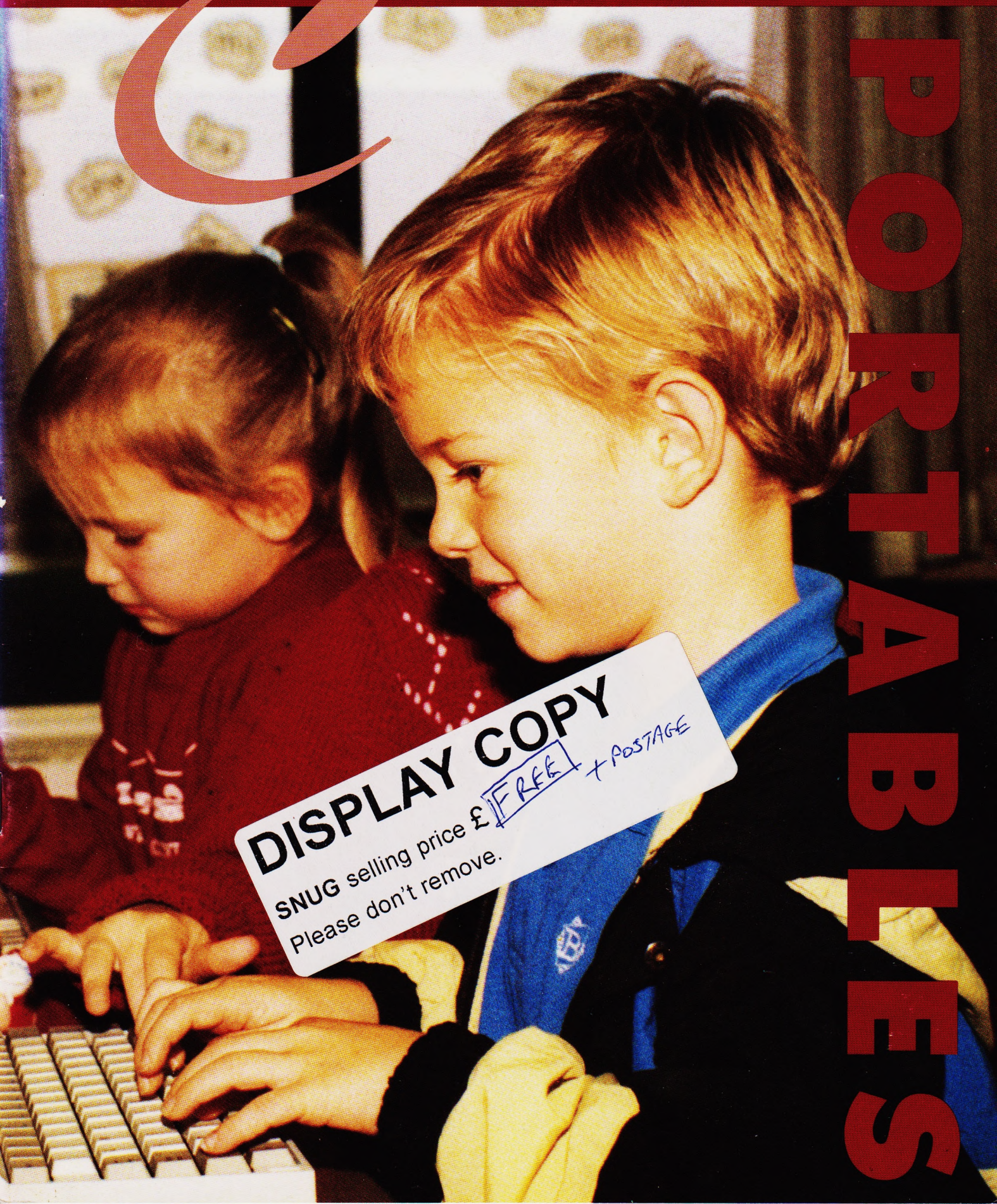
NCET

Choosing and using portable computers

PORTABLES



PREFACE

It is only a matter of time before every learner and teacher who wants a portable computer will have one.

