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ABSTRACT

The program for City Technical Colleges (CTCs) draws on ideas and resources from government, private industry, and education to focus on the educational needs of inner city and urban children. Mathematics, science, and technology are at the center of the CTCs' mission, in a context which includes economic awareness and a commitment to enterprise and wealth creation. This discussion addresses the question of computer provision in the context of the need for children to learn skills in the technologies now central to their existence, and their need for sufficient access to relevant equipment through their learning experiences at school if they are to develop such skills. This paper presents a rationale for providing information technology (IT); a discussion of how subject areas in the National Curriculum, ranging from science to dance, can be enhanced by its use; suggestions for staffing and administering IT programs; and a discussion of issues concerned with system purchase, support, and maintenance. Suggestions are based on an analysis of needs, value for money, the nature of educational computing, parity between CTCs and the external world, and an attempt to predict the future direction of educational information technology. Two appendices provide an annotated list of sources of information and resources for curricular issues, the purchase and evaluation of equipment, satellite systems and remote sensing, issues relating to the management of information technology, MS-DOS educational software, and software for alternative computing platforms; and a glossary and explanation of terms. (KRN)

Curriculum and resources: computer provision in a CTC

Lawrence Denholm

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Number 1 in a series of CTC Trust publications.
General Editor Dr Helen Sharp.

The author

Lawrence Denholm is the Curriculum Development Director for Information Technology at the City Technology Colleges Trust.

He was on the team which opened the first purpose-built CTC in Nottingham. As headmaster of a Scottish secondary school he was a regular contributor to the Scottish edition of the Times Educational Supplement, and spent ten years in Africa and the Middle East working in education for the Ministry of Overseas Development and the Ministry of Defence: being the only European at a school on the edge of the Nigeria-Biafra divide during the Civil War was a seminal experience.

As founding director of a sixth form consortium in Lincolnshire, he was involved in the creation and development of the Brealey Languages Centre and spent time seconded to the Micro-Electronics Education Development Unit in Lincoln before joining the CTC programme. He is a graduate of Edinburgh and Nottingham universities and an amateur musician.

This series of publications is intended to disseminate within the educational arena in this country and abroad, the information, expertise and experience emerging from CTCs. CTCs are independent colleges; within national guidelines each is free to develop the CTC initiative in its own way. The CTC Trust respects this independence and wishes to state that their publications do not necessarily reflect the policy or practice of the movement as a whole.

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Preface

The programme for City Technology Colleges draws ideas and resources from government, private industry and education to focus on the educational needs of inner city and urban children. Mathematics, Science and Technology are at the centre of the Colleges' mission, in a context which includes economic awareness and a commitment to enterprise and wealth creation. The National Curriculum is the bedrock on which work in the CTCs will be based.

It is our intention that Information Technology will pervade the curriculum, both as an object of study and a means to facilitate learning in a range of National Curriculum subjects.

This paper analyses the strategies needed to reach those aims. It suggests fruitful areas of exploration for teachers who wish to apply IT either in their subject specialisms or the cross-curricular initiatives which will be a feature of CTCs in their research and development role.

City Technology Colleges do not exist in a vacuum. Points of reference include the good practice which has emerged from government support for Information Technology in schools, drawing especially on advice from the National Council for Educational Technology and the Scottish Council for Educational Technology, from the outcomes of the Technical and Vocational Education Initiative (TVEI) and the work of the regional computer centres set up under the Micro-Electronics Project (MEP).

Those findings are applied to the deployment of resources and the management structures to optimize their use. Crucial to this discussion are the issues of training and technical support to provide staff with the necessary skills to exploit the technology at their disposal and apply it most effectively to children's learning.

There is a review of competing systems in the IT market, and recommendations that CTCs equip themselves to meet industry standards, but maintain access to the excellent resources which have emerged from Educational Support Grant (ESG) initiatives. The paper stresses that the criterion for equipment choice remains fitness for purpose, and relates this purpose to the central thrust in Mathematics, Science and Technology.

The work is a checklist, not an encyclopaedia; a basis for development rather than a final statement of policy. It does not claim to provide definitive answers, but to contribute positively to the debate and the developmental work currently in progress in secondary education.

Susan Fey
Chief Executive, CTC Trust

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Acknowledgements

Mrs Helen Grubin was an able and sympathetic editor who took the first draft of the manuscript and effected changes at both a structural and stylistic level from which it benefited greatly. Any remaining blemishes are my own, as are expressions of opinion and matters of emphasis.

Jon Coupland and Francis Hewlett of the National Council for Educational Technology will recognize my indebtedness to the work produced in the MITS programme (Managing Information Technology in Schools) and accept my thanks for the lucid exposition of their findings. Staff of Sleaford's Brealey Languages Centre (particularly the founding director Sue Hewer and her successor Berthold Weidmann) first opened my eyes to the potential of IT as a creative medium in education, and Dr John Marsden (the director of MEDU) who added substance to this.

The curriculum development unit is funded jointly by the Department of Education and Science and private sponsorship from Findlay Publications and the Esmee Fairbairn Foundation. Information Technology seminars for the CTCs have been supported by all the major computer manufacturers and IT support agencies, and the Trust works closely with NCET and the computer industry to provide consultancy and training services for the City Technology Colleges. Their input to the conferences and seminars organized by the Trust has been crucial and informed much of the thinking in this paper.

Lawrence Denholm
Curriculum Development Director
(Information Technology)

Summary

Children should learn skills in the technologies now central to their existence. To do this, they need sufficient access to relevant equipment through their learning experiences at school.

This paper addresses the question of computer provision in this context. The author does not seek to dictate which hardware and software should be purchased, nor how any system should be used in the classroom; this will be decided by individual CTCs. However, imaginative and innovative uses of IT in each National Curriculum subject are suggested and issues concerned with system purchase, support and maintenance are discussed.

The focus is on the use of computers in schools, touching only briefly on other aspects of IT such as television, telecommunications and satellite technology which warrant separate studies in their own right.

Some of what is said will be of particular relevance to CTCs, but much of it is of general application and will be of interest to all schools. Suggestions are based on an analysis of needs, value for money, the nature of educational computing, parity between CTCs and the external world, and an attempt to predict the future direction of educational IT. The following is a summary of the most important points raised.

- The children's learning needs, not the market in central processors or the current fashion in operating systems, are the criteria on which provision should be decided. In learning, the three central components are the child, the discipline and the process.
- Educational computing must interface to the business world, but the artificial distinction between business and educational software should be avoided; relevancy is the most important criterion to be used when choosing software for the classroom. The mantle of industry standard should not be used to obfuscate educational priorities, to restrict imaginative use, or to limit the available technology.
- Assumptions about a system's use are central to purchasing decisions. Remember that pupils, teachers and administration staff will all require access to it, and will want to exploit its capabilities in different ways.
- System purchasers should not attempt to replace books or teachers with hardware and software. The challenge is to identify those aspects of learning which depend on computers as their appropriate tool or which allow us to explore aspects of reality for which no other medium is adequate.
- A computer system can aid learning in many ways, but the program must remain a tool, not an object of study in its own right. An obsessional focus on the technology rather than the task at hand can have detrimental effects on the education of the children it is intended to improve.

- A systems manager who is part of the curriculum support structure of the college will be needed. This person will be responsible for system management, software evaluation and installation, management of the electronic mail service, first line repair and maintenance and staff training.
- A common output interface for transferring data between different machines such as CNC, language laboratories and robotics is vital. In particular, word processing packages should have the ability to generate ASCII text which can then be transferred to other software packages as well as being sent down modems or across electronic mail networks.
- There is no single correct solution to the challenge of networking a school or a CTC. Both in terms of the network software itself, and the machines to be attached to it. If a required function can only be provided well by a specific hardware or software component, then that component should be included in the system's specification.
- Tender documents should ask for specific functionality and describe exactly what is required but should not be so exclusive that they identify a particular brand in all but name.
- Future directions in IT may lie with interactive media such as Laservision, which has the prospect of more materials from government initiatives in Mathematics and Science over the next couple of years, or CD-ROM technology. A system purchased now must be flexible enough to adapt to new developments in these emerging technologies.

I. Introduction

A starting point, not a conclusion...

The problem between teachers and computers is that the former are too busy and the latter too complicated. Only the most keen have been able to pursue Information Technology (IT) in depth, particularly in terms of software development. For me, it has been a huge advantage to be able to travel deeply into the current state of the art over the past six months. The purpose of this paper is to write up the findings of my journey.

A modern economy depends on computer technology to run efficiently. From washing machines to weapons, rail networks and air traffic control, we rely on the microchip; tasks as different as grading potatoes and monitoring life support systems are computer-controlled.

Children should learn skills in the technologies now central to their existence. They need sufficient access to relevant equipment, and its use must be incorporated into a child's learning experiences at school. The order for Technology in the National Curriculum presents a structure for this. It is the starting point for a City Technology College in addressing one of its primary roles:

> 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 nations wealth. (HMSO, 1990, Foreword)

There is evidence that the use of computers and other aspects of IT can help children's learning across a range of subjects. Stephen Heppell (Heppell, 1991) contrasts two approaches, both equally relevant to a CTC:

> On the one hand are developments that produce a simple and quantifiable increase in fairly narrow parameters of success: "Will the Maths improve? By how much will the reading scores be enhanced?" But focussing merely on the easily quantifiable can hamper more imaginative uses of the Technology.

This paper seeks to address ways in which imaginative and innovative uses of IT can be harnessed to a principal thrust of the CTC initiative: raising the attainments and expectations of inner city and urban children. It is not intended as a riposte to hard-pressed and under- resourced urban schools, but as a model for industry, government, teachers and parents to demand as the norm for city children in the maintained sector.

Linked to those criteria are complex decisions about curriculum, staffing, training, technical support and the purchase of computers and IT equipment. These are within the realm of project teams and College principals, not the CTC Trust, but factors affecting the decisions are complicated, and the timescale in which they have to be made is fairly tight.

This paper represents a starting point rather than a conclusion. Some of what I have to say will be of particular relevance to CTCs, but much of it is of general application and will be of interest to all schools. Suggestions are based on an analysis of needs, value for money, the nature of educational cc nputing, parity between CTCs and the external world, and some attempt at future proofing. Computers are not merely gadgets which can marginally enhance performance in existing tasks. In quantity they create new possibilities, and addressing these is one of the tasks of a City Technology College.

II. The uses of computing

A curricular rationale for IT provision

IT is difficult to define satisfactorily. In education it has become almost synonymous with computer use of any sort. In this paper I intend to concentrate on the use of computers in schools, touching only briefly on other aspects of IT such as television, telecommunications and satellite technology which warrant separate studies in their own right.

The National Curriculum sets out helpful guidelines. It clearly distinguishes between the use of computers in Technology, for example working with materials, and in Information Technology, where the following targets are laid down:

> Pupils should be able to use Information Technology to:
>
> - communicate and handle information;
> - design, develop, explore and evaluate models of real or imaginary situations;
> - measure and control physical variables and movement.
>
> They should be able to make informed judgements about the application and importance of IT and its effect on the quality of life (HMSO, 1990).

The detailed programmes of study and attainment contained in the National Curriculum are incumbent upon CTCs, as on any other maintained school. However, the CTCs' focus on Mathematics, Science and Technology and their relationship to business and industry, together with their brief to act as test beds in piloting curricular and resource innovation mean that they should be at the forefront of IT development in schools.

It is not the function of either the National Curriculum or of schools simply to train keyboard operatives or to teach children about computers. It is open to question whether computing and IT are the most important parts of the CTC mission. They make best sense in the context of a rounded technological education and as a way to direct the intelligence and capabilities of a group. They demand their own skills for mastery, of which keyboard competence is absolutely central. Readers are recommended to the paper on this topic by my colleague Mrs Eve Gillmon, the CTC Trust Curriculum Development Director in Business Education.

