

CRANFIELD INSTITUTE OF TECHNOLOGY

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**THE ROLE OF INFORMATION TECHNOLOGY IN
SUPPORTING THE DEVELOPMENT OF SCIENCE LINKED
TECHNOLOGY EDUCATION**

'A Pilot Computer Database Development '

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ABSTRACT

This study builds on my earlier 1983 Masters research at Cranfield, which was an investigation of early technology education in the UK and USA and a pilot evaluation of the introduction of technology education into the curriculum of Stantonbury Campus in Milton Keynes, England. This gave an indication of the international trends in technology education and showed some of the potential of a problem-oriented approach to learning in schools based around a new integration of subjects and skills. It also showed the challenge to existing school teaching staff who often had to learn new skills themselves, often had to teach in new ways, and had to broaden their orientation after being single subject specialists most of their careers. Teaching materials had to be developed from scratch. IT had to be got to grips with.

In September 1984, I took the post of Co-ordinator of the Schools Science and Technology Centre at the University of Oxford and had to implement a policy for science-linked technology education through a fast-changing period. During 1987 the pace of change accelerated rapidly being driven by the demands of the emerging new National Curriculum. By that time technology education, including IT, seemed to have become accepted as an important theme in the school curriculum in its own right. The Oxford Centre was there to offer in-service support in the development of training and teaching materials. It was, therefore, a good base for a study which could document the challenge of implementing technology education on a wide scale.

In the end the sheer pace of change enacted by the government between 1987 and 1992, and shifts of position over the place of technology education, made the study a harder task than I expected. I was aiming at a fast moving target. But I hope the work is of value in exploring the link between the aspirations of those who advocate "technological capability and literacy" in our school population and what is currently being achieved. This thesis tries to explore the key areas of progress we need to make if technology education is to become a reality in our schools.

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CHAPTER 1

THE DEVELOPMENT OF TECHNOLOGY EDUCATION OVER THE LAST DECADE

This chapter traces the background to the policy issues and ends with a statement of the research approach.

The chapter concludes that over the past decade industry has both recognised the importance of technology education and been prepared to support it, even if the exact meaning of the term has remained vague and its interpretation in schools has varied with DES policy and with the realities of resourcing.

CHANGES IN THE ECONOMY AND THE INTERNATIONAL COMPARATIVE SITUATION

This section covers the Economic Background 1981-91; Industrial Support for Technology Education; Industry and Skill shortage; and School Response to Skill Shortages.

Economic Background 1981-91

In 1983, in my study of 'Technology Education UK, USA'¹, I indicated that:

"Technology has become the prime generator of society's, in this case of Britain's wealth. It plays a crucial part in the manufacturing process of industry e.g. by setting the price of goods, by determining productivity which is related to employment, which is a pre-requisite of wealth creation. The more technologically advanced, the more profitable the goods. Prosperity also depends upon the exploitation of technical skills by society in order to create and produce high-value goods for the market place which are the result of Britain's outstandingly rich scientific and technological ideas. Manufacturing industry, from which these high-value goods arise, creates circa one third of the country's wealth."

The background to the emergence of technology education was the concern with Britain's competitive position. Cecchine² pointed out that over the 1980s the competitive performance of EEC industry in world and European markets had not been good when compared to that of the Japanese and the Americans. These latter two were increasing their market share at the expense of the EEC, especially in advanced technology sectors such as electrical and electronic goods, office automation and data-processing.

The pressure was greater because of the relative failure of the GATT (Global Agreement on Trade and Tariffs) talks to regulate global trading arrangements. Britain was vulnerable. The UK Treasury ³(4) reported in 1991 that over half the UK trade was with EEC countries, that the UK's largest overseas trading partner was the USA, and that about 80 per cent of the UK's trade was with other industrialised countries.

In 1988 an EEC report argued that the completion of the EC internal market in 1992 should lead to the exploitation of new opportunities and a better use of available resources, and that the main players in this new market would be drawn from the manufacturing and service sectors. Cecchine agreed, but argued that *"..businesses' capacity to develop new forms of organisation, to penetrate new geographical markets, to invent new products and new processes -- these are the stuff of which competitive edge is made"*

Presently these challenges are all overshadowed by the prospect of major economic changes associated with the Eastern European countries and Soviet Union (CIS) taking up their new positions in the world market place.

The net effect has been increasing pressure for Britain to be able to compete in a future where new technologies will play a major role.

Which are the new technologies? A literature search in 1991 found that the analysis of the most important new technologies put forward in the earlier 1983 thesis⁴ (ref) was still valid. These were information technology (including main frame and microcomputing applications, software and design); advanced production techniques for industry; modern materials use and processing; vehicles technology; fibre optics; control engineering, including robotics; biotechnology; medical technology and energy technology. (Evidence in support came from the DTI, the National Science Foundation of the USA, Harwell, CIT, BAe, and The House of Hardy.)

The demands for the new technologies were still coming from major growth points such as Biotechnology; Communications Satellites; New Materials; Transport; Telecommunications; Machine Tools; Information Technology. (Evidence in support of this came from the DTI, BAe, The House of Hardy, Sproat, Wilkins, Jenkin, and N.C. Verlag)

Industrial Support for Technology Education

During the 10 year period there was clear evidence of practical support from UK industry for school technology education either by sponsorship or by directly associated agencies of long standing such as the SCSST (Standing Conference on Schools Science and Technology); the BP Educational Service (British Petroleum); the BIS (Banking Information Service) and the Comino Foundation.

According to Bloomfield⁵ the SCSST exists to support science linked technology education. Annual reports from this body indicate that it has had substantial funding for the support of school science and technology education from most of the UK's major industrial and commercial concerns since its inception some 20 years ago. One recent initiative, funded by Lloyds of London in 1985, was concerned with the establishment of regional young engineer clubs in school technology departments. These clubs have links with local industry and often receive additional funding and support from this source.

The BP (British Petroleum) Education Service, which was established some 25 years ago, is the educational arm of the company British Petroleum. It has a BP Educational Catalogue⁶ that contains a huge range of support materials for the school curriculum including school Science and Technology. BP also provides scholarships/bursaries for teachers of science and technology for a variety of purposes. OSSTC (Oxford Schools' Science and Technology Centre) holds approximately 400 items which range from audio tapes to curriculum packages. Many items include computer software, written, and visual media. The Co-ordinator of OSSTC was a beneficiary of one of the scholarships during 1986.

The BIS (Banking Information Service) is the charitable arm of the high street banks and has been supporting education for more than 20 years. An interview with Gleave⁷ revealed that the BIS funds an extensive selection of educational material which supports the business and economic concerns of technology education. In recent times, during the period 1987 to 1989, it has produced computer software and resource materials for financial planning and management of technology project work. Two items of software

development, TechData 50 and Citylink, covered later in this study were funded by this organisation.

An interview with Bates⁸ in 1991 revealed that the Comino Foundation, which arose out of the company Dexion approximately 15 years ago, had supported technology education with funding for its 1987 GRASP (Getting Results And Solving Problems) programme for Technology Teachers and SATRO Directors along with the Department of Industry Education Unit. This programme provided a series of residential INSET courses specifically designed for technology educators. The GRASP technique has been introduced to approximately 400 technology educators who have attended this on-going programme.

During the last ten years new supporters have arisen from industry.

Bradstock⁹ revealed, in a personal conversation, that The Oxford Trust, which was set up in 1984, is the charitable arm of the company Oxford Instruments. This organisation instigated Schools Industry (Science and Technology) Grants for schools in Oxfordshire during 1986. This programme, for students in Oxfordshire, supported industry/school collaborative science/technology projects. Grants provided to 1/12/89 covered 120 students working with about 40 companies collaborating on approximately 50 science and technology projects.

Interviews with staff at the Smallpiece Trust of Leamington Spa¹⁰ in 1991 indicated that it was sponsored by industry. and that this organisation has funded CAD INSET courses for Technology Teachers for some years. It also funded the setting up of the DATA (Design and Technology Teachers Association) for all those concerned with technology education during 1989. DATA is the major national UK association concerned with the field of technology education.

The new CTCs (City Technology Colleges) are funded and supported by many of the UK's major companies. In 1990 about 23 sites were identified for CTCs and approximately 4 were intended be on line shortly. In all cases local and national industry pledged substantial funding for such developments. A prime example of this is provided in a CTC brochure from Cable and Wireless¹¹. This indicates that the new Bristol based John Cabot City Technology College is due to take its first students in 1993; and that this initiative has been funded by the City Technology Trust, The Kingswood Schools Foundation, Cable and Wireless plc and the Wolfson Foundation.

A recent example of industrial support for technology education, in particular the IT (computing) element, was the 1987 ASI (Apple Schools Initiative)¹². Apple Computers undertook to equip every teacher training college in the country with a network of Apple equipment including a laser printer and CD-ROM drive. Because of the considerable numbers of commercial users that Apple can call on, the company was also able to offer an 'Insights into Industry' program - a scheme that partners college lecturers with corporate computer users.

Industry and Skill Shortage

Further evidence of the place of technology education arises in the debate about skill shortage. This section covers the situation in the UK, and that of our competitors in the USA and New Zealand.

In the UK a report on the employment of women in science and technology related careers, published in 1988 by the FEU (Further Education Unit)¹³ indicated that there is uncertainty about the actual numbers of jobs to be created in the growing new

information technology based industries. However, the numbers of jobs were likely to be substantial because prospects for industrial growth were good.

In 1987 NEDO¹⁴ indicated in a report on employment that although employment will decline, occupations in computing and microelectronics can be expected to grow as more technological jobs will be created in the manufacturing sector.

"while employment may continue to decline, 'occupations in computing and microelectronics can be expected to grow' IT (Information Technology) has created new manufacturing jobs developing, producing and linking the hardware, and there has been an even greater expansion in jobs in the software industry. Technological jobs in IT demand and use a wide range of skills - systems and design, software engineering, robotics, electronic and 'telecoms' engineering, technical authorship, education and training of end users, as well as research and development."

The Further Education Unit¹⁵ also commented upon the fact that the UK is facing a shortage of skilled IT personnel, in particular those with supervisory and management roles; and that there will be a need to educate professionals and management across both industry and commerce with IT techniques. In the UK Her Majesty's Inspectorate of Schools commented on the problem in 1989 based on inspections carried out over a five year period.¹⁶

Dean¹⁷ also indicated that a programme based at Salford University (UK) highlighted the shortage of suitably trained engineers and scientists and young school leavers about to enter industry.

A 1990 report from the University of Sussex¹⁸ raised the issue of the 'demographic time bomb':-

"A massive and immediate increase in the number of people being educated to degree level is needed to meet the needs of the economy over the next decade, according to a wide-ranging report published yesterday by the Institute of Manpower Studies. Drastic measures are needed to increase the number of school-leavers entering higher education to offset the "demographic time-bomb" of a drop of 25 per cent in the number of 18-year olds over the next five years."

Evans¹⁹ commented in 1990:-

"The most comprehensive study yet of almost 6000 young adults aged from 16 to 19 carried out by more than 20 academics from 5 universities, has exposed a 'tremendous gap' in attitude and thinking between those who leave school at 16, with few or no qualifications, and teenagers who continue with further education" he further indicated that the project director, Professor Bynner had highlighted "The 'Staggering difference' in the proportion of largely unskilled youngsters in Britain who alternate between unemployment and part-time work- anything up to 25% of the population under eighteen" and "That this is far, far higher than you would expect in any other western countries. Our main competitors, West Germany, France, The Netherlands and Scandinavia, have nothing comparable"

In the USA Dyrenfurth²⁰, a technology educator commented in 1987 that unless the world helps youth to understand, develop capability, and to assess technology the world could end up with economic chaos. He indicated:

"My thesis is simple. Namely that the schools have not made any changes that would compare with the magnitude of change experienced by the society housing them. That is why we are faced with a critical situation and I would submit that much of the world is

also experiencing this imperative! If our schools do not help youth understand technology, if they do not develop the capability to use technology, to assess technology, to control technology, then the only viable prediction is one of catastrophe."

In New Zealand Ferguson²¹ pointed out that in 1989 a government paper had indicated that there was a need for economic development to aid economic recovery, and that science and technology would play a part.

School Response to Skill Shortages

The role of schools and colleges in fulfilling these skills shortages is obviously a critical one. In the UK a reasonably reliable guide to the present performance of schools in both attracting pupils towards the technological subject areas and in educating them successfully are the statistics relating to GCSE (General Certificate of Secondary Education) examinations taken at the age of 16. On the following page will be found an analysis of the figures for 1988 and 1989 (see Table 1 overleaf). In each case the subject with the highest number of entries has been taken as the examination cohort, a guide to the number of school leavers in a particular year. This cohort will be taken as representing those who are potential recipients of a technologically based education.

Table 1

GCSE RESULTS 1988 & 1989										
Subject	Percentage of Candidates obtaining each Grade in 1988									
	Number	% of Cohort of Candidates	A	B	C	D	E	F	G	Total
Business St.	47365	7.07	7.80	10.1	23.2	23.4	14.4	10.6	4.1	93.6
Computer St.	100329	14.97	5.4	10.8	17.8	16.6	16.1	15.4	11.9	94.0
CDT	157747	23.54	7.0	11.6	17.5	19.0	18.8	15.4	7.8	97.1
English Lan	666962	99.53	6.7	14.2	23.0	23.0	17.7	10.8	4.0	99.4
English Lit.	394818	58.92	9.6	17.2	24.4	22.1	15.5	8.0	2.5	99.3
Geography	305575	45.6	8.0	14.1	19.7	18.9	15.9	12.4	7.2	96.2
History	256309	38.25	9.7	14.8	19.3	17.0	15.5	11.9	7.8	96.0
French	265317	39.59	19.8	14.4	15.9	18.0	15.0	11.8	4.8	99.7
German	75684	11.29	22.3	15.5	16.9	16.9	12.9	10.4	4.1	99.0
Mathematics	670128	100.0	6.0	8.7	21.9	15.9	16.3	15.3	7.1	91.2
Religious St.	104512	15.6	8.7	13.3	19.2	17.7	16.6	12.5	7.5	95.5
Chemistry	217638	32.48	10.6	14.7	23.8	18.3	13.9	10.6	5.0	96.9
Physics	254107	37.92	9.2	14.5	20.9	19.2	16.9	11.9	5.7	98.3
Science	155713	23.24	5.2	8.8	17.7	19.6	20.8	15.9	8.2	96.2
Averages			9.71	13.05	20.09	18.97	16.16	12.35	6.26	96.6
Subject	Percentage of Candidates obtaining each Grade in 1989									
	Number	% of Cohort of Candidates	A	B	C	D	E	F	G	Total
Business St.	28957	4.43	5.7	12.	24.8	21.8	16.3	10.6	4.1	95.3
Computer St.	81379	12.45	6.9	11.6	19.0	17.4	15.9	13.5	9.4	93.7
CDT	156832	23.99	8.8	12.8	17.6	18.1	18.8	14.2	7.1	97.4
English Lan	653821	100.0	7.9	15.3	25.0	23.0	16.3	9.1	3.0	99.6
English Lit.	389323	59.55	10.7	19.2	27.0	21.6	13.7	6.0	1.5	99.7
Geography	276740	42.33	10.2	14.8	20.1	18.5	15.9	11.2	5.8	96.5
History	232476	35.56	12.0	16.3	19.6	17.0	14.1	10.7	6.7	96.4
French	265239	40.57	21.0	15.5	15.8	17.5	14.4	11.2	4.2	99.6
German	77067	11.79	22.7	16.1	16.6	17.3	11.8	10.3	4.7	99.5
Mathematics	651951	99.71	6.4	9.3	22.4	17.6	17.0	13.8	6.7	93.2
Religious St.	93972	14.37	9.6	14.2	18.7	17.0	15.1	12.3	8.3	95.2
Chemistry	201799	30.86	11.7	15.1	24.4	17.8	13.9	10.3	4.4	97.6
Physics	224052	34.27	12.6	14.0	22.7	19.4	14.7	10.4	4.7	98.5
Science	171883	26.29	4.5	8.2	20.0	19.9	18.5	14.3	9.0	94.4
Averages			10.76	13.89	20.98	18.85	15.46	11.28	5.69	96.9
St. Deviation			5.11	2.79	3.32	1.92	1.84	2.17	2.22	

Source - Daily Telegraph 9/89

Not only is the total number in the cohort declining, the demographic time-bomb, but the percentage of potential students following a physics curriculum is also decreasing. in just one year by one tenth. The percentage of CDT students remains about constant, representing just less than a quarter of the cohort, but the percentage of students studying computer studies and business studies is falling dramatically. These are trends directly opposed to the perceived needs of the country.

Given that there will inevitably be some overlap, i.e. there will be many students of physics who choose to include computer studies and CDT in their curriculum, it appears

reasonable to suggest that over one half of sixteen year olds have already chosen to forsake careers in the practical, productive or innovative aspects of industry or commerce.

THE EMERGING AND CHANGING DEFINITION OF TECHNOLOGY EDUCATION

This section suggests the most helpful way to define technology education is through its main dimensions. There is evidence that technology and science are closely linked and science does not simply play a supporting role to technology education as sometimes thought. There is considerable conceptual confusion about technology, about what subjects it should be allied with, or even about the subject heading under which it should stand. This section discusses technology education in Britain and then offers comparisons with other countries.

A conclusion is that the dimensions developed here appear to apply to ideas of technology education across the world, but that the UK has in fact given lower priority to a strong link between science and technology than many other countries.

The Main Dimensions of Science-Linked Technology Education

Over the 1980's technology education moved away from its early "craft and design" origins and became more associated with science and in particular with systems thinking. By 1989 National Curriculum Reports for Mathematics, Design and Technology were adding ideas such as control and modelling, skills such as media manipulation and good presentation. By 1990 I argued the following dimensions (see Table 2) were implied:-

Table 2

MAIN DIMENSIONS OF TECHNOLOGY EDUCATION - JUNE 1990

- a. Has strong links with science and mathematics
- b. Is generally broad based, encompassing different subjects, disciplines, and skills;
- c. Has a knowledge base derived from practical experience and empirical evidence;
- d. Involves the creative process of invention and innovation to satisfy human needs;
- e. Is process based, and involves design and problem-solving as key elements;
- f. Is about materials and use;
- g. Involves practical manufacturing/making skills;
- h. Applies the systems, modular, and project approach to the technical and social areas.
- i. Necessitates communication, data gathering and information analysis, control, modelling, and simulation;
- j. Implies an inherent enhancement of attainment, capability, and awareness;
- k. Involves media manipulation and display and presentation skills.

This definition is the basis of research undertaken in this thesis.

The Science/Technology Interface In Education

The links between Science and Technology, in educational terms, have been identified by a variety of agencies and institutions including, the Schools Council, the National Science Foundation, Lucy Hodges, the Secondary Science Curriculum Review, and the DES.

As long ago as 1968 the Schools Council²² in their paper 'Technology and the Schools' indicated that university students required less factual knowledge, a greater understanding of scientific method and a more developed creative and inventive ability. They stated:

"There is, in particular, a serious need to consider whether the country might not generate a better supply of potentially effective scientists and technologists if it were accepted that students, at a time of moving to higher education, need less factual scientific knowledge, but a greater understanding of scientific method, and a more developed creative and inventive ability."

In 1982 the National Science Foundation ²³ of the USA indicated that science and technology are intimately linked, provide powerful tools for the educational process and that an improved level of science and technology among the general public is desirable. They stated:

"Science and Technology Education are intimately linked. Not only are science, mathematics and technology significant components of the curriculum at all educational levels, but in addition, science and technology provide powerful tools that are broadly applicable in the educational process itself. Furthermore, since many other professions and occupations that formerly had little scientific or technological content now require a moderate level of competence in those areas, and since numerous public policy issues have significant science and technology components, an improved level of science and technology among the general public is becoming increasingly desirable."

In an article in the Times newspaper in 1983 ²⁴ Hodges indicated that a recent report on school science advocated science up to the age of 16 years, that the subject should be broadened and that all students should undertake a technological project. She wrote:

"Substantial changes in the way that science is taught in secondary schools are proposed by a government-backed body in a report being distributed to educationalists and to industry and commerce. The proposals are that pupils should learn science up to the age of 16, that their courses be broadened to include astronomy and that they be taught how to tackle practical difficulties. Students would also be required to undertake one technological project. The plan prepared by the Secondary Science Curriculum Review over the last two years, is based on the premise that a scientific and technologically literate population is central to economic growth and well-being."

The Secondary Science Curriculum Review ²⁵ further indicated in 1983 that there is a widespread view that enhanced scientific and technological literacy is central to economic growth and there is a challenge to involve a wide sector of the community in science and technology education to improve excellence and educational opportunity. They pointed out in a consultancy paper that:

"This consultative paper incorporates a bold and imaginative set of proposals which will lead to a significant re-orientation of science education programmes for young people aged 11-16 years. It reflects a widespread view that enhanced scientific and technological literacy set within a broad general education is central to economic growth and social well-being, and may help young people better manage the complex demands of life in an advanced technological democracy. The proposals in this paper represent a major challenge to the education system and to all those who support it. It is published in order to involve a wide community of interests in the complex process of enabling education through science and technology to further extend excellence whilst increasing educational opportunity."

The DES in their 1986 Policy Statement on Science Education²⁶ indicated that science and technology permeate every aspect of daily life, that the rapidity of technological change requires a supply of high quality scientific technical and engineering manpower, that they should lay a foundation for those progressing to further education in science and technology, and that links between science and CDT teachers were necessary to avoid a damaging and unnecessary division between science and technology. They also indicated that all science courses should have a technological content and all technology courses should have a scientific content, and that courses should be developed to foster science content, skills, and processes whilst providing opportunities for related technological work.

At this point it is argued that it is clear from the above that it is widely considered that technology and science, are closely linked. Science does not play a supporting role to technology education, as commonly thought. It is inherent within the subject and cannot be separated from it. It would seem from the above that the links between science and technology education do exist and have done so for quite some time. These links revolve around:

understanding scientific method and developing creative inventive ability; the need to provide powerful tools applicable to the educational process; the requirement to fulfil the needs of industry commerce and society as a whole; enhanced scientific and technological literacy being central to economic growth and well being; the individual being able to bring a scientific approach to bear upon the practical, social, economic and political issues of life in a modern technological society; enlightening and serving humanity through a process of investigation combined with creative ability and knowledge.

Technology Education-the Current UK Debate

This section covers the current UK debate in terms of technology education in the contexts of science and CDT, Home Economics and Business Studies and Technology Across the Curriculum.

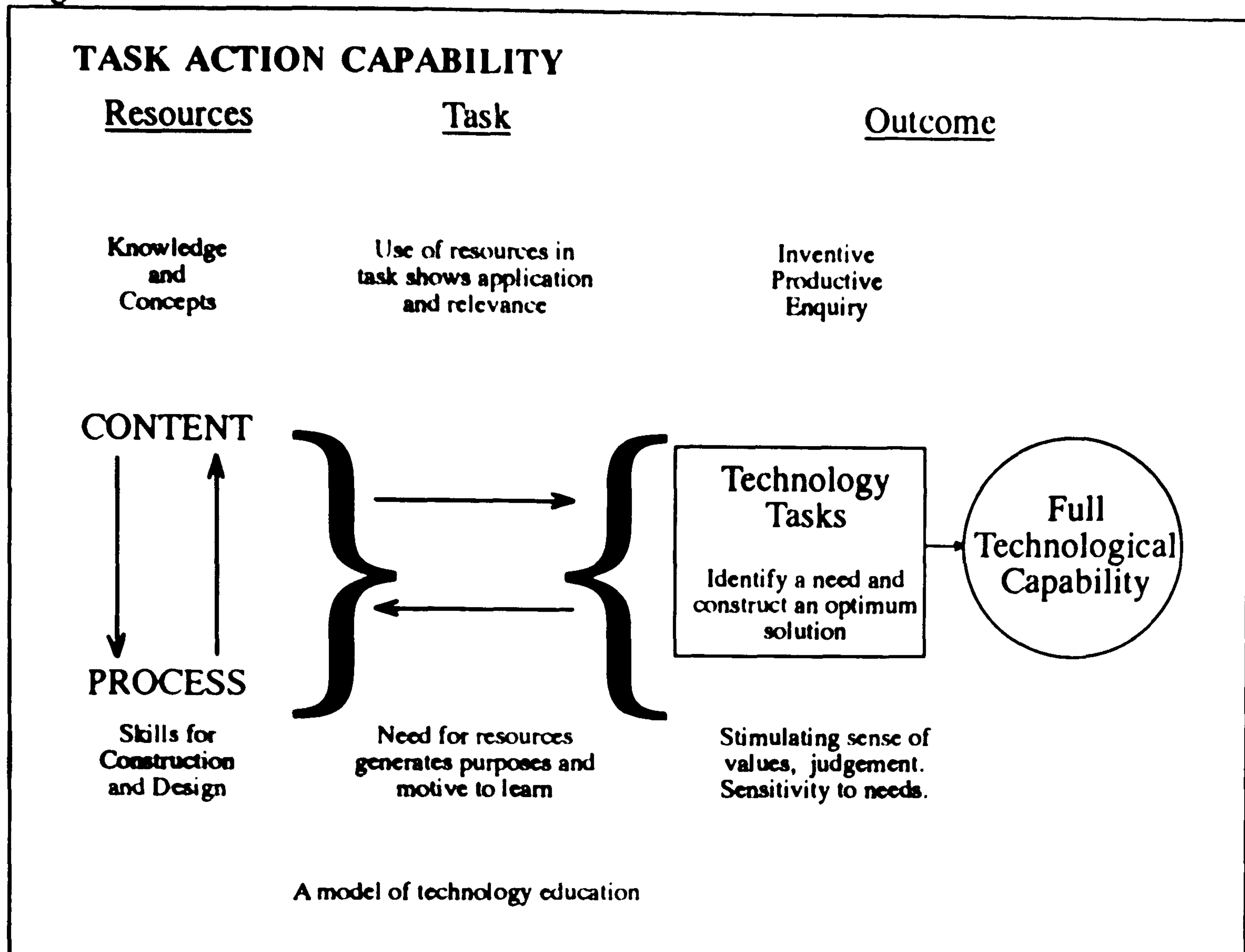
One major debate currently underway in the UK concerns the place of 'technology' in the curriculum or indeed its ownership within a science/CDT context in education generally. This debate seems to be derived from premises drawn from government, industry and HMI in that there is great concern for making both the CDT and science curriculum relevant to work in the real world.

Many of these issues have been simmering at a school and local level for some time. The TVEI (Technical and Vocational Education Initiative) has played its part in these developments, but is only an element of a multi-faceted development of the curriculum, including the development and improvement of the UK's educational training at all levels.

Much of this debate had been chronicled by Black and Harrison²⁷ in their paper 'In Place of Confusion, Technology and Science in the School Curriculum.' Essentially they present the idea of 'Task-Action-Capability' as the main target of technology education. Their paper indicates that in their view *"an interdisciplinary approach to technology is essential"*. They go further and indicate *"that the two problems can only be solved if the areas interpenetrate and support each other"* also other areas such as mathematics and English provide necessary resources.

Their model for TAC (see Fig.1 overleaf) revolves around resources, tasks and outcomes which leads to full technological capability via a process of development.

Figure 1



Source - Black & Harrison, In place of Confusion²⁸

The debate about technology belonging to science or CDT has also been underpinned by developments including: a 'Science and Technology' PGCE (Post Graduate Certificate in Education) course at Kings College (London University); the LEAG (London and East Anglia Examining Group) 'Technology as a Science' GCSE; and the work of the SSCR (Secondary Science Curriculum Review).

The SSCR in their newsletter Autumn 1987 suggested the following about 'Technology' in the School Curriculum:

"1. Schools should be encouraged to implement, as part of their whole curriculum policy, a broad and balanced technology curriculum for all pupils up to 16."

"2. The technology curriculum which all pupils experience should reflect and exemplify the multi-disciplinary nature of technological activity. To this end a school's provision for technological studies should be developed in co-ordination with existing subjects, especially, but not exclusively, CDT and Science."

"3. A school's technology curriculum should exhibit breadth and balance with respect to:

content (subject matter related to a wide variety of aspects of science, and including/alternative technology);
 context (range and variety to ensure relevance);
 process (design, construction, investigation and evaluation);
 values (evaluation criteria related to ethics and social and environmental considerations, as well as to utility, economics and aesthetics)."

Overall there needs to be balance between acquisition of knowledge, skills and experiences and application of these in creative tasks."

"4. The science curriculum should be characterised by balance, breadth and relevance to pupils' lives in order to make its proper contribution to the development of technological awareness and capability."

"5. Technology ought to feature strongly in the curriculum, but should not dominate it. One way of trying to ensure overall balance of experience across the curriculum would be to develop other interdisciplinary activities alongside those which are primarily technological."

The SSCR²⁹ also claimed in 1987 that an important characteristic of technology is that it is: *"a creative human activity concerned with practical problems and tasks related to the achievement of human purposes and needs-directed to the production of an artefact system or process which will effect people and/or control some aspect of their environment. Usually in corporate endeavour, multi-disciplinary, drawing from a wide range of knowledge, skills and experiences "*

Another current debate concerns the place of Home Economics and Business Education within the context of technology education. This debate has arisen as a direct result of the inclusion of these subjects within the brief of the NCDTWP (National Curriculum Design and Technology Working Party)³⁰ This inclusion spurred on those involved with the subjects to ensure that their point of view was put forward.

Home Economics

A submission to the NCDTWP (National Curriculum Design and Technology Working party) was made in 1988 by NATHE (the National Association of Teachers of Home Economics). The document entitled 'The Place of Home Economics in Technology'³¹ put the definitive case for the subject in terms of spelling out: a. what they saw as technology; b. why home economics should be included in technology; c. how technology education could be identified within the home economics curriculum. Various items of interest concerning home economists started to appear in educational newspapers and journals

a. It would seem that the major influences upon this would be for the NATHE the Black & Harrison TAC Model (see fig 1 above). The NATHE indicated that: *"An important part of the work at all stages, has to do with the development of attitudes and values, and of the capacity to make judgements based on a reasonable consideration of evidence ----- Technology is, therefore, given a human aspect, and becomes more than the application of science ."*

The views of HMI are indicated in Curriculum Matters 5.-Home Economics 5-16³², and Curriculum Matters 2.³³ which showed that the consideration of values and attitudes, must be an integral part of technology. HMI indicated that *"Technology is about people controlling things, not things controlling people."*

These concerns generated the need to implement and deliver home economics as stated in the National GCSE Criteria for Home Economics³⁴ under the technology heading because: *" Home Economics is the study of the inter-relationship between the provision of food, clothing, shelter, related services and people's physical, economic, social and aesthetic needs, within the context of the home."*

b. The NATHE³⁵ spelled out why Home economics is inherent within Technology. This it would seem is based upon the concept put forward by Black and Harrison in their

'Task Action Capability' model (see fig.1) which embodies: a. resources; b. capability; c. awareness; perception and understanding. These key elements are seen by home economists not as discrete units but units that constantly interact with each other in the subject.

a.) The resources are *"Knowledge of family and society, food, fabric, material and energy, skills of analysis, investigation, research, planning, problem -solving, decision-making, psycho-motor, communication and evaluation"*.

b.) Capability is outlined: *"The unique nature of home economics enables pupils to manage resources of time, effort, finance, energy , food, textiles and equipment. It is an applied subject that synthesises theory with practice to solve real life problems by: identifying factors and priorities such as time, cost, aesthetics, performance, constraints and opportunities; generating ideas and investigating possible solutions; planning, managing and organising activities and resources efficiently; evaluating activities and outcomes for effectiveness; communicating and handling information; applying scientific and mathematical concepts and skills ; developing responsibility and concern for self and others."*

c.) Awareness, perception and understanding they consider are essential because: *"Knowledge of facts is no longer sufficient to equip students for adult life. They require an understanding to develop a critical awareness to live in a modern society where social, economic and technological change is taking place. Home economics develops this awareness by: exploring aspects of the nature and role of technology and control technology in household management systems; analysing the criteria for informed consumer choice, fitness for purpose, quality form and function of design, ergonomic efficiency, health and safety; encouraging the development of personal values, judgement, aesthetic, economic and social considerations; stimulating the ability to critically appraise the technological change."*

Another view of Technology resulting from the fact that home economics was not included in the national curriculum subjects and was only included in the brief of the Design and Technology Working Party in late 1987 is given in the journal 'New Home Economics' by Green and Daniels³⁶ who indicated that technology :

"implies a systematic study of the design, production and use of artefacts; includes processes or methods by which some objective is obtained; is frequently employed to adapt the environment; reflects our constant desire for efficiency; its ultimate purpose is to promote human well being". They also observed that "Technology incorporates a number of disciplines, for example, science, design, aesthetics, mathematics, ethics and a knowledge of human needs in a variety of contexts ".

Technology, in the context of home economics, they considered could easily be tied to the subject as presently taught in schools, as the aforementioned items were inherent within it, under the following headings: 'Problems Arising From Human Needs and Purposes; Adaptation Of The Environment; Efficiency; Human Well-being'.

Business Education

Kelsey and Lambert³⁷ outlined what business education was about and how it related to technology as a subject. They pointed out that business education is concerned with the economics and business life of the community and the pupils understanding and participation within the same in the context of their own personal future and life in general. They also made the point that it was about the products and services for sale to them, and social issues within the community. They stated:

"Business education is concerned with enabling pupils to understand, relate to and participate in the economic and business dimensions of the community. It helps them to ask business and economic questions and to evaluate economic experiences; it helps them to think for themselves and to make informed decisions - about themselves and their future pathways, about their personal budgeting and spending, about the products and services offered for sale, and about social and economic issues in the community."

The aim of business education they describe as being to: enable students to gain a knowledge of the world of business and economics, to ensure that students have the basic skills to deal with new technology and can adapt to technological change, and to ensure that students communication skills are improved and that they can undertake business and economic enquiry and solve problems with confidence using their own initiative when working with others.

The aims of business education they summarised as:

"to increase students' knowledge and understanding of the business and economic world as it relates to individuals and groups in society in their roles as producers, consumers and citizens;

to equip students with basic skills in, and understanding of, new technology used in business; and to encourage attitudes and learning skills necessary for adaptability to rapid technological change;

to contribute to the improvement of communication skills, including literacy and mathematical skills;

and to help students develop the initiative, confidence and flexibility to undertake business and economic enquiry, to generate design ideas, to identify and solve problems, to make and implement decisions, and to work on their own and with others."

They further describe the context of business as covering the development within students of an orderly and systematic approach to work, the ability to address priorities, a spirit of co-operation and respect for different viewpoints and ways of life, and a critical awareness and respect for evidence forming the basis for sound judgements.

They claim that their description of business education falls within the STF (School Technology Forum) definition of technology.

"Business education as described above clearly has a part to play in the broad definition of design and technology adopted by this working group. Indeed the STF definition of technology "as a disciplined process of using scientific, human and material resources to achieve human purposes" could equally be offered for the activity of business organisations."

They indicate that the contribution of business education to design and technology may be seen in three aspects:

1. the process of design and problem-solving.

2. the personal qualities identified by Black and Harrison in their paper (In Place of Confusion-Technology in the school Curriculum Ref 40 of this study):

- "- personal driving qualities such as determination, enterprise, resourcefulness.*
- personal innovative powers of imagination, intuition and invention.*
- willingness to make decisions based both in logic and in intuition.*
- sensitivity to the needs being served, to the possible consequences, benign or harmful, of alternative solutions, and the values being pursued."*

3. school business simulations and mini-enterprise activities:

"Business simulations and mini-enterprise activities encourage the growth of such qualities. Creating business opportunities and tackling business problems requires a combination of the speculative/creative and systematic/analytical approaches to design and problem solving. Business and economic problems are by nature practical and interdisciplinary and business education teaching can both contribute and derive benefit from being integrated with core design and technology tasks."

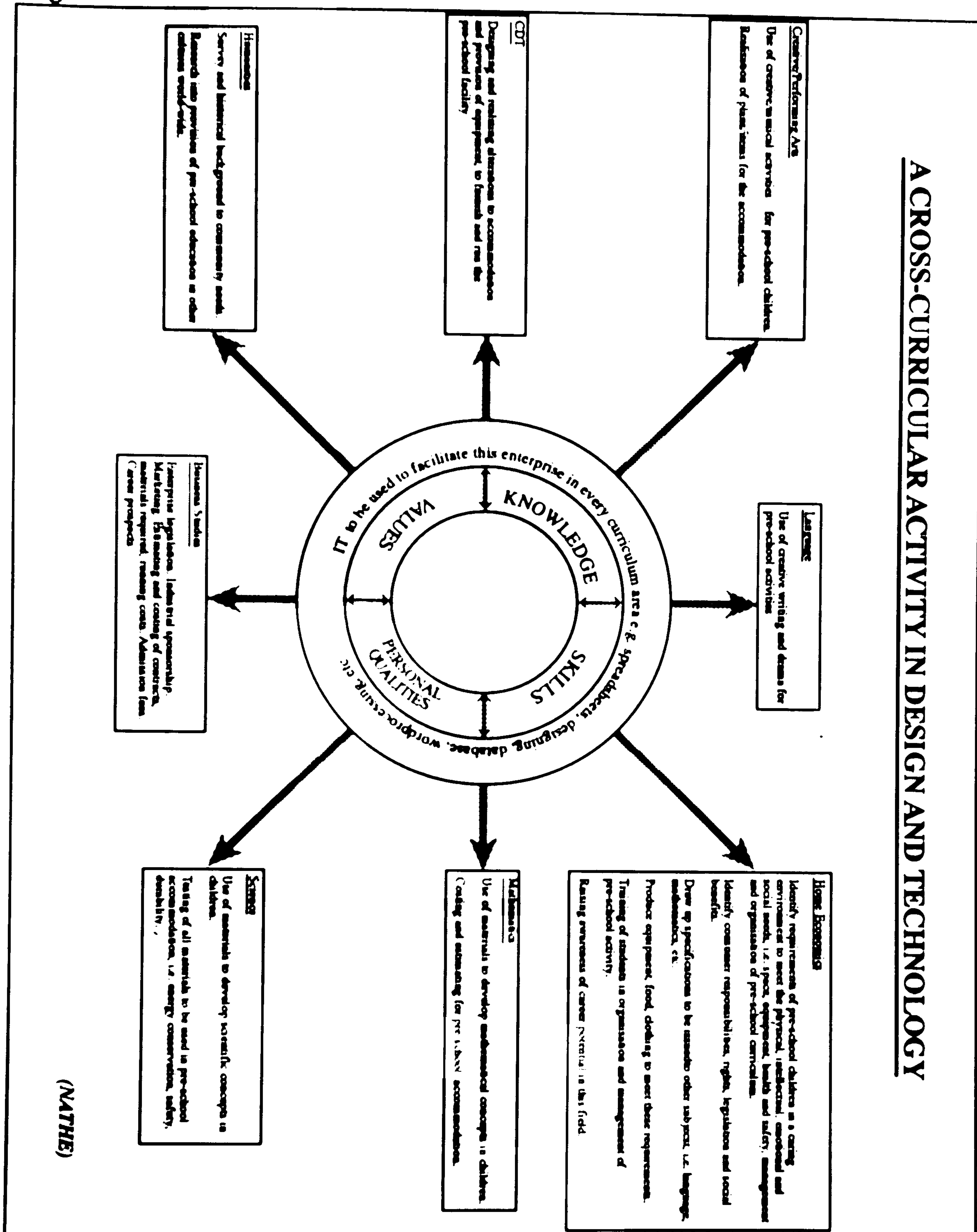
Cross-Curricular Technology

Recent developments support the notion of technology across the curriculum which scientists see as important. Excellent examples of this would seem to be put forward by models arising from both the Home Economics and CDT areas.

The ASE (Association for Science Education) Science and Technology Committee³⁸ stated that 'the ownership of technology education' was a major issue for debate. They indicated that they could see technology across the curriculum in terms of whole school policy. They raised the question concerning who actually takes responsibility for technology education in a school. They pointed out there are many successful examples of both science and CDT responsibility for technology and they also conceded that there was a case for IT and home economics within the scheme of things. They further pointed out that the science department runs the risk of limiting technology to a particular form of scientific problem-solving and applications concerned with science and society, neither of which would encompass the elements of technology education. Finally they considered that there is a strong case for the possibility of a 'technology co-ordinator' being responsible for technology policy throughout a school at the secondary level. At a primary level they thought that the school technology co-ordinator would cover both science and technology.

The model produced by home economists (see Figure 2 overleaf) indicates a cross curricular approach to technology in terms of all the major disciplines within the curriculum, namely home economics, mathematics, science, business studies, humanities, CDT and creative/performing arts. This presents a core base surrounded by IT(computing) comprising Knowledge, Skills, Personal Qualities, and Values. According to the model the process is envisaged to be two way.

Figure 2

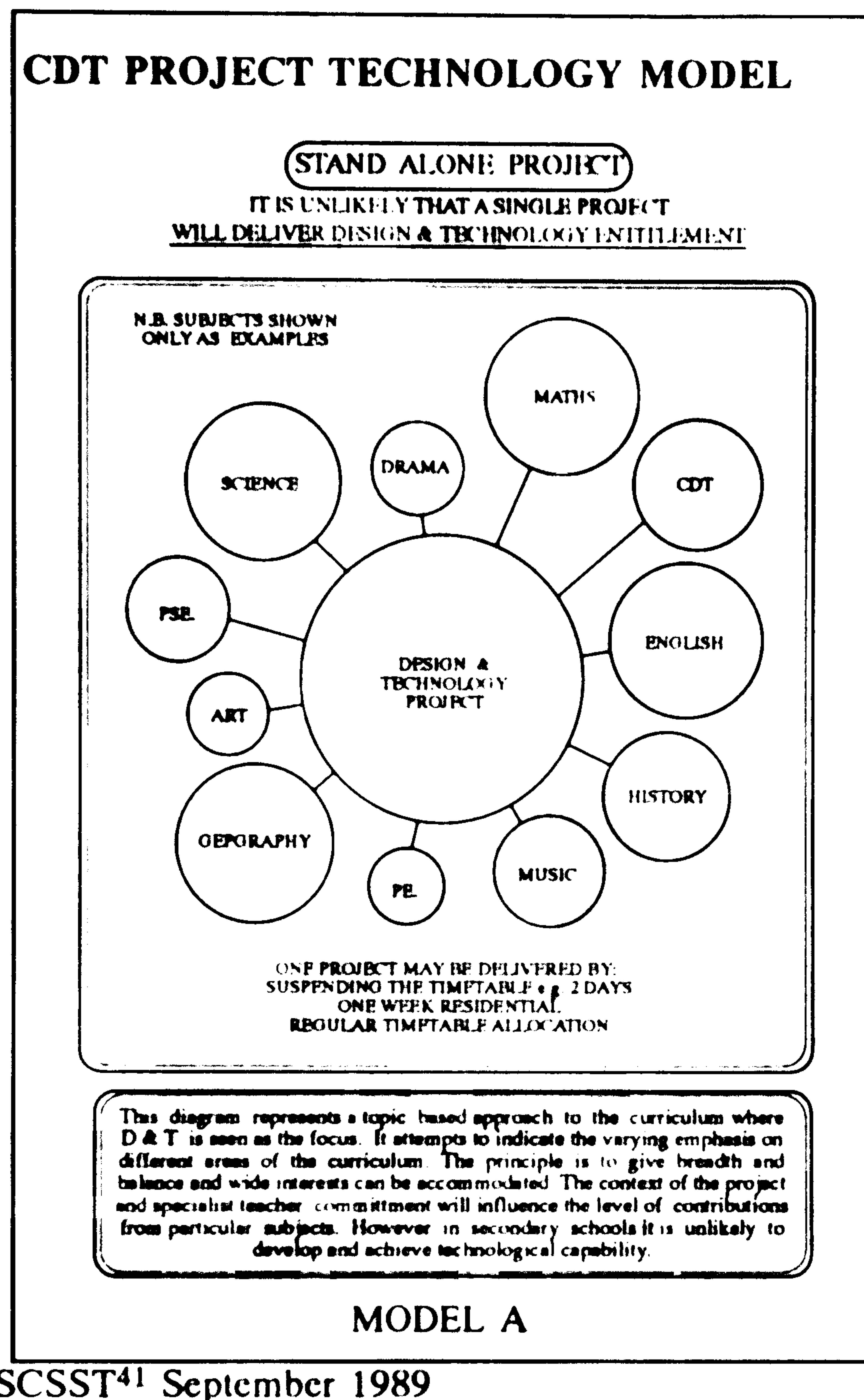


Source- School Technology Journal ³⁹ May 1988 Response from NATHE, NCWG.

The cross curricular model put forward (see Figure 3) for CDT by SCSST (Standing Conference on Schools Science and Technology) and SATRO⁴⁰ (Science and Technology Regional Organisations) puts design and project at the centre of the curriculum universe with the subjects of science, drama, mathematics, CDT, English, history, music, PE (physical education), geography, art, PSE (personal and social education) contributing to it. They indicate that this represents a topic-based approach,

however, they consider that it is unlikely to develop and achieve technological capability in secondary schools.

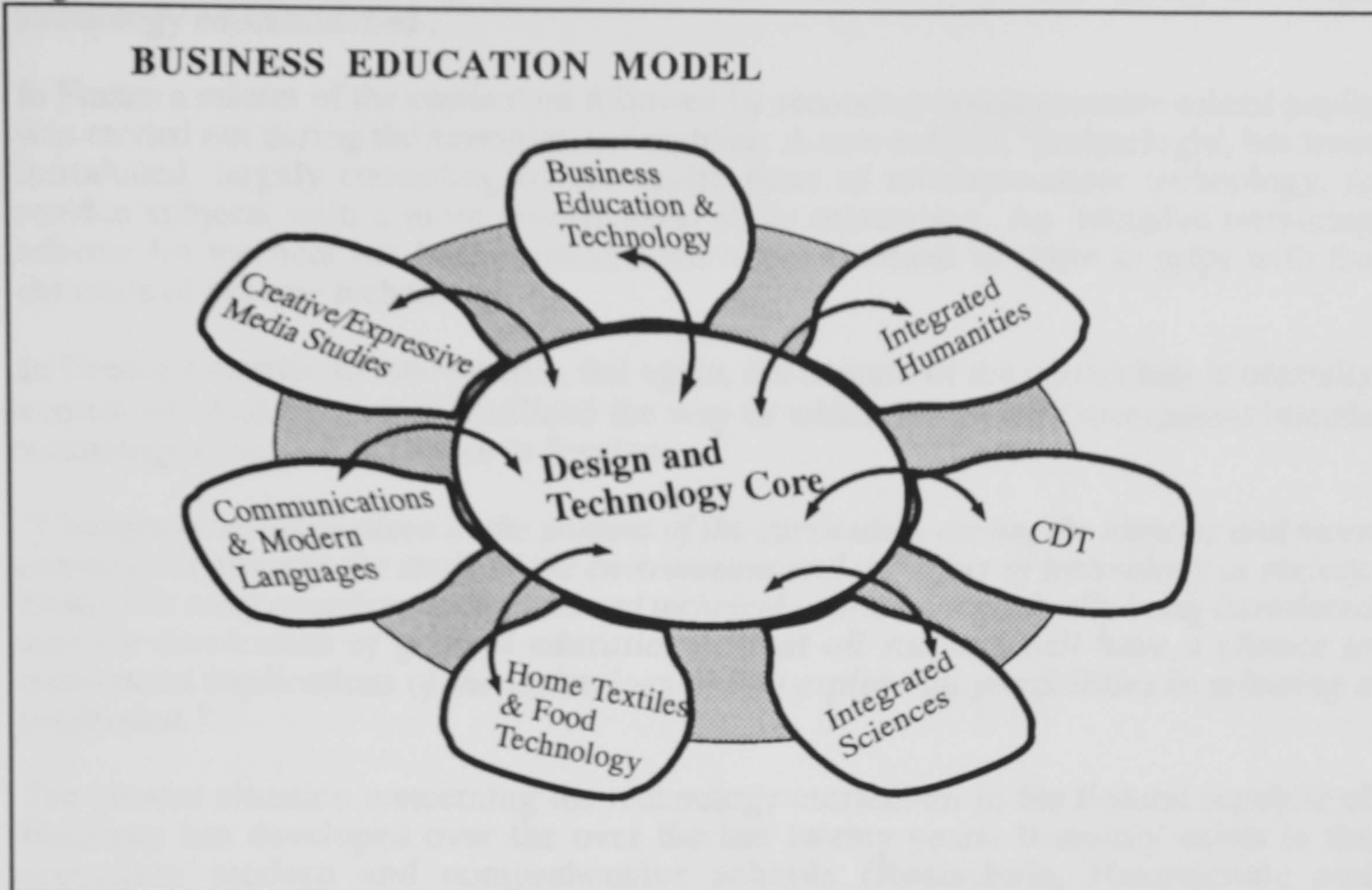
Figure 3



Kelsey and Lambert ⁴² indicated that they saw Technology in a cross curriculum context. They suggested that there needed to be a cross curricular approach to the development of both design and technology as this was important for the holistic development of school pupils to enable them to see and utilise the links between different areas of learning in later life. They suggested that the subject of Design and Technology should concentrate upon the process of design and technology as a tool; and that business education should cover the world of business as a context for the development of business understanding, subject knowledge, and application of a business or economic like way of thinking.

Kelsey and Lambert ⁴³ put forward a cross-curricular model for the school subject of Business Education as seen in Figure 4. below. This model has at its heart the Design and Technology Core. This is surrounded by business education & technology, integrated humanities, CDT, integrated sciences, home textiles & food technology, communication & modern languages, and creative/expressive media studies. The process is indicated to be two way.

Figure 4



Source - Kelsey B & Lambert P⁴⁴, Fig 1, Design and Technology & Business

To summarise it would appear from the above evidence that the trends in technology education in the UK at the present time seem to point to considerable conceptual confusion concerning what technology is all about, and with what subjects it should be allied, or even under what heading it should stand.

The nature of technology and the way it is viewed by technology educators under the various headings varies: some see it as linked to science; others as including home economics, business education, art and design, IT (computing); and others as permeating the curriculum as a cross-curricular activity. It seems likely that the debate concerning the place of technology in the UK school curriculum will continue for some time yet. Even so if the models described above are viewed in terms of the Main Dimensions of Technology Education (1990) it may be seen that they could generally comply with them.

Technology Education in a European Context

During the last twenty years a movement towards the development of technology education for schools has been emerging in most of the westernised nations. Europe in particular has been the vanguard of this development and has at the present time, in 1991, a substantial world lead in this field.

Apart from the UK, the Netherlands has been the leader in terms of European technology education. The Netherlands educational authorities have discussed and implemented proposals for Attainment Targets for Technology Education in their new national curriculum.

Other EEC members, namely France, Italy, Belgium, and Greece, are well advanced with their work in school technology education. The educational authorities of the remaining members of the EEC are actively interested in moving forward with this development.

The non-EEC members, both in the east and the west, are also going down the technology education road .

In France a reform of the curriculum followed by secondary comprehensive school pupils was carried out during the seventies and eighties. A new subject, 'Technologie', has been introduced, largely consisting of the applications of microprocessor technology, to replace subjects with a more craft/manual skills orientation. An intensive retraining scheme for teachers has been implemented to enable them to come to grips with the demands of the new technology.

In Greece a similar situation exists, but again, the content of the curriculum is centrally controlled. Androuridakis⁴⁵ outlined the way in which the Greek Government intends technology education in Greece to develop:

"Changes have taken place in the content of the curriculum during the eighties and more emphasis is given in the study of the environment and the effect of technology in society. Under this reorganisation, vocational and technical courses are gradually being introduced into the curriculum of general education so that all students will have a chance to understand implications of the technology and to explore all possibilities in selecting a profession."

The present situation concerning the technology curriculum in the Federal republic of Germany has developed over the over the last twenty years. It mainly exists in the secondary modern and comprehensive schools (Realschule, Hauptschule and Gesamtschule). The curriculum of the "Gymnasium", grammar schools, has not yet subsumed a great deal of the modern technologies. Whereas in France two hours per week are normally devoted to Technologie, in Germany this may be taken as a maximum figure. The former German Democratic Republic revised its school syllabuses between 1984 and 1987 with an increased emphasis on the use of integrated circuits in electronics and microcomputers for data processing and control.

The European Society for Technology Education (EGTB) with its headquarters in West Germany was formed in the latter part of 1988, as a result of the above developments and initiatives to ensure that Europe maintained its lead in this industrially and economically relevant education field. The EGTB currently had members in universities, colleges, schools, education authorities and institutions and government departments in the UK, West Germany, the Netherlands, France, Belgium, and Greece. It was intended that this membership would be extended to all EEC member States within a two year period.

In 1989, however, new developments in the European scene took place with the rise of national technology education associations who were independent of the EGTB. This caused the notion of a SCESTE (Standing Conference of the European Societies for Technology Education) to arise. The EGTB Structural Reform paper authors Tyrshan and Kussmann⁴⁶ indicate that SCESTE will have have the brief of:

"the scientific exchange of experiences concerning technology education in the member countries; the running of common scientific conferences and research projects; the co-operation with constitutions for technology education on the international level"

It can be seen that a consensus of opinion on the direction that technology education must take in the 1990s has emerged in Europe, as Tyrchan⁴⁷ has commented:

"Technology education on the continent is a fairly installed and well founded subject for general education. Whereas there were, years ago, a variety of different syllabuses

without contacts, without any interferences, we find nowadays approaches with convergent philosophies and with an astonishing correspondence concerning the topics."

Colleagues in the USA, Australia, and New Zealand have grasped the importance of technology education and substantial moves are being made to ensure that they are not left behind in its development.

Technology Education in the Wider Context

The USA in particular has been very active, since Fisher⁴⁸ described embryonic developments in 1983, in sending task forces to Europe in order to gain our expertise. He indicated that USA education authorities were well advanced in promoting the subject in schools, eg. New York State and Virginia have well established school technology curricula. US industry is also backing them eg. NASA and IBM. An ITA (International Technology Association) is also well established. The USA technology educators have continued to work from this base and are still making progress.

In Australia the situation concerning technology as a subject has been clearly stated by an ACT (Australian Capital Territory) Educators report⁴⁹ on Science and Technology. This report indicates that science and technology is an integral part of society and that those who have no understanding, or cannot communicate in this medium are cut off from their culture, are likely to be severely handicapped in their ability to benefit from science and technology in their personal lives, and will be handicapped in playing a part in the democratic process in influencing those who make decisions about how science and technology are put to work. They also made the point that science and technology affects everyone and hence everyone should have a basic grounding in it and how it affects society.

With regard to the definition of Technology in an Australian context the ACT paper indicates that science and technology are linked. The paper indicates that science can be thought of as the systematic and formulated knowledge of natural phenomena which is based upon particular methods of enquiry and thinking firmly grounded in attitudes of open-mindedness and impartiality. This would include respect for data and tentativeness in accepting results as final. They consider that the critical appraisal, based upon scientific critical thinking, theory and practice, that are used to explain natural phenomena, are at the heart of science.

Technology they consider to be the practical developments and applications of science, or more suitably the purposeful use of scientific knowledge, of human knowledge, of materials and sources of energy, and natural phenomena. They also point out that many technological applications have come from scientific knowledge or new technology, eg the development of metals and knowledge of chemistry of metals evolved together. These educators further indicate that recently the word 'technology' has become associated with computers, genetic engineering, and electronic devices.

It is evident in Australia that there are seen to be links between Science and Technology. Indeed the ACT paper goes further by indicating that the ideas of science and technology have a lot in common and that it is over simplistic to consider science theoretical and technology practical; both have elements of each. They go on to say it is the attitudes, skills and methods of science and technology that set them apart from other areas rather than the specific subject content.

Recent ACET (Australian Council for Education through Technology) Conferences (1988 and 1990) showed the many technology education initiatives and developments which abound in Australia. One example, visited in the course of this study, is the South

Australian Technology School of the Future. This institution which brought together teachers, pupils, industrialists and academics, relied upon commercial, scientific, mathematical, engineering, and computing expertise for training and education, in order to produce commercial products which would be appropriate to future needs and trends.

In New Zealand technology education as part of general education was not very well developed in 1989. Ferguson⁵⁰ indicates :

"There have been elements of technology in various aspects of the curriculum over a long period of time but no real recognition of the value and importance of technology education"

Ferguson referred to a working party of teachers and technology educators who had made a recent statement with regard to technology education in order to encourage local innovations in technology education and to advise government on the need for a policy in technology education. They made a number of suggestions about the development of technology education which have been communicated to New Zealand teachers in a newsletter from the Curriculum Development Division of Education.

The working party suggestions concerned the principles of technology education which covered the multi-disciplinary nature of the subject, equal gender opportunities, the ideas of students, the cultural background of students, technological examples of 'hands-on' technology from past and present including 'high-tech' items, the impact of technology upon society and the environment, practical problem-solving, assessment of financial, social and environmental costs, and the co-operative nature of the subject of technology.

According to Ferguson the working party also suggested a mission statement that should be adopted in New Zealand. This statement covered the needs of all students for technological capability, awareness of a range of technologies, the ability to select and use appropriate technologies, an understanding of the achievements of technology and its limitations.

Ferguson indicated that the working party recommended six inter-dependant and inter-related strands for future development. These are:

1. Development of a Curriculum Policy
2. Development of teacher and student resources
3. Liaison with interested groups and the establishments of networks - teachers, teacher organisations, tertiary institutions, government departments, industry.
4. Teacher education
5. Research
6. Encouragement of local initiatives

Technology Education in Developing Countries

In 1983 Unesco⁵¹, which has a brief for developing countries, indicated that it had considered science and technology and science related technology education were intimately connected. It saw the purpose behind a scientific activity as gaining an explanation of providing a true description of an event or condition. It also saw the purpose behind technology as putting technology to good use, to facilitate human aspirations, to solve practical problems, to put knowledge to good use, to extend the boundaries of existing possibilities. It also pointed out that science and technology are not identical, they are interdependent but contrasting activities, one calling for powers of investigation the other calling for creative ability combined with knowledge.

Unesco clarified this by indicating that a good example of this was given by the fact that science explains why rapidly moving air over a surface causes lift, however, it takes technology to demonstrate that a machine will fly:

"Thus it is the purpose of science to explain why air that moves rapidly over a surface exerts less pressure upon the surface than does slowly moving air. But to demonstrate how this fact might be used to build a machine that will fly is a technological achievement."

It further pointed out that science and technology use existing knowledge and existing know how, and in this sense they are interdependent; and developments in technology may have a greater impact upon what is taught, especially where new ideas in the sciences are matched by new methods of doing things in technology. Unesco stated:

"Yet in pursuit of their respective purposes science and technology employ existing knowledge and existing know how. Both dip, as it were, into each other's basket. In this sense they are interdependent." Finally they added a rider to the above: "Developments in technology may have an even greater impact upon what is taught, though much of this will be mediated indirectly through the impact of technology on society as a whole. Where new ideas in the sciences are matched by new methods of doing things in technology, the impact upon education will be especially marked."

POLICY INITIATIVES OF THE DES AND THE NATIONAL CURRICULUM

This section shows that, within the past 10 years, the DES determined that a subject called Technology would exist at a GCSE examination level and as a National Curriculum Foundation Subject; that this Foundation subject would cover designing and making, and include under its heading the school subjects of CDT, Home Economics, Business Education, and Art and Design, supported by IT

HMI contributed to the development of the National Curriculum Technology (IT) when they indicated in detail what IT(Computing) curriculum should cover. HMI suggested that school pupils experience with IT should enable the acquisition of knowledge, skills and understanding and capability to communicate ideas and information via word processing, electronic mail, and desk-top publishing. HMI also suggested pupils should learn to store or gain access to, and to change and interpret information using such items as databases, spreadsheets, or viewdata systems and they should access critically the content and presentation of information from these sources.

A central element of the DES IT Orders of both the Statements of Attainment and Programmes of Study was the concept of database understanding, use, and capability which will have to be delivered by all technology teachers to their clients in schools.

However, the DES also allowed the removal by the NCC of the formal connection between technology and science and mathematics as linked supporting subjects. This was out of line with mainstream technology education development.

It would also seem that the rapid rate of development of modern technologies has placed unparalleled strains on European educational systems as they try to meet an increasing and ever changing demand from industry and society in general.

The General Certificate of Secondary Education

Historically, in the UK, schools have had external examinations for young people at the age of 16 at the end of compulsory schooling. Recently fundamental change has taken place within this context, which has effected change in the whole school curriculum.

The GCSE (General Certificate of Secondary Education) examination has been introduced to replace the CSE (Certificate of Secondary Education) and the GCE (General Certificate of Education) examinations. In 1988 GCSE examinations were sat by all eligible pupils in the UK for the first time. The introduction of GCSE had a profound effect upon the teaching of technology in the science/CDT (Craft Design and Technology) subject departments of secondary schools in the UK. For the first time a set of National Criteria for technology, which all examinations bearing the name technology must comply with, to gain national recognition, had been specified by the DES. The National Criteria Subject Specific Statement for CDT⁵² indicates what technology is seen to be and what it should involve in terms of GCSE. The actual statement for technology is as follows:

" 6 CDT: TECHNOLOGY. Technology is principally concerned with design and problem-solving processes leading to the making and evaluation of artefacts and systems. It draws upon scientific principles. Technology also involves management of the environment, and familiarity with the concepts of materials, energy and control. "

Clearly there is a strong link here with science although the subject is specific to another area of the curriculum in terms of public examination courses. It is also interesting to note that the subject content of the new CDT GCSE examination (see Table 3), includes much that is being covered in traditional science courses. It should however be noted that design is the main area which is not generally covered by scientists in a formal way.

Table 3

<u>CDT</u> (GCSE)	<u>Design and</u> <u>Realisation</u>	<u>Technology</u>	<u>Design and</u> <u>Communication</u>
<u>Skills</u>	design making communication	design making communication	design making communication
<u>Knowledge</u>	materials and components	materials and components	materials and components
	principles and concepts		principles and concepts
		energy	energy
		control	control
	design and society	technology and society	graphic design and society

Source - fig 9 GCSE Guide for Teachers ⁵³

It is now apparent, with such statements and external examination recognition, that 'Technology' is now recognised as an examination subject in the secondary school curriculum in its own right.

In 1988 GCSEs for business education, home economics, and art and design were not considered or scheduled in the same way as technology and were treated as independent subjects. In 1990, these GCSEs were being reviewed in the light of National Curriculum developments described below.

The National Curriculum and Technology

In July 1987 the UK government stated its intention to introduce substantial educational reform, in the form of a National Curriculum, for all schools covering the ages from 5 to 16 years. It also indicated that this new curriculum was to have specified core subject covering Mathematics, English and Science and a supporting foundation subject entitled 'Technology'. In the consultation document covering 'The National Curriculum 5 - 16'⁵⁴, under Section B (Page 5) the government gave specific details of the form that the school curriculum should take. This document declared that:

"13. Maths, English and science will form the core of the curriculum, and first priority will be given to these subjects. They and other foundation subjects are to be followed by all pupils during compulsory schooling. The Government has proposed in addition to English, maths and science, the foundation subjects should consist of a modern foreign language, technology, history, geography, art, music and physical education. The degree of definition in the requirements set out for each of these subjects will vary considerably, and will be greatest for the three core subjects."

The government also went on (see Table 4) to suggestion the amount of curriculum time which might be allocated to various subjects in years 4 and 5 but in Para 16 to declare an intention not to prescribe curriculum time. They indicated that:

"The Secretaries of State do not intend to prescribe in legislation how much time should be allocated to each subject."

Table 4

SECONDARY PHASE - YEARS 4 & 5 ALLOCATIONS OF CURRICULUM TIME		
<u>Foundation Subjects</u>		<u>Additional subjects eg for GCSE might include:-</u>
	%	10%
English	10	Science
Maths	10	Second Modern
		Foreign Language
Combined Sciences	10-20	Classics
Technology	10	Home Economics
Modern Foreign Language	10	History
		History/Geography or
		Business
		Studies
History or Geography	10	
Art/Music/Drama /Design	10	Art
		Music
Physical Education	5	Drama
		Religious Studies

Source -The National Curriculum 5-16 Sect. B.⁵⁵

Technology now had a slot, in its own right, within the newly proposed national curriculum. This was a step forward and a recognition of the subject's importance within the school curriculum. However, all was not yet cut and dried with regard to the subject of technology within the curriculum because, at this point in time, it was not known precisely what was proposed under the heading of 'Technology'.

The National Curriculum Working Group for Design and Technology

The Working Group had a brief⁵⁶ that indicated the view of technology education in terms of the school curriculum and the other subjects were associated with it.

This brief firstly indicated that it was the area of the curriculum in which school pupils design and make useful artefacts utilising skills and knowledge from a wide range of subjects but specifically involving science and mathematics. The brief specifically stated:

"The working group is to view technology as that area of the curriculum in which pupils design and make useful objects or systems" and "pupils will draw on knowledge and skills from a range of subject areas, but always involving science or mathematics. They should be taught the principles and practice of good design" and "Technological education should equip pupils with basic IT skills and develop an awareness of the potential use of IT".

Secondly, it makes the point that technology is a subject area in its own right and that schools will be free to teach technology as they wish, provided it is within a distinct programme with the objectives of technology in mind. The brief also stated:

"Technology is an area of study in its own right" and "This does not necessarily mean that technology must be a separately timetabled subject: schools will be free to teach technology how they choose, provided that the activity is co-ordinated as a clear programme and directed towards the distinctive objectives of technology."

The National Curriculum Council (NCC)

The NCC clearly agreed with the view put forward by the Design and Technology working Group that Technology was the area of the curriculum concerned with making and doing. They also confirmed, as a result of consultation, the view that technology was best delivered through CDT, home economics, business education, art and design, with the general support of other curriculum subjects. They also removed the specific links between science and mathematics in a school curriculum context and confirmed the foundation subject's name should be 'Technology'.

The NCC⁵⁷ indicated in November 1989, in the foreword to the consultation report, that they considered technology to be the subject in the National Curriculum that was concerned with generating ideas and making and doing. They stated:

"The one subject in the National Curriculum that is directly concerned with generating ideas, making and doing. In emphasising the importance of practical capability, and providing opportunities for pupils to develop their powers to innovate, to make decisions, to create new solutions, it can play a unique role."

The NCC, was the body designated to handle the consultation process associated with the technology area of the National Curriculum surveyed the field. After they had surveyed the field they indicated:

"560 responses and 1290 letters were received of which 170 responses were from organisations formally consulted and the remainder were from other organisations, schools and individuals."

The NCC⁵⁸ summary of the statements of the responses indicate the appropriateness of the proposed technology curriculum, and its place in the school curriculum, according to the considerations of the majority of the respondents to the consultation process. Their feedback indicated that: respondents' responses were equally divided on the proposal to divide up aspects of IT capability between a design and technology and information technology profile component; that the majority of respondents came from Craft Design and Technology, Home Economics, Business Education, Art & Design, and Information Technology; and that there was widespread approval of the suggestions of the Design and Technology Working Party. The NCC actual findings and conclusions drawn from the consultation process were that:

"Respondents were split equally on the proposal to divide aspects of information technology capability between a design and technology capability profile component and an information technology profile component. The view that information technology is cross-curricular in nature and should not be closely associated with design and technology capability was expressed frequently." and

"The majority of respondents agreed that the proposals covered the range of design and technology work currently undertaken in craft, design and technology, home economics, business education, art and design and information technology...More detail was requested to help develop an identity for each specialist area, and simple and straightforward expression to help non-specialists understand the range of the proposals.".... "There was widespread approval for the suggestions in the Working Group's proposals on links with core and other foundation subjects. The benefits to other subjects of learning through design and technology activities was not considered to be prominent in the proposals. It was suggested that NCC should publish a table which shows the knowledge and skills common to several core and foundation subjects."

Finally, in the section covering the NCCs advice⁵⁹ and recommendations they indicated that they considered the title of the subject should be 'Technology' and that it should have two profile components, namely 'design and technology capability' and 'information technology capability'. They stated that :

*"Council recommends that the name of the foundation subject should be Technology, and that there should be two profile components: ** design and technology capability;
** information technology capability."*

The National Curriculum Draft Orders for Technology

The Draft Orders for Technology⁶⁰ published in December 1989 by the DES indicated in its content that the main recommendations of the November NCC consultation report on Technology as described above had been accepted as the basis for the subject in the UK. This consultation document only indicated the perceived final content and form proposed for the Orders for Technology. It should be noted that in terms of subject name, definition, content, and links, nothing had changed from the NCC consultation report recommendations. This document was just what it purported to be, a draft form of the final document.

The IT Curriculum from 5 to 16

At approximately the same time that the Draft Orders for Technology indicated an information technology capability profile component, a view of the UK situation with regard to IT (Computing and Microelectronics) was given in the 1989 HMI document 'IT from 5 - 16' ⁶¹

HMI declared that IT has contributed significantly to our way of life within the context of rapid change, and that IT may be defined as the technology concerned with the handling, storage, processing and transmission of information by electronic means. They also pointed out that IT is a feature of our present way of life and has transformed the world of work ; and that the national economy, international finance and employment patterns are affected by IT. They also made the point that citizens must be aware of the ways in which computerised information may be used or abused, that adults are still coming to terms with IT , children take it for granted and it has potential to transform the classroom. HMI stated in the introduction to this document that:

"1. The twentieth century has seen an unparalleled rate of technological development leading to fundamental changes in our way of life and in the nature of society. Since the first powered flight in 1903 and the manufacture of the first microcomputer in Britain in the late 1970s, the speed of change has continued to increase. Latterly information technology (IT) has contributed significantly to these developments.

2. IT may be defined as the technology associated with the handling of information: its storage, processing and transmission in a variety of forms by electronic means, and its use in controlling the operation of machines and other devices.

3. IT is already a feature of everyday life. Many domestic appliances can now be programmed by means of microprocessors. Relatively inexpensive computerised toys, games and calculators are in common use. Supermarkets use bar code readers to list and price purchases and control stock. The recent growth in electronic communications enables teletext information to be obtained from the comfort of an armchair. Automatic cash dispensers check the details of an account and hand over money at times when the banks or building societies are closed. The world of work has been transformed by such devices as robots and word processors.

4. The national economy, international finance and employment patterns are profoundly affected by IT. This has led to fundamental changes in the way we do things at home and at work and in the range of facilities and artefacts available to us. In particular, today's citizen needs to be aware of the ways in which computerised information may be used, or abused.

5. Adults are still coming to terms with IT, children take it for granted. Indeed, technology seems to give rise to great interest, and often excitement and pleasure, among young people. New technology has radically changed the home and the workplace and it has a similar potential to transform the classroom."

HMI also spelled out in the appendix the IT skills for the particular curriculum subject areas associated with technology, namely Art, CDT, Home Economics, Mathematics, Science.

For Art they suggested that CAD (computer-aided design), image generation, an understanding of input peripherals, and databases were appropriate.

For CDT they suggested that measurement and control, CAD and modelling, selection of microelectronics components, and use of databases were appropriate.

For Home Economics they indicated that there was a need for a command of the common terms and use of every day IT systems, to use measurement and control activities related to the equipment in home economics field eg. radio alarm or calculator and in everyday applications such as bar codes and auto banking machines. They further suggested that an

understanding of viewdata and teletext databases was important, as was an understanding that individuals should not become too dependant upon uncritically processed data.