The issues surrounding portable computers go far beyond the educational values of portability. The advent of portables has made us think about what education would be like with far greater numbers of computers than we have at present. How do classrooms operate with portable computers available at all times, when they are far less physically obtrusive than desktop computers? How can pupils and teachers benefit from ownership of their own personal electronic workspace? How should schools respond to the private ownership of computers, bought by pupils or parents?

Fortunately we have a little time to consider these and related issues, for the technology is still developing, and wholesale investment at this stage would be premature. Questions of reliability, resilience, battery life, recharging, size, weight and price are only some of those raised in the following pages. Beyond these technical considerations lie broader questions of staff expertise in IT, and learning and teaching methods, resource management, curriculum development and planning, all of which will evolve through practice.

This publication draws upon the lessons of many small-scale studies. It presents an encouraging, but nonetheless critical view so that future practitioners may be informed by the experience of those already working in this area.

Fred Daly
Director, Technical Consultancy
NCET

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A Notebook on Every Desktop

Even those of us who are not so long in the tooth will remember our own primary school days when there were ink monitors and dip-in pens. We may remember, too, our teacher explaining that if we dipped our pen too far into the inkwell, our writing would become all blots because we would drown the good writing fairy sitting on the tip of the nib. They were primitive days but we were not rationed – at least we had a pen apiece.

More recently we can recall the appearance of calculators. Gone are the days of log tables and slide rules. Today it is accepted that nearly everyone owns at least one calculator, and we reach for it without thinking, often to do the simplest of calculations. Yet many of us still in our thirties probably passed through school without owning or using a calculator.

Today's portable computer, like the dip-in pen and pocket calculator, is a piece of personal equipment. The majority of those who have them talk about "my computer" and it is unthinkable that it should not be available all the time. Ideas flow through their fingertips and keys and onto the screen. The writer and the computer become one in much the same way as a car and its driver. For this symbiosis to occur, the computer has to be readily available and its use become second nature. It makes no more sense for a word processor to be available for the odd half-hour than it does for a car or a pen.

We are not at the stage where schools can afford to give a portable computer to each child, or indeed parents afford to buy them, but it is only a matter of time. It will be only a short time before we reach the 1:1 computer to pupil ratio when measured against the backcloth of educational innovation generally, and the history of technological advance suggests that it will come sooner than we expect. Five years ago, few would have predicted that this ratio would be reached during this century, but now most would agree that (at least for the majority of pupils) the day of the personal microcomputer will arrive during the 1990s.

There have been a number of pilot projects throughout the country over the past few years designed to anticipate the arrival of truly personal computing. These local initiatives are scattered from Kent to Scotland. Many are characterised by selecting one class in a school and giving each pupil his or her own portable computer: a laptop, a notebook or a low-cost word processor. Invariably, the computers are class sets – all the same type and model. Being realistic, though, about the future for many schools, the introduction of portables will be evolutionary, rather than revolutionary. A mixture of machine types, models, applications software, overall performance and ownership is far more likely to be the pattern.

The personal portable

A personal computer used to mean a heavy, bulky desk-top machine at work, and for the enthusiast, another one at home. It will not be long before personal implies portable.

Many portables are much more than just simple word processors. The more sophisticated machines will run the whole range of industry-standard software packages as well as subject-specific programs. You may not necessarily need it all to be provided on the personal machine, but there are distinct advantages in having it all available. Compatibility with networked desk-top computers will create the opportunity to share work and integrate various computing activities to achieve a common purpose.

The fundamental applications on the personal portable are:

- a word processor (WP) with a spell checker
- a desk-top publisher (DTP)
- spreadsheets and database packages
- communications software.

AN IT-RICH ENVIRONMENT

Macmillan City Technology College, Middlesbrough

The aim at Macmillan is to make the use of information technology second nature by having it permanently available to pupils and staff. Since 1989, every student has been equipped with a personal word processor on entry to the college. The staff have been using IBM PC compatible notebook computers (competitively priced clones) with 40Mb hard discs since 1992.