The computer as an aid to learning

The curricular challenge is not to invent areas where computing will replace books or teachers, but to identify those aspects of learning which depend on computers as their appropriate tool or which allow us to explore aspects of reality for which no other medium is adequate. Computers seem a particularly effective aid to learning in the following ways.

1. They can be used to encourage analytical and logical thinking;
2. The ability to author languages enables children to structure material and questions for teaching to their peers, with a gain in both self-confidence and clarity of understanding;
3. Computers can act as catalysts for co-operative learning and the shared exploration of topics; they permit the pursuit of learning habits which encourage differentiation between individual, peer and group activity;
4. The use of CAL (Computer Aided Learning) material allows differentiation and progression by age and attainment. It also provides a way to direct a group's method of thought. The vocational relevance of much of the material is a powerful motivating factor, especially to older children using the commercial standard software and equipment they are likely to meet in their work experience;
5. In art and graphics the computer is an enabling device which can contribute to developing and organizing visual ideas across the curriculum;
6. Computers can help elevate self-esteem. For many children, a word processor gives them their first experience of producing work which looks immaculate.

The technology which permeates the curriculum should be both relevant and current, leading directly in to the industrial process (IT manufacturers reckon on a two to three year replacement life of a technology). The basis of technology in empirical synthesis must be supported by an adequate analytical and theoretical framework in the sciences and mathematics. The human qualities, attitudes and skills required for a workforce which may have to retrain several times in a lifetime, need to be laid down from the beginning of a child's secondary education. A pupil will learn about computing and IT, and their use in business, and gain skill in the applications he or she might expect to find on joining the workforce.

One must be aware of the dangers of an obsessional focus on the use of computers, however. These include the cult of the new, and obsession with novelty to the exclusion of substance, leading to a focus on the technology rather than the task at hand; the disenfranchisement of the child's own intellect, reducing him or her from the status of explorer to that of input device; a disproportionate shift of resources to fund the systems; a reduction in the perceived value of other modes of learning; the danger of a commodity-driven curriculum and lastly, a reduction of the teacher's role to managing equipment rather than children and learning.

However, entirely new tasks, unimaginable without a computer, become viable. These include simulations of 'real world' tasks, such as viewdata or electronic banking. Solving them extends a child's competence, as do tasks which reflect changes in the industrial and commercial world, and where relevant prior experience is an essential part of a child's vocational preparation.

Plainly, educational computing must interface to the business world, but is likely to be substantially different from it if only because so much more versatility is demanded of computers in schools than in business. Equipment must be user-friendly at the level of the user's competence. It makes sense for a sixteen year old leaving the college to be familiar with industry standard software but it is not necessary to impose this on an eleven year old, who must be able to use software which matches his or her skills and ability as soon as possible while allowing an advance to more difficult applications.

Assumptions about computer use

How much time will a child spend in front of a computer and for how long will he or she require exclusive use of the machine? How much of a machine's life will be spent on relatively simple functions, such as word processing, process control or data logging, which can be carried out efficiently on a low-powered terminal, and how much time will be spent on processor and memory intensive functions like graphics, design and music?

Assumptions about use and time are central to purchasing decisions. If a child requires exclusive use of a computer for an hour per day, then a college of 1000 pupils working a 40-week year with 25 hours of lesson time per week will need a minimum of 200 terminals. Requirements are unlikely to be distributed evenly; at times, demand will peak and children will seem to be clambering for scarce resources, but there will also be troughs when equipment may stand idle for long periods. For the most part brief access to, rather than the exclusive use of, a machine will be needed. Children will observe the machines in operation as well as working with them. They may share a computer in project or collaborative work where computer time is part of a process rather than the centre of it. The nature of the task will determine terminal types, from cheap portables at around £200.00 to high level CAD (Computer Aided Design) or other design workstations at £2000.00 or more each. Given the additional costs of trunking, network cabling and peripherals, the cost of equipping an institution with around 200 workstations (which would appear to be the minimum viable IT base for a CTC type of curriculum) will be around £250,000.00.

There is a fear that a concentration on hardware and equipment fails to address the more profound question of curricular purpose. The children's learning needs, not the market in central processors or the current fashion in operating systems, are the criteria on which provision should be decided. In learning, the three central components are the child, the discipline and the process.

Principal areas of skills training

Although many computers will be visible, children will not spend all day hunched in front of them. During his or her time in college a child is likely to encounter some or all of the following:

- training in the fundamental applications of word, data and spreadsheet processing;
- control programs and CNC (Computer Numerical Control) equipment such as lathes, milling and knitting machines;
- programming languages from LOGO to C+;
- data capture from local or remote sensing in science;
- Computer Aided Design, drawing and animation;
- graphics and visual display, i.e. image capture and manipulation;
- the manipulation of sound and rhythm;
- online databases and CD-ROM (Compact Disc Read Only Memory) applications;
- interactive video (IV) and other multimedia applications;
- communications and electronic mail;
- training in operating network systems and utilities;
- administration of their own learning records and records of achievement on a local database;
- recording of school library use and school meals with a smart card or bar code reader.

In short, the child will experience the computer as a tool for thinking numerically, graphically and verbally. He or she will also be able to exploit it to control equipment and information, be it sound, vision or text, with CD-ROM technology likely to play a growing part.

A curricular overview

The preliminary skills associated with computers include keyboard mastery, a basic understanding of authoring languages, understanding word processing and printing functions, and an elementary familiarity with operating systems. Computer use itself reinforces and teaches these skills, providing an interactive model:

Preliminary Skills for Computer Mastery —— Computer Use → Derived Skills and Learning Achievements

The level and range of computing and IT equipment which we wish to exploit in a CTC should make a qualitative difference to a child's learning. A school broadcast video production, for example, might involve cross-curricular elements such as reporting skills, the manipulation of sound and images, and the creation of animated sequences to illustrate or precede the project. I shall attempt to show how subject areas can be enhanced by the use of IT. These benefits will, in the longer term, be available to the whole of the maintained system.

Mathematics

Spreadsheets make possible graphical and tabulated data presentation. These may include mapping functions such as creating and exploring graphs from formulae and the effect of varying terms, statistical analysis and data modelling, the generation of 3D diagrams from graphs, and the simulation of mechanics and statics. One of the benefits of computers in schools is that teachers can take advantage of packages like MathType or Chi Writer to prepare and store lesson material. However computers act as an aid to teaching in a more general way too, allowing teachers to encourage analytical and logical thinking; for example, specialist packages in Logo and other programming languages could also be exploited. The idea of classwork can take on a new meaning.

Among the concepts that can only be explored with a computer is the idea that one can generate images and pictures from formulae as well as observation. This can bring about an understanding of the way information can be compacted and the realization that the program which generates the image is the only objective description of the work.

An Archimedes program like Numerator allows the use of both art and graphics packages for demonstrating translational and rotational symmetry and parametric design tools for mathematical modelling.

Science

Some of the most powerful tools in electronics and design are now available in educational versions on MS-DOS systems. In data capture and manipulation, patterns and relationships can be identified and represented graphically long before the necessary mathematical skills are normally acquired. Analysis of ephemeral or very long events is also possible, thus extending the scope of what can be studied. Other areas include Remote Sensing, Control, Data Logging and Analysis.

Appendix A touches on sources for exploiting satellite data. For further information, the reader is recommended to the CTC Working Paper *Using IT in Science Teaching* by Ian Lynch, the Curriculum Development Director for Science and a national expert on all aspects of IT in education.

Lynch draws attention to audio digitizing and Fourier analysis of sound and the use of video-mounted microscopes in digitizing and image processing, both rapidly expanding fields in the medical industry. He suggests that physical education and health science can be linked in bio-mechanical software. A program like Orrery can simulate astronomical observation, while techniques like ray tracing, delta file animation and colour combination are essential to existing and future technologies.

The British Aerospace Dartcom Project exploits satellite for Remote Sensing and data logging of the human and meteorological environments. CTCs are well-equipped with satellite technology, but have had little chance to exploit it. If they are used as a base for national developments in the technology this could both justify the investment and allow CTCs access to the untapped facilities of the resources they have on site.

In Science, the National Curriculum requires pupils to be able to 'select an appropriate piece of data management software to perform a particular task in data storage and retrieval'. They should 'have the opportunity to use databases and spreadsheets in their work'. Modelling is also a key element. Computers allow the simulation of dangerous experiments, such as modelling genetic structure and evolution, and the capture and manipulation of data from organic sources using appropriate sensors.

CTC colleagues are presently using computers in Science for control, data logging and analysis, simulations in Biology, Chemistry and Environmental Science, and all kinds of statistical analysis as well as the more mundane tasks of writing up data and experiments using the word processor.

In psychology, a popular option with older students, the computer's facility for generating visual data can be used for experiments in perception and illusion, and pattern and face recognition. Statistical analysis of performance and data becomes possible, giving the opportunity to use the microprocessor's timing device and display as a self-regulating tachistoscope for the display of information to an experimental subject. For example the computer can reproduce the Muller-Leyer illusion and measure its intensity in relation to angles.

Technology

Industry standard software for both design and control is available in Technology. The software allows for drafting and plotting complex diagrams and the interface to robotics needed to handle equipment from ORT. The Technology Attainment Target 5 at Key Stage 4 requires students to 'use information handling software to capture, store, retrieve, analyse and present information', all of which should be encompassed by such programs.

In Electronics, it is possible to achieve on-screen creation and testing of circuits before building them at the workstation using a 'circuit processor'. Connected to a CNC engraving machine, it can then output the design directly to a printed circuit board.

Graphical communication is a key skill which can be addressed through the use of commercial CAD packages which allow, among other possibilities, the kind of rotation and sectioning which cannot be achieved manually. Designs can be transmitted to CNC equipment for output and manufacture. Production of an artefact and learning about fundamental industrial processes are both tackled.

Art, Design and Graphics

Art education in a CTC is not computer-led, but there should be access to the tools of graphics, design and image manipulation which characterize it in the industrial and business world.

Harry French (whose award-winning computer art from Welton School has been featured in national advertising by Acorn Computers) describes the surprise of visitors when they come to his classroom and find computers sitting between the pottery and the etching press. For him they are merely another tool in a process which derives its force from the aesthetic, not the computer.

> Access to IT can provide a genuine opportunity to understand how to present ideas in visual form. Pupils need to be aware that the computer can provide support and enhancement to existing Art and Design media, as well as a means of generating imagery in its own right. (Renou, 1989, page 3)

Some or all of the following can be achieved or studied:

- repetitive design;
- manipulating images of 3D objects in the pre-design stage using repeat patterning, colour separation or perspective;
- use of packaging in design and manufacture;
- the computer as a textile design workstation for direct printing;
- CAM (Computer Aided Manufacturing) and CAD in knitting;
- pattern generation and interface to knitting and textile equipment;
- the use of a laser disk for easy access to and manipulation of banks of visual material;
- animation and data capture of visual material for processing with, for example, a light pen or a mouse;
- interactive video to store libraries of slides and graphic images which offers easier access than a paper or cellulose based system would allow.

Only the most sophisticated systems transcend the computer's limitations and allow student and teacher transparent access to the materials' own aesthetic and design criteria.

Home Economics

At the simplest level, word processing recipes and translating data into tabulated form is possible. As well as the obvious applications in textile design, the use of spreadsheets to analyse nutritional content and of databases to store and update recipes, come to mind, as does modelling the results of using different ingredients. Software is available to analyse diet patterns and stages in ergonomic processes and to record results in statistical or experimental work.

Music

Pupils, working individually and at their own speed, and who may not have much dexterity, can compose music that is complex in both rhythm and pitch. The child can have access to a great variety of sounds and manipulate them with acoustic and other electronic instruments. He or she will be able to incorporate the results into video or slide sequences, for example.

It is possible to look at musical notation and relate it closely to sound and output, and then produce accurate and legible printed output. As a cross-curricular resource, computing allows music in science for instance to be involved in acoustics, sound sampling and regeneration.