For Mathematics they suggested numerical, algebraic, graphical and programmable calculators; spreadsheet usage, unfamiliar calculator and microcomputer usage, simple programming, problem-solving, and mathematical modelling.

For Science they suggested; measurement and control, simulations of processes and database usage.

HMI made clear in this document the expected objectives of IT for 5-16 (in paras 10,11); gave some indication of teacher IT INSET needs (in para 88); and pointed out what was required for specialist computing courses (in paras 98,99). They suggested that the secondary school curriculum should cater for computing as a specialist subject. Pupils should study a broad range of applications and contexts; analyse systems and apply the problem-solving approach. The industrial and commercial and public service contexts of IT and the application of computer technology in society should be covered.

In particular they pointed out that school pupils' experience with IT should enable the acquisition of knowledge, skills and understanding and capability to communicate ideas and information via word processing, electronic mail, and desk-top publishing. They also suggested pupils should learn to store or gain access to, and to change and interpret information using such items as databases, spreadsheets, or viewdata systems, and that they should access critically the content and presentation of information from these sources.

HMI gave details of specific IT areas to be covered: namely mathematical investigations and simulations; aesthetic graphical representation; measurement control and instrumentation; social and ethical purposes. They indicated that as pupils progress through the National Curriculum 4 stages they should gain confidence with IT.

In terms of Computing as a Specialist Subject HMI went on to indicate that pupils by the age of 16 years should be able to make explicit the techniques used in arriving at solutions using computers and that the secondary curriculum should also cater for the needs of those pupils with a special interest in studying information systems and computer applications in greater depth.

They also indicated that computing as a specialist subject now had to build on pupils' cumulative experience of IT within the school and elsewhere and that the aim of computing as a specialist study should be to extend, unify and deepen pupils' understanding of computer technology and its applications.

HMI particularly stressed that computing should help pupils to: study the capabilities and limitations of a broad range of applications and the contexts in which they are useful; analyse systems and to apply IT creatively in the solution of problems using reasoning, judgement and persistence; study ways in which computer applications affect the operation and management of industrial and commercial concerns or public services; to gain some understanding of the working of systems which extend users' mental and physical functions and capabilities; carry out sustained pieces of work that are formally assessed related to the application of computer technology in society.

Concerning the issue of general IT needs the main points that HMI considered necessary for all pupils revolved around the pace of technological change, the problem and the appropriateness of a computer solution, the methodology of arising at an IT solution, knowledge of the way computers are used and the range of use in commercial and industrial contexts, a critical understanding of computer guides, an understanding of the function of computer hardware and software systems, a knowledge of how computers

store information, an understanding of the principal functions of computer peripherals and the broad principals of communication systems.

The National Curriculum Orders for Technology

In March 1990 the Orders for Technology ⁶² were published by the DES with only minor changes from the Draft Orders for Technology. These orders indicate that the DES see technology as the one subject in the curriculum concerned with: generating ideas, making and doing; that pupils must become technologically capable and aware as they will have to live in a technological society; that a technologically capable and literate workforce is vital to industry and commerce for wealth generation, and the future of the country.

It is worth considering the foreword in the document because it spells out the government's view of Technology education for schools. This states that:

"Technology is the one subject in the National Curriculum that is directly concerned with generating ideas, making and doing. In emphasising the importance of practical capability, and providing opportunities for pupils to develop their powers to innovate, to make decisions, to create new solutions, it can play a unique role. Central to this role is the task of providing balance in a curriculum based on academic subjects - a balance in which the creative and practical capabilities of pupils can be fully developed and inter-related. The subject has a crucial part to play in helping pupils to develop these important personal qualities and competencies."

The document also indicated the governments view of the importance of the subject for school students when it stated:

"Whilst the contribution of technology to the personal development of individuals is very important, of equal importance is its role in helping pupils to respond to the employment needs of business and industry. Pupils will become aware of technological developments and the way in which technology is changing the work place and influencing life styles. They will learn that technological change cannot be reversed and will understand its enormous power. Knowledge of technology enables citizens to be prepared to meet the needs of the 21st century and to cope with a rapidly changing society."

This document also makes the point that the government believes that this subject is essential to the UKs industrial future, and future as a whole, when it stated:

"Business and industry need young people who have the vision to combine enterprise, initiative and imagination with knowledge and skills to solve problems and create the nation's wealth. If this need cannot be met, then our national development in these areas will not prosper, a failing which will have dire consequences for our whole future. The present proposals specify an educational programme to enable pupils to meet this need and Council believes that their successful implementation is vital to the future of this country."

The UK National Curriculum IT (Computing) Demands

As pointed out earlier, in March 1990⁶³ the National Curriculum Orders for Technology as a whole were published by the DES. Technology included Information Technology Capability and it's Non-Statutory Guidance. These orders included Attainment Targets and Programmes of study for school students up to the age of 16 years..

The Attainment Targets (ATs) are the knowledge, skills and understanding which school students of different abilities and maturities are expected to have attained in each subject

area. The Programmes of Study (POs) which are matters, skills and processes which have to be taught to school students of different abilities and maturities during each stage in order for them to meet the objectives set out in attainment targets.

The Orders clearly spelt out the ATs and the POs for the subject as a whole, whilst the Non-statutory Guidance covered Information Technology, Managing Information Technology in schools, Incorporating Programmes of Study into Schemes of work, and Appendices.

A central element of the IT Orders Statements of Attainment and Programmes of Study was the concept of database understanding, use, and capability which will have to be delivered by all Technology Teachers. The Statements of Attainment cover databases in depth from Level 2 to Level 9 (see Table 5) as do the Programmes of Study (see Table 6). This element has to be delivered by teachers to pupils from the ages of 5 to 16 years inclusive.

Table 5

Statements of Attainment IT Relating Specifically to Databases	
Attainment Levels	Detailed Statements
Level 2 ---	" 2b. use Information Technology for the Storage and retrieval of information "
Level 3 ---	" 3c. collect information and enter it in a database (whose structure may have been prepared in advance), and to select and retrieve information from the database "
Level 4 ---	"4c. amend and add to information in an existing database, to check its plausibility and interrogate it."
Level 5 ---	"5d. use a software package to create a computer database so that data can be captured, stored and retrieved"
Level 6 --	"6c. identify advantages and limitations of data-handling programmes and graphics programmes and recognise when these offer solutions to a problem of data handling"
Level 7 ---	"7d. select and interrogate a computer database to obtain information needed for a task"
Level 8 ---	"8b. select and use software to capture and store data, taking account of retrieval, ease of analysis, and the types of presentation required."
Level 9 --	"9c. understand the effects of inaccurate data in files of personal information"

Table 6

Programmes of Study IT Relating Specifically to Databases	
Key Stages	Detailed Programmes of Study Statements
Key Stage 1	"Pupils should be taught: how to store, select and analyse information using software, <i>for example using a simple database package</i> " "Pupils working towards level 3 should be taught to: locate information stored in a database ; retrieve information and add to it; check the accuracy of entries."
Key Stage 2	"Pupils should be taught to: use information technology for investigations requiring the analysis of data , <i>for example using a simple database</i> ; know that information technology can be used to do things that can also be done in other ways, <i>for example using a database rather than a card index.</i> " "Pupils working towards level 4 should be taught to: insert and amend information in a computer database ; test their procedures by checking how reasonable the results are, <i>for example comparing collected data with national statistics.</i> "
Key Stage 3	"Pupils working towards level 7 should be taught to: use search methods to obtain accurate and relevant information from a database ; <i>for example use a database where knowledge of Boolean logic will improve the efficiency of the enquiry.</i> "
Key Stage 4	"Pupils should be taught to: select software for a particular task or application; <i>choose a database package which can handle large quantities of data, to set up a system to contain the results of a questionnaire for the whole school.</i> "

TRENDS IN THE EDUCATION OF TECHNOLOGY TEACHERS AND SCHOOL RESOURCING

This section argues the following:-

- a) The National Curriculum Working Party found the lack of professional expertise and confidence and shortage of teachers for technology were causes for considerable concern. There has been and still is a massive shortage of Technology Teachers in the UK; this position appears to have been much worse in 1990 than in 1983.
- b) Another important factor is the fact that the UK has had and still has a massive shortage of physics and mathematics teachers who contribute strongly to the subject of technology education.
- c) The UK is not alone in its difficulties regarding the supply of suitable qualified teachers, other European countries face a similar situation whereby teachers have not been adequately prepared for the advances of science and technology.
- d) Previously this situation was coped with by ensuring that support for serving teachers was available. Once in post in the UK a teacher has traditionally had access to several sources of expertise and information. These sources are disappearing with the decline in the abilities of LEAs and schools to pay for support services.
- e) SATROs were set up to support science and technology and play an important part in the process of educating the educators. Recent information to OSSTC as a SATRO member has indicated a contraction in this service. It has also become apparent that this service will no longer be available on a cost free basis.

Teacher Education and Training

Well educated, qualified and informed teachers, as the front line providers of education, have the greatest part to play in the education of young people especially in the many countries where educational provision is directed nationally. The National Curriculum is seen by the UK Government as a means by which it can ensure that teachers provide an appropriate technological education. A working party was set up in April 1988 to recommend a teaching approach to Design and Technology, which eventually became known as Technology.

Although governments may be legislating to aid the development of a technologically competent population, experienced teachers in secondary education contend that for many pupils the choice of examination subjects depends more on the quality of the teaching to which the pupils have already been exposed than on a rational choice of subjects needed to facilitate a particular career. In the past it has been noted by OSSTC staff that the teacher who was enthusiastic about his or her subject, with a flair for communicating their enthusiasm, regularly attracted the larger classes. But no matter how inspired and motivated teachers may be, insufficient training will limit their effectiveness. It seems that this is supported by Moore⁶⁴ who has conjectured that the entire attitude of pupils to technology may be adversely affected by the quality of teaching:

"One explanation for the absence of a strong classroom effect on pupils' attitudes may be linked to the low level of teacher qualifications and training. If confirmed, this finding could have important implications for the wider introduction of Technology into the school curriculum and the involvement of teachers whose expertise lies in other subjects. The study suggests these teachers will need additional training and that this should give particular attention to the use of technical resources and teacher-pupil interactions."

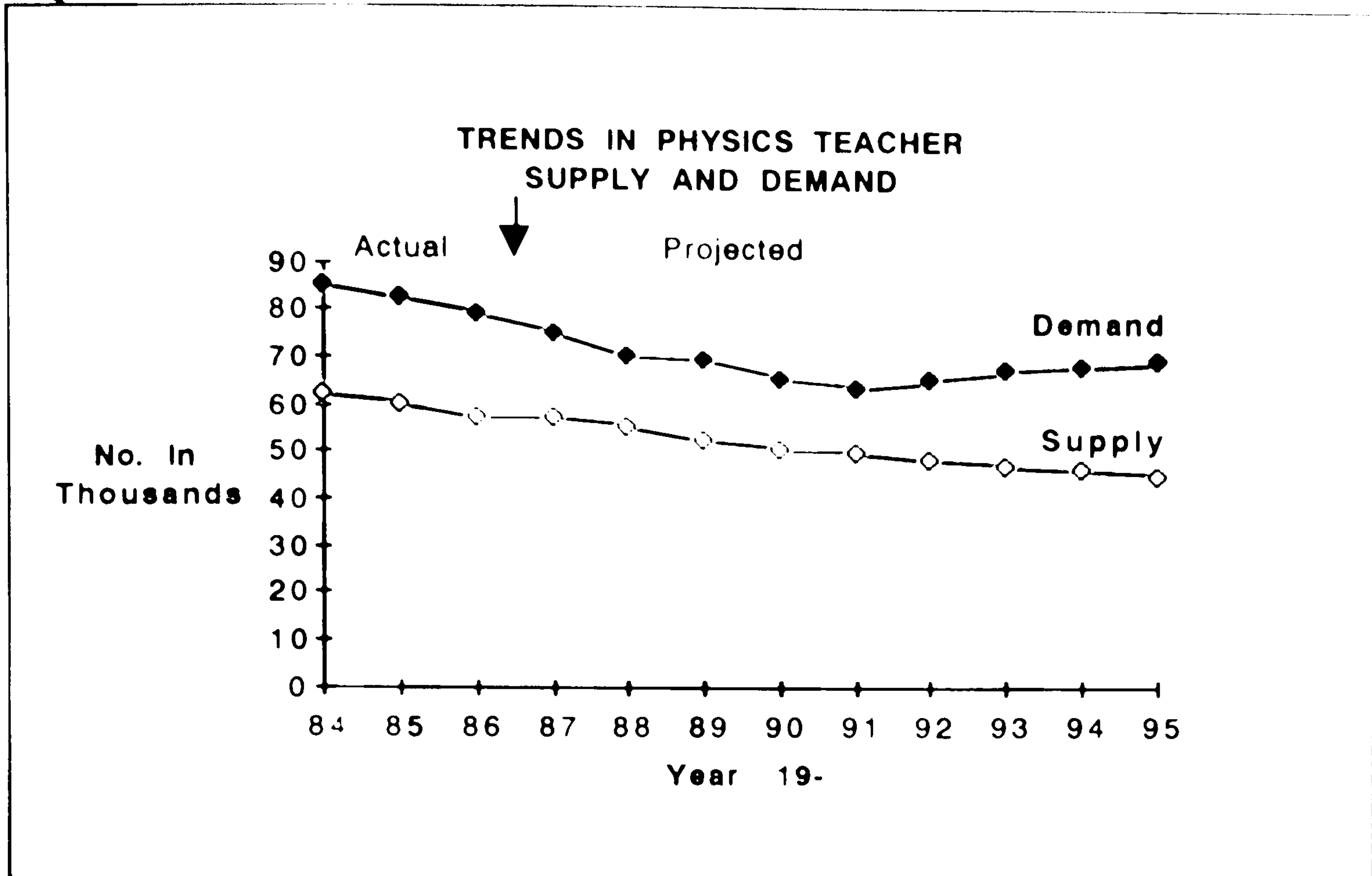
In a summary⁶⁵ of the views expressed to the National Curriculum working party during the consultation process, the lack of professional expertise and confidence together with a shortage of teachers for technology was causing considerable concern. They indicated:

"The current lack of expertise and confidence among teachers, especially primary teachers, was a cause for concern. There are also shortages of teachers in craft design and technology, information technology and business studies...initial teacher training courses will need modification, with a major challenge being the training of non-specialist primary teachers. Technology will need to feature in the professional studies of all intending primary teachers."

There has been and still is a massive shortage of Technology Teachers. Fisher in 1983 described the position in his Cranfield Masters research. The current position in 1990 appears to be much worse than in 1983. Hard evidence concerning the national shortage position is very difficult to obtain as many schools, as a result of LMS financial constraints, are in a contracting staffing position. Additionally, non-specialist technology teachers may well be teaching technology in some schools and heads are reluctant to make details available where this is the case. Most evidence at present is anecdotal and is as a result of conversations with professionals in the field.

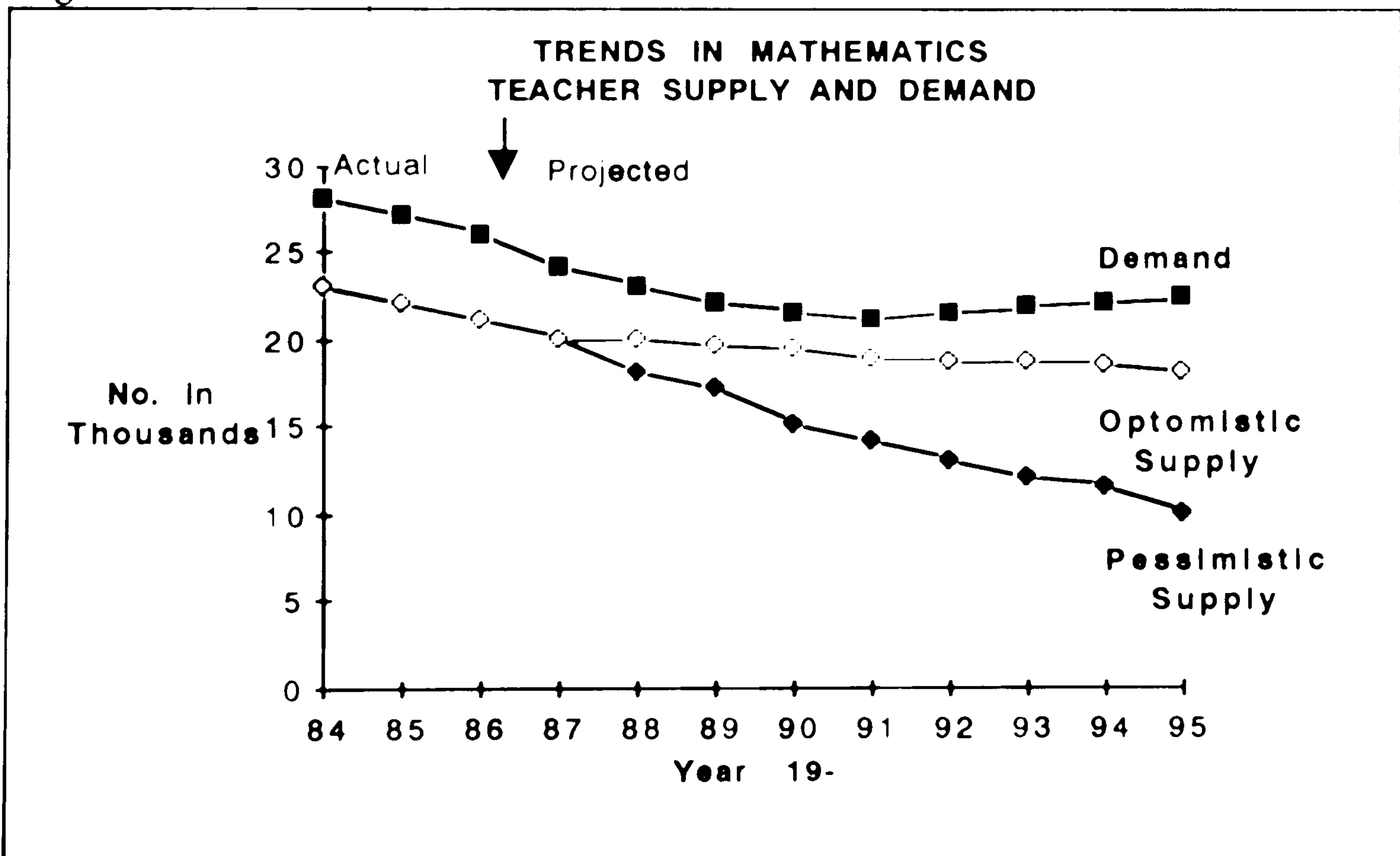
Another important factor is that the UK has had, and still has, a massive shortage of physics and mathematics subject teachers who contribute strongly to the subject of technology education. In 1988 the Headmasters Conference (independent schools organisation) in association with the Engineering Council and The Secondary Heads Association (maintained sector organisation)⁶⁶ gave an indication of the severity of the situation for physics and mathematics. They noted the projected widening gap between supply and demand for these specialist teachers (see Fig 5 & 6 respectively).

Figure 5



Source Figure (A) HC/EC/SHA⁶⁷ Paper.

Figure 6



Source Figure (B) HC/EC/SHA⁶⁸ Paper.

The UK is not alone in its difficulties regarding the supply of suitable qualified teachers; in Hungary the situation exists where teachers have not been adequately prepared for the advances of science and technology. Indeed Fekete⁶⁹ has questioned the propriety of expecting teachers to implement a curriculum for which they have not been prepared. He stated:

"Most teachers were caught unprepared by the concept of new technology education. Due to their traditionally specialised training, they felt somewhat uncertain in the areas that were outside their scope. What should the teacher who teaches Technics be: a specialist or an all-round teacher? Is it morally right for the education administration to expect them to teach a subject that their qualification is not suited for. Teacher training and extension training play an important part in the quality of teachers. Predominant in their training was academic education, with little emphasis given to the practical and methodological aspects. This is clearly a source of failure in practice-teaching."

The UK National Curriculum Working Party⁷⁰ pointed out that a careful assessment of teaching resources for technology was needed covering staff time for the development of a co-ordinated approach to technology in secondary schools, staff to teach technology, appropriate equipment and accommodation, technology teacher INSET education and the skills of secondary teachers. It declared that:

"A careful assessment of resources is needed in relation to:

- * staff time for the development of a co-ordinated approach to the teaching of technology in secondary schools;*
- * staff to teach technology;*
- * the provision of appropriate equipment and accommodation;*
- * the need for a major in-service training and initial teacher training initiative - particularly to develop the knowledge and skills of primary teachers and to broaden*
- * the skills of secondary teachers."*

The working party recognised that as well as a need for improved facilities and teaching resources there will be a continuing need for teachers to develop their teaching skills and to keep up to date with both advances in educational practice and developments of technology in general, when it stated:

"It is still true to say that the majority of teachers were trained at a time before the personal computer, as an example of the modern technology, became widely available. As a result the feelings of these teachers may vary between diffidence and terror in the company of computer technology. Provision of help for these teachers is becoming a recognised priority."

Technology Teacher INSET

It is instructive to consider the means by which the expertise of the teaching profession is increased. Every year a fresh, and enthusiastic, influx of teachers enter the profession from university and college education departments. It would be reasonable to expect that these entrants to the profession would be fully acquainted with the latest advances of technology, but this is not found to be the case. The situation concerning the shortfalls of initial training and the need for retraining of teachers, known in the UK as INSET (In-service Education and Training) is commented upon by Page⁷¹ when he stated:

"In the context of the varied demands laid upon a teacher, training (in) technology, overlaid with an on-going shortage of physical science and craft (or industrial arts) teachers, teacher training has not been an easy task...and has been one of the factors slowing down the introduction of technology into UK schools...the emphasis needs to be on training or re-training of experienced teachers in the first instance."

The lack of technological competence of recently trained teachers has been ascribed to the failure to invest in the technological aspects of education which is nowhere more apparent

than in university / college education departments with very low budgets for particular technology subject areas. In a recent 1990 article Heppell⁷² noted this fact and wrote:

"Teacher educators face enormous difficulties with information technology in their BEd and PGCE courses. Generally the training colleges are pitifully under-resourced, as a survey by their representative body, Information Technology in Teacher Education, revealed. They are also woefully underfunded with some BEd and PGCE courses struggling along on a total IT annual budget of £3,000 or £4,000 per year."

Hepple⁷³ asserts that teacher education still needs a lot of support and the government's lack of commitment to IT initial training causes INSET problems for teachers. He stated:

"Teacher education still needs a lot of support and this needs to be acknowledged nationally. However, this work shadow scheme, with Apple's backing, is a model for education/industry partnership. If the government's commitment to teacher education was as long-term and as generous, training colleges would be exporting students with computer expertise rather than the IT in-service problems that typify their current output."

The educators, though, realise that such inputs of funds may partially be altruistic as business looks upon education as an investment. No matter how teachers succeed in using the investment to provide a complete education, the hidden message of the advertisers must get through, or they would not invest such large sums.

Hepple noted that the biggest problem was not computer equipment but rather for teacher educators to update their personal skills in the light of current industrial and commercial practice. This he pointed out was a particular problem because of the extended time horizons of training process and the fact that education lags behind state-of-the-art computer usage. He stated:

"Resourcing is not their biggest problem; computers in the classroom are used as a support for learning. The claim is generally made that they are used to develop problem-solving skills (for example interrogation skills) that will be both relevant and enduring when they enter the world of industry and commerce. The problem for teacher educators is how to update their own insights into the ways that computers are used in industry and commerce." and "This is a particular problem because of the extended time horizons facing teacher educators; a BEd student starting out this year will not graduate until 1993 and probably not get further in-service training until 1996 or 1997. Clearly a feel for how computers might have been used in the Seventies and early Eighties is inadequate. They need insights into state-of-the-art, applied technology and the answer to questions like 'How has the computer affected the process of creativity, for example in art and design?'"

It should not be thought that the problem of retraining teachers is confined to the UK. Similar problems have been detected in all other European countries. To illustrate the situation, for example, Dudziak⁷⁴ has said the following about Polish schools:

"Out of necessity schools have to employ as technology teachers people of insufficient qualifications eg. graduates from secondary technical schools, engineers and help them to get prepared for this occupation."

Also Deijsselsburg⁷⁵ has commented about the poor quality of the technology teachers in the Netherlands. He stated:

"In general, teachers in vocational education, especially in technical subjects, are specialists whose careers started also in the same vocational schools with much emphasis on their technical abilities and less attention for general educational subjects. Their

relatively narrow education makes them less aware of the fundamental concepts of technology."

Sources of Expertise and Information

Once in post in the UK a teacher has traditionally had several sources of expertise and information which they may access. These sources include in-service training days, in-service courses, secondment, and advisory teachers.

The limitation of these days for teachers of science and technology in the UK was expressed by Lady Parkes (Chairperson of the National Curriculum Working Party on Design and Technology) in her address to the Electronics Systems News conference held at the Institute of Electrical Engineers in 1989. Lady Parkes, in response to a question, said that no funding was to be made available for training days as it was expected that they would be held within schools where staff would share their expertise. The obvious difficulties for schools where expertise was not already present were evidently not considered.

In service courses

In service courses have traditionally been provided both at the local level and nationally. Local Education Authority (LEA) advisers and advisory teachers have been funded to provide courses for teachers in their area delivering the curriculum area for which the advisers hold responsibility. Where necessary they have been able to bring in specialist help in the form of lecturers and equipment from external bodies on a consultancy basis. Alternatively the LEA advisers have had access to funds which have enabled school staff to attend nationally run courses on special topics in science and technology. These staff have then returned to advise and encourage their fellow teachers. It should be remembered that the cost of such exercises includes that of supply teacher cover during the duration of the course. With the advent of local management of schools (LMS) it is unlikely that such arrangements will continue, for the simple reason that the cost of sending one teacher on a 5 day course may exceed the total capitation budget for a school science or technology department.

Secondment

In the past a teacher having completed ten to fifteen years of teaching had at least some chance of a term's, or even a year's, secondment to a professional training course at perhaps diploma or further degree level in their area of the curriculum. Such secondment was funded by the LEA. The advent of LMS (Local Management of Schools) has led to the closure of many such courses at university departments of education through lack of applicants. Schools do not have sufficient funds to provide the teaching cover required during the absence of the seconded teacher. A good example of this is that all OSSTC full-time and part-time Technology INSET courses for 1990 have ceased as no funding is available for such courses from the LEA.

Advisory teachers

Historically the role of LEA employed subject advisers and advisory teachers has included visits to schools to assist in the implementation of educational developments. Advisers have been able to assist schools in developing new teaching schemes and pedagogical methods by funding both equipment and accommodation improvement and acquisition. The implementation of the National Curriculum has meant that the advisory role is being replaced by an administrative and inspectorial role. An Advisory Teacher for Technology based at OSSTC indicated that the role of such a person is changing from

helping and advising to inspecting and assessing competence. The professional experience of OSSTC staff working in the field and meeting many advisers confirms this position.

Alternative Support For Educators

Alternative means of supporting the classroom teacher are obviously needed as the traditional resources are being whittled away. Some help has been forthcoming from commerce and industry, particularly where the organisation concerned has become aware of a possible shortfall in recruitment in the near future. Institutions such as OSSTC and the other SATROs are becoming more important as they have a specific brief to support, develop resources and to provide INSET for science and technology education, including IT (computing), and have substantial expertise in the field.

OSSTC

The OSSTC was created in 1971 following work by such bodies as the Schools Council Project Technology Group, the Royal Society, the local Association for Science Education, and other national bodies. It is an independent Oxford University unit located in the Clarendon Laboratory in the heart of the Science and Engineering complex of the University. It is in effect a partnership between all those who have an interest in the support of the teaching of school science and technology education. This partnership includes all the science departments of the University, the Department of Educational Studies, Oxfordshire Local Education Authority, and the Standing Conference on Schools' Science and Technology, to name but a few.

The centre exists to provide services and to link the experimental sciences/technologies, to science and technology educators in the Oxfordshire region and beyond. Its physical location provides an unparalleled base for those educators who would otherwise have very little contact with the science and engineering complex of England's oldest and most distinguished university. Currently the service that OSSTC offers, linked to science and technology, revolves around the following areas:

Technical Information and Support; Educational Guidance and Development; Physical Resources; Research; Project Development; Inservice Education and Training; Information Dissemination.

Perhaps the most significant of the above, in the context of present day school science and technology, is research and project development, support and Inservice Education for Teachers (INSET). OSSTC has access to high level expertise from a wide area within Oxford University, Oxford Polytechnic, Industry and SATRO (Science and Technology Regional Organisation) networks.

OSSTC operates at a local, National and International level. Locally within a 30 mile radius of Oxford; nationally with the 40 SATROS and as a consultant to various bodies; internationally - with colleagues in Europe, Australia and the U.S.A.

OSSTC has a brief to consider any contractual programmes related to either Science or technology education, especially those concerning research, INSET or project material development in both the UK and overseas.

The SATRO

In 1967 the Schools Council established Project Technology⁷⁶ for an initial period of three years to develop teaching material in schools and to stimulate technological work in schools. As part of this programme the Project's central team, based at Loughborough

College of Education, developed a large variety of educational material which was used by more than a thousand schools. This material was disseminated through the project journal 'School Technology' and many other publications which contained information and abstracts related to technology education in schools.

At the same time as undertaking the above tasks the project promoted outside support for the development of applied scientific and technological work in schools from other sectors of the education service and industry.

As a result of the work of Project Technology and its regional groups, and of the activities of the Schools Science and Technology Committee, which was chaired by Prince Philip, a meeting was held at the Royal Society in February 1970 in order to consider the possible linking of local organisations in some kind of national framework. In September 1970 the Schools Science and Technology Committee held a meeting attended by representatives of all interested bodies, such as the ASE (Association for Science Education), to consider the findings of the report 'Support for School Science and Technology,' produced by the Schools Council. At this meeting it was agreed to establish a "Standing Conference for the Support of School Science and Technology."

In 1971, as a result of this decision, the SCSST (Standing Conference on Schools' Science and Technology) was formed to co-ordinate the effort of its hundred plus member organisations. It also took under its wings the fledgling SATROs (Science and Technology Regional Organisations). SCSST outlined the main role of SATROs:

"Science and Technology Regional Organisations are regional centres which develop active dialogue between schools, further and higher education, industry and commerce" also "SATROs are partnerships of local education authorities, industry and commerce, and have management committees with wide-ranging representation. They are often located in Polytechnics and Universities"

According to SCSST, in terms of science and technology, SATROs are specifically concerned with: linking schools to industry and commerce; enriching the school curriculum with relevance to a changing world; the initial training and INSET of teachers, the initiation of project work and competitions; enabling information and experience to be shared through conferences, symposia and seminars; innovating developments. It stated:

"With reference to science and technology SATROs are concerned with: linking schools, industry and commerce; enhancing the curriculum with relevance to a changing world; enriching the initial and in-service training of teachers; initiating project work and competitions for pupils to encourage further activity in schools; enabling information and experience to be shared with others; informing through conferences, symposia and seminars; innovating developments in education through think-tanks and frontier groups."

In 1985 the concept/role of SATROs was clarified further when it was stated by SCSST that SATROs are a network of independent regional centres. They exist to enhance young peoples understanding of science, engineering, industry and technology; help people in industry and technology to understand school education; provide teaching resources with industrial and technological relevance; promote technological problem-solving and project work with young people; and act as a focal centre for information and support.

As indicated in the previous section OSSTC acts as a SATRO on behalf of the SCSST.

STATE OF THE ART COMPUTER HARDWARE AND SOFTWARE FOR SCHOOLS

This section argues:-

- 1) Technology teachers in the UK will be required to be conversant with the latest trends in computer software and hardware for their science-linked technology work in schools. This is especially vital if they are to comply with the National Curriculum IT demands.
- 2) Software and human-interface investigations indicate that the GUI and CUI approaches are in common use across a wide range of microcomputers, including those in use in schools. The investigations also revealed that GUI approach to the human computer interface with programmes is the one which is the most beneficial to both novice and experienced computer users.
- 3) The speed of development of computer hardware in recent times is staggering. For the purposes of this study it would seem appropriate to concentrate upon the new 16 and 32 bit industry standard microcomputers and the programming tools that technology educators are likely to have daily access to in 1991 or in the near future. It is generally accepted that the Apple Macintosh and the IBM PS2 series microcomputers are the market leaders and industry standards against which all others are judged.
- 4) Over the last few years, the compact disc (CD) has become one of the most successful consumer products of all time. Education can benefit immensely from CD-ROM technology. The potential to combine media, in particular, the media elements of sound and vision with computer data, in a database that can be interactively explored and navigated is a reality now made possible by CD-ROM technology.
- 5) Technology educators should consider using a GUI as it appears to result in higher output per hour, higher productivity, lower levels of frustration and fatigue, and greater return upon school information technology software investment. They should also become conversant with state of the art IBM and Apple Macintosh 16 and 32 bit microcomputers and CD-ROM technology.

Human Computer Interfaces/Ergonomics

The GUI (Graphical User Interface) and CUI (Character User Interface) approaches are in common use across a wide range of microcomputers, including those in use in schools. In this sub-section the approaches are described and discussed.

The characteristics of the GUI approach is that it:

1. uses a "point and click" approach. Users point to an icon upon a computer screen with a "mouse" and then "click" the mouse to activate a program function concerned with that icon;
2. allows a common command structure to be used across computer software applications;
3. provides immediate visual user feedback of an activated program function via an effect called WYSIWYG "what-you-see-is-what-you-get". For example if you change a wordprocessor font from plain text to bold text, the word typed immediately appears bold on the computer screen

The characteristics of the CUI approach is that it:

- a. uses a "typed character or word" approach. Users either hit a character/function key or type a word to activate an associated program function;
- b. does not make use of a common command structure for all computer applications;
- c. does not necessarily give immediate visual user feedback of an activated program function. For example a wordprocessor font may be changed without the user seeing the result of that change on the computer screen.

It is suggested that the GUI approach to the human computer interface with programmes is the one which is the most beneficial to both novice and experienced computer users, as it results in higher output per hour, higher productivity, lower levels of frustration and fatigue, and greater return upon information technology investment.. A recent report upon the benefits of the GUI by a USA company TempleBS⁷⁷ based upon a major industrial research programme co-sponsored by Microsoft and Zenith Data systems supported this contention when it concluded that :

"GUI generates 1. higher output per work-hour, through higher productivity, 2. higher output per employee, because of lower levels of frustration and fatigue, and 3. greater return on information technology investment than CUI."

This research also supported the premise GUI supports a generalised 'navigation theory' that leads to the notion that computer users, are more productive, self sufficient, and confident than CUI users. TBS also indicated about this 'navigation theory' that:

"the evidence from this research supports a more general explanation of the benefits of GUI, which we called "navigation theory". This theory posits that the intuitive metaphors embodied by GUI facilitate exploration, use and self retention of the functions of one or more applications, making users more productive, self sufficient, and confident. "This hypothesis is supported by quantitative measurements of performance for both novice and experienced users; by observations of novice learning; by attitudinal surveys; and by other specific findings. The theory is also consistent with other research observations and common sense."

It also suggested that GUI was superior to CUI for all corporate, clerical, professional, and managerial computer users. TBS further stated:

"The navigation theory suggests that GUI is superior to CUI for all corporate microcomputer users - clerical, professional, and managerial - and that as the knowledge-intensiveness of work grows, the value of GUI to the user and the corporation will increase."

TBS specifically indicated that the hardware and operating systems were DOS (IBM) and System (Macintosh). It is interesting to note that no significant difference was found concerning GUI on either of the two leading mainstream microcomputer platforms:

"For the purposes of this research, the CUI environment was represented by IBM-compatible PSs running DOS. To represent the GUI environment, Macintoshes were used in the novice test. In the experienced-user test, TBS used a mix of GUI on both Macintoshes and IBM PCs using the Windows GUI environment. TBS found no statistically significant difference in the results for the Macintosh and the IBM-compatible PC-based GUI using Windows."

Anecdotal evidence from the information/ computing systems and business press would seem to suggest that the GUI will eventually become the dominant and exclusive form of

the human computer interface. Almost every computing magazine during 1990 and 1991 discussed in length a new or improved version of GUI. TSB also supported this view when they further stated :

"Most recently , the business and information systems press has approached a consensus that GUI will eventually become the dominant, if not the exclusive, microcomputer interface."

This clearly will have its effect upon technology teachers who in the main at present use a CUI approach because the majority of microcomputer systems in schools have not been supplied with GUI software. Personal experience has indicated this situation for schools is changing rapidly. However, no reliable details of the rate of change or the degree of change taking place is available at present.

Microcomputer and Software Developments

The rate of change in terms of the development of computers in recent times is staggering to say the least. It seems that new systems and programming tools appear every three months or so. However, for the purposes of this study it would seem appropriate to concentrate upon the new 16 and 32 bit industry standard microcomputers concept and their programming tools that technology educators are likely to have access to in their daily work today or in the near future.

It is generally accepted that the Apple Macintosh and the IBM PS2 series microcomputers are the market leaders and industry standards against which all others are judged. Accordingly, for the purposes of this study, these and their associated software are described below.

The Apple Macintosh

The Apple Macintosh (32 bit) concept is particularly interesting as Apple⁷⁸ in 1989 claimed that throughout the world more Apple computers are used in schools than any other microcomputer. It grew from an imaginative set of 1984 prospective user precepts which were produced for the first Macintosh. These precepts were that it should be simple to use, complexities should be hidden, the technologies were to be invisible and the microcomputer should be a tool that was understandable and responsive to user needs. The user needs, in terms of education, were targeted at the administrator, the teacher, and the pupil. Apple claim it was the first affordable computer to display high resolution graphics, and the cut and paste integration of graphics and text. It was mouse driven and employed the GUI point and click approach. Apple stated in their brochure for schools :

"Throughout the world, more Apple computers are used in schools than any other computer" and "Macintosh introduced in 1984, grew from an imaginative set of precepts: What if computers were simple to use ?

What if all their complexities were hidden, and their technologies invisible ?

What if all you saw was a tool which was surprisingly understandable, and responsive to your needs ?"

"The needs for example of the administrator who doesn't want just another piece of technology, but a more efficient and productive way of working. The needs of the teacher who demands ease of use and computing power that is easily accessible; a tool to inspire rather than inhibit learning. The needs of the pupil who responds to new ways of investigating and solving problems" and "a computer does not need to be difficult to use. The previous generation had no choice. Today's generation has."

Apple also declared that the Macintosh was the first affordable computer that could display high-resolution graphics allowing cut-and-paste integration of graphics and text within the confines of consistent software which allowed the basic understanding of all further applications.

"It (The Macintosh) was the first affordable computer to display high-resolution graphics, to allow cut- and paste integration of graphics with text and to use software so consistent that once you had learned one application, you grasped the basics of them all".

The concept of simplicity in particular has been extended from the microcomputer to the machine system as a whole. Experience at OSSTC has been that whenever a hard-disk, or extra memory, or other peripherals are added to the Macintosh it is a very simple procedure. Items are connected, software where appropriate is installed, and the item functions. No complicated configuration routines are necessary before use. This is particularly helpful when working with technology educators, especially those who have limited computer experience and expertise.

All software applications for the Macintosh work in a human-like way. The 'Desktop' presents and organises the dialogue between the user and the computer by using familiar items in the form of icons such as a wastepaper basket, files and folders. The mouse, a pointing and clicking device, allows the user to select and command the activities that are required without having to remember or type commands. To transfer information from one file to another all that is required is to 'Cut' and 'Paste'. Once one application is used knowledge of the basic principles of use are self-evident for all future applications.

Experience with teachers and pupils at OSSTC and has found that it only takes 10 minutes for an individual to grasp the basic concept of GUI operation and after that users are 'hooked' on the computer and rarely wish to move to other systems.

Software development systems for the Macintosh come in three groups; 1. low level personal educational user scripting, 2. high level commercial individual language based, 3. high level autocode writing applications.

1. In terms of low level educational user software development systems Apple distribute the 'Hypercard' software with all their machines. Hypercard is effectively a low level programming system based upon a form of programming called 'Scripting' rather than a conventional computer language such as C. or Pascal. Hypercard is best described as a super cardbox or filing system which can hold text, graphics and sound. This system is used to produce small low level applications known as 'Stacks'. This software is widely used by schools and colleges for many educational applications from physics simulations to lists of class names and addresses. Hypercard is the market leader in educational user development software systems; Apple bundle it free of cost with their microcomputing systems for education.

Many Hypercard stacks are available for use in education. The Oxford based Macintosh User Group⁷⁹ has some 105 stacks listed, many of which can be utilised by technology educators. Examples include :

- HC 73 Graphics, Animation, Title Loop, Mayan Icons, Show Pict;
- H 68 Education, Engineering Guide;
- HC 69 Database, Action Items, Address and Calendar, DiskBox, Growing Maps, Haz Mat, Hyper Wallet, Message Centre, Organiser, Tinplate, To Do Archive;
- HC60 Comms, Appletalk Lookup, Connectivity, E-Mail, Hyperterm, News Stack, Send Serial, Serial Port XCMD.

2. In terms of software for commercial or high level individual development Apple supplies and supports the 'Apple Programmers Workshop'. This system provides languages such as C. or Pascal and allows access to the Rom based Macintosh graphics interface, thus enabling high level applications to be written.

An example of a Macintosh programme developed using this system is described later in this study in Chapter 4 under the 'CityLink' heading.

3. The high level autocode generating applications are best personified by the Omnis3 series application generators. Omnis3, written initially for the Macintosh, allows a high level applications developer to build applications by coding within the master application. This coding generates Pascal language code, which is not normally accessible to the user, which actually forms the final application. Upon completion the application usually runs under the 'run-time' or application generator.

ME electronics in Oxford used Omnis 3 to develop their software 'Schoolworks' which is in effect a complex yet simple school administration package. This application received acclaim from Wills⁸⁰. He stated:

"We bought a relatively new piece of school administration software called 'Schoolworks' which comes close to providing the head with the kind of support which is needed and can integrate easily with other software in the system."

The IBM Series

The IBM series concept was that established by the original IBM industry standard series. In 1988 the IBM PS2 (16 Bit) was introduced and functioned much as the old IBM series microcomputers did under the well established PCDOS system (please note that it can also run under the new OS2 system). The DOS system was effectively based upon CUI text entry via the keyboard and the accessing of a tree like system of directories and paths. Users have to have knowledge of this DOS system and know how to configure the system in order to utilise the microcomputer and to run any programmes. To anyone who has little or no experience with microcomputers this approach can be quite daunting as constant usage is necessary to learn DOS. However, once mastered, the system is quite usable, and of course is in wide use throughout the world. However, it does have one bad side effect in that it tends to create experts who baffle others with their expertise and deter them from using computers as the everyday tool that it is. OSSTC experience with technology teachers is that many have great problems learning DOS.

The installation of any hardware requires the user to reconfigure the microcomputer and very often this can be a time consuming, labour intensive event, especially for technology educators. OSSTC experience is that few installations are without their problems, and very often help has to be requested from manufacturers or third party hardware suppliers.

All IBM software has to be installed and run under the above mentioned CUI DOS interface which can at times cause considerable problems for the user. To overcome the difficulty of non-user-friendliness several computer software companies have come up with a system similar to the Macintosh approach. One such GUI has been developed by the Microsoft company and is known as Windows. Windows has to be installed on the computer and then the computer may be configured to open with this user interface. It is similar in nature to the Macintosh system in as much that it uses the point and click approach to open programmes. However it is not as efficient or as friendly, as the keyboard is often required to input program names. It is however a good attempt to bypass an inherently unfriendly machine system and to ensure that the system does not

get in the way of the user utilising the microcomputer as an everyday tool. A recent release of this system, known as Windows 3, is a very good attempt to emulate a Macintosh-like system. The one drawback of this release, and indeed all Windows releases, is that it requires the machine to have substantial additional memory, and in common with all software solutions slows machine operation down considerably.

Software development systems come in three groups; 1. low level personal educational user writing, 2. high level commercial individual language based, 3. high level autocode writing applications.

1. A recent successful attempt by IBM to produce a non-complicated simple user-programmable GUI development system for educators resulted in the 'Linkway' package. This package is similar to hypercard, in as much that it again relies upon utilising simple text to generate computer language code which is hidden from the user. A small library of icons are available to be used and others may be generated by the user; text and graphics can be inputted into a series of window-like files. The user-friendly click and point approach is inherent within the completed application.

An example of an IBM program generated utilising the Linkway system is described later in this study in Chapter 4 under the 'CityLink' heading.

2. A development application produced for commercial usage by Matrix Technology entitled 'Matrix Layout' is perhaps the leader in the field of code generating language based application generators for the IBM PS2. This system is effectively an automatic C. code-generating system for producing free-standing applications. When this is combined with the 'Synergy Toolbox', also produced by Matrix, it becomes a very powerful system for software development; completed applications do not require a run-time language element.

As this system is relatively new and has a considerable number of bugs in it few serious market applications can be found. However, the OSSTC experience with this system and CityLink is described later in this study.

3. The high level autocode generating applications are personified by the GUI series application generator Omnis5. This was written initially for the Macintosh and is now available for the IBM PS2 series running DOS, or OS2 running under Windows 3. It allows a high level applications developer to build applications by coding within the master application. This coding generates Pascal language code, which is not accessible to the user, which actually forms the developed application. Upon completion the application usually runs under the 'run-time' or application generator. One very special attribute of this software OMNIS 5 is that the application generated on the IBM PS2 or upon the Macintosh can be run on either machine without any alteration.

Microcomputer Peripherals

The peripherals described below are the CD Rom, the scanner and digital camera, laser printer, and the hard disk. All these are available for use with the Apple Macintosh and IBMPS2 series microcomputers.

CD-ROM

Over the last few years, the compact disc (CD) has become one of the most successful consumer product of all time. World-wide sales of CD players have now reached nearly 50 million and CD sales are running at several billion.

The CD holds music stored digitally on its surface in the form of light and dark areas or pits on the disc. Many millions of them form a spiral track from the centre outwards. These pits are read by a laser beam which is directed at the surface, and the reflection is read and processed by sophisticated electronics which converts the pulses into sound. Because there is no direct contact with the surface, the disc does not wear and the quality of reproduction is excellent.

It is the compact disc which provides the basis for CD-ROM (Read Only Memory) technology. The CD-ROM first appeared in 1985, with the basic technology from the audio system upgraded for use with a computer. The CD-ROM disc is physically identical to the audio CD and is made in the same way. The CD-ROM disc can hold music but also computer data. The light and dark pits on the disc represent binary Os and Is associated with digital data. The density of storage is extremely high; a single disc has a capacity for over 550 megabytes of computer data, enough to hold an entire set of encyclopaedias, or 250,000 pages of text, 5,000 colour photographs and so on.

The CD-ROM can hold a diverse combination of media types; text data and graphics can be supplemented with sound and animation to provide a rich, powerful resource for educational or commercial applications. Information held on the discs is permanent: it can not be erased, changed or added to, and, provided the disc has been made correctly, will last for many years.

In the commercial and industrial markets the CD-ROM is well established as the ideal medium for publishing large databases, imagebases or texts. Everything from medical records, through financial reports, multilingual dictionaries to the entire UK postal addresses can be found on a disc. The complete Oxford Dictionary is now available on disk.

The cost of producing a CD-ROM is very low (in 1990). A Cambridge company Next Technology can produce a single at £300 and bulk orders of 1000 or more discs can be produced for as little as a £1 each. Small companies like Genome are making CD-ROM tracks slots available for as little as £100 for those who cannot afford to pay for a full disk. This company is also producing a CD-ROM on how to make a CD-ROM for Apple Macintosh users.

Education can possibly benefit greatly from CD-ROM technology. The potential to combine media, in particular the media elements of sound and vision with computer data, in a database that can be interactively explored and navigated is a reality made possible by CD-ROM technology.

A number of CD-ROM discs are available that contain thousands of "clip-art" images ranging from maps of the world to pictures of birds and scientific drawings. These images may be used by teachers and students alike to supplement or clarify hand-outs or project work when using DTP software. The NERIS Database is available on CD-ROM. All major computer companies supporting education such as Apple, Acorn, IBM, Research Machines are involved in providing educational material on CD-Roms. The BBC Interactive Television Unit has produced a multimedia, multilingual CD-ROM, which integrates photographic images, graphics, sound, text and data, in nine languages to provide an interactive simulation of a nature reserve.

Scanner & Digital Camera

Both the scanner and digital camera are devices which provide a user with a means of inputting graphical images directly into the microcomputer. Once in the computer these images can be manipulated by software and inserted into documents being compiled with

word processors. A good example of usage of this technique is provided by this thesis, in as much that both text and graphics have been inputted via these devices.

Laser Printer

The laser printer is a device for outputting high quality text and graphical hard copy from a microcomputer onto paper or acrylic sheet. It is available with and without 'Postscript' a computer language which defines high quality outlines for both text fonts and graphics. It also allows scaling of these items. It has been used for the production of this thesis.

Hard Disk

These microcomputer peripheral devices have been around for a considerable amount of time. They are basically a fixed rotating disk coated in magnetic media, upon which moderate quantities of data can be stored. They are an essential storage medium for anyone developing educational software as they can hold much more data than a floppy disk (NB. A standard floppy disk can only hold a maximum of 2 megabytes of data whilst the smallest hard disk currently found can hold 20 megabytes of data.). Many colleges and schools utilise these, within their computer systems, upon a daily basis for educational use with students/pupils and for administration because they can hold substantial quantities of data and more than one item of software.

INFORMATION SOURCES AVAILABLE TO TECHNOLOGY EDUCATORS

This section argues:-

All school technology educators will need access to up-to-date information if they are to teach technology effectively in schools. In particular it is suggested that they will need information for four major areas of their work.:

1. to enable them to teach the National Curriculum Technology;
2. to enable them to cover the 16 to 18 Technology Courses;
3. to enable them to advise school students undertaking project work for GCSE and for 'A' level examinations;
4. to produce new curriculum and project materials, and to locate new equipment for use in schools.

It is also apparent they will need different types of information to support their technology curriculum and project work; these range from national curriculum details to consumable resources etc.

Unfortunately the pool of sources, and access to these, are inadequate for a variety of reasons ranging from changes in the very nature of the school technology curriculum demands, to lack of funding for the source or service etc.

This section does not cover computerised databases as these are discussed in the following section.

Need for Information

It is instructive first to consider the information needed by school technology educators in terms of their professional work in schools and teaching technology to students up to the age of 18 years. Technology educators will need information for four major areas of their work; 1. to enable them to teach the National Curriculum Technology; 2. to enable them

to cover the 16 to 18 Technology Courses; 3. to enable them to advise school students undertaking project work for GCSE and for 'A' level examinations; 4. the design and manufacture of new curriculum and project materials, and new equipment for use in schools

1. The National Curriculum Technology has two major elements, Design and Technology and Information Technology; Both these elements have Statements of Attainment and Programmes of Study for which information will be required.

2. The 16 to 18 Technology Courses in schools are mainly covered by the AS and A level courses in Technology published by the various examination groups such as the Midland Examining Group. Detailed information upon the contents of these examination syllabuses and syllabus requirements will be needed if school students are to have the depth of education to which they are entitled.

3. All GCSE and A Level Technology courses have an individual personal design and make project requirement within them for assessment purposes whether it be in the Technology, Design and Technology, Design and Communication, or Information Technology areas. School technology educators will need to obtain information to support this work.

4. Many school technology educators have been involved in the design and development of new materials and equipment for use in schools. These items range from curriculum packages on say racing car design through to such things as jigs for drilling and computer interfaces. As this is a never-ending, demanding job technology educators need immediate rapid access to accurate information from a wide area.

Type of Information

It is also worth considering the type/nature of information that a secondary school technology educator may require for their curriculum and project work as this is likely to determine what sources of information and what services are consulted. This information may be textual or graphical. Technology educators may need to cover the following to find information on:

National Curriculum Details: because the National Curriculum is mandatory in law details of them will be required in order that the educator can draw up a scheme of work appropriate to the age range, intellectual demands and physical capability of the target population of students.

Teaching Schemes: will need to be consulted to be considered for adoption as the scheme of work.

Technical Data: will almost certainly be needed for any science-linked technology curriculum or project.

Public Examination Scheme Details: are a must for educators teaching school students in the 16 year age range because all students will have to take them, with the exception of those with special needs.

National Curriculum Assessment Details: will have to be consulted when they come on-line (currently only Key Stage 3 has been trialled).

Careers Details: it may be useful to have information about careers, depending upon the level of the course and the examination requirements.

Equipment Availability: it will be necessary for a technology educator to check that generalised and specialised equipment is available so that a scheme of work can actually function.

Consumable Resource Availability: all technology courses will use consumable material in the design and manufacture stage of a course or project.

Internal Pump Priming Funding: internal school funding of a course or project may well be required, especially if it is a new element of the individual school curriculum.

External Pump Priming Funding: internal school funding is extremely short at the present time with LMS which may force a technology educator to look outside the school for funds for new courses or projects.

Laboratory/Workshop: will be mandatory when any technology course or project is being considered as specialised equipment or working conditions will be required.

School Curriculum: consideration of this element is essential as all schools have to balance their time table across a wide area, especially with the suggested time slot of 20% of time to Technology within the National Curriculum.

Technician: technician support may well be necessary in order to prepare materials, laboratories and workshops, and specialised tools for use by technology educators and students.

Sources of Information

The sources of information available to the technology educator are varied and may well only be consulted if appropriate to the type of information required. The following is a list of sources available for consultation. Comments pertinent to the present situation concerning these sources are also made.

In the recent past sets of school text books were essential to technology education work; many schools purchased class sets of books such as the Schools Council Modular Courses in Technology⁸¹ series. Today this is no longer so, with the changed teaching approach in this area from that of formal class teaching to a consultative approach due to the demands of the National Curriculum, and constraints upon school funding. A telephone enquiry and interviews with educational publishers in Oxford, (Basil Blackwell and Oxford University Press) revealed that they were selling very few classroom sets of text books and no longer saw that as a strong market. They also indicated that there was a demand for books which included freely photocopiable materials which most class texts do not. It should also be noted that sets of text books for a class of 30 can be quite costly (eg. 30 books @ £10 each total £300), and are bulky to store.

All schools will have reference books of one sort or another, especially those appropriate to technology education. Many of these are likely to be new because they will need to address the new National Curriculum and GCSE Technology. Examples are CDT Technology⁸² and Craft Design and Technology, a complete course for GCSE⁸³. Enquires to Oxford publishers, (Basil Blackwell and Oxford University Press) revealed that this is the growth area upon which they were concentrating their marketing efforts. They also indicated that they had recently produced a range of publications targeted at the National Curriculum technology field. They further indicated that the words National Curriculum Technology on the publication virtually sold the book on its own because technology educators appeared to be desperate for new references in this field. They also

indicated that technology educators could only really afford one or two of a particular book title for reference purposes.

A variety of educational journals are available to schools c.15 in number ranging from those addressing secondary education to in-service education etc. A good example would be the British Journal of In-Service Education Vol 15, No1⁸⁴, a quarterly publication. However a telephone poll of some 10 Oxfordshire school Librarians revealed that few purchased journals as their budgets did not allow this. Most referred their staff to higher education institution libraries for these items. Enquires of technology educators in Oxfordshire revealed that they did not buy educational journals unless specifically advised to do so when on an in-set course.

There are only 4 school technology journals generally available to Oxfordshire technology educators. Examples of these Journals are given by Design and Technology Teaching, Volume 22 No2⁸⁵ which concentrates upon practical technology teaching, and The International Journal of Design and Technology Education Volume 1 No 3⁸⁶ which concentrates upon technology education research and development. Personal experience with secondary technology educators in Oxfordshire revealed that almost all of them took one or more of these journal in their school departments. Few school librarians in Oxfordshire indicated that they purchased these as they were items that could be bought out of school library departmental budgets. They also pointed out that these journals could be bought though INSET funds but they had no control over these moneys.

The whole range of UK newspapers, some EEC and USA, papers are available to Oxfordshire technology educators. Typical of these might be Times⁸⁷ or Guardian⁸⁸ newspapers. Enquires in Oxfordshire secondary schools revealed that most staffrooms had a UK quality daily newspaper, few had the popular press newspapers. Many Oxfordshire technology educators take a daily newspaper at home; usually this is one of the quality papers. Schools or technology educators did not appear to take EEC or USA papers.

Technology education will feature in education newspapers from time to time and information may be accessed from them. These newspapers are The Times Educational Supplement⁸⁹ or The Education Guardian⁹⁰, occasionally the Times Higher Education Supplement⁹¹ may be taken. Almost all Oxfordshire schools take the main Education Newspapers in their staffroom. Many Oxfordshire technology educators take one or the other at home.

Without exception all Oxfordshire schools are bombarded with commercial pamphlets and commercial advertising material. Typical items are those produced by Atari with their Portfolio brochure⁹² and Microsoft with their flier The Microsoft Office⁹³. Enquiries to Oxfordshire technology advisory staff and educators indicated that the vast majority of this material goes in the bin without being read, only those directly pertinent to school work or from known suppliers is retained.

Many of the large industrial concerns and institutions produce educational material which is sent out at no or low cost to schools. This ranges from books, through material samples, to teaching schemes. The Post Office for some years has sent out excellent computer software to schools at cost or free of charge (such as the new Big Post Office⁹⁴ package due to be sent out in late 1991). From personal experience with this material at OSSTC, 25% is excellent, the other 75% has limited value because it is often too specific to the company or institutions interests, and does not comply with National Curriculum Demands.

Excellent material has been produced by agencies working on a contractual basis for both the DTI and DES. A good example is provided by the NEMEC (National Electronics and Micro Electronics Consortia) Material on Basic Concepts and Approaches to Electronic Systems⁹⁵ produced under contract by the Southern Science and Technology Forum (SSTF) at Southampton University. INSET Programmes were run at OSSTC to enable c.140 technology educators in Oxfordshire to use this scheme in schools. Written material in the form of books was provided to these educators. As the director of this programme, I can state that the scheme documentation is expensive if a full set is to be obtained, even though it has been subsidised by government. This material, if not held in a school, is only available from the SSTF.

A vast range of filmstrips are available to technology educators, and many schools have these in the library or school departments. Waddington⁹⁶ produced the well used Environment Filmstrip which is typical of those found in schools. However, discussions with Oxfordshire technology Advisory staff and School Technology co-ordinators indicate this material is little used because much is outdated, the projectors are not freely available, or in many cases are broken and outdated, and funds do not exist to repair or maintain them in the present financial climate of constraint.

Videos are freely available in all secondary schools as is the equipment for playing them. Information on a vast range of subject areas is covered including science and technology. An example of a video is The Chip⁹⁷ from the series Electronics Now. Oxfordshire technology advisory staff indicate most teachers of technology use videos on a regular basis in their teaching. Many schools in Oxfordshire maintain a library of these and use a technician to keep them updated and in good order. It should be noted that the Oxfordshire Audio-Visual Aids Centre, Witney which was a specialist Video unit closed August 1991, the 1 remaining member of staff of 7 being transferred to the Cricket Road Centre, Oxford.

Access to a range of education and public television services from ground stations and satellites, from which information may be extracted, is available to all technology educators. Both the BBC and ITV produce programs for schools. TV reception equipment is available in all Oxfordshire schools.

The teaching profession has always had professional organisations and trade unions each of which produce their own in-house journals. These journals, which are mailed out to members and subscribing educational institution, and can contain information pertinent to technology educators from time to time. Typical of these is the AMMA journal Report⁹⁸ for July 1990.

Almost all equipment supplied for technology education will have with it associated manuals or Datasheets. These will be held in the school either in the library, relevant department, or specialised centre. Several suppliers of scientific and technological equipment offer manuals and data sheets upon specialised items from which information can be gained. An example of the former would be the manuals for use of a particular make and model of microcomputer held in a school; examples of the latter are the excellent manuals or electronic item/component data sheets from RS Components, details of which will be found in their 1991 RS Catalogue⁹⁹. CLEAPSS¹⁰⁰ school science service also provides an equipment bulletin and technical data sheets upon equipment, these may be held in the school library or relevant school department. The CLEAPSS service is only available to LEA consortia members who fund it.

Technology educators will have access to information from a variety of commercial educational catalogues because all schools keep a selection of them. Typical of these are catalogues from Rapid Electronics¹⁰¹ and Apple UK¹⁰². The Rapid catalogue covers

electronics items, batteries and tools; the Apple Educational Software catalogue covers the types of computer software available, brief details of the software, the source of the software, and the current cost of it.

All technology educators in UK maintained secondary schools will have access to National Curriculum Science and Technology Orders and Documents, either in school generally, within their own school department, or personally. They will use information from these documents because the national curriculum has to be complied with by law and is now the basis of all work being undertaken in schools

Information on the whole range of educational developments and research in the UK is available from the British Educational Index. Technology educators may access this if it is easily available to them. It may be held in the school library, but more likely it is held in a higher education institution library or public library.

All public examination boards publish examination syllabuses, booklets and information sheets upon the examinations and the service that they offer. All secondary technology educators will have to consult these in the context of the courses they are teaching in the schools in order to comply with National Curriculum demands. Typical of these are the GCSE CDT Technology syllabus B¹⁰³ and information sheets from the Northern Examining Association.

Services for Accessing Information

The following is a list of the main services available to technology educators seeking information. Comments concerning these services are also made.

British Library Inter-library Loan Service allows schools, colleges, and public libraries to obtain books or photocopies of relevant sections of texts from the British Library, based in Wetherby in Yorkshire, for research purposes and is available to all technology educators. This service is not free and can only be accessed through a librarian in a library participating in the scheme.

The vast majority of professional associations such as the AMMA or NUT have their own educational libraries which are available to members. Only paid-up members of the particular association may use these services

The School Library Service will supply of reference books upon a specific topic for use in school project work. Technology educators can arrange for a supply to their school for a set period of time. Usually this is a branch of the County Public Library service and may only be accessed within the confines of a particular county. Funding for this service is being hit by the severe constraints upon local authority spending.

Every local authority in the UK has a public library service which is freely available to all. Most have a reference section which may be used by technology educators. These libraries have set times of opening and restrictions on the loan of reference texts.

Most FE colleges have educational libraries and resource collections which will contain items which are of use to technology educators for information retrieval purposes. Often these libraries may be accessed by school technology educators. However, this will depend upon local arrangements between a particular FE College and School. Payment for the use of this service may be required.

Many counties in the UK have higher education institutions in their midst. All of these institutions concerned with teacher education will have education libraries which may have sections covering the needs of technology educators. The vast majority of these libraries are open to local teachers upon making a telephone call or registering with them. A technology educator on a long or short course at one of the institutions will automatically have full access to these and associated libraries.

Some forty school science and technology centres exist in the UK at present to support the teaching of science and technology in schools. Some of these have libraries and resource collections appropriate to science and technology activities in schools. These facilities will almost certainly be available to technology educators in a particular defined region. Payment for the use of these services is likely unless they are directly funded by a local education authority or charity. Several are closing in the near future, eg. Avon SATRO August 1991, OSSTC August 1992.

Many LEAs in the UK offer this service to schools. Often the service will lend commercial or locally made videos and audio visual equipment to technology educators. Until recently these services were free, however, as a result of constraints upon local authority spending, charges are made. With constraints upon LEA funds many of these facilities are closing, eg. the Oxfordshire Witney AVA Resource Centre.

Nearly all LEAs have a computer centre with staff and resources to support the IT element of the school curriculum. This service will be available to technology educators, usually this is by appointment. Charges appear to be coming commonplace for this service. Many services are being discontinued or hived off to commercial groups, e.g. The Oxfordshire LEA Computer Centre at Wheatley will be in this position during 1993.

Nearly all LEAs have subject advisers and advisory teachers for technology, many of whom maintain a pool of resources of curriculum and project material and equipment. These resources will be available to technology educators. Advisers themselves are excellent sources of information. The pools of resources appear to be diminishing and will have to be booked well in advance. LEA funding constraints has hit this service very hard and will continue to do so for some time to come. Oxfordshire has one technology adviser to cover both primary and secondary education, having recently (during 1990) made one technology adviser redundant. It has thinned its advisory teachers considerably in 1991, 4 times 0.5 for some 265 primary schools and 0.5 for some 40 secondary schools. Buckinghamshire discontinued its use of all advisory teacher staff during 1990.

In many areas local networks of technology educator colleagues have been set up to exchange ideas and information upon new curriculum developments, availability of resources, equipment, inset, examinations, etc. Oxfordshire voluntary area group meetings for technology educators. Meetings of these groups have been run on a regular basis for the last 5 years. However, they seem to be falling into disuse at the present with meetings becoming less frequent. Enquiries of advisory staff indicated that school work level demands were now so great that teachers were disinclined to attend meetings in their own time.

Other Professional UK Colleagues outside the locality or county are sources of information. The major vehicle for this connection is through the School Technology Forum and the annual Design and Technology Exhibition. Many technology educators meet and exchanged information upon a huge range of topics at these events. Both of these events take place annually. Because many schools are now feeling constrained by LMS it would appear that fewer technology educators are attending these events. In 1990

in Oxfordshire it seems that no one attended the Forum and only 12 technology educators attended the Exhibition.

Connections with other Professional Colleagues Mainland Europe are usually made though either, educational exchanges and visits by to EEC LEA schools in mainland Europe, or attendance at the main PATT (Pupils Attitudes to Technology and Technologists) conference in the Netherlands, or the embryonic conferences of the EGTB European Society for Technology Education. Technology educators then have an opportunity to obtain information either directly from newsletters, or from personal postal or telephone connections. My information as a professional leads me to believe that in the past visits and exchanges of technology educators to mainland Europe were always thin on the ground. In 1988 Oxfordshire school technology educators made a visit to Denmark to see technology in schools. This party was led by the redundant technology adviser. Enquires to PATT and the EGTB indicate that no Oxfordshire school technology educator has ever attended the PATT or EGTB European mainland meetings.

TECHNOLOGY EDUCATION AND IT (COMPUTING)

As a direct result of political initiatives and policy statements during the period 1978 to 1982 school IT(computing) was established. All schools technology educators are likely to have access to some microcomputers as a direct result of government initiatives and funding. The prime objective of IT for technology educators is to develop expertise and capability with computers and microtechnology in order that they can deliver a technological school curriculum appropriate to student needs.

It is also suggested that microcomputer software and hardware are needed by technology educators to enable them to cover the demands of specific technical areas related to recent technology curricula. The technical areas in question cover control technology sensing and data gathering, communication systems, desk top publishing, expert systems, economic awareness, computer aided graphics, computer aided design, computer aided manufacture, computer aided learning, language development, modelling, databases, spreadsheets, problem-solving simulations, word processing, programming, and industrial and commercial contexts.

From this technical need it is inferred that technology educators will need state-of-the-art peripheral hardware software and microcomputers; and will need to be aware of issues such as data-protection, management, administration, INSET, access and ownership, support services, external co-operation, industrial contributions and finance.

It is therefore concluded that technology educators will need to come to grips with IT(computing) not just as a passing interest but as a personal entitlement if they are to deliver a technological school curricula.

A History of IT (Computing) for the School Curriculum.

This sub-section gives a general introduction to the UK history of IT (Computing) for schools from 1978 to the end of 1981. It does this by presenting the main policy milestones and initiatives which form the foundations upon which the school IT curriculum rests .

On the 1st January, 1978, the Cabinet Office commissioned the Advisory Council for Applied Research and Development (ACARD) on to set up a Working Party¹⁰⁴ to project the effects of the development in semi-conductor technology in the UK. over the next seven years. The resultant report from this body recommended that schools explore

urgently the need to take into account the effects of semiconductor technology on school curricula, including CSE and GCE O and A level syllabuses.

In 1978 the BBC television Horizon programme 'Now The Chips Are Down',¹⁰⁵ is reputed to have alerted Britain to the advances in Information Technology. It is said that the screening of this program led to the Government's adoption of measures to support the UK electronics industry.

In 1979, Sir Keith Joseph, who was later to become the Secretary of State for Education, requested a Conservative Party working group to produce a political policy statement for Information Technology¹⁰⁶. A section of the statement (pages 48-9) covered the Policy for Education.

Another ACARD report¹⁰⁷ in January 1980, recommended that changes in education and training would be necessary for the wider introduction of Computer-Aided Design (CAD) techniques; that computing principles should be introduced in schools at the earliest possible opportunity; and suggested that CAD could provide a ready entry for girls into engineering, a initiative which should be encouraged.

In March 1979 a DES Consultative Paper¹⁰⁸ outlined a development programme to help schools and colleges to become aware of microelectronics, and to make the best use of opportunities it offers. Comments on this consultative document were invited by April 1979 on proposals for the five year proposed programme which was to cost an estimated £12 million.

In February 1980 the Treasury¹⁰⁹, declared its willingness and intention to take advantage of new technology when it indicated:

"The British Government, like that of other major industrial countries, is acting to ensure that our industry is ready to take advantage of the new technology."

The most far reaching and important ACARD report¹¹⁰ appeared in 1980 and was entitled 'Information Technology'. This report took into account the knowledge that some the United Kingdom's major competitors had well-developed plans for promoting information technology (computing) by concerted action from their governments and industrial interests. Consequently the principal recommendation was that one minister and government department should be responsible for the co-ordination of government policies and actions on the promotion and development of information technology and its applications. This decision had very definite implications for the development of IT in schools.

In March 1980 came the announcement of the Government's £9 million four-year microelectronics development programme¹¹¹ for schools and colleges (for England, Wales and N. Ireland). This consisted of a number of co-ordinated projects through national, local and international bodies, managed by a full-time director and financed by grants from the education departments, with CET providing central administrative and accounting services. Priority was given to curricular development, to the development of material for teacher training courses and to arrangements to make more and better software available to schools and colleges.

A one-year study¹¹² on the impact of new microprocessor-based office technologies on staff, particularly women, sponsored by the Equal Opportunities Commission which reported in 1980, pointed out the need of curriculum planning in schools to train pupils in information skills.

On 6th May, 1981 Mr Kenneth Baker, MP, Minister of State for Industry and for Information Technology, launched the Microtrain, a specially equipped train which was

part of the DOI's Microprocessor Applications Project (MAP)¹¹³ to encourage UK manufacturers to apply microelectronics. The train spent a week in each of 25 centres to bring microelectronics and information technology to the general public. The exhibition train was open for visits by Schools during the afternoons.

On the 2nd November, 1981, 'Information Technology Year, 1982', was launched by the Secretary for Industry and Information Technology. The text of Bakers speech¹¹⁴ launching 1982 as Information Technology Year included references to various government initiatives which included the Micros in Schools programme, and the establishment of IT centres providing training in basic electronic and programming skills for young people without qualifications. The DOI in portfolio of papers¹¹⁵ outlined the government's involvement in the promotion and development and use of information technology in the UK. This included the extension of the Micros in Schools Scheme currently being run by Fothergill for the DOI.

A DES press release in April 1981 reported a speech by Education Minister, Baroness Young¹¹⁶ at a London conference on Schools Examinations in Computer Studies. The theme of this press release was that young people must be taught to recognise the speed of change in new technology and be ready to retrain at intervals throughout their working lives. Baroness Young stated:

"It is vital that pupils should become familiar with the use and applications of computers, particularly through direct experience in the course of their studies. The use of computers and other microelectronics based devices in schools is of growing importance, not only in computer studies but also in mathematics, science and other areas of the curriculum."