Pupils in Years 7 and 8 have a portable on personal loan for two years, during which time the machine travels with them to lessons and between home and college. The Cambridge Z88 was bought initially, but this has given way to the Tandy WP2 more recently. Both these machines run on AA size batteries which the college buys in bulk and sells on to pupils at cost. Rechargeable batteries have, in the main, been avoided.

The portables are part of an IT-rich environment which incorporates a broadband network delivering television, radio, video and data signals to stations around the school. In this hi-tech environment these relatively cheap and lightweight machines were chosen to enable pupils and staff to have the opportunity to use the computer when and where appropriate.

The portables are all configured to enable them to be used for Spanish, which all pupils begin learning on entry to the college. There is no imperative during these two years to use the computer during a lesson or as part of an activity. Pupils are able to master the keyboard at their own speed and in their own time: at home, at break or during a wet lunchtime. A help desk is staffed to deal with queries and assist pupils when they have difficulties with software applications, access to printing or any technical problems.

Once pupils move into year 9 they are encouraged to become regular network users and only those considered to have a special need, for example access to a spell checker or needing a keyboard for text production, retain portables as personal tools.

Other software will come along, but it is probably significant that no new generic applications have been invented in the last decade; the increase in sophistication of the existing software marches on with new versions of old friends appearing yearly. Already the distinction between DTP and WP is becoming blurred, and many WP packages have gained the ability to import graphics and data from spreadsheets and databases.

The trend towards working in a user-friendly environment with a graphical user interface (GUI), such as Microsoft Windows, will continue and make using computers more attractive to non-computer specialists. The facility with which GUIs and software packages can be customised means that users will optimise their computing environment in a way which is unique to them. Those of us who have done this will know how inconvenient it is to have to use someone else's machine which is set up in a different way. In time, intelligent software which learns and optimises itself to a particular user's pattern of activity will begin to appear, making human–computer interaction even more personal.

The school network

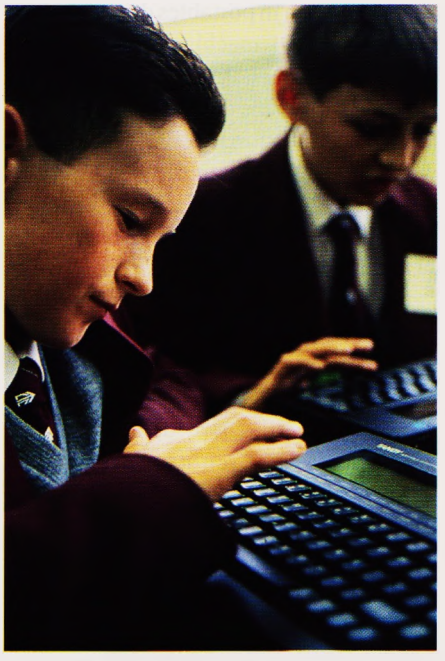
Despite all these personal computers in the school of the not-too-distant future, there will still be a need for a school network. However, it will be used differently from today's network: it will provide an information backbone rather than a computational one. The recent interest in networked CD-ROM points the way forward. Pupils, like all users, need access to a great deal of data and it is increasingly difficult for the traditional library to keep up with the demands of the information explosion going on all around us.

Access to the network will be by personal machines so that pupils can capture what they need and continue working on it at school and at home. No matter how much memory and file storage a personal computer has built in, it will still need access to external information sources. Data is being created at such a rate that it is no longer possible to keep up with it on a personal basis. The strength of the portable personal computer will be in selecting and acquiring data, using it and then sharing the results of one's work.

Tomorrow's portable

The notebook size product lines will probably stay for some time. The limitation on going smaller is the size of the human hand. QWERTY keyboards still have a strong future, although pen-based computers which can interpret handwriting are now appearing. At present, these are very expensive, and the handwriting recognition is inadequate, but in the long

Macmillan College



Tandy WP-2

term they will undoubtedly open up the use of computers to new classes of users for whom the keyboard is an obstacle.