Very high quality is offered in recording and sound processing for Drama, Music and Dance: at all times the intention is to use equipment in manipulating sound as a compositional tool.

Central to all this is MIDI, the Musical Instrument Digital Interface, which allows the computer to access and control a range of sounds and instruments. MIDI instruments are not simply keyboards. They include simulations of brass, string and woodwind instruments which let even non-keyboard players tap into the aural resources of the medium through digital skills acquired from their own instrument.

IT can become another tool with which to access the practical aspects of music, that is listening, performing and composition with a particular emphasis on the last. Advanced level study can be enhanced by using the multi-media CD-ROM presentations on Beethoven's 9th Symphony or Mozart's Magic Flute for example where the score and performance are appended to an encyclopaedic reference work on all aspects of the music and composer.

Dance and PE

A computer can be used as a straightforward database to record and analyse the results of fitness tests. But there are also imaginative uses for cross-curricular work. Painting programs, for example, might allow children to design floor patterns, shapes and visual stimuli as well as plotting movements in choreography which can then be synchronized with music through a MIDI interface.

English

Word Processing is central to a child's preparation and presentation of his or her own written work. Desk top publishing (DTP) packages allow high standard individual or co-operative publications such as magazines and newspapers which integrate work from other areas like design or local history in cross-curricular projects. Key Stage 3 of the National Curriculum requires a child to 'have opportunities to produce writing and proof read on a word processor'; the requirement of Key Stages 3 and 4, to find 'appropriate methods of presentation for each piece of work' is also fulfilled by the use of word processors and DTP.

For a child, the user interface is the key to access. The combination of textual elegance and fluidity encourages close editing of work and the chance to upgrade and incorporate change, not least spelling corrections. The best spelling checkers highlight errors and allow the child to view and choose the proper word form. This is sound psychology, presenting and reinforcing the correct solution, not just annotating the mistake.

Outline programs like Brainstorm or PC Outline allow thought and ideas to be structured and logical connections to be established. Their ability to structure data in 'chunks' closely matches the way short-term memory functions and enhances ease of learning and recall. There is now substantial evidence from both national research and our own experience in the early CTCs that access to word processing allows quite dramatic improvements in children's learning skills in writing and communication, and their ability to organize written material (SCET, 1991; ETCA).

For children with learning difficulties, programs like Cloze, Muddles and Developing Tray allow repetitive presentation and built-in success. DTP both emulates real world use and allows a production facility to be set up in newspaper and magazine work.

One fundamental requirement, after ease of use, is for a system that will generate and process ASCII text within a DOS or UNIX operating environment. This must allow the freedom to manipulate text, to create a capacity for shared input and group work without the intervention of handwriting, and to foster a delight in presentation.

Humanities

In Geography, the National Curriculum requires children to 'analyse and interpret data from complex secondary sources, for example from a Census database'. In History they are to 'organize and express the results of historical study ... for example by creating a database'.

Spreadsheets and flatfile databases permit the modelling of statistical data and the exploration of tabulated material from, for example, censuses and parish death records. In physical geography, computers are likely to find a place in mapping, climatology and the reception of data from satellite receiver stations for weather and resource plotting. Appropriate resources are listed in Appendix A.

CD-ROM facilities relevant to geography and the humanities include not only programs like PC Globe, but also archived newspaper and magazine files; one CD-ROM can hold a whole year's issues of a newspaper. The search and retrieval facilities of a computer make exploration of free-form data infinitely easier than using paper or microfilm records for research. A pupil could trace the records of a story in three different papers, looking at emphasis and (at worst) bias, or more subtly at differing editorial values.

Multi-media presentations include the Commodore disk on the Treasures of the Smithsonian, the Interactive Learning Productions' disk on the Leningrad Museum Art collection, the Interactive Video in Schools programs on volcanoes, and Virgin Publishing's Ecodisk. Upgrades to the Domesday system allow teachers and students to access clips for their own presentations using Archimedes programs like Key Plus or Genesis.

There are computerized economic and military simulations (BP's Business Game is a particularly good example) while the facilities of electronic mail systems allow collaborative work across CTCs and partner schools internationally through, perhaps, the AT&T learning network. See Appendix A for details.

Modern Languages

Communication and electronic mail are likely to feature as key IT activities in the languages centre, reinforced by authentic and immediate material available off air from satellite. However there are time and staffing implications if this is to be exploited fully.

The use of authentic material can extend to native language CAL and word processing packages, or the 'repurposing' of foreign IV disks to reinforce both their original training function and the student's language learning. MS-DOS allows access to a bank of European software, including that produced for language teaching under EC sponsorship.

Linking a computer to an audio or video recorder provides a pupil with a level of attention and reinforcement in repetitive learning throughout a 40-minute period, in contrast to the few minutes of individual attention a teacher can give to one child in a class of 30.

Business Studies and Economics

An important CTC function is to train children and other users in real world applications and establish a base where standard resources are available for industrial training. (There is significance here in the fact that 75% of all installed systems are now MS-DOS-based and IBM compatible.)

The main areas of activity are likely to include economic modelling and analysis, financial control and accounting (including help for small businesses), keyboard training using computer interactive methods and a focus for mini-enterprise activities (either in administration or the provision of services like DTP).

Special Educational Needs

As well as interactive programs which operate at a child's level in language, mathematics and other basic skills there are a number of valuable enhancements available. These include speech synthesizers, concept keyboards and input devices to develop skills of dexterity, reaction time and co-ordination.

The experience of success, reinforcement and the motivating capacity of the equipment are all relevant in this area. Colleges will find it useful to subscribe to SEND (the Special Educational Needs Database) which is available either online or on CD-ROM subscription. This constantly updated catalogue of software, equipment and resources is targeted on children with exceptional learning needs. Further details of this service are in Appendix A.

Conclusion

In context, the impact of IT can be used to reinforce learning as part of a range of strategies to motivate and inform. The learner's response to material varies depending on its source, be it direct experience, personal narration, carefully studied words, fleeting glimpses of televisual images or passing billboards. Reading a book may be a more enriching experience than watching a film adaptation, the result of active engagement with, rather than passive assimilation of, material, but that does not negate the value of film, nor of CD-ROM.

In information retrieval or supported self-study the growing library of CD-ROM material is likely to prove significant. Computer books are not merely electronic page turners; they let teachers quickly pick chunks of text for study or incorporation into test material. Developments in technology leading to the CD-ROM allowed the creation of huge textual databases like the Grolier or Compton encyclopaedias or Whitaker's *Books in Print*. The availability of powerful computers means that this data can be searched and retrieved with remarkable speed, satisfying the National Curriculum requirement to 'find material from a range of sources'.

However, computers on their own are not enough. Investment in equipment not matched by a corresponding investment in training will produce only meagre returns, while a computer system that is not supported by relevant peripherals is essentially crippled. It would be fatuous for example to have machines in an Art department without image grab facilities, scanners and colour printers!

Similarly, lathes are not the only tools which can be computer-controlled, and may indeed be among the worst candidates for a school CNC base. Roland produce a range of milling and marking machines, including machines which can model in three-dimensional wax. ORT produce equipment for robotics and control. Brother and Clwyd Technics combine to produce a package which applies CAD/CAM to knitting — from initial design to final garment. At the top end of the market studio standard equipment in media control and animation is also available.

All of these facilities have a claim on finite budgets, but a judicious balance and a willingness to bypass the obvious can make an IT resource much more valuable, and enhance the quality of learning that it mediates.

Staffing and administration

Recruitment

CTCs are perhaps uniquely placed today in that they are creating a whole school ethos from scratch. Along with the excitement and challenge is the chance to mould the teaching in a way that may not be possible in an established school. The emphasis on IT not only in the National Curriculum but in the CTCs themselves because of their links to business and industry means that a teaching force trained in IT and computing skills is essential. Acquiring expertise requires the investment of time and adequate training, but without these IT remains an expensive irrelevance.

It is unlikely that a CTC will be able to recruit an entire IT literate staff skilled in all appropriate uses of IT in their specialist areas. The quality of IT provision in the maintained system, the low level of training and the fact that the teaching force does not yet include the children of the IT revolution mean that CTCs will need to invest in extensive staff training if they are to exploit their resources. Overall responsibility for staff training and development (crucial when there is a contractual obligation on staff to undergo periods of training each year) is likely to be devolved, under the Principal, to a Deputy Principal, Curriculum Manager or Professional Tutor.

Before a CTC opens, it would be helpful if all staff had knowledge of and experience in general IT and also in specific applications of it. Training in layout and design may also be desirable; output from DTP systems can be embarrassingly bad if it is not matched by a basic discipline in design and typography. Basic skills can be initiated in house, but external training will be necessary too.

Staff training

IT training will be most effective if teachers have access to a computer when they have time to use it. The period between staff appointment and college opening is crucial to provide adequate training to exploit a CTC's IT resources.

In the frantic pace of starting up a new college this will almost certainly mean at home. One way to enhance skill and confidence in computers would be to build up a pool of machines for home use by staff, but this is subject to cost and quality constraints. Diverting large sums from curricular provision is unacceptable, yet purchasing low-end machines may be inadvisable. For example, the Cambridge Z88 has a tiny and illegible screen, a non-standard keyboard and software that is likely to differ considerably from the main college programs.

If the college computing base is to be a network of IBM PC compatibles, end of the range MS-DOS machines are an attractive way of putting powerful computers into the hands of teaching and support staff. The first generation Amstrad portables are now being remaindered at between £200.00 and £400.00 depending on the model (variations are in memory size, number of floppy disk drives and the fact that the top end unit, the PPC 640, has a built-in modem). They have full-sized standard keyboards and run most IBM software (WordStar, Microsoft WORD, Word Perfect, Multiplan, PC Quest and DBase III). They may represent an affordable solution.

As for external training, senior staff might be invited to consider their own training in greater detail, benefiting perhaps from the experience of other CTCs. Residential courses have proved both a cost effective way of learning and an investment in team building and staff solidarity. Staff at Djanogly CTC, for example, began their employment with a weekend at the Brealey Languages Centre in Sleaford (see Appendix A for details). This Centre is unique not only in the level of its equipment and resources, but in the concentration of expertise in their use. Kenneth Baker called it 'the most advanced facility of its kind in the UK'.

The weekend course covered a number of topics beginning with an overview of IT in education and moving on to language teaching and the role of IT, electronic mail and communications, the use of computers in profiling and records of achievement, and IT and special needs. There were also sessions on newspaper simulation and DTP in the classroom, major careers databases and their application and content-free applications (word processing, databases and spreadsheets).

Software identification and purchase together with curricular training will be the remit of the College's curricular IT specialist who should be able to help staff identify and exploit provisions relevant to the IT statements in the National Curriculum and the specific requirements of their own subject areas. He or she should also be able to address the cross-curricular issues and innovative teaching which will develop in CTCs.

It may be useful to set up a working or management group to act as a focal point for discussion and decision-making. It would keep track of existing use, share skills and information, identify training and software needs and work on development planning. A smaller purchasing group would have the task of putting those plans into costed form for orders to be placed.

Setting up systems and applications

Priorities in the first year might be to make terminals available to all form tutors for use in profiling and record keeping, to ensure that computers are backed up by necessary peripherals, to maintain a software budget for disposal at faculty discretion and to lay the foundation for future expansion and upgrading. On the teaching side aims might be to establish at least one facility where every child in a class can have sole access to a computer, to ensure access in the necessary group sizes and to maintain the specialist input in Technology, Music, Design and Art which are the distinctive mark of the college's contribution in those areas.

A possible model for the phases of installation is:

Stage 1:	Preliminary installation and systems for year one.
Stage 2:	Staff/pupil learning and familiarization.
Stage 3:	Input to plans for second phase of installation; modification/improvement of existing systems; training of new staff and pupils.