Baroness Young also pointed out that one of the main tasks of schools was to teach children to be receptive to new ideas to enable them to take full advantage of new technology, and that school entries for computer studies related school examinations had risen from 11 000 in 1975 to over 37 000 in 1980.

The Director of the MEP Programme, (Microelectronics Education Program), Richard Fothergill¹¹⁷, in the foreword to the MEP strategy paper, recalls that the programme was announced by government in March 1980, that he took up appointment in the November, and that this statement was dated April, 1981. The strategy paper itself states the aim of MEP as being to help schools to prepare children for life in a society in which devices and systems based on microelectronics are commonplace and pervasive.

Richard Fothergill in an interview with Robin Bradbury, in Educational Computing¹¹⁸ outlined the three-year strategy for the MEP. He said the main issues to be addressed were co-operation, liaison, on-going initiatives, and help for teachers in the form of regional information centres and in-service courses; he also mentioned the problems of hardware/software compatibility which would need to be addressed.

The Micros In School Scheme brochure¹¹⁹, was published in 1981. This had a foreword by the Prime Minister, the Rt Hon. Margaret Thatcher, MP, explaining the scheme. It outlined the background and gave details of the scheme, which made funding available to local education authorities to help secondary schools without a microcomputer to purchase one to allow their pupils to have 'hands-on' experience. The proposal, in operation from June 1981, aimed to ensure that all secondary schools would have a microcomputer by the end of 1982. Schools had the choice of either the Research Machines RML 380Z or the BBC Microcomputer from Acorn Computers.

There were new developments in the Microelectronics Programme for schools in 1981: new curriculum materials had been commissioned; INSET materials were being prepared;

and two tiers of the regional information centres would begin work later in the year. In a press notice replying to a question in the House of Commons, the Under Secretary of State, Department of Education and Science, Mr. Neil Macfarlane¹²⁰ stated:

"A strategy for the Programme was published on 6 April. Since then new curriculum materials have been commissioned and the staff of the Programme are preparing in-service training materials to support the Department of Industry's Micros in Schools Scheme. Two-thirds of the proposed regional information centres will begin work in the autumn."

A September 1981 report 'MEP: study of the use of microcomputers in secondary schools'¹²¹ on the one-year project based at the Advisory Unit for Computer-based Education, Hatfield, under the direction of Dr. W. Tagg, Director of the Unit, outlined the broad aim for a national survey indicating the way in which LEAs intended to develop the use of microcomputers in secondary schools.

In November 1981 DOI press notice reported the announcement by Mr Kenneth Baker, MP¹²², of the extension of the Micros in School scheme at the launching of Information Technology Year 1982. This press notice also indicated that of the 2500 - 3000 secondary schools previously without microcomputers, 1900 had applied and been awarded 50% of the cost of purchasing one; and the DOI estimated that by the end of 1982 the target of a microcomputer in every secondary school would have been reached. The notice announced that the scheme was to be extended so that from 1 January, 1982, secondary schools that already had equipment would also be eligible for the grant.

It is clear from these initiatives and policy statements that by the beginning of 1982 the foundation upon which school IT(computing) rests was established and would be expanded to ensure that all maintained sector schools had microcomputers.

IT (Computing) in the School Technology Curriculum

The development of IT (Computing) for technology education is described in this subsection under the following headings: IT for Individual Technology Subjects; Database/Computer Aided Learning For CDT (Technology); IT CDT (Technology) Teacher Training and INSET

IT for Individual Technology Subjects

MUSE ¹²³ Report No 7 in 1985 outlined IT (computing) for the individual subject areas of business education, home economics, and CDT. For business education this was to cover the electronic office and the tools associated with it, namely word processing spreadsheet and business graphics, communication via teletext and electronic mail, and accounting software. For home economics this was to cover; communications media, microprocessor controlled devices, data processing analysis and display. CDT was to cover control and robotics, systems building, computer aided design and manufacture.

In 1988 Kelsey and Lambert¹²⁴ gave an indication of how they saw IT related to technology (business) education when they pointed out that it played a prominent part in the development of business education and that attention should be given to process skills in this context. They stated :

"Information Technology plays a very prominent part in the development of business learning and should be fully integrated into the learning implementation process. Equally, prominence should be given to how children learn as well as what they learn. To this end attention should be given to process skills to complement their cognitive learning. A wide

range of learning styles should be employed to motivate and to reflect the wide range of attitudes and abilities."

Database/Computer Aided Learning For CDT (Technology)

The Association of Advisers in CDT¹²⁵ pointed out in 1985 the database needs in this area when they indicated that there was a need for further software for CDT and that software should be user-friendly and that expert systems combining computer aided learning and databases should become available. They stated:

"2. There is a need to develop further software to assist in the teaching of CDT. New areas for software can now be considered because the new 16 bit large memory machines are now available. Identifying the right areas for software development is vital since good quality software is expensive and funds will be limited."

"5. Software must be user-friendly so that those with little computer knowledge can quickly become confident in its use."

"6. Expert systems could be expected in the future. These will combine the best attributes of CAL and databases."

They further suggested that a national CDT database should become available and should include information on learning resources, books and periodicals, materials, sources of components electronic and pneumatic, useful electronic and pneumatic circuits, ideas for projects, examples of curriculum materials, available INSET courses, and available examination syllabuses. They also indicated that some of the database categories should be self-financing. They gave the following details:

"Databases for CDT:

A national CDT database should be established. This database should be accessed by means of a 'modem', via a telephone line. The database itself could be part of the Prestel System. Sections of the database should include information about:

- 1 Learning resources such as Films, videos, slides and software*
- 2 Books and periodicals with comments on the contents*
- 3 The properties and uses of materials*
- 4 Sources of information about components*
- 5 Details of useful electronic circuits*
- 6 Pneumatic components and circuits*
- 7 Ideas for CDT projects*
- 8 Examples of curriculum materials*
- 9 In-service training courses available*
- 10 Examinations syllabuses*

Some of these categories should be self financing as certain organisations will be prepared to have their information brought to the attention of teachers. Sponsorship of this kind should be available from publishers, suppliers of components and materials, inset providers and examination boards."

IT CDT (Technology) Teacher Training and INSET

This sub-section indicates the concerns of technology education advisers with regard to the professional development of teachers; the appropriateness of computer software for technology; the skillbase coming from science as well as CDT; the various models of INSET.

The CDT Advisers ¹²⁶ expressed their view that there was a need for professional development across a wide capability level, and that teachers should know the 'why'

element before the 'how' element. The courses that were to be offered should be short and sharp for all CDT teachers, but a small number should continue on to high level capability 'application' courses. Courses should be certified and could be presented in a variety of forms including distance learning, or day and block release and that funding for these courses might be provided by ESG or similar programmes.

The advisers gave their criteria for software: "The use of software, including those programmes described as commercial or industrial, must be complimentary to the learning process. The inter-action of the user (whether pupil or teacher) and the programme should be in harmony with contemporary educational practice. Criteria should be established to enable teachers, writers and publishers to specify and produce teaching materials, including software, that compliment given educational aims. The material should be tested and evaluated by teachers and learners."

They further made the point that there could well be a core of IT skills such as investigation, analysis, electricity, electronics and programming techniques that could come from science and computer studies as well as CDT, and that these possibilities needed investigation with a view to the co-ordination of approaches within schools. In addition they indicated that there was a need for both secondary and primary teachers to be offered IT skills which spread across simple electronic control and other applications.

They were explicit in stating that the IT experience must be of a 'hands on' nature. They also recognised that many teachers would be unable or reluctant to leave home for a period of training of say six weeks.

They made various recommendations concerning the modes of training which might be adopted. These included training taking place in school time, being serviced by LEAs via a national programme; teachers being paid to attend courses on a Saturday or evening basis; LEA IT specialists giving on the job training to teachers.

They also recommended the development of distance learning material and offered suggestions for its use for INSET:

"Distance learning:

Distance learning material should be developed and made readily available. This material could be used to assist in-service training in the following ways:

- 1. Courses which may be conducted entirely at a distance, e.g. computer programming skills without the additional requirements of interfacing for control applications.*
- 2. Courses in which some work is distance based, the skills and application element being provided by a national team as training on a local LEA basis.*
- 3. Courses covering 16+ topics. Training provided by a national team of expertise who would also offer training to LEA based future local trainers. The manpower for a national programme would be provided partly by the local trainers working alongside members of a national team."*

They addressed the issue of the development of suitable learning material for use by teachers:

"Learning material:

Suitable written material is required for:

- 1. Direct use by teachers for personal development.*
- 2. Support material offering information on classroom skill techniques and open problem solving opportunities.*

3. Learning material that provides resources for project work. It may be necessary to provide practise experience in problem solving. Individual groups within a class being guided through alternative solutions to a problem. Each proposed solution being evaluated by the class group.

4. Material written for children's use under teacher guidance or independent use in situations where able children may have more specialised knowledge than their teacher."

The conclusions arising from this sub-section are that the Technology Advisers considered that the professional development and training for CDT (Technology) teachers in the use of IT in schools would be essential; and that great care should be taken when developing or selecting software for technology in schools; various models of INSET existed and should be investigated; that distance learning should be considered; that suitable learning material for IT should be developed.

An IT Entitlement for Technology Educators

This sub-section, which takes the form of a statement on IT (computing) for technology educators, was written to give an indication of technology educator IT(computing) expertise, hardware, and software requirements. Elements of it were based upon a paper first presented at the ACET¹²⁷ conference in Australia during early 1990. The statement appears to be particularly pertinent to this study as it :

1. makes comments on the IT awareness and capability of technology teachers;
2. mentions databases and spreadsheets(a form of database);
3. makes suggestions as to what microcomputer software and hardware is needed by technology educators;
4. discusses other IT associated issues which are of concern to the technology educator;
5. was intended to be adopted or considered by senior LEA technology educators when establishing a policy for the field.

The IT Entitlement Statement

This statement was specifically designed to stimulate an interest in IT awareness and capability. It indicates that all technology educators should be IT literate, and 'technate', by which is meant 'technically capable'. It indicates the prime objective of IT with regard to technology education. This statement further lists in some detail an IT technology curriculum entitlement, covering control technology sensing and data gathering, communication systems, desk top publishing, expert systems, economic awareness, computer aided graphics, computer aided design, computer aided manufacture, computer aided learning, language development, modelling, databases, spreadsheets, problem-solving simulations, word processing, programming, and industrial and commercial contexts. It makes statements with regard to computer hardware, software and microcomputers for use in schools and covers other issues such as data-protection, management, administration, INSET, access and ownership, support services, external co-operation, industrial contributions, and finance.

IT Objectives for Technology Educators

It is now apparent that the prime objective for technology educators is to develop expertise and capability with IT (Computers) and associated microtechnology in order that they can deliver a technological school curriculum appropriate to student needs.

Curriculum Content

The elements listed below are considered essential to school technology education.

Control Technology, Sensing and Data Gathering: covers the data gathering and control applications of microcomputers and microprocessor systems technology in schools. The size of control systems ranges from the domestic washing machine to the national electricity grid and their complexity from the push-button telephone to the communications satellite. All technology educators need an understanding of the principles by which such systems operate if they are to competently develop this area of the school curriculum. Both school staff and teacher educators require a theoretical and practical appreciation of the applications of analogue and digital systems, sensing and control systems (and the effect of feedback loops), parallel and serial systems, the concept of multiplexing and the various types of computer interface.

Communication Systems: are becoming increasingly important to education, both inside and outside schools. Many schools and colleges have computer networks with 'mailboxes' for staff, a form of electronic communication, and have access to databases (information stores organised on a logical basis) via the telephone system. Typical of these are, at a local level, the OXSIS (Oxfordshire Schools Information Service) an educational mailbox service based upon the county council mainframe computer and, at a national level, databases such as NERIS (the National Educational Resource and Information Service) and Campus 2000 (The Times Network for Schools). Internationally, it will soon be possible to access databases such as NEXUS in South Australia. All clientele need to be aware of, and have experienced the use of, a major educational resource which at present is much under used.

Desk top publishing (DTP): offers the ability to plan and lay out pages of text and graphics using a microcomputer. DTP gives the opportunity to produce highly professional levels of presentation in a wide range of areas, from policy documents down to newsletters, magazines, and worksheets for pupils. The professional quality of work possible means that project folders, invitation cards, and pamphlets, etc. can be produced, perhaps for sale within the 'Young Enterprise Scheme' context. Design Technology clearly should be a major user of DTP with its emphasis upon quality of design, written presentation and innovative use of graphics.

Expert Systems: an expert system is a specialised, interactive, database which provides a succession of simple questions for its user, each one based on previous responses. From these the system can identify items from the database that will assist the user in his task. Expert systems are now being widely used in such fields as policy development, pollution surveys, aero-engine design, catering, medical diagnosis, and air-traffic control. The expert system has great potential for use within education because it provides a superb tool for the development and organisation of ideas, one of the baseline activities of any teacher. However, educators will require training in its use if they are to maximise its benefits.

Economic Awareness : is a much neglected area in the terms of the use of computers in technology education. Excellent software concerned with banking, costing projects and running a business exist which would benefit both the schools curriculum and management. A good understanding and practical experience of financial planning and management is crucial to understanding the worlds of industry, commerce and research.

Computer Aided Graphics (CAG): can provide an opportunity to create images and simulate the appearance of products during their development. Analysis and evaluation of visual images showing line colour, pattern, texture, shape and form is possible without

the tedious repetition of conventional production processes. All technology educators require acquaintance with CAG, however those in contact with pupils and students need to be particularly conversant and practised in this area.

Computer Aided Design (CAD): is extremely important in the world of industry. Computers provide users with an unparalleled tool for the rapid design of a wide range of items. CAD is essentially a technique for producing high quality drawings, or designs, of a product that is to be manufactured. Industry uses CAD in a wide range of applications such as the design of motor vehicles, printed circuits, textiles, and architecture. Drawing 2 and 3 dimensional images, using a computer, will become common in education and hence all technology educators will need to be aware of the expertise required in the technique. Teachers, advisers, and teacher educators should have practical experience of the use of CAD within the school environment.

Computer Aided Manufacture (CAM): is a means of a computer controlling the processing, and manufacture on an automated production line without the use of human manpower. CAM is usually allied with CAD, and is widely applied industrially, from small units manufacturing electronic components, to motor vehicle production lines. All technology educators should be aware of its implications; advisers, teachers and teacher educators should be capable of small scale modelling and implementation within the classroom.

Computer Aided Learning (CAL): allows an individual by using a computer to study of a particular topic with progress checking within a wide range of contexts. It is a technique that is widely used in both education and industry to train individuals in new fields and techniques. Self study units cover such topics management skills, learning a foreign or technical language, ergonomics, and computer programming. CAL can be useful to all technology educators when they need to update themselves in a particular area or field.

Language Development: computers provide an excellent vehicle for the development of language skills especially in technology domain. Technological language is full of acronyms, slang, and new words. These can easily be demystified and placed within a plain technical and scientific language context.

Modelling : the computer provides a modelling environment which users can easily investigate and manipulate. The process can be used at three levels:

1. users using a tried and tested known model to develop their understanding of a topic or situation,
2. users investigating and testing a model to see how well it might perform in reality, and to see the effect of changing parameters of the model,
3. users developing and testing their own models.

Databases: provide a means of data storage and retrieval. The data can be in a variety of forms which may include text, graphics, digital, audio, computer languages. Their uses are numerous within education. An example of a simple database might just be one which contains a list of pupil names and addresses, which the teacher needs in order to communicate with parents or guardians.

Spreadsheets: provide a means for manipulating tabulated numerical data and are widely used for modelling applications. Spreadsheets can be used effectively over a wide variety of subject areas. The modelling technique lends itself particularly well to policy development and design and technology projects at all levels. Technology educators will benefit from familiarity with the applications and use of spreadsheets.

Problem-Solving: is complex and several theoretical models of it exist, however, it is considered that computers can help to deliver general problem-solving skills. Several software packages have been designed to help users develop a logical approach to problem solving, emphasising the division of a problem into self contained sections, which can be solved and checked individually and then put together in a structured way to solve the complete problem. A 'Logo' type programming environment is a good example of such an application. Problem solving packages relate especially well to the technology field where the problem-solving process is central to much that is being undertaken.

Simulations: are an essential feature in the research of manufacturing processes and hence to the world of design and technology education. Frequently it is not possible to show an industrial process, for example steel production, live in the classroom and a simulation to demonstrate the process is necessary. Useful software is now available giving interactive simulations of most large scale industrial processes.

Word Processing: is a fundamental skill both in the offices of industry and education and in technological writing. Word processors allow the drafting and redrafting of typed work, the automated checking for accurate spelling, grammar, and word meaning, and its presentation in the final printed form. Word processing allows creativity in the use of language and is set to become the standard writing medium of the future. It is considered important that all technology educators should have a working knowledge of the use of a word processing package.

Programming: computers are not inherently intelligent; programming provides the computer with a set of instructions which it must follow. Computers will not function properly unless instructed in a specific way via the appropriate computer language. There are many programming languages, requiring various levels of expertise from the user. The low level languages will often require the user to have special skills in mathematics whilst the high level may not. All programming languages require the user to have a knowledge of their special syntax and structure. In schools much software is still written in the high level language BASIC and it is clear that teachers will require some understanding of a language such as BASIC in order that they can modify software for the control of particular artefacts or the gathering of data. Advisers and teachers educators should also have some understanding of the various computer programming languages available. Some educators will require a good working knowledge of both high and low level languages, particularly if they are developing software for use in schools.

Commercial and Industrial Aspects: with the increasing emphasis being placed on the vocational aspects of education in today's high technology world, it is important that technology educators should have an understanding of the way in which computers are used in commercial and industrial contexts. All of the curriculum ideas discussed in this paper have application in the wealth creating sections in this country. Visits to centres of commerce and industry may provide educators with the opportunity to note both the applications of the modern technology and the ways in which education can facilitate pupils' success in their careers.

Computer Hardware and Software: can be a controversial issue, with devotees of various items from particular manufacturers claiming that their own favourite is the best for use in education. This situation is potentially dangerous; it is more practical to suggest that it is appropriate to make use of equipment which can be obtained within budgetary limitations. The purpose of this statement is not to dwell upon present controversies but rather to make some sensible comments about what should be viewed as being important when considering microcomputers for technology education in the light of current rapid technological developments. The comments take the form of a list of points.(see Table 7)

Table 7**Computer Systems and Software**

In order that technology educators can deliver all the areas covered under 'Curriculum Content' they need;

- a. a full 32 bit processor and a maths co-processor,
- b. at least 2 Megabytes of on board memory and the capacity to add further memory up to c.8 Megabytes,
- c. a hard disk or r/w optical disk of at least 100 Megabytes,
- d. a mouse or tracker ball,
- e. at least two serial and one parallel communication ports and a SCSI port,
- f. a high level (24 bits) graphics card on board,
- g. a high definition colour monitor,
- h. a full multi-tasking capability,
- i. virtual memory capacity,
- j. a minimum of three industry standard expansion slots,
- k. access to a good range of peripherals including printers, plotters, and control and data logging interfaces,
- l. a good international and local commercial educational software base,
- m. an intuitive user interface that requires a short use learning curve,
- n. clear, easily read and understood system hardware and software manuals,
- o. good manufacturer and dealer technical support,
- p. an educational software bundle comprising at least a wordprocessor, spreadsheet, and database package,
- q. a competitive educational price with no hidden extras,
- r. system and data back-up software,
- s. a good low cost network capability.

Other Issues

Data Protection: is very important for any computer user, but especially in an educational context. Most western countries have data protection legislation which should be strictly adhered to. All clientele are advised to obtain a copy of the legislation details before building databases containing individuals personal details. Software protection is also very important, especially with several types of computer viruses travelling around. It is recommended that all master software be kept write locked and in a safe place and that no-one is permitted to introduce foreign software into a system.

The Management of any Computer System : is a vitally important issue which needs to be addressed. All those involved with technology education need good direct accessibility to the microcomputer and peripherals at all times in the immediate locality within which they work. Many institutions have dedicated network rooms or internal networks which can be very useful as a back up, however this is not a substitute for having access at all times to appropriate hardware and software. Nothing is worse than knowing the equipment is available for use in two weeks time, because all time with the items has been booked until then, when you need to give an immediate response to a problem. Ownership is also important because, unless someone is responsible for the system, repair, updating and development is unlikely to take place.

Administration: excellent software packages for such administration applications as time-tabling, school visits, attainment record keeping and report writing already exist and are in use within the system. Industry standard packages are used by most LEA

administrators. It seems sensible that all clients should have some experience of the use of the computer as an administrative tool.

In-service Education and Training: is essential for technology teachers if they are to have the expertise to deliver the curriculum content described earlier. Experience indicates that IT (Computing) knowledge and capability among many of technology educators seems to be limited and much work needs to be undertaken to ensure further development in this field.

Technical Support for Hardware and Software: is essential in order to keep up to date, to modify, or to repair equipment. This support is available from many quarters e.g. commercial dealers, LEAs, educational institutions, and educational charities. An individual within the maintained sector of education in Oxfordshire could approach a variety of institutions for help if they so wished. Typical of these institutions are: ME Electronics plc, Oxfordshire LEA Schools Computing Centre, OSSTC, Oxford University Department of Educational Studies IT Unit, Oxford Polytechnic Education Faculty Computing Centre, and Oxfordshire Technology Regional Groups. It is useful to develop a network of contacts for self help rather than rely solely on individual agencies.

Funding: often moneys and/or donations of equipment and software can be raised from a variety of sources and not just those associated with individual a technology educators institution. Technology educators should be prepared to go to both industry and charities in order to supplement software and equipment provided by their particular agency.

The rate of change of microcomputer systems for the technology area is extremely fluid at the present time and major developments in graphic display, storage, and memory are in the pipeline. Exactly what will be available in the next few years is difficult to predict as much of the world market for microcomputers is saturated. All that can be said is that DOS, UNIX, and an Apple Macintosh-like system are well established internationally and will be around for some time to come.

THE PRESENT SITUATION CONCERNING COMPUTER DATABASES FOR TECHNOLOGY EDUCATION

With technology educators' need for information now being apparent, and with the emphasis that is being placed upon IT (computing) in the context of technology education it seemed appropriate to investigate the situation concerning the availability and appropriateness of present computer database provision in this area.

It was found that educational database systems were available and could be accessed by technology educators using a microcomputer and appropriate communication software and modem (via telephone or dedicated data lines) but there were technical limitations that revolved around the medium and nature of the transmission of data that reduced the benefits of these systems to technology educators.

Many educational databases of different types exist yet all of the educational database systems investigated, without any exception, were found to use a CUI approach. Most utilised low quality graphics of the viewdata type for different user front ends. Only one database had any data in its system concerned with school technology education, and this was limited in quantity and difficult to find.

Payment was required for the use of these database services in the form of an annual subscription or fee for the particular service as well as the use of the telephone or data line and time used; this was expensive for technology educators.

Despite the fact that educational databases exist, no evidence could be found to suggest that a truly comprehensive school science linked technology education database exists in the world at the present time.

The following sub-sections give a critique of Database Systems in current use by teachers. This is presented under the headings of: The Computer Database; Local and Remote Databases; Technical Data and Cost Limitations.

The Computer Database

In simple terms a database is a collection of information. A computer database may therefore be described as a computer program which is capable of organising and presenting a collection of information. There are a number of different types of database programs which cater for the variety of different ways in which data can be stored and retrieved.

Types of Databases

The most common type of database stores data in the form of electronic record cards. Each record card holds information which can be retrieved and presented to the database user when the series of conditions entered are met. Very often these databases have a graphing facility which enables data to be presented to the user in graphical form.

Another type of database simply stores information in viewdata form. Each page of which can be viewed in sequence. Low resolution teletext graphics can be included in this type of database. A good example of this is the Ceefax or Oracle database service available on the UK BBC and ITV television service.

Yet another form of database stores information as a series of yes/no questions and answers. This type of database is particularly useful for storing scientific information under classification headings. It also has the ability to learn and make appropriate responses from the answers to various questions.

A recent form of database is fully relational. This means a certain number of conditions or rules have to be set when data is entered. These rules will determine what data is extracted when a request is made. Rather than extracting a record from just one stack of information, many stacks of information may be interrogated and data presented if the conditions designed in the search procedure are met.

The CD-ROM (Compact Disc-Read Only Memory) device has been about for quite some time. It is described earlier in this chapter under the heading Microtechnology Developments. As this device can hold large quantities of data it is the ideal medium for database information storage. The disadvantage of this device is that data can only be written to it once, hence it only allows data retrieval by the user. CD-ROM databases are now available containing the complete works of Shakespeare and the Oxford English Dictionary. A brief search for new CD-ROM databases offered to the public, in the 1990 computer journals and computer advertising literature held at OSSTC, revealed that some 132 new titles had appeared during this period of one year. Many more have no doubt been produced in 1991.

Local and Remote Databases

Over the last few years 'connectivity' has been an important feature of the world of information retrieval. This means that individual personal microcomputers are being linked in a local area network to a mainframe computer with a databases held upon it.

Through this local mainframe, access can also be made to various databases held upon remote mainframes. Information can be entered or retrieved from both the local and remote mainframe. In most cases a fee has to be paid for the use of the datalines used and the services being accessed.

On-line information services are used extensively by scientists and engineers and by the financial sectors of commerce and industry. Summaries of papers from most of the major scientific, technical and medical journals are available on-line. Managers of small businesses are likely to find these services for such things as credit checking, marketing, and market research. With several thousand databases available on line most serious personal computer users should find one to suit their personal needs.

A local database might be set up in an institution or administrative area for the use of its members; its users also being the providers of its data. Probably connected into the institutions personal computer network the local database would be held on a hard disc storage system. Personal computers act as terminals to the database system users who have the facility to add material to the database as well as having access to its contents. A dedicated data network can give very rapid and reliable access to information, however, if standard telephone lines are used the problems of speed alluded to later will be encountered. An example of this is provided by OXSIS (Oxfordshire Schools Information Service). This system theoretically links all Oxfordshire LEA schools to each other, and to LEA support and other appropriate OCC (Oxfordshire County Council) services via the County Council Mainframe Computer. It is only available to institutions in Oxfordshire.

Remote databases are typically held on a main-frame computer where data is stored either on large hard disk systems, known as Winchester, or on magnetic tape; both methods allow the storing of large amounts of information. Access is obtained either via the telephone network or dedicated data lines, using a personal computer as a remote terminal, usually utilising teleprinter text (TTY) or Viewdata protocols. Where search facilities are provided the found items may be made directly available via the terminal or they may be sent as a printout (hard-copy) through the post. The latter system is adopted, for example, by European users of United States based databases available via DIALOG.

Smaller documents may be conveniently held on a database system in their entirety while references are provided to other, larger, publications such as books, audio/visual resources, computer software and so on. Database systems are often run in parallel with an EMAIL (electronic mail) system which enables messages to be sent to other users of the system, bulletin boards, and conferencing facilities, all via the central computer. An example of such a system was the USA MIX¹²⁸ (McGraw-Hill Information Exchange). Mix was a subscription database system for educators, experts, authors and professionals offering EMAIL, conferencing, seminars, up to date research material, lesson plans, teaching tips and employment opportunities for an annual fee around \$60. During 1988 the MIX venture ceased to function because the database was sold by Macgraw-Hill and the new owners declined to continue the service for commercial reasons i.e. because it was unprofitable.

Educational Databases

One of the first educational databases (and electronic mail systems) in the United Kingdom was the TTNS (The Times Network Systems). This system was recently reconstituted as Campus 2000¹²⁹. It has a large number of general and specialist educational databases included within its system. It uses a TTY system for text, but can switch to Viewdata modes for low definition graphics. Databases are interrogated using a type of tree organisation. On accessing the database a main menu, the trunk of the tree, is

presented from which one option, a branch, is chosen. Usually this branch will be a sub-menu from which a choice must be made. Further branches may be encountered until a twig (document) is found. A tree structure of this type has the merit of speed of access, requiring little typing from the client other than the entry of a series of numbers. A major drawback is that once a document has been found it may be necessary to return all the way to the main menu before the search for the next document is commenced. It would be much quicker to hop from twig to twig!

The NERIS¹³⁰ (National Educational Resources Information Service) database in the UK uses only Viewdata format when accessed on line. The database is interrogated using either of two logical search systems: a standard search; and an extended search. Using the standard system two interest areas are entered, linked by either AND or OR as a logical operator. A list of the interest areas is available extending from A LEVEL to ZZING together with some numerical items. As only 12 interest areas are given in each frame scanning the whole list for the apposite word can be tedious. Media (e.g. printed AND/OR audio) and age phase (e.g. junior AND/OR secondary) are then selected. A report frame is then generated giving the number of documents found matching the search criteria. All the items found to match may then be listed for choice by the client. As only three or four item can be presented on each Viewdata frame, merely viewing the list of potential items can be a lengthy exercise. Once an item has been selected, a frame or frames will be presented giving details of the item, or, in some cases, the item itself which can be down-loaded to a printer or disk. Originally available free of charge, supported by the UK Government Department of Trade and Industry, from 1st April 1990 the charges per annum are £60 for primary schools and £140 for secondary schools and colleges. Taylor, the Director of NERIS, indicated in 1991, in a telephone conversation, that some 3000 schools use this service. The difficulties over speed of access to NERIS should be somewhat ameliorated by the use of the CD-ROM version. Unfortunately, this will require a large investment in hardware by prospective clients.

According to the Director of NEXUS III the more geographically widespread the clients of a database system, the more potentially advantageous it becomes. In South Australia, where neighbouring schools may be hundreds of kilometres apart, the Education Department funds the provision of the NEXUS III¹³¹ system by the Angle Park Computing Centre. Users of the database pay for connection time (and their own telecoms charges). Services provided include searchable databases, EMAIL, bulletin boards, and CHAT, a conferencing facility. The latter facilities are particularly useful for in touch with developments in neighbouring schools where personal contact is not possible on a regular basis. Since 1984 NEXUS has expanded from 1 telephone line to 64 lines with about 1500 clients. NEXUS uses a Viewdata format with transmission speeds of up to 2400 bits per second.

A new 1990 UK electronic communications service for education, not technically a database, but intended for the passing of data between schools, LEAs, The DES, Examination Boards, Colleges, Educational Suppliers Secondary and Primary Schools, is 'DIALnet'¹³². PMS, a private company, indicate that this service is primarily designed for school and LEA administration, and will allow schools to send LMS and other data to their LEA directly from their microcomputer. DIALnet is effectively a bulletin board similar to the concept embedded in NEXUS 111 described above, except is being run on a commercial profit-making basis rather than a break-even cost basis.

The assumption may appear to have been made that databases accessed by microcomputer must of necessity be entirely computer based. It should be noted that this is not so. For example the ERIC¹³³ (Educational Resources Information Centre), run by the United States Department of Education, is based on a microfiche system. Retrieval from the system is based either on on-line database retrieval services offered by commercial companies or batch-oriented searches offered by more local concerns. Once a document

has been located by computer search it can be obtained, in its original form on paper, either from its originator or from a master microfiche copy held by ERIC. More usually educational databases are held entirely on a computer system.

Technical, Data and Cost Limitations

The benefits of databases to educators are limited by the nature of the transmission medium. The advantages of dedicated data networks have already been mentioned, however, they are not usually available for use by school and college educators, who must rely on national telephone networks. Computer communications via the telephone system employ two formats for the data, which result in different displays at the terminal.

The Viewdata format for transmission over a telephone type system is similar to that used by television broadcast systems employing a frame display limited to 20 rows of 40 columns of characters. Graphics are limited to prescribed block symbols in simple colours.

The alternative TTY (Teletype) format is usually displayed with 80 columns of text characters showing as many rows as the terminal screen will hold. The display is monochrome and no graphics characters are included. At the present time, for practical purposes, the telephone system in Europe is limited to a data transfer rate of 2400 bits per second. Most educational establishments, especially in the UK, are equipped with modems which allow the use of transmission rates of up to 1200 bits per second, which in effect gives a speed of about 100 characters per second. Hence in practice a standard Viewdata frame requires a minimum of about 10 seconds to update, the time depending on the complexity of use of colour graphics within the frame.

A further complication arises from the nature of the telephone system when used for data transfer. The standard voice telephone system can be used, but interference on the network can lead to loss of data and long distance connections become expensive. To reduce costs various data handling systems have been installed which incorporate error correction techniques and allow connections to be charged at local call rates, irrespective of the final destination. To maintain the efficiency of these systems batches of data (called packets) from different users, are sent serially along the same network. A delay may be encountered at busy periods as the required packet of data queues to be transmitted. Because several packets are required to transmit a whole Viewdata frame the time required to present a whole frame is typically extended to at least 15 seconds. When the extra time required by the network switching system, the access time of the host computer, is included such database systems can seem very slow in operation.

All of the above systems, with the exception of MIX, were accessed during the period of this survey. (Mix was accessed in 1985 at a demonstration of it at the ITA (International Technology Association) conference in Norfolk, Virginia.) This was with a view to obtaining information pertinent to technology education. It appeared that the only one which permanently held information which might be used by a UK technology educator was NERIS. It was found that information was difficult to obtain as a direct result of a lack of a GUI, and many of the above described system limitations. Cost in terms of the time needed to access this database to a technology educator unfamiliar with the system could have been prohibitive in terms of their school departmental budgets which do not include moneys for such services. An Oxfordshire technology teacher, who had considerable experience with microcomputers, took at least 20 minutes to get into the system and 1 hour to extract a small quantity of information upon IT and technology education. The dataline costs alone, without the annual subscription cost of the service, were c £15 as this was an out of local area connection; the cost to the school of having a

teacher use 1 hour and 20 minutes of their time out of their normal time table was c.£20. The total cost of this one session was c.£35.

CONCLUSIONS TO CHAPTER 1

From the main discussion points it can be argued that:

There is a need to support technology education for economic, competitive and technological skill reasons. Even though science linked technology has been defined in terms of its main dimensions developments in the field are confused. The need to educate technology educators in non traditional ways is now apparent. Recent developments in the field of microcomputers, hardware, software and peripherals are now available for use by technology educators. The information sources and services presently consulted by technology educators are inadequate to meet their needs. Technology educators have a professional IT (Computing) entitlement in professional development terms. Present education databases are inadequate, difficult to use, and inappropriate for the support of technology education.

Further Investigations and Developments

Investigations

The above summary of the findings and conclusions of the analysis of the development of technology education indicated several areas that merit further investigation to illuminate further the development of IT-supported technology education over the last decade. The four areas, within the limitations of this study, are concerned with:

1. future technology, and associated science and IT (computing) education, trends;
 2. technology teacher INSET and professional development;
 3. technology teacher IT (Computer) capability and literacy;
 4. information usage by technology teachers.
5. Accordingly, it would now seem appropriate to investigate further the design of a dedicated computerised database for technology education.

Developments

It was apparent to me that the best way to undertake the illumination required for 1. was to survey expert technology educators, and for 2. 3. & 4. to investigate actual technology education practice in the field. Fortunately the opportunity to undertake the necessary investigations had been presented because, as a director of a school science and technology centre, I had a brief to investigate, support and develop these areas and was undertaking pertinent work. This was particularly appropriate because I was:

a. involved with the development of European technology education, with the EGBT, and was about to investigate future technology subject detail trends in this area; b. supporting technology teacher development via a large Oxfordshire LEA technology INSET programme; c. asked by the Oxfordshire LEA Technology Adviser to investigate technology teacher IT (Computing) capability and literacy; d. providing a science-linked technology education information service to Oxfordshire technology teachers.

The survey of three of these areas b.c.& d. are covered in Chapter 3.

I was also able to consider investigating the design of a dedicated technology education database as per 5. because funding was likely to become available and a brief from EGBT

and Oxfordshire colleagues to pilot and develop a new European science-linked technology education database system was likely to be forthcoming.

The research methods for the survey of practice and the development methods are covered next in Chapter 2.

CHAPTER 2

RESEARCH METHODS

This Chapter covers the research methods utilised for this study. It does this under the following headings: Survey Instrument Development; The Techniques Utilised for this Study; The Application and Relevance of the Techniques; The Collection of Data.

SURVEY INSTRUMENT DEVELOPMENT

Four instruments were developed for this research programme:

1. The Oxford SCITECH Futures Questionnaire;
2. The Oxford Inset Survey Pre-course Knowledge, Teaching Experience Questionnaire & The INSET Participant Response Schedule;
3. The Oxford Technology Educators Information Access/Usage Questionnaire;
4. The Oxford Technology IT (Computing) Questionnaire.

1. The Oxford SCITECH Futures Questionnaire (see Appendix B); was based upon the University of Queensland, Department of Education, 1987, BASTECH Futures probe; was designed, in mid 1989, at OSSTC (Oxford Schools' Science and Technology Centre) at the University of Oxford. This instrument was designed to be submitted to a panel of European technology education experts to elicit basic information upon educational trends in School Science, Technology, and Information Technology over the next decade.

2. The Oxford INSET Survey Pre-course Knowledge and Teaching Experience Questionnaire (see Appendix B). This instrument was developed, in late 1989, specifically to investigate technology teacher INSET and professional development. It was used to collect data from TRIST technology course participants and was related specifically to the ten course topics. The Oxford INSET Survey Participant Response Schedule (see Appendix B) was designed as a free response item unit to be completed by TRIST INSET course participants and handed in at the end of the course. These were developed by the course director as part of his contractual evaluation brief for the INSET programme and was approved by the sponsoring committee, the Oxfordshire LEA Technology Advisers Group.

2. The Oxford Technology IT (Computing) Questionnaire (see Appendix B) was originally developed by a Cranfield masters student M. Fisher. Fisher was investigating Science Education IT in Oxfordshire and it seemed logical to utilise the instrument that she had initially developed and piloted, with modification of subject headings. It was used to investigate technology teacher IT (Computer) capability and literacy. This was undertaken, in mid 1990, in order to: 1. allow a degree of comparability of findings for later use by those planning INSET and introducing the National Curriculum IT element across both the school science & technology areas; 2, to reduce duplication of work to a minimum; 3. to gain political acceptance by technology subject advisers of the viability of such a probe, in as much that it was already accepted by the Science adviser and Oxfordshire Head teachers.

3. The Oxford Technology Educators Information Access/Usage Questionnaire (see Appendix B) was developed specifically, in late 1991, to investigate information usage by technology teachers. It was used to collect data from a small group of Oxfordshire technology educators at a research seminar at OSSTC. It was designed to elicit data upon the sources, frequency, and type of information, required by technology teachers undertaking a new electronics curriculum programme, or helping students with their personal electronics projects in the context of their National Curriculum work.

THE TECHNIQUES UTILISED FOR THIS STUDY

The techniques considered appropriate and applied to this survey were the review, content analysis, postal survey, the delphi, self administered questionnaire, group administered questionnaire, group feedback and personal informal interview.

The Review

The review approach was used because it allowed a wide range of national and international technology education material to be covered. It would seem to be particularly appropriate as the technique attempts to clarify the use of an 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 technology education. It has been previously used in Europe and the USA for many technology education surveys including the following:

An 'International Study of Curricular Organisers for the Study of Technology' undertaken by Barnes¹³⁴ in 1987, as part of his Doctoral Dissertation work, at Virginia Polytechnic and State University, Blacksburg, Virginia, USA.

Soper¹³⁵ in his 1986 investigation of technology and the links between science and CDT departments in Oxfordshire, as part of his Special Diploma Dissertation work, at the University of Oxford Department of Educational Studies, Oxford, UK.

Content Analysis

The content analysis method was chosen for this study as it has been used widely in education to view and analyse many hard documentary sources in the past. It was used to gain a view of many details of technology education relevant to this study. Technology education is one area which has a considerable quantity of official and unofficial documentation which required detailed investigation.

Hodson¹³⁶ used the approach in 1987 in his in depth investigation of the study of electronics education in Oxfordshire schools, as part of his Special Diploma Dissertation work, at the University of Oxford Department of Educational Studies, Oxford, UK.

Ditchfield and Stewart¹³⁷ in their 1987 investigations into technology and science utilised content analysis in a limited way as a basis for their discussion paper concerning issues and ideas for the field.

The Delphi

The Delphi, or futuring technique, was chosen for this study because it would enable detailed subject data upon future trends in European technology education over the next decade to be obtained. This was because such information would be useful for those educational policy makers planning future technology education development.

It is concerned with eliciting detailed information from a panel of experts, usually between 15 and 20, upon future trends and events over a decade of time. It comprises an instrument which is submitted to a panel up to three times after each has been analysed and modified to take the findings into consideration. The end result being a consensus of opinion from the panel of experts upon a particular subject area.

This technique was used in 1987 by the SEFIT group, under BASTEC heading, at the University of Queensland, Department of educational studies to elicit basic yet detailed

information upon educational trends in School Science, Mathematics, English, Technology, and Information Technology in Australia.

Postal Survey

The Postal survey was utilised for obtaining IT (computing) data from technology teachers in Oxfordshire schools for the following reasons; namely that, the benefits of usage outweighed the disadvantages within the constraints of the staffing, time scale and finance available for data gathering.

indeed Oppenheim¹³⁸ noted these very points when he indicated the advantages and disadvantages of this technique. He indicated that the advantages were that: it was a low cost way of obtaining data; it did not require the use of trained field workers; secretarial support was available for the administration of the survey; it released the researcher for other essential tasks associated with the development project; the processing and analysis was simpler and less time consuming than in the case of interviews; it allowed a large number of respondents to be surveyed; it increased the accuracy of the sampling; eliminated bias induced by interviewers; resulted in a simpler survey instrument. The disadvantages he noted were: that bias could be introduced because the questionnaire could be passed to another person other than that indicated; or by perusal of the questions before responding; or by the lack of a personal introduction to the research.

It has previously been used by Fisher¹³⁹ in 1983 in his study of embryonic technology education in the UK and USA, as part of his Masters Thesis work, at Cranfield Institute of Technology, Cranfield, Bedfordshire, UK. This was specifically to investigate employers' views on the technological capability of former School pupils working in Milton Keynes industry.

Self-Administered Questionnaires

Self administered questionnaires were utilised to gain data about technology teacher expertise. This approach ensured a high response rate, accurate sampling and kept bias to a minimum. By using a qualified teacher to administer the questionnaire it also ensured time and cost effectiveness which is so essential when dealing with timetabled school staff.

Oppenheim¹⁴⁰ also indicated that: "The self-administered questionnaire is usually presented to the respondents by an interviewer or by someone in an official position, such as a teacher, or a hospital receptionist. The purpose of the inquiry is explained, and then the respondent is left alone to complete the questionnaire, which may be sent or collected later. This method of data-collection ensures a high response rate, accurate sampling, and a minimum of interviewer bias, while permitting interviewer assessments, providing necessary explanations (but not the interpretation of questions), and giving the benefit of a degree of personal contact. Research workers may in this way utilise the help of someone in an official capacity who is not a skilled interviewer. However, the greatest care is needed in briefing such persons or they may, with the best intentions, introduce fatal biases."

Moore¹⁴¹ used the technique in 1986 to investigate classroom activities in the teaching of computer studies of some 235 teachers in the Hull region of the UK

Group Administered Questionnaires

Group administered questionnaires were used with technology teachers to obtain information upon technology teacher expertise and information access/usage because small groups of participants had to be got together at specific times (as a result of school timetabling constraints); full responses to all questions were to be made in the right order; and contamination of responses through talking and discussion could be kept to a minimum by the presence of a trained researcher.

With regard to this technique Oppenheim ¹⁴² further indicated that: "The group-administered questionnaire is also largely self-explanatory and is given to groups of respondents assembled together, such as school children or invited audiences. Depending on the size of the group and its level of literacy, two or more persons will see to the administration of the questionnaires, give help where needed (in a non-directive way), check finished questionnaires for completeness, and so on. Sometimes, variations in procedure may be introduced. For instance, the audience may be provided with empty booklets; some slides or a film may be shown, and then a group of numbered questions might be read aloud, one at a time, while the respondents write their answers in the booklets next to the question numbers. This ensures that all respondents answer the questions in the same order and that they all have the same amount of time to do so. Groups of forty can readily be controlled in this way, but contamination (through copying, talking, or asking questions) is a constant danger."

This technique is in wide general usage by technology education advisers in Oxfordshire schools.

Group Feedback

This technique was utilised in order to gain feedback data from technology INSET seminar/course participants and is used widely in the educational field.

The technique is concerned with eliciting feedback responses upon all aspects of seminar/course content, teaching approaches, resource material etc. Usually a trained expert in the field/observer sits in upon such a session taking notes upon the feedback elicited from participants by the seminar/course director. Participants are encouraged to talk freely and to cover both positive and negative aspects of seminar/course provision. This technique has the advantage of gaining immediate feedback data that has not been coloured by reflection and categorisation over a period of time. Great care must be taken by the conductor of the session to ensure that his/her personal biases do not direct outcomes in terms of responses.

This technique has been utilised by Oxfordshire LEA and OSSTC for feedback from all technology INSET courses over the last ten years.

Personal Informal Interview

This technique was used to gather evidence from technology experts throughout the world which would not have been available from a written source or obtainable with survey questionnaires as a result of problems arising from logistical, time, or financial constraints.

The technique is concerned with persuading experts at meetings, conferences, dinners etc., to spend a few minutes giving their view upon a specific subject or developments in the field in the form of an unscheduled informal interview. It is opportunistic in nature and can result in valuable leading edge data. However, great care must be taken to: select

that data that is truly genuine rather than anecdotal; and to ensure that interviewer bias does not creep in.

Fisher¹⁴³ in 1983 used this technique in his previous research into embryonic technology education in the UK and USA, as part of his Masters Thesis work at Cranfield Institute of Technology, Cranfield, UK.

THE APPLICATION AND RELEVANCE OF THE TECHNIQUES

The techniques described above were applied to broad topic areas which cover National & International Technology Education Developments, Technology INSET, Technology Curriculum Software and Hardware Projects and Technology Education Practice. The relationship between them is shown below in Table 8.

Table 8

TOPIC GROUPS AND TECHNIQUES	
Topic Areas	Techniques
1. <i>National & International Technology Developments</i> -----	Review, Content Analysis, Personal Informal Interview Delphi.
2. <i>Technology INSET</i> -----	Review, The Design Process.
3. <i>Technology Education Practice</i> -----	Postal Survey, Self Administered Questionnaire, Group Feedback.

The relevance of the techniques is best viewed in the context of the various research headings where the use of these techniques and their purposes are then clearly seen. These headings are: The Development of Technology Education Over the Last Decade (Chapter 1); Technology Education in Practice (Chapter 3).

The Development of Technology Education Over the Last Decade

The Review of a Field and Personal Informal Interview techniques to be used to elicit information to give a view of the policy supporting the science linked technology education scene in the widest available context relevant to this study, especially with regard to:

- a.) Changes in the Economy and the International Comparative Situation, which investigated industrial support, the skill shortage and the role of schools related to skill shortages.
- b.) The emerging and changing definition of Technology Education, which investigated science, science education, technology, technology education, the science technology interface in education;
- c.) The main dimensions of school science linked technology education, which investigated the links between science and technology education, details of the current UK technology education debate and technology education in a European and world context.
- d.) Policy Initiatives of the DES and the National Curriculum, which investigated the GCSE, the national curriculum and technology, the national curriculum working party on design and technology, the national curriculum council, the national curriculum draft

orders for technology, the IT curriculum from 5-16, the national curriculum orders for technology and the UK national curriculum IT (computing) demands.

e.) Trends in the Education of Technology Teachers and School Resourcing, which investigated teacher training, technology teacher INSET, sources of expertise and information and alternative support for educators.

f.) State of the Art Computer hardware and Software for Schools, which investigated human computer interfaces; the microcomputer and associated software developments and peripherals.

g.) Information Sources Available to Technology Educators, which investigated the need, type, and sources of information and services available to school technology educators and details concerning the adequacy/inadequacy of the sources and services.

h.) Technology Education and IT (Computing), which investigated history of IT (computing) in the school curriculum, IT (computing) in the school technology curriculum and an IT entitlement for technology educators.

i.) The Present Situation Concerning Computer Databases for Technology Education, which investigated the nature of a computer database; local and remote databases; technical data and cost limitations.

In addition to the above, in order to give a view of Future Educational trends in School Science, Technology, and Information Technology over the Next Decade, the Delphi technique was to be used to obtain detailed information.

Technology Education in Practice

For the surveys covered under this heading a variety of approaches/techniques to be used to obtain data on technology education practice and policy in Oxfordshire. These approaches were the Review Approach, the Postal (Mail) Survey, the Self Administered Questionnaire, the Group administered Questionnaire, Group Feedback and the Personal Informal Interview. This was with regard to:

1.) The Oxfordshire INSET and Computing Situation; which investigated an introduction and setting for the Oxfordshire surveys of policy and practice.

2.) The Oxfordshire Technology INSET survey, which investigated the knowledge and understanding of science and technology teachers in various key topic areas of technology education.

3.) The Oxfordshire IT computing survey, which investigated IT (computing) provision; technology teacher microcomputer usage, technology teacher computing expertise, technology teacher access to microcomputers and details of technology teacher INSET needs.

4.) The Oxfordshire Technology Information Access/Source survey, which investigated the sources, type of information practising technology educators seek and the services accessed when they are starting to teach a new technology topic.

THE COLLECTION OF DATA

The collection of data was achieved by utilising a variety of approaches. These approaches, with their associated problems, concern: the 1. Development of Technology Education Over the Last Decade; 2. and Technology Education In Practice

1.) Data on the Development of Technology Education Over the Last Decade in the UK, Europe and the Wider context was to be obtained from a wide range of sources.

Many books, journals, periodicals, papers, and individual experts in the field of science and technology, industry, and education were consulted.

Personal academic visits to technology education conferences and universities, colleges and schools in the UK, mainland Europe, the USA, and Australia were made and relevant information was obtained in written, graphical, and oral form. Companies and institutions concerned with microcomputing and technology education related products were also visited.

Computer searches were undertaken upon the subject of science linked technology education. Meetings of European technology educators at Oxford were attended (details of conferences attended, visits made, libraries consulted, and computer databases searched may be seen in Appendix A.).

The problems associated with the collection of data this area were both major and minor. The major one was that the unprecedented rate of change of education, particularly in the UK with its new national curriculum, resulted in an enormous amount of relevant documentation to be read, digested, sorted, and presented. A minor problem was that the Cranfield Management library proved to be virtually useless when seeking material on school science and technology education, or indeed almost anything upon secondary education generally. Surprisingly, computer searches of relevant educational databases such as NERIS (National Education Resources Information Service) It revealed little about science linked technology education or information technology related to secondary education in both the UK and mainland Europe. On the whole though few problems were met when collecting data for this chapter

Another problem that arose in this element of the study was that.

a. It was intended that a Delphi probe, originally designed for use in Australia was to be used to collect further data from European (UK and Mainland) technology educators. It became impossible to use this original probe, even after desk-top publishing and modification, for the following reasons: 1. it became apparent that for this to become valid, for comparison purposes, it could only be utilised in a national context in the UK as this was the only system that related in any way to that originally envisaged. The European systems of education were all different in the individual countries and hence comparisons were not possible; 2. the actual time required for an expert to complete it was c.4.5 hours for the 1st round. Several experts when consulted indicated that this expenditure of their time was unacceptable as they did not have so much time available to devote to such external research however worthy it was.

This decision, of non-use of the Delphi probe, led directly to the development of the three following research probes that were to be used to investigate technology education in practice in Oxfordshire.

2.) Data acquisition of Technology Education In Practice, was obtained from technology educators by the use of generalised research techniques and three research instruments developed especially for this study. They are associated with The Oxfordshire Technology and INSET Situation, The Oxfordshire IT(Computing) Survey and the Oxfordshire Technology Educators Access/Usage Survey. (The research instruments developed and used for this purpose may be seen in Appendix B). The process was relatively straight forward and substantial quantities of quality data were obtained.

However, some problems did arise:

i. It was also intended to conduct research into the behavioural aspects of information usage and the ergonomics educational computer software and software use but this proved to be difficult to undertake within the logistical, time and financial constraints of this study.

ii. For commercial, competitive confidentiality reasons data on client usage of existing world educational databases proved not to be available. A computer search revealed nothing of any use. Telephone calls to a known colleague directing one of these services resulted in the statements like "I have a confidentiality clause in my contract which forbids me to pass on any information which might be of use to a competitor so I cannot help you even though I would like to". Because it was known, as a direct result of advisory and consultancy work with technology teachers in Oxfordshire schools, that very few schools provided access any external national or international database system it was evident that a small scale survey of teacher usage of such databases would reveal little or nothing which could be of significance to this study.

iv. Enquires to professionals in the field of educational IT(Computing) concerning the ergonomics of the human computer interface of educational software, in the context of classroom use by teachers and school students, revealed an almost complete lack of knowledge of research or good practice in in this area. The enquiries were made to the directors of two university education IT(computing) units, an educational software company director, a educational software developer and a computer scientist. These all, with the exception of the the computer scientist, agreed that such ergonomic considerations were of importance but could not point to any hard evidence from educational sources to support this contention. Hardware ergonomics were not considered because existing computer makes in schools were varied and it was impractical and to expensive to replace these if they were found to be badly designed.

These factors in i. led to the small scale behavioural survey, undertaken as part of this study, concentrating upon the situation concerning Oxfordshire technology teachers access and usage of information sources and services when generally teaching or supporting student electronic projects as part of a school technology curriculum programme.

The situation described in b.iv. led to the software ergonomics issue being covered early in this study. This was because the computer scientist suggested it was worthwhile looking at the most recent USA research programme on computer graphical and character user interfaces as this would suggest the way forward with the human-computer interface for new software design.

One major problem/constraint arising which affected all elements of this research project, which was completely unseen and unanticipated, came as a direct result of the possibility of OSSTC's LEA grant being lost through Oxfordshire County Council being Community Charge Capped in 1990. It also resulted in the director of the research project having to spend a substantial proportion of additional time on OSSTC business in order to ensure future staffing and the survival of OSSTC. No time was lost from the project; however considerable unnecessary additional stress was placed upon the project director. Finally it was announced in mid 1991 that OSSTC was to loose its external grant, and with the present dire situation concerning the lack of university funding for such enterprises, it would close at the end of August 1992.

CHAPTER 3

TECHNOLOGY EDUCATION IN PRACTICE

This chapter is concerned with providing evidence from current UK practice which clarifies and illuminates further the development of technology education in Oxfordshire. In particular it investigates technology teachers professional development via INSET, technology teacher IT (Computer) capability and literacy, and information usage by technology teachers. Conclusions are then drawn with regard to the way forward and future developments.

It does this under the following headings: The Oxfordshire INSET and Computing Situation; The Oxfordshire Technology INSET Survey; The Oxfordshire IT Computing Survey; the Oxfordshire Technology Information Access/Source survey.

THE OXFORDSHIRE INSET AND COMPUTING SITUATION

This section introduces the setting for the following surveys by introducing the County of Oxfordshire, Oxfordshire LEA, Oxfordshire teacher education, and the situation concerning microcomputers in Oxfordshire LEA schools.

The County of Oxfordshire

Geographically the UK county of Oxfordshire is firmly planted in the heart of the golden quadrilateral of industrial Europe, namely London, Birmingham, Hamburg and Frankfurt. It is situated in the South Midlands of England and has at its heart the famed University city of Oxford. It is bordered in the North by Banbury, the South by Henley-on-Thames, the East by Thame, and the West by Burford.

It is primarily a rural County with agriculture being its biggest industry. The towns generally are modest and provide homes for the expanding small high technology businesses, many of which have been attracted to the region because of the proximity to the UK's leading University at Oxford. The largest industrial plants in the region are situated in Oxford and Banbury; these are Austin Rover and General Ford respectively. The County also plays host to the largest concentrations of scientific and technological laboratories in Western Europe: including The Rutherford Appleton Laboratory; Culham Laboratory; AERE Harwell Laboratory; Esso Laboratory etc.

It is a county of high employment and most young people leaving school either go into higher or further education, take up employment immediately or at least within a very short time. Currently, in 1990, unemployment is c.2% overall, and enquiries to the local job centre elicited the fact that they had a substantial number of job vacancies they could not fill as there were just not enough people living in Oxfordshire. Approaches to Oxfordshire careers service resulted in the statement that "we do not have any trouble placing young people into employment or further education and training; the major problem seems to be not enough youngsters to satisfy the demands of industry and further education".

Oxfordshire LEA

Oxfordshire LEA is administered from Oxford; it has 3 further education colleges, some 40 secondary schools, and 265 primary schools. Because of its attractive rural environment Oxfordshire LEA has rarely had any problems concerning the shortage of teachers. It has had a stable teaching force spread across the whole curriculum. Its

Science and Technology teachers are generally mature, innovative, and well-versed in their arts.

Oxfordshire also has a substantial number of high quality independent secondary and preparatory schools such as Oxford Girls, Radley, St. Edwards and the Dragon School.

Teacher Education in Oxfordshire

The Oxford University Department of Educational Studies and the Oxford Schools Science and Technology Centre, are both concerned with secondary level teacher education (either initial training or INSET) and are conveniently situated in Oxford itself..

Oxfordshire has two other teacher education establishments. These are the Oxford Polytechnic Faculty of Arts and Education; and Westminster College Oxford. Both of these institutions are concerned with the initial training and INSET of teachers.

The role of the OSSTC has already been described earlier in this study, however, it is worth pointing out that the major INSET programmes undertaken by OSSTC have always been undertaken in partnership with Oxfordshire LEA and have always been targeted at the Secondary level Science and Technology area.

OSSTC has a brief to provide and deliver INSET for both science and technology educators. The OSSTC co-ordinator has been very active both in a formal and informal way in this area. Total numbers of teachers on formal technology INSET courses over the period from September 1985 to 1990 are estimated to be at least 500 without considering those having informal instruction. It should be noted at this point as already mentioned earlier in this study that all funding for formal technology INSET courses will cease in September 1990.

Of particular relevance to this study are the following two examples of technology INSET under the 'GRIST' and 'Miscellaneous' headings.

OSSTC offerings for the 1989-90-91 academic years comprise:

1. a 13-day intensive course for beginning teachers, and a two-year part-time diploma course being offered in association with the Oxford Polytechnic. The polytechnic diploma is recognised by the Department of Education and Science as an advanced course. The Polytechnic courses are directed to teachers of lower secondary classes at present.
2. a special diploma level course, in association with the University Department of Educational Studies, designed for those who will be designated technology curriculum co-ordinators in Secondary Schools. It is designed for senior management staff and those concerned with curriculum planning.

OSSTC has also run many short one day courses targeted at science-linked technology over the last five years. They range from microscopy through to basic chemical and material handling.

Microcomputers in Oxfordshire LEA Schools

Investigations revealed that Oxfordshire LEA appointed its first Microtechnology adviser in September 1981, up to this date the LEA had few microcomputers in Oxfordshire schools. The first job of this adviser was to install in the schools RML 380Z microcomputers. These were purchased partially with a DTI grant, to bring total numbers of computers in Oxfordshire schools up to the 50 mark. Today the situation is considerably better with more microcomputers and a greater variety. Walton¹⁴⁴ indicated

in 1989 that the provision had expanded considerably, almost to the 2000 mark, and covered 480Z, Nimbus, BBC, and Others (see Table 9).

Table 9

Computers in Oxfordshire LEA Schools					
Schools -----	Secondary (35)	Middle (12)	Primary (241)	Special (20)	Totals (308)
480Z	343	52	319	2	716
Nimbus	443	40	327	3	813
BBC	147	15	44	65	271
Other	83	9	16	11	119
	-----	-----	-----	-----	-----
Totals	1016	116	706	81	1919

Oxfordshire LEA also has a Computer Centre at Wheatley with full-time staff for the support and maintenance of this provision. Other Oxfordshire based institutions with educational microcomputer centres also give support from time to time. These institutions include OSSTC, Oxford University Department of Educational Studies, Oxford Polytechnic Faculty of Arts and Education, and Westminster College, Oxford.

OXFORDSHIRE TECHNOLOGY EDUCATORS AND TECHNOLOGY INSET

During the period 1986-9 a series of TRIST (TVEI Related INSET) INSET courses described by Fisher and Collins¹⁴⁵ were conducted at the OSSTC to improve the knowledge and understanding of 100 science and technology teachers in various key topic areas of Technology.

The Oxfordshire Technology INSET Survey

This survey investigates the TRIST technology educator Technology INSET courses. It covers the course topics, research and evaluation, methodology, results, and cybernetic models. The findings are then discussed, and general conclusions and items relevant to a future pilot computer database are presented.

Course Topics

The course topics for this Technology INSET programme chosen were ones which from experience were known to present difficulties to many technology teachers. The topics were seen to be either inadequately taught or not attempted at all by teachers.

Initially the selection of course topics (see Table 10 overleaf) was made by the OSSTC Co-ordinator and the Oxfordshire Local Education Authority Science Adviser on behalf of the Technology Advisers group. This group ratified and approved the program of studies following.

Table 10

Technological Topics Chosen for INSET Courses		
<u>Specific Topics</u>	<u>Included in CDT Syllabus</u>	<u>Included in Science syllabus</u>
1. Biotechnology		*
2. Electronics/Electricity	*	*
3. Microcomputing & Control	*	
4. Computer-aided Design	*	
5. Product Design	*	
6. Graphic Communication	*	
General Topics		
7. Curriculum development in Science/Technology areas;		
8. High Tech Areas of Industry;		
9. Problem-Solving;		
10. Microcomputing in Science/CDT area.		

Although these topic areas were aimed specially at CDT-Technology, equal numbers of science and CDT teachers attended the course. Some of these science teachers taught technology, but the rest had no involvement with it. It was intended to encourage this group's interest in technology, and to help cement relationships and shared teaching of Technology between science and CDT teachers. During the initial period of the INSET courses in 1986/87 almost 100 teachers completed the technology courses.

Research and Evaluation

Associated with this programme was a demand for some form of feedback, and accordingly the Co-ordinator of OSSTC Fisher undertook undertake this by developing a small research programme as described following. (NB The end result of this research was that a preliminary analysis of all aspects of these INSET courses was carried out and reported on in an internal unpublished paper by Fisher and Endean ¹⁴⁶ in 1988.) The following description outlines this work.

Methodology

Instruments

1. A pre-course questionnaire on knowledge and teaching experience in ten topic areas was filled in by all participants and was received before commencement of courses.
2. A participant response schedule was handed out at the beginning of the course, and collected by the conclusion of the course.
3. An evaluation of the effectiveness of the teaching of the course areas was held at the end of course. This evaluation took the form of informal round-table discussions which were recorded and analysed. In some cases the tutor in charge of the topic also made a written submission.
4. Debriefing reports were received from various groups and individuals.

Clientele

The participants were chosen as a result of the following process:

- a. The Science and CDT Advisers for Oxfordshire and the Co-ordinator of the Oxford Schools' Science and Technology Centre held discussions about the implications of the white paper Science 5-16, GCSE Technology CDT National Subject Specific Criteria. The National Curriculum 5-16 - A Consultation Document and state of the art so far as Technology Education developments in the areas Science and CDT were concerned in Oxfordshire. The group then identified ten interdisciplinary areas of deficit which would need to be addressed if the aims of the documents and national developments were to have a reasonable expectation of being realised in Oxfordshire. These interdisciplinary areas were considered. A program was then drawn up and presented to the Technology Advisers Group for approval.;
- b. The Headteachers of all forty secondary schools in the area where then circulated with information about the courses envisaged, and invited to respond.
- c. Headteachers from twelve schools responded.
- e. Six schools were selected from the twelve which applied. A criterion used to select the schools was knowledge of interest of staff in forging Science - CDT links to teach GCSE 'Technology' (CDT National Subject Specific Criteria).
- f. Subsequently one school dropped out at the last minute.
- g. The places allocated to this school were filled by participants who responded to a direct advertisement to local schools.

Methods of Analysis

1. The pre-course content knowledge and teaching experience questionnaire was analysed in terms of knowledge and teaching experience of all participants in the ten topic areas (see Fig 17) and in terms of relative average knowledge in the ten topics, as well as the range of expertise in the ten topics (see Fig. 7 to 17 inclusive).
2. The teacher response schedules, which were open-ended, were coded and wide categories were set up which permitted analysis of patterns of response across the whole population of participants.
3. An analysis of the responses to the informed topic discussions was translated into broad categories in a similar fashion the those in the course response schedules.
4. The schools' debriefing reports were analysed into broad categories as above.
5. Patterns were searched for and identified in the above data.
6. A cybernetic model incorporating insights derived from 1 - 5 above was constructed.

Results

1. Pre-course Knowledge and Teaching Experience Questionnaire.

Histograms were constructed showing the status of all of the course participants (n=59) in knowledge and teaching in each of the ten selected target areas which were:

1. Electricity and Electronics;
2. Microcomputing in Science/CDT areas;
3. Microcomputing and control technology;
4. Computer Aided Design;
5. Problem Solving;
6. Graphic Communication;
7. Product Design;
8. Curriculum development in science/technology areas;
9. Biotechnology;

10. High technology areas of industry.

Participants had been asked to rate both their knowledge and teaching experience in these ten areas on a 4 point scale from none/little (1) to good/excellent (4). The responses for each topic is displayed graphically (Figures 7 to 16 inclusive). There were five topics (Electricity & Electronics, Microcomputing in Science/CDT. areas, Microcomputing in Control Technology, Biotechnology, and High Technology Areas of Industry) with no entries in category 4. The pattern of responses represent an evaluation of the decision-making process which led to the selection of these ten areas for inclusion in the course.

In addition a pie-chart was produced (Figure 22) which displays the knowledge of all participants in all the areas chosen. This addresses the question: were the ten areas relevant for the course not only in terms of their content, but also in terms of the course participants' knowledge of these areas?

Figure 7 shows that in area 1 (electricity and electronics) that there are no participants in category 4 and few in category 3.

Figure 7

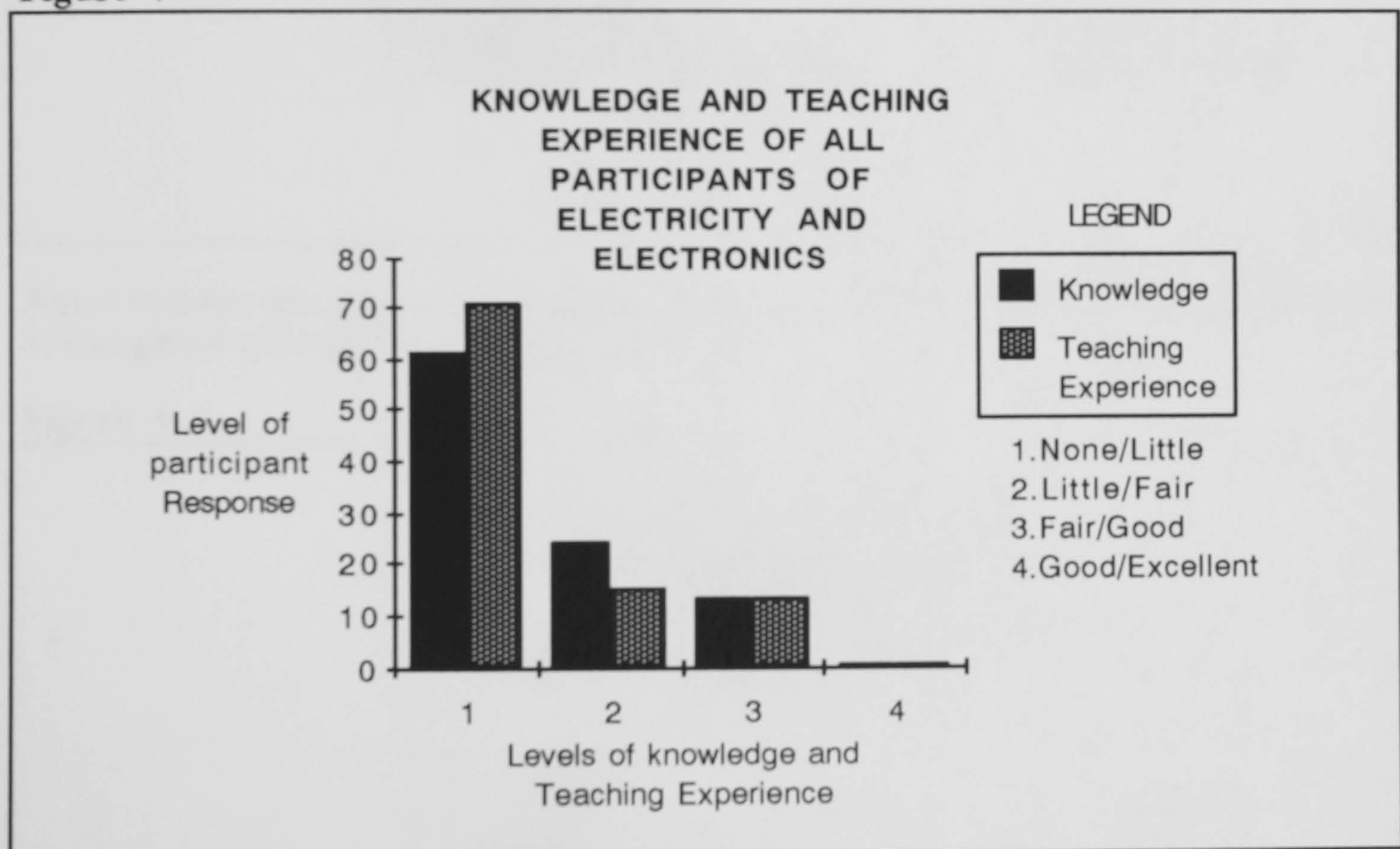


Figure 8 shows that in area 3 (microcomputing) there are no participants in category 4 and very few in category 3.