Screen resolution is already very good, with the best monochrome units operating at near photographic level. Colour, which is expensive and power-hungry at present, will become the norm and screens will work well in adverse light conditions and from oblique viewing angles – unlike today's models.

The machine of the future will have plenty of storage, both memory and hard disc space. RAM cards, which are at present quite expensive and used mainly on sub-notebook machines, may replace floppy discs on all types of machines providing faster, more reliable and compact file storage. On the other hand, plug-in match-box size 20Mb hard discs now exist and these may come to rival RAM cards.

Batteries incapable of lasting throughout the school day will become yesterday's problem. Low-power electronics combined with smart software and improvements in battery technology will enable machines to last the whole day without recharging.

Cost perspective

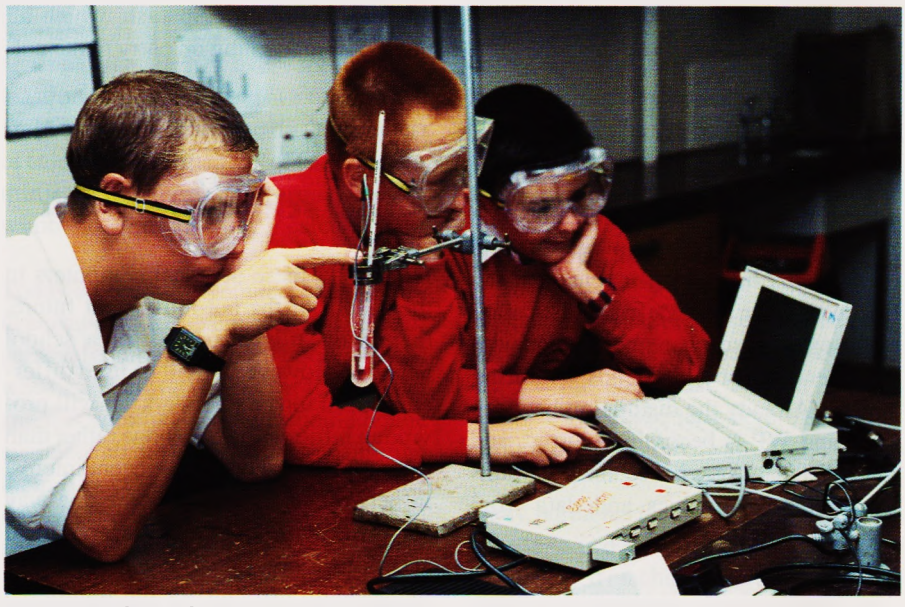
Cost does not tend to fall as rapidly as might be hoped. This is because performance, capacities and expectations all increase. Just because 40Mb hard discs are the 1992 norm in portables does not mean that the 20Mb machines of 1991 will continue to be available, but at half their old price: it means that 20Mb discs are no longer manufactured and now you get a 40Mb machine for roughly the same price as the old 20Mb model. So the vision of a modestly priced, modestly configured 'DOS box' will probably remain a vision.

We can expect unit costs to fall somewhat whilst functionality will increase more rapidly. This will increase popularity and that in turn will drive demand up and prices down. But even at today's prices, it is not too difficult to argue the case if the cost of the computer is offset against the whole cost of a child's education instead of the tiny amount traditionally set aside for equipment. Under LMS, there may be more chance of this happening.

Orgill Junior School

Tandy 1100

Samuel Ward School



Data logging with the RM Notebook

St Joseph's School

Tandy 102

BUILDING INDEPENDENCE IN LEARNERS

Orgill Junior School, Egremont, Cumbria

In 1989, the whole school, with a pupil roll of about 170, shared only four computers. Now there are over 70 computers and the majority of them are portables. These have been funded by a number of grants from both the public and private sectors. There are a variety of machine types in the school, but most of the portables are Tandy 1100s (IBM PC compatible with a single 720Kb floppy disc drive) with a smaller number of Tandy WP2s personal word processors.