In the first year of operation the most significant uses of the system are likely to be training in applications (word, data and spreadsheet processing), finance and administration. This last would include profiling and records of achievement, pupil and staff records and timetabling. Control technology and data capture in Science, CAD, graphics and visual display involving image capture and manipulation would also be important, as would library administration, online databases, CD-ROM applications, such as interactive video, communications links and electronic mail. Functions will grow as people discover the system's potential.

Computers can assist in pupil profiling, record keeping and assessment, daily registration and the maintenance of statistical records for DES purposes. Systems to record and control admissions and pupil information, including records of achievement, can be set up. On Campus 2000 there is online access to databases (ECCTIS, NERIS) which are also available on CD-ROM as are the COIC *Open Doors* careers database and JIG CAAL careers advisory systems. Shared access from college terminals to a CD-ROM file server means that personal research can be done at any terminal, leaving time free for counselling and discussion.

The issue of performance-related pay in teaching is a thorny one, but there are areas where clearly-measurable performance indicators can be established. It might be possible to link some minor salary enhancements to demonstrable competence in IT skills. RSA, Cambridge Syndicate and Pitman all run modular IT schemes; it would not be unreasonable to require staff to gain measured competence in some fields. The National Inter Action Computing Award

Scheme (NICAS), accredited by RSA and outlined in Appendix A, is also worth considering in this context. Under the scheme, knowledge and skills are assessed at a number of levels.

Systems support staff

Whatever choices for IT provision are made, purchase of a system will include networked computers. Although the initial delivery and connection and major repairs of the physical plant will be carried out by the suppliers, updating and maintaining the operating and applications software, encouraging staff use and the day to day running will require a full-time systems manager.

The systems manager is part of the curriculum support structure of the college. Working parties on areas of the curriculum, each with a coherent view of the whole, should be established. The systems manager will be a senior member of, and answerable to, the curriculum management group. Advice from computer manufacturers to the CTC Trust at a symposium (September 1989) was summarized by John Foster, Director of the US Government's Technical Education Research Centre:

> A systems manager (NB not a glorified technician nor a misemployed member of the teaching staff) should be appointed early and if possible (even when designate and not yet employed) should be involved with the tendering companies in the specification. This post is seen as a key role in a CTC. He or she will be an IT expert (not a hobbyist) and will need to be appointed well in advance of opening — ideally at the same time as senior posts. The job specification will embrace some training functions and line management for IT technician support, which in the expensive, complex IT environment of a CTC is an essential additional provision.

Among the duties attached to the post will be system management, software evaluation and installation, familiarity with educational uses of IT, management of the electronic mail service, first line repair and maintenance, staff training and support, establishing a system to record pupil details and achievement, registration and administration and maintaining parent databases. On the financial side the post will include co-ordination of purchasing in response to staff and curricular needs, establishing a system to handle accounts, invoicing, stock control, salaries and school meals payments.

Training in administrative systems (such as electronic mail and generic or content-free software) and basic systems competence (switching on the machine, formatting disks, directory maintenance, loading and operating printers and other peripherals) will fall to the systems manager, as will day to day network troubleshooting.

If such a person can be appointed with the initial tranche of staff, his or her understanding of the IT system will be informed by the curricular thinking of the staff team, while the systems manager's skills in training and IT use will be at the staff's disposal during the critical run up to opening. The person appointed may have an industrial or educational background. He or she will be a key figure in establishing the college, ensuring that the technology matches and supports the CTC's curricular mission, and in providing for adequate training. Most colleges will want to use external consultants and advisers in evaluating systems. If the systems manager can influence decisions at this stage there will be several benefits, not least that a working system will be available to staff who have sufficient expertise to use it when the college opens.

Administration

Computers do not replace paper, but they can make sense of information that reaches us on paper which eventually has to be transferred to other pieces of paper in a different form. So far as adminstration is concerned, it would be helpful to have routine management and information systems in place at the project phase.

Computers will be used for correspondence and communications on electronic mail. Timetabling, pupil record keeping and profiling, staff records, and registration (via a Micro Systems time manager) and an analysis of attendance statistics together with a database of admissions, class lists and records of achievement lend themselves readily to being stored on computer. Finance, stock ordering and control can be handled by the computer too. DTP should be used for Staff and Pupil Handbooks, examination entries and the publication of results. A distributed network in the College is useful in day to day administration and as an electronic bulletin board. 'Smart card' systems are under development which will monitor attendance electronically, and which can transfer and tabulate attendance in ways that not only match legal requirements for registration of pupils but release staff time from the tedium of pursuing attendance records.

All this may mean that one terminal is required for the Principal and for each Deputy Principal, Faculty Director, secretary and member of the administrative staff. A self-contained multi-user system, possibly UNIX based, could also be used in administration. Such a system would be capable of downloading information from the main college network but could not be accessed from it. The timetabler might wish to use a standalone machine. The IBM Schools Timetabling System is excellent, but systems from Scientia on Apple and Minerva on the Archimedes have much to commend them, as does the TOR Auto Timetabler (see Appendix A for details). This is an area where the convenience of the operator is more important than being attached to a network.

The college technical support function will also be backed by computers in its maintenance programme and in the control of stock, orders and suppliers. It will be linked to the main college database, which will hold security information such as the registration of equipment codes. The monitoring and control of physical data, such as temperature and fuel consumption, and the ability to computerize lighting systems in drama and media studies may also form part of this subsystem.

Teaching and administrative staff will be able to use accounting and stock control packages. There is likely to be a self-contained subsystem to handle secure records, payroll and major finance.

The point of IT in administration is to release time to deal with people, both staff and pupils. Time in formal consultation can then be augmented by personal access, giving the staff the chance to explore their achievements and see how they can develop both as individuals and for the college.

III. Hardware and software

Next to the building, the IT network is likely to be the biggest single investment a college makes. Suppliers are aware of this, and are keen, both from goodwill and for their own reputation, to give the best service possible in providing it. A clear concept of the working requirements of IT is essential to define the equipment needed. There are various balancing equations to be made about performance, price, durability, reliability, software and interface costs. It is likely that most colleges will exploit the Windows 3 format and its related applications. It is likely too that they shall want to access data from a number of sources and different disk formats. The latter means having 3.5" and 5.25" high density drives built in, as well as hard disk storage. For most staff the computer is likely to be a substitute secretary, capable of producing documents fit to be seen by the outside world. There must therefore be a high quality printer.

Chips and operating systems

The microprocessor at the heart of a computer determines not only what work can be done but also its speed and quality. It is often described by the number of binary digits (or bits, the two values of zero and one which comprise binary notation) which it can process or access at one time. Processors like the Z80 or the 6502 (which powered the Acorn BBC B) could handle data only in chunks of 8 bits and were restricted in the amount of memory they could use.

As chip technology grew, the power of programs (and ease of use) increased dramatically. Second generation educational programs exploited 16-bit processing, to which we therefore need access. The connections offered by computers to the outside world (control devices, probes and sensors and so on) are equally important. The ability to replicate industrial control or monitor external sensors was an important element in the success of the BBC B and Master, whose range of input and output facilities far exceed that of most other equipment.

An operating system is a set of coded instructions which tells the computer how to run. It handles disk drive operation, loading software into memory, the output of information to the screen, printers and other output devices, and the input of information from keyboards and so on. It deals with the allocation of files and directories — the general housekeeping duties which are required to make sense of data stored in the machine, rendering it ordered and accessible.

Computers using the MS-DOS operating system were developed to cope with three main functions: word processing (still the single largest use of computers), databases and spreadsheet analysis. MS-DOS has become the *de facto* operating standard in the world of 16-bit desktop personal computers. It goes without saying that these must feature largely in a child's preparation for working life, but they must not constrict too severely a college's choice of equipment since there will be growing areas where IT is important to which a college may lose access, like the convergence of video technologies and computing.

Not all MS-DOS machines are IBM compatible; there is more than one MS-DOS standard. Apricot, Sanyo, Hitachi and Research Machines Ltd (RM) all made MS-DOS machines which were not PC compatible. In addition, programs written to run under later versions of MS-DOS are not backwardly compatible. In education, this is of more than academic interest. For example, consider the RM Nimbus. This used an Intel 80186 chip and a version of MS-DOS which allowed programmers to exploit a graphical environment which was superior to, but not compatible with, the 8088 based IBM PC. A range of input and output connections allowed access to hardware and peripheral devices developed for use on the BBC Micro and access to most IBM software which was well-behaved and did not use sound or require EGA or VGA graphics was possible using an emulator. Superior memory management in fact made it a better engine for running Windows-based programs like Excel than the IBM-XT.

This could be seen as an attempt to create a closed standard which locked education into a single hardware supplier. In fact the argument is more complex: there is not a great deal of profit in education, yet companies required pricing stability to allow them to invest in the expensive process of developing software and applications of high quality. The directory of educational products for the Nimbus PC186 runs to 160 closely-printed pages of A4. The original Nimbus was an innovative machine responding quite specifically to a market created by the needs of schools.

Now, much of the Nimbus-specific software is available in generic MS-DOS versions. RM's new machines are wholly compatible with the PS/2 Micro Channel Architecture standards adopted by IBM for its latest generation of machines, albeit to provide compatibility with the vast software library developed for the 186 machine. There is therefore a serious case for considering this as an option for part of any college's IT provision.

The artificial distinction between business and educational software should be avoided. There is merely relevant software. There is little point in buying enormously powerful spreadsheets and databases for eleven year olds to use. However a CTC's business orientation is not compromised if systems or software are purchased which match the conceptual and curricular needs of the age group, or which address issues exploiting legitimate computer use but are little seen in the business world, such as teaching chemistry or modelling environmental systems.

The Archimedes option

Among the Acorn machines, the Archimedes is exceptional. As an engine for running a word processor, a DTP function and logging onto external communications sources it is a cost effective solution. With its 32-bit power and graphical user interface, its use should be identified and encouraged where it is the most appropriate tool for a particular task.

The Archimedes cannot be recommended as an environment for running MS-DOS. The best DOS programs now run under Windows 3 in an environment which is infinitely more elegant and user friendly than the early IBM PC standard. But Impression, one of the best and cheapest DTP options available, runs on the Archimedes platform and exploits its graphics ability to the full.

However there is software which permits a mixed computing economy without having to run elaborate conversion programs on data files or use the Archimedes solely in PC emulation mode. Pipedream is one answer. This hybrid program uses a spreadsheet matrix as a store for both word and data processing functions, and exists in versions for the PC, the Archimedes and (most famously) the Cambridge Z88 portable. Each version is file-compatible with the others and runs in native mode on the Archimedes. Unfortunately it is not the most elegant of programs, each component performing less adequately than a dedicated version. Colleges which plan intensive use of the Z88 could benefit from installing Pipedream on an Archimedes or PC platform to exploit its full capabilities.

Protext, which is simply a word processor, can run in native mode on either the PC or the Archimedes producing mutually readable files. It has a number of attractions, being multi-lingual, with dictionaries available in foreign languages, a complete range of foreign language characters, and altered keyboard layouts to match continental practice. For younger children or the visually impaired it can be used in a large character mode. As an added bonus it allows the WordStar command sequence to be used. This is important for touch typists as they are not then hindered in speed by the need to use mice and menus, which are wonderful for beginners but a delaying irritant beyond.

Logic Works is of particular interest, as it has been translated from Macintosh Plus format. Basically a circuit editor, allowing the user to create and test circuits on screen before manufacturing them, it also allows the use of high level programming languages to create simulated PLCs (programmable logic controllers), one of the key components in our BTEC Engineering courses. Porting this kind of program to the Archimedes enhances the case for specialized Archimedes work groups in a networked PC or UNIX environment.

Software use and evaluation

Despite the level of resourcing, one of the facilities enjoyed by LEA schools which CTCs are not yet able to provide is a library of software for evaluation. In Lincolnshire, for example, I had access to three to four hundred programs in BBC, Apple and MS-DOS formats. I was able to use them at a central resource centre before committing a school to the cost of purchase and the possibility of expensive mistakes.