Figure 8

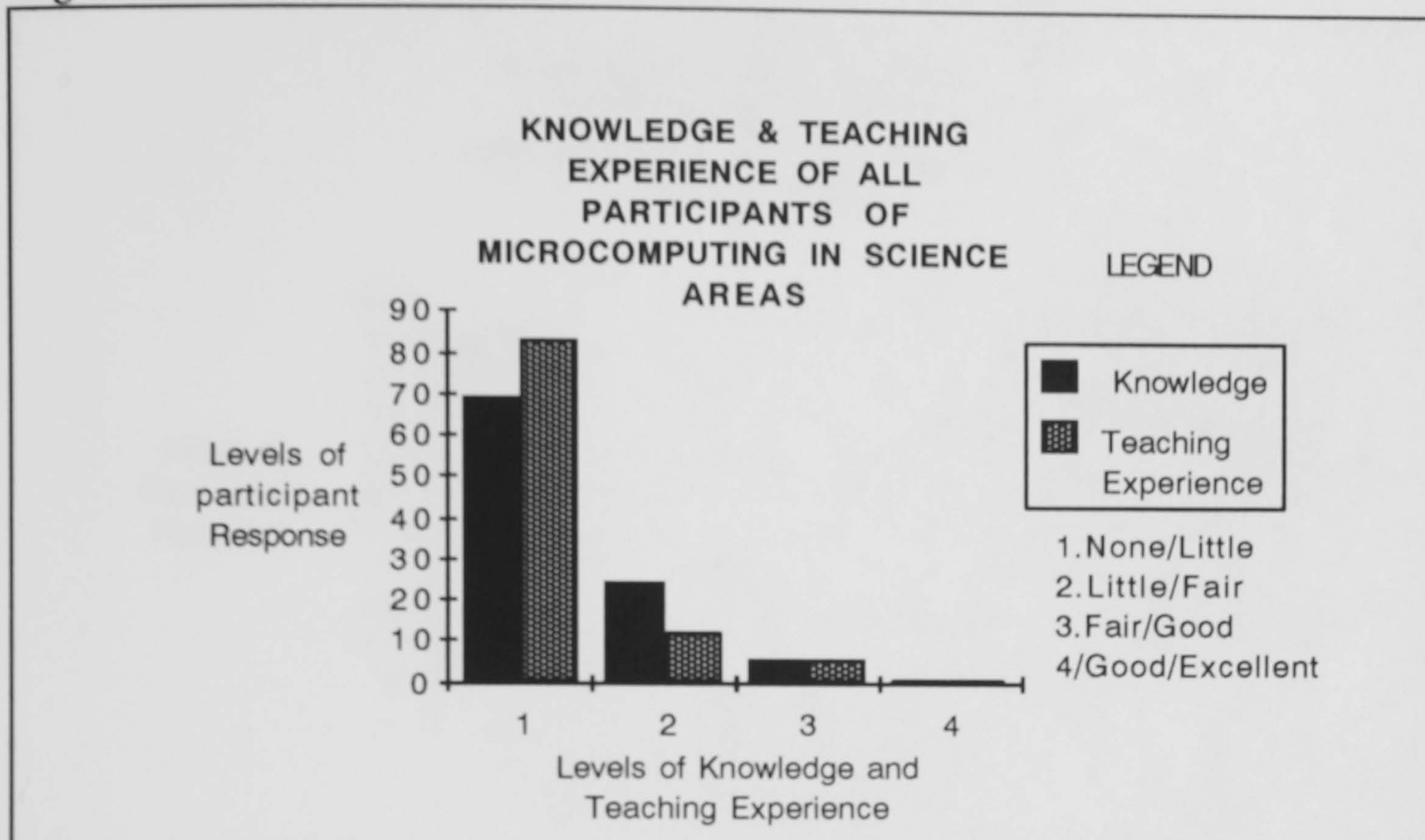


Figure 9 shows that in area 4 (microcomputers and control) that there are no participants in category 4 and very few in category 2 & 3.

Figure 9

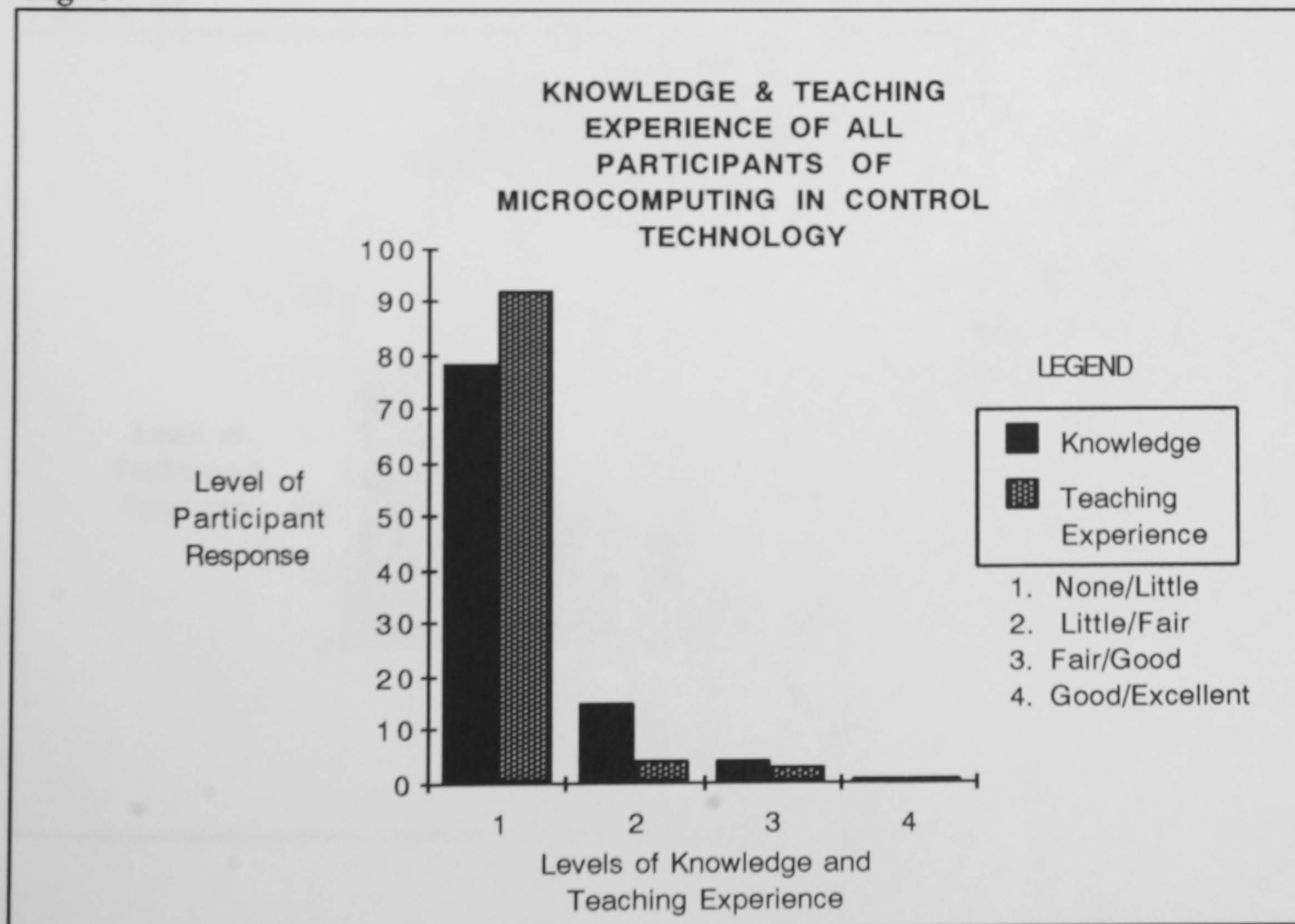


Figure 10 shows that in area 4 (computer aided design) that there are almost no participants in category 2, 3, & 4.

Figure 10

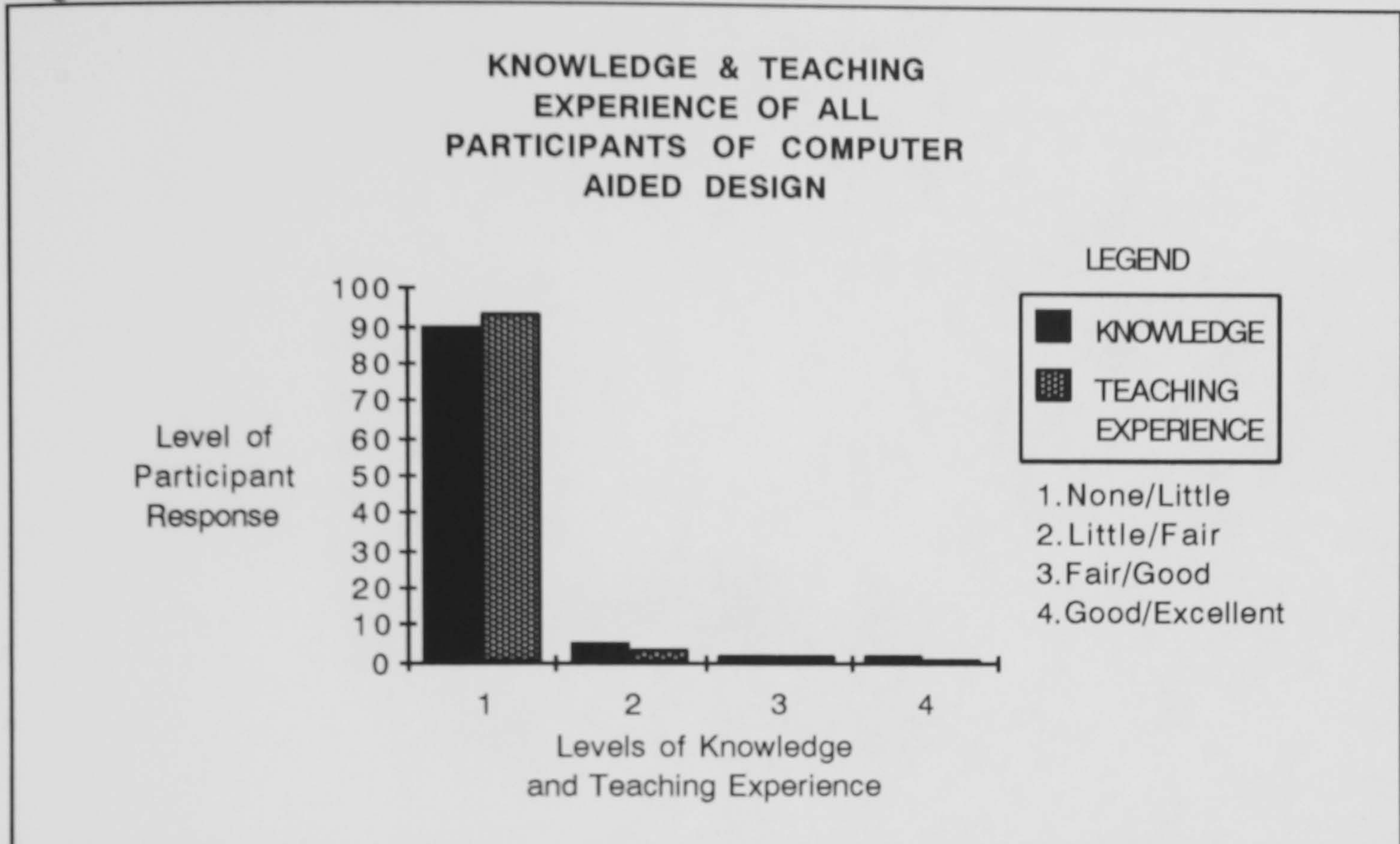


Figure 11 shows that in area 5 (problem solving) had an atypical distribution of knowledge showing a significant number of participants in categories 3 & 4

Figure 11

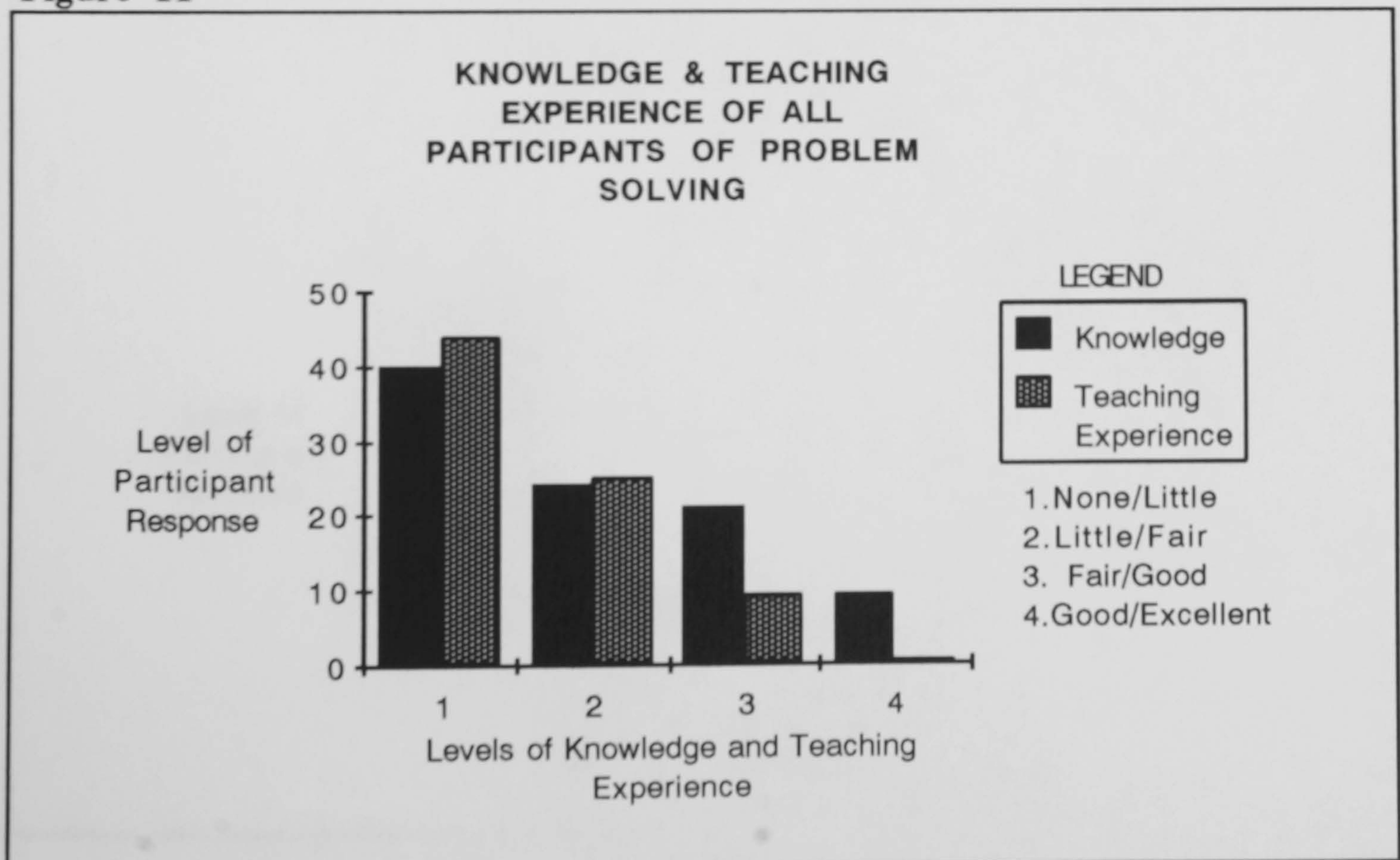


Figure 12 shows that in area 6 (graphic communication) had a atypical distribution of knowledge with some participants in categories 3 & 4.

Figure 12

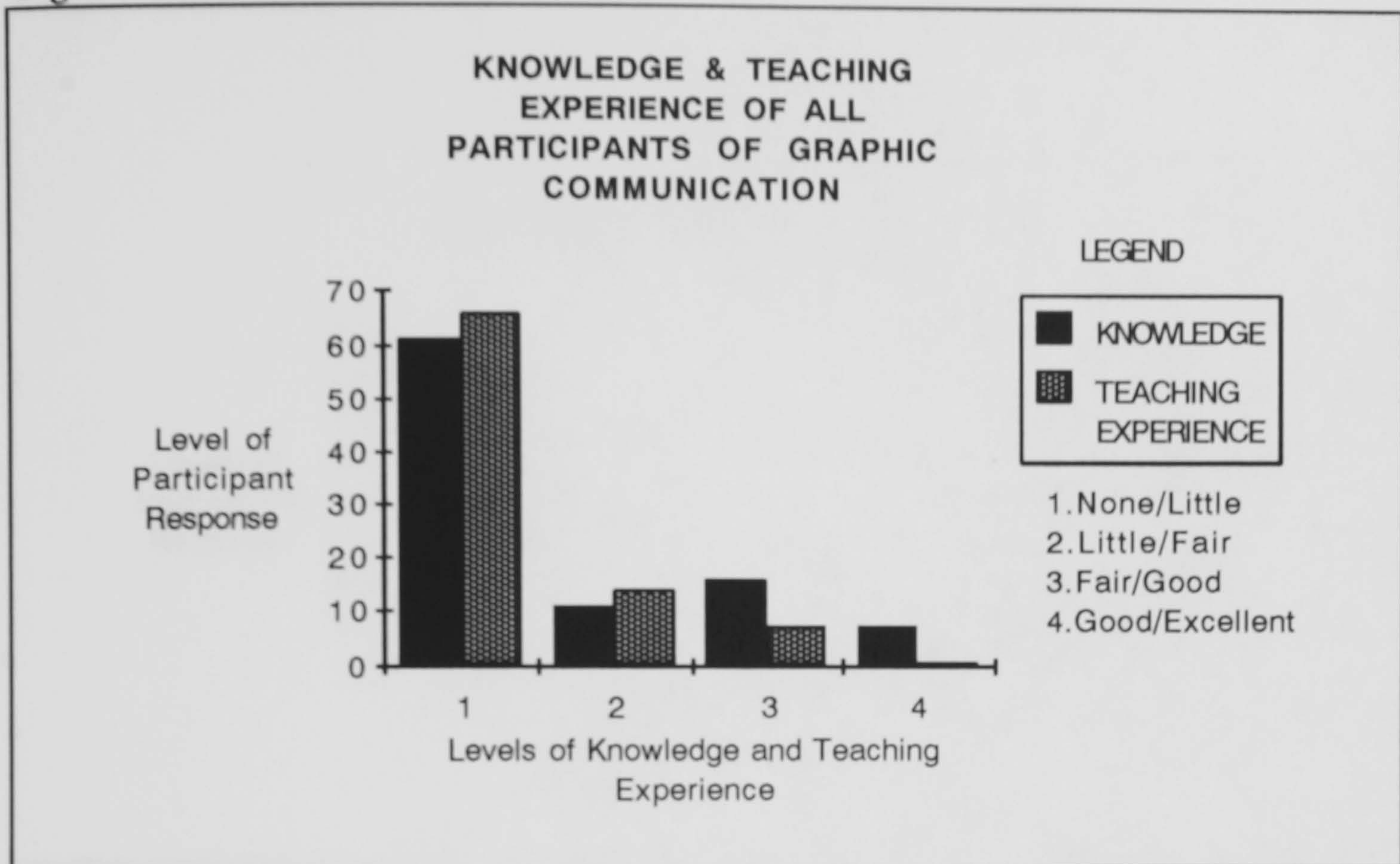


Figure 13 shows that in area 7 (product design) had few participants in category 2,3 & 4.

Figure 13

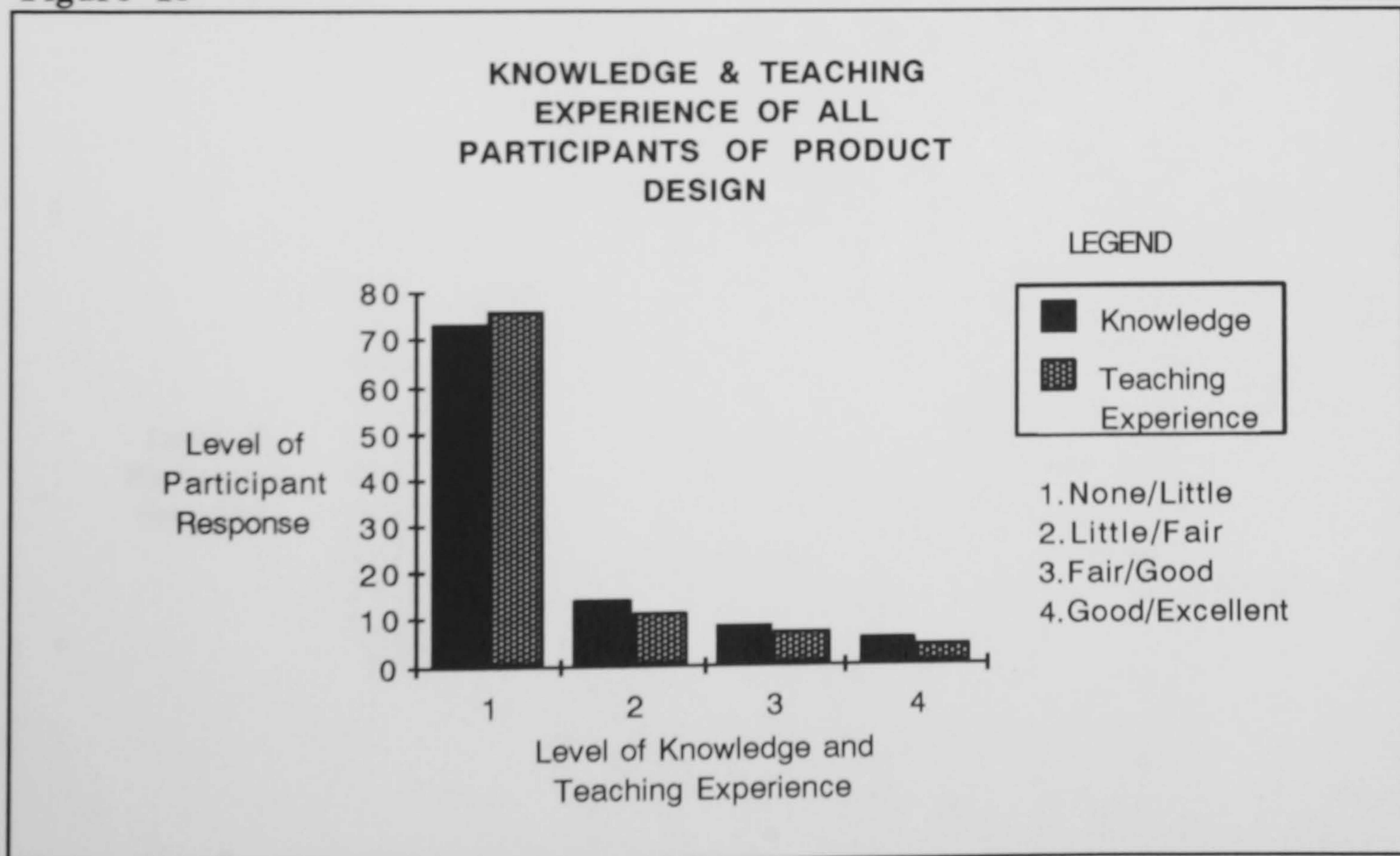


Figure 14 shows that in area 8 (curriculum development) had few participants in category 2,3,& 4.

Figure 14

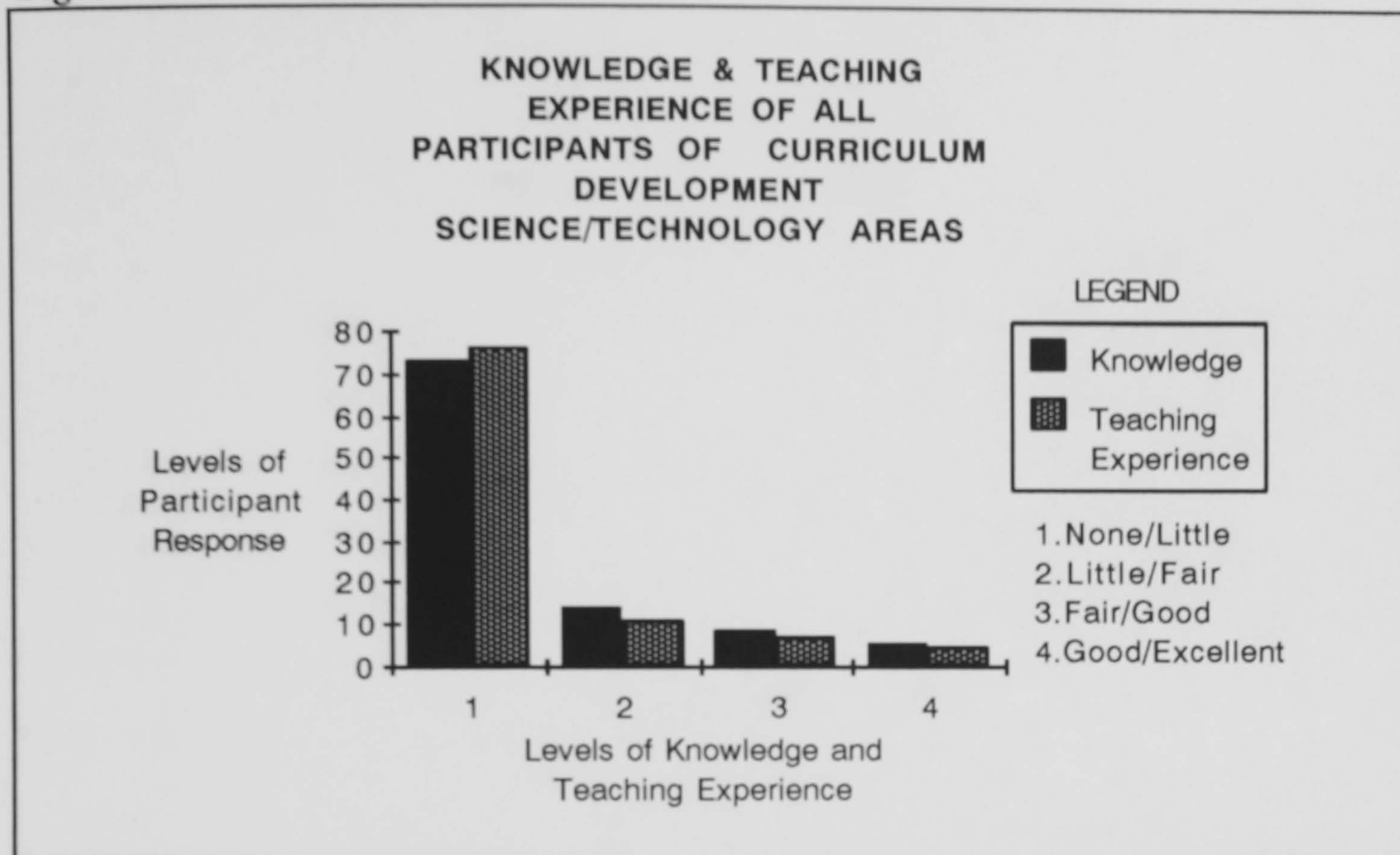


Figure 15 indicates in area 9 (biotechnology) that participants in category 2,3,4.

Figure 15

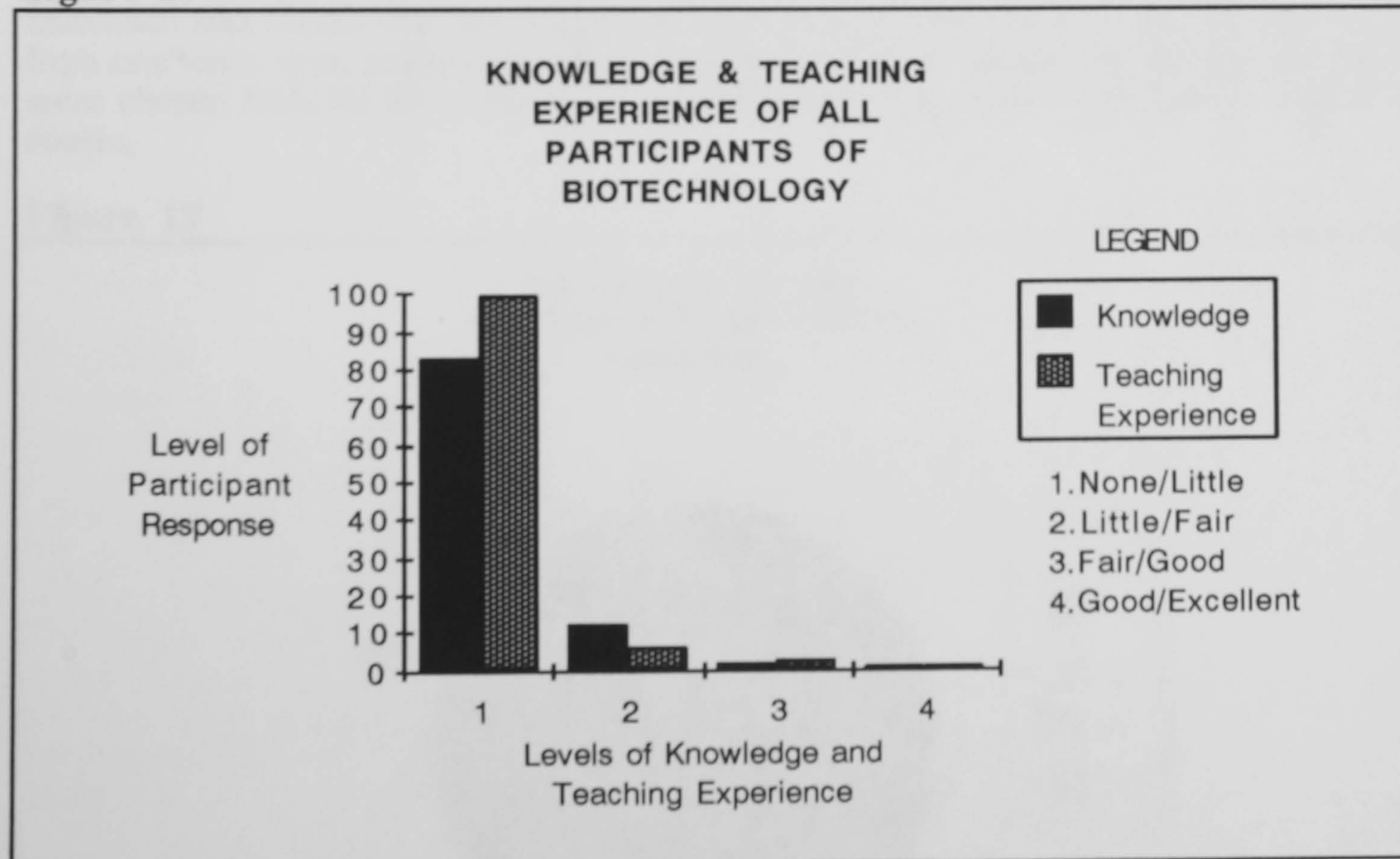
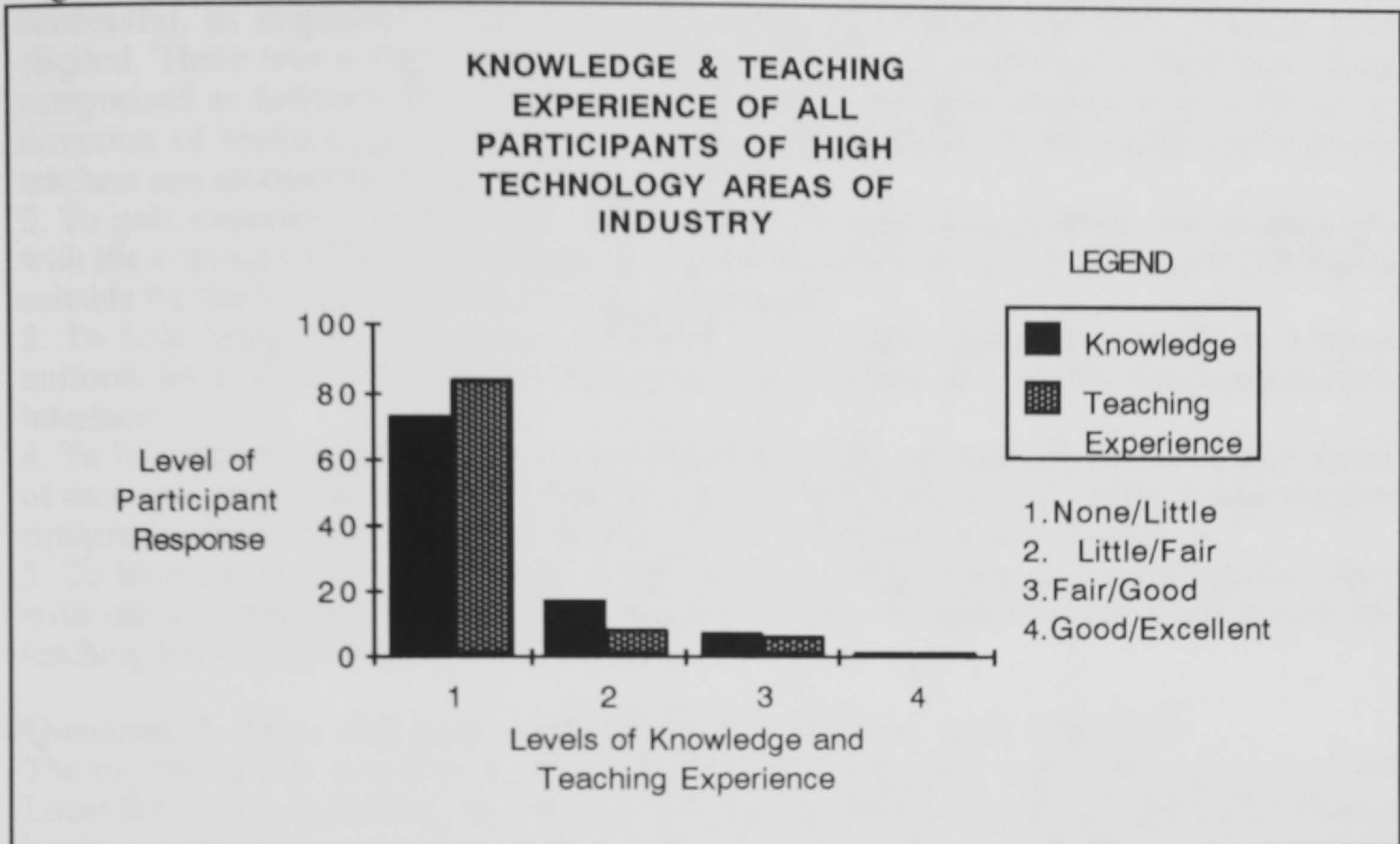


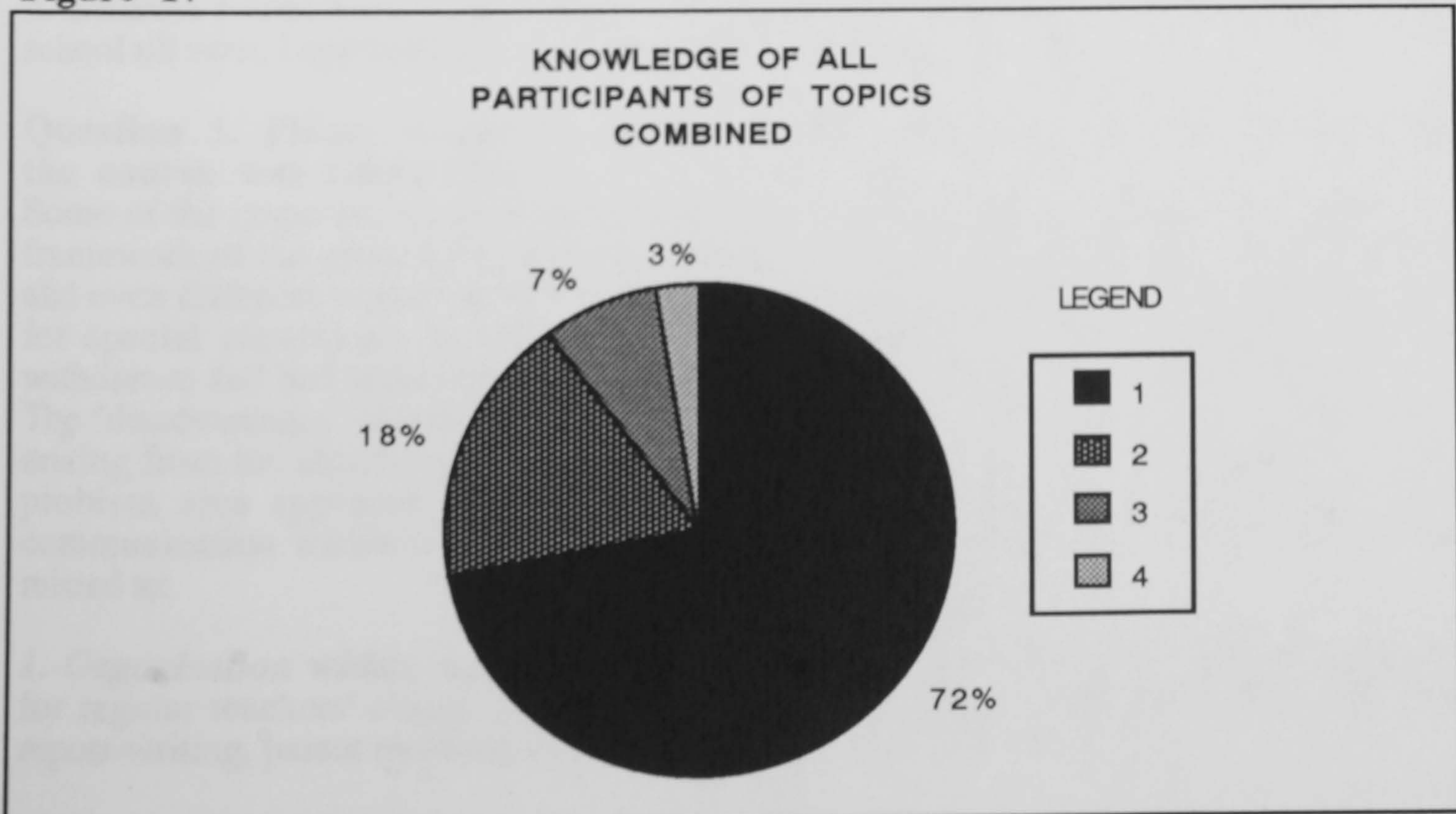
Figure 16 indicates in area 10 (high tech areas of industry) that there were no participants in category 4 and very little in category 2 & 3.

Figure 16



Inspection of the pie-chart (Figure 17) shows that 72% of the participants had no or very little knowledge in the ten topics chosen for the course, and only 3% had a very good/excellent grasp of some of the topics. In fact, study of the histograms for the individual area shows that this 3% comes from 5 topic areas. The bulk of the 3% comes from one topic area, problem-solving. It therefore can be concluded that the ten topic areas chosen fulfilled the criteria for selection very well, both individually, and as a course.

Figure 17



2. Teacher Response Schedule (All Participants)

Question 1. What are your hopes/expectations of this course ?

1. This question aimed to pin-point needs at more than a personal level. In this it was successful, as responses at the personal, class, department, and system level were elicited. There was a high degree of communality in the responses, which have been categorised as follows: To gain an understanding of the philosophy, aims, objectives, direction of technology teaching in schools, and to discover how craft and science teachers can co-operate in new integrated courses.
2. To gain expertise in curriculum construction, incorporating science and technology, with the coming GCSE requirements in mind, and particularly to gain insight into topics suitable for the lower school technology programme.
3. To help bring the knowledge and skills of the CDT and science staffs to a more uniform level, thus facilitating development work in the new GCSE - directed subject interfaces.
4. To be directed towards tested resources, both hardware and software, to avoid waste of time and money when introducing new topics to school, to learn how to operate new equipment and to gain confidence in introducing technology to school classes.
5. To increase my own knowledge base, learn something new, and to be able to share with other participants experience, discussion and consideration of implications for teaching the various elements in the course.

Question 2. How did you come to be involved in this course ?

The motive of this question was to see if the expected communication channels of the Local Education Authority, its schools and other agencies, its head teachers, department heads and teachers, were functioning. The main responses, categorised below, suggest that communications are in good order:

1. The school was offered INSET, and Head Teachers and Science and Technology Heads decided the school accepted the opportunity, all the staff concerned were sent to course.
2. The staff was interested in the integration of technology and science in the school curriculum and when heard of the offer decided to go, because of the new course(s) being shortly introduced to the school.
3. LEA. advisor drew our attention to course as we were establishing a new course for year 1 - 3 and many of the staff were keen to gain experience in the technology area.
4. Because I continually expressed interest, and there has been no technology in our school till now, I applied for a place on the course and was selected.

Question 3. Please comment on the advantages/disadvantages of the way the course was timetabled.

Some of the responses to this question need to be considered within the organisational framework of the groups responding. This is because different patterns of withdrawal, and even different venues were involved. Some participants spent all their time, except for special excursions, at the OSSTC. Another group of participants had half-day withdrawal and had to drive to a variety of different venues to undertake the course.

The "disadvantages" noted by different groups were directly related to logistical problems arising from the structure, venues and timing of the courses they were taking. Another problem area appeared to be closely related to breakdowns of organisation and communication within schools themselves. The problems were categorised as being related to:

1. *Organisation within schools:* (a) supply cover with suitability qualified teachers for regular teachers' absences; (b) adequate cover for absent teachers' other duties eg report-writing, parent meetings etc.

2. Communication: (a) within schools eg last minute changes of plans by Head Teacher, failure of subject heads to distribute information to participating teachers; (b) from Oxford Schools' Science and Technology Centre to teachers - the broken link usually appeared to be at subject head to teacher level.

A. Disadvantages:

1. Problems with suitability of supply teachers.
 2. Problems with school expectations - parent days, report activity, preparation and correction of pupils' work etc.- giving teachers on the course double load of responsibility, resulting in fatigue, frustration, and resentment.
 3. Problems with some courses caused by time of travelling, difficulty parking, and missing meals.
 4. Some problems with level of treatment of certain topics e.g. "has been helpful to me, but way over the head of some colleagues".
 5. Course too concentrated, should be longer, and needs two or three follow-up sessions.
- Although the disadvantages noted tended to apply to participants in particular course patterns, and to lack much generality, the advantages noted were more general, although (3) and (6) below apply to certain block release participants.

B. Advantages:

1. The course gave teachers time out to stop, learn and think.
2. Bringing such a wide range of teachers together has helped bridge the gap between them.
3. The concentrated nature of the course should turn out to be an advantage to participants.
4. The topic areas covered were appropriate.
5. Helpful to learn about technology from the science point of view.
6. An advantage is that it is a normal working day, but away from school distractions.

Question 4 Any other comments at this stage?

These comments were useful and informative. It is of interest that in one group approximately half of the participants failed to respond to his question. Some of the matters raised were useful starting points for the end - of - course topic evaluations which were to follow:

1. Did not receive pre-course information about aims/objectives of course. Suggest this plus some reference books on topics, which could be studied for a reasonable period before course began would be very helpful to catch up with beginning level assumed by tutors.
2. Level of equipment at the Oxford Schools' Science and Technology Centre emphasises how inadequate provision at school is.
3. Biotechnology was extremely well presented and useful.
4. Would like more for lower ages and abilities of pupils.
5. Electronics aimed at too high a level (several participants from science areas mainly).
6. Organisation good, but should consider individual needs more e.g. programmed approach to use of oscilloscope.
7. All tutors should have expertise and knowledge of school and classroom situations as well of subject matter.

3. Topic Teaching Effectiveness Evaluation

Some tutors conducted these sessions with the participants at the end of the course. A summary was made of the main comments arising from each of these sessions. The topic analysis results are as follows:

1. Electricity and Electronics

1. The mixture of existing knowledge was a problem - maybe the group should be split in some way. Level of lecturing was too high for participants;
2. Several would have benefited from a introductory preamble about electronics before starting course. Some suggested that references to suitable reading would be beneficial several weeks before course started;
3. More handouts during the course would have been appreciated;
4. Oscilloscope needed more explanations;
5. More time was needed on projects;
6. More direction and a more adequate introduction needed at the beginning of this course;
7. It would have been better had Science and CDT. teachers worked in pairs, whereas they tended to pair in their own areas and get further apart;
8. Greater emphasis is needed on explaining terms and items of equipment needed. Details of resister colour code and of other equipment should be explained;
9. Language should be simple, and more explanations of basic equipment are needed. Cards displaying components would be useful Jargon words act as a barrier to understanding;
10. More time is needed to solder;
11. The course was good revision for many of the scientists;
12. More work was needed by some on Verobloc and circuits;
13. Suggest jig for drill, PCB. holder and mag. There was a high rate of failure of components;
14. Space was somewhat of a problem;
15. Many participants requested a follow-up course;
16. Two participants said they needed more INSET. One had been 15 years, the other 6 years without any;
17. Some said schools should be visited to check resources to ensure that the practicals are possible in schools;
18. Visits to Rutherford, Appleton and Harwell were considered excellent;
19. Logistical problems getting to course, or causing hunger/fatigue or loss of money were mentioned;

3. Microcomputing and Control Technology (Courses 1& 2)

1. It would be better to start courses at two levels (a) beginners, and (b) advanced;
2. More tutor help is necessary to avoid waiting time;
3. Too much was expected of participants on this course;
4. Computer literacy is felt to be a missing component of the INSET programme;
5. The equipment was reliable;
6. Time for course was insufficient;
7. Would have liked less theory and more practical work;
8. It would have been a good idea to provide a bibliography of reading to follow up this course;
9. Key words in LOGO ought to be on permanent display - perhaps on a wall chart;
10. It was possible to pick up LOGO, but it should have been simpler to do so;
11. There are many different languages - which is the best to use?
12. Sensors should be available to all course participants, not just a few;
13. A list of sensors needs to be compiled;
14. Better use could have been made of pre-course questionnaire;
15. Why does hardware/software not work? Tutor needs to be aware of and correct problems;
16. What about other machines such as 480Z, Nimbus etc?
17. Participants should be made to work in pairs;
18. Felt the need for an overview of CONTROL, stages of the course, how they fit together;

19. Too much theory, not enough practical.

4. Computer Aided Design (Courses 1,2,3,& 4)

Responses were made to programmes used during the courses. Whereas these varied somewhat, depending upon the circumstances of each course, there was a common thread running through each of the courses.

Some participants in each course stressed the need for "manuals to manuals" or "idiot guides". Some also suggested that wallchart flowcharts would have been very useful. The following points were also noted:

1. Instructions should be made available for printers and plotters;
2. It is desirable to get a framework outline with each package;
3. Would have liked more CAD;
4. Input devices influenced the quality of the software experience;
5. It was difficult to see the potential of certain packages in the school curriculum;
6. It is useful to have a video camera or tape image on video, especially for the advanced CAD package;
7. MICAD 2: annoying when it would not edit;
8. MICAD 3D: very hard, poor quality;
9. MICAD: very difficult, unfriendly, definition poor;
10. BITSTICK TEXT: didn't work;
11. BITSTICK: has a poor range of colours, but liked it;
12. IMAGE: baffling at first, but in the end liked it;
13. Liked GRAFPAD, but there were difficulties with erasure;
14. GRAFPAD: will not run on master;
15. 5-Ways CAD (3D): very good, but will not function on Master;
16. RM. CAD: needs watching, and grid. Otherwise good.
17. NOVACAD: easy to use, but could not save Icons. Has a badly organised manual, which needs an 'idiots' guidebook";
18. COMPAS 2D: malfunctioned;
19. PAINT: fun;
20. PAINTSPA: good, beautiful.

5. Product Design (Courses 1 & 2)

1. The course should be longer - at least one full week, with follow-up sessions later;
2. As it stood, this course was a bit too concentrated;
3. The hands-on experience was valuable;
4. The Oxford Schools' Science and Technology Centre (rather than schools) was a good venue;
5. A pinboard display centre, or something similar, would have been useful;
6. A fume extractor, and air conditioning are needed in the working area of the Oxford Schools' Science and Technology Centre;
7. Logistic problems affected proper attendance (1 group only);
8. It was felt Product Design should come before Computer Aided Design in the presentation sequence;
9. Good range of practical equipment was provided - it's just what the schools need.

4. Tutors Debriefing Evaluation

Electronics Unit.

1. Was surprised at the wide range of abilities or readiness. Recent physics graduates were very well prepared, but the range went from them to a CDT teacher (with a home economics background) who had recently completed a CDT conversion course. In hindsight the best way to organise working pairs is of great importance. Should it be equal ability pairs, or one scientist and one technologist?

2. The participants and myself realise the importance of follow-up teaching so that the gains made in this short course do not evaporate.
3. Organisational logistics problems resulted in some teacher absence and unpunctuality, as well as travel and parking problems, resulting at times in high frustration levels.

Curriculum Development in the Technology Area

1. I organised the course according to a model with me as 'teacher' and course participants as 'class'.
2. The class was given 'make, test, explain, estimate, speculate, and innovate' exercises which started off as highly prescriptive, and became increasingly open-ended.
3. Emphasis was placed on asking questions to promote thinking, on the recording of results and methods of evaluation such as 'fair testing'.
4. Class were to make three working models, and on the basis of seeing them work, explain scientific principles at work, estimate the effects of changes, speculate about improvements, and work on an innovation. They used simple fastening techniques to achieve rapid changes in the design. They were trained to know where problems are likely to occur and how to manage a similar situation in the school classroom or laboratory.
5. I carried out no formal evaluation but offer the following subjective comments:
 - (1) All groups were very responsive. Discussions on classroom organisation and management were lively and well informed.
 - (2) Most participants demonstrated an adequate grasp of the scientific principles (with the physicists well ahead!) necessary to cope with the topics in a sound technological way.
 - (3) More had problems with construction techniques but many had difficulties coping with problems of a simple mechanical design. I hope they learned enough to avoid such problems or take steps to improve their own expertise in this respect.
 - (4) The main problem with the course is lack of follow-up. Teachers need to be set the task of implementing ideas, then to come to a group meeting at which the results can be assessed. Then it would be possible to evaluate the quality of the learning experience for the participants.

Schools

The schools which had sent their Science - CDT teachers to one of the courses which are the subject of this study conducted sessions some time after the return of their staff members to normal duties. Debriefing reports were sent by them to the Co-ordinator of the Oxford Schools' Science and Technology Centre. These reports dealt with four aspects:

1. Value of each of the ten topic offerings from the course;
2. The organisation and presentation of the course as a whole;
3. Logistical matters at the school and regional level which had a bearing in the course;
4. Future plans and prospects.

The method of reporting varied from school to school, from a tabulated and sub-headed summary of seminar findings all the way to a collection of individual hand-written reports from individual staff members. Nevertheless, the four themes set out above were discernible in them all.

1. Whereas participants appreciated the potential value of all of the topic areas, their assessment of their usefulness to them related to the gains they felt that they had individually made. These gains were related to their initial state of knowledge and readiness and the educational expertise of those taking each topic.
As educationalists themselves, they were able to appreciate the difficulties of catering for such a heterogeneous group, and also to have some coping strategies at their disposal. In the group few individuals had some coping strategies at their disposal. In those few

instances where those running a topic took little or no cognisance of such strategies, some participants felt unable to maximise the INSET experience for themselves and suffered considerable frustration over what seemed to them a situation which had arisen over a neglect of proper pre-planning and also class organisation. One or two areas were criticised by virtually all participants on pedagogical grounds, while others were highly praised. The respondents were able to, and did, explain what needed to be done to improve the problem topics, and to analyse and explain the excellence of others. Thus valuable constructive criticism became available to inform further course planning.

2. In the process of evaluating the topic areas, the participants had already begun to identify important issues in preparation presentation, and class organisation. Depending upon the organisation pattern that applied to particular groups, logistical aspects, particularly at the school end, were identified and discussed although at a rather more general level than had occurred in the Course Response Schedule. One clear result here seems to be that block withdrawal courses held at predominantly one venue during the normal working day but free from the interruptions of school is the most satisfactory format for such courses.

A rider needs to be added that it is recommended that, where whole Science and CDT staffs are to be withdrawn, special efforts need to be made not only in terms possibly of reorganisation of the school programmes in science and technology, to minimise negative effects on pupils, and 'the participants' feelings of guilt that they are "to blame for this".

3. The school authorities obviously need to be prepared, when releasing staff to intensive courses, to relinquish them entirely. Unfortunately in many instances teachers missed part of the course, or were forced into unpunctuality because of demands made by the school that they attend parents' meetings, set and correct class and homework, correct exam papers, write reports, and so on. Tired and harassed participants cannot expect to get maximum benefit from any course.

There was universal disappointment that LEA Advisers were not more involved with the courses than they were. In most cases their participation seemed limited to a single appearance. This may have been unavoidable, or even by design, but perhaps some steps should be taken in future not to have participants harbor unreal expectations.

There was universal approval of the unifying presence of the Oxford Schools' Science and Technology Centre Co-ordinator who served in the participants' eyes to tie the course together, and to provide an on-going helping hand and ready advice for projects that they might undertake later. The participants perceived the co-ordinator's mix of practical knowledge and helpful warmth as being of great value. The same applied to some, but not all, of their topic tutors. It is obviously important to have a person who is an expert in the area, and who has experience of the classroom, as a co-ordinator or anchorman, in such courses.

4. The future plans of the participants with respect to a new look at teaching technology in CDT and Science areas, were on the whole, very positive. Even those participants who had felt at a disadvantage during the course because they had no previous experience in Information Technology and Electronics, had not only "muddled through and got something out of it", but were determined to improve their skills in these areas by taking courses, conferring with colleagues, and so on. This shows that the main aim of the course itself, which was to provide awareness and stimulate interest in Technology possibilities in the CDT and Science areas, had been admirably satisfied.

Cybernetic Models

Building a Cybernetic Feed-Back Model:

The sequence of events in the six pilot courses were flowsheeted (see Figure 18 overleaf) Feedback arrows (dotted lines) were added. New areas dictated by the feedback from evaluation instruments were indicated (in stipple). The main elements of Figure 18 were reorganised to set up a cybernetic model for use in future courses (see Figure 19). This model incorporates important areas which had previously been given insufficient attention, such as the nature and comprehensiveness and usefulness of the pre-course information, and the need for pedagogical principles to be discussed, pondered upon, and incorporated into a classroom management strategy by the tutor of each topic before the course commences. Also a GIST (Girls into Science and Technology) box has been included. The dotted lines indicate a cycle which involves the tutors, pre-course teaching techniques seminars, and GIST issues, which operates before the topic workshops commence, and tutors chosen. As numbers of participants accumulate, it is important to keep the original feedback instruments unchanged to preserve compatibility of data. This permits the accumulation of useful information about teachers in this new area. It is better to proceed with educational planning on the basis of concrete data than intuition alone. So far as the courses and topics are concerned, however, the use of a cybernetic model should facilitate an evolutionary development of courses which will increasingly efficiently provide for the needs of new curricula, schools, teachers, and pupils, as well as progressively time-tuning the model itself.

Figure 18

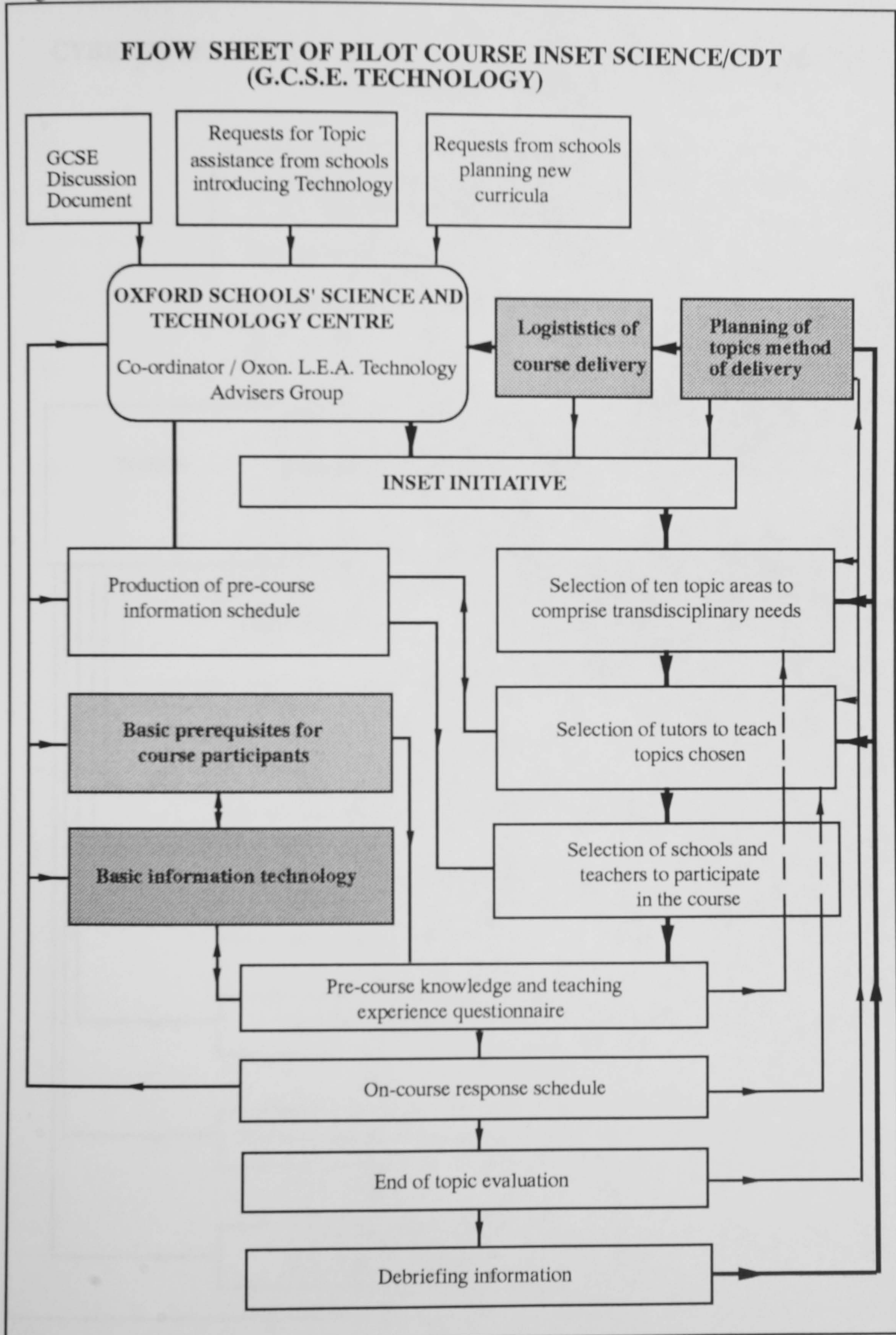
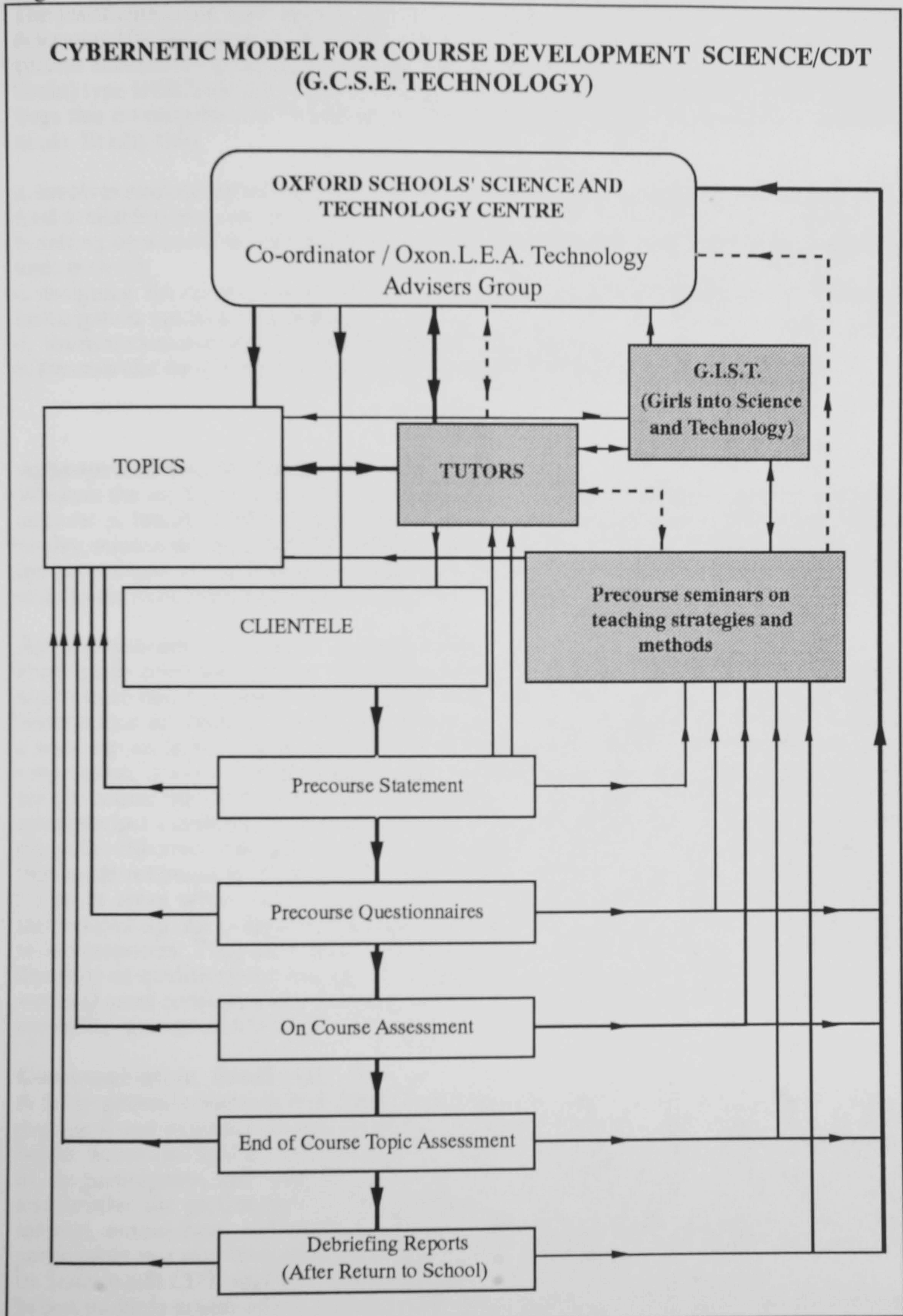


Figure 19



Justification of the Stages and Links of the Cybernetic Feed-Back Model

The justification for the stages in the model and the links between each stage is firmly determined by the nature of the system being addressed which includes: a the policy and system adopted by government when providing funds for ESG (Educational Support Grant) type INSET; b. the LEA advisory system of administering INSET; c. the findings from this investigation of Oxfordshire INSET; d. the LEA school situation, e. clientele needs. Briefly this:

- a. involves responding with a proposal to government, gaining approval of that proposal, fund availability and receipt;
- b. setting up a small committee to organise the programme, contacting tutors, designing topic material;
- c. designing the course, and selecting the tutors, bearing in mind the issues raised in this investigation, particularly gender;
- d. the minimum disruption of curriculum time for schools ;
- e. the case that the clientele will need adequate preparation for Technology INSET.

Discussion

Appropriateness of Topic Selection:

Whereas the ten topic areas selected for the INSET course (see Table 12) were not only relevant to interdisciplinary technology but also correctly identified as areas in which neither science nor CDT teachers had much knowledge, it was not possible to say, with the instruments at our disposal, whether or not there were equally worthy topics which still remain to be identified. (See Figures 7 to 17 inclusive)

Appropriateness of Topic Presentation

Participants considered all the topics themselves as valuable. They considered that some topics were better prepared and presented than others, and that some tutors had a much better notion of classroom management than others. A fairly general view was that while a wide sweep of very differently qualified participants was one of the strengths of the programme, it was a double-edged sword, because there were pedagogical implications for pre-course information and for differentiation of offerings to cater for a group whose members had a multiplicity of starting points. Being teachers, the participants were able to pin-point effective strategies for future reference. In addition to those mentioned above, they made reference to using wall charts or other methods of permanent display for key terms in areas where not everyone had a knowledge of the jargon, and operating instructions e.g. for computer languages such as LOGO for people who were unfamiliar with computers. They also made it clear that a practical way of putting the group's diversity of qualifications and experience to work would be for the organisers to set up working pairs consisting of a scientist and a technologist who together form a gestalt of capability, greater than the sum of its parts.

Communication Problems

A fairly general comment from the participants was that they needed, but did not get, a statement and explanation of the aims and objectives of the course, before the course began. Some also said it would have been helpful to know what the course would expect of the participants, and supply, where they were available, references to useful books and articles the participants could consult to prepare themselves for the course. The interest, enthusiasm, and desire to maximise their gains from the course shows the participants in a very favourable light. Oxfordshire has cause to be proud of the calibre of its Science and CDT teachers, it would seem.

In fact multiple copies of pre-course statements were taken physically to all participating schools by the Co-ordinator of the Oxford Schools' Science and Technology Centre (Program Director) and the Science Adviser together. A relatively small proportion made

their way to the participating teachers. The remainder were blocked at the subject head's in-tray or even at the headteacher's office. Cognisance needs to be taken of this, and in future practical steps need to be taken to make sure that all teachers know a pre-course statement is available for them. Perhaps to display the statement itself on a board in the staffroom with a note to say that they may get their own copy from the school, would alert them to its availability.

Implications Concerning the Precourse Statement

The pre-course statement itself needs to be re-evaluated in terms of the participants' suggestions and requests. Details of the upcoming programme - the subjects, the agency, the venues, the dates and times, were provided. This comprised of an outline of each part of the course, and varied in format and detail from topic to topic continued here was no statement of the prerequisite knowledge or skills, or references which might be useful to help gain pre-course perspectives. In fact, in some areas, worthwhile references of the desired type do not, as yet, exist. This does of course add weight to the contention of many of the participants that the organisation should take cognisance of individual differences in knowledge and expertise. A common complaint even from those who received the pre-course topic statement, was that they needed to know the aims and objectives of the course itself. These do exist, although they were not distributed to participants with the pre-course statement. However, the Committee statement of expectations was at a rather general level. This was probably unavoidable as things stood, because of pressing time constraints. Nevertheless, it is clear that what is necessary is to provide participants well ahead of time with a course statement which should be spelled out operationally, with examples. So far as the various topics are concerned, a statement of basic prerequisite knowledge and skills to get maximum benefits from each particular topic should be provided. A statement level of achievement which is realistic for someone lacking some or all of the prerequisites ought to be provided. Basic IT courses should be recommended for those who had no computer experience. If participants are told ahead of time how much fairly simple IT skills will benefit them in terms of getting the most out of the topics presented, many will make the effort to gain those skills. Others, who are not disposed to do this at the time, will enter the course knowing that their expectations might have to be lowered at least in some of the topics offered.

Tutors

Tutors should all have had classroom teaching experience. They should build in to their topics examples of how the materials and techniques can be adapted to the classroom situation, especially with lower-school classes. They should be capable of making practical suggestions about classroom management. They should also demonstrate their grasp of teaching and management skills in the way they organise their own topic presentation.

Participants

Participants should be provided with topic information (which is part of the pre-course information) a list of jargon words and meanings, drawings, and diagrams of equipment, guides to the manuals used in computer based courses such as CAD, and anything else that cannot be assumed to be known by anyone who is totally naive in the topic area. References to suitable basic texts (where they exist) which it would be helpful to have read before the course begins, should also be provided. Participants then arrive having a clear idea of prerequisites, realistic expectations of themselves in areas where they do not have these prerequisites, and a range of useful "crutches" which would allow them to progress constantly instead of waiting about helplessly until aid is available. This would have the effect of minimising the frustrations they were likely to experience, and of supporting, rather than possibly threatening, their self-concepts. Obviously, this means that briefing and development work will have to be carried on before the course begins, with the tutors. They need to know the pedagogical as well as the content priorities of

their clients, and they need to be able to discuss and decide the management procedures they intend to use in their own topics.

The other half - Participation of girls & women in technology

Out of the 59 participants in the course, only 3 were women. None of the tutors were women. When the GCSE initiatives are implemented, in many classes half of the pupils will be girls. The three female participants' comments showed that they noticed covert, and sometimes very overt, male chauvinism and sexist attitudes operating in the course. One said she felt for the most part the men concerned were unaware of this, and expressed some misgivings about how girls would be likely to fare when technology was taught by a male today. Most of the tutors who mentioned the female participants at all seemed to think the course had been "a success" for them. One tutor was derogatory about one female participant.

How then are GIST (Girls into Science and Technology) objectives to be implemented in this course? There are few female Head Teachers in Oxfordshire Secondary Schools, there are no female Heads of CDT Departments, although there are a few female Heads of Science, there are only five female CDT teachers and all of them are of relatively low status being very recently retrained. Female science teachers are outnumbered by male science teachers. Consequently it seems that the organisers will need to look beyond the staff of the LEA to provide role models for science/technology. Local high technology firms may be able to loan some expert female technologists to demonstrate some skills. This is an area to explore before the next run of courses. It would be a step in the right direction if every school had a chance to think seriously about girls' education in technology, and make appropriate plans, before the GCSE initiatives are formalised. The attitudes of science teachers to the importance of technology in girls' adult lives is negative. They do not perceive technical qualifications as being important to girls in their future lives. These teachers (apparently the majority) who hold sex stereotyped attitudes will certainly convey their values to their female pupils who will then be under-represented in technology. TVEI, by highlighting sex stereotyping, has obliged LEAs to reconsider adequate and appropriate provision for girls in this era of vocationalism in schools, lest girls' career choices become even more narrowed and devalued than they already are. Clearly in view of the staffing situation in science and technology, the commonly held sex stereotypic attitudes held by these teachers, and the on-going opportunities for vocational change, it is of great importance that those who make decisions must regard the vocational future of girls as a subject to be tackled quickly and rigorously.

Aims of the TRIST Technology Course:

The aims of the Course Statement ¹⁴⁷ from the Report on the Oxfordshire TRIST Technology Training Programme are as follows

"1. To provide LEA and school based retraining and updating of Science and CDT teachers in the following areas: Biotechnology; Electronics; Microcomputing; Control Technology; Computer Aided Design; Product Design; Curriculum Development. The general target area of the programme is 'Technology Education', and accordingly, the above courses are intended to cement the shared teaching and development links between Science and CDT Department in Oxfordshire Secondary Schools. It is also concerned with promoting an awareness of technological issues across and within the school curriculum as a whole, as well as practical curriculum planning schemes within the individual schools participating in the programme:

The planning committee envisaged the course acting as a retraining and updating vehicle for CDT teachers. So far as science teachers were concerned it was envisaged that some, depending upon their background in Science and their teaching experience might well benefit at least in some areas, in the same "retraining and updating" mode as the CDT

teachers were expected to. Expectations for other teachers in the science areas who had no practical experience in these technology areas were that they should gain a sensitivity to and perspective about technological issues which transgress the hitherto kingdoms of science and CDT teaching. It was envisaged that the insights gained by this group of science teachers would facilitate Science - CDT staff co-operation in the creation of new Science - Technology core course in particular for the GCSE (GCSE National Subject Specific Criteria - Craft, Design and Technology, Jan '85.)"

However, the Committee statement of expectations was rather too general. This was probably unavoidable as things stood, because of pressing time constraints. Nevertheless, it is clear that it is necessary to provide participants well ahead of time with a course statement which should be spelled out operationally, with examples.

So far as the various topics are concerned, a statement of basic prerequisite knowledge and skills to get maximum benefits from each particular topic should be provided. A statement level of achievement which is realistic for someone lacking some or all of the prerequisites ought to be provided. Basic IT courses should be recommended for those who had no computer experience. If participants are told ahead of time how much fairly simple IT skills will benefit them in terms of getting the most out of the topics presented, many will make the effort to gain those skills. Others, who are not disposed to do this at the time, will enter the course knowing that their expectations might have to be lowered at least in some of the topics offered. Tutors should all have had classroom teaching experience. They should build in to their topics examples of how the materials and techniques can be adapted to the classroom situation, especially with lower-school classes. They should be capable of making practical suggestions about classroom management also. They should also demonstrate their grasp of teaching and management skills in the way they organise their own topic. Participants should be provided with topic information (which is part of the pre-course information) a list of jargon words and meanings, drawings, and diagrams of equipment, manual to the manuals used in computer based courses such as CAD, and anything else that cannot be assumed to be known by anyone who is totally naive in the topic area. References to suitable basic texts (where they exist) which it would be helpful to have read before the course begins, should also be provided. Participants could then arrive having a clear idea of prerequisites, realistic expectations of themselves in areas where they do not have these prerequisites, and a range of useful "crutches" which would allow them to progress constantly instead of waiting about helplessly till aid is available. This would have the effect of minimising the frustrations they were likely to experience, and of supporting rather than possibly threatening, their self-concepts.

Obviously, this means that briefing and development work will have to be carried on before the course begins, with the tutors. They need to know the pedagogical as well as the content priorities of their clients, and they need to be able to discuss and decide the management procedures they intend to use in their own topics.

