
```

Altering the time delay in line 230 can have interesting effects on the relays, if they are switched on by DIP switch 2 Nos. 1 to 6. The delay figure can be reduced as low as 5!

Software.

```
 10PROCset
 20MODE7
 30PRINT:PRINT
 40PRINTTAB(5,6);CHR$(141)" TRAFFIC LIGHT DEMONSTRATION 1"
 50PRINTTAB(5,7);CHR$(141)" TRAFFIC LIGHT DEMONSTRATION 1"
 60PRINT:PRINT
 70PRINT"This programme demonstrates a traffic"
 80PRINT"light sequence for one set of lights."
 90PRINT:PRINT
100PRINT CHR$(136)"Change Line 210 for different effects."
110REPEAT
120FOR x=1 TO 4
130READledno,timeon
140PROCswitch(ledno)
150TIME=0:REPEAT UNTIL TIME>timeon
160NEXT
170RESTORE 120
180UNTIL FALSE
190DEFPROCset:?&FE62=&FF:ENDPROC
200DEFPROCswitch(value):?&FE60=value:ENDPROC
210DATA4,300,2,200,1,300,3,200
```

4. 4. An example program listing (MODE 7 colour characters removed).

APPENDIX 5.

5. Course Information for Research Subjects.

Micro/Control Course

Course Outline

1. Connecting and Powering up Micro, Monitor, Disc, Drive and Printer.
2. PROCDEF - BBC BASIC. Procedure Definitions and Calls.
3. Binary and Hexadecimal Number Systems.
4. User Port - Programming for output and input.
5. Analogue Port - Programming for output and input.
6. Hardware Add-ons-Buggy, Robot Arm, Stepper Motor, Sensors etc., connection and programming.
7. Low Budget Sensors. Buying in and building up.
8. BBC BASIC. FX Functions. Changing user port states using FX.
9. Logic Functions - AND, OR, NOT AND, NOT OR.
10. Robot Drives - Stepper Motor, D/C Motor, 6 axis movement.
11. Other Peripherals - Mouse, Teletext (Softward Download), Pilot 1 and Control kits, Joystick for parallel ports, Alfred Robotic Arm, CNC Miller (Feedback Instruments), Small interface boards.

OUTLINE OF ELECTRONICS MICROCOMPUTER AND CONTROL COURSE.

1. The major aim is to introduce 'computer naive' teachers of CDT / Science / Technology, to a microcomputer and peripherals, with a view to increasing their awareness of the possibilities and application of this 'New Technology' to educational advantage.

2. A BBC microcomputer with the cover removed will be demonstrated. A brief explanation of the essential components and output ports will be given, with an introduction to some of the terms and 'jargon' in common use.

3. Differences in board layout and capabilities of the various models of BBC micros will be highlighted.

4. The different methods of putting information into a microoomputer and outputting to a variety of peripherals will be demonstrated and discussed.

5. A brief introduction to the use of a word-processor. Participants will be expected to use the word-processor to write a brief report, notes etc. during the course. A critical evaluation of their work and the course should be included.

6. A PCB design software package will be demonstrated, (Vinderen Associates PCB). Course members will then have the opportunity to translate a simple circuit diagram into a practical PCB layout. The process of photo-etching a PCB will be demonstrated.

7. The computer will be linked to a small demonstration CNC machine (Feedback Control milling machine / drill), which will be used to drill holes in a PCB board from a pre-prepared program. The method of programming will be shown and opportunity given to participants who wish to try it out for themselves.

8. A demonstration of simple electronic circuit production and components will be given, followed by a practical session where participants will assemble simple user and analogue port interfaces.

9. From pre-prepared programs, the boards will be used for demonstration and solving problems. The method of listing the program and identifying the various routines will be demonstrated and modification encouraged. (No prior knowledge of programming is expected).

10. The analogue port will be used as a sensing input to the micro. Control of D.C. motors, servos, and stepper motors will be discussed. The use of a relay to switch motors will be demonstrated, thus introducing the principles of motor control, protection and relays.

11. Participants will undertake a set practical project involving the construction of a relay interface and equipment to be controlled by it. A CAD package will be used in the design stage of this project.

12. Opportunity will be given for participants to use a variety of commercially produced software packages and robot arms etc.

A.G.P. 7.1.'87.