One of the problems of an IT system with a single type of machine which is wholly networked and entirely diskless is that adding software to the network can be quite expensive if a site or multi-user licence is used. People may be reluctant to commit themselves to such an expenditure without the chance to try things out.

The normal terms of software licence restrict its use to one machine on one site. This means that the possibility of sharing evaluation copies among CTCs or other institutions is a non-starter. Some of a college's IT budget could be used to set up a staff software library, allowing people to use and evaluate single copies of a program before committing the college to the expense of a site or network licence. Legally, this would require one to use a machine or machines which had local storage for programs. To avoid compromising the security of the network it would be best if they were self-contained. Access to program areas on the network would remain restricted to the systems manager in order to keep software secure and possible viruses out.

Standalone machines are likely to be of interest in IV (interactive video) too. There is some excellent material now available for staff development, much of it from Scotland where the Scottish Interactive Technology Centre is a national leader sponsored by Sony, Philips and Commodore among other industry leaders. Sony, Philips and Microvitec all produce IBM compatible computers with a built-in Laservision player. If a college had one or two, this would both give access to a growing library of IV resources, and act as the standalone MS-DOS platform for program evaluation.

Hard disk portables represent one solution, but the lack of a colour screen rather restricts their use for the better curricular programs. It may be helpful to have an evaluation suite, with standalone computers from Apple, RM and Acorn. Although the best single source of software information is the Research Machines' PC186 directory, not all of this runs in IBM mode. However it is a useful resource and the directory of suppliers at the end is worth circularizing to ensure that the college is on all the relevant mailing lists. (See Appendix A for further details.)

Concept keyboards are now available on some MS-DOS machines. There is an excellent program called Touch Explorer Plus which the National Council for Educational Technology (NCET) was instrumental in producing. The concept keyboard is not a means of bypassing keyboard skills, but a way (like a touch screen, perhaps) of harnessing computer power to help the learning of children who, in many cases, may lack the mental or physical dexterity which would allow them to use a normal keyboard.

Whether computer use should be supplier-dictated or curriculum-oriented is a moot point. I suspect that in CTCs it has to be a bit of both. They have a training function in respect of commercially-oriented applications and programming languages. However it is also assumed that IT will be used in teaching a range of subjects, and it is the needs of those subject specialists and the availability of relevant software and applications which will dictate a college's requirements.

Word Processing: industry standards

The numbers used by a microprocessor to represent printable characters and certain non-printable instructions have been more or less standardized in the computer industry as the American Standard Code for Information Interchange, or ASCII for short.

Text which is encoded in ASCII format can be transferred easily between applications on one computer (for example reading addresses from a database to use in a sequence of letters to different people, or importing details of a child's record of achievement from the school's management system to an employer reference). It can be moved via disk from one machine to another or passed across a network system. It is the accepted form for transmitting textual material in electronic mail, such as Campus 2000, where the nature of the terminal does not matter so long as it can use a modem and access ASCII text.

The modem (MOdulator-DEModulator) is the other part of the equation for electronic mail and online databases. It is a device for converting a digital signal from a computer into an analogue signal for transmission across telephone lines. The signal is then reconverted by another modem at the receiving end.

DTP programs accept text in ASCII format, although most of them contain filter or conversion programs for importing text from the more common word processors. WordStar (Version 4), Word Perfect (Version 5.01), Microsoft Word (Version 4) and Multimate are found on any import list, along with a range of other programs.

The version number is important. WordStar 5 attaches additional information to a file which frequently has to be stripped before importing to a DTP package.

It includes a printer driver for producing text in Version 4 format which can then be imported directly to, for example, Pagemaker or Ventura. The characters in which it saves text are enhanced with additional information, but it can output text in non-document mode which is 'clean' ASCII, or print ASCII text to a disk file for transmission over an electronic mail system. Similar things happen with later versions of Word Perfect, which still allow output to Version 5.01 format. Word processors which function with pure ASCII text can operate as text editors in programming languages such as Basic or Pascal, as well as editing database files stored in ASCII CDF (character or comma delimited) format.

A college is advised to choose a word processing system which can either operate in text mode or can output text in ASCII format for electronic transmission or use by other programs. Some word processing packages such as WordStar and Microsoft Word produce non-ASCII format text files (or add coded printing instructions) which prevent transmission over data lines. They require secondary processing if they are to be used by, for example, Pagemaker or Ventura. ASCII text produced by the elementary program Oxfordshire WRITE (supplied free with Nimbus) can be used with WordStar or Windows. It is also immediately ready for electronic mail transmission or DTP inclusion.

The program must be a tool, not an object of study in its own right. The normal learning pattern should be to move from an elementary and user transparent program to one of the industry standards like Microsoft Word, WordStar or Word Perfect. There is little point in investing in the complex learning required by programs like View, which combine the worst of both worlds being difficult to learn and use and having no installed user base in the commercial world. The time required to master a complex word processor is months rather than days, and it is important that it is not wasted on a package which will be discarded on leaving school.

If the decision is to furnish the college with DOS or OS2 based machines, this does not preclude the use of other systems (Apple or Archimedes) for the DTP specialist function. They are capable of reading most disk formats, and their superior speed and graphics capability make them strong contenders for those specialist applications. The college must have at least one system capable of transferring data among the different MS-DOS disk formats (1.2 MB and 360k 5.25" disks, 1.4MB and 720k 3.5" disks), as well as CP/M and BBC formats.

Text and material generated by children must be instantly accessible to the network's main storage medium. If just text, it should be available as printed output or ready for electronic mail transmission and if text and graphics, it should be capable of being ported into DTP applications. It should also be capable of being stored in free-form databases for profiling and records of achievement. The system must be able to import text and data from CD-ROM or online electronic mail and database applications, and incorporate this into a child's work.

A common output format, rather than a common user interface, is probably more significant in choosing software for school use. It is important to distinguish industry standards (like ASCII or TCP/IP) from installed user base, market share, and current sales. One hears the argument for example that MS-DOS computers are prevalent in Europe: we want to communicate with Europe therefore require MS-DOS computers to do so. What you require, of course, is a telephone line and an appropriate modem; the computer could equally be a Sinclair Spectrum or an IBM mainframe.

The commercial dominance of IBM in the early 1980s created a huge market in machines which could use the software base they established. Relatively few of those machines can run the latest graphic and memory intensive software, while the installed user base in Apple systems is much greater (and offers a wider variety of equipment and software) than comparison of crude figures might suggest. There are also many industrial applications for which the PC standard is inadequate or inappropriate. On a recent visit to a UK manufacturer of IBM compatible machines, it was interesting to see Apple Macintoshes used for DTP, with Apollo Unix machines being used for high-end graphics work!

Industry standards describe technical specifications (like the High Sierra format for CD-ROM, or the compact cassette standard in audio) which have been agreed among major companies. The term 'industry standard' is all too often merely a marketing ploy used to obfuscate serious discussion; it is only the arrival of Windows 3 which is finally presenting PC users with the elegance and ease which Apple and Archimedes users had enjoyed for some years. Having arrived, though, it is so good that one cannot cavil, but commend it without reservation to those with the resources to buy the high-end machines required for its serious use: Time Computers recommend at least a 386sx processor with a VGA colour monitor and a minimum of 3 megabytes of memory.

Some possibilities

If a college is to use Windows 3 as the common user interface then Word for Windows is an expensive but elegant solution. For younger children copies can be configured to present a simple interface, access to more powerful formatting and tabular features being introduced with growing skill.

Integrated packages containing word processor, spreadsheet, database and (sometimes) communications programs seldom have components which match dedicated programs in features or sophistication, but the best of them come very close. Several colleges have decided to use Microsoft WORKS as the software base. Available in both Apple and MS-DOS incarnations, it can share files across the systems.

Ease of use and a common set of commands across the applications are the chief features of packages like Smart, Framework and Symphony, but the same is true of packages which are written to the Windows 3 format. MS Write, packaged with Windows, is a very adequate program. There is a case for using Write as the elementary package, underpinning training in Word in specialist courses later on rather than buying a Word site licence for the whole college.

A specialist program like VuWriter will not commend itself for whole college use, but for science or languages departments it produces files in Greek, Cyrillic or scientific notation and is also capable of producing straightforward ASCII text. Anyone using only this could still generate text to be incorporated in DTP output, or material to be piped into an electronic mail system. Departments and individuals might choose programs which match their special needs, so long as they retain a degree of ASCII compatibility for porting text to other users. For scientific and mathematical work Chi Writer also has a lot to commend it, producing mathematical, technical and scientific notation directly to screen and printer.

Recent evaluation of MathType, which runs in the Windows 3 environment and produces formulae and equations which can be pasted into Write or Microsoft Word, has been very encouraging. CTCs plan to collaborate to produce material in this format for sharing, particularly among Mathematics and Science departments. The item bank of materials which emerges from the collaboration will be available in the public domain (in a sponsored database on Campus 2000) in the second half of 1991.

Networking protocols and system design

I have assumed that all CTCs will exploit network technology in their systems installation. Networks of computers can share a single printer or printers, data and program files, CD-ROMs, online information bases, modems, fax-cards and other devices. In a network, one computer acting as server hosts a resource and makes it available to other linked computers. The user of those other machines receives the network facility as a local drive, and can use a huge range of programs without having to bother about floppy or hard disks, and save data either on the file server, on a local hard disk or on a floppy disk which can be transferred among different machines.

There is now a protocol whereby open architecture network systems allow bridges between Ethernet and Acorn's proprietary (and low cost) Econet. There may, for example, be an Econet work group of five to eight Archimedes or BBC Master machines in a Design, Music or other specialist area linked to a fibre-optic Ethernet system through a bridging machine.

At present this protocol is only available in a UNIX environment (it is possible to run a DOS shell under UNIX) but it does offer a serious chance to retain access to an educational user base while simultaneously operating on the leading edge of network technology without compromising the industrial standard built into the system.

There is no single correct solution to the challenge of networking a school or a CTC. Variations already exist in the physical nature of the networking provision (broadband or baseband, fibre-optic or co-axial cable) and the assumptions about the kind of computers which should be attached to it, not only in terms of brand loyalty (as ardent as that of motor car enthusiasts) but even as to whether disk-based or diskless terminals be used.

One view is that children should hold their work on a disk. This then becomes a storage device for information like a file or an exercise book. Some colleges have chosen to purchase diskless LAN stations, with children's work being stored in a sub-directory of the college file server up to an agreed limit. By eliminating moving parts from the children's terminals this provides enhanced security and reliability and makes software piracy impossible.

So far as cabling is concerned, there are two main choices: broadband and baseband. The main distinction between the two is that in baseband, digital signals are applied directly to the cable, leading to extremely efficient and secure data transmission. In a broadband system, the cable carries two or more high frequency radio channels, allowing multi-channel communications. Digital output from a file server is translated into analogue signals, which are carried on the radio channel for reconversion at the terminal. Current thinking is that the future of integrated services local network (ISLN), which will transport a mixture of voice, video and data, lies with high speed fibre-optic systems.

The financial penalty (and a query as to the needs of a CTC) may restrict colleges to a baseband Ethernet system (albeit using fibre-optics) or to a co-axial broadband system such as those successfully installed in Middlesbrough and Bradford CTCs. These already carry more than a dozen channels, including the computer data network. In an existing building it is easier to install broadband than baseband (there being only one run of cable for a multiplicity of services); for a new build, the equation is more complex.

The technology already exists to carry UNIX and MS-DOS systems on the same network, leaving open the possibility of a completely secure and self-contained finance and administrative system using commercial software. This is crucial given the combination of budget and autonomy which CTCs enjoy. Equally it is possible using TCP/IP to have subsidiary networks of Apple or Archimedes computers (for specialized use, perhaps in Design, Graphics or DTP) co-existing with an Ethernet network through an 'intelligent bridge', that is, a high-powered machine running both systems. The ability to link specialized work groups to a principal network is attractive, and greatly enhances the flexibility of IT in a CTC.