INSET Modelling

It became apparent from the above cybernetic models (see Figures 18 & 19) that the whole planning process had to be modified to ensure that greater efficiency, in terms of INSET, became the norm to ensure that the course participants were gaining the full benefit of such courses provided as part of the normal pattern of government funded adviser led personal and professional development in the technology field of education.

This study has been overtaken by events. New developments in the UK educational scene have emerged in 1990 with the National curriculum, particularly with LMS (Local Management of Schools) resulting in schools having direct control of their INSET funding rather than the LEAs. This will necessitate a review of these models and the production of another targeted at the alternative methods of INSET in order that future INSET may be efficiently delivered and may be appropriate to technology teacher needs.

Main Conclusions

There are technological subject areas which desperately have to be addressed in the future INSET plans for technology teachers. These plans need to include alternative, appropriate methods of INSET delivery .

The INSET process can be significantly streamlined, made more cost-effective and beneficial to teachers if those running courses follow the practise of: 1. flow sheeting plans for the initial run; 2. producing cybernetic frames; 3 producing later generation models.

The use of simple evaluative instruments can enrich the knowledge about technology teachers and technology in schools and help to clear away counter productive mythology about the subject.

Such a *modus operandi* is apposite to the rhetoric of the times, and as such not only makes sense to its practitioners and participants, but to its political patrons.

Items Relevant to a Pilot Computer Database Development

The items of relevance, arising from this INSET survey, to the Pilot Database development are that it:

1. gave an indication of Oxon. LEA technology INSET and school computer provision prior to the start of the pilot project.
2. provided an in-depth understanding of the competencies and awareness of technology educators in Oxfordshire schools concerning many of the key subject areas of technology and IT (computing);
3. indicated a technology educator INSET and school resource requirement for technology and IT (computing);
4. made the point that plans and a vehicle were needed for an alternative form of INSET delivery for technology educators under LMS;
5. pointed out the need for the production of a dedicated technology education database that required no pre-use INSET or extensive reading.
6. emphasised the importance of planning, management, and modelling based upon feedback when addressing technology educators needs.

OXFORDSHIRE TECHNOLOGY EDUCATION AND INFORMATION TECHNOLOGY (COMPUTING)

During the latter part of 1989 all Oxfordshire LEA secondary subject departments who contributing to the national curriculum designated 'Technology' area (CDT, Home Economics, Business Education , and Art and Design) were surveyed with the aim to: 1. provide data upon one LEA IT (computing) provision; 2. give an indication of technology teacher microcomputer usage; 3. give an indication of technology teacher computing expertise; 4. indicate the situation concerning technology teacher access to microcomputers; 5. gain a picture of technology INSET needs.

The Oxfordshire IT (Computing) Survey

This investigation acted as an extension and reinforcement for the findings of the Oxford Technology INSET Survey which preceded it. For the purpose of this study the individual subjects of CDT, Home Economics, Business Education, and Art and Design were treated as one subject 'Technology' (as per the sense of the new UK national

curriculum legislation). This section covers the research and evaluation undertaken, the results and the conclusions drawn.

Research and Evaluation

The survey Instrument (See Appendix B) utilised for this survey took the form of a questionnaire designed to investigate Technology in an IT(microcomputing) context. It covered the following areas of interest:

1. Equipment and Location

To give an indication of the location of IT (computing) equipment in schools in terms of whether they were in the school network room or in their own departments and what equipment was available.

2. Equipment Use;

To find out the procedure for booking and the microcomputing equipment in schools; whether access to electronic databases was available and if so whether they were used.

3. Teacher Expertise;

To indicate the expertise levels of technology teachers in terms of general and technology subject specific teaching.

4. Teaching With Microcomputers;

To find out the subject specific areas for which microcomputers were being used in a teaching context.

5. Access to Microcomputers Outside School;

To enquire about technology teacher access to microcomputers at home.

6. Teacher INSET;

To find out if users had had, or required any INSET for microcomputing in the technology field.

7. Areas of Perceived IT Usage;

To enquire about the areas which technology educators consider or need to be addressed.

8. General School Details.

To give an indication of the size of the pupil cohort, pupil age range, pupil gender, technology teacher staffing and age, and teaching rooms utilised for technology in a typical LEA.

Initial selection of areas of interest to be investigated were identified by the Co-ordinator of OSSTC after consultation with Oxon. LEA Technology Advisers, and M. Fisher who was concurrently investigating Science Education and IT in Oxfordshire LEA.

Clientele

The DT Advisers for Oxfordshire, the Business Education Advisory Teacher, the Home Economics Advisory Teacher and the Co-ordinator of the Oxford Schools' Science and Technology Centre held separate individual discussions about the IT(Computing) implications of the National Curriculum 5-16 and state of the art so far as IT(computing) technology education developments in Oxfordshire. The Co-ordinator of OSSTC then identified eight interdisciplinary areas which would need to be investigated if the aims of the national curriculum (technology IT) were to have a reasonable expectation of being realised in Oxfordshire. The questionnaire was then obtained from and discussed with M. Fisher. It was modified, and submitted to the Oxfordshire LEA Design & Technology Adviser, the Senior Education Officer chairing the Technology Advisers Group, and the Senior School Adviser, for approval for use in Oxfordshire.

Upon approval the Headteachers and senior staff from the technology areas of all 35 Oxfordshire secondary schools in the area were then circulated with the probe. Senior staff but not headteachers were invited to respond.

Out of a total of 140 possibles some 89 Senior Technologists responded by returning the questionnaire This represents a 63.57% return.

Results

The results of this survey are presented in tabular, graphic, and written form below under the following headings discussed in the previous section : Equipment and Location; Equipment Use; Teacher Expertise; Teaching With Microcomputers; Access to Microcomputers Outside School; Teacher INSET; Areas of Perceived IT Usage; General School Details. All data obtained is from the IT survey instrument indicated above. All responses for the individual technology subject areas are treated together as a whole for the purposes of this study. (NB. This is as a direct result of the UK National Curriculum legislation, combining these subjects under the Technology heading, described earlier in this study).

Equipment and Location

It is quite apparent from the figures below in Table 11 that the vast majority of respondents knew that school network rooms were available and could be used for Technology work. It should be noted that 3 respondents were not aware of the network room provision and 4 did not know the network provision could be used for Technology work.

Table 11

Network Rooms				
SUBJECT AREA	School Network Rooms		Network Rooms Available for Technology	
	Question 1		Question 2	
	In school	Don't Know	Available	Don't Know
Totals	153	3	120	4

The respondent returns in Table 12 indicated that they were also aware of the numbers and types of computers in their schools. (1342 Nimbus (MSDOS-16Bit) of which 1098 were colour systems, 16 BBC/Master (BBCBASIC-8 Bit) systems all of which were colour, 42 other systems of which 10 were colour systems) The other systems were in the main RM 380 & 480 Z (CPM-8Bit) with a few IBMPCs (DOS-16 bit) and a few RM Nimbus (DOS 286-16 bit).

Table 12

Numbers and Types of Microcomputers in Network Rooms						
Question 3						
	Nimbus	Colour	BBC/Master	Colour	Other	Colour
Total	1342	1098	16	16	42	10

They also indicated in Table 13 that they all had access to microcomputers, and peripherals, in their own departments (the total number of microcomputers and peripherals were 815 units). They also indicated that the microcomputers were split into three main groups: RM Nimbus (total number 1429); BBC (total Number 49) and Other (total number 63). (Nb. The other group was generally split between PC clones and RM 8 bit machines with a smattering of odd 8 bit machines.)

Table 13

Computers For Use in Department									
Questions 4 & 5									
Dept	Number	Colour	Mono disc	tape	printers	Sensors	Nets	Total	
Total	259	203	37	187	0	108	1	14	815
Computers	RM Nimbus	BBC/Master		Other					
	87	33		21					

Equipment Use

Of those surveyed (see Table 14) 40% indicated that they could book a class into the network room at least three weeks in a term; 12.86 % indicated that they could not do this at all; 33.57% said they could book two or three weeks before starting a topic; 15.71% indicated that they could not book the room two or three weeks before starting a topic. With regard to booking computer time 64 responses indicated that there was a formal booking scheme for the school computer network, and only 17 responses indicated that there was a formal system for booking departmental computers. Some 26 responses indicated that departmental use was as a result of informal negotiation.

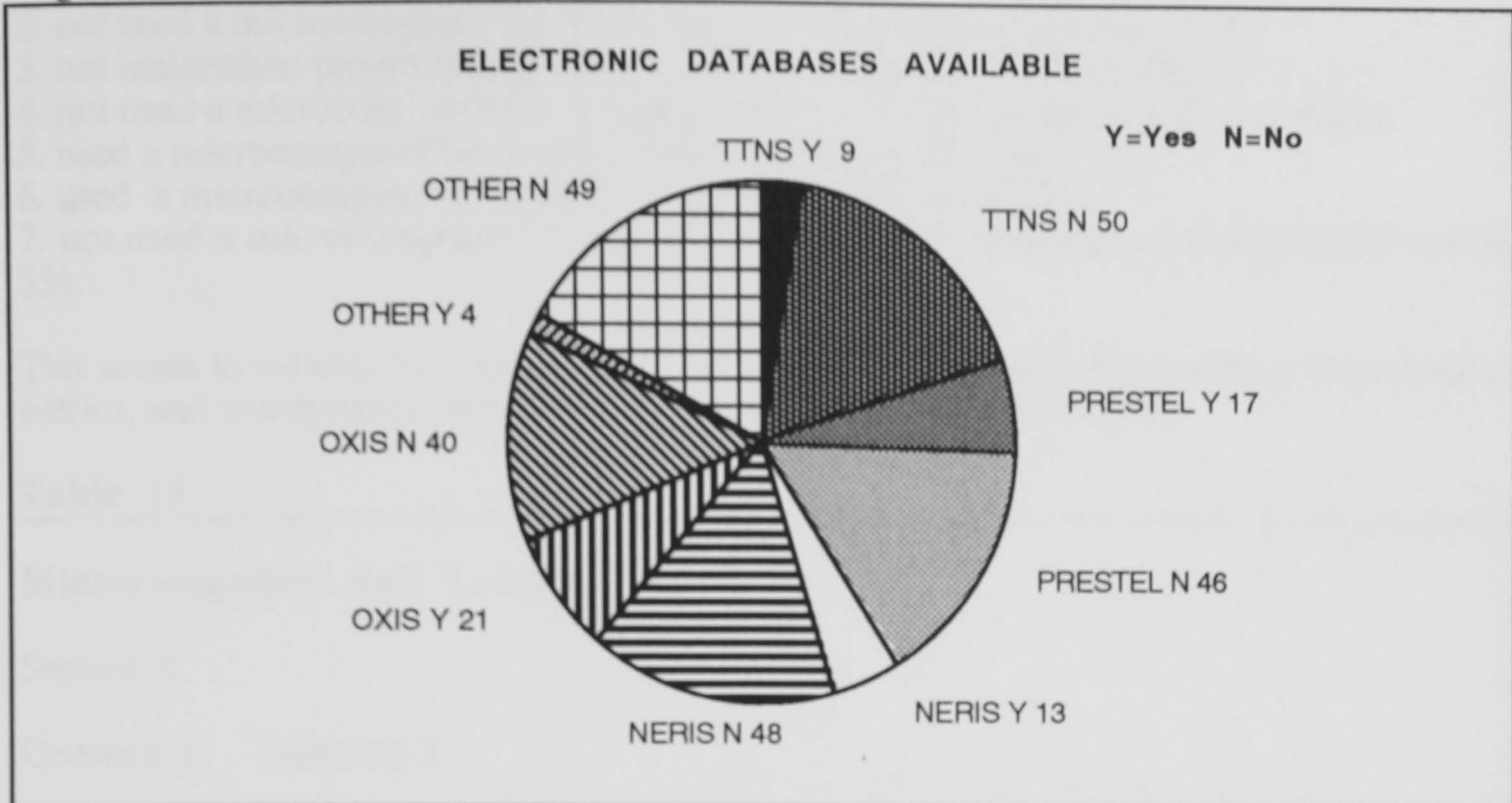
Table 14

Microcomputer Advanced Notice and Booking								
Network Room Timetabling Advance Notice					Booking Computer Time			
Question 6					Question 7a		Question 7b	
year Y	N	2-3 wksY	2-3 wksN		CLO	Other	H o D	Other
Total	56	18	47	22	2	0	3	0

Teacher Expertise

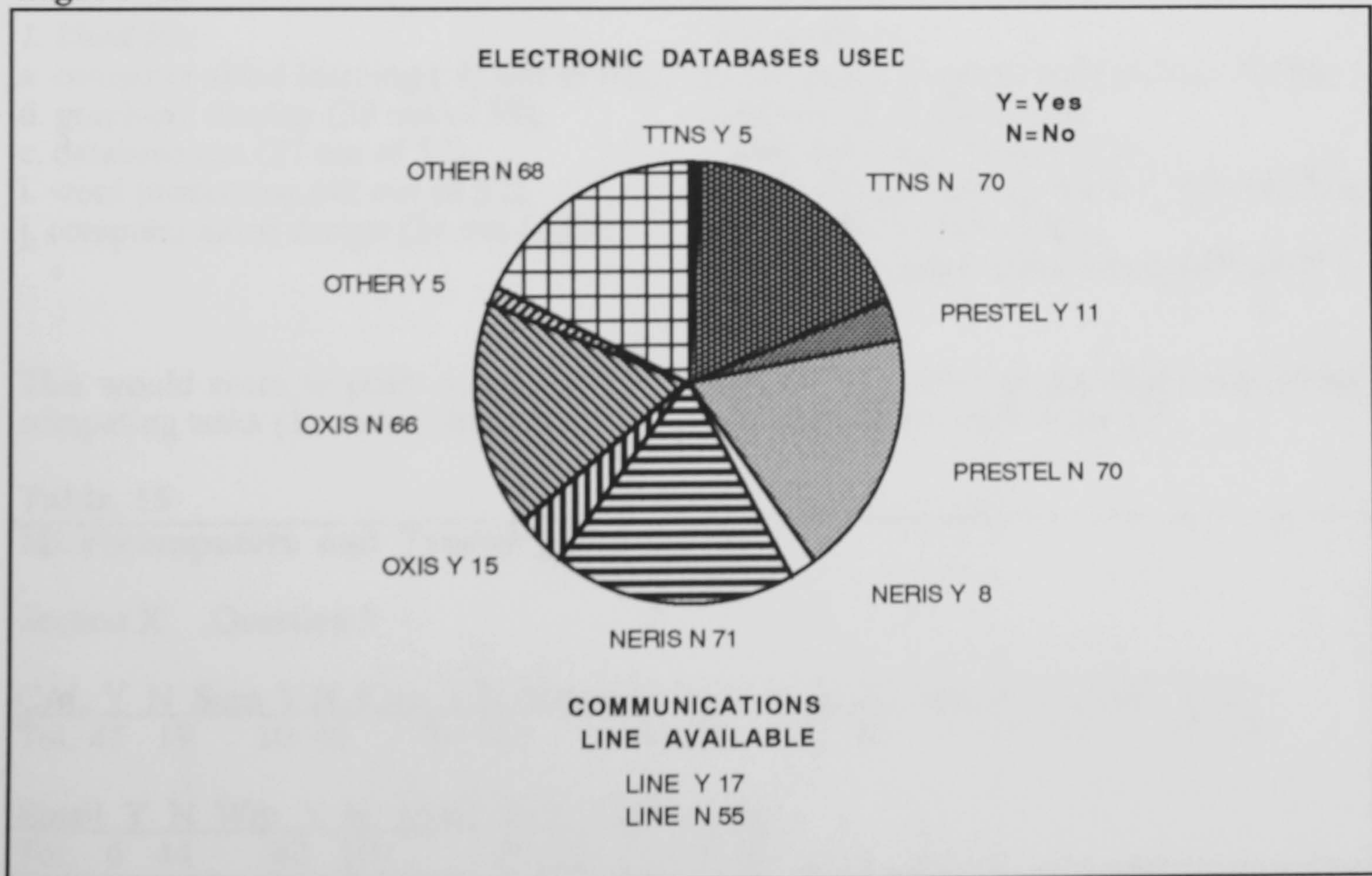
Over 50% of respondents had little experience with accessing electronic databases (see Figure 20) Large numbers of respondents indicated that electronic databases were not available to them; TTNS (50 out of 89), PRESTEL (46 out of 89) OXIS (48 out of 89), OTHER (49 out of 89), an average total of (193 out of 356) 54.21% combined.

Figure 20



If Figure 21 is consulted it will be seen that the vast majority of the respondents indicated that they had not accessed an electronic database at any time. These included TTNS (70 out of 89); PRESTEL (70 out of 89); NERIS (71 out of 89); OTHER (68 out of 89); a Total of (297 out of 356) (83.43%); they also indicated that 55 out of 89 (61.79%) had no access to a school telephone data line for electronic communication

Figure 21



Teaching With Microcomputers

The data obtained from respondents (see Table 15) indicated that the majority of technology teachers had:

1. used a microcomputer for teaching (74 out of 85);
2. not used a microcomputer for recording pupils attendance (66 out of 73);
3. not undertaken programming using a microcomputer ; (37 out of 54)
4. not used a microcomputer for keeping records of pupil progress (32 out of 61);
5. used a microcomputer for word processing (39 out of 55);
6. used a microcomputer for examination entries (33 out of 55),
7. not used a microcomputer for sending messages to other staff and pupils (37 out of 53).

This seems to indicate that the teachers utilised microcomputers for teaching, examination entries, and wordprocessing, but not for general administrative tasks.

Table 15

Microcomputers and Teaching a.																				
Section X																				
Question 1						Question 2														
Ever	Y	N	Att	Y	N	Prog	Y	N	Rep	Y	N	W/p	Y	N	Exam	Y	N	Memo	Y	N
Tot.	71	14		7	66		17	54		29	32		39	16		33	23		16	37

As to the purpose of using computers the teachers (see Table 16) give an indication that they were:

1. Used for:

- a. computer aided learning (41 out of 60),
- d. graphical display (38 out of 53),
- e. database use (27 out of 52),
- i. word processing (42 out of 52),
- j. computer aided design (34 out of 49);

2. Not used for:

- b. sensing and monitoring (42 out of 52),
- c. control (41 out of 50),
- f. simulations (35 out of 53),
- g. modelling & spreadsheets (36 out of 51);
- h. EMAIL (44 out of 50),
- k. computer aided manufacture (45 out of 49).

This would seem to point to respondents utilising the computer for basic technology computing tasks (1), rather than for more complex extensions of that use (2).

Table 16

Microcomputers and Teaching b																											
Section X Question 3																											
CAL		Y	N	Sens		Y	N	Con		Y	N	Graph		Y	N	Data		Y	N	Sim		Y	N	Mod		Y	N
Tot.		41	19	10		42	9		41	38		15	27		25	18		35	15		36						
Email		Y	N	W/p		Y	N	CAD		Y	N	CAM		Y	N												
Tot.		6	44	42		10	34		15	4		45															

Concerning the place where microcomputers have been used within the school for specific microcomputing activities responses in Figure 22 indicated that the major use is in the Laboratory/Subject Room, followed by the Network Room, and virtually not at all

in the General Classroom. As regards use made of the microcomputer the usage appears to be for:

1. Main Usage: Word Processing; Graphical Display; Computer Aided Learning; and Database Work.
2. Secondary Usage: Modelling, Computer Aided Design, and Simulation.
3. Almost Insignificant Usage: Sensing, EMAIL, and Computer Aided Manufacturing.

Figure 22

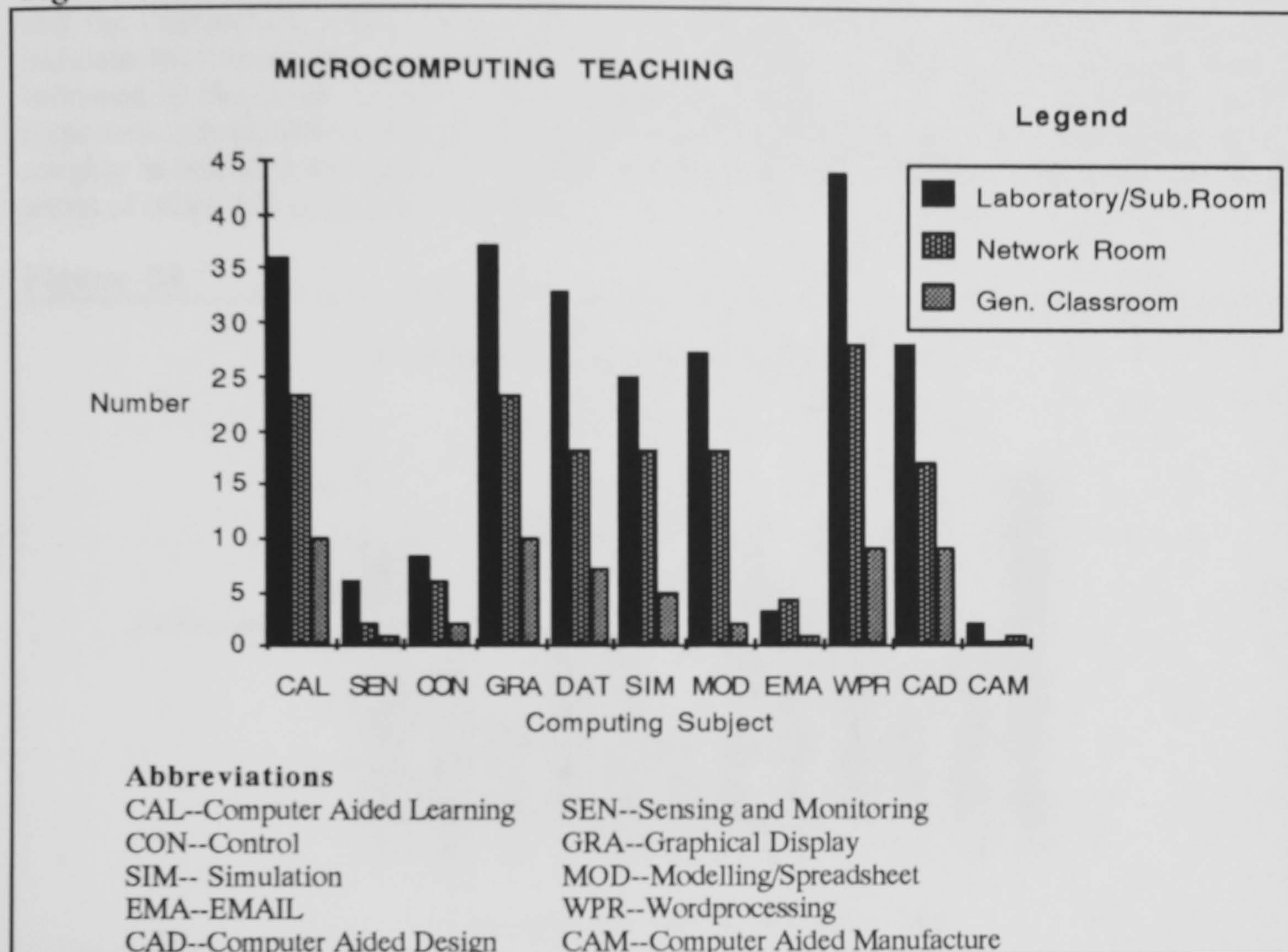


Figure 23

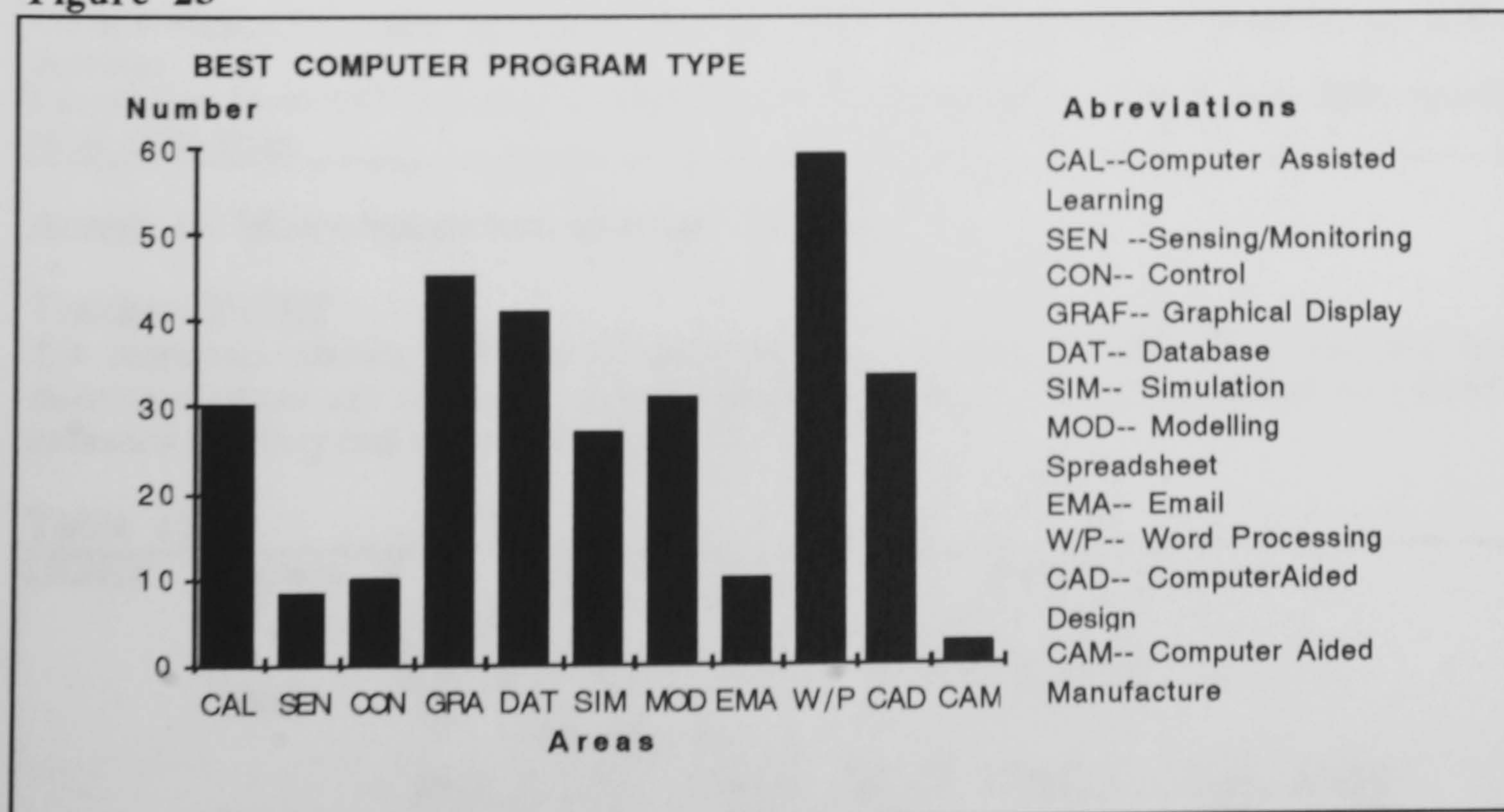


Table 17 also indicates some 76 out of 89 (some 85.39%) had some microcomputing INSET; 28 (32.58%) at the OCC Wheatley computing Centre, 16 (18.60%) at OSSTC, 27 (30.33%) in their own school, and 18 (20.22%) from other sources.

Areas of Perceived IT Usage

Respondents indicated (see Table 18) that microcomputers can give opportunities for open ended technology learning 41 out of 78; could give opportunities 14 out of 15

Table 18

IT Usage					
Question 6					
Can	Y	N	Could	Y	N
	47	21		14	1

General School Details

Table 19 indicates that some 369.1 technology teachers serviced some 35 schools in the 11 to 18 age range (includes other) with some 69,328 pupils on the role. Of these schools 30 were mixed, 3 were females only, 2 were males only. They also indicated that they made use of some 270 technology rooms/facilities within the schools.

Table 19

General School Information											
Pupils	Age	11-16	11-18	9 - 12	13-18	Other	Pupils,	M	F	Mixed	Staff
69,328	16	47	3	15	8	2	3	30	161.1	208	270

Personal Details

Figure 25 shows the age distribution of 83 of the technology teachers, male and female combined. It should be noted that the vast majority are in the 34 to 45 age range, few are in 21 to 33 age range, and few are in the 52 to 65 age range.

Figure 25

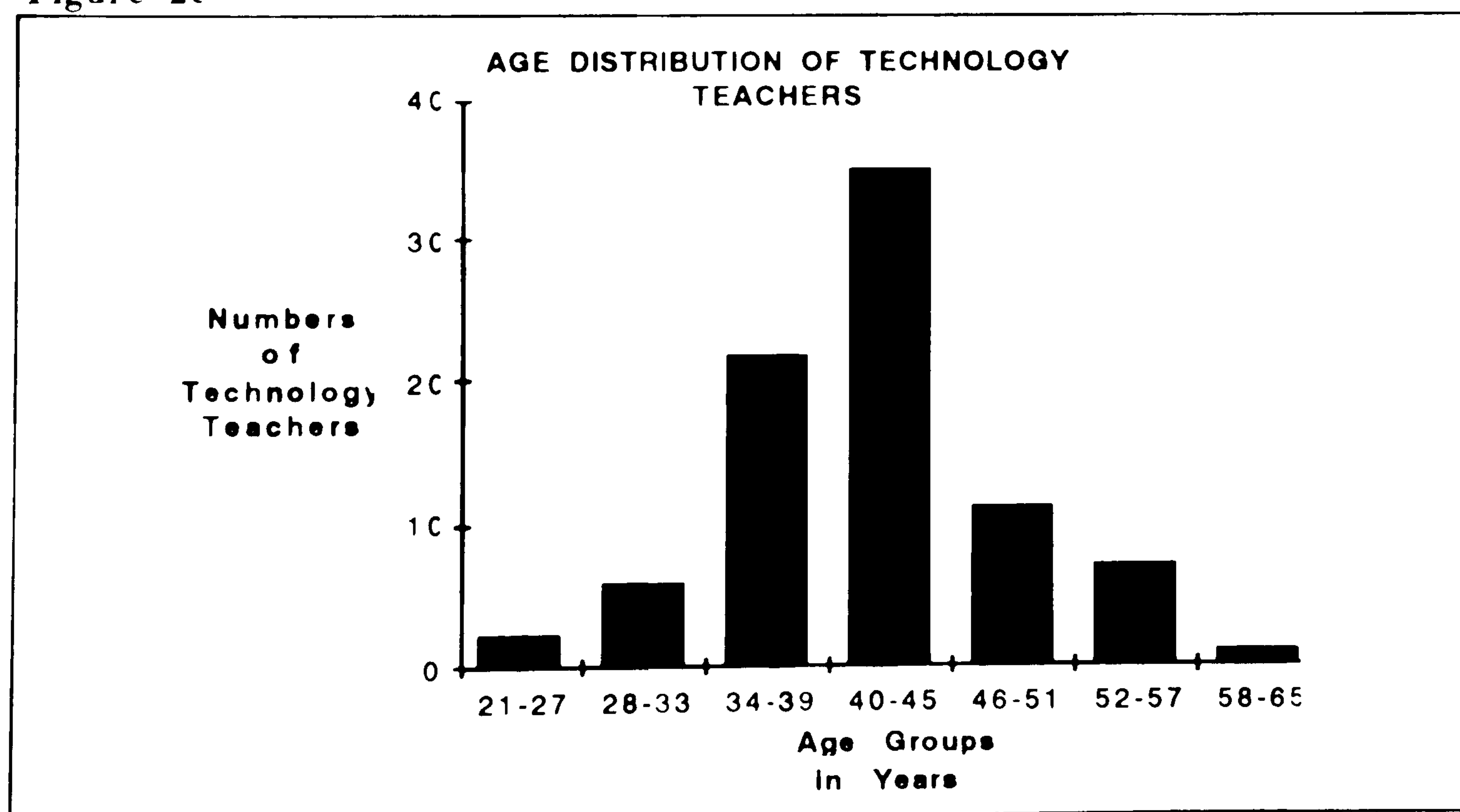


Table 20 indicates the sex distribution of the 83 male and female technology teachers is almost balanced 43 Female 44 male.

Table 20

Personal details									
	Female	Male	Age 21-27	28-33	34-39	40-45	46-51	52-57	58-65
Total	43	44	2	6	22	35	11	7	1

Summary of Findings

With regard the microcomputing situation for teaching technology in Oxfordshire, the above findings show that the following is the situation for the various areas of interest :

1. Equipment and Location

The vast majority of secondary school technology teachers were: aware of the provision of microcomputer network rooms in schools; knew what types of microcomputers existed in their schools; had some microcomputers in their departments; but indicated that they had few peripherals other than printers available to them. They also indicated that the majority of microcomputers in use were DOS based. Evidence also indicates that the DOS acquisition trend is likely to continue.

2. Equipment Use

The majority of technology teachers indicated that they could book the network rooms in advance with notice and had access to those in their department.

3. Teacher Expertise

It is quite clear that the majority of technology teachers did not have expertise gained from experience with electronic databases; the vast majority had not used one, and the majority had no access to a telephone data line. It was also apparent that technology teachers did not use microcomputers of administrative tasks; but utilised them for teaching basic tasks rather than complex subject specific tasks.

4. Access to Microcomputers Outside School

In terms of access to and use of computers out of school: at home less than half of the technology teachers indicated they had access to one; over half of technology teachers had some INSET for IT (computing).

5. Areas of Perceived IT Usage

Technology teachers indicated that microcomputers can and could give opportunities for open ended learning in technology.

6. General School Details

This elicited the fact that technology teachers had an average pupil load of 187.87 in Oxfordshire LEA, and that the vast majority of technology teachers were in the middle (34 to 45 year) age range. Only 18.4% of technology teachers are younger than 34 or older than 52.

Conclusions

The conclusions which may be drawn from this Oxfordshire study of IT (microcomputing) are as follows:

- a. the majority of technology teachers are aware of and have had access to the microcomputing provision in their schools;

- b. there are few peripherals available other than printers;
- c. the main type of microcomputer is DOS based and it seems that this will be the future trend;
- d. the teachers have little experience, expertise with, and access to electronic databases;
- e. that teacher microcomputing expertise is limited to basic rather than complex tasks;
- f. just under half of the technology teachers required IT INSET;
- g. that the vast majority of the technology teaching force are inbetween 34 and 45.

OXFORDSHIRE TECHNOLOGY EDUCATORS AND INFORMATION ACCESS/USAGE

The Oxfordshire Technology Information Access/Usage Survey

This small scale survey covered sample Oxfordshire Technology educators. It was designed to find out the information sources, services and type of information technology educators use when they are starting to teach a new technology topic such as systems electronics, or advising a student undertaking a personal electronics project in the context of their National Curriculum Technology examination work. The survey findings and conclusions drawn were intended to contribute to the case for a pilot technology computer database.

The Research Process

The survey Instrument (See Appendix B) used took the form of a questionnaire designed to elicit data from technology educators upon three areas main of interest. It covered:

1. Sources of Information

To find out the main sources of information that technology educators in Oxfordshire schools were likely to use for technology education in schools.

2. Services for Accessing Information

To find out what information services technology educators in Oxfordshire were likely to use when sourcing information for use in schools.

3. Types of information.

To find out the types of information that technology educators in Oxfordshire would require for their school technology programmes.

This questionnaire was passed to some 15 technology educators, attending an ESTED information seminar at OSSTC on the 25th November 1991. The majority of participants completed it in the time set aside for this purpose at this seminar. A few, upon hearing of the seminar and finding that they could not attend for a variety of reasons, requested the questionnaire in advance of the event and came to OSSTC to complete it at an alternative time.

Upon completion of the process of data acquisition the data was collated and analysed under the section and question headings.

Findings

The findings of this survey are covered within the three survey sections under individual questions . They are as follows:

Part 1 of this survey covers the findings concerning sources of information likely to be used by technology educators for new technology (electronics) topic teaching and student personal project (electronics) advice and the frequency of use of these sources.

Table 23 (overleaf) gives the numerical responses to the survey questions 1 to 21 inclusive. These responses in this table are in terms of Yes No, and two subsets of answers 1. Daily Weekly Monthly Termly Annually; 2. Inappropriate Not Available Cost Other. The subsets relate 1. to Yes and 2. to No answers .

If the findings concerning the Totals element are viewed by consulting Table 21 below it will be seen that :

a. there are some 221 Yes and some 157 No responses; this represents a 58.2% Yes to 41.8% No situation;

Table 21.

INFORMATION SOURCES USED BY TECHNOLOGY EDUCATORS												
Sources	Question No.	Y	N	D	W	M	T	A	I	NA	C	O
School Text Books	1.	13	3	2	6	3	2		1	1		1
School Reference Books	2.	15	3	2	7	3	3	1	1			2
General School Journals	3.	11	8	1	1	5	4		2	3		3
School Technology Journals	4.	11	7		2	6	3		3	3		1
School Science Journals	5.	8	10		1	5	2		3	4	1	2
Newspapers	6.	12	6	3	8	1		1	1	5		
Education Newspapers (Times Educational Supplement or Education Guardian)	7	13	6		12	1			3	2		1
Commercial Pamphlets	8	14	4				6	7	1	2	2	
Commercially Produced Educational Materials (BP or Shell)	9.	14	5	1		2	8	3		2	1	
Government Sponsored Teaching Scheme Materials (eg. NEMEC)	10.	7	11		1	1	4	1	3	7		1
Filmstrips	11.	5	13		1	1	2	1	2	8	1	
Videos	12.	16	2	1	5	6	2		1			
Television	13.	12	6	3	3	7	2		2			1
NERIS	14.	2	15				2		2	7	2	3
Professional Journals (eg. AMMA, NUT)	15.	8	10	1		4	3		3	4	3	
Technical Manuals/Data Sheets (eg. RS Electronic books & Data Sheets)	16.	11	7	3	4	2	2	2	1		1	2
Educational Catalogues (eg. Unilab, Griffin & George)	17.	10	8		1	7	1	1	2	3	1	
National Curriculum Technology Documents	18.	17			5	5	7					
British Educational Index	19.	3	16				1	1	2	6		5
Educational Abstracts	20.	7	11			1	2	4	4	5		2
Examination Board Material	21.	12	6	1	5	5	2	1	1	1	1	2
Totals												
		221	157	18	59	71	59	17	40	63	11	26

b. in terms of the subset 1. that the majority of responses indicate that the usage was mostly **Weekly** (59 responses), **Monthly** (71 responses), and **Termly** (59 responses), from this it may be deduced that the peak was **Monthly**;

c. in terms of subset 2. the majority of responses indicate for non-use of the information sources was that they were **Inappropriate** (40 responses) or **Not Available** (63 responses). These figures indicate that the main reason non-usage of these sources was the **Non-Availability** of these resources.

A detailed examination of the findings in table 23 indicates 6 main items that should be considered because a. they are used infrequently; b. there is more scope for their use; c. they could be promoted more. These are:

School Science Journals with (10 No responses), (3 Inappropriate and 4 Not Available responses);

Government Sponsored Teaching Scheme Materials (eg. NEMEC) (11 No responses), (7 Not Available responses);

Filmstrips (13 No responses), (8 Not Available responses);

NERIS with (15 No responses), (7 Not Available responses);

British Educational Index with (16 No responses), (6 Not Available responses);

Educational Abstracts (11 No responses), (4 Inappropriate and 5 Not Available responses).

There were no findings from Question 22. concerning other sources of information used.

Part 2 indicates the services that technology educators would use to search for information for new technology (electronics) topic teaching and student personal project (electronics) advice, and the frequency of the use of these services.

Table 24 gives the numerical responses to the survey questions 23 to 41 inclusive. These responses in this table are in terms of **Yes No**, and two subsets of answers 1. **Daily Weekly Monthly Termly Annually**; 2. **Inappropriate Not Available Cost Other**. The subsets relate 1. to **Yes** and 2. to **No** answers .

If the findings concerning the Totals element are viewed by consulting table 24 (overleaf it will be seen that :

there were 83 **Yes** and 245 **No** responses, this represents a 25.3% **Yes** to 76.7% **No** situation;

in terms of subset 1. the majority of responses for use of information services were **Termly** (33 responses) or **Annually** (32 responses);

in terms of subset 2. the majority of responses for non-use of the information services were **Inappropriate** (77 responses) and **Not Available** (73 responses), significant **Other** (66 responses) can be noted. Respondents when personally questioned about **Other** indicated that this represented **Time and Distance** constraints.

A detailed examination of the findings in table 22 indicates two clusters of main items that should be considered further because they are neglected and are potential sources of valuable information. These clusters revolve around **Library Services** and the other **European and International** services, in particular:

British Library Interlibrary Loan Service (2 **Yes** responses), (8 **Not available** responses);

Professional Association Library (1 **Yes** response), (6 **Not Available** responses);

Oxford Polytechnic Library (2 **Yes** Responses), (6 **Other** responses);

Westminster College (2 **Yes** responses), (5 **Other** responses);

Oxford University Education Library, (0 Yes responses), (Inappropriate 5, Not Available 5, Other 5 responses);

and

Professional Colleagues Mainland Europe (1 Yes response), (Inappropriate 6 & Not Available 5 responses);

Professional Colleagues World Wide (0 Yes response), (Inappropriate 5 & Not Available 6 responses);

EEC Institutions (0 Yes response), (inappropriate 5 & Not Available 5);

UNESCO (1 Yes response), (Inappropriate 8);

PATT (0 Yes response), (Inappropriate 4, Not Available 4 and Other 5 responses);

International Databases (2 Yes), (Not Available 8).

Table 22.

INFORMATION SERVICES USED BY TECHNOLOGY EDUCATORS												
Services	Question No.	Y	N	D	W	M	T	A	I	NA	C	O
British Library Interlibrary Loan Service	23.	2	16				1	1	4	8	4	
Professional Association Library (eg AMMA Library)	24.	1	15					1	4	6	2	3
Oxfordshire School Library Service	25.	13	4			2	9	4	2			2
Oxfordshire Public Library Service	26.	8	9			2	6		4	2	1	2
Oxford Polytechnic Education Library	27.	2	15			1		1	3	4	2	6
Westminster College Library	28.	2	17			1		1	3	1	1	5
Oxford Schools' Science and Technology Centre Library	29.	6	11		1	1		4	2	1		8
Oxford University Education Library	30.		16						5	5	1	5
Oxfordshire LEA AVA Resource Centre	31.	6	12				3	3	4	4		4
Oxfordshire LEA TVEI Centre	32.	6	11			1	1	4	7	1		3
Oxfordshire LEA Computer Centre	33.	13	6		1	3	5	4	3	2		1
Oxfordshire LEA Technology Advisory Service	34.	13	6			3	6	4	1	2	1	2
Professional Colleagues in the UK (Outside Oxfordshire)	35.	7	12		2	2	1	2	4	2	2	4
Professional Colleagues Mainland Europe	36.	1	15					1	6	5	2	2
Professional Colleagues World Wide	37.		18						5	8	2	3
EEC Institutions	38.		16						6	6		4
UNESCO	39.	1	16				1		8	4		4
PATT	40.		15						4	4	2	5
International Databases (eg. Dialogue or ERIC)	41.	2	15					2	2	8	2	3
Total		83	245	0	4	16	33	32	77	73	22	66

The findings concerning question 42 Any Other Service used are as in table 23 below. It should be noted that only one response was given to the frequency of use element of this question and that this referred to Local industry as a service which was consulted annually.

Table 23.

Question 42.

Any other Service	Daily	Weekly	Monthly	Termly	Annually
Local Industry					1
Colleagues in School					
Technicians in School					
NASA					

Part 3 of the questionnaire asked about the type of information that technology educators would require for new technology (electronics) topic teaching and student personal project (electronics) advice under a series of headings. Table 26 gives an indication of the type of information required and the numerical responses either Yes or No to questions 43 to 55 inclusive.

The findings were that if the total responses in this Table 24 are viewed it will be seen that 178 responses indicated that technology educators required the different types of information listed, and 42 indicated that they did not require these types of information. In percentage terms 80.9% of responses indicated they required the type information listed for new technology topic and student personal project advice.

Table 24.

TYPE OF INFORMATION REQUIRED BY TECHNOLOGY EDUCATORS

Type of Information	Question No.	Yes	No
Curriculum Details	43.	16	2
Teaching Schemes	44.	16	2
Technical Data	45.	16	1
Conceptual Frameworks	46.	11	7
Examination Scheme Details	47.	16	1
National Curriculum Assessment	48.	17	
Equipment Availability	49.	15	2
Consumable Resource Availability	50.	14	4
Internal Pump Priming Funding	51.	9	5
External Pump Priming Funding	52.	9	6
Laboratory/Workshop Availability	53.	13	5
School Curriculum Time Slots	54.	13	4
Technician Availability	55.	13	3
Total		178	42

Question 56 asked whether technology educators would use an extensive European science linked technology education database if it were available and linked to a microcomputer in their individual schools.

The findings were that there were 14 Yes and 3 No responses to this question. In percentage terms this was an 82.35% positive response from technology educators to this question.

Summary of Findings

Part 1.

It is quite clear from the overall findings that the responses indicate that the majority of the cohort of Oxfordshire technology educators access a variety of sources to obtain information. However, it is also clear that the percentage difference of 16.4% between those who accessed the services and those who did not was very small. It would seem to indicate that a large proportion of Oxfordshire technology educators used a small number of sources of information for their curriculum and student project work.

In terms of the use of the main sources it was apparent that the majority of the technology educator accessed these services on a weekly, monthly or termly basis, most activity being centred upon monthly access.

It also appeared that those sources of information which were not used by technology educators were either seen to be inappropriate to their work or not available to them. The high level of non-availability of certain sources of information is of concern, Oxfordshire technology educators cannot assess their usefulness or use them if they are not available to them.

It is also apparent that there were six main sources of information which were not generally being accessed which could be brought to the attention of those involved in science-linked technology education. These sources are concerned with science education, government sponsored technology education schemes, technology filmstrips, the only UK national educational database NERIS, the UK national educational index and UK national educational abstracts.

It is further apparent that these important sources of information are generally not available to technology educators in Oxfordshire schools. This situation, of poor access to important sources of information, must give rise to doubts that technology educators can properly deliver meaningful well balanced new curriculum schemes and properly support students technology projects.

Part 2.

The overall findings regarding the services used by Oxfordshire technology educators to support their curriculum and student project work are of great concern. A very large majority of the responses, 76.7% indicated that Oxfordshire technology educators did not use the support services listed; and that the 25.3% of technology educators that did use the services only used them on a termly or annual basis. Those that did not use them considered these sources were: inappropriate to their work, not available to them in their schools, or they were constrained by lack of time and the distance to the services.

There were two areas of services which were deserving of attention, one which revolved around library services the other around European and international services.

It would seem that with respect to library services, Oxfordshire technology educators do not appear make use of many of these. In particular they made virtually no use of the UK Interlibrary loan services, professional association libraries and local university and polytechnic education libraries. The vast majority of technology educators seem to view these services as inappropriate or not available, some concern was shown to time and distance constraints.

Regarding services, in terms of the use of European and international networks, it would seem that virtually no use was made of these by Oxfordshire technology educators. In particular professional colleagues from mainland Europe and others world-wide are neglected as are EEC institutions, UNESCO, PATT and international educational databases. In all cases the technology educators considered that these services were either inappropriate or not available to them. This serious situation should be investigated further as soon as possible because this is non-use of services must be a major constraint upon Oxfordshire technology educators.

Part 3.

The findings concerning the type of information required by Oxfordshire technology educators to support their work was as indicated in Table 26. A large majority of positive responses 80.9% of the technology educators support this; only 19.1% of the responses were negative.

Some 82.35% of the Oxfordshire technology educators who responded indicated they would use that a European science-linked technology education database associated with their school microcomputers if one was available.

Main Conclusions

It is generally concluded from the findings above that :

1. the majority of Oxfordshire technology educators access a wide variety of sources of information;
2. they mainly access these on a sources on a regular basis during term time;
3. a substantial number of these technology educators do not access more than a few information sources;
4. major information sources available to Oxfordshire technology educators are being neglected and this includes a national educational database;
5. the vast majority of Oxfordshire technology educators do not use many of the information support services available to them;
5. these technology educators do not consider that library services or European and world-wide services are appropriate or available to them, including international databases;
7. it is evident that a further investigation of technology educator usage of some of the sources of information and information services would be merited at a later date;
6. the vast majority of Oxfordshire technology educators would use a science linked technology education database linked to their school microcomputer, if a database were available

CONCLUSIONS TO CHAPTER 3

This section presents and summarises the main conclusions arising from the findings of practice, with regard to Oxfordshire Technology Educators and INSET, Oxfordshire Technology Educators and IT (Computing), and Oxfordshire Technology Educators and Information Access/Usage, and points the way forward to a new development.

Oxfordshire Technology Educators and INSET

The survey findings would seem to point to major deficiencies in the teachers understanding of the ten technology topic areas indicated; a need for considerable improvement in the organisation of such INSET courses; a need for more INSET to address technology teachers. In particular it is concluded that they:

Gave an indication of actual Oxon. LEA technology INSET and school computer provision., and provided an in-depth understanding of the competencies and awareness of technology educators in Oxfordshire schools concerning many of the key subject areas of technology and IT (computing).

Indicated a technology educator INSET and school resource requirement for technology and IT(computing) and made the point that plans and a vehicle were needed for an alternate form of INSET delivery for technology educators under LMS.

Pointed out the need for the production of a dedicated computerised technology education database that required no pre-use INSET or extensive reading.

Emphasised the importance of planning, management, and modelling based upon feedback when addressing technology educators needs.

Oxfordshire Technology Educators IT (Computing)

It is concluded that the Oxfordshire IT (Computing) survey found out the actual situation with regard to Oxfordshire technology teachers and Technology (IT). In particular it is concluded that it:

Indicated that majority of Oxfordshire technology teachers are aware of and have access to the microcomputing provision in their schools and that Oxfordshire schools had few additional peripherals to use with their microcomputers other than printers.

It also found that the main type of microcomputer in use in Oxfordshire schools is DOS based and it seems that this will be the main future trend; and that Oxfordshire technology teachers have little experience, expertise with, and access to computer databases.

Found that technology teacher microcomputing expertise is limited to basic computing tasks and operations and that nearly half of the technology teachers required basic IT (Computing) INSET.

Oxfordshire Technology Information Access/Usage

It is concluded that the survey of Oxfordshire technology teachers information access/usage found that:

Although Oxfordshire technology teachers do need to, and regularly do, access a wide range of sources of information and information services there are substantial number of teachers who do not make full use of available information and information providing services. The majority of these Oxfordshire technology teachers do not consider that external information services are appropriate to their needs or are available to them.

It is evident that a further investigation of technology educator usage of some of the sources of information and information services would be merited at a later date.

If a science-linked computerised technology education database were available for use by Oxfordshire technology educators in their school they would use it.

The Way Forward-Development

It is evident from the above conclusions, arising from the three surveys, that:

1. the INSET needs of technology educators could be addressed via a new non-traditional vehicle in the form of a user-friendly dedicated computerised technology education database;
2. the demands for information access/usage by technology educators could be met by a technology education database;
3. the low level of computer capability, in terms of microcomputer software and usage by technology educators, would have to be taken into consideration in the design and development stages of such a database;
4. that DOS microcomputer systems should be addressed by those developing a school technology database;
5. It is essential to plan, manage, model and obtain feedback from technology educators when planning any new initiative such as a dedicated technology education database

Fortunately I was now in a position able to investigate the design of a dedicated technology education database, as suggested earlier in the Conclusions section of Chapter 1, because funding was available. I also now had a brief from EGBT and Oxfordshire colleagues to pilot and develop a new European science-linked technology education database system.

It is therefore intended, because of the cumulative conclusions from the review of the development of technology education over the last decade and the surveys of technology education practice, to pursue the design and development of a pilot science-linked technology education database. Such a development will take into consideration all of the important points arising from the various elements of the review and this research.

This pilot database development will be covered next in Chapter 4.

CHAPTER 4

THE PILOT COMPUTER DATABASE DEVELOPMENT

This chapter describes the initiatives which form the Pilot ESTED (European Science and Technology Education Database) development which arose directly from the conclusions of the development of technology education over the last decade and technology education practice as found at the ends of Chapter 1. & 3. respectively. It covers this under the headings: the ESTED feasibility study; A European View of ESTED; Industrial Development Techniques; The ESTED Pilot Project; ESTED Associated Activities. It then presents and summarises the main findings.

THE ESTED FEASIBILITY STUDY

The ESTED feasibility study relates specifically to the future ESTED pilot project. It covers all the Oxford initiatives over the last 6 years that have had a contribution to make to the form and operation of the proposed new dedicated technology education database software.

ESTED Related Database Developments and Projects

This section describes four initiatives which took place at the OSSTC, during the period 1985 to 1989, which contributed significantly to the main ESTED development. They are covered below under the following headings:

The Overture Project; The TechData 50 & Macadder and CityLink Databases; The OSSTC ARIC (Apple Regional Information Centre); The Oxford Datalogging and Control Projects; the Main Conclusions are then drawn.

The Overture Project

It is clear from the brief description below that the Overture Project provided vital experience with data handling, installation, formatting, compilation and retrieval of science and technology material.

"Overture" was a databank of resources developed by the "Study of Resources" project at Southampton University on behalf of the DTI Industry Education Unit. The databank, for science and mathematics courses leading to GCSE for (11 to 16 year olds), contained ideas, information and everyday applications for the support of practical assignments, problem-solving, project work and exam questions in real life and industrial contexts. The aim of this project was to produce some 5000 resource items to be accessed by both pupils and teachers on the DTI database. This database was the forerunner of the NERIS database described earlier in this study.

OSSTC was involved in this project in as much that it had a grant to place as many as possible of the resources that it had onto the database. The project organisers at Southampton provided a Resource Package ¹⁴⁸ to enable the OSSTC project officer to input data into Overture. Data was first collated then input into the database as per the appropriate designated form. The resource package guide to use, which is far too big to be included here, gives an indication of the client groups and the data input codes (see Table 25) under which data would be entered.

Table 25

Guide to Use of Package

<u>User of Package</u>	<u>Codes</u>
Industry, commerce, higher education etc. - ideas input	A B D F G *E
Teachers, examiners, advisers etc. - resource writers/producers	A B *E F G H I
Subject Group members, editors indexers	A C H I
General users of database	A C F G

<u>Legend: Codes</u>	A. Aims and Requirements
	B. Offer of Help
	C. Types of Resources
	D. Guideline's for "Input of ideas, data etc."
	*E. Guideline's for producers/writers of resources
	F. Subject topics
	G. Examples of Resources on Database
	H. Header sheets and guideline's
	I. Copyright papers and guidelines

Source - Overture Resource Package¹⁴⁹

Over the 16 weeks period of the project in 1986 some 150 inputs were researched and entered into the form shown below (see Table 26).

Table 26

<u>Data Entry Form</u>	
1. NERIS REF TITLE MEDIA AUTHOR SERIES PUBLISHER PUBLISHED	7. SOLUTIONS
2. CONTENT KEY TERMS AUDIENCE	8. GRAPHICS
3. AVAILABILITY	9. DESCRIPTORS
4. COMMENTS	10. TITLE
5. DATAFILE REF NO DEWEY NO ENTERED UPDATED	11. CONTENT
6. TEXT UPDATED	12. AUDIENCE
	13. MEDIA
	14. AUTHOR
	15. PUBLISHER
	16. IP FILENAME REF NO ISBN DEWEY NO ENTERED

TechData 50, Macadder, and CityLink

There were lessons arising from these projects which were to be directly applicable to the development of ESTED. Techdata 50, Maccadder and Citylink were in many ways the pre-pilot projects for the ESTED software design.

It is apparent that these following items of software cover and exhibit the main stages of development that led to the concept of appropriate user-friendly educational database software utilising the GUI 'click and point approach'. This approach came to be used for the future main ESTED development described later in this study.

TechData 50

The Techdata 50 Database structure was originally conceived in late 1987 with a design brief to produce:

- a. a user-friendly piece of computer software for both school teachers and pupils,
- b. to be usable across a variety of school microcomputers,
- c. software for financial planning and management of technology projects.

The design brief specified that:

- a. that the software learning curve should be very short and steep for the user;
should be simple to use and require the minimum attention to the manual;
all commands should be on screen and easily understood;
the database should be easily updated with some protection for the updater;
should be able to be duplicated by the user in unlimited quantities;
should be on screen window based;
should interface to a standard Epson printer protocol;
be written in BBC Basic;
should be accessed via a CUI Function Key approach;
- b. for BBC Master & Compact, Archimedes, RM. Nimbus, and IBM. PC. Clones;
- c. producing a method of costing up a typical school technology project.

The development program was timetabled over a period of 12 months from September 1988 as follows:

1. September /October --- formulation of software development brief
2. November/December/January/February --- programming
3. March --- alpha version modification and manual development
4. April --- alpha version testing in schools and with teacher groups
5. May --- beta version software and manual final testing and modification
6. June --- initial production run of finalised software and manual produced.

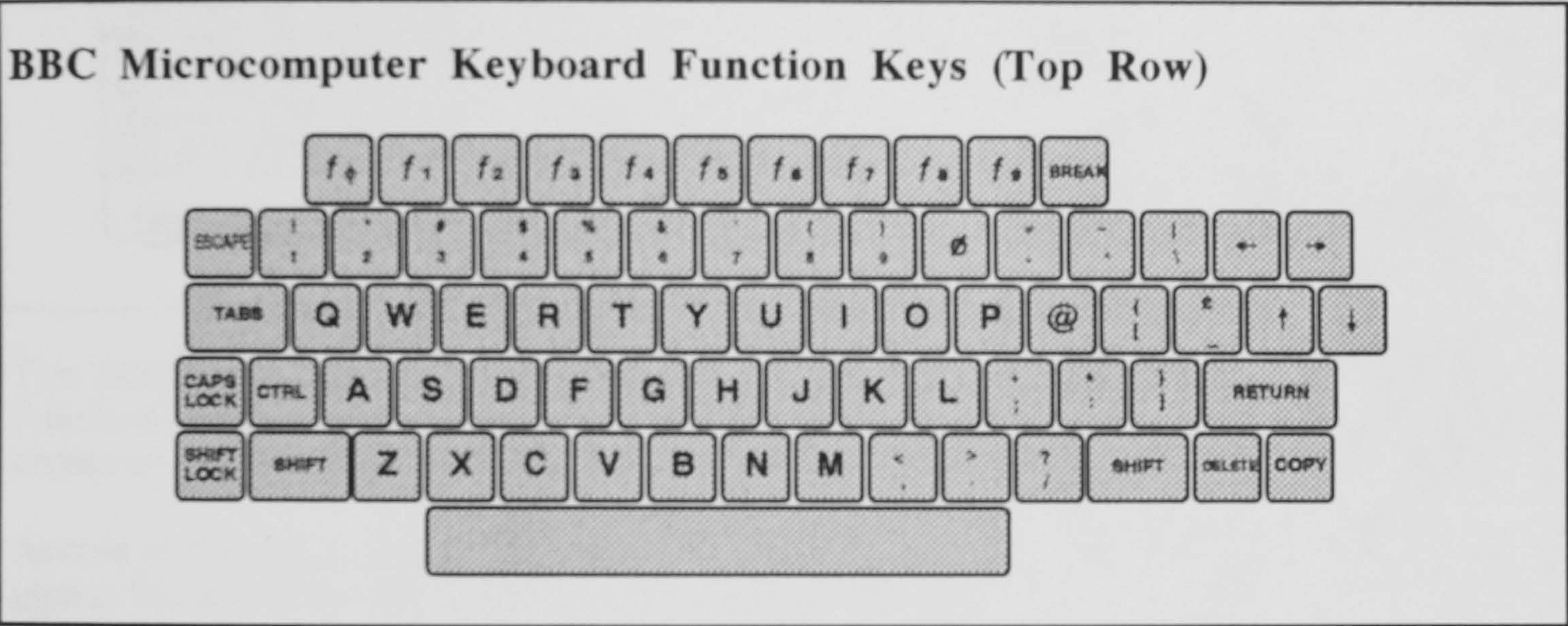
Few problems were met in the development of this software, those that were outside the control of the development group and consisted of small bugs in the early versions of RM Nimbus and IBM PC BBC Basic. Usually they revolved around the different graphics environment encountered.

To manage this project a small team was set up comprising an educationalist (director) , two programmers, and occasional outside consultants. This proved to be a very successful combination as the initiatives came from within, were readily agreed, did not require any more time than initially outlined in the original schedule for the programme, and stayed within the agreed budget.

The process of designing and building the software and documentation was completed as per the development timetable above. BBC Basic was the high level language utilised for the production of TechData 50. Initially work was undertaken on an Acorn BBC Master 128 microcomputer, and then the program was transferred to other machines through a communications link and was run, after modification, under the appropriate version of BBC Basic. For the IBM PC this was BBC Basic 86+; for the RM PC this was BBC Basic 86; the Acorn Archimedes only required the BBC Basic to be converted to run on the machine as the computer uses BBC Basic under a RISC system. It is estimated that a total of some 900 man hours were spend upon the development of this software and documentation.

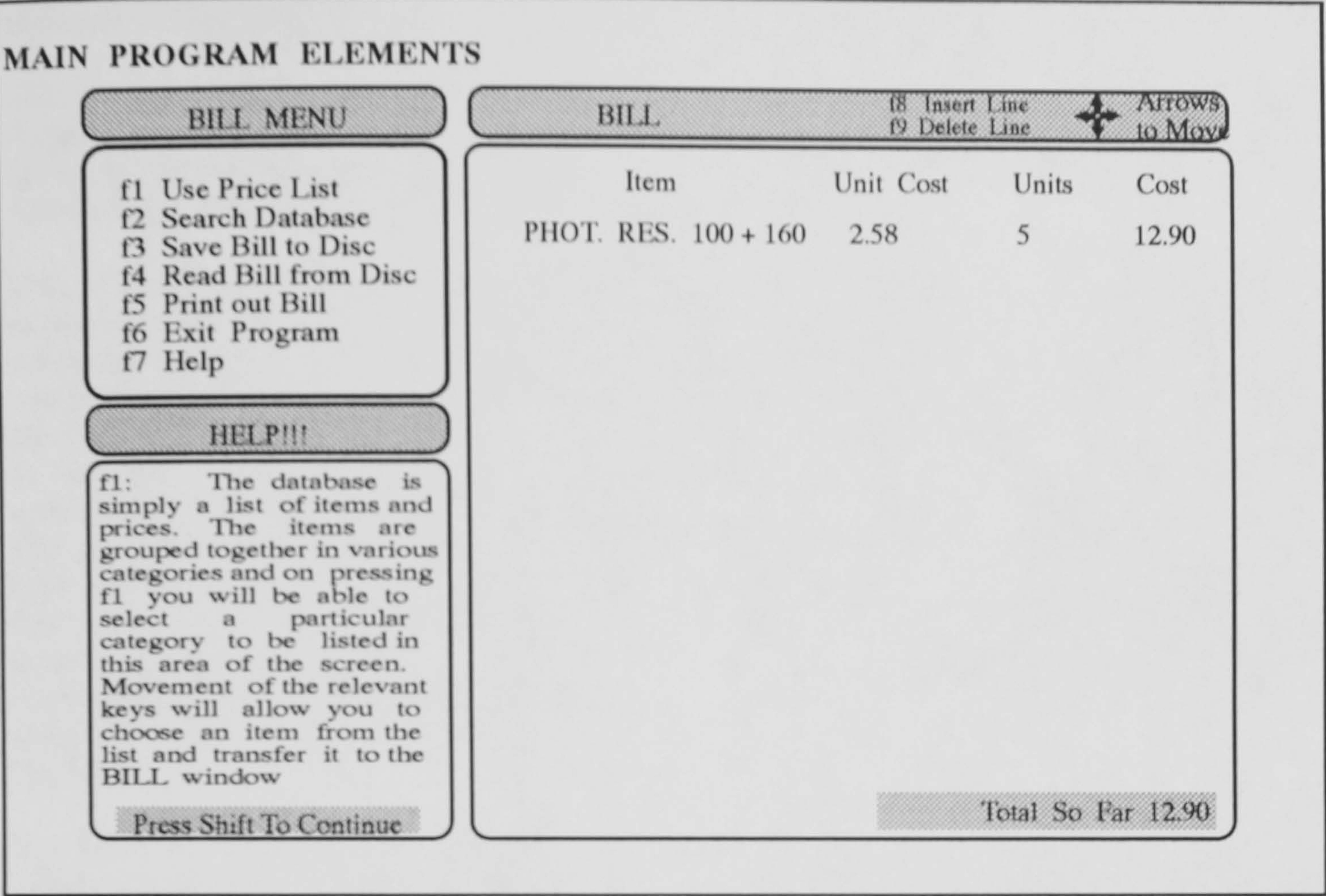
The user interface for this software is simple yet effective for the client groups and is based upon use of the computer keyboard function key facility F1 to F6 allowing various menus to be accessed depending upon the level required through a three element fixed window screen. The Function key facility for a BBC Microcomputer may be seen below in Figure 26.

Figure 26.



The Main Program screen elements are 'Bill Menu', 'Help', and 'Bill'. (see Figure 27 overleaf).

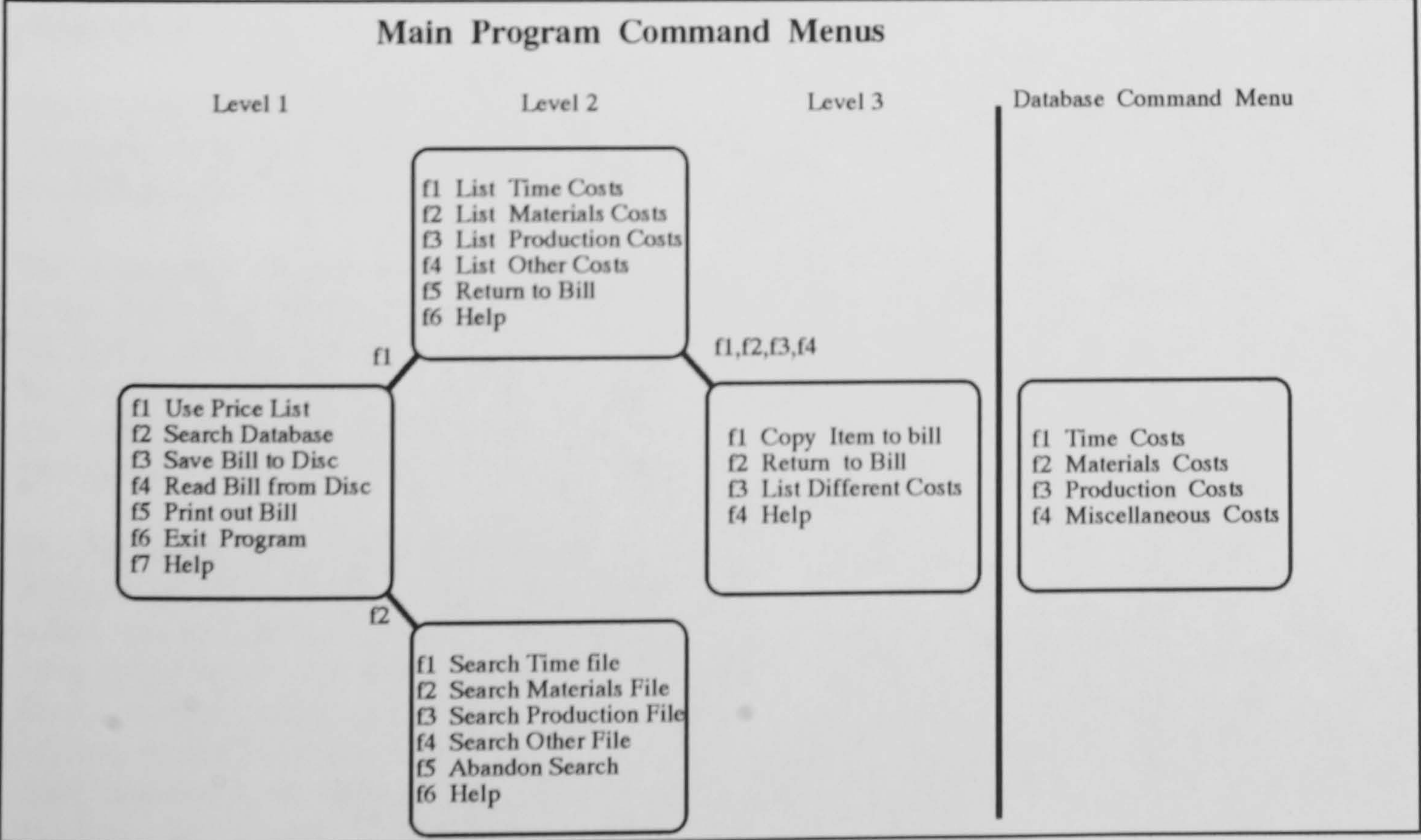
Figure 27



The 'Bill Menu' gives access to all program functions that may be accessed utilising the Function Keys. Please note that on-screen 'Help' is available at all times and that when access to the database is required it appears in this window in place of the 'Help' data.

Access to the 1st, second, and 3rd levels of the programme are through the various level menus via the 'Function Key' system (see Figure 28).

Figure 28



Access to the 'Updatable Database' is via the 'Introductory Menu' via a password. This element of the program functions in an identical manner to the 'Main Program'.

The program itself and the supporting documentation are available for viewing (see Appendix C) for details. Please note that the software is available in various BBC Basic versions for microcomputers utilised in schools namely, BBC Master Series, Archimedes, IBM PC, RM Nimbus.

The trialling of this software was undertaken by two groups: firstly by some 40 experienced science and CDT teachers on technology INSET courses at OSSTC; secondly, by some 120 school pupils in an Oxfordshire secondary school. The science and technology teachers were allowed to run the software individually in the presence of the director of the project. Oral comments upon the software were then made by the user at the time of trial and later at a group session. The trial in the secondary school was undertaken by a senior teacher of science and technology with 4th year technology pupils. The resultant comments from the pupils and from the teacher as a professional in the field were fed back orally to the Director of the project. Resulting feedback was included in the final versions of the software. The main areas of feedback concerned the actual detailed content of the teacher updatable database element of the software rather than the graphics or program operation which were found to be very acceptable. The handbook had to be simplified and rewritten to include the modified example from the teacher updatable database.

The brief for this project was fully met. The final product was delivered in final form, without bugs, and on time. This software was so successful and appropriate for schools that the DTI, through the BIS (Banking Information Service), distributed it to all of the UK's secondary schools free of charge in 1989. (The DTI production run for BIS was 6500 copies of Techdata 50; total numbers produced are now in excess of 7000 copies.) Feedback from teachers, locally and nationally, also indicated that the software met its development criteria. It should be noted at this point in time, February 1990, that requests for this software are now being received from the USA, Canada, and Australia, in addition to UK schools. Currently some 7000 copies have been delivered to schools and colleges.

Macadder

The design brief for 'Macadder' was similar to that for 'TechData 50' except that it had a requirement to address the Apple Macintosh interface and system. It was intended to be a general purpose educational tool for costing projects.

The Macadder programme is effectively an extension of the original concept and coding of the Techdata 50 software implemented for the Apple Macintosh microcomputer under HCI (Human Computer Interface) version of BBC Basic for the Macintosh. The program has been modified to fit the normal Macintosh intuitive interface and to match the graphic and colour demands of the baseline version of the Macintosh. It still addresses the same educational area of financial planning and management, via 'Project Costing'.