In terms of the main networking software, the clear market leader is Novell, and for good reason. Although expensive (around £7000.00 for the operating system alone) Novell Netware 386 (available from RM under their own brand name of RM Netware) is fast, extremely secure, does not degrade under heavy processing loads and provides huge amounts of storage. It also allows Apple Macintoshes to use a network software server directly through the AppleTalk Filing Protocol. Moreover Novell does not simply encrypt passwords at the server. It encrypts them on the wire, thus preventing network analysers from reading data sent to the server from a station. One can confidently run even the most confidential and sensitive financial controls across Novell systems, as indeed one can across IBM's Token Ring and other proprietary systems.

The topology of a network means that the distribution of terminals has to be carefully planned in advance and related to the traffic capacity of a physical network. There will be relatively few departments of a CTC which require a room full of computers. Terminals need to be set up where children can have supervised access without disturbing other groups. There will also be clusters of machines where children will work in groups. Design, Music, Art or Science may require half a dozen dedicated machines running specialist software and linked to peripherals such as digitizers, scanners, MIDI equipment, colour printers, light pens and cameras, without which the computers are useless boxes.

Purchase: advice from suppliers

It should be remembered that suppliers can be most helpful if they are kept fully informed of what a college needs, and if the college is prepared to ask advice as to how goals can be most efficiently achieved.

Tender documents should ask for specific functionality and describe exactly what is required. Specifications should not be so exclusive that they identify a particular brand in all but name when the needs could be met by another manufacturer in an equally satisfactory but different way. Tender documents should be sent direct to every major manufacturer who may then pass them on through a dealer chain or handle them directly. The tender should be returned with full details including equipment costs, installation, training and maintenance as appropriate.

A realistic lead time to ensure that equipment is delivered for a September term would be no less than six months, with final orders placed in April or May for delivery in June to allow time for installation and training. Requests for delivery and/or advice during the February/March end of year period should be avoided if possible, as suppliers frequently have to cope at short notice with large LEA or government orders placed to clear surplus budget at the end of the financial year.

There needs to be a realistic budget allocated to maintain and support a computer system. The options will be to have sufficient in-house staff (without misemploying teachers), to contract a support organization or to use a combination of both. The role and advice of the systems manager will be crucial to these decisions. It is important for colleges to define what they want (and why) from a computer system. It may well be that there are sound reasons for a diversity of provision within an institution, but such diversity must be justified.

IV. Conclusion

It is important that an institution investing in IT chooses the right system, since the consequences of the decision will be with them for many years. CTCs are fortunate enough to have a substantial IT budget. They are also in an ideal position to phase the purchase of an IT system and for the system to grow as pupil numbers rise, a possibility that may not be available to all schools.

When considering what to buy, the institution should keep in mind the three areas for concentrated attention identified by the Education Minister, Michael Fallon: laptop computers, CD-ROM technologies and interactive learning. Possible future developments and extensions to the system should also be considered. We can see from the past that IT capabilities change very rapidly. Computers were first developed to process numbers. Later, word processing became commonplace. The growing field at present involves the use of images, particularly in graphics and design, and the use of sound. Ideally, a system should be flexible enough to adapt to circumstances which may not even be clear at the moment. Such a system is unlikely to be the cheapest but may prove to be the best investment in the long run.

Schools must not be constrained to conform to industry standards if they do not match the required educational and technological functions. Other equipment such as language laboratories, robotics kits and instruments for data capture may interface only to certain computer equipment, and may dictate its purchase, but machines and software should be chosen because they perform a required function, not because they run under MS-DOS or Windows. Educational needs and best practice are of paramount importance.

I have suggested that a networked system will be needed by any school installing computers. The number of terminals required is a function of pupil numbers, the amount of time each pupil will need to use a machine alone and the amount of time needed for group work. Here one is dealing with speculation, but having a clear idea of the role of IT in school and the extent of its classroom use should make an intelligent guess possible.

It must be remembered that children will not be the sole users of the system. Teachers must also know how to operate the equipment; their capabilities in exploiting IT to the full may be enhanced by being able to use computers at their leisure at home. The other users of the networked system will of course be the administrative staff, who must have daily, unhindered access. Their needs will increase the number of terminals required on the networked system; in addition, a few standalone machines will probably be desirable.

The easy methods of communication afforded by IT such as electronic mail make collaborative efforts realistic, not only between schools, but also between research institutions and pupils. For instance, schoolchildren all over the country can be involved in gathering data for a centralized project. This novel use of the children's talents will instruct in many ways, not least by bringing about an understanding of the meaning of team work.

Specific recommendations are difficult, but a few pointers may be of interest. The progressive sophistication of educational computing renders much criticism either inaccurate or outdated. BBC B machines are out of date (although still useful as control devices, for data capture or for online terminal access) but no more so than their contemporaries in the business world, the 8-bit CP/M machines. It is as fatuous to compare early BBC programs with Apple System 7 or Windows 3 as it is to match the power and elegance of the Archimedes against cumbersome CP/M programs like DataStar or VisiCalc.

The medium through which children become computer literate and numerate is less important to employers and sponsors than the developed skills they bring from it. My own view is that networked MS-DOS machines are a correct but not the only solution. However, the MS-DOS platform may not be the best for the new, emerging technologies such as multi-media.

The future may lie with interactive media such as Laservision which already provides a vast amount of material; more materials from government initiatives in Mathematics and Science are expected over the next couple of years. The developments of CD-ROM technology are even more promising. The prospect of being able to manipulate not only words, but sound and images too, is alluring not only for teachers but for the next generation of schoolchildren, and takes several stages further the chances offered by existing technology for national and international collaboration.

Appendix A: Information and resources

Curricular issues

1. Commercial material for the National Curriculum is readily available; the Longman Logotron catalogue is particularly worth a browse. However, many of the most interesting case studies and curricular materials are not yet in the public domain. To this end the CTC Trust produces a regular *IT Update* newsletter, usually two or three pages of A4 describing materials or resources, inviting collaboration or writing up any particularly interesting projects. The Trust keeps a limited supply of the items described which are available on request through an attached order form, and the broadsheet is available free on request from:

   IT Update: CTC Trust,
   15 Young Street,
   London, W8 5EH.

   Telephone: 071 376 2511

   The CTC Trust are also encouraging the production of collaborative materials for Mathematics and Sciences (item banks, assessment sheets and so on) in Windows 3 format using MathType, an equation editor which is available to schools at a cost of £200.00 from:

   The Text Formatting Company,
   1 Suffield Road,
   London, N15 5JX.

   Anyone interested in joining a users group to contribute to, build up and benefit from banks of material is invited to contact the author of this report at the Trust.

2. Much of the work funded by the government's education support grant (ESG) scheme is now seeing the light of day, and several LEAs are publishing excellent National Curriculum support materials for IT. Lincolnshire is a case in point with excellent published work on planning IT activities and case studies which is available outside the county at a cost of £10.00 from:

   Curriculum Support Services,
   Lincolnshire County Council,
   Newland,
   Lincoln, LN1 1YQ.

   Telephone: 0522 552222

3. Technical and Vocational Education Initiative (TVEI) has been another fruitful source of material. The University of Sussex collaboration with Brighton Polytechnic and Kent County Council was funded by the Training Agency's TVEI Unit, and has produced a series of guides to whole school IT

development comprising a preliminary decision guide and three supporting policy papers. The material costs £20.00 and is available from:

ITSCST,
Tunstall Court,
Gore Court Road,
Sittingbourne,
Kent, ME10 1QL.

Telephone: 0795 427836

4. I have recently come across some excellent publications by the Advisory Centre for Computers in Education, based in Cardiff. Based on the order for technology in the National Curriculum which relates to the IT capability, the programme of study and statements of attainment have been analysed in terms of the following five strands of IT capability:

- communicating ideas;
- handling information;
- modelling;
- measurement and control;
- evaluating applications and effects.

Under each heading, the information is presented in four sections:

- the programmes of study for each key stage;
- statements of attainment, with examples, for each level;
- a summary of the study programme for each key stage;
- a summary of the statements of attainment.

There are seven books in all; two provide a general introduction:

- *IT Diaries: A teacher's guide to IT capability*;
- *A Framework for IT Across the National Curriculum.*

The others form a series of resource books. This may not yet be the definitive work on IT in the National Curriculum, but it is a hugely useful resource which should be in the hands of all staff with IT responsibility for teaching or maintenance. The pack costs £14.00, and is available from:

Dr Mike Treadaway,
Advisory Centre for Computers in Education,
Cefn Road,
Mynachdy,
Cardiff, CF4 3HS.

5. Digital Equipment Co Ltd in association with Hobsons Scientific have produced a useful free publication called *A Teacher's Guide to IT in Schools.* It is worth having if only for the decision tree on page 5. It also demystifies much of the jargon surrounding IT. It is available from:

Hobsons Scientific Publishing Department,
Hobsons Publishing plc,
Bateman Street,
Cambridge, CB2 1LZ.

6. Most colleges already receive the ITV schools update on National Curriculum software. The television output is listed in the *Annual Programme Booklet* sent out in March each year. These are obtainable from:

ITV Association,
6 Paul Street,
London, EC2A 4JH.

Telephone: 071 247 5206

Anglia Television's Key and Key Plus programs are supported by an excellent range of datafiles for exploratory work in both Science and Humanities. Philip Harris equipment in data logging is designed to interface with Key programs, whether in BBC or DOS format.

Both Key and Quest (see below) allow colleges to address National Curriculum attainment targets in Geography, History, Science and Technology.

7. The Advisory Unit's Quest database has migrated from its BBC origins to an MS-DOS version which runs elegantly under Windows. This removes the need for the cumbersome command line control which was offputting both to staff and children. Like Key, it is supported with datafiles which encourage exploratory skills in database handling as well as knowledge about the topics covered. The Windows version is called Oriel, and is available from:

The Advisory Unit,
Microtechnology in Education,
Endymion Road,
Hatfield,
Hertfordshire, AL10 8AU.

Telephone: 0702 65443

9. Scetlander Ltd is the commercial arm of the Scottish Council for Educational Technology. Their space and weather projects are particularly good, as is their range of commercial simulations relating to airline booking and car hire. Their address is:

Scetlander Ltd,
74 Victoria Crescent Rd,
Glasgow, G12 9JN.

Telephone: 041 357 1659

10. SEND (Special Educational Needs Database) is available either online via Campus 2000, or (under subscription) on CD-ROM. The database lists all available software, equipment and resources for use in this area, and there is

some especially interesting work (based in Edinburgh) on the use of Interactive Learning with hearing and visually impaired children. Contact either of the following:

Stuart Beresford,
SEND,
74 Victoria Crescent Rd,
Glasgow, G12 9JN.

The Scottish Interactive
Technology Centre,
Moray House,
Holyrood Road,
Edinburgh, EH8 8AQ.

Telephone: 031 556 8455
Fax: 031 556 3458

11. For those of you concerned with timetabling, the IBM Schools Timetabling System is excellent, but systems from Scientia on Apple and Minerva on the Archimedes have much to commend them, as does the TOR Auto Timetabler from I.L. Software at the following address:

I.L. Software,
100 Rectory Road,
Gateshead,
Tyne and Wear, NE8 1XL.

Telephone: 091 478 7518

The purchase and evaluation of equipment

1. The National Council for Educational Technology (NCET) and the Scottish Council for Educational Technology (SCET) are important sources of information on best practice in the use of IT nationally. NCET and SCET resources catalogues are invaluable assets and are available from:

NCET,
Sir Williams Lyons Road,
Science Park,
University of Warwick,
Coventry, CV4 7EZ.

Telephone: 0203 416994
Fax: 411418

Publicity Officer,
SCET,
74 Victoria Crescent Rd,
Glasgow,
G12 9JN.

Telephone: 041 334 9314

2. The NCET User Specifications (USPECS) provide information to educational users on selecting and operating equipment for teaching and learning. The following USPECs are of particular interest and can be obtained free from NCET at the address above:

15: CAD and the School Curriculum;
24: Electronic Music;
35: Desk Top Publishing;
36: Interactive Video in Education.