The modifications concern the entry into the programme, slight re-definition of the screen window co-ordinates, menu name changes, ensuring the programme runs in a black and white two colour mode, help text updating, and the addition of pull down menus. Menus were provided to activate all items; the function key facility was retained. This provided the user with a slightly more friendly interface to the software than with Techdata 50. It represents the halfway stage between the 'function key approach' and the 'full point and click' approach, as the item lacking is the defined active button function, even though one window click sequence is available on the introductory screen.

The main entry/exit sequence to the programme is :

- | | |
|---|---------------------------------|
| 1. Mouse 'click' in Macadder Icon | to bring up Introductory Screen |
| 2. Mouse 'click' upon Introductory Screen | to bring up main program |
| 3. Mouse Pull- Down Menu 'Base' | password sequence |
| 4. Type Password | enter database program |
| 5. Mouse Pull-Down Menu 'Main' | return to main program |
| 6. Exit Pull down Menu 'Exit' | |
| (available in both programs Main & Base) | Quits programme. |

If the screens are viewed by running the program (see Appendix C) it will be seen that the graphics are very similar to Techdata 50 above except they have pull down menus implemented at the top.

The programme took approximately 250 hours to develop spread over a period of a year. This was because the original version of BBC Basic for the Macintosh was flawed, causing the microcomputer to lock-up or crash. It did not include all the necessary functions to enable the programme to work in a 'Mac-Like' manner. In particular, the pull-down menu facility was not implemented until quite recently when version 2 of HCI's BBCBasic language implementation was released.

Although this programme has been available for some time, it is not yet in production. Trialling and testing has only been undertaken by four technology teachers closely associated with OSSTC. Full conclusions have not yet been made, however, preliminary feedback from the triallers indicates that the implementation is appropriate to needs.

CityLink

The CityLink Database structure was conceived in early 1988, and the design brief agreed, at a meeting of the BIS in London as; a. a user friendly unit of software devoted to teachers and advanced student users; b. being usable across two main microcomputer systems. The educational aim was to address with computer software the needs of the advanced level economics area of the curriculum and especially to encourage and promote an understanding of the City of London market places in school 6th form and further education students.

The design brief specified that:

- a. the software should be friendly and the learning curve should be short and steep; it should be window based (as per Apple Macintosh form); it should have on-screen help at all times; the database should be up-datable in a limited fashion by the user; should be easily duplicated yet protected; should run on a microcomputer with a minimum memory of 1Meg, be written in C.
- b. it should address the Apple Macintosh and IBM PS 2 Model 30 microcomputer and PC clones.

A development programme as such was not drawn up, other than to specify that the project should start in September 1988, and full brief and all database materials should be produced by the end December 1988 so that programmers should start actively programming January 1989. This was undertaken with a view to delivery of the initial software packages for the 1st June 1989 for production and distribution in July 1989. This time scale was extended, as a result of problems described later, to completion by 7th September 1989; this extension was met.

In management terms this project was successful in as much that the software was delivered on time. However, the problems of managing a larger team comprising, an educationalist (Director), an economics consultant, three programmers, two secretaries, outside consultants, and BIS associates, resulted in a much more complex project organisation which did not help progress during the development phase of the software.

Problems related to hardware and software caused by the incompatibility of the versions of C, the Macintosh system and DOS, were the source of great problems which were extremely hard to resolve. Manufacturers made claims about the development software which were untrue, gave virtually no technical support, and were effectively testing alpha and beta versions on the unsuspecting market. Many additional non-contractual hours were spent before reliable development software for the PC was found. The low level of funding of this project caused a run on the very limited budget and actually resulted in a financial loss which would have been disastrous in a commercial environment. The above problems were so serious that doubts on completion were actually expressed. They caused the final completion deadline to be met with just 2 days to spare.

The languages used for the development of the Citylink software was C (Lightspeed & Zorland) (UNIX 4.3 Berkley with C). The development tools were for the PC Matrix Layout and IBM Linkway; for the Macintosh the APW (Apple Programmers Workshop). The machines utilised for the development of the program were: IBM PS2 Model 30 and 50; HLH Orion Minicomputer; and the Apple Macintosh SE and 11cx. Additional software utilised was as follows: Microsoft Word 3; Cricket Draw; Macdraw; Macwrite; Versaterm Pro; Versa Scan; Omnipage; Aldus Freehand; and Aldus Pagemaker.

The process of development was started upon the Orion minicomputer and then transferred to the Macintosh and PCs for further development and production of the two versions of CityLink software. Initially work was undertaken utilising Matrix Layout on the PCs and Lightspeed C on the Macintoshes. The work utilising Layout had to be abandoned as the software would not perform as per specification and could only produce trivial programmes, inputting large graphics proved to be a major headache. Linkway was adopted and was eventually used to produce the final PC version of the software. The Macintosh development tools proved to be more than adequate for the task. It is estimated that some 50,000 lines of debugged C code were produced for the Macintosh version of the software, and some 20,000 of debugged C code for the PC version. It is estimated that 5000 man hours in total were spent upon this project.

The user interface which operates the computer program was based upon the 'Pull Down Menu', 'Icon' and 'Button' activated by the 'Mouse Point and Click technique'.

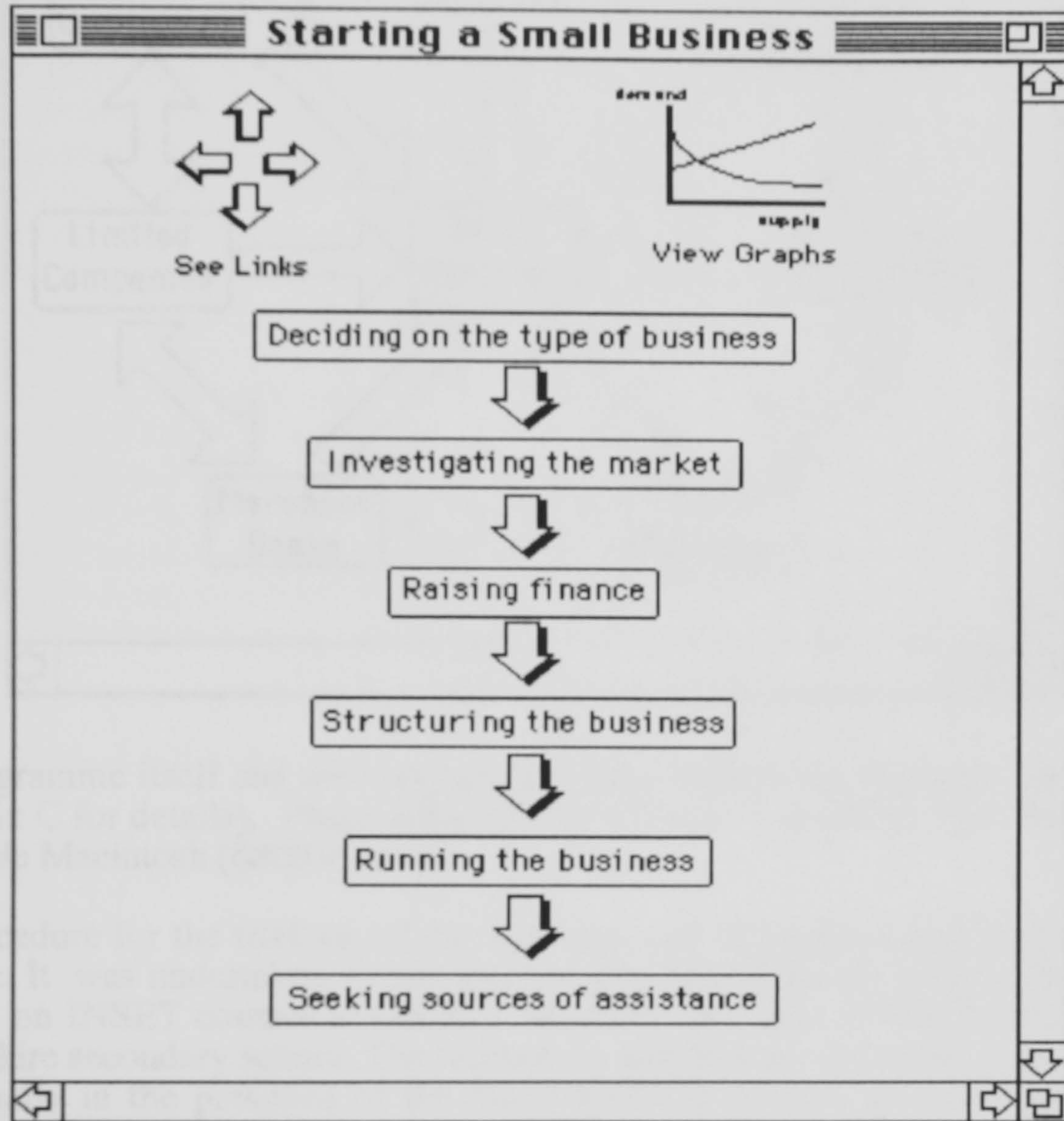
The 'Pull Down Menu' is only a feature of the Apple Macintosh system in this program context. The IBM version relies upon Icon Accession. Icons are small pictures that act as active areas (often they are known as 'Buttons') which when actuated they elements of the computer program to operate.

In terms of CityLink this meant that active areas (Buttons) could open elements of the program, were critical to the operation of it, and were information providers for the user. Users could step forward and backward as they wished, and could activate appropriate areas using a GUI system without having to learn a list of keywords to search for data.

For example, the active areas of one of the events from the program 'Starting a Small Business' (see Figure 29), illustrates this principle. If any of the three sets of active buttons (1. 'See Links', 2. View Graphs, and 3. 'Deciding on the type of business/investigating the market etc.) have the mouse cursor over them, the mouse button is clicked on the area covered by the graphic, then another window is displayed.

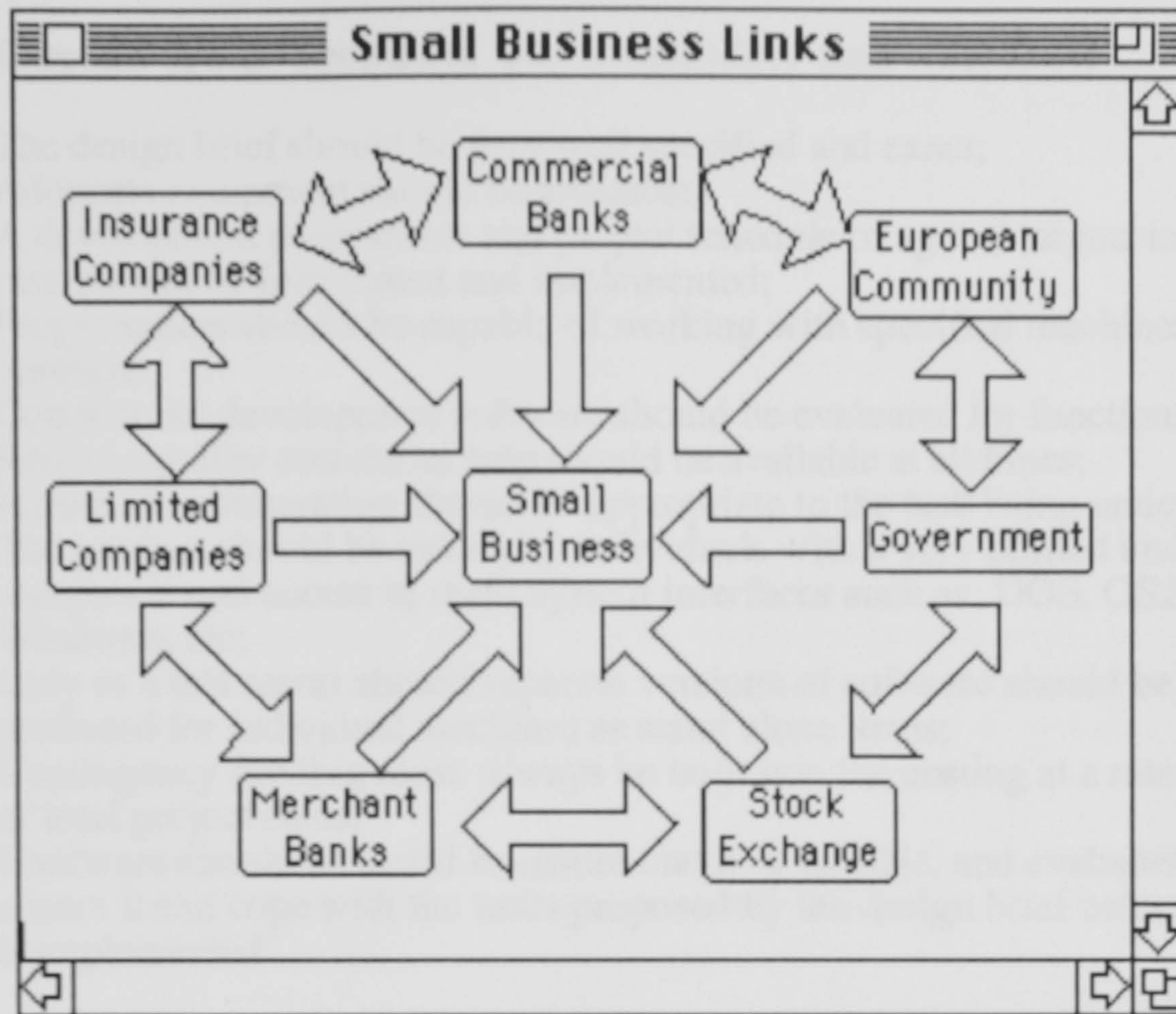
Please note that up to 14 windows may be opened up on the screen at any one time on the Macintosh and a lesser amount upon the IBM PC. All windows are sizeable and scrollable and can hold text or graphics on the Macintosh; the IBM uses fixed scrollable windows which can hold text or graphics. Both versions of the software produce and have virtually identical visual and program features.

Figure 29



By clicking the 'See Links' button the following 'Small Business Links' window is opened (See Figure 30). This allows access to the data and graphics associated with this window. To activate more areas more buttons may be opened by pointing and clicking. If the buttons enclosed in the 'Square Boxes with Text' or the 'Arrows' are activated by pointing and clicking further boxes with active areas may be opened. At each stage information can be liberated by reading what is on the screen and clicking for further information. The user only has to use one device, the mouse, once the program is installed upon the hard disk of the computer, whether it be an Apple Macintosh or IBM PC or clone.

Figure 30



The programme itself and the supporting documentation are available for viewing (see Appendix C for details). Please note that the software is available for IBM PCs (EGA) and Apple Macintosh (680030 series).

The procedure for the trialling of this software was identical to that of the Techdata 50 software. It was undertaken by two groups: firstly by some 20 experienced technology teachers on INSET courses at OSSTC; secondly, by some 30 6th form students in an Oxfordshire secondary school. The technology teachers were allowed to run the software individually in the presence of the director of the project. Oral comments upon the software were then made by the user at the time of trial and later at a group session. The trial in the secondary school was undertaken by a senior teacher of technology with his 6th form students. The resultant comments from the pupils and from the teacher as a professional in the field were fed back orally to the Director of the project. Resulting feedback was included in the final versions of the software. The main areas of feedback concerned the actual detailed content of the updatable database element of the software rather than the program operation which were found to be acceptable. Some slight cosmetic colour changes had to be made to the graphics on the PC version.

The software developed fitted the criteria as specified above hence it can be said to be a success. Teachers and 6th form students trialling and using it have indicated that find it very useful and easy to use. Some 500 copies of this software have been produced.

The lessons that were learnt for the future ESTED development from these three projects covered 11 areas of concern (see Table 27 overleaf)

Table 27**Lessons from TechData 50, Macadder, and CityLink**

1. The design brief should be very well specified and exact;
2. Adequate equipment should be available;
3. A development programme and project schedule of agreed targets to be met, should be formulated and implemented;
4. Programmers should be capable of working with specified machines and systems;
5. Commercial development software should be evaluated for functionality;
6. Reliable quality secretarial help should be available at all times;
7. Financial remuneration should be appropriate to the task being undertaken;
8. The product should be usable by individuals with a very limited understanding of computers and access to main system interfaces such as DOS, OS2, Macintosh, Windows, etc;
9. Only as a last resort should separate versions of software should be produced for individual machines as stand alone items;
10. Contingency funding must always be built into the costing at a rate of c. 40% of total project costs.
11. Hardware should be tested to ensure that it is reliable, and evaluated to ensure it can cope with the tasks proposed by the design brief before the main task is implemented.

The Oxford ARIC(Apple Regional Information Centre)

This sub-section describes the situation concerning ARICs generally, and Oxford's specifically. It gives general details of the support policy in this area and indicated the level of hardware, software, and service support which was available for the support of school science linked technology education and IT. It provided specific details of the OSSTC facility, which was available to the technology educators in the Oxford region and to prospective ESTED development staff, including new microcomputing equipment and the Apple bulletin board/database. It also provided the future ESTED developers with experience with mailboxes, data retrieval and storage systems.

So far over 30 ARICs have been set up throughout the UK, each located in an existing LEA resource base for information technology in education. The Oxford ARIC was established at OSSTC as part of Phase 4 of the Apple planned programme in March 1990.

Apple Regional Information Centres are intended to supplement the existing resources within a Local Education Authority, and to enable teachers and advisers to have 'hands on' experience of this level of technology. The equipment is set up in a 'working environment' that will enables teachers to work in this location at a professional level. The Centres are a valuable additional resource for the INSET of teachers and will provide opportunities for teachers to develop their own materials. Connectivity to the BBC Microcomputer is provided so that a link is established between resources currently in schools and the Apple systems.

The ARIC comprised the following hardware and software:

2 Apple Macintosh Plus microcomputers

1 Schools DeskTop Publishing System comprising an Apple (additional) Macintosh Plus microcomputer, a 40Mbyte hard disk, LaserWriter IINT laser printer, Hypercard software and BBC Microcomputer connectivity.

1 Apple SE microcomputer with 40Mbyte hard disk

1 Apple 1200 baud Modem

Connectivity of all components via the AppleTalk network.

Additionally, a library of software appropriate to education was provided together with supporting documentation.

The retail value of this resource in 1989 was approximately £12,500.

The system was sited in the main room of OSSTC and was linked to the other OSSTC equipment via an appletalk network.

The use of the Apple Regional Information Centre was entirely at OSSTCs discretion, it provided a valuable extra resource for teachers. Teachers were making much use of the resource, particularly in terms of in-service training in the fields of desktop publishing communications and graphic work. (Currently, by October 1990 four INSET courses have been run by either OSSTC or ME Electronics and two were scheduled for January 1990) This provision alone initially covered the INSET of some 80 teachers; it was likely that many more teachers would use the facility at a later date. Apple provided appropriate training for OSSTC staff and included them in support systems for the other ARICs around the country. Connection to the Apple bulletin board and database was provided for the use of OSSTC staff.

Apple¹⁵⁰ when they established this facility indicated that they would wish to give long term support to the Oxford ARIC and to the development of teachers skills in the field of IT (computing) when they stated:

"On our part, we would wish to maintain the identity of the ARIC as an Apple environment and would request feedback from you concerning the use to which the equipment is being put and the suitability of the hardware and software resources to educational needs. You may wish to identify areas for development which you feel it would be appropriate for us to address. In common with the other major suppliers of microcomputer equipment to education, we recognise the need to work closely with advisers and teachers if relevant and useful resources are to be provided for the education sector." and "You will be aware of the terms of the new Educational Support Grant under which LEAs undertake to collaborate with industry and commerce in the promotion of information technology. Apple Computer UK Ltd welcome this development. Its scheme of Apple Regional Information Centres is intended to help LEAs and Regions to extend their resources and to provide teachers with the opportunity to gain practical experience with equipment which is in common use throughout industry and commerce."

Over the last five years OSSTC has been involved with development of much equipment and material for use by both science and technology teachers teaching technology. Typical of these developments are those described in the following under the 'Datalogging and Control Project' heading.

The Oxford Datalogging and Control Project

This sub-section describes one of the elements of the Oxford Datalogging and Control project, undertaken in 1989, under the VELA (Versatile Laboratory Aid) Project heading.

The VELA project was undertaken by the OSSTC Co-ordinator in association with Bowron¹⁵¹ an Oxfordshire science teacher for three purposes. Firstly, to provide for teachers an uncomplicated guide for the VELA, and to provide experimental projects that could be interfaced to the machine; secondly, to indicate the problems associated with the production of an experimental data item for inclusion on a future ESTED; thirdly, to allow guidelines for data-item submission for ESTED to be produced.

Regarding the production of the VELA paper, the OSSTC Co-ordinator undertook the writing, design, graphics, checking of accuracy of technical and commercial data, and the associated problem-solving, from rough raw material provided by Bowran, an Oxfordshire teacher. Bowran proof read the document, the OSSTC Co-ordinator was responsible for the production of the final document.

After a brief summary and introduction, the paper covers: The VELA and Use; Internal VELA Programmes; VELA in the Laboratory/Workshop & Field; VELA User Support; Discovering VELA ; Pupil Projects (Windmill & Tyre Pressure); Accessories & Books. It should be noted that it includes material of a technical/scientific nature and graphics to a high level of sophistication; and that these items have been presented as simply as possible in order to allow those with limited, or no experience, to utilise the VELA.

This paper has: highlighted the problems associated with papers likely to be received from technology educators, especially with those serving in secondary education; and enabled the development of a form of guidance for submitters of material for installation on ESTED.

Bowran, a very busy highly-professional teacher of science preparing and introducing the new national curriculum, produced the rough paper outline to work upon. This was in order that the ESTED developer might glimpse the problems that could arise from papers to be included on ESTED. This material proved to be of enormous value as it enabled the production of guideline's for future paper presentation.

The major problems were:

1. the paper was hand-written and all graphic illustrations were hand sketched;
2. the material was not in any particular order, all items were jumbled up;
3. much of the language and technical details were indecipherable;
4. technical details had not been checked for any form of accuracy ;
5. spurious comments of an ad-hoc nature were included in the paper;
6. logistical communication with the teacher proved to be difficult;
7. instant production results were required;
8. copyright of elements of the paper had not been checked;
9. the level of the paper writing did not match the needs of the clientele ;
10. expenditure on time and materials had not been taken into account in production terms;
11. commercial information had to be included in the paper, and the company concerned had not been approached for its consent to this;
12. no references to data sources were quoted.

The guidelines for papers being produced for inclusion upon the future ESTED paper (see Table 28 overleaf) were drawn up to be simple as possible. This was because conversations with Bowran elicited the fact that the vast majority of teachers undertook educational material development at home, where they in many cases did not have even a typewriter or access to a telephone, in the evening as they were too busy during the daytime. He also made the point LMS (Local Management of Schools) was imminent and in his opinion teachers would have even less time to produce items not directly concerned with their day-to-day work; and teachers would have declining resources and finance to work with.

Table 28

Guidelines for Papers/ Curriculum items for ESTED from the VELA Project

- a. Should be upon white A4 plain paper, preferably typed or word-processed, if hand written they should be succinct, written in plain English, and be legible.
- b. Graphic items should be separate and upon A4 plain paper preferably computer generated, hand sketches are acceptable if they are clear and are in black ink .
- c. All items should be numbered in the correct order and graphics placement should be indicated within the text.
- d. Technical/scientific detail accuracy should be checked before paper submission.
- e. The paper writing level should be targeted at a level appropriate to perceived clientele.
- f. Copyright consent must be obtained for items included in the paper before submission.
- g. Copyright consent for the paper to be included in its entirety upon ESTED must be given in writing.
- h. References should be included at the end of the paper as per the Harvard scheme.

The most important finding from this sub-section for ESTED was that the VELA Project : provided useful guidelines for material to be entered in the prototype database; and gave experience of co-operation between individuals in a curriculum material/hardware environment.

Main Conclusions

It is concluded from the findings from the four initiatives described in this section that they all had a contribution to make to the development of the future pilot ESTED. In particular:

The Overture Project provided vital input guidelines which would allow material to be entered into the pilot database. It also gave valuable experience with data handling, installation, formatting, and the retrieval of school science and technology material .

There were lessons in terms of function, structure and operation arising from the Techdata 50, Maccadder and Citylink projects which were directly applicable to the design and development of a technology education database.

The OSSTC ARIC gave access to new microcomputing equipment and the Apple bulletin board/database; it also gave experience with the equipment, mailboxes and data retrieval and storage systems.

The Oxford Datalogging and Control project gave insights into the nature of the raw written and graphical material which was likely to be forthcoming from practitioners in the field.

One factor which is not obvious, but is vitally important, is that all of the above projects gave valuable experience of working in a co-operative development mode with various agencies concerned with the support of school science linked technology education.

A EUROPEAN VIEW OF ESTED

The major conclusions for the Pilot ESTED that arose from the events; launch, seminar and conference described below; is summarised as:

full support for the development of a European science and technology database was forthcoming from EGTB members throughout Europe; the concept and form it was being produced in was appropriate; the hardware and software target was defined correctly for the clientele; the medium of delivery (CD-ROMs & Bulletin Board) were appropriate; the database would fill the formal non-communication vacuum that currently existed throughout Europe amongst technology educators; the database was essential for teacher Initial training and INSET related to technology education.

It was identified that European technology educators understand that science and technology are intimately linked to technology education; and that technology education is firmly linked to design and manufacturing in scientific and industrial contexts.

The ESTED Launch

In September 1989 the opportunity to formally launch the ESTED Pilot project presented itself when Lord Jenkins of Hillhead, Chancellor of Oxford University, came to open the newly refurbished OSSTC. Representatives from industry (Manufacturing and Service), Education (University, Polytechnic, Colleges and Schools), and institutions and trusts (associated with Science and Technology) attended a reception and dinner at St Cross College Oxford.

At this reception views were canvassed concerning the project and whether it was needed. Typical statements of participants were as follows:

Industrialist -- "cannot understand why this was not undertaken ten years ago; its a pity education lags so far behind industry"

Computer Manufacturer -- "We will ensure that you get support for your work in this area; do keep in mind 1992 will soon be on us"

Software Producer -- "Do keep in touch, any help we can offer we will, it's vital for the UK to get in first with a development"

Senior Science/Technology Teacher -- "It's long been needed, something easy to use, I don't want to think -just switch on and go, I haven't got time to mess about with a class or with my limited free time"

Education Officer -- "Do bare in mind up north that we have a considerable investment in Macintosh and DOS machines, the BeeB is out now."

Software Developer -- "We are going down the CD-ROM route with our next development, are you?"

Science/Technology Institution Director -- "Europe has been neglected for so long, particularly the economic awareness element; I am pleased you are including this element in your database.

Technology /Computer Liaison Teacher -- "The trouble is that the majority of teachers who say they can use a microcomputer can't; they can't even configure it; you need to make it dead easy for them to use. And another thing is that schools generally have incompetent computer liaison officers so you will have to make it simple for them to, make sure its for industry standard machines DOS and MAC"

Higher Education Science/Technology Educator -- "The sooner the better, I hope its easy, have you tried NERIS. It's awful; nothing on it for me"

European Technology Educator -- "Thank you, do make sure the database medium is in English; we are all used to it and write in English."

The after dinner speech by a former President of the European Parliament, elicited the following statement concerning ESTED.

" Instead of waiting at the station and waving good-bye to the train, or fighting for a seat after the train has left, as Britons are oft to do; James Fisher is not only catching the train but is in before all of the other European passengers, and what is more, he is urging the train to start " -- "We wish him well with Europe, and the links he is making, as we are part of it"

Clearly substantial support for ESTED development from the reception guests and a prominent European had been forthcoming. Not one person at this launch indicated that the project was not needed, many gave encouraging statements indicating the project was on target.

The Oxford Conference

The Oxford 1990 conference was a joint EGTB/OSSTC (ESTED) organised event. It was a vehicle for obtaining of information of mutual benefit for both parties and for placing issues and developments effecting both parties before the membership.

In particular its purposes were to:

1. gain an indication of future European funding sources;
2. to present the ESTED concept, programme, and progress and to obtain feedback as to its appropriateness and acceptability;
3. to gain an overview of European (EEC) member states school technology national curriculum initiatives;
4. to hold the EGBT AGM and to formally elect the society's UK Officers.

Of particular interest to this study are 1, 2, and 3 as they relate directly to the ESTED project ; 4 is peripheral yet has some slight relevance to ESTED.

The conference had two elements a seminar and formal dinner at St. Cross College Oxford; and a one day conference at the Oxford University Department of Educational Studies. The seminar at St. Cross College took the form of a reporting, presentation, and brain-storming session on future funding for the EGTB and ESTED. This was followed by informal conversations, before, during, and after dinner. The one day conference took the form of a series of presentations from visiting speakers from the UK, West Germany, France, and the Netherlands on the subject of national curriculum technology in their countries; and the AGM of the EGTB.

Some 35 European technology educators attended the seminar at St. Cross College, and some 40 the one day conference; approximately one third of the participants of the dinner attended the conference too. The participants could be split up into groups representing industry and commerce, secondary education, further education, higher education, educational administration and government, and professional institutions.

The President of the EGBT (European Society for Technology Education) made a very short presentation on the rationale of the EGTB requested help and advice on this subject. This was followed by the Director of ESTED's paper presentation which outlined ESTED and the current level of development (Alpha Version). Oral Feedback was then invited on the project, its future form, and desirability.

The Seminar and informal conversations at St. Cross College elicited the following information with regard to: a. the rationale of the EGTB; b. funding; c. ESTED.

a. The President of the EGTB made a statement at this meeting concerning the rationale of the EGTB:

- "1. the diplomatic perspective of a united Europe is an essential component in the mechanism of world political stability and environmental responsibility;
2. a strong European economic base is necessary to ensure its (Europe's) strength and status, and thus the continued availability of political influence;
3. research into and development of technology underpins the combined economic base of the member states;
4. the promotion of technological capability is needed to develop the educational foundations for the expert and skilled manpower required for technological progress."

Participants indicated in a wide ranging conversation that :

b. "Funds could be available through the Erasmus project if the universities across several EEC countries got together however this might cause difficulties with access for those who were not in the higher education sector; multi-national European manufacturers could be approached for funds bearing in mind that generally speaking each branch of the company usually only sets aside funds for use in host countries; institutions who had an interest in science and technology education such as the Fellowship of Engineering, could be approached as they are becoming more interested in post 1992 developments and a European dimension; it was hopeless to approach the DES or the DTI as they appeared to be non-responsive and evidence existed to indicate that the government in the UK resented EEC interference in primary and secondary education (the 1989 government rejection/refusal to take up the EEC funds assigned to offer all school children in the UK a second European language was cited as an example)".

Generally speaking, solid advice was not forthcoming with regard to funding, although participants were sympathetic. However, two very serious comments that arose out of this conversation were that all educational institutions concerned with technology education were desperate for funds and few individuals knew how to access the EEC funding system. This resulted in the suggestion that MEPs (Members of the European Parliament) should be approached for help and advice.

c. It was indicated that the ESTED project was desirable. Participants stated:

" The ESTED project was highly desirable as many present databases were inadequate; there was need to communicate ideas and information in order to stop the circle of replication of ideas and products; to acquaint colleagues with research that had been undertaken or the progress of research programmes; to ensure that people had access to individuals areas of expertise; that they had honest information upon commercial products and their source; that they were not confined just to national databases; to create a sense of European identity as opposed to national identity; to provide a form of teacher INSET and generally further professional development; to deliver an element of economic awareness sadly lacking in present educational provision".

It was also indicated that: "the approach to database access, namely click and point, was the way to proceed as educationalists, especially teachers, had little time to learn how to use computers and software; a bulletin board element was desirable for rapid communication across Europe"

They also liked the fact that "the software being developed was transparent across DOS and the Macintosh operating system" as these were the systems in main use across Europe.

The conference programme covered the following:

1. a statement on the form of the EGTB- current and future;
2. two presentations upon Technology in the UK National Curriculum : The NCC and Open University View;
3. three presentations from Europe upon their National Curriculum Technology - France, the Netherlands, and West Germany;
4. Questions and Discussion on all of the above;
5. the EGBT AGM.

Conference paper presenters from the UK, Netherlands, West Germany, and France put forward the current situation concerning technology education in their respective countries and related these to the UK national curriculum subject 'Technology'.

1. The major items of interest as far as ESTED is concerned are:
 - a. the fact that several national divisions or societies have developed in the UK, France, Netherlands and that others are in the process of being formed;
 - b. that communication throughout Europe is a very costly, time-consuming process;
 - c. the statutes of the EGTB need to change and a structural reform was necessary to form a Standing Conference of the European Societies for Technology Education (SCESTE). (NB this latter development was described earlier in this study in the section entitled EGTB).

The purpose of these presentations was to respond to the new UK National Curriculum Orders for technology education, and to brief European technology educators upon the present state of affairs in the maintained sectors of education in the various European national states. The European mainland presenters compared their technology elements with the UK situation/view in terms of their individual national developments.

The NCC UK situation/view was that published in their proposals document as described earlier in this study (in Chapter 1.). One point of interest and pertinence to this study was that the NCC, as a result of the consultation process, was responsible for the removal of the formal links between technology and science and mathematics proposed in the design and technology working party report, also described earlier in this study.

The Open University UK situation/view of the technology orders was that they considered the breadth of the coverage of four subjects (CDT, HE, BE, A&D) to be too wide; they regretted the removal of the preferential links between technology and science and mathematics; and considered that there was a poor understanding of the industrial design and manufacturing process by those who produced the orders. It was also indicated that the present GCSEs in technology were inadequate as a basis for technology at Advanced Level: pupils must have science and mathematics.

The French situation/view of technology education was that: it was closely associated with vocational education; and as yet the subject of technology had not been accepted as a national curriculum subject for secondary education; it was undertaken in schools on non-approved basis; was mainly the province of the post-16 year age group; that it had a high reliance upon science and mathematics; it was hoped that it would be included in some form of national curriculum; teachers were already being trained in universities to teach the subject; INSET was a major priority area for serving teachers and was being tackled.

The Netherlands situation/view concerning technology education was that: technology was for all school pupils up to the age of 15 years and was to be established within the frame work of the new Netherlands national curriculum programme; the programme that

was emerging was somewhat vocationally-oriented and was disastrous and incoherent as there seemed to be no logical links between elements; the curriculum resembled a list of random items thrown together; there was no conceptual understanding of what technology education was about by those who designed the technology national curriculum element; they did not understand that designing and making is never done in a vacuum materials, mathematics, and science are all major contributors; and they did not take into consideration the fact that initial training and INSET, was inadequate to support technology.

The West German view was that: they did not have a coherent national curriculum for technology, it varied from state to state, and from county to county (the example given was from North Rhine Westphalia county); not all schools were involved, in particular Gymnasias were excluded; the county curriculum was very much vocationally oriented; technology was seen to be related to the industrial design and manufacturing process and needs of industry; initial and INSET training was well developed however much work had still to be done; mathematics and science were crucial elements of any technology curriculum; international co-operation on technology education was essential; and UK /West German were already in place.

4. The questions and discussion element of the conference never took place as the time slot for this element of the conference was taken up by the individual presentations. Only 4 questions were asked during the presentations and these covered minor details.

5. The EGTB (UK) AGM was of no relevance to this study other than to indicate the breath of support from industry and education in the UK for European developments, and the fact that the ESTED project was supported; the director of this project was elected secretary of the EGTB.

INDUSTRIAL DEVELOPMENT TECHNIQUES

Having presented the Feasibility Study conclusions and European Technology Educator representations it is essential to indicate the industrial development techniques applied to the following ESTED Project and how these techniques relate to the ESTED development project which follows.

The Techniques

This sub-section describes the industrial development techniques that were to be used for the developmental element of this study under the headings: The Feasibility Study; Injective Technology; The Development Process; The Design Process.

The Feasibility Study

A feasibility study is in effect the whole project in miniature. It is mainly a paper exercise, but relies upon conducting key experiments and tests. It keeps large financial risks to a minimum, is a positive form of management, provides results which give a clear assessment of risk and benefit, and an outline plan for proceeding to the next stage. It is a precursor to the main initiative.

A good example of this process in education is given by the Schools Council¹⁵² who undertook a study of technology and the schools by investigating the pilot of the project technology programme with the aim of making recommendations for technology in schools throughout the whole of England and Wales.

An excellent example of a current feasibility study is that concerned with technology in secondary schools in the form of the DES initiative covering City Technology Colleges described by Baker¹⁵³. (NB Full details of this experiment have not yet been published). A good example from the world of industry would be the investigations concerned with the production of a new item of equipment. Oxford Cryosystems¹⁵⁴, a producer of specialist low temperature equipment, undertook a full feasibility study before manufacturing their product the Oxford Cryostream low temperature measurement device.

Injective Technology

This allows the combining of an existing application or newly developed application with technology in a development that will produce a new or improved product for a new market.

Vincent¹⁵⁵ described the characteristics of Injective Technology when he indicated that:

"Every development project starts with the perception of an opportunity. The better this is characterised, the easier it will be to judge the levels of expenditure and risk that are justified.

There are some characteristic patterns by which technology creates new products and new services. Identifying these patterns and exploiting them early gives a company a significant competitive advantage.

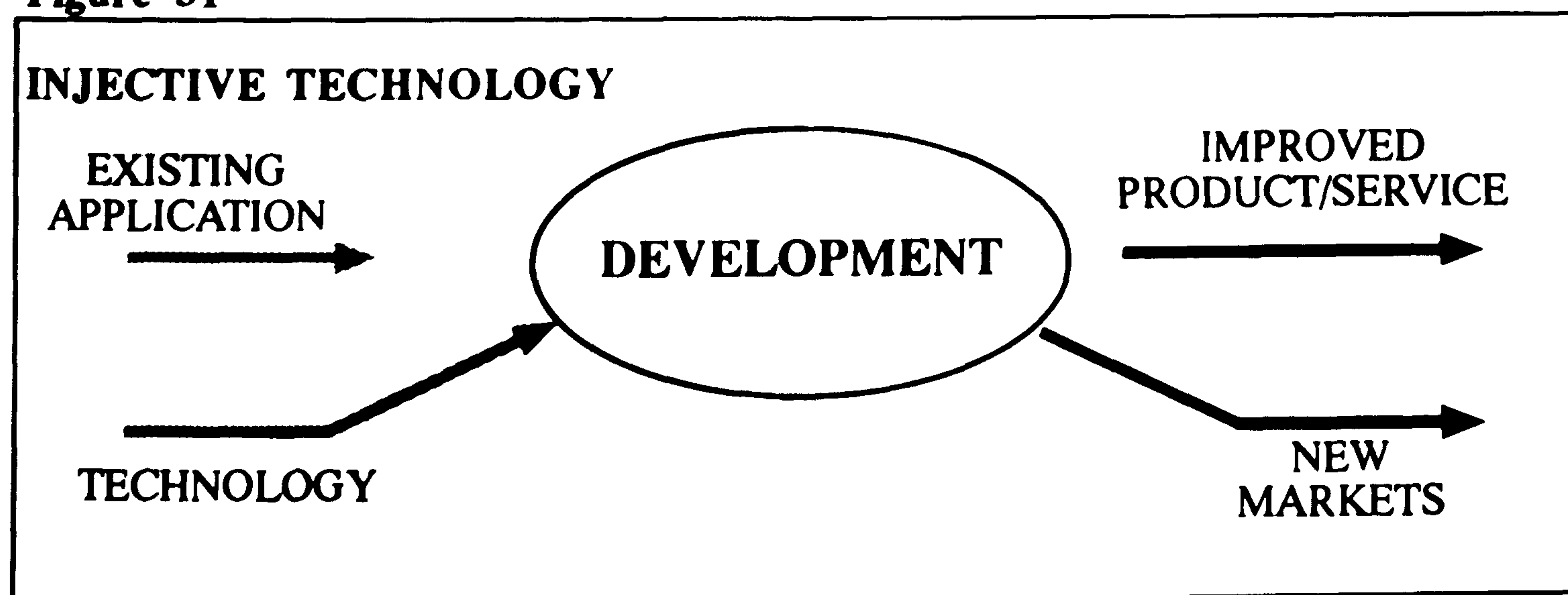
Always, there are two factors to be considered: market trends, and technology opportunities. A significant movement in either of these - or sometimes, a slow change which finally crosses the barrier of economic feasibility - can create a new business opportunity.

Often, the injection of technology to an existing business will lead to a more effective product or service.

Technology can make an existing product cheaper; it can also make it easier to use."

Injective technology has been utilised to develop a wide range of products for the market. Typical of these would be the microcomputer itself, and the many forms of computer software which go hand in hand with the device. The Oxford Interface, described later in this study, was typical of an educational product developed utilising this approach. Vincent's¹⁵⁶ model is seen below in Figure 31.

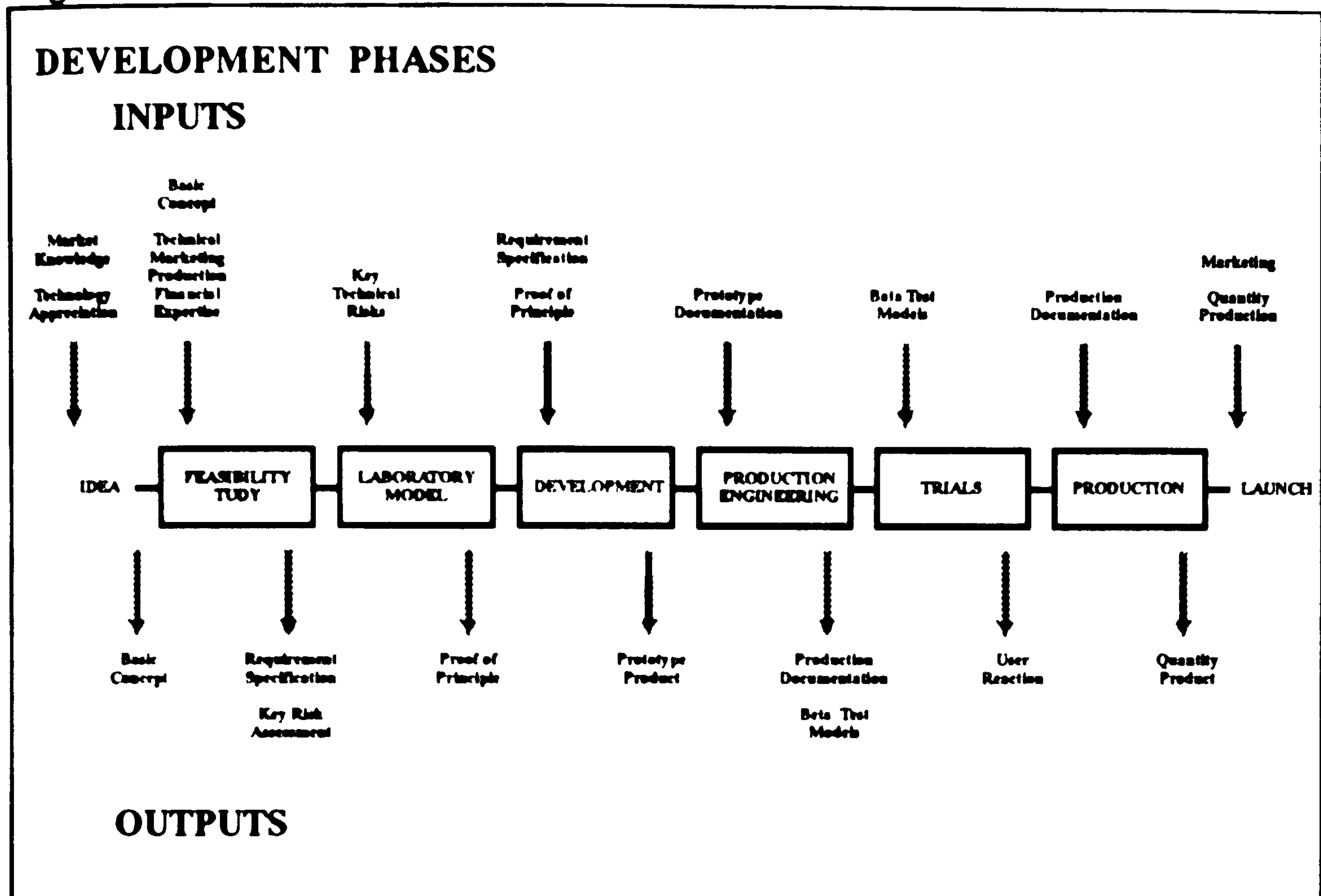
Figure 31



The Development Process

Figure 32. shows Vincent's¹⁵⁷ view of the major phases of a project.

Figure 32



Vincent¹⁵⁸ gave an excellent description of this process when he indicated that:

"Development is not one activity but many. Any project goes through a number of stages, each of which has its own characteristics. Techniques applied to, say, the design stage are not appropriate when it comes to production engineering. Different skills need to be brought in. To be successful, the project needs to be run in different ways at different stages of the process. " and

"The best technique is to recognise the difference between activities and to split the project into a number of distinct phases. This not only divides up the work in a convenient way, it also allows the risk and the finance involved to be controlled effectively. In a well run project, there is a definite breakpoint between each phase where the project is reviewed, the results of the previous phase recorded, and the decision taken whether to proceed to the next." also

"The end of a phase marks a change in the type of activity and gives a sense of achievement and completion to project members. This is particularly important on a long project. It also allows new skills and fresh look to be brought in where appropriate and permits weakness in previous work to be admitted and corrected (without loss of face) before they become impossible to change. The end of a phase is a convenient point for the next part of the work to be re-planned and re-estimated, and for risk and financial benefits to be re-assessed."

This process has been used extensively in industry for the production of almost every commercial product that is on the market from the manufacture of motor vehicles to

microchips. A superb example in industry was given in the BIS¹⁵⁹ videotape which showed a case study of the development of a handset for NHS hospital usage by a Banbury design company.

The Design Process

The design process relates to almost every element of the development process it is a method by which individual artefacts or systems are produced and as such is relevant to this study, especially in the database development phase.

Heap¹⁶⁰ in 1989 described the design process when he stated:

"Design (in this case subsuming innovation) is thus a complex process consisting of a number of activities affecting many attributes of a product or service including: what it does; how well it does it (performance); how it looks (aesthetics); how it is made/delivered; how it is packaged; how long it lasts; what it costs; its customer appeal; how it integrates with other products/services. Such attributes or factors make up the 'design mix'."

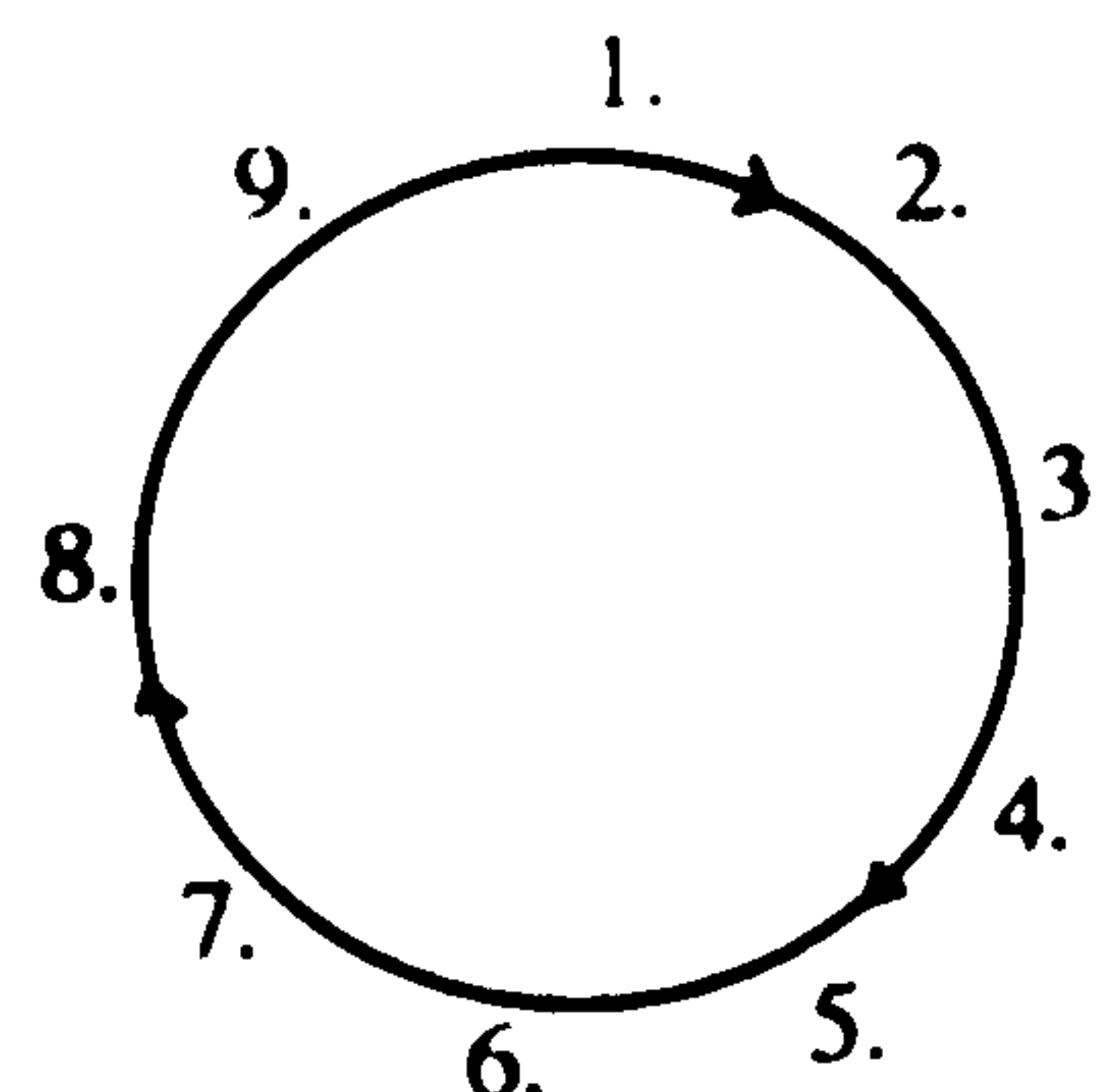
Typical examples of the use of this process are indicated by Heap¹⁶¹ within the context of industrial product development in his case studies of: Pittersgill-Kaye the Lockmakers; and Steelcase Inc. the Office Furniture Makers.

The Design Process model in general usage is cyclic in nature, constantly repeating itself in a feedback loop until the optimum final solution is reached. This model in a simplistic form is as follows in Figure 33:

Figure 33

THE DESIGN PROCESS

1. Specify and Define the Problem 2. Research the Problem 3. Produce Preliminary Solutions 4. Select the Most Appropriate Solution 5. Build the Chosen Solution 6. Test and Evaluate the Built Solution 7. Modify the Solution as a result of Testing and Evaluation 8. Redefine the Problem 9. Continue the Process A 10. Stop The Cycle When Optimum Solution is Reached.



The Application of these Techniques

This sub-section indicates how the industrial development techniques described above were applied to the ESTED project.

The ESTED software development feasibility element was in the main a paper exercise which conducted the whole project in miniature to see if it was a viable proposition. It revolved around the assessment of risk and benefit and the outline plans of the physical development process. The lessons learnt from TechData 50, Macadder, and CityLink

software were applied to the project within the context of the development process (see Table 29).The guidelines learnt from the Overture project, and Vela were applied to data-input in terms of form, users, and categories (see Table 28).

In terms of injective technology a new perceived science linked technology education market opportunity for ESTED was available through the EGBT and throughout an enlarged free trade European market arising in 1992. New technology in terms of computer hardware and software from IBM, Apple, Aldus, Blythe, and Microsoft was available to support such a development An improved service to European technology educators was to be the end result .

Vincent's Injective Technology model (see Figure 31) was applied to ESTED because:

<i>The Existing Application Technology</i>	was the Omnis 5 Software Development System; was the new Macintosh 11cx, Apricot 386 Zen i, and Windows 3;
<i>Development</i>	was the ESTED software system;
<i>Improved Product/Service</i>	was the ESTED Database System;
<i>New Markets</i>	was the post 1992 European Educational Market.

The development process was applied to this project because it provided a framework for the control of the ESTED project. The whole of the actual ESTED software project was therefore treated under the following headings; the Idea, Feasibility, Laboratory Model, Development, Production Engineering, Trials, Production Version.

The design process is in an integral part of the design of any new product and was applied alongside and within the development process.

THE ESTED PILOT PROJECT

This section covers the initial proposal for the pilot project, the development and production process, the final database product and the conclusions; and contentions concerning this new computer database for technology educators. This is covered under the following headings: The Initial ESTED Proposal; ESTED Development and Production; ESTED The Final Product; and The Unique Characteristics of ESTED

The Initial ESTED Proposal

This sub-section describes the initial ESTED proposal put forward in 1989. The proposal briefly outlines the original concept, clientele, staffing and responsibility, industrial support, the feasibility timetable, content and facilities, development needs, equipment and software, costing, further equipment and financial requirements, the project schedule and outcomes.

Concept

The ESTED Pilot was established at OSSTC, within Oxford University during the 1989/90 academic year because there was a perceived need to provide access to information and to communicate it to all involved in school technology education in the EEC and its main associate member states. This was considered essential if Europe was to continue to lead the technology education field. This pilot (Phase 1) ESTED project was endeavouring to ascertain the feasibility of the main ESTED development which it was hoped would receive funding for Phase 2 implementation during the academic year starting in 1991. This database would be established at Oxford University, with the support of the EGTB, and hopefully the proposed SCESTE, for the benefit of all EEC members.

The pilot database network was to comprise an experimental node at Oxford, on the Janet network, with a terminal in West Germany. In its final form it was expected to take the form of a database with a series of nodal points in each EEC and other European Member States connected to each other through either the EARN and Janet networks or the Olympus Satellite System. It was intended that each database should be accessed through the local telephone network of the EEC member state or by personal CD-ROM discs. The final stage would ensure that overseas and non-member European states could also access the database.

Clientele

The target clientele envisaged for this development were European :

1. Technology Educators (University/College/School); 2. Industrialists; 3. Governmental Agencies (EEC & National); 4. Specialist Groups (e.g. Disabled) 5. LEA Staff.

Responsibility and Staffing

The Co-ordinator of OSSTC was to lead, and have full responsibility for this project. All project funds, staff and the project programme were to be controlled by the Co-ordinator supported by a Project Officer. The project staffing had two elements: 1. the working team based at Oxford University (OSSTC); 2. supported by voluntary consultants from education in Oxford and the EGBT. The Staffing expertise was to be further supplemented and supported, as and when necessary, by consultants drawn from professionals working in the technology education field including EGTB members.

Industrial Support

Several companies and organisations were to support this pilot project by donating either equipment, software, technical support, consultancy or expertise. Among these were: IBM (UK), Acorn (UK), Apple (UK), Design Craft and Graphics (Long Hanborough), and ME Electronics (Oxford).

Feasibility Study Timetable

The feasibility study was to take the form of a research and development project to be undertaken over a period of two years (89/90 & 90/91). It was to investigate the educational and technology education database scene at the same time as actually building the database and formulating the final bid for funding for all EEC countries to be on the network. It was to cover:

- a. A review of existing literature related to databases in education and technology education
- b. Visits to gather data on existing educational and technology education databases in Europe, USA., and Australia
- c. Views upon technology education experts upon such a development;
- d. Database design
- e. Software design
- f. Equipment design and needs including Satellite hardware
- g. Input data
- h. Trialling and evaluating the database
- i. Formulation of phase 2 EEC bid

Content and Facilities

It was thought that the database would contain items related to school technology education such as:

research papers; school curriculum material; lists of dissertations and thesis; reports and occasional papers; lists of specialists and their areas of expertise; details of appropriate equipment reviews of manufactured products; lists of specialist institutions and agencies supporting the field; a mailbox facility; back-up facilities for projects and other network nodal points

Development Needs

The following were needed, and either were in place or were in hand, for the pilot project development:

appropriate software; a minicomputer and terminals; assorted computer hardware and consumables; dataline installation rental and use; Janet Node subscription; office consumables, facilities and secretarial support; development staff; travel and subsistence; specialist consultancy; and technical support .

Equipment & Software

The following equipment and software was already specifically assigned to the pilot project:

- a. two Mac 11cxs, a Mac SE30, and IBM PS 2/ 30 & 50 microcomputer systems -
- b. an IBM Minicomputer

- c. four Printers (Apple NT11x Laser Printer, Apple Imagewriter11, IBM Proprinter)
- d. misc. Equipment including a Microtech Scanner, and a Canon P7 Photocopier
- e. Software for the microcomputer including MS Word, Aldus Freehand, Omnis 5, Oasis, Omnipage, and MS Chart

The above were to be supplemented by the full range of OSSTC computing equipment, software and services

Costing

A substantial contribution to the project had already been found and more funding would be sought. This covered three main areas:

1. In-kind Contributions had already been made in the form of Software, Equipment, Consultancy, Staffing, and Travel.
2. Further Cash Contribution were sought to cover Dateline Connection and Use, and Staffing.
3. Further donations of equipment were sought.

Pilot Project Schedule

The initial Pilot project schedule was envisaged to be spread over the period September 1989 to July 1991 inclusive. This may be seen in the following Table 29.

Table 29

Initial Pilot Project Schedule		
Sept. 1989- Dec.1989	Jan 1990 - March 90	Apr. 1990 - Jul. 90
1. Initial Planning Meeting Phase 1.	8. Progress Planning Meeting	15. Submit Questionnaire
2. Data Collection-Tech. Ed.	9. Questionnaire Design	16. Visit USA Tech. Ed. Database
3. Setup Equipment Facility	10. Complete Initial Software Design	17. Initial On-Line Trial
4. Start Designing Software	11. Trial Entries	18. Revise Software
5. EGTB Visit and Discussion	12. UK Database Data Collection and Collation	19. More Trial Entries
6. EGBT Presentation	13. a. Visit to Australian Database Present Paper	20. Halfway Stage Review and Planning Meeting
7. UK Database Visit and Data Collection	b. EGTB Paris Presentation	
	14. Collate- Tech. Ed. Data	
Sept. 1990 - Dec 90	Jan. 1991 - March 91	April 1991 - July 91
21. Analysis of Questionnaire	25. Continue Adding Data	27. Final Report
22. Field Trials of Beta Version Completed Database	26. Start Writing Up Report	28. ESTED Available
24. Progress and Planning Meeting		29. Start Phase 2.

Outcomes

It was intended that a report on the Oxford ESTED developmental project would be produced. This report would be submitted as part of a request for Phase 2 ESTED funding to the EGTB, EEC, and to other agencies.

ESTED Development and Production

This sub-section describes the development approach, timetable, facility, design process, the laboratory models, and the production model.

Development Approach

The development approach for this project was based upon the industrial development techniques described in the preceding section of this Chapter. This was in order to ensure that the development of ESTED was undertaken in a rigorous, scientific/technological, comprehensive, and orderly manner.

Development Timetable

The actual timetable for this development was not as that indicated in the in the initial main project schedule but arose out of external constraints, related to OSSTC and its future, beyond the control of the project director. The actual time table was as shown in Table 30 .

Table 30

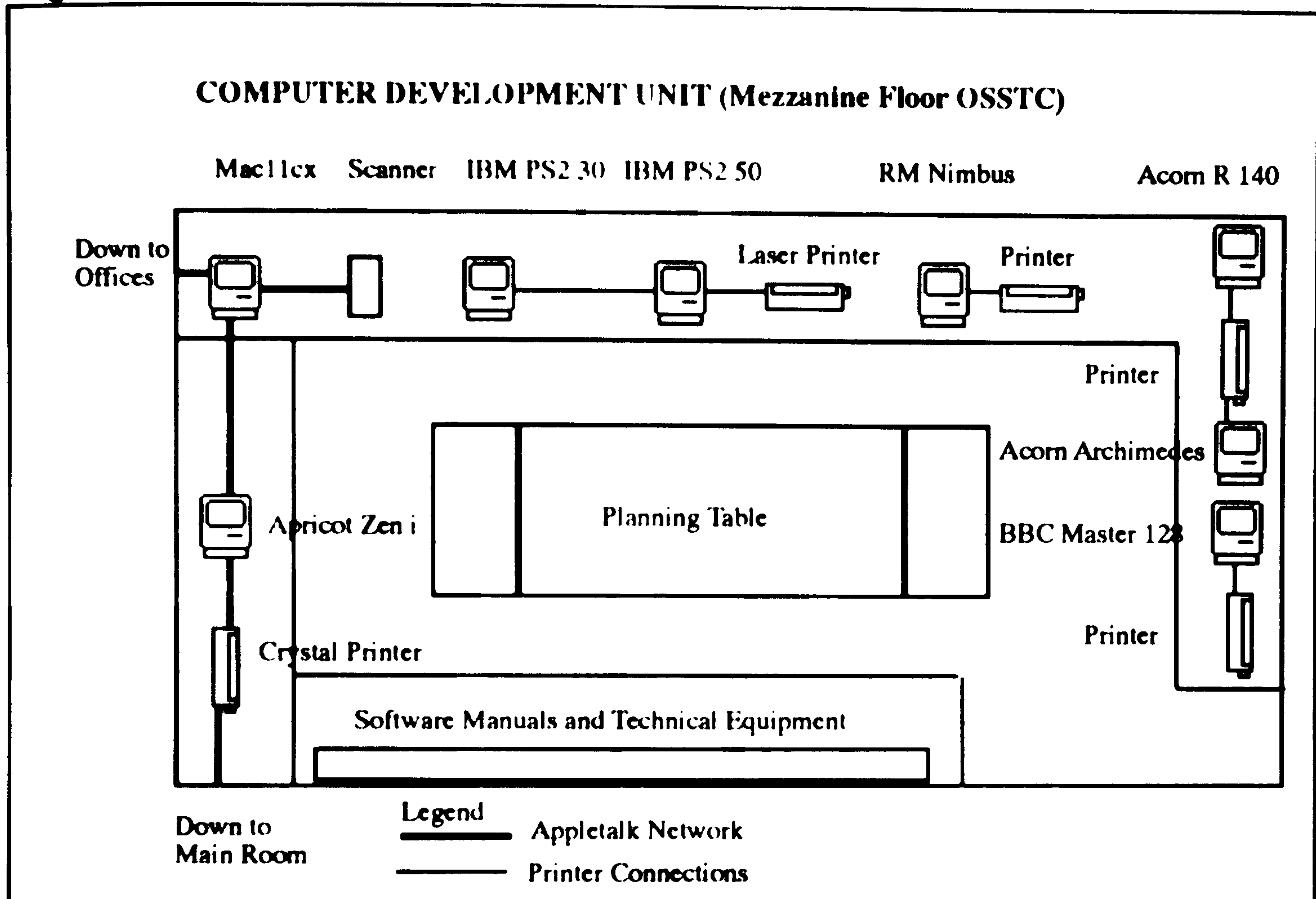
PILOT PROJECT SCHEDULE		
Sept. 1989 - Dec.1989	Jan.1990 - March 90	Apr.1990 - Aug 90
1. Initial Planning Meeting Phase 1.	8. Progress Planning Meeting	15. Progress Planning
2. Data Collection-Tech. Ed. Questionnaire	9 Questionnaire Design	16. Analysis of
3. Setup Equipment Facility	10.Complete Initial Software Design	17. Initial On-Line Trial
4. Start Designing Software Software	11.Tech. Ed. DataTrial Entries	18. Main Field Trials of
5. EGTB Visit and Discussion	12. UK Database Data Collection and Collation	19. EGTB Paris/Oxford Presentation
6. EGBT Presentation	13. a.Visit to Australian Database Present Paper	20. Alpha Production Version ESTED Software
7. UK Database Visit	14. Submit Questionnaire	21. Software Development
Sept.190 - January 1991	Feb.191- June. 91	Jul. 91 - Nov. 91
22. Beta Software Production	24. Minor Modifications to ESTED Production Version	26.Submit Bids for Finance to Appropriate Agencies for Phase 2
23. Start to Write Up Research	25. Complete Writing Up	

A copy of the daily diary from September 1989 to December 1989 related to the above development time table (see Appendix A) gives a full indication of the volume of work undertaken during this period. From this daily diary it may be seen that work was not just undertaken on pilot project work but upon other elements of this study. All this work ran alongside other work concerned with a busy centre actively supporting school science and technology.

Development Facility

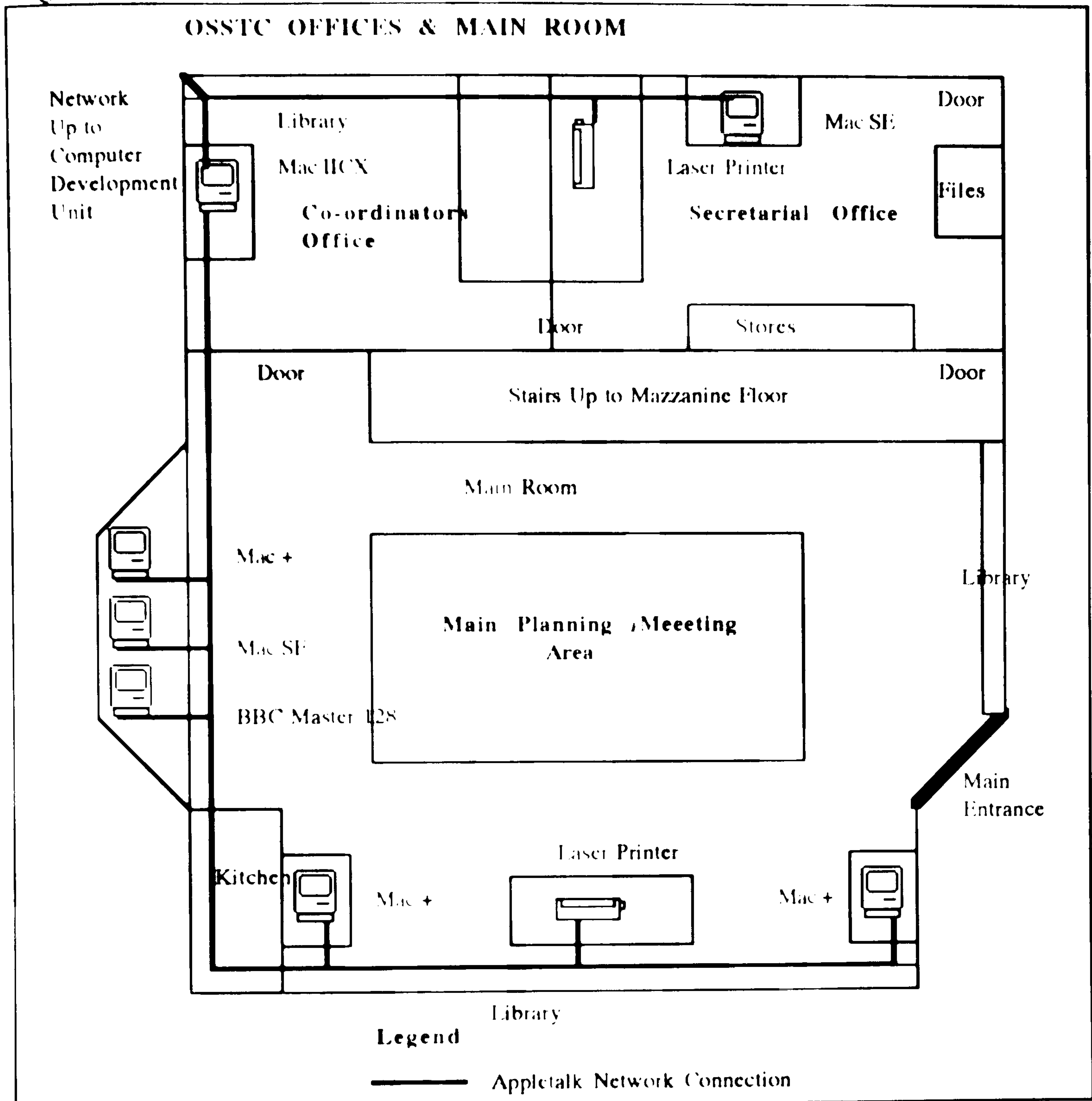
The development facility used for ESTED, and the various other elements of this study, took place in a purpose designed facility for such work at Oxford University, OSSTC. This facility, actually designed, equipped, staffed, and in the main funded by moneys obtained by the ESTED Project Director, comprised the following (see Figures 34 & 35).

Figure 34



This layout was designed specifically to allow a variety of activities to take place with the minimum of disruption; it was also designed to allow rapid communication between staff. In terms of the ESTED development it proved to be the ideal working environment, as not only was it self contained in itself, it was in a position to take advantage of informal opinions, suggestions, technical support, from highly qualified leaders in the field of science, technology and computing within the UK's leading (UFC * ratings 1989) university science complex, namely that of Oxford University. It also provided access for researchers to excellent scientific, technological, and education libraries.

Figure 35



Development Process

The basic idea was to produce a user friendly science linked technology software database package that could be utilised by educational clientele who had minimal computer expertise. The software was to run on both IBM PCs and Apple Macintoshes. Ideally the software was to utilise a GUI click and point approach, be self-installing, and should not require the user to have a substantial knowledge of the field to retrieve data. Associated with this database should be a bulletin board which could be accessed by users. The database itself should be portable and not rely upon accessing through the telephone or dedicated dataline network.

The feasibility of the idea was further determined by the availability of raw data, finance, equipment, and expertise which was available as a result of several years of experience, entrepreneurial activity, and contractual software development. Accordingly, the main issues were specific hardware and appropriate software for development of the database.

The Hardware that was to be used for ESTED development was narrowed down from the initial selection indicated in the initial proposal to :

- 1 Apple Macintosh SE 30 (68030) 4 Meg 45 Meg Hard Disk, Monochrome;
- 2 Apple Macintosh 11cx (68030) 8 Meg 100 Meg Hard Disk, Colour & A3 Monochrome system;
- 1 IBM PS2 Model 50 (286) 3 Meg 20 Meg Hard Disk, Colour;
- 1 IBM PS2 Model 30 (8086) 1Meg 20 Meg Hard Disk, colour;
- 1 Apricot Zen i (386) 5 Meg 30 Meg Hard Disk, Monochrome ;
- 1 Apple 11NT Laser Printer;
- 1 Qume CrystalPrint Publisher Printer;
- 1 Microtech Scanner;
- 1 Apple CD-ROM;
- 1 Optical Disk Drive.

The Mac 11cxs, PS2 30, 11NT, and Microtech Scanner, were initially linked via a localtalk network. The IBM PS2 50 was a stand-alone system. This network was changed for technical reasons as the project progressed to one that included the Mac 11cxs, Apricot Zen i, 11NT, Qume CP, CD-Rom, and Microtech Scanner (see Figure 30 above). The major reasons for changing the network was that the PS2 30 was a very slow machine with limited memory and was incapable of Running Omnis 5, whereas the Zeni had more memory and was very fast when it came to running Windows and Omnis 5; also the transferring of Omnis 5 ESTED data via the localtalk network and Tops was more convenient than by hand to the PS2 50 as a stand-alone item; the CD-ROM was needed to hold the prototype database.

The IBM PS2 50 was a stand alone system from the start, because it was a microchannel device and a localtalk flash card was not available for it. This was joined with the PS2 30, as a stand alone system, upon the network change. A flashtalk microchannel card became available for the PS2 50 in late April 1990 too late for inclusion in the project for financial reasons (i.e. funds had run too low to purchase it).

All of this hardware was supported by the existing OSSTC hardware which included all of the devices itemised in the initial proposal, with the exception of the IBM Minicomputer which never appeared.

The issue of suitable development software was clearly determined by the following criteria; the fact that it should be transparent across the microcomputers specified, should be able to deliver the user-friendly click-and-point approach end product, be easily installed, and require the minimum programming skills. To ensure that appropriate software was utilised a review of significant recent/new development software available for use in Europe was undertaken. This review took the form of: a. a search of relevant journals for information upon databases for the hardware chosen; b. obtaining sample software and viewing the same, bearing in mind that initial development was to be on the Apple Macintosh Microcomputer and then the IBM PC, and that files should be capable of being stored as SQL (Standard Query Language) on a minicomputer.

a. The search of the journals for database information resulted in the unearthing of the MacUser UK Labs Report No 42 which is effectively an expose` and comparison of the databases available for the Macintosh. This document indicated that as far as best buys were concerned that Omnis 5 stands out above all the others available. Indeed it was stated in this document that:

" From the tests conducted , Omnis 5 stands out. Although it was not the fastest in every aspect, it nevertheless coped with everything thrown at it with consummate grace. It

offers a comprehensive range of customisation facilities and generally adheres closely to the Macintosh interface. It doesn't balk at large data files, and it has the most comprehensive import/export facilities of any of its competitors. It is relatively easy to programme and grants all this at the lowest price but one in its class (multi-file database). Omnis 5 is head and shoulders above the rest."

It should be noted at this point that the MacUser Lab Reports are considered definitive in the field. The writers of the reports, and the journal MacUser are independent of all hardware and software suppliers and have built up a high reputation for accuracy, integrity and honesty.

b. The actual software that was tested was DBase Vista, Foxbase, Omnis 5, and 4th Dimension. This was obtained in sample form and the testing results were as follows.

Dbase Vista, proved to be a system that relied upon complex programming and was rejected immediately as the expertise to develop a database utilising this system was beyond the financial and technical resources allocated to and associated with this project.

Foxbase was a strong contender (as a result of being 2nd Choice in the MacUser Lab Report No 42) fitting the software criteria, and being available for both the Macintosh and PC. However, the demo version proved to be somewhat difficult to use, and technical support very difficult to obtain, and hence it was rejected.

Omnis 5 was the front runner (as a result of being 1st Choice in the MacUser Lab Report No 42) fitting the ESTED development software criteria, and being available for the Mac and PC. The demo version proved to be relatively easy to use and excellent technical support proved to be available when detailed technical information was required. This database generation system seemed to be well within the resources, expertise, and scope of the project. Advice from an Oxford Omnis developer elicited the fact that they would be moving to Omnis 5 for all their future software database developments as the previous version of this software proved to be simply the best that was available.

Fourth Dimension, although an excellent system, was rejected immediately as it was only available for the Macintosh, and hence did not fit the criteria.

After considering both a. and b. above Omnis 5 was chosen because it clearly was the leading and most appropriate software available and complied fully with the criteria set for development software for ESTED.

Upon receipt of Omnis 5, the software chosen, time was then spent by the developers familiarising themselves with the system, both hardware and software prior to actual development.

Quality support software was critical to this project and this was as indicated in the initial proposal. It is worth mentioning that without: the word processor Microsoft Word 4; the drawing package Aldus Freehand; the word recognition and scanning package Omnipage; the communications package Tops; and the graph package Microsoft Chart; it would have been impossible to undertake this software development project.

Hardware problems in the main revolved around peripherals for the PCs rather than the Macintoshes. Every item that was attached or installed in the Macintoshes functioned immediately, no problems were encountered with these systems. The PCs, both IBM and Apricot were a nightmare, devices did not function first time, memory was difficult to obtain, both required considerable physical hardware and software configuration, and devices did not physically fit machines they were designed for. Much time was wasted

with installation of devices and software for PC's; some packages did not function as manufactures indicated or were incompatible with other packages, those that did often required re-configuration of the machines or new system software. All software packages for the Macintosh functioned well and were devoid of the problems associated with PC software.

The security and 'jumping on the project bandwagon' areas proved to be a problem because it became apparent as the project continued that many individuals and organisations, from both education and industry, not formally associated with ESTED wanted to be involved with it for reasons which were not always appropriate and supportive. Some of the expressions actually made were:

" It would do my career a lot of good to be associated with a project at Oxford" (a professional colleague from higher education) ;

"We could make a lot of money out of this if you link to my company" (a company director);

" If you publish exclusively in my journal I'll not bother to referee the paper" (a educational journal editor");

" Can we have a pre-release copy of your software?, with our experience in the USA we can be of considerable help" (a software developer who had been known to pirate other pre-release software).

Other expressions were rather vague and incoherent and incomprehensible.

Often these approaches were made by individuals who just appeared without appointments, were very persistent, and were very difficult to eject. Some time was wasted in fending off these approaches and in two cases additional local Clarendon Laboratory staff had to be brought in to help with the removal of these individuals.

It may be because OSSTC was an open unit and was so successful that the project became a victim of that success, or that individuals and groups are out to deliberately pirate work and ideas, which caused or allowed the problems to arise. Nevertheless they were disruptive and resulted in some loss of time and ideas.

Although the Omnis 5 manuals are very good many items were not covered or neglected. This caused some problems resulting in a series of unnecessary telephone calls to Blyth Software. Eventually it was discovered that the technical datasheets had not been sent to us. These datasheets were in effect the updating of the manuals for the software. Most items encountered were covered by these excellent technical information sheets.

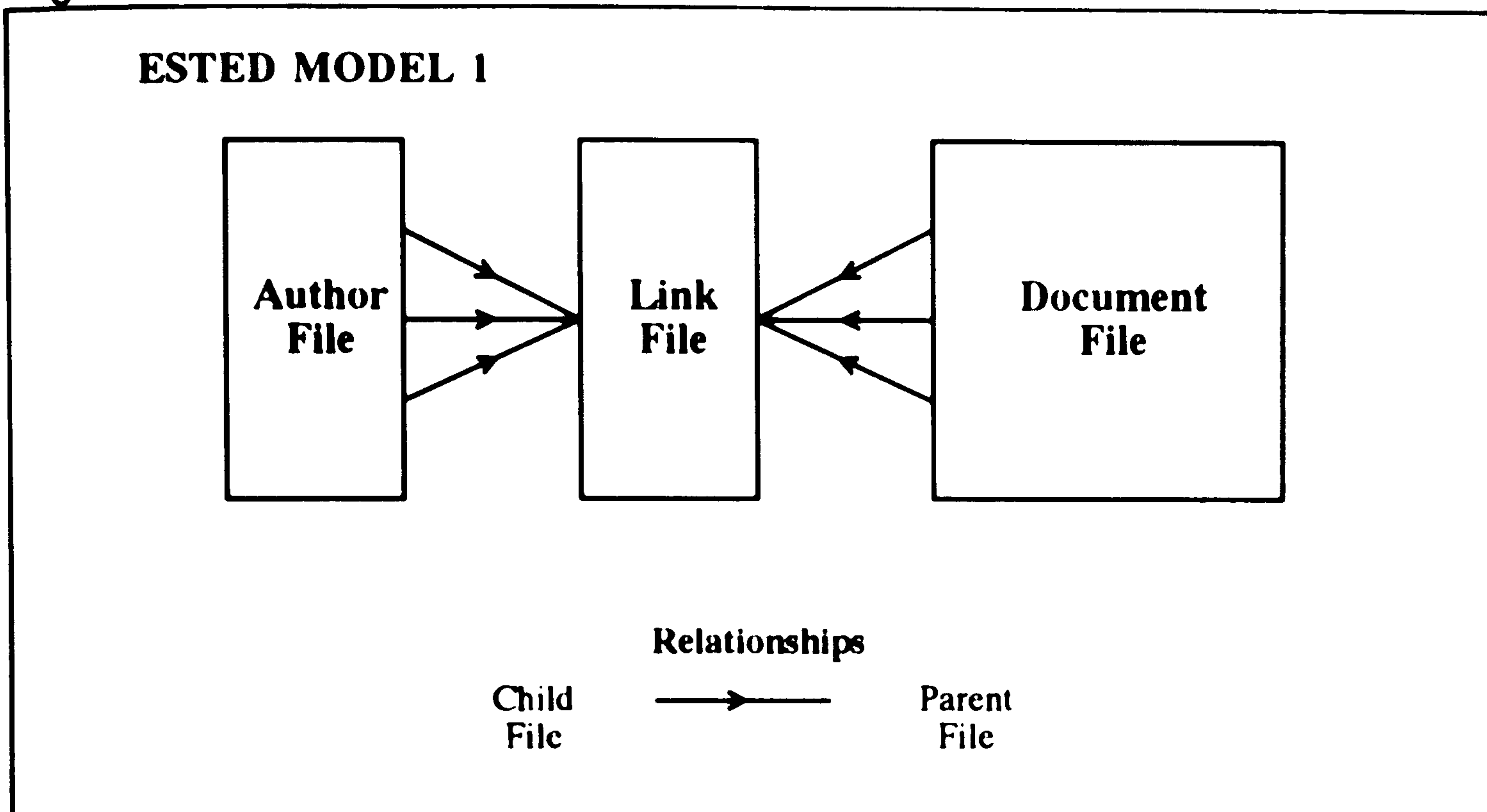
Laboratory Model and Development

Having concluded that the Omnis 5 database development package from Blyth Software would provide an appropriate environment for the type of database required, it was essential to spend some time gaining familiarity with the software. Accordingly, about 50% of the working time of the first two weeks of September 1989 were spent using the tutorial package accompanying the software. Having assessed the package, which is based on a business application, it was concluded that certain features required of an educational database, such as the handling of complex searches and the inclusion of graphics in documents, could only be explored by the construction of a simple laboratory model.

The experience gained in accessing various commercial databases enabled a specification for the structure of an experimental database, in terms of the formats of data files, windows, menus, searches and reports, to be drawn up. The model was then

programmed using the Omnis 5 system. The overall structure of this first laboratory model, ESTED1 is shown below (see Figure 36).

Figure 36



In order to handle multiple relationships it was decided at an early stage that the database could be made more efficient in terms of the use of memory if records of the details of authors of documents were held in a separate file with cross references to the file of documents. As more than one author could have responsibility for each document and an author could be involved with more than one document, it was necessary, under Omnis 5, to introduce the Link File

The Author File contained the name, qualifications and contact point of each author, the name field being indexed to permit rapid searches for the work of a known author. As well as acting as the connection between documents and authors, the Link File held the accession data for each document. The document file comprised fields for the title, abstract, relevance, technology and clientele of a document, together with fields to hold up to six graphics figures for each document. The majority of the field names are self explanatory aspects of the document, the technology field was intended to record the particular aspect of science or technology concerned, for instance 'stepper-motor-control'.

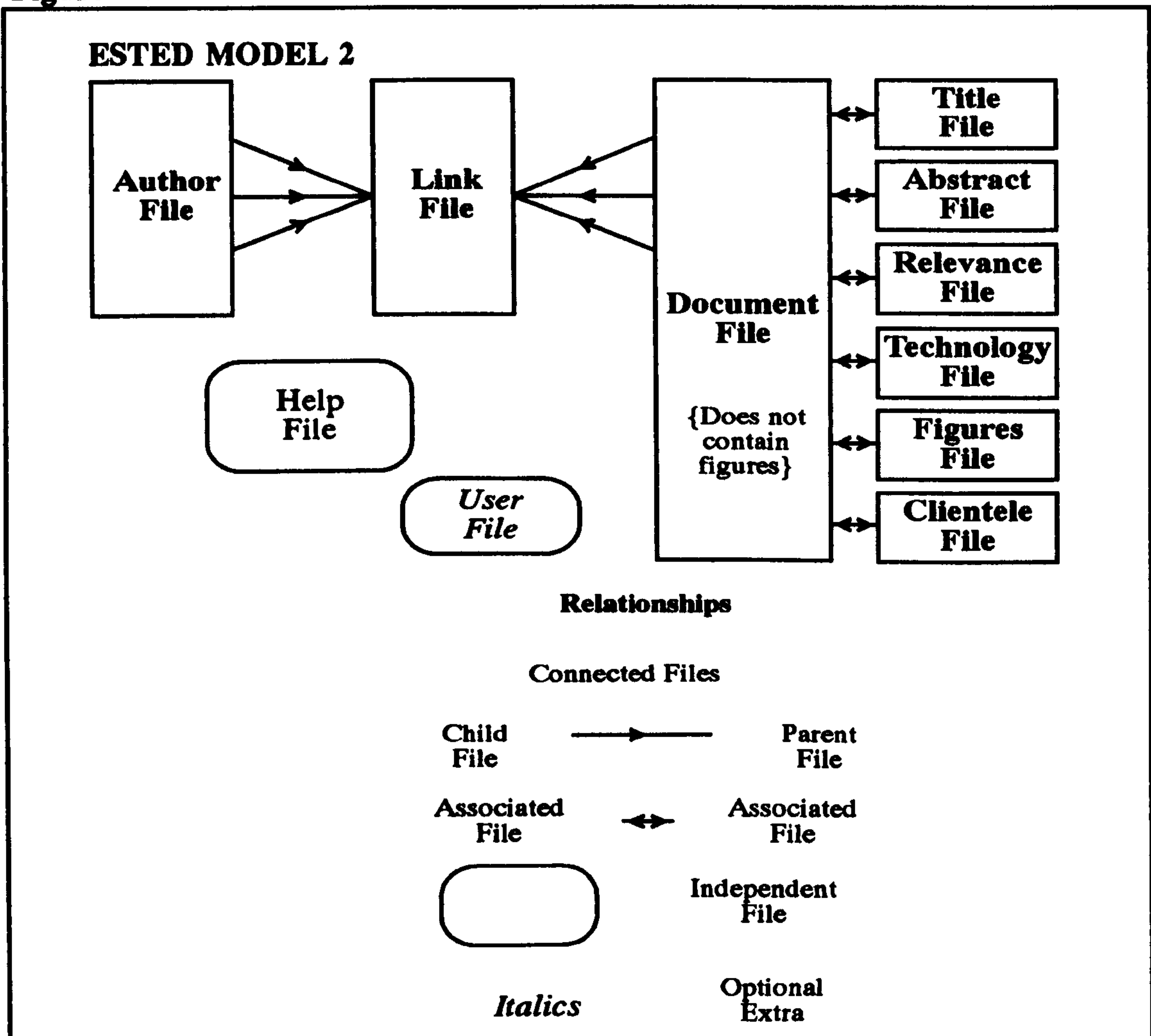
It was important to use Omnis 5 because the final application is completely compatible with the standard Macintosh environment. It ensured that the implementation of the structure discussed above, which involved the design of Menus giving access to the functions of the database and Windows permitting the entry and recovery of data, fully complied fully with the microcomputer handling demands; it also allowed the production of the necessary File Formats, Search Formats and Report Formats to control the storage recovery and output of data respectively. It was also important to use Omnis 5 because it demands and allows a high standard of presentation both on screen and on paper.

Although initial results with model ESTED 1, were most encouraging difficulties were encountered with large documents, especially those containing figures. When a search was undertaken it took quite a long time to extract data from the hard disk and to display it to the screen. This exposed a major problem concerning the time taken for searches when large text documents or graphics were encountered. This followed from the Omnis 5

search process of loading the whole of every record (and all connected records) into the Current Record Buffer in RAM even when only a small field such as the Title Field was being searched. The long time taken to read a succession of figures each of 48K bytes from a hard disk into RAM was considerable. Accordingly, it was necessary to move on and develop the ESTED 2 Model.

ESTED 2, was designed to overcome some limitations of the first version. As the main limitations concerned on screen help and a password protection facility these elements had to be considered for incorporation in the new model. It was decided to incorporate, on a trial basis, extra facilities such as a Help menu, and a User File making password protection of facilities possible. The structure of ESTED 2 model is shown in Figure 37.

Figure 37



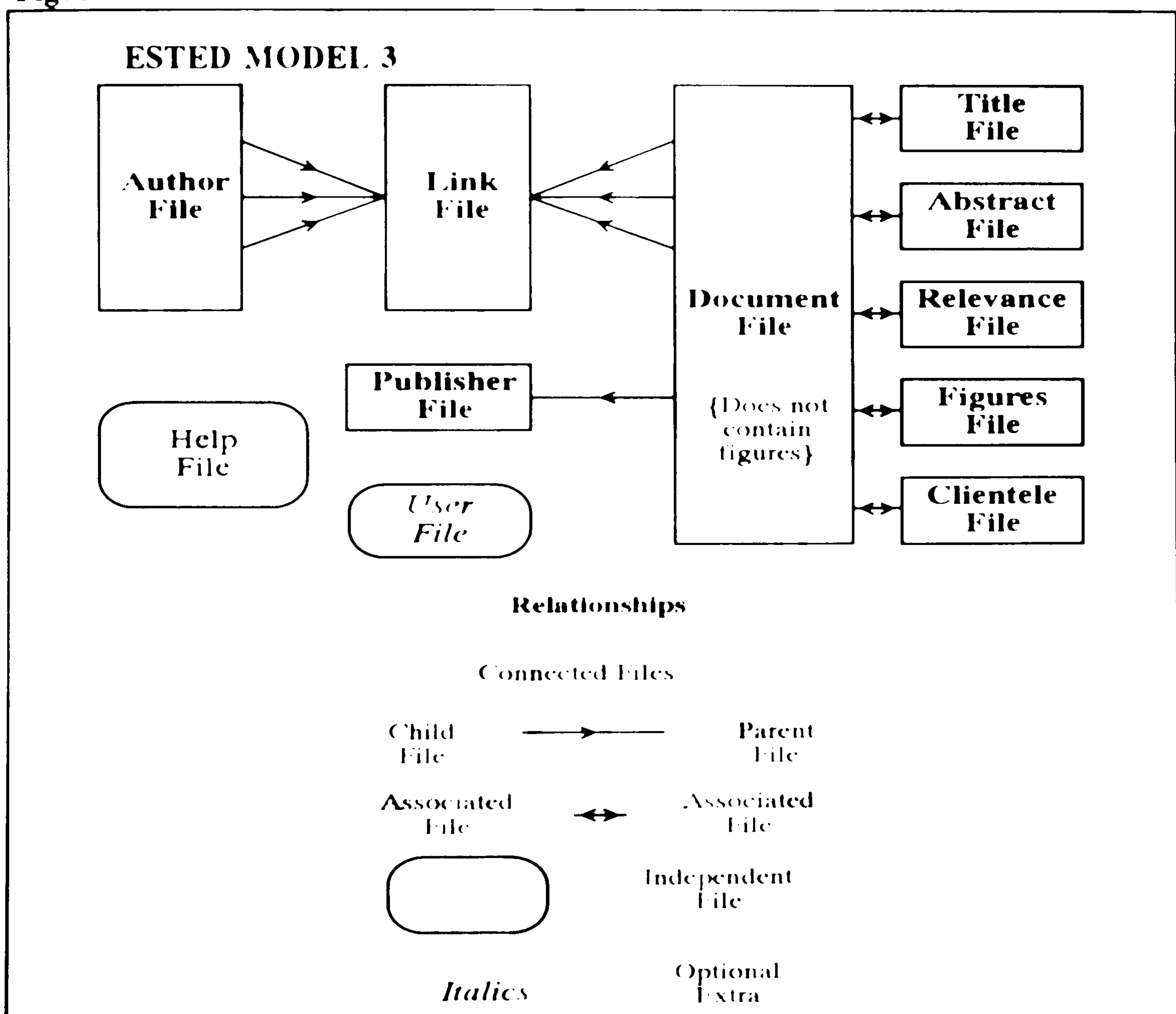
It may be observed from the ESTED 2 model that a Document File and connected Author File were still utilised and that a new set of Associated Files (Title, Abstract, Relevance, Technology, Figures, Clientele) had been incorporated. The entries in the Associated Files were exact copies of files derived from the appropriate fields in the Document File, each sharing the common reference number which was the Document File Accession Number. As these were not connected files reading records from them into the Current Record Buffer did not entail also reading in records from other files. The entries in the Title, Relevance, Technology and Clientele files were intrinsically small in size, hence

their transfer to the Buffer was rapid and searches through these fields could be undertaken quickly. Searches through the Abstracts File, containing larger records, would, of necessity, take longer.

The limitations of this ESTED 2 model was that the use of separate (unconnected) files for searches make for faster searches but at the price of two drawbacks: 1. inefficient use of memory/harddisk space as now some information is being duplicated being held on both and being extracted from both in a concurrent sequence; 2. inclusion of a help file implied use of the export import facility to handle the installation of the help reference file into new data files, and this led to a problem in indexing between parallel files, especially the graphics file.

ESTED 3 was developed to incorporate the best attributes of the first two models and attempted to overcome the limitations of the second version. This model may be seen in Figure 38.

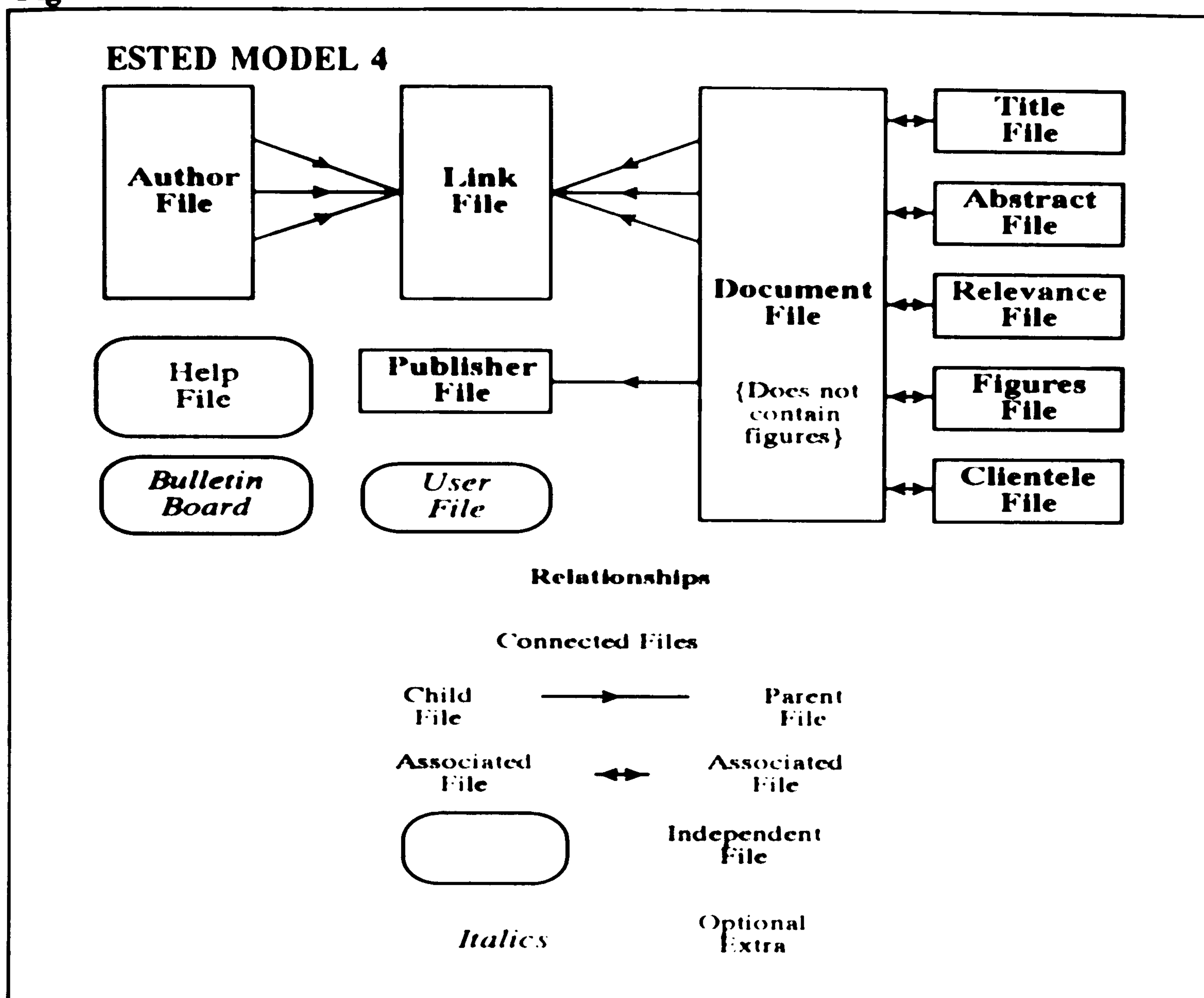
Figure 38



This ESTED 3 model is significantly streamlined when compared to previous models because the Associated File (Technology) no longer exists and modifications to the internal coding were undertaken which speeded up operation and removed the defects found in the ESTED 2 model. A new one-way file entitled Publisher was added to this model in order to hold further necessary data.

Upon close examination it was found that this model still needed modification to include the facility to access an external bulletin board or external computer program. This was undertaken and the following ESTED Model 4, as seen in Figure 39, was produced.

Figure 39



The Model 4 database system became the 'Production Model' after a reasonable amount of data was included in its files. For convenience it was decided to use material which was to hand and from which no copyright problems could arise. In order to give an indication of the potential and possibilities it was decided that an appropriate combined theme for the database would be electronics, control & sensing, and communication. Accordingly, source data was entered and formed the basis of the database proper; this sample database was then saved to disk to become the source from which future CD-ROMs could be made.

Upon completion of the source data entry the manual/instructions for using ESTED was prepared (see Appendix C for details).

Trials of the Beta (Model 4) version of the software were undertaken with groups of European technology educators and selected technology/IT specialists at OSSTC during the month of May 1990.

The trials were to find out whether the system as a whole was appropriate to the needs of the school technology educator and IT experienced technology educators. That the system was reliable and functioned as it had been designed. It was also to find out if the choice of

the GUI interface was indeed the correct choice. It was further to find out if any improvements to the basic structure of the Model 4 needed to be made.

The hardware utilised for these trials was that found in the main room and development facility at OSSTC described earlier in the initial proposal and shown in Figure 34 & 35.

The group trial by 14 technology educators, took place on the 21st May at OSSTC 1990 as part of the EGTB executive meeting. The programme was made generally available to the educators who spent time using it on OSSTC microcomputers. The oral feedback indicated that the software was appropriate to its task as a European science linked technology database, and functioned as it should. The only item of contention pointed out was that it would be helpful if the host software framework graphics were in colour as it made the whole package more attractive to users. Users made the point that the whole system was extremely easy to use for searching and finding, items and that GUI was the right choice. Enquires regarding cost of the final product were also to the fore and it was pointed out that at this point of time a costing had not been embarked upon as a total expenditure breakdown had not been undertaken.

The individual trial was undertaken at OSSTC by some 5 school technology educators, who indicated that they were satisfied in every way with what had been produced. All approved of the GUI point and click approach.

The minor modification, concerning colour, was included in the Beta Version which then became the Pre-Release or Model 5 Version of the ESTED software.

The Final ESTED Product

The final product, in terms of the prototype database, is the ESTED Model 6 as seen in Figure 40. This finalised ESTED version, which runs on all Macintoshes and on 236 and above PCs under Windows 3, came into being as a result of a rethink concerning new database elements and an effort to speed up access. The new form split the database up into 4 elements:

1. The Main Database

The Main Database was to cover and allow searches for whole documents.

2. The Suppliers Database

The Suppliers Database was intended for obtaining information upon business types and products.

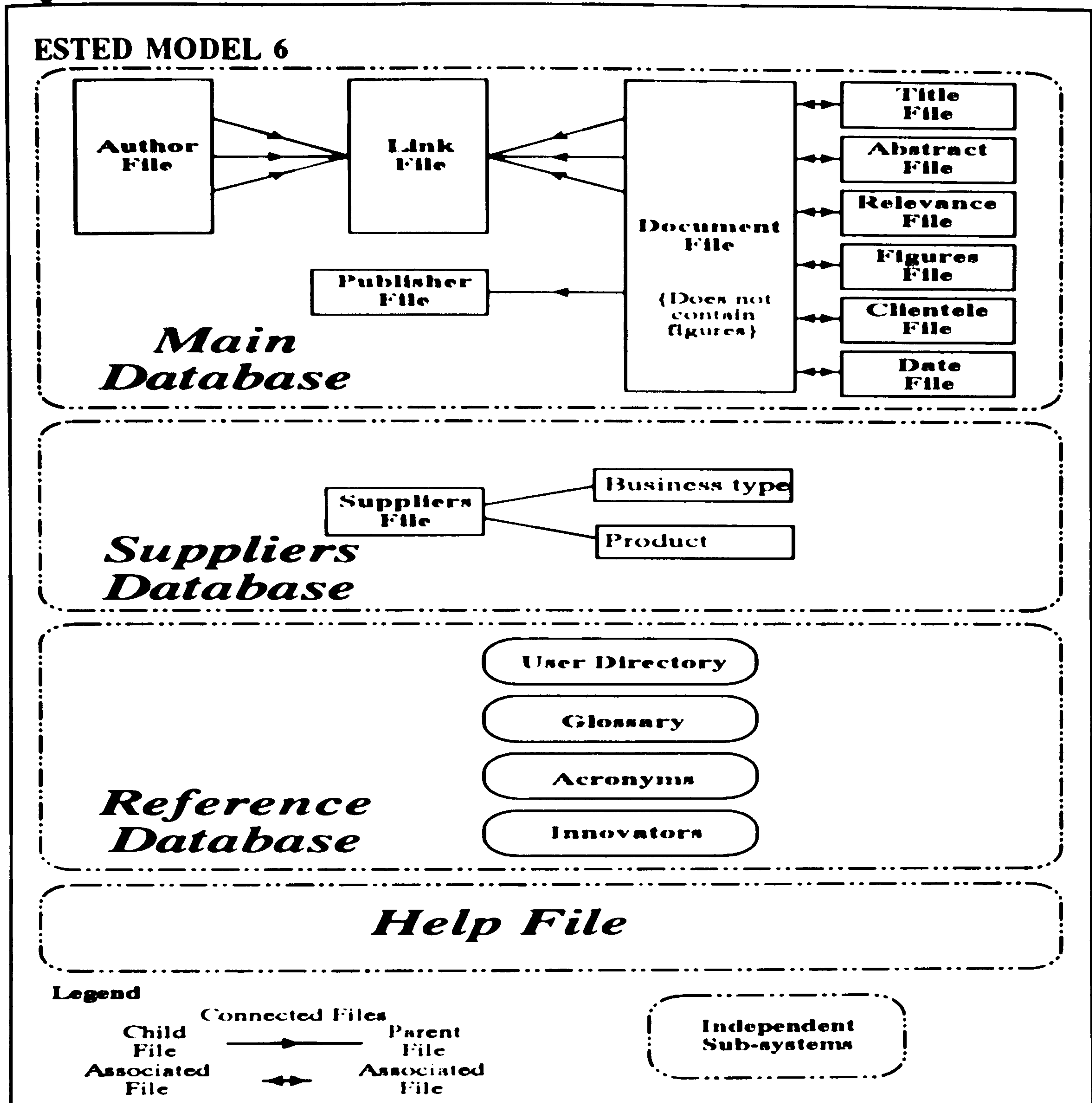
3. The Reference Database;

The Reference Database for obtaining information about miscellaneous items such as users, a glossary, acronyms, and innovators;

4. The Help File.

The Help File for obtaining on-line help concerning the function and operation of the ESTED programme application.

Figure 40



To speed up the operation of the database system, rather than loading most of the database data directly into the memory of the microcomputer, the system was configured to only load data into memory when it was actually called from a name heading. This process increased the speed of access on both microcomputing systems by c.30% and actually made more efficient use of low microcomputer memory as well as solving a small software bug problem which had resulted in infrequent freeze-up on the IBM PC.

Two versions have been produced, one for the Macintosh and one for the IBM PC. Instructions for obtaining the ESTED software prototypes are found in Appendix C. Both versions are designed for personal use on a microcomputer in a users base rather than in an on-line situation.

Bulk production of this database will not actually take place until after further funding becomes available. Hence, from an ESTED point of view, production will take the form of a submission of an operating database system to the EEC as part of a proposal for long-term funding. The submission of the prototype database, under the OEDS (Oxford Educational Database System) heading, will also to be submitted to Blyth Software and

others for discussions concerning world- wide distribution and commercial sale of the software.

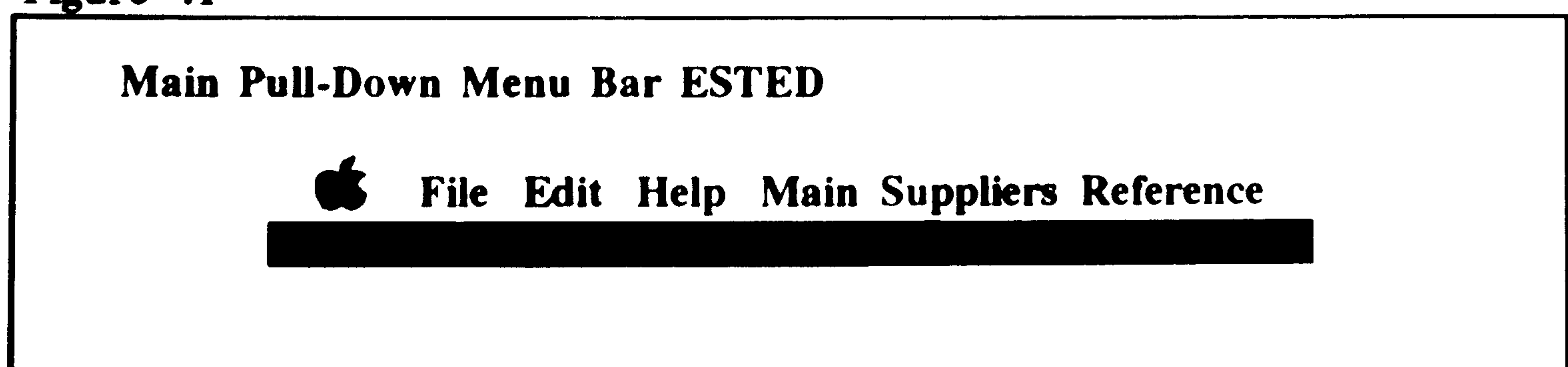
The ESTED User Interface

As already indicated in this study experience, and investigations had indicated that the user interface had to be simple and easy for technology teachers and educators to use. The GUI click and point interface type environment was chosen as an inherent part of the development under Omnis 5 because care was also undertaken when designing data access procedures because investigations of existing databases had revealed difficult and awkward access procedures for obtaining data. Much time was therefore invested in producing a database user-front-end that could meet the specialised requirements of the newly minimally-computer-literate-and-capable technology teacher and educator who was trying to use a computer programme to obtain useful data for the first time from a relational database.

The friendly front-end displayed to the user comprises two elements, firstly a menu bar from which selections can be made and secondly a window which contains elements which can be used to access or display information. The ESTED system comprises customised graphic formats for: 4 menus; 44 windows; 8 report formats; 14 file formats; and 14 search formats. Both elements use the GUI click/select and point system to allow use of the database system. The keyboard of the microcomputer is used only when an individual is searching by entering relevant text. All database coding is hidden from the user and the application can be password protected. This is designed to be in the interests of the user in terms of simplicity of operation and security of data and database design. Examples of these user friendly secure visual formats are given below (for full details of all graphic formats see ESTED computer programme via Appendix C).

The main Pull-Down Menu is as shown in Figure 41 and is the means by which the database elements are activated rather than by the use of Function Keys. The four menus actually created for this programme are covered under the Help, Main, Suppliers, and Reference headings. The other elements are provided by the Omnis 5/Apple development system. (Please note that the Apple item does not appear on the PC version of the software.)

Figure 41



The Main Search Title Window shown in Figure 42 is an example of a Window into which text may be entered and active areas in the form of the buttons 'And/Or' and 'Carry Out Search' and 'Exit Search' are present to activate a software function on the users behalf.

Figure 42

Main Search Title Window ESTED

Searching By Titles

Enter Up to 4 Words or Phrases, choosing a suitable logical Operator AND/OR between each one. A greater number of search items linked by ANDs gives a more accurate search.

Search For

*

☐ And ☒ Or

Search For

*

☐ And ☒ Or

Search For

*

☐ And ☒ Or

Search For

*

☐ And ☒ Or

Carry Out Search

Exit Search

The Report Format shown in Figure 43 is the vehicle for displaying information that has been called for from the database, it may show either text or graphics or a combination of both, and may comprise one or more pages depending upon how much information is available to be displayed.

Figure 43

Report Format

☐ Report R_ITEMS

Page Heading

AUTHORS

Record

D_TITLE

P_Name

D_Date

D ISBN ISSN

Totals

End of Report

End of Report

The File Format as shown in Figure 44 is the former which holds the data of the items to be called when a particular search is requested. The example below is the call structure for Help.

Figure 44

File Format FHELP			
	NAME	TYPE	DESCRIPTION
1	H_NUMBER	Sequence	IND
2	H_HEADING	National	32 IND
3	H_TEXT	Character	2048
4	H_PIC	Picture	
5			
6			
7			
8			
9			
10			

The Search Format, as shown in Figure 45, is the former which holds the search structure of items that may be called from an active window. The example below is the search structure for Clientele.

Figure 45

Search SCLIENT1			
	FIELD	MODE	VALUE/CALCULATION
1	C_CLIENTS	CON	(FIELD)
2		OR	
3	C_CLIENTS	CON	(FIELD2)
4		OR	
5	C_CLIENTS	CON	(FIELD3)
6		OR	
7	C_CLIENTS	CON	(FIELD4)
8			
9			
10			

Data Searching and Acquisition

As indicated above the ESTED database system is designed to present the user with a graphical-user-interface. Database functions are accessed and initiated by means of pull-down menus and window buttons which provide a totally "point and click" system. Before actually trying to understand the process of searching ESTED for data the following should be born in mind:

The ESTED database is subdivided into three sections, a document database, a suppliers database and a reference database.

The document database consists of text and illustrations, the text ranging from single pages to perhaps the whole contents of work-sheets, pamphlets, monographs or text books.

The Suppliers Database is a system especially developed for teachers who are regularly involved in placing orders for school equipment and consumables. It may be used to hold details of a supplier, the type of business concerned and the range of stock held.

The reference database contains a glossary and acronym compendium relating to science and technology education, a directory of scientific and technical innovators and a personal directory for the user.

The pre-production ESTED has sample data included in it.

The following sub-section should be read in conjunction with the ESTED application actually running upon a microcomputer.

Searching the Database

In order that the database may be searched quickly and efficiently references to documents are stored in files under several headings, separately from the document text and any illustrations. Each of these files may be searched individually or in combination to provide access to the desired document. The files are 'Title' which is the title of the main document, 'Clientele' which is a file of the perceived users, or target audience, of the document, 'Relevance' which contains the educational areas addressed by the document, and finally 'Abstract' which is a summary of the document outlining the main points discussed in the document. A linked set of files in the database contains the names of all documents' authors, the names and addresses of the documents' publishers and finally the date of publication of the document.

The process of the search for a document is virtually the same under all of the headings. The search procedure of the database has been configured so that ordinary English words or phrases can be used as the search criteria. The result of a search is presented as a list of all the titles on the database meeting the search criteria. The user may then select one title at a time from the list for examination. Should the list of titles not be suitable the search criteria may be changed and the list reformed.

Using the Search Database

As an example, let a user consider searching the 'Titles' file. Suppose that a user wishes to find documents concerned with the systems approach to the teaching of electronics, as an educational methodology. It is unlikely that there is a title 'Electronics Educational Methodology', so the user must cast her/his net rather wider. Electronics contains the letter e so does systems so does education and so does methodology, so a request for all the titles containing the letter e should produce a list of all relevant titles. To try this, the user opens the Searches menu, by clicking the mouse on it and dragging down until the Title section is highlighted. Releases the mouse and hence open the Searching by Titles window. Four search for boxes linked by logical operators (ANDs and ORs between them*) are revealed, with the cursor illuminating the asterisk in the top Search For box. Typing a letter e will put an E into the box, replacing the asterisk and clicking the Carry Out Search button will initiate a search of the database. The result of the search will be a list of all titles containing the letter e. The list is presented in a scroll box so that the user can zoom up and down the list looking for the title required. This may give very large list of items to be viewed, depending upon the size of the database, and is likely to be an inefficient operation.

A much more efficient way of accessing a large database would be to specify the search more closely, hence producing a shorter, more relevant, list. Clicking on the Change

Search Criteria button, will allow the user to go back to the Searching By Titles window. ESTED automatically then gives access to the top Search For box the letter 'E' being highlighted. Typing in 'Elec' will replace the letter e with ELEC and the search can be repeated. This time it is found that the user has titles including 'electricity' and 'electronics' only.

With a large database, the user may still not have specified our search sufficiently accurately to produce a workable list of documents to look at. The user should therefore Click, to 'Change Criteria' again and go back to 'Searching By Titles', this time click on 'AND', press Tab to move into the second search for window. Type in 'sys', so that the system will search for titles which contain elec and sys together. Click on 'Carry Out Search,' titles such as Electronics systems, Introducing Electronic systems and Systems Electronics - a Course for GCSE. will be listed The title appearing most relevant to the users requirements can be selected by clicking on it in the list window. The one that is highlighted may be inspected by clicking 'Report On This Document'. A report will be compiled giving all the information held on the database about that document including any document text . If a printer is available hard copy of the screen report may be obtained. If illustrations from the document are held on the database they will be displayed after the document report is closed. Illustrations may also be printed from the database if a suitable printer, preferably a laser printer, is available.

The searches for Clientele, Relevance, and Abstract are operated in exactly the same way. The abstract search is prefaced with a warning about the length of time which may be taken by such a search.

The search for documents by a specified author is arranged differently. An alphabetical list of authors is held on the database, when Search by Author is selected the list is presented. The works of the author required may be located by either scrolling down the list until coming to that author, or starting to type the family name of the author. As soon as letters are typed in, the list will move to the section showing names beginning with those letters that you have typed. When the author required is highlighted the user should click on List Titles and see all of the titles written by that author which are stored on the database.

The search for items due to a particular publisher also uses a list. Choosing to 'Search by Publisher' produces a list of all the publishers whose productions are stored on the database. Double clicking with the mouse on a particular 'Publisher' will present a list of all the works from that publisher. Alternatively, clicking on a 'Publisher' and obtaining a report on the publisher by clicking 'Report On This Publisher, will show a list of all the titles as before.

Documents may also be located by knowledge of their approximate date of publication (not the date of accession to the database). Selecting 'Date' from the 'Search Menu' will open a window into which the earliest and latest dates of publication possible may be typed; the 'Search' resulting in a list of titles as before.

When searching by 'Dates', the dates can be recognised by the system when entered in almost any way. For example the first of March 1986 could be entered as 1,3,86, 1/3/86 or as 1 Mar 86 but not as 1 M 86. When an exact date is not given for a document, the 31st of December for the appropriate year is used.

Should searches under one heading still be producing too many references, the area of search can be further narrowed by considering searches under several headings at once.

The searches menu includes a 'Combination' search. This enables a 'Title', 'Clientele' and 'Dates' search to be carried out simultaneously. Only documents for which all four criteria match will be listed. As an example in the 'Title' box the user might enter 'electronics', in the 'Relevance' box, then might enter GCSE, in the 'Clientele' box one might enter Teachers and in the 'Dates' box we might enter '1.1.85' to '31.12.99' and find a list of documents which meets those criteria.

It should be remembered when searching the database, that the more closely the search area is specified, the smaller the number of documents which will be listed for inspection. However, the search is a literal one. Should a search criterion not be spelt in exactly the same way as in the reference then the document will not be found. Hence it is wise to start by specifying a fairly wide search to get some flavour of the references to documents on the system and then progressively narrow the search until a document suitable to requirements is located.

Having located a document information about the author or publisher may be required. Under the 'Search' menu will be found 'Author' and 'Publisher' information entries. Selecting either of these will produce the appropriate list of entries from which the required information may be obtained by scrolling the list and clicking to select an entry, or clicking on the list once and then starting to type the required entry for the list to perform an automatic find. Entries may be viewed as a screen report or printed out if required.

Using the Suppliers' Database

The Suppliers' Database essentially consists of an up-datable file of the names of suppliers who will supply the educational market. As well as a search of a scrolling list of names (All Suppliers) the file may be searched by means of a search for specific products by selecting 'Products' from the 'Suppliers' menu. The search is conducted in exactly the same manner as the search for document titles outlined above.

Lists of Retailers, Manufacturers and Mail Order specialists are also available by selection from the 'Searches' menu, producing an appropriate list of entries from which the required information may be obtained by scrolling the list and clicking to select an entry, or clicking on the list once and then starting to type the required entry for the list to perform an automatic find. Entries may be viewed as a screen report or printed out if required.

Using the Reference Database

The reference section of the database, accessed via the 'Reference' menu has four sections, namely user Directory, Glossary, Acronyms and Innovators, which all may be accessed in the same way by selecting from the menu.

Selecting one of the sections from the menu will display a window showing a scrolling list of the entries in that file. The desired entry may be located by scrolling the list and clicking to select. Entries may be viewed as a screen report or printed out if required.

Edit facilities are provided to enable the user to rapidly update these files either by modifying existing entries or by adding extra entries. New entries will automatically be incorporated in alphabetical order when the section is next accessed.

*The logical operators obey the laws of Boolean Algebra: if criteria are linked by the operator OR, titles meeting either or both the criteria will be listed; if criteria are linked by the operator AND, only titles that meet both criteria together will be listed.

The Unique Characteristics of ESTED

It is contended that the Unique Characteristics of ESTED relate mainly to eight major areas and that these are:

1. its mode of operation uses a GUI as opposed to a CUI;
2. is identical in all respects on the industry standard vehicles of an Apple Macintosh and IBM PC (under the Windows 3 system);
3. it has the ability to store retrieve and display of high quality graphics;
4. a user does not require knowledge of a vast number of codes or keyword and an exact type match of these codes or keywords to find information;
5. a user will not always require to go on line to a remote computer to use the system;
6. a novice user can access and build up a personal database quickly and easily;
7. it could partially fulfil a technology educators technology INSET needs;
8. it supports UK and European technology curriculum development needs.

It is further unique because the whole nature, and development of, the database is based upon extended experience of technology education, with technology educators, technology INSET and database software development over a substantial period of time within an environment which has a brief to support science and technology educators.

ESTED ASSOCIATED ACTIVITIES

Two activities arose out of, and were undertaken concurrently with, the ESTED development process. They were not directly part of this activity, but were closely associated with it. The activities consider the issue of ESTED as: a portable database for technology educators; and a school Biotechnology database.

Portable Microcomputers and ESTED

As part of the process of ESTED development and evaluation and as a result of a casual comment from a visiting technology educator from Australia; "Wouldn't it be great idea if I could just carry ESTED around in my pocket or briefcase"; the possibility of a portable medium (computer system) which could: a. carry the developed product; b. fulfil some of the IT (computing) needs of technology educators ; was looked into.

The approach to this was for ten machine systems to be evaluated at OSSTC with ESTED and technology education needs in mind. The systems were deliberately chosen to cover the 1990 microcomputers in the £200 to £1000 price range which, from experience and discussions with professionals in the field, was appropriate and within the technology educators, and LEA schools/colleges own purchasing capability. They were selected on the basis of availability from local dealers for the time slot, July 1990, allocated for testing.

Initially a trial machine, the Atari Portfolio, which belonged to the project, was evaluated in some detail. Then a simple technique, namely a six point checklist concerning possibility for ESTED use from 'Very Useful' to 'Totally Useless', was developed from this more detailed review of the Atari Portfolio and applied to all other machines. The Atari Portfolio review, upon which the checklist is based, is as follows:

The Atari Portfolio Review

The first impression given by the product is that of a very well designed, compact, robust device that could usefully be utilised in Education.

The moulded case seems to be of exceptional quality for such a device. Holes or slots have been kept to a minimum. The latching device appears to be very efficient. The hinge is good, strong and positive in action. The cover for the expansion bus is securely fixed. The Memory Card load slot being open is a weak area as dust or dirt could easily find its way into the machine and foul up the edge connection and other vital items in the machine. The speaker is well protected.

A Detailed Look

The LCD proved to be a clear useful screen. The only reservations that were held with regard to this device were that text did not have true descenders and viewing in poor light was difficult for some people. Limited graphics would also have been useful.

Without doubt this is the best implementation of a reduced size keyboard that has been seen. It is very well laid out, positive in its action, and can easily be read. The angling of the keys was a stroke of genius. The Atari and Function keys are very well placed, as is the cluster of application keys. The separating of the contrast adjustment is also a good feature.

With regard to peripherals, neither the RS 232 or Parallel port, or memory cards have been seen thus making it difficult to comment upon their effectiveness and use. However it would seem appropriate to make the following observations:

1. The non-inclusion of a serial port located in the machine itself, say with a standard mini-drive output connection, was a mistake. (I wonder how many individuals bought the machine and could not transfer data out of it through lack of any way of doing this).
2. The availability of memory cards, their high price, and short life, compared to 3.5" discs is a problem for educational users.
3. No indication of the range of items that might interface to the Bus Connection was available
4. The lack of a dedicated mouse port was evident.

A full detailed examination of software has not been undertaken, however a cursory examination revealed the following:

The built in software suite seems quite usable and useful as a substitute for a filofax. The dialling facility is not substitute for a modem. It's a pity that the calculator was not an integrated feature, being separate it loses its usefulness. It would also have been useful to have a mini-page icon with the software so that tracking of where one was on a page could be easily be identified. It is noted that no languages such as BBC Basic were available for the machine and that no ROM slots were available. Full DOS compatibility was not an issue as far as education is concerned, as specific software would be written for a particular purpose.

The Owners Manual is only usable, in a world of generally poorly written computer documentation. I am sure this will be rectified as time goes on as I suspect many non-computer literate, first time computer users will find difficulties with it. On the whole the manual did not make a positive impact.

Initially it seemed that on the whole the pricing (£189 + VAT) was about right (in 1990) for such a product. However upon closer investigation when compared with the opposition i.e. Z88, Tandy 102, the price seemed a bit high, bearing in mind the extras to be purchased to make the computer usable, £150 + VAT for the base machine would have made it much more competitive.

The Portfolio would seem to have great potential for use in School & College education, particularly in the Science and Technology fields. In general terms it would be used by both students and teachers and further education for general administration in a 'filofax' mode.

In terms of Science & Technology education it could be used in conjunction with an expansion and appropriate software (as per the Compaq lab top expansion box concept) as: 1. a controller, 2. a data logging system, 3. control and instrumentation unit.

Summary of findings

- a. It is quite clear that the Atari Portfolio is an exciting first rate quality product which has potential for use in schools, colleges and teacher training institutions.
- b. The machine has been manufactured to a very high level of quality though some attention could still be paid to openings.
- c. The LCD could do with some modification to improve it further.
- d. The keyboard and layout is first rate and cannot be faulted.
- e. The peripherals situation is not nearly as good as it could be. The lack of an integral RS232 port within the basic machine is a definite disadvantage. The Memory cards are far too expensive. A ROM chip socket on the machine would improve it considerably.
- f. The software supplied is versatile but would be enhanced considerably with a chip based version of BBC basic which could be plugged into an appropriate socket.
- g. The manual is versatile but needs to be reviewed in the near future with a view to improving it.
- h. The Portfolio seems to be slightly over priced when compared to the opposition.
- i. This machine has great potential for use in the science/technology area of education, especially for data logging and control with an appropriate expansion bus and software.
- j. the lack of an integral disk drive of any sort is a big disadvantage for technology educators because it makes it difficult to transfer data to a desk-top microcomputer.

Recommendations

It is recommended that school technology educators consider the constructive points made in the summary and act upon the ideas noted particularly with regard to RS 232, ROM Sockets, and BBC basic. Concerning the issue of Data logging, Control and instrumentation it is suggested that OSSTC undertakes some development in this area. It is further recommended that this machine is not utilised within the context of ESTED as its concept is that of a 'note holding/taking filofax' rather than a true portable computer.

The Portable Computer Survey

As a direct result of the Atari Portfolio review a checklist of items, against which other portable microcomputers could be compared, was produced. This was used for this survey. The ten computers surveyed were: The Atari Portfolio, Psion MC 400, Tandy 102, Toshiba T1000 SE and T1000, Compaq LTE, the Zenith Minisport, Cambridge Z88, Sharp PC4602, and Amstrad PPC640.

These machines were obtained from local suppliers and educational institutions in Oxford and were examined at OSSTC during January 1990. The first impressions checklist form

derived from the Portfolio review was used in connection with each microcomputer in turn. The results of survey of all computers are shown in Table 31

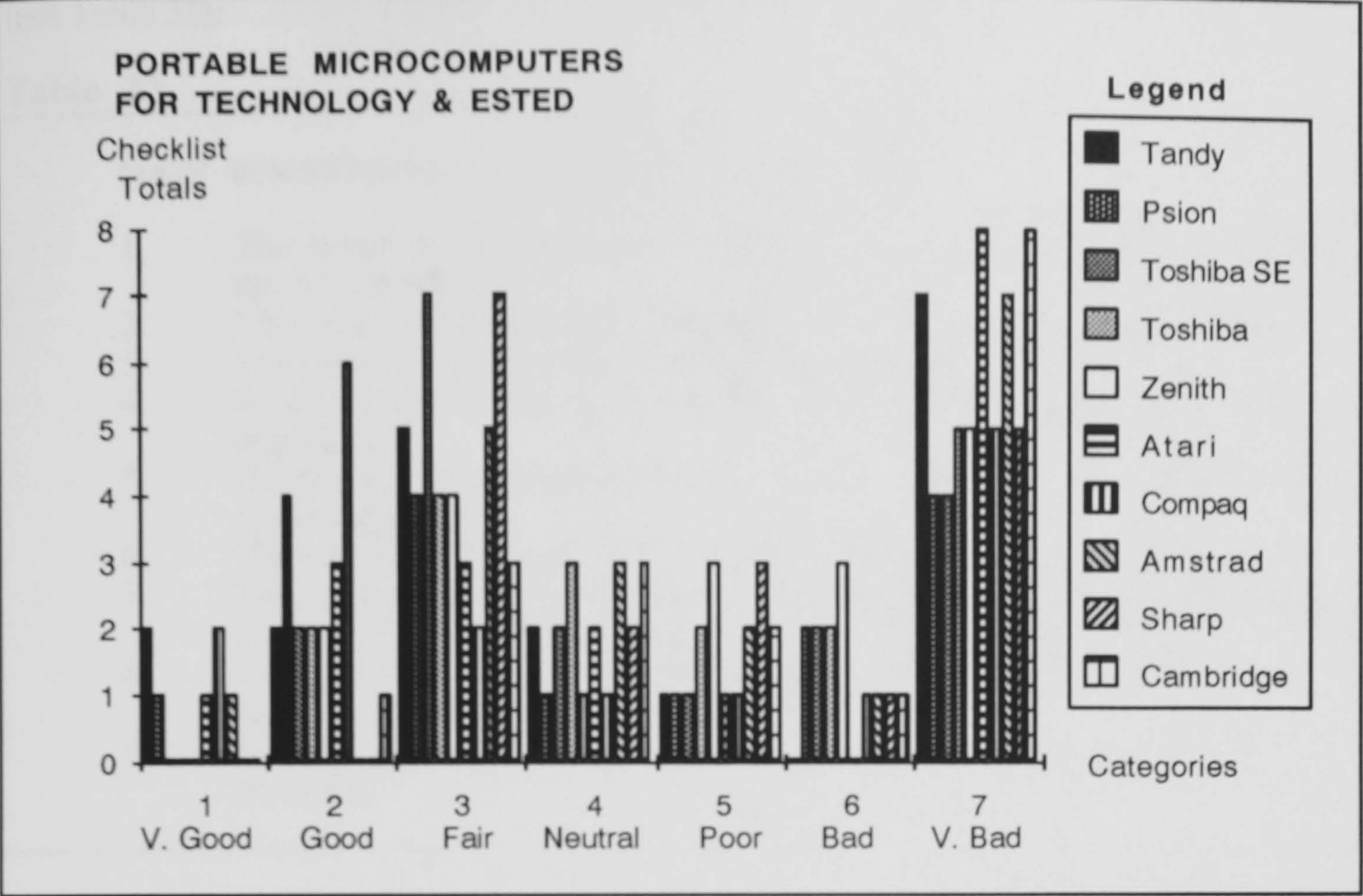
Table 31.

PORTABLE MICROCOMPUTERS FOR ESTED - FIRST IMPRESSIONS CHECKLIST							
Computer	All	Date Checked Jan 1990					
Categories -----	V. Good	Good	Fair	Neutral	Poor	Bad	V. Bad
Items							
Battery Life		2	3	1		2	2
Memory		2	4	2		2	2
Construction	2		4	2	1	1	
LCD Screen	1		1	1	3	3	1
Keyboard		3	4	1			2
Ports	1	3	4		1	1	
Documentation			5	2	3		
Pricing			2	2	2	4	
Weight		2	5		2		1
Size	1	1	4	3			1
Portability		4	5				1
Security				1			9
Bundled Software		1	1	3	4	1	
Disk Drive		2	1				7
Hard Disk							10
Modem	1		1	1			7
WIMP Environment		1					9
Peripherals Supplied							10
Use ESTED							10
Use Technology Education			5		3	1	1
Total	6	24	48	18	19	13	71

The total numerical individual findings of all the checklists per machine indicated two area clusters that seemed prominent, one which revolved around the 'Fair' area and another around the 'V. Bad' area; however, the main overall trend appeared to be towards the 'V. Bad' end of the spectrum.

An investigation of these graphical clusters per machine (see Figure 46), and a more detailed analysis of the data found in the individual checklists revealed that: a. the 'Fair' peak could be dismissed as this related in the main to external physical attributes of the machines and the use within technology education generally; b. the main finding was, as far as this search is concerned, at the present time none of the current low cost machines could run the ESTED software for three main reasons: firstly, because they all had insufficient memory to handle Omnis 5 (it requires at least 2 Megs); secondly, they did not have hard disks; thirdly, no suitable GUI/WIMP environment was available and would run on them.

Figure 46



ESTED and School Biotechnology

As part of the process of evaluating ESTED for use in education during early 1991 the Director of a National Centre for Schools Biotechnology, requested that Biotechnology as a school science-linked technology subject be investigated as a potential data source to be resident upon the ESTED system. Accordingly the following investigation of the subject was undertaken in the light of its science,/technology links.

Introduction

For some considerable time Biotechnology has seen to be the preserve of the scientists in schools. However with the advent of the international development of school technology curricula, which have been designed with a much wider brief than in the past, encompassing such biotechnologically relevant subjects as Design and Technology and Home Economics, it would seem sensible to review this situation and the arguments surrounding it. This section therefore addresses the definition, situation, and the argument under the following headings: What is Biotechnology; Biotechnology Science or Technology; Biotechnology and Industry; the Links between School Science & Technology. It then goes on to draw some conclusions concerning the way it might be treated in ESTED terms.

What is Biotechnology?

The first question often asked by Technology educators is "what is Biotechnology and where did it come from?". To answer this question it is worth while looking at the subjects main dimensions. These dimensions have been drawn up from a series of definitions. To put this into perspective it is then worth looking at a brief history of the development of Biotechnology and of its progress.

The main dimensions of biotechnology would appear to revolve around the following: (see Table 32):

Table 32.

MAIN DIMENSIONS OF BIOTECHNOLOGY 1991	
1.	The industrial application of bioscience to manufacturing services, and to the environment;
2.	Microbial fermentation, enzymology, immunology and plant biology;
3.	The practical application of biological organisms;
4.	Production processes involving the use of cells and tissues from higher organisms;
5.	Biochemical and cellular processes for the industrial production of useful compounds;
6.	The use of living organisms or their components in industrial processes;
7.	The application of scientific and engineering principles to the processing of materials by biological agents to provide goods or services.
8.	The application of biochemistry, biology, and chemical engineering to industrial processes and products
9.	Production of health-care, energy, or agricultural, or environmental products.

These main dimensions have been identified from the following statements which give an indication of what 1. Germany, 2. United Kingdom, 3. Canada, 4. Netherlands, 5. Australia, 6. Europe, and 7. the International community mean by Biotechnology.

1. (Germany)

'Biotechnology is concerned with the use of biological activities in the context of technical processes and industrial production. It involves the application of microbiology and biochemistry in conjunction with technical chemistry and process engineering.'¹⁶²

2. (United Kingdom)

a. 'The application of biological organisms, systems or processes to manufacturing and service industries.'¹⁶³

b. 'Biotechnology can be described as the industrial application of biological processes - the four contributing areas for him being microbial fermentation, enzymology, immunology and plant biology.'¹⁶⁴

c. 'The application of biological organisms or processes to manufacturing and service industries.'¹⁶⁵

d. 'Biotechnology is an area of applied bioscience and technology which involves the practical application of biological organisms, or their sub-cellular components to manufacturing and service industries and to environmental management.'¹⁶⁶

3. (Canada)

a. 'The application of biological organisms, systems or processes to manufacturing or service industries.'¹⁶⁷

b. 'The utilisation of a biological process, be it microbial plant or animal cells, or their constituents, to provide goods and services.'¹⁶⁸

4. (The Netherlands)

'The science of applied biological processes. The science of the production processes based on the action of micro-organisms and their active components, and of production processes involving the use of cells and tissues from higher organisms (narrower

definition). Medical technology, agriculture and traditional crop breeding are not generally regarded as biotechnology.¹⁶⁹

5. (Australia)

'The devising, optimising and scaling-up of biochemical and cellular processes for the industrial production of useful compounds and related applications. This definition envisages biotechnology as embracing all aspects of processes of which the central and most characteristic feature is the involvement of biological catalysts. Plant agronomy falls outside this definition but plants provide the raw material for most biotechnological processes, so research in plant breeding and productivity is of direct importance.'¹⁷⁰

6. (Europe [General])

- a. 'The integrated use of biochemistry, microbiology and engineering sciences in order to achieve technological (industrial) application of the capabilities of micro-organisms, cultured tissue cells, and parts thereof.'¹⁷¹
- b. 'The collection of industrial processes that involve the use of biological systems. The use of living organisms or their components in industrial processes.'¹⁷²
- c. 'The industrial processing of materials by micro-organisms and other biological agents to provide desirable goods and services.'¹⁷³

7. (International [General])

- a. 'The application of biochemistry, biology and, chemical engineering to industrial processes and products (including here the products in health care, energy and agriculture) and on the environment.'¹⁷⁴
- b. 'The application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services.'¹⁷⁵

The argument concerning whether Biotechnology is Science or Technology seems to be the perfect example of a none argument. Clearly, from the definitions above, the main dimensions and the history, Biotechnology is one of those subjects which is an excellent example of science and technology functioning together as a whole. It necessitates both scientists and technologists to produce an industrial product.

Biotechnology and Industry

A brief history of Biotechnology would seem to indicate that it has been around for quite some time indeed much that it is possible to indicate the main industrial historical events (see Table 33 overleaf).

TABLE 33.

INDUSTRIALLY RELEVANT RECENT BIOTECHNOLOGICAL EVENTS 1944 to 1984	
Penicillin G mass produced, putting the drug within the reach of all	1944
Introduction of streptomycin, cephalosporin, and other new antibiotics	1950
Tetracycline, the parent tetracycline antibiotic, discovered	1954
The mining of uranium with the aid of microbes began in Canada	1962
Tetracyclines totally synthesised	1962
Brazilian government initiated major fuel programme to replace oil with alcohol	1973
Formation of Genentech, the first genetic engineering company in the USA. specifically formed to use rDNA methods to make medically important drugs	1976
Rank Hovis McDougall obtained permission to market fungal food for human consumption in the United Kingdom	1980
Commencement of construction work on the first industrial plant designed for the manufacture of insulin by the use of rDNA procedures	1980
Use of first monoclonal antibody diagnostic kits approved in the USA	1981
First automated gene synthesiser marketed	1981
More than eighty new biotechnology firms formed by the end of the year	1981
Sickle-cell anaemia became the first genetic disease to be diagnosed ante-natally and directly at the gene level by restriction enzyme analysis of the DNA	1982
Genetically engineered insulin approved for use by diabetics in the USA. and the United Kingdom, and placed on the market under the trade name of HUMULIN	1982
First rDNA animal vaccine (for colibacillosis) approved for use in Europe	1982
First plant genes expressed in a plant of a different species	1983
A genetically engineered growth hormone for the treatment of dwarfism was approved	1984

If one consults Table 33 above it may be seen that industry has been involved in Biotechnology in a big way for some time. However it seems useful at this time to point out in more detail a few of the areas where production has been undertaken. Examples below come from the following areas: human food production; industrial waste treatment; and cleansing systems.

Food

Fungal Protein production by Rank Hovis McDougall

In 1964, Rank Hovis McDougall decided to work on protein production from carbohydrates, for direct human consumption rather than animal food. There was a plentiful supply of wheat starch as a by product from washing wheat protein (gluten). RHM decided that the textural advantages of fungi were worth considering as a meat substitute. They decided to concentrate on microfungi as the biotechnological organism because of the lack of toxicity problems sometimes associated with some yeasts and bacteria.

In connection with this development RHM collected and screened three thousand soil samples from across the world. Eventually a fungi strain of *Fusarium graminearum* was chosen from a garden just 3 miles from the RHM laboratories at High Wycombe in the UK.

The industrial production of the RHM 'Myco-protein' is now in full swing. The product produced is now found in a wide range of processed meat foods. It contains more protein and dietary fibre than most meats as well as less fat and salt.

Industrial Waste Treatment

Oil Spillages

During the Gulf war large quantities of oil were spilt, contaminating large areas of an enclosed sea. Industrial companies, in particular a USA company Alpha Environmental, and its UK subsidiary, Alpha Biological Services, have been developing biotechnological

products to eat oil. These products are bacterially based and actually convert the oil to carbon dioxide and water and produce more microbes.

As yet the process is experimental and is only used in the confines of closed vessels as the effects of contaminating the ecosystem are not known. Ideally, in the future, one would like to be able to seed the oil slicks and see them eaten away rather than using detergents to break up the slicks and allowing the oil to sink to the bottom of the sea thereby causing more problems.

The Oil company ARAMCO had flown the above company's experts, who developed the process for oil disposal, to the gulf in order for them to address the oil spillage problem arising from the Gulf war.

Cleansing Systems

Enzymes in The Detergent Industry

Many bacteria and fungi secrete enzymes used in 'Biological detergents'. These are mainly from the Bacillus strains such as *B.amyloliquefaciens*. These enzymes have peculiar properties that make them particularly useful in washing powders such as:-

- stability at high temperature
- stability at high pH values (9-11)
- stability when in the presence of metal ion chelating agents

A product containing these enzymes can result in considerable energy savings in that boiling can be avoided. However they do have some disadvantages as some people have allergic reactions to the so called biological washing products.

Most of the worlds main industrial manufacturers of washing products such 'Lever Brothers' with their 'New Persil Automatic' use these enzymes.

Conclusions

It may be that one way to address this subject area of biotechnology in schools and colleges might be through industrially related 'cross- curricular technology project and activity' involving both school science and technology departments. Another way might be to treat the subject as a simulated industrial process in a Technology programme under a production heading. A further way may be for school students to go into limited production as a company under a 'Young Enterprise' heading in order to cover economic awareness issues. Clearly this subject is vast and many possibilities arise and will arise in the near future. Accordingly it is believed that this will result in much more biotechnological activity within the context of school technology.

If this is the case then technology educators will need to gain expertise in this area if they are to deliver the subject to school pupils. One way to gain this expertise clearly is to attend INSET courses, should they be available. If not the other way might be to use ESTED loaded with a school biotechnology database to study at their own pace whenever time presents itself.

In terms of the form of school relevant biotechnological material; most of it is scientific/technological paper textual and graphical media and as such is in an ideal form to be loaded on to a relational database system configured for technology education.

It is recommended that technology educators in particular should acquaint themselves with and gain expertise in this industrially-relevant field via a version of ESTED loaded with biotechnology data.

CONCLUSIONS TO CHAPTER 4

This section presents the conclusions which arise from the ESTED Feasibility Study, ESTED Pilot Project, and ESTED Associated Activities. It then summarises the main elements of them.

ESTED Feasibility Study

The findings that arose from this sub-section came from the sections covering: The Overture Project; The Databases Techdata 50, Macadder and Citylink; The Oxford ARIC; The Oxford Datalogging and Control Project; The Oxford Datalogging and Control Project.

The Overture Project

The Overture Project was concerned with the collation of database material for school science and mathematics, and the placing of that data upon a national database. A form for data entry was established for the project which enabled some 5000 subject items to be entered into the database.

This project provided vital practical experience relevant to ESTED, especially with data handling, installation, formatting and compilation and retrieval of science and technology material.

The Databases Techdata 50, Macadder and CityLink

These three related projects which were designed at OSSTC prior to ESTED were as follows:

TechData 50

The Techdata 50 Database structure was originally conceived in late 1987 with a design brief to produce a user-friendly piece of computer software for both school teachers and pupils, which was to be usable across a variety of school microcomputers, addressing the financial planning and management of technology projects. This subsection indicates that the project design brief was met fully.

The relevance of this project to ESTED was that it provided experience with database and software design, and software programming for the field of technology education. It developed items that would be essential to the future database form of ESTED.

Macadder

The Macadder project, an extension of the TechData 50 software, had a software design brief was similar to that for TechData 50 except that it had a requirement to address the Apple Macintosh interface and system. It was intended to be a general purpose educational tool for costing projects.

As ESTED was programmed upon the Macintosh this was relevant because it provided the first experience of programming upon this platform.

CityLink

The CityLink software project was substantial team programming project that had a design brief to produce an item of software for Advanced Level Economics that was: a. a user friendly unit of software devoted to teachers and advanced student users; b. usable across two main microcomputer systems. In terms of a and b the specific brief was as follows:

a. the software was be friendly and the learning curve was be short and steep, window based (as per Apple Macintosh form), to have on-screen help at all times, the database be up-datable in a limited fashion by the user, to be easily duplicated yet protected, to run on a microcomputer with a minimum memory of 1Meg, and to be written in C. Code ;

b. it should address the Apple Macintosh and IBM PS 2 model 30 microcomputer and clones.

The subsection indicated that the software developed fitted the criteria set and hence it was a successful development.

The findings arising from these three projects TechData 50, Macadder, and Citylink were of great importance to ESTED. Overall the lessons that were learnt from these three projects for ESTED covered 11 areas of concern:

1. the design brief should be very well specified and exact;
2. adequate equipment should be available;
3. a development programme and project schedule of agreed targets to be met should be formulated and implemented;
4. programmers should be capable of working with specified machines and systems;
5. commercial development software should be evaluated for functionality;
6. reliable quality secretarial help should be available at all times;
7. financial remuneration should be appropriate to the task being undertaken;
8. be usable by individuals with a very limited understanding of computers and access main system interfaces such as DOS, OS2, Macintosh, Windows, etc.;
9. only as a last resort should separate versions of software should be produced for individual machines as stand-alone items;
10. contingency funding must always be built into the costing at a rate of c. 40% of total project costs.
11. hardware should be tested to ensure that it is reliable, and evaluated to ensure it can cope with the tasks proposed by the design brief.

These projects were in many ways the pre-pilot database projects for the ESTED software design.