In addition to USPECS, NCET produce a series of USPEC Information Sheets which provide initial information about new technology and equipment of interest to education and industrial training; these are also available free from NCET. The following are particularly recommended:

5: Servicing Equipment for Use in Educational Technology;
7: Satellite Systems and Education;
9: Remote Sensing by Satellite;
13: Interactive Video;
14: IT and School Buildings.

3. There are specialized publications which deal with CD-ROM technology. *CD-ROM EndUser* magazine is 'free to qualified subscribers worldwide', and worth having. Obtainable from:

DDRI Inc,
510 N Washington St,
Suite 401,
Falls Church,
Virginia, USA 22046-3537.

To place orders, telephone: 010 1 703 237 0682

4. The *CD-ROM Shoppers Guide* (also from America) catalogues all available CD-ROM titles by category. The contact address for British distribution is:

Images and Data,
Berkeley Farms,
Swindon Road,
Wroughton,
Swindon, SK4 9AQ.

Telephone: 0296 641110
Fax: 641889

5. Commodore Business Machines have software catalogues available for the CDTV system launched in early 1991. Information is available from:

Commodore Business Machines,
The Switchback,
Gardner Road,
Maidenhead,
Berkshire, SL6 7XA.

Telephone: 0628 770088
Fax: 771456

Satellite systems and remote sensing

Several projects are under way to exploit the satellite technology capacity in CTCs. The benefits of authenticity and immediacy which such technology can bring to language learning and communication are clear. The challenge is to use the huge flux of information to produce manageable interactive packages which present a consistent appearance to the user and relate to the National Curriculum attainment targets.

1. The use of satellite equipment in Geography, Science and Technology is important to the technological base of CTCs. Excellent material is available on request from the British National Space Centre: It is beautifully produced, and (perhaps as a result) they guard it rather jealously. On receipt of a formal request to the address below, they will dispatch the following free publications along with other information sheets and posters:

   - Britain in Space;
   - Satellites in Schools;
   - Remote Sensing Applications;
   - The Earth Below;
   - Image Analysis.

   Mike Blackwell,
   Press Office,
   BNSC,
   Millbank Tower,
   London, SW1P 4QU.

2. At a more specialist level, Keith Hilton has edited a collection of resources and images entitled *SPACEVIEW UK: A Teacher's Guide to Landsat Images in the Classroom.* It costs £3.95, and is available from:

   The Remote Sensing Society,
   The Remote Sensing Unit,
   University of Nottingham,
   Nottingham, NG7 2RD.

   Telephone: 0602 484848.

3. British Telecom have, for some years now, sponsored the work of The Satellite Project within Dyfed LEA schools. Some fine resources have been developed from this, including a British Telecom video (available free on loan) and an accompanying booklet in which Annette Temple, the project's director, presents a concise and well-illustrated overview. For more information about the project, contact:

   Mrs Annette Temple,
   Dyfed LEA Satellite Centre,
   Aberard,
   Newcastle Emlyn,
   Dyfed, SA38 9DB.

   Telephone: 0239 710662

   The video and other useful materials and catalogues are available from:

British Telecom Education Service,
Room B4074,
British Telecom Centre,
81 Newgate Street,
London, EC1A 7A.

Telephone: 071 356 5674

4. A team at the University of Nottingham's Institute of Management Studies are currently undertaking a feasibility study of the potential for a dedicated satellite channel for UK educational institutions; among the aims of their study is to find out what the likely use of such a system might be. For further information, please contact:

   Inger Boyett and Uta Khendek,
   Satellite Educational Channel Research Team,
   Institute of Management Studies,
   Social Sciences Building,
   University Park,
   Nottingham, NG7 2RD.

   Telephone: 0602 484848

5. The American company AT&T have entered this area with a scheme called the AT&T Learning Network. This aims 'to link a community of educators and students from elementary and secondary schools world-wide' with classrooms using the AT&T telecommunications network at local rates.

   Six to nine distant classrooms are linked into a 'learning circle'. Curriculum choices include Computer Chronicles, Places and Perspectives and Global Issues. The materials provided with the scheme are specific to the grade level and subject. The 15-week programme costs £600.00 for four schools, based on the assumption that three schools pay £200.00 each and the fourth school joins in free of charge. Details are available from ED Berman at the address on page 40.

6. The Dartcom desktop satellite image acquisition package from British Aerospace is claimed to be the world's best selling system of its kind and was winner of the 1990 British Computer Society applications award. Transmissions can be received from any polar orbital or geostationary satellite, with the VGA version presenting a good starting point for colleges. Training details are available from:

   Richard Saull,
   Telephone: 0822 88315
   Fax: 0822 88232

7. NICAS (the National Inter Action Computing Award Scheme) plans to assess the acquisition of knowledge and skills in a wide variety of computer applications with ten tasks at each of three levels. The scheme presently has the following six topics: Wordprocessing; Databases; Spreadsheets; Desktop Publishing; Logo; Telecommunications. As in the Cambridge Modular IT

scheme, plans are afoot to increase their coverage to 15 topics over the next three years. Details of the NICAS scheme are available from:

ED Berman MBE,
Inter Action (NICAS),
HMS President (1918),
Victoria Embankment,
London, EC4Y OHJ.

Telephone: 071 583 2652

Issues relating to the management of IT

1. A project to support the Management of Information Technology in Schools (MITS) was sponsored by NCET. Excellent work has emerged from the five groups which produced material. The MITS co-ordinator at NCET is Jon Coupland. Copies of the newsletter are available from the NCET publications department whose address is given above.

   In Northern Ireland the issues of training, support and the role of the IT co-ordinator were considered in great detail. *Managing Information Technology: The Role of the IT Co-Ordinator* is available from the University of Ulster. A collection of exercises, discussion papers and audit tasks, it is an invaluable resource for senior staff planning and development. The work is copyright-free within the purchasing institution, so it can be copied or reproduced onto OHPs for staff training and discussion sessions. It costs £9.50 and is available from:

   Dr Reg North,
   Faculty of Education,
   University of Ulster,
   Magee College,
   Northland Road,
   Londonderry, BT48 7JL.

2. The NCET Field Report No 1 (*Monitoring IT in Secondary Schools*) presents a series of brief case studies, including one from Kingshurst CTC. It contains useful check lists and discussion topics for surveying IT use and potential and for developing policies about staff training and the division of labour and responsibility. The publication is available from NCET (address on page 36) for £3.50.

3. There is a well-documented account of the use of portables, where the experience of Macmillan College is significant. The PALM project (developing Pupil Autonomy in Learning with Microcomputers), which was supported by NCET, the University of East Anglia and a consortium of local authorities, generated sound practice; the Norfolk project officer, Bob Davison, was particularly concerned with the use of portables in Science. The report was written in conjunction with East Anglia's School of Education. For information contact:

PALM Project,
School of Education,
University of East Anglia,
Norwich, NR4 7TJ.

Telephone: 0603 56161 extension 2633

4. A Tandy-sponsored exercise looking at children's use of portable computers in Dumfries schools produced some worthwhile outcomes. Information is available from SCET at the address and telephone number given on page 36.

MS-DOS educational software

The strength of the BBC educational computing base was the wealth of material directed not to learning about computers but to learning through computers. CTCs rightly build their computer provision on the MS-DOS platform, but its market dominance disguises some limitations, not least of which has been a dearth of easily-affordable software for use in education (as opposed to the training function in commercial software).

However this is now being rectified. There are now several sources of good MS-DOS software. I draw your attention to the following catalogues and suggest that if you do not already have them, it would be worthwhile to get them.

1. In conjunction with J Whitaker & Sons Ltd, NCET have recently published the definitive compendium of educational software for primary and secondary education. It covers every machine and medium. Nearly 400 pages list some 5000 packages from 270 leading UK software houses. At £18.00 the book is available from NCET or any bookseller (ISBN 0 85021 213 8). A version on CD-ROM is likely in the near future. The superior indexing and search facilities may commend it in preference to the printed document.

2. The single best source of information solely concerned with MS-DOS educational software remains the *RM Nimbus PC 186 Directory*, which is a compilation from all known sources. Much of the software is available in standard IBM format. Contact Research Machines Ltd at the following address and ask for part number 26847 for a free copy.

   Research Machines Ltd,
   Mill Street,
   Oxford, OX2 OBW.

   Telephone: 0865 791234
   Fax: 796279

3. The *Educational Software Directory* from Rickitt Educational Media has a six-page supplement of IBM-compatible software, much of it for the earlier Key-stages. It is available from:

Rickitt Educational Media,
Ilton,
Ilminster,
Somerset, TA19 9HS.

4. AVP's *Big Black Catalogue* claims to be 'a comprehensive guide to the best educational software for the BBC, RM Nimbus, IBM PC, Archimedes and Amiga'. Many of the programs are for the BBC B run under emulation. IBM UK sponsored a large PC Supplement in the Spring of 1991; both are available from:

   AVP,
   School Hill Centre,
   Chepstow,
   Gwent, NP6 5PH.

   Telephone: 0291 625439

5. Shareware is the name given to copyrighted or patented programs marketed on a 'try before you buy' basis. It provides software cheaply for evaluation, usually the cost of the disk. Some is amateurish or cumbersome, but there are also excellent products which are worth looking at. Handbooks are included as text files on disk, and are supplied on the understanding that regular users will register and purchase a full copy of the program. This usually includes properly-bound reference material and telephone support in the program's use, although this can be more difficult for material from America.

   An excellent source of information for the IBM PC and its compatibles is *The Shareware Book*, price £2.00 from Shareware Marketing. A similar catalogue is available free from Gemini Shareware.

   Shareware Marketing,
   Beer,
   England, EX12 3HW.

   Telephone: 0297 24088

   Gemini Shareware,
   42 Cannon Street,
   Bedminster,
   Bristol, BS3 1BN.

   Telephone: 0272 637033
   Fax: 637030

   Colleges which exploit a Windows environment may like to obtain a catalogue from Omicron Systems Ltd, who specialize in shareware written for Microsoft Windows; programs on Fractals and Chaos theory are particularly attractive to mathematicians and artists.

   Omicron Systems Ltd,
   45 Blenheim Crescent,
   Leigh on Sea,
   Essex, SS9 3DT.

   Telephone: 0702 710391

6. For modern language teaching, the *ReCALL Software Guide*, sponsored by the IBM Trust and produced at the University of Hull, is useful. Much of the

material is directed towards more advanced learners than we yet have in most of the CTCs, but the addresses of European contacts and agencies are valuable. Together with other information on the Computers in Teaching initiative, it is available from:

Mrs June Thompson,
Information Officer,
CTI
Centre for Modern Languages,
University of Hull,
Cottingham Road,
Hull, HU6 7RX.

Telephone: 0482 466373
Fax: 465991

7. The Brealey Languages Centre in Sleaford served as a model for facilities in some of the earlier CTCs. Among the most advanced language-learning centres of its kind anywhere in Europe, it has developed a range of material and expertise designed to meet the needs of ordinary children in a Lincolnshire secondary modern school. Further details are available from:

Berthold Weidmann,
Director,
Brealey Languages Centre,
St Georges School,
Sleaford,
Lincolnshire, NG34 7PS.

Telephone: 0529 306083

Some alternatives

1. One could make a case for relegating MS-DOS altogether and using the Apple Macintosh as a computing platform in IT provision. Several local authorities in Scotland have done this and others in England (released from the strictures of ESG regulations) are beginning to consider it. Anyone who has used an Apple Macintosh will recognise its appeal and will be further tempted by the *Apple Education Software Catalogue* available from:

Apple Computer UK Ltd,
6 Roundwood Avenue,
Stockley Park,
Uxbridge,
Middlesex, UB11 1BB.

Telephone: 081 569 1199

2. The Micro Express catalogue from Eltec Computers has been widely distributed by the Secondary Heads Association. The company distribute not

only the Laserstar system but also kit from Apple, IBM, Amstrad, ICL, Philips and Toshiba. The catalogue is available from:

Micro Express,
Units 2-4,
Listerhills Science Park,
Campus Road,
Bradford, BD7 1HR.

Telephone: 0274 309999
Fax: 0274 731716

3. Finally, let us consider Acorn. It was once common to hear the Archimedes range derided as typical of British technology: brilliant, but inadequately represented in the real world (whatever that is) and lacking the software base to exploit the 32-bit power of its RISC processor. However the real world has beaten a path to Acorn's door. Apple Computers have made a major investment in a new company to exploit the ARM3 processor, backed by other substantial American finance.

   It is not easy to tell an Archimedes from a PC as the keyboard, mouse, floppy disks and so on are identical. The graphical user interface is sufficiently similar to Windows on the PC and the proprietary Apple display to allow easy movement among them. It runs Word Perfect perfectly as well as Lotus 1-2-3, DBase III and so on, if it has to. The software base is finally coming of age, with over a thousand highly professional software packages listed in their Education Directory, an invaluable source book. The directory costs £4.95 and is available from:

Acorn Computers Limited,
Fulbourn Road,
Cherry Hinton,
Cambridge, CB1 4JN.

Telephone: 0223 245200

The Archimedes is the engine for the remarkable British Nuclear Forum interactive video package in Energy, Radiation and Statistics. The whole package is available as AB LaserStar V for £1900.00 from Eltec Computers (address as for Micro Express, above). Colleges with a Domesday system can upgrade it for £1100.00. They can use their existing Laservision and release the remainder of the kit (the BBC Master, monitor and disk drives) as a useful addition to college resources. A report by Dr Tom Margerison on the project can be obtained from:

British Nuclear Forum,
22 Buckingham Gate,
London, SW1E 6LB.

Telephone: 071 828 0116

Appendix B: Glossary and explanation of terms

Apple

A major computer manufacturer whose innovative technology first set the standards other companies aspired to in terms of software design and user friendliness. Arguably the Apple II and its ability to run spreadsheet programs marked the transition of personal computing from hobbyism to business, while the WIMPS (qv) interface on the Apple Macintosh has become the norm in other operating systems.

Archimedes

A proprietary brand name of Acorn Computers. The Archimedes family of computers represents the most technically advanced systems currently available to education. Widely used in medicine, design and scientific research as well as education the Archimedes is an essential component of a college's IT provision. Acorn's parent company, Olivetti, market network systems which can incorporate curriculum work groups of Archimedes machines.

ASCII

The acronym for American Standard Code for Information Interchange, the agreed industry standard by which a computer translates binary digits into alphanumeric characters and certain agreed control sequences. ASCII text which is stored on a character by character basis can be read by and exchanged among virtually any make of machine or operating system.

ASCII CDF format

Data stored in character delimited format (sometimes comma delimited format) or CDF can be transmitted easily among systems and can be accessed by most database programs, as well as being used by word processing programs in mail merge (qv) functions.

Authoring languages/Authoring systems

These terms refer to utility programs such as MicroText or TopClass which help create CAL (qv) materials. Courseware may be created using text and graphics, with questions and responses which exploit the programs' branching facilities. Particularly useful for providing instruction in structured material, they can also allow for the analysis and assessment of student input.

C+

C is one of the major programming languages, and C+ is a propietary version of the language which runs on a number of different platforms, allowing applications written in this language to be translated more easily among different systems.

CAL/CBT

Computer Aided Learning/Computer Based Training. Much of the first generation material is repetitive and sterile. The use of interactive video and a more graphically-oriented environment now allows for more interesting and motivating resources.

CAD
Computer Aided Design.

CAM
Computer Aided Manufacturing.

Campus 2000
An electronic mail and online information system for schools operated jointly by British Telecom and Times Newspapers, combining the services of the Times Network for Schools (TTNS) and Telecom Gold.

CD-ROM
Compact Disc Read Only Memory: a technology which uses the capacity of the audio Compact Disc (CD) to store the equivalent of 400 or more floppy disks.

Chi Writer
This is a proprietary title for a specialized word processor which contains mathematical and scientific characters. MathType performs a similar function in a Microsoft Windows environment.

Cloze
A procedure whereby children recreate text from which letters or words have been systematically removed. Their engagement with the text is active rather than passive, while the technology of the computer makes it an ideal vehicle for presenting material in this fashion. Also the name given to a piece of software which supports this procedure.

CNC
Computer Numerical Control. Binary codes are used to transmit instructions to machines as varied as robots, lathes, milling or knitting machines.

COIC
An acronym of the Careers and Occupational Information Centre which compiles, publishes and distributes a variety of publications on careers.

Content-free
This is used to describe programs like spreadsheets, word processors and databases where the user generates information and uses the program to manipulate it.

CP/M
An early operating system for 8-bit microcomputers. Introduced in 1975, CP/M (Control Program for Microcomputers) was the original standard for machines that used processors from Intel (the 8080) and Zilog (the Z80). It

still survives as the operating system for the Amstrad PCW word processor which thus can access the enormous (and still extant) library of software developed for this platform — although all the programs show their age when compared with the elegance of their successors.

DataStar

The database management component from MicroPro's INFOSTAR information handling suite of programs. Now little seen but still useful as an adjunct to WordStar as it can edit the matrices used by the MailList component.

Download

To take material off a machine or database. For example, one might download information from Campus 2000 onto one's own terminal or printer.

DOORS

An acronym for Data On Occupations Retrieval System, available from COIC (qv) either on Prestel or CD-ROM. The material is constantly updated, and allows an enormous bank of occupational information to be searched on different parameters, with the results available either to screen or in hard copy. Most careers rooms will have a copy.

DOS

Disk Operating System. The sequence of commands which handles a computer's control of its internal and external resources including the use of disk drives for the storage and handling of data and programs. Operating systems are usually machine or processor specific. Among the operating systems which can activate and control the INTEL 80xxx family of processors (the basis of the IBM compatible world) are DR-DOS, CP/M-86, PC-DOS and MS-DOS (qv). Because those systems present the user with little information and require complex instructions, various intermediary systems have developed which typically use pictures or graphics to symbolize entities and procedures. These include DR GEM, Microsoft Windows, Xwindows and Apple System 7.

DTP

Desk Top Publishing.

ECCTIS

The Educational Counselling and Credit Transfer Information Service runs a UK wide computerized database of further and higher education courses plus their entry requirements, and is accessible on Campus 2000 on payment of an additional subscription charge.

EGA

Enhanced Graphics Adaptor. One of a range of standards for graphics output display from a PC. Most colleges will want to standardise on VGA (qv). Graphics adaptors determine the output resolution: the higher the resolution, the greater the clarity and freer the screen is from the nauseating flicker of earlier VDUs (video display units).

ESG
: Educational Support Grant. An important government inititative which funded not only (in phase one) the purchase of equipment, but also the deployment of advisory teachers to train and support teachers in their use of the equipment and the development of teaching strategies. The complex criteria whereby local authorities reclaimed purchase costs from central government originally included restrictions on hardware purchase.

File server
: A computer at the centre of a network which stores the data and programs shared by its users and which controls the resources of the network and the signal traffic that it generates. There can be several file servers on a network.

Fixed disk
: A high capacity storage medium built into the machine. The hard disk in the original IBM PC-XT was a massive 10 megabytes in storage capacity (the height of technology). 100 megabytes is now common, and devices whose capacity is measured in gigabytes rather than megabytes can typically be found in file servers.

Floppy disk
: A circular piece of pliable (floppy!) plastic on whose magnetic segments data can be written and retrieved. Held in a rigid or semi-rigid plastic envelope which contains a window to allow the disk drive's read/write head to access the disk, they are available in various sizes: 2", 3" (Amstrad PCW), 3.5", 5.25" and 8". Within those sizes storage capacity can also vary depending on the density of the magnetic medium. Typically a 5.25" disk may hold 180K, 360K, 800K or 1.2 MB. A 3.5" disk is usually formatted at 720k or 1.4MB. Incompatible disk formats present horrible frustrations to computer users.

Hard disk
: See Fixed disk.

ILP
: Interactive Learning Productions. A company based in Newcastle whose science teaching materials on interactive video disk (commissioned by British Nuclear Forum) present radically new ways of teaching and exploit the technical brilliance of the Archimedes platform.

IV
: Interactive Video.

JIIG CAL
: Job Ideas and Information Generator — Computer Assisted Learning. Originally sold as a mainframe service to LEAs, JIIG-CAL is now available

from the company of the same name as a desktop product, albeit one that requires fairly massive storage — around 8MB of hard disk space. The program analyses a client's interests and personality, matching those to a range of suitable jobs for further exploration.

Laservision
A proprietary disk-based video system, utilizing analogue signals and a 12" diameter disk.

LMS
Local Management of Schools. A scheme to place responsibility for delegated budgets in schools rather than County Hall.

Logo
A programing language developed by Seymour Paepert who claimed that it would allow children to program computers rather than being programmed by them. Typically it allows one to learn programming, control applications and mathematics. Logo turtles are not necessarily green or mutant.

Mail merge
A word processor function which replaces characters in a piece of text with variables drawn from a data file, typically but not necessarily names and addresses.

MIDI
Musical Instrument Digital Interface.

Modem
Modulator/Demodulator. A device to translate a computer's digital code into the analogue signals required by the telephone network and back again. It allows computers to communicate across the telephone network.

MS-DOS
Microsoft Disk Operating System. See also DOS.

NCET
National Council for Educational Technology.

NERIS
The National Educational Resources Information Service. This service operates throughout the UK either online or on CD-ROM subscription to provide the education profession with information about curriculm materials and development.

Online Database
A database held (usually) on a remote mainframe computer which is accessed by a modem, the telephone network and appropriate communications software.

ORT

The Organization for Rehabilitation through Training (a rough translation) began as a response to the Russian persecution of Jews in the 19th Century pogroms. Nowadays ORT run a large number of specialist technical schools in Israel, and in locations as far apart as Buenos Aires and Bombay as well as providing technical advice and assistance to developed and third world governments — and to the CTC Trust, who are privileged to work closely with ORT and to enjoy access to their UK training and technical facilities.

OS2

A disk operating system produced jointly by IBM and Microsoft to exploit the power and multi-tasking capabilities of the more powerful Intel 80286 and 80386 central processors. It is similar in appearance and 'feel' to Windows 3, which seems largely to have displaced it in the market place.

PC

Personal Computer.

RM

Research Machines Ltd.

RSA

The Royal Society of Arts.

SEND

Special Educational Needs Database.

TCP/IP

Transmission Control Protocol/Internet Protocol. Originating with the US Department of Defense who despaired at the multiplication of competing (and non-communicating) systems, it is an interim series of technical protocols for allowing different network systems to communicate with each other.

UNIX

An operating system developed by Bell Laboratories (now AT&T) which allows large computers to run remote terminals. Processing is done in the central computer. In a PC Network, processing is done in the terminal, with the network and file server being merely a resource for storing files and sharing peripherals. Unix shared with CP/M the privilege of being a model for the earlier versions of MS-DOS.

VGA

Video Graphics Array. See also EGA for a discursion on graphics standards.

VisiCalc

One of the earliest commercial spreadsheets for the Apple II.

WIMPS

An acronym for Windows, Icons, Mouse, Pointers. Originally found on the Apple Lisa, most other systems now offer a WIMPS interface to users including Acorn's RISCOS, Windows 3, Amiga DOS and DR GEM.

References

ECTA English Teaching with Computers Association, Flexible Learning Project, Braidfield high school, Queen Mary Avenue, Clydebank, G81 2LR.

Heppell, Stephen (1991) *Times Educational Supplement*, 8th March.

HMSO (1990) *Technology in the National Curriculum*.

Renou, Janet (1989) *Art, Design and Technology*, Djanogly CTC, Nottingham.

SCET (1991) *Computers in English*.

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