The OSSTC ARIC

This item described the situation concerning ARICs generally, and Oxford's specifically. It gave general details of the support policy in this area and indicated the level of hardware, software, and service support which was available for the support of school science linked technology education and IT. It gave specific details of the OSSTC facility which was available to the ESTED development staff.

The findings arising from this sub-section were that: the Apple supported ARIC facility gave OSSTC staff access to new microcomputing equipment and the Apple bulletin board/database. It also gave the ESTED developers experience with bulletin-boards, mailboxes, data retrieval and storage systems.

The Oxford Datalogging and Control Project

This project, based upon a Vela paper, was concerned with the production of school science linked technological textual and graphical material which would be used by technology educators. It was intended to be an example of typical material which would be likely to be entered in the prototype database. It was also concerned with practical experience and co-operation between individuals in a curriculum material/hardware environment.

The conclusion was that this project resulted in Guidelines for ESTED for papers and curriculum items which would be entered upon the database. These guidelines were that:

- a. all text should be upon white A4 plain paper, preferably typed or word-processed, if hand written they should be succinct, written in plain English, and be legible;

- b. graphic items should be separate and upon A4 plain paper preferably computer generated, hand sketches are acceptable if they are clear and are in black ink;
- c. all items should be numbered in the correct order and graphics placement should be indicated within the text;
- d. technical/scientific detail accuracy should be checked before paper submission;
- e. the paper writing level should be targeted at a level appropriate to perceived clientele;
- f. copyright consent must be obtained for items included in the paper before submission;
- g. copyright consent for the paper to be included in its entirety upon ESTED must be given in writing;
- h. references should be included at the end of the paper as per the Harvard scheme.

A European view of ESTED

This subsection describes the ESTED launch, the Oxford Seminar and Conference. These events were intended to give a European technology educator view of ESTED. The relevant conclusions for ESTED derived from these events can be itemised as:

- i. full support for the development of a European science and technology database was forthcoming from EGTB members throughout Europe;
- ii. the concept and form it was being produced in was appropriate;
- iii. the hardware and software target was defined correctly for the clientele;
- iv. the medium of delivery (CD-ROMs & Bulletin Board) was appropriate;
- v. the database would fill the formal non - communication vacuum that currently existed throughout Europe amongst technology educators;
- vi. the database was essential for teacher Initial training and INSET related to technology education;
- vii. to identify the fact that science and technology are intimately linked to technology education;
- viii. that technology is firmly linked to design and manufacturing in scientific and industrial contexts.

Overall this suggests that there was full support from European technology educators for the Oxford Pilot ESTED Project in the form envisaged by its developers as it would be used to support present and future science linked technology education

The ESTED Pilot Project

This sub-section covered the conclusions of the ESTED Pilot Project in terms of: The initial Proposal for the Pilot Project; The ESTED Development and Production; The ESTED Final Product; The ESTED User Interface; The Unique Characteristics of ESTED. It covers the development process leading to the computer database development and the characteristics which it exhibits.

The initial proposal for the Pilot ESTED outlined the original concept, clientele, staffing and responsibility, industrial support, the feasibility timetable, content and facilities, development needs, equipment and software, outcomes, costing and further equipment and financial requirements.

The ESTED Development and Production describes the rigorous development approach, timetable, facility, design process, and the various laboratory models leading to the Alpha version of ESTED.

The ESTED Final Product describes the final software product, the main elements of the new database, and final ESTED model. Suggestions concerning production and future funding of the ESTED were made.

The ESTED User Interface describes the ESTED user interface and gives details of menus, windows, report formats, and file formats.

The Unique Characteristics of ESTED gave details concerning the uniqueness of ESTED, a new database approach for technology educators. The Unique Characteristics of ESTED relate mainly to eight major areas and that these are:

1. its mode of operation uses a GUI as opposed to a CUI;
2. is identical in all respects on the industry standard vehicles of an Apple Macintosh and IBM PC (under the Windows 3 system);
3. it has the ability to store retrieve and display of high quality graphics;
4. a user does not require knowledge of a vast number of codes or keyword and an exact type match of these codes or keywords to find information;
5. a user will not always require to go on line to a remote computer to use the system;
6. a novice user can access and build up a personal database quickly and easily;
7. it could partially fulfil a technology educators technology INSET needs;
8. it supports UK and European technology curriculum development needs.

It is further unique because the whole nature, and development of, the database is based upon extended experience of technology education, with technology educators, technology INSET and database software development over a substantial period of time within an environment which has a brief to support science and technology educators.

Overall this section gave details of the actual development process which led to and the design of a new computer database model in the form of ESTED.

ESTED Associated Activities

The conclusions of this section arose out of the following two areas: A Portable Database for Technology Educators; A School Biotechnology Database.

A Portable Database for Technology Educators

Under this heading it was indicated that an investigation concerning the use of portable, low cost, microcomputers for ESTED was necessary after investigating the Atari Portfolio. A selection of portable microcomputers were surveyed, including questions concerning whether they were appropriate for use with ESTED.

This investigation found that none of the 1990 microcomputers in terms of the current low cost machines could run the ESTED software for three main reasons: firstly, because they all had insufficient memory to handle Omnis 5 (it requires at least 2 Megs); secondly, they did not have hard disks suitable for the storage of large amounts of data; thirdly, no suitable GUI/WIMP environment was available for these microcomputers.

A School Biotechnology Database

An investigation into this area revealed that if the links between biotechnology and technology are accepted then it would seem logical to pursue biotechnology in the context of a school technology programme.

It was considered that one way to address this subject area of Biotechnology in schools and colleges might be through industrially related 'cross-curricular technology project and activity' involving both school science and technology departments. Another way might be to treat the subject as a simulated industrial process in a technology programme under a production heading. A further way may be for school students to go into limited

production as a Company under a 'Young Enterprise' heading in order to cover economic awareness issues.

It found that technology educators will need to gain expertise in biotechnology, if they are to deliver the subject to school pupils, by attending INSET courses should they be available. If not an other way might be for technology educators to use ESTED loaded with a school biotechnology database and study at their own pace whenever time presents itself.

It pointed out that biotechnological material was expected to be in scientific/technological paper textual and graphical media and as such is in an ideal form to be loaded on to a relational database system configured for technology education.

Finally, it indicated Technology Educators in particular should acquaint themselves and gain expertise in this industrially-relevant field via a version of ESTED loaded with Biotechnology data.

Summary of Main Points

1. The Overture Project provided vital practical experience relevant to ESTED, especially with regard to data handling, installation, formatting and compilation and retrieval of science and technology material.
2. The three software database development projects TechData 50, Macadder, and Citylink were of great importance because the lessons that were learnt from these three projects covered 11 areas of concern to a technology education database developer. These projects were in many ways the pre-pilot database projects for the ESTED software design.
3. The exposition of the Apple supported ARIC facility indicated that it gave ESTED project staff access to new microcomputing equipment and the Apple bulletin board system. It also gave them experience with mailboxes, data retrieval and storage systems.
4. There was full support from European technology educators for the Oxford Pilot ESTED, in the form envisaged by its developers, because it would fill a major information communication vacuum that existed throughout Europe and would support the future work of technology educators.
5. The ESTED Pilot database development gave details of the actual development process which led to the design of a new computer database model. It also makes eleven statements concerning the uniqueness of the ESTED human computer interface for the support of technology education.
6. The Portable Computer investigation found that none of the low cost 1990 microcomputers could run the ESTED software because they did not have a GUI operating system or hard disk facility .
7. This indicated Technology Educators in particular should acquaint themselves and gain expertise in the industrially relevant field of Biotechnology via a version of ESTED loaded with Biotechnological data.

CHAPTER 5

RESEARCH FINDINGS, IMPLICATIONS AND POLICY RECOMMENDATIONS

This chapter gives details of: the Main Research and Development Areas addressed; the Main Findings; and Implications and Policy Recommendations arising from this study.

MAIN RESEARCH AND DEVELOPMENT AREAS

This research arises out of the analysis of the changes that have taken place in the development of school technology education over the last 10 years (1981 to 1991) under thematic headings that cover:

Changes in the Economy and the International Comparative Situation;
The Emerging and Changing Definition of Technology Education;
Policy Initiatives of the DES and the National Curriculum;
Trends in the Education of Technology Teachers and School Resourcing;
State-of-the-Art Computer Hardware and Software for Schools;
Information Sources Available to Technology Educators;
Technology Educators and IT Computing;
The Present Situation Concerning Computer Databases for Technology Education.

The summary of the findings, and conclusions of the analysis of the support for the development of technology education, highlighted three areas that merited investigation to illuminate further the development of IT supported technology education over the last decade. It is these areas that have been the main focus of the research element of this study. The three areas in particular that needed to be further investigated, if a full case for the continued support of technology educators was to be made, were:

1. The actual support for technology teacher development.
2. Technology teacher IT (Computer) capability and literacy.
3. Information usage by technology teachers.

I was also able to consider investigating the design of a dedicated technology education database because funding was likely to become available and a brief from EGBT and Oxfordshire colleagues to pilot and develop a new European science-linked technology education database system was likely to be forthcoming.

It was apparent at this point in time that the best way to undertake the illumination required for 1. 2. & 3. was to survey actual technology education practice in the field; this research was undertaken. In particular three areas were investigated:

- a. a large Oxfordshire LEA technology INSET programme which was an actual example of an initiative intended to support of technology teacher development;
- b. Oxfordshire technology teacher IT (Computing) capability and literacy;
- c. science-linked technology education information usage by Oxfordshire technology teachers introducing a new subject such as electronics and supporting student project work in this field.

Whilst undertaking b. I decided to investigate the design of a dedicated technology education database because funding became available and a brief to pilot and develop a new European science-linked technology education database system existed. This was undertaken under the 'ESTED' heading.

The following main research findings arise from the review and analysis of policy, the surveys of practice and the pilot computer database development.

MAIN RESEARCH FINDINGS IMPLICATIONS AND POLICY RECOMMENDATIONS

Finding 1.

Changes in the Economy, the International Comparative Situation and the Demand for Technology Education

There have been changes in the economy and the international competitive situation that demand science-linked technology education that supports current and new industrial technologies which ensure wealth creation and hence the economic well-being of an advanced European country such as the UK.

Implication

Because it is now generally accepted that to be a successful competitor in the international market-place any country requires a steady output of competent and adaptable technicians, scientists, engineers and designers from its schools and colleges. It is suggested that the building of such a workforce must have its foundations in the technology education provided in schools. It is also apparent that UK industry has been promoting and sponsoring science linked technology education for some time as industrialists see technology education as being essential to the support of the future economic well being of a developed country. It is evident that industry believes that an understanding of, and competency with, technology, science, and mathematics is essential to an educated, responsive and entrepreneurial work force capable of meeting the challenges of the 21st century. This understanding also encourages a technologically sympathetic workforce to consume the high-tech products that are to be produced by UK industry in the future.

Recommendation

The UK government and industry must continue to actively support and finance the development of school science-linked technology education to ensure the supply of a scientifically and technologically literate and capable workforce can be maintained. This will ensure the UK's economic well-being by providing the competitive edge that is needed to compete effectively in a changing world market and to create wealth. It must also continue this support for the subject in schools to ensure that the high-tech products of the UK's industry and commerce will be consumed in the future.

Finding 2.

The Emerging and Changing Definition of Technology Education and the Conceptual Confusion faced by Technology Educators

Even though the main dimensions of science-linked technology education have been established it seems likely that the debate concerning the place and nature of technology in the UK school curriculum will continue for some time yet. At present the situation is confused and confusing. Governmental policy initiatives further add to the confusion surrounding technology education, especially as they in particular put the UK out of line with mainstream European and World technology education developments.

Implication

It would seem that those who are involved in the school technology education development process are confused in their thinking to such an extent that do not seem to be aware of the consequences of their actions. The alternative is that they are aware of their actions and are deliberately pursuing a certain line for political or self-aggrandisement reasons. What ever the reason for this situation it is apparent that there is

a great danger that school technology as subject may disintegrate into some chaotic form or move backward to a previous form. Technology policy makers, managers and teachers in schools will be encouraged to play-safe, not to innovate and to follow the line of least resistance when implementing what they see as an unknown or poorly-defined entity which is being bounced around by so many interest groups.

Recommendation

To allay the confusion surrounding the concept, nature, and role of technology education it is recommended that :

Firstly, technology theorists, educators, and governmental policy developers adopt the simple dimensional model of technology, which has evolved from this and my previous research and experience as a practitioner in the field, when considering further development of the subject. Such an adoption will give those involved in developing school technology education a clear, easily understood definition template against which they can compare present and future initiatives. The simple dimensional model, which takes the form of a table, is shown in the reproduced Table 2. that follows.

Table 2.

THE MAIN DIMENSIONS OF TECHNOLOGY EDUCATION	
a.	Has strong links with science and mathematics;
b.	Is generally broad based, encompassing different subjects, disciplines, and skills;
c.	Has a knowledge base derived from practical experience and empirical evidence;
d.	Involves the creative process of invention and innovation to satisfy human needs;
e.	Is process based, and involves design and problem-solving as key elements;
f.	Is about materials and use;
g.	Involves practical manufacturing/making skills;
h.	Applies the systems, modular, and project approach to the technical and social areas.
i.	Necessitates communication, data gathering and information analysis, control, modelling, and simulation;
j.	Implies an inherent enhancement of attainment, capability, and awareness;
k.	Involves media manipulation and display and presentation skills.

Source Table 2., Chapter 1.

Secondly, the government should commission an independent body to investigate a. how confused the situation actually is in UK schools, and b. the full extent of the mismatch between the form of technology in the UK and form in the other G7 countries. Upon receipt of the commission report policy makers in the DFE should then consider a revision of the present UK National Curriculum Technology Orders to ensure that school technology teachers offer to their students a technology curriculum that matches mainstream European and World technology education developments.

Finding 3

Trends in the Education of Technology Teachers and School Resourcing

The low level of recruitment of technology educators, and of available school positions for those teachers from Mathematics and Science who have in the past contributed strongly to school technology education, is a major problem which needs to be addressed with affirmative action. The lack of support for serving technology educator's professional development suggests that alternative means of supporting the technology

teacher in schools are needed because the traditional support resources are being whittled away.

Implication

The maintained sector of education is suffering from a shortage of technology teachers entering the profession which will damage the long term continuity and development of technology education in schools. Teachers who are not qualified to teach the technology, science and mathematics are filling specialist teaching positions which prevents the recruitment of new teachers. Serving technology teachers have INSET needs which will need to be addressed in a new way if they are to deliver an effective technology curriculum that supports the immediate scientific and technological needs of their school students.

Recommendation

It is essential that those in government and the DFE responsible for the recruitment of technology, mathematics, and science teachers take immediate positive action to ensure that school head teachers redeploy those teachers, not qualified to teach these specialist subjects in schools, to areas where they may make best use of their particular professional subject qualifications. This will then allow the recruitment of new teachers, with appropriate specialist qualifications, who will be able to secure the long term future of school technology education.

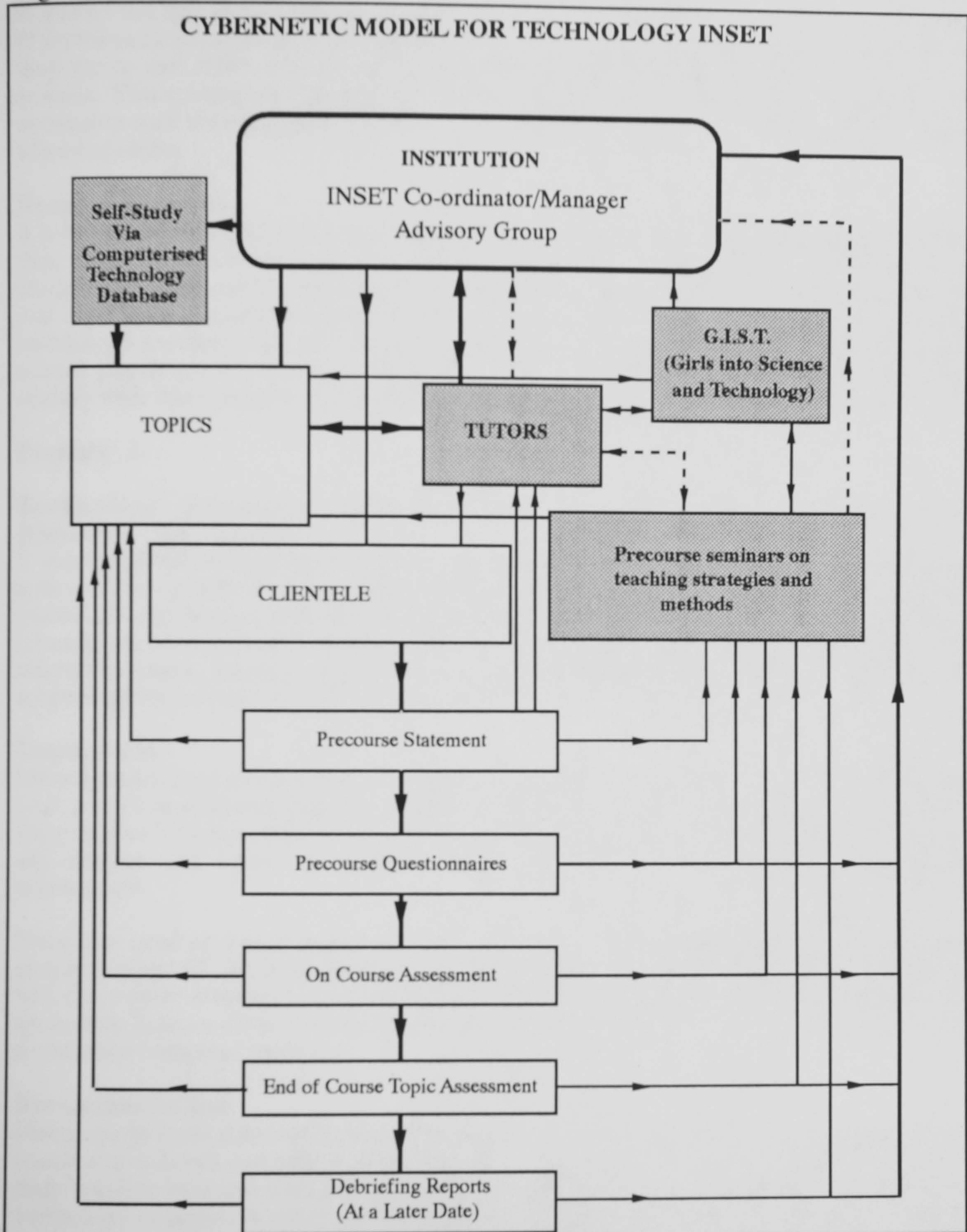
It is also recommended that the INSET needs of serving technology teachers be addressed by both innovative off-site courses and self-study via a computerised technology database as this will ensure that technology educators are competent to deliver a relevant up-to-date technology curriculum.

Off-site INSET courses targeting and up-dating the technological skill base of serving teachers must be available. These courses which require equipment and materials not readily available in all schools should be similar to those innovative courses run at Oxford under the 'TRIST' heading. These should be funded by a consortia of schools out of their INSET budgets together with contributions from industry and the support of LEAs. Such INSET provision should not be designed in a haphazard way but should be designed by reference to a model to ensure that it is cost effective, apposite to the rhetoric of the times, and makes sense to its clientele and patrons.

Consideration should be given to the INSET opportunities afforded by microtechnology in the form of a new low cost computerised GUI dedicated science-linked technology education CD ROM database system. Such a database system could have self-instructional program materials held on it in addition to a wide range of scientific, mathematical and technological materials and data appropriate to school technology. These instructional programs would be designed to address those elements of school technology education which could be undertaken in schools or at home with existing school equipment and consumables.

Those responsible for planning, co-ordinating and managing the INSET provision for a particular institution for serving technology teachers should use a cybernetic model which has been developed specifically to cover both the off-site and self-study elements recommended above. This will ensure that whatever is undertaken is fully organised, is effective, is rigorous and is in line with current developments in the field. It will also ensure that the needs of the particular individual, the school and the student clientele of the school are met. It is therefore further recommended that INSET is undertaken within a new cybernetic framework model such as that developed from this study and shown in Fig. 47.

Figure 47.

**Finding 4.****Technology Educators and IT (Computing)**

Technology educators have an IT (Computing) entitlement which should be addressed to enable them to make the best use of available computer hardware, software and peripherals. It was also found that technology teacher microcomputing expertise is limited to basic computing tasks and operations and that a substantial number technology teachers required IT(Computing) INSET.

Implication

It is essential that technology educators come to terms with the fact that they do have an IT entitlement and a professional responsibility to become computer literate and capable if they are to use effectively the computer software and hardware available to them in schools. This competency should go beyond the perceived basic computing tasks and operations and should enable them to deliver a comprehensive IT entitlement to their school students.

Recommendation

It is recommended that technology teachers themselves demand the opportunity to fulfil their personal IT(Computing) entitlement. They should lobby the school INSET policy makers and managers to ensure that this entitlement is recognised. School policy makers and managers should recognise these demands and plan immediately to provide technology teachers with the means to deliver a comprehensive IT entitlement to their school pupils via an effective INSET programme. The form of this INSET should comply with that described in the recommendations associated with Finding 3. above.

Finding 5.**Technology Educators and State-of-the-Art Computer Software and Hardware for Schools;**

It was found that technology educators need get to grips with a computer system software with a GUI as it will result in higher output per hour, higher productivity, lower levels of frustration and fatigue, and greater return upon school information technology software investment. They should further become conversant with state of the art 32 bit microcomputers, associated peripherals and CD ROM technology. The majority of schools are still using 8 and 16 bit microcomputers

Implication

School technology educators should have access to the same high level state of the art GUI computer software that is available to industry, commerce and higher education. Only then will they be able to increase their productivity, lower their levels of frustration and fatigue and ensure a greater return upon future school computer software investments.

They also need access to and experience with the same leading edge 32bit computers, peripherals and CD ROM technology that is generally available outside of education. This will also ensure that their expertise level is such that they are able to deliver an effective up-to-date science-linked technological education to their students utilising the most appropriate computer hardware.

Recommendation

New moneys must continue to be made available by government, in the form of grants, to ensure that schools can afford to update their computer software and hardware to bring them into line with that used in higher education, industry and commerce and the new city technology colleges. A major government grant should be made immediately as a matter of priority to ensure that teachers can deliver to their students an effective technological education with state-of-the art software and equipment which will be acceptable to those in higher education and those employers in industry and commerce. Guidelines on what is an acceptable purchase should be issued by the grant agency. These guidelines should not be manufacturer specific but should provide a type of item purchase framework. Schools should have direct access to these moneys rather than through an LEA to avoid having costly central purchasing arrangements imposed on them by those with vested institutional or personal interests. They should manage their budgets in such a way that any moneys available for the purchase of such new software equipment is actually spent

upon up-to-date items. They should consult the grant agency guidelines and seek advice from independent sources on the appropriateness of the items being purchased before purchasing them at the best possible price on the open competitive free market. They should also avoid being tied into purchasing consortia which appear to have vested interests by being linked in some way to a certain type of equipment or a particular manufacturer.

Finding 6.

The Information Source Availability and Access Needs of Technology Educators

Technology educators need access to up-to-date technical and professional information if they are to continue delivery of an effective economically relevant school technology curriculum. Many of the present information sources and services are not available to technology educators for financial and logistical reasons. New developments of computer hardware and software and peripherals are available for use by teachers in schools which allow rapid, timely, flexible access to information via a dedicated computer database system.

Implication

All technology educators must make attempts to ensure that they access and make full use of current and new information sources and services that are available to them as professional educators. These information sources and services should be in their school or be easily accessible in their particular regional institutions. They must also be aware of new technology in the form of computer hardware and software which will allow them access to new and existing information sources via dedicated computer database systems. Accurate up-to-date scientific and technological information will allow informed teaching and will directly benefit their school students undertaking technology courses and developing individual technology projects.

Recommendation

It is apparent that technology educators must make efforts to find out and use the sources of information and information services that are relevant and available to them in their particular institution. They must make representations to the institutions specialist information provider and senior school management staff concerning their specialist requirements. School managers should recognise their responsibilities in this area, respond to representations from technology teachers, and should develop an information access policy which can be implemented by the professional information specialist provider. Such a policy should take into account access to and the funding of documentary sources, the many on-line information services, and especially the new computerised, dedicated, CD-ROM specialist database systems.

Finding 7.

The Benefits of a Computerised Technology Education Database

A dedicated computerised technology database would support and facilitate the transmission of useful scientific and technological data to technology educators. It would reduce the amount of duplication of effort going into technology education and allow technology education to be developed further in Europe. It would facilitate the continued professional development of technology educators and enable technology educators to communicate their personal and professional expertise to their professional colleagues.

Implication

Such a computerised technology education database needed to be designed and to be put in place as soon as possible to enable technology educators in schools and colleges

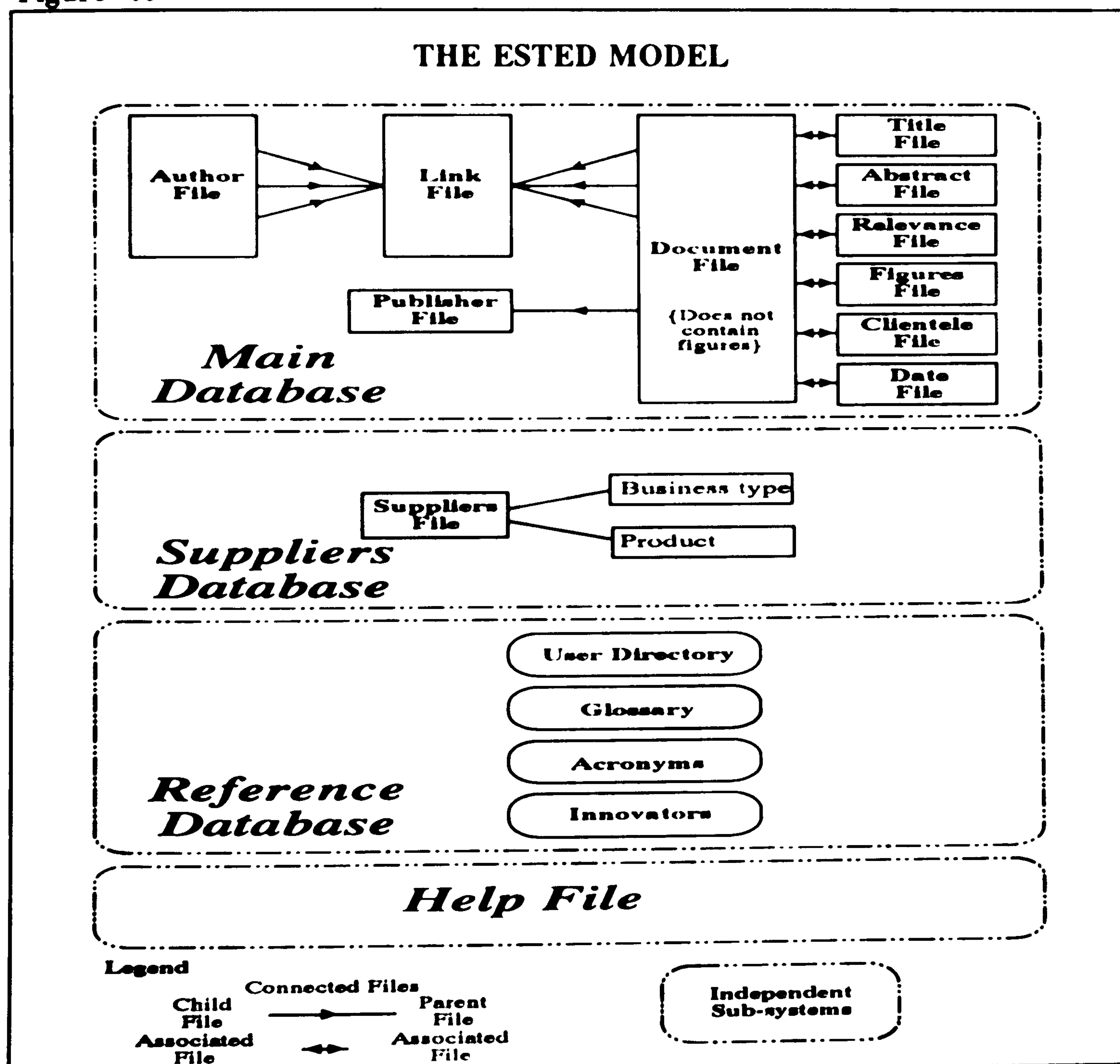
throughout Europe to efficiently and effectively access information and develop technology education further. It should also enable technology educators to partially continue their personal professional development and communicate with their colleagues throughout Europe in their preparation and free time.

Recommendation

It is recommended that a Europe wide dedicated computerised technology education database which can enable rapid access to scientific and technological information, reduce the duplication of effort when developing new curriculum materials, contribute to the professional development of technology educators and allow communication between colleagues throughout Europe be established at the earliest possible opportunity. This should be done in order to draw upon the experience and expertise that has been built up in the field over a considerable time.

It is specifically recommended that the new technology education database should be as per the Model developed for ESTED shown below in Fig.40.

Figure 40



Source. Figure 40, ESTED Model 6, Chapter 4.
Finding 8.

The Pilot Science-Linked Technology Education Computer Database 'ESTED'

The dedicated computer database 'ESTED', described in this study, is a unique leading edge database system which has been specifically designed and developed to meet the information needs of European technology educators and others world wide. It is the only recently-completed, leading-edge GUI-based, fully-relational, user-friendly dedicated science linked technology education database system development in the world today. It is unique because it has been developed by a practising technology educator in a university centre dedicated to supporting science-linked technology education and IT(computing); and has unique characteristics relevant to science-linked technology education because of the extensive, relevant research undertaken before its development.

These unique characteristics are that:

its mode of operation uses a GUI as opposed to a CUI;
 it is identical in all respects on the industry standard vehicles of an Apple Macintosh and IBM PC (under the Windows 3 system);
 it has the ability to store retrieve and display of high quality graphics;
 a user does not require knowledge of a vast number of codes or keyword nor an exact type match of these codes or keywords to find information;
 a user will not always need to go on line to a remote computer to use the system;
 a novice user can access and build up a personal database quickly and easily;
 it could partially fulfil technology educators technology INSET needs;
 it supports UK and European technology curriculum development needs.

It is further unique because the whole nature, and development of the database is based upon extended experience of technology education, with technology educators, technology INSET, and database software development over a substantial period of time within an environment which has a brief to support science and technology educators.

Implications

Because a dedicated computerised database such as ESTED can support European school technology education and the professional needs of technology educators its use needs to be promoted at the earliest possible date. Successful promotion would ensure that European technology educators have access to a computerised database for school science-linked technology education. It is essential to maintain detailed up-to-date information on technology education developments, initiatives and policy if such a database is to be effective

Recommendation

It is therefore recommended that European technology educators should obtain and use a dedicated computerised technology education database, such as ESTED, as this will provide them with the means to view current technology education policy and practice and support their professional work in schools.

ESTED is already at a stage of development where phase 2 could be immediately implemented by:

- i. drawing up a proposal for European wide implementation of the ESTED system ;
- ii. submitting this proposal to appropriate EEC and other European agencies for funding;
- iii. investigating potential ESTED data entry nodal points in EEC member state higher education institutions;
- iv. considering the need for further future development of the ESTED system;
- v. discussing with the main software tool providers the arrangements for purchasing the main software incrementor and run-time for ESTED,

- vi. investigating the implementation of the bulletin board element.
- vii. investigating the cost of production of the CD-ROM that will eventually hold the database and database system.

It is also recommended that an initial European wide survey, collection, and collation of technology education material suitable for entering upon the ESTED be implemented immediately upon receipt of funding.

It is further recommended that an investigation of possibilities for the use of the ESTED system outside Europe is made; particularly in Australia, New Zealand, and the USA.

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BIS, Cogan Page, London, UK, 1989.
- Whittaker, M.** Basic Concepts and Approaches to Electronic Systems, Microtechnology
Inset Team, NEMEC, SSTF, Southampton University, UK, 1986.
- World Conference on Computers in Education**
IFIP Fifth World Conference, WCCE90, Conference Abstracts, ACCE,
Myrad Communications, Sydney, Australia, 1990. ISBN 0-646-00011-X
Proceedings, WCCE90, Elsevier Science Publishers BV, Amsterdam,
The Netherlands, 1990. ISBN 0-444-88750-4

APPENDIX A

RESEARCH LOGISTICS

Conferences

Visits

Libraries Consulted

Computer Searches

ESTED Diary Abstraction

Conferences

The following major conferences were attended:

1st World Congress on Technology Education 1987, International Technology Association, Norfolk, Virginia, USA.
 Conasta 1988, ICASE, Canberra, ACT, Australia
 Association for Science Education Conference 1988 & 89, UK.
 Design and Technology Conferences and Exhibitions, 1987, 88, 89 & 90 National Exhibition Centre, Birmingham, UK.
 PATT Conference 1988, University of Technology, Eindhoven, The Netherlands.
 SCSST 1987, Institute of Aeronautical Engineers, London.
 SCSST 1988, Design and Technology in the Curriculum, Institution of Chartered Accountants, London UK.
 EGTB 1987, Inaugural Conference, Royal Society, London.
 Australian Council for Education through Technology 1990, International Conference Centre, Adelaide, South Australia.
 EGTB 1990, Oxford Conference, University of Oxford Department of Educational Studies, Oxford, UK.

Visits

Visits were made to the following major institutions and companies:

La Trobe University, Department of Education, Melbourne, Australia.
 Oxford Polytechnic, Faculty of Education, Oxford, UK.
 The Southbank Polytechnic, London, UK.
 The Technological University of Eindhoven, Pedagogical Technological College, Eindhoven, The Netherlands.
 The University of Queensland, Department of Education, Brisbane, Queensland, Australia.
 The University of Wollongong, Department of Technology and Information Technology
 Oxfordshire LEA Administration Offices, TVEI Centre, Secondary Schools and FE Colleges.
 SCSST, London, UK.
 Apple UK Ltd., Stockley Park, London, UK.
 Blythe Software, Saxmundenham, Suffolk, UK.
 Design Craft and Graphics, Long Hanborough, Oxon., UK.
 IBM, Portsmouth and Warwick, Hants and Warks, respectively, UK.
 The Banking Information Service, Lombard St., The City of London, UK.
 The Oxford Trust, Oxford, UK.

Libraries

Libraries consulted were:

OSSTC Resource Library, Clarendon Laboratory, University of Oxford, Oxford, UK.
 The Radcliffe Science Library, University of Oxford, Oxford, UK.
 The Education Library, Department of Educational Studies, University of Oxford, Oxford, UK.
 The Management Library, Cranfield Institute of Technology, Cranfield, Beds., UK.
 The Main Library, Education Section, The University of Queensland, St. Lucia, Brisbane, Queensland, Australia.

Computer Searches

Computer searches were undertaken on the following systems:

NERIS, Bedfordshire, UK.

SATRO Database, Campus 2000, London, UK.

ERIC, Washington, UK.

ESTED Diary Abstraction

ESTED DIARY ABSTRACTION SEPTEMBER 1989 TO DECEMBER 1990

September 1989

- 4 **am** - team meeting to discuss present situation, future action, agenda for project, allocation of tasks, need for resources.
 pm - re-organisation of facilities in centre, disposal of non required/useful items
- 5 **am/pm** - Discussion, research and ordering of stationary, office and data base hardware.
- 6 **am** - setting up Mac system, investigation of Omnis 5.
 research and ordering of networking hardware - for Unix Works station, EGA card for IBM.
 pm - compilation of supporting data for for Rationale for Development
- 7 **am** - learning Omnis 5.
 pm - conference paper
 Abstract for ACET conference Adelaide Jan 70
 Produce ETED stickers
 work up ETED prospects
 Information sheet about ETED
 Times 12 point 3m margin all round
 Double line space
 Tables 1 cm in RL & LT
 Titles 1st & bold
 Margin (sections) centred, upper case
 References - Harvard System (and footnote)
- 8 **am** - Discussion of technical matters
 Discussion to obtain Mini Quisk hard disc unit for back-up purposes
 Tops & Card for Mac/IBM (inc & VGA cad)
 pm - Installing EGA board in IBM
 Learning Omnis 5.
- 11 **am** - Yet more Omnis
 EGTB meeting in centre
 ETED to report to EGTB as progress is made
 pm - Omnis/ EGTB continues
- 12 **am** - rewriting proposal/costing documents
 pm - further compilation for Rationale
- 13 **am** - Configuring IBM to access extended and expanded memory
 install windows 286
 pm - work on MAC
- 14 **am** - Start sorting out/ compiling material for Feasibility Study/ Visas Aust. Visit/
 preparation OSSTC Opening/ Launch ESTED
- 15 Chancellor Oxford University, Lord Jenkins-- Open Refurbished OSSTC/Launch ESTED
- 18 Omnis 5/ Meeting Delphi Probe/
 talking to Omnis re art layouts etc
- 19 Further sorting out of material for Feasibility Study/ Citylink Development
- 20 getting to grips with scanning in info
 Text works fine - view Omnipage
- 21 Scanning in images - fine, but how do we manipulate them?
- 22 Start on D/B
 edit proposal IT doc
- 25 Edit proposal IT doc, delphi probe discussions
 Omnis d/b delphi probe design

- OSSTC steering committee meeting
- 26 am - Questionnaire design/ Citylink Development
- 27 Questionnaires, report discussion
- 28 Citylink Development
- 29 Questionnaire design
- October**
- 2 Database design
- 3 Database design
Access Campus 2000 - set up terminal etc.
- 4 D/B design continues
- 5 Ditto - city windows (Mark 1) complete - starting on procedures to drive the beast
- 6 Ditto - city windows word
- procedures over
- 9 Electrical Testing day (all ESTED equipment tested)
- 10 Omnis learn/ Final Version Citylink
- 11 Using NERRIS & TTNS - boy are they slow?
- 12 Omnis
- 13 Repair defective ESTED Equipment (2 computers, EGA board & Disk drive)
- 16 Omnis 5 - database shortly to opp
- 17 Ditto/ Questionnaire Design
- 18 Ditto - appears to be bug in link files
Preparation of ETED proposal (begging letter info)
- 19 To Design & Technology Exhibition (@ NEC
- 20 - Omnis linked files don't! work, ETED proposal
NERRIS investigation
- 23 Report, design Omnis proposal, & discussion
- 24 Report, searches & bugs
- 25 Search design/ Discussions Citylink
- 26 Search & reports now sorted
- 27 Omnis 5/ IT Questionnaire Design
- 30 Scanner Power supply failed send for repair, rig up jury system
- 31 Omnis 5/ Scanner Trials

November

- 1 Omnis 5
- 2 CityLink Launch
- 6 Thinking sessions
Renamed as ESTED
Omnis 5 - drawing needs pics
- 7 Putting the S in ESTED graphics
worked on Delphi probe
- 8 Omnis 5 adding link modification
ESTED pamphlet modification
- 9 Final work on Citylink documentation
- 10 Techdata 50, minor modification
- 13 Omnis reports not functioning
- 14 Omnis reports not functioning
- 16 Omnis reports still not functioning
- 17 Not a good day! running round in circles trying to get Omnis to report
- 20 Sorting out Omnis ESTED system
- Having to rethink the whole search routine!
- 21 Have got search to find authors OK
The problem is search is too slow!!
- 22 Can we link main files to speed the search system?
- 23 Omnis
- 24 ESTED now works! Searches implemented
- now we need to put in some data!
- 27 Getting abstract search to work
- 28 ditto
- 29 Final Draft IT (computing) Paper
- 30 Further work on Feasibility items

December

- 1
- 4 Work on Omnis 5 - fine tuning
- 5 Ditto - lists don't always behave!/Questionnaires in Post
- 6 Omnis 5 - sort out lists
- 7 Omnis 5 - lists
- 8 Omnis 5 - lists
- 11 Final Check Draft IT (paper)
- 12 Omnis 5 must get pie handling system to work!!
- 13 Check & confirm ACET 90 & flights to Australia
- 14 Omnis- fine tuning
- 15 Omnis Model 2
- 16 Rethink Database /Discussion
- 17 More Queries Tech Data 50
- 18 ESTED Design
- 19 Major computer crash - surge on main power line/rebuild hard disks
- 20 Close and secure systems for Christmas Break

APPENDIX B

RESEARCH INSTRUMENTS

Oxford SCITECH Futures Probe
Oxfordshire (TRIST) INSET Probe
Oxfordshire IT (Computing) Probe
Oxfordshire Technology Information Access/Source Probe

Oxford Schools' Science and Technology Centre

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OXFORD SCITECH FUTURES QUESTIONNAIRE

As an expert in the field of Science linked Technology Education you are being asked to identify basic skills and abilities (in the areas of scientific knowledge, technology, and information technology) that will emerge as important foci for learning within secondary education during the next decade.

All responses will be treated in the strictest confidence. Your name will be given a number code as soon as I receive your questionnaire, and I will be the only person to have access to the coding. When the research is written up there will be no way of identifying individuals.

There is no such thing as a right or wrong answer; it is your expertise that is required, and your confidentiality is ensured. Please help by completing the questionnaire now; it should take about 2 hours. A prompt return would be appreciated.

Thank you for your help!

James S. Fisher

NUMBER:

NB. This Oxford SCITECH probe is based upon the University of Queensland, Department of Education 1987 BASTECH FUTURES STUDY Probe.

INSTRUCTIONS FOR COMPLETING THE QUESTIONNAIRE

Technology

How to fill in the vertical columns

Where marked with '*' please enter any further topics that you believe will be significant components of basic technology by the year 2000.

- Column 2 Indicate for each topic area whether it will be less important (L), more important (M) or about the same in its importance (S) to basic technology in the year 2000 as now.
- Column 3 Tick those areas representing areas that will be obsolete as basics by the year 2000. *Add any comment supporting these entries in Column 11.*
- Column 4 Tick those areas representing areas that will survive as basics but with substantial changes in approach by the year 2000. *Add any comment supporting these entries in Column 12.*
- Column 5 Tick those areas representing areas that will be most important for students to know how or about in the year 2000. *Add any comment supporting these entries in Column 13.*
- Column 6 For each of the areas ticked in Column 3 enter the number of any area that will subsume or replace it.
- Column 7 For each area enter a 1, 2, or 3 if it will be a basic skill contributing to the general quality of life, including leisure, in the year 2000. #
- Column 8 For each area enter a 1, 2, or 3 if it will be a basic skill contributing to the expected requirements of a 'blue collar' worker in the year 2000. #
- Column 9 For each area enter a 1, 2, or 3 if it will be a basic skill contributing to the expected requirements of a "white collar" worker in the year 2000. #
- Column 10 Refer to column 5. Rate the areas in column 5 by placing a 1 against the most important etc. (please note that equal ratings may be used)

Add any information, opinions or relevant data on the matching Column 1 Topic Area in Column 14, or on a separate sheet if so desired.

Please use the following scale:

1.	Very important.
2.	Of moderate importance.
3.	Of little importance.

Uses of Information Technology

How to fill in the vertical columns

Where marked with '*' please enter any further technological media that you believe will be significant in education by the year 2000.

For medium numbers 1 - 17.

- Column 2 Indicate for each medium whether it will be less important (L), more important (M) or about the same in its importance (S) as a medium of instruction and learning in the year 2000 as now.
- Column 3 Tick those media you believe will be obsolete by the year 2000.

- Column 4 Tick those media you believe will be widely used in the year 2000 but with modifications.
- Column 5 For those media ticked in Column 3 write the numbers of the media that will subsume them in the year 2000.
- Column 6 Rate the importance of each medium as a contributor to the learning/instructional process in the year 2000 by entering a 1, 2, or 3. #
- Column 7 If the media are to fulfil their potential by the year 2000, estimate the latest year by which equipment refurbishing and personnel retraining should commence. if no action is required enter NIL for that medium.
- Column 8 Tick if sufficient expertise exists within the teaching profession to mount and develop the medium to its potential.
- Column 9 Tick if you believe the medium will enhance the quality of instruction beyond its present level by the year 2000.
- Column 10 Tick if the medium will make new kinds of learning possible. *Add comments to amplify your response in Column 17.*
- Column 11 Tick if the removal of this medium would markedly detract from the quality of learning/instruction.
- Column 12 Rate the potential of each medium to contribute to improved education for the physically or learning disabled. #
- Column 13 Indicate whether students will have individual access(I), small group access (S) or large group access (L) to each medium.

For medium numbers 18 - 21

- Column 14 By the year 2000 School curricula should address and foster these levels of literacy:
 (A) Compulsorily for all students.
 (B) Selectively, for some students.
 (C) Specifically for students proceeding to further education
 Enter A, B, or C.
- Column 15 Enter Z, R, M or D reflecting your perception of its current use.
- Column 16 Enter Z, R, M or D reflecting your expectation of its use in the year 2000.
 (Z), Nil (R), Rarely (M), Moderately (D), Frequently
Add comments to amplify your response in Column 18.

Add any information, opinions or relevant data on a Column 1 Topic Area on a separate sheet if so desired.

- # Please use the following scale:
- | | |
|----|-------------------------|
| 1. | Very important. |
| 2. | Of moderate importance. |
| 3. | Of little importance. |
-

Science

How to fill in the vertical columns

Where marked with '*' please enter any further topics that you believe will be significant components of science by the year 2000.

- Column 2** Indicate for each item whether it will be less important (L), more important (M) or about the same in its importance (S) to science in the year 2000 as now.
- Column 3** Tick those items representing areas that will be obsolete as basic scientific knowledge by the year 2000. *Add any comment supporting these entries in Column 11.*
- Column 4** Tick those items representing areas that will survive as basics but with substantial changes in approach by the year 2000. *Add any comment supporting these entries in Column 12.*
- Column 5** Tick those items representing areas that will be most important for students to know how or about in the year 2000. *Add any comment supporting these entries in Column 13.*
- Column 6** For each of the items ticked in Column 3 enter the number of any item that will subsume or replace it by the year 2000.
- Column 7** For each item enter a 1, 2, or 3 if it will be an attribute contributing to the general quality of life, including leisure, in the year 2000. #
- Column 8** For each item enter a 1, 2, or 3 if it will be an attribute contributing to the expected requirements of a 'blue collar' worker in them year 2000. #
- Column 9** For each item enter a 1, 2, or 3 if it will be an attribute contributing to the expected requirements of a "white collar" worker in the year 2000. #
- Column 10** Refer to column 5. Rate the items in column 5 by placing a 1 against the most important etc. (please note that equal ratings may be used)

Add any information, opinions or relevant data on the matching Column 1 Topic Area in Column 14, or on a separate sheet if so desired.

- # Please use the following scale:
- | | |
|----|-------------------------|
| 1. | Very important. |
| 2. | Of moderate importance. |
| 3. | Of little importance. |

Technology

Topic Areas											Columns			
											11	12	13	14
											Comments regarding Column 3	Comments regarding Column 4	Comments regarding Column 5	Extra information about Topic Areas
1. Practical activities	Use of hand tools	1	2	3	4	5	6	7	8	9	10			
	Setting up and operating equipment e.g. machine tools	2												
	Measuring, reading, instruments	3												
	Observing/recording data	4												
	Displaying data e.g. graphs, tables	5												
	Problem solving and design	6												
	Manufacturing	7												
	Using media to capture data e.g. film/video	8												
		9												
		10												
2. Knowledge of specifics	Specific facts e.g. properties of materials	11												
	Terminology e.g. boiler types	12												
	Conversions e.g. measuring systems (metric etc)	13												
	Definitions e.g. density, elastic modulus	14												
	Formulae e.g. moments of inertia, velocity ratios	15												
	Formulae e.g. Ohm's law	16												
	Modelling e.g. scale and computer	17												
		18												
		19												
		20												
3. Higher knowledge	Analyzing data	21												
	The design loop i.e. investigating	22												
	Specifying	23												
	Constructing	24												
	Testing and finishing	25												
	Modelling	26												
	Written reporting	27												
	Oral reporting	28												
		29												
		30												
4. Scientific support	Physics of materials	31												
	Density of materials	32												
	Biotechnology	33												
	Ecology	34												
		35												
	Effect of relationships mathematically	36												
	Selecting relevant formulae	37												
	Manipulating formulae	38												
	Checking consistency of calculations	39												
	Displaying outcomes graphically	40												
5. Mathematical support	Using calculations to speed results	41												
	Using computer programs for special problems	42												
		43												
		44												

Uses of Information Technology

[illegible]

Science

Topic Areas											Columns			
											11	12	13	14
											Comments regarding Column 3	Comments regarding Column 4	Comments regarding Column 5	Extra information about Topic Areas
1. Experimental Activities	Assembling equipment													
	Operating equipment													
	Special skills e.g. microscopy, spectroscopy													
	Sample e.g. experiments by computer													
	Observing/Recording data													
	Measuring/reading instruments													
	Displaying data e.g. graphs, tables													
	Using media to capture data e.g. film, video													
2. Knowledge of specifics	Specific facts e.g. properties of a substance													
	Terminology e.g. chemical symbols													
	Concepts e.g. direction of current flow													
	Definitions e.g. resistivity													
	Principles e.g. Ohm's law													
	Formulae e.g. Ohm's equation													
	Explanatory techniques e.g. Monte Carlo simulation													
3. Higher knowledge	Analyzing data													
	Formulating hypotheses													
	Interpreting data and calculations													
	Designing experiments to test hypotheses													
	Predicting/Verifying/Interpreting													
	Oral reporting													
	Report writing													
4. Mathematical support	Expressing relationships in algebraic form													
	Selecting relevant formulae													
	Manipulating formulae													
	Checking consistency of calculations													
	Comparing answers graphically													
	Using calculators to work from													
	Using computer programs for special problems													
	Writing computer programs to assist solutions													
5. Views of science	As pure enquiry (as most nations)													
	As accessible to them only													
	As discrete disciplines e.g. physics, chemistry													
	As an integrated field of enquiry e.g. ecology													
	As a high status subject													
	As a noble discipline													

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TRIST QUESTIONNAIRE

TRAINING NEEDS OF SCIENCE AND CDT TEACHERS

Dear Colleagues,

The purpose of this questionnaire is to investigate your inset needs with regard to the TRIST programme for Science and Technology Teachers shortly to be implemented by OSSTC in conjunction with Oxfordshire LEA.

It is envisaged that the programme will cover the following areas: Electricity/Electronics; Microtechnology/Control; Computer Aided Design; Product Design Graphics/Problem-Solving. In addition to these areas it will also cover Curriculum Development, in a school based situation, and will allow for Visits to various institutions related to Science/ Technology/Biotechnology/Engineering.

I would appreciate it if you could complete the questionnaire, by answering the questions overleaf, in order that a full programme related to your individual needs can be drawn up as soon as possible.

Many thanks for your co-operation.

Yours Sincerely

James S. Fisher
Director Oxon TRIST Programme
for Science and Technology Teachers

"Links between teachers of science and CDT teachers are vital if a damaging and unnecessary division between science and technology is to be avoided. All science courses should have a technological content, and all technology courses should have a scientific content."

Science 5-16: A Statement of Policy,
DES, March 1985.

EQUAL OPPORTUNITIES EXIST FOR BOTH GIRLS AND BOYS IN SCIENCE AND TECHNOLOGY

NAME:

SCHOOL:

DEPARTMENT:

QUESTIONNAIRE

PLEASE TICK BOXES AS APPROPRIATE

[]

K (Knowledge) T (Teaching Experience of Areas Listed)

	None/Little		Fair		Good		Very Good	
	K	T	K	T	K	T	K	T
Electricity /Electronics	[]	[]	[]	[]	[]	[]	[]	[]
Microcomputing in Science/CDT Areas	[]	[]	[]	[]	[]	[]	[]	[]
Control Technology	[]	[]	[]	[]	[]	[]	[]	[]
Computer Aided Design	[]	[]	[]	[]	[]	[]	[]	[]
Problem-Solving	[]	[]	[]	[]	[]	[]	[]	[]
Graphic Communication	[]	[]	[]	[]	[]	[]	[]	[]
Product Design	[]	[]	[]	[]	[]	[]	[]	[]
Curriculum Development in Science /Technology/ Biotechnology/ CDT Areas	[]	[]	[]	[]	[]	[]	[]	[]
Biotechnology	[]	[]	[]	[]	[]	[]	[]	[]
High Tech Areas of Industry	[]	[]	[]	[]	[]	[]	[]	[]

Any Other Relevant Information

NB. I Will be talking to you individually at a later date.

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OXFORDSHIRE TRIST PROGRAMME B1. TECHNOLOGY TRAINING

Pre-Course Questionnaire for Delegates

1. What are your hopes/expectations for the course?

2. How did you come to be involved in the course?

3. Please comment on the advantages/disadvantages of the way in which this course has been organised/timetabled ?

4. Any Other comments at this stage ?

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QUESTIONNAIRE:

USE OF MICROCOMPUTERS IN TECHNOLOGY EDUCATION 11-16 IN OXFORDSHIRE.

ESTED SURVEY

As a Technology Teacher and Head of Department (CDT, Home Economics, Business Education, Art and Design) in an Oxfordshire school, you are being asked to help with a local survey which will show the current use of microcomputers in Technology throughout the county. Your knowledge and opinions are important, so please complete the questionnaire, even if you have never used a computer.

NB Each questionnaire sent out under the individual subject heading is identical with the exception that the Technology subject name as listed above has been entered into the appropriate place

I am looking forward to the result of this survey and incorporating the findings in the ESTED Feasibility and Development pilot project. I am also looking forward to the feedback from the research which will be presented to Technology Advisers in order to help in planning future INSET courses. Some schools will be asked to give follow-up interviews so that some of the good ideas that have evolved for using microcomputers in Technology will be shared. Hopefully, this may ease the introduction of the Information Technology aspects of the new National Curriculum in Technology for some schools.

All responses will be treated in the strictest confidence. Your name will be given a number code as soon as I receive your questionnaire, and we will be the only persons to have access to the coding. When the research is written up there will be no way of identifying individuals.

There is no such thing as a right or wrong answer; it is your expertise that is required, and your confidentiality is ensured.

Please help by completing the questionnaire now; it should take about 20 minutes. A prompt return would be appreciated.

Thank you for your help!

James S. Fisher

Questionnaire

Instructions:
Most questions can be answered by **ticking boxes** for Yes Y[], or No N[], or by **circling** your selected word.
Others ask for your **comments**.
If the space provided for answers is insufficient, please feel free to extend your answers by writing on the back of the paper (and of course marking the question numbers clearly).
Please do not waste time by checking on information that you do not know already - just write 'Don't know'.

Section A: Location of Equipment

Survey Coding Box []]]]

Network Room(s)

1) Please circle the number of network rooms that are in your school:

0 1 2 3 4 Don't know

2) How many of these network rooms are available for CDT teaching? (Please circle)

0 1 2 3 4 Don't know

3) Please describe briefly the makes and approximate numbers of microcomputers in the network room(s). If there is anything that you do not know, just write 'don't know' in the answer space.

Room	Microcomputer make and model ?	How many of this model?	How many of this model with colour monitors?
e.g. 1	R.M. Nimbus PC1	9	9

Section B: Location of Equipment

CDT Department

4) How many microcomputers are available for use in the location of the CDT department?

.....

5) For each microcomputer within the CDT Area, would you please give the make and type of computer, the sort of monitor (colour or monochrome), the way the programs are loaded (tape/disk drive[one or two slots? 40 or 80 track? switchable?]/hard disk), and peripherals (e.g. printer/temperature sensor/robotic arm/mouse etc.) that are usually used with that particular microcomputer, and state the room in which they are based. If the room is connected to a network system, please state it.

Make & type	colour/mono	disc drives/tape	peripherals	Base	Network
e.g.BBC B	col.	dd(2)	printer &	Lab.2	No
		40/80 switchable	light sensor	(Biol.)	

Section C: Use

6) Is it possible to timetable a class into the computer network room for a block of at least 3 weeks in a particular term

- a) before the school year starts? Y [] N []
 b) two or three weeks before starting the topic? Y [] N []

7) Please describe briefly the procedure for booking computer time:

a) for a network room

7) Please describe briefly the procedure for booking computer time:

b) within the location of the CDT

8) Do you have access to the following electronic databases at school? (Please tick Yes or No)

- a) TTNS (Times Network) Y [] N []
 b) PRESTEL Y [] N []
 c) NERIS (National Educational Resources Information Service) Y [] N []
 d) OXIS (Oxfordshire's Database) Y [] N []
 e) Any other remote database (please specify): Y [] N []

9) Have you ever used any of these electronic databases? (Please tick for Yes or No.)

If Yes, please give a short example of what you used the database(s) for.

- a) TTNS Y [] N []
 b) PRESTEL Y [] N []
 c) NERIS Y [] N []
 d) OXIS Y [] N []
 e) Any other remote database Y [] N []

Which ?

f) Is a telephone line available exclusively for electronic communications in your School ?

Y [] N []

SECTION X

1) Have you ever used microcomputers for your teaching? Y [] N []
 If Yes, please continue in numerical order. If No, please move on to section Y.

2) Have you ever used a microcomputer in the following ways for your teaching?

- a) keeping records of pupils' attendance Y [] N []
 b) keeping records of pupils' progress Y [] N []
 c) writing school reports Y [] N []
 d) word processing work-sheets Y [] N []
 e) writing examination or test papers Y [] N []
 f) sending messages to other staff/pupils Y [] N []

3) Have you ever used microcomputers in the following ways for teaching:

- | | | |
|---|-------|-------|
| a) Computer Assisted Learning | Y [] | N [] |
| b) Sensing/Monitoring (e.g. temperature) | Y [] | N [] |
| c) Control (e.g. a lathe) | Y [] | N [] |
| d) Graphical Display | Y [] | N [] |
| e) Database | Y [] | N [] |
| f) Simulation (e.g. of a casting process) | Y [] | N [] |
| g) Modelling/Spreadsheet | Y [] | N [] |
| h) Electronic mail | Y [] | N [] |
| i) Wordprocessing | Y [] | N [] |
| j) Computer Aided Design | Y [] | N [] |
| k) Computer Aided Manufacturing | Y [] | N [] |

continued over

If all of your answers were No, please move on to question 6.

4) Where have you used microcomputers for teaching CDT in each of these ways? Please tick all places that apply.

- | | Workshop/Lab. | Network-room | Classroom |
|-------------------------------|---------------|--------------|-----------|
| a) Computer Assisted Learning | [] | [] | [] |
| b) Sensing/Monitoring | [] | [] | [] |
| c) Control | [] | [] | [] |
| d) Graphical Display | [] | [] | [] |
| e) Database | [] | [] | [] |
| f) Simulation | [] | [] | [] |
| g) Modelling/Spreadsheet | [] | [] | [] |
| h) Electronic mail | [] | [] | [] |
| i) Wordprocessing | [] | [] | [] |
| j) Computer Aided Design | [] | [] | [] |
| k) Computer Aided Manufacture | [] | [] | [] |

5) If you have answered yes to any part of the last question, please use the space below to write the name of the best program that you have used, and tick Y [] if you would want to use it again, or N [] if you would not want to use it again.

- | | | | |
|-------------------------------|-------|-------|-------|
| a) Computer Assisted Learning | _____ | Y [] | N [] |
| b) Sensing/Monitoring | _____ | Y [] | N [] |
| c) Control | _____ | Y [] | N [] |
| d) Graphical Display | _____ | Y [] | N [] |
| e) Database | _____ | Y [] | N [] |
| f) Simulation | _____ | Y [] | N [] |
| g) Modelling/Spreadsheet | _____ | Y [] | N [] |
| h) Electronic mail | _____ | Y [] | N [] |
| i) Wordprocessing | _____ | Y [] | N [] |
| j) Computer Aided Design | ----- | Y [] | N [] |
| k) Computer Aided Manufacture | _____ | Y [] | N [] |

A) Proportion of the class using a computer

When teaching, the computer can be used by all, or part of a class. Please estimate the percentage of computer-time that you usually use for each of the following sizes of groups.

A i) whole class	%
A ii) most of class	%
A iii) half class	%
A iv) small group	%
A v) individuals	%

Total = 100 %

B) Teaching Strategies

Please estimate the percentage of computer time that you usually use for each of these strategies.

B i) as an introduction (to a new topic/concept)	%
B ii) as the lesson core	%
B iii) as reinforcement of a topic/concept already taught	%
B iv) as extension work (covering new aspects of a topic or concept already taught)	%

Total = 100 %

C) Type of Pupil

Please estimate the percentage of computer time that you give to each of these types of pupils:

C i) 'gifted' pupils	%
C ii) pupils with 'special needs' (other than 'gifted')	%
C iii) pupils other than 'special needs', 'gifted'	%

Total = 100 %

SECTION Y: INSET

1a) Do you think that microcomputers are useful in a CDT teaching/learning context?

Yes [] No [] Unsure []

1b) Please explain your views and, if possible, please refer to your experience with specific hardware and/or software.

2) Do you have access to a microcomputer at home? Yes [] No []

If Yes, please state the make and model

.....

3) Do you have any programming experience? Yes [] No []

If Yes, please specify briefly the languages and/or operating systems that you can use

Language(s)..... Operating Systems.....

4a) Have you had any INSET for computing? Yes [] No []

If No, please move on to question 5.

If Yes, please tick the provider(s) and give further information about the course content:

Provider**Areas covered by INSET**

- ☐ Wheatley Computing Unit
- ☐ Home Economics Advisory Teacher
- ☐ Oxford Schools' Science & Technology Centre (OSSTC)
- ☐ School
- ☐ Other agency

5) How could future INSET plans be used to give you maximum benefit in using computers as a CDT Teacher ?

6) Do you think that the use of computers can give opportunities for open-ended learning in CDT ?

Yes ☐ No ☐

If Yes, please give a short example from your experience.

If No, do you think that the use of computers could give opportunities for open-ended learning in CDT ?

Yes ☐ No ☐

7) Please describe briefly any CDT teaching situation that you feel could be improved (or clarified) by using computers:

SECTION Z: GENERAL INFORMATION**School**

1) Please give the approximate number of pupils on role in your school _____

2) Please circle the age range of your school

11-16 11-18 9-12 13-18 Other (please state age range).....

3) Please circle gender of pupils at your school in the 11-16 age range.

F M M+F

4) Number of CDT (full-time equivalent e.g. FTE may be 3 P.T. People) _____

5) Number of CDT Teachers. _____

6) Number of Teaching Rooms _____

Personal profile.

1) Title: Mr ☐ Mrs ☐ Miss ☐ Ms ☐ Dr ☐

2) First Name: _____

3) Surname: _____

4) Gender: Male ☐ Female ☐

5) Age group: 21-27 ☐ 28-33 ☐ 34-39 ☐ 40-45 ☐ 46-51 ☐ 52-57 ☐ 58-65 ☐

6) Please circle the subject area in which you are best qualified:

B CDT, Art & Design, Business Education , Home Economics, Other (please specify).....

7) Please underline the subject area that you have spent most time teaching over the last 12 months.
Use the list given in question 6)

8) I would be grateful if you would be prepared to spend a maximum of 30 minutes in a follow-up interview, if your school is selected for further study.

Please indicate if you are willing to be interviewed: Y ☐ N ☐

Thank you for your time and your help.

An analysis of this survey will be available for inspection at O.S.S.T.C., as soon as possible.

Please post your reply in the S.A.E. attached to this form.

Oxford Schools' Science and Technology Centre

**James S. Fisher MSc.,
Co-ordinator.**

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or 27200 Ext 320

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England.

OXFORDSHIRE TECHNOLOGY INFORMATION ACCESS/SOURCE SURVEY

Information Seminar September 1991

**Oxford Schools' Science and Technology Centre
Clarendon Laboratory**

Dear Colleague

As part of my research into technology education and databases I have noted the many changes have come about through the development of Science and Technology in recent times. Many technologists have used their knowledge and expertise to solve the industrial and social problems around them. I suggest from my experience in a scientific and technological industrial and research environment that these problems could not be solved without access to sources of information in a variety of forms from a variety of sources. I also consider from personal experience, as a former technology teacher and teacher technology educator and supporter, that this situation is mirrored in a school by technology teachers in their every day work. However, I am not fully conversant with the present situation concerning information access and retrieval hence this questionnaire which I would ask you to complete. You are being asked to indicate from where and how you seek information when you are starting to teach a new technology topic such as systems electronics, or advising a student undertaking a personal electronics project in the context of their National Curriculum Technology examination work.

I would therefore be extremely grateful if you would help me by completing the questionnaire below and return it to me at the end of this seminar.

Please note that all returns will be treated in complete confidence.

Many thanks for your help

James S. Fisher

Questionnaire

Please answer Yes or NO and indicate your preference on the scale items assigned to the particular question by ringing the selected item as per the example. The scales are as follows:

D (Daily), W (Weekly), M (Monthly), T (Termly), A (Annually)

I (Inappropriate), NA (Not Available), C (Cost), O (Other) Please specify briefly in the space provided.

Example

- | | | |
|--------------------------------------|-----|---------|
| i. Do your parents eat chocolate? | Yes | No |
| If Yes how often do they consume it? | D | W M T A |
| | Yes | No |
| If No why Not? | I | NA C O |

Part 1

Please indicate whether you would consult the following list of sources of information for new technology (electronics) topic teaching and student personal project (electronics) advice, and the frequency of use.

- | | | |
|-------------------------------|-----|---------|
| 1. School Text Books | Yes | No |
| | D | W M T A |
| | I | NA C O |
| 2. School Reference Books | Yes | No |
| | D | W M T A |
| | I | NA C O |
| 3. General School Journals | Yes | No |
| | D | W M T A |
| | I | NA C O |
| 4. School Technology Journals | Yes | No |
| | D | W M T A |
| | I | NA C O |
| 5. School Science Journals | Yes | No |
| | D | W M T A |
| | I | NA C O |

6. Newspapers
- Yes No
- D W M T A
- I NA C O
7. Education Newspapers (Times Educational Supplement or Education Guardian)
- Yes No
- D W M T A
- I NA C O
8. Commercial Pamphlets
- Yes No
- D W M T A
- I NA C O
9. Commercially Produced Educational Materials (eg. BP or Shell)
- Yes No
- D W M T A
- I NA C O
10. Government Sponsored Teaching Scheme Materials (eg. NEMEC)
- Yes No
- D W M T A
- I NA C O
11. Filmstrips
- Yes No
- D W M T A
- I NA C O
12. Videos
- Yes No
- D W M T A
- I NA C O
13. Television
- Yes No
- D W M T A
- I NA C O

- | | |
|---|---|
| 14. NERIS | <p>Yes No</p> <p>D W M T A</p> <p>I NA C O</p> |
| 15. Professional Journals (eg. AMMA, NUT) | <p>Yes No</p> <p>D W M T A</p> <p>I NA C O</p> |
| 16. Technical Manuals, Data Sheets (eg. RS Electronic books & Data Sheets) | <p>Yes No</p> <p>D W M T A</p> <p>I NA C O</p> |
| 17. Educational Catalogues (eg. Unilab, Griffin & George) | <p>Yes No</p> <p>D W M T A</p> <p>I NA C O</p> |
| 18. National Curriculum Technology Documents | <p>Yes No</p> <p>D W M T A</p> <p>I NA C O</p> |
| 19. British Educational Index | <p>Yes No</p> <p>D W M T A</p> <p>I NA C O</p> |
| 20. Educational Abstracts | <p>Yes No</p> <p>D W M T A</p> <p>I NA C O</p> |
| 21. Examination Board Material | <p>Yes No</p> <p>D W M T A</p> <p>I NA C O</p> |

22. Any Other Sources (Please specify and indicate the frequency of use in the space provided below.)

Part 2

Please indicate the services that you would use to search for information for new technology (electronics) topic teaching and student personal project (electronics) advice, and the frequency of use.

23. British Library Interlibrary Loan Service

Yes No

D W M T A

I NA C O

24. Professional Association Library (eg AMMA Library)

Yes No

D W M T A

I NA C O

25. Oxfordshire School Library Service

Yes No

D W M T A

I NA C O

26. Oxfordshire Public Library Service

Yes No

D W M T A

I NA C O

27. Oxford Polytechnic Education Library

Yes No

D W M T A

I NA C O

- | | | | | | | | | |
|------------|--|------------|-----------|----------|----------|----------|--|--|
| 28. | Westminster College Library | Yes | No | | | | | |
| | | D | W | M | T | A | | |
| | | I | NA | C | O | | | |
| 29. | Oxford Schools' Science and Technology Centre Library | Yes | No | | | | | |
| | | D | W | M | T | A | | |
| | | I | NA | C | O | | | |
| 30. | Oxford University Education Library | Yes | No | | | | | |
| | | D | W | M | T | A | | |
| | | I | NA | C | O | | | |
| 31. | Oxfordshire LEA AVA Resource Centre | Yes | No | | | | | |
| | | D | W | M | T | A | | |
| | | I | NA | C | O | | | |
| 32. | Oxfordshire LEA TVEI Centre | Yes | No | | | | | |
| | | D | W | M | T | A | | |
| | | I | NA | C | O | | | |
| 33. | Oxfordshire LEA Computer Centre | Yes | No | | | | | |
| | | D | W | M | T | A | | |
| | | I | NA | C | O | | | |
| 34. | Oxfordshire LEA Technology Advisory Service | Yes | No | | | | | |
| | | D | W | M | T | A | | |
| | | I | NA | C | O | | | |
| 35. | Professional Colleagues in the UK (Outside Oxfordshire) | Yes | No | | | | | |
| | | D | W | M | T | A | | |
| | | I | NA | C | O | | | |
| 36. | Professional Colleagues Mainland Europe | Yes | No | | | | | |
| | | D | W | M | T | A | | |
| | | I | NA | C | O | | | |

- | | |
|---|--|
| 37. Professional Colleagues World Wide | Yes No
D W M T A
I NA C O |
| 38. EEC Institutions | Yes No
D W M T A
I NA C O |
| 39. UNESCO | Yes No
D W M T A
I NA C O |
| 40. PATT | Yes No
D W M T A
I NA C O |
| 41. International Databases (e.g. Dialogue or ERIC) | Yes No
D W M T A
I NA C O |
| 42. Any other Service (Please specify and indicate the frequency of use in the space provided below.) | |

Part 3

Please indicate the type of information that you would require for new technology (electronics) topic teaching and student personal project (electronics) advice.

- | | |
|---------------------------|-----------|
| 43. Curriculum Details | Yes No |
| 44. Teaching Schemes | Yes No |
| 45. Technical Data | Yes No |
| 46. Conceptual Frameworks | Yes No |

- | | | | |
|------------|--|------------|-----------|
| 47. | Examination Scheme Details | Yes | No |
| 48. | National Curriculum Assessment | Yes | No |
| 49. | Equipment Availability | Yes | No |
| 50. | Consumable Resource Availability | Yes | No |
| 51. | Internal Pump Priming Funding | Yes | No |
| 52. | External Pump Priming Funding | Yes | No |
| 53. | Laboratory/Workshop Availability | Yes | No |
| 54. | School Curriculum Time Slots | Yes | No |
| 55. | Technician Availability | Yes | No |
| 56. | Any Other type of Information (Please specify in the space provided below.) | | |

-
- 58.** If an extensive european (including the UK) wide database of school science linked technology education were available in your school in CD ROM form, and you could access it using your school microcomputer, would you use it ?

Yes No

Any Other Comments (Please specify in the space provided below.)

APPENDIX C

Computer Software

**TechData 50
CityLink
ESTED**

Please obtain from Policy Studies Group