The portables are not normally moved about the school: they are wired into communal work areas located between classrooms. Typically there are clusters of 6 to 12 machines and a couple of printers. One cluster uses standard hexagonal tables; a more recent innovation is a zoned-off area with purpose-built pine benchtops and swivel chairs. Advantages of using portables, rather than desk-tops, include the small 3-D space they occupy and their unobtrusive and unthreatening qualities. The strategy of locating them in wide corridors frees up other space in classrooms for curriculum-specific use. The corridors are studies of concentration as pupils quietly get on with their writing independently, without the need for constant teacher supervision.

Pupils of all abilities now have a much more positive attitude to writing and they write more. The quality of work has improved. There is a greater amount of self-correction as pupils seek to refine their work. There is more dialogue on the use of language, both between pupils and teacher and amongst themselves. Overall, there is more visible focus on language within the school.

As the role of computers has increased, so has an awareness of tension between its acceptance as a normal part of school life and it becoming so normal that it is taken for granted and looked after as well as it might. As the resource base has grown, so have expectations and knowledge about what is possible, so that for example, scanners and CD-ROM are being introduced. The children have access to other equipment in the school, including the photocopier and fax machine. They recently produced an article on their rock-climbing club, desk-top published it, and faxed their copy to a well known outdoor pursuits magazine. A number of local schools also produce weekly newspapers to deadlines and fax them to one another. The pupils learn to use technology to produce and deliver quality work on time.

The school has, with IT, the capability to resource itself. Technology is helping to define the curriculum. Documentation is being produced in the knowledge that it can be adapted and reprinted easily. Assessment tasks are being produced with the technology. The children are both consumers and producers of text books – the school has produced, for example, its own atlases.

IT capability is not necessarily a quality sought in new teaching staff appointments: more important are the willingness to learn and underlying attitudes. This is a school where there has been careful handling of change and staff development alongside IT procurement. The staff have developed a sense of ownership, control and confidence with the new ways of working. IT has been become an effective school-wide resource, underpinned by addressing pupil needs, provision of in-service training, and coherent management.

Tomorrow's school

To be able to exploit the potential of truly personal computers in schools, we will also need a different kind of school. We need one anyway: one in which more flexible teaching and learning styles, and a more resource-led structure, can inspire the work done at every level in school and make the higher aims of the National Curriculum attainable.

Some of the portable computer projects which have already taken place are pointing the way towards this new kind of school and, more importantly, providing guidance on how we get from where we are now to where we need to be.

Macmillan College

Cambridge Z88

Classes of Portables

The term *portable computers* means that *class* of machines that fit easily into a briefcase or pocket, and are light enough to pick up with one hand. They run on batteries, or with a mains adaptor, and have an integral screen. This class can be divided into four *families*:

- laptops
- notebooks
- palmtops
- low-cost word processors

Laptop has a very specific meaning to PC manufacturers and suppliers. Unfortunately, it has become a generic term in the world of education, often being applied to all types of portable. In this publication, however, the term *laptop* refers to first-generation portables, as defined below.

Portables represent the compact, lightweight end of the personal computer (PC) market. The other, larger, heavier kind of PCs in schools (like traditional BBC, Archimedes and Nimbus machines) are called *desk-tops*. To carry a desk-top computer more than a few yards, you probably need a trolley or a weight-lifting qualification (and you may need both). Today's portables are genuinely portable, for adults and children alike.

Laptops

Laptops were the first portables that enjoyed any market success. Some of these typewriter size machines of the late 1980s weighed as much as 5kg without the batteries. The gas plasma screens produced an eerie orange glow which, together with the hard disc if fitted, consumed a good deal of power and made a mains adaptor all but essential.

Later laptops have liquid crystal displays (LCDs). The early versions displayed blue letters on a silvery, reflective background. Today's best screens have black letters on a bright white side- or back-lit background. These LCDs provide equivalent functionality to the monochrome monitors used with desk-tops. Colour LCDs have been widely available (at a price) since 1991. There are two types: active and passive displays. The former are better quality, but more expensive.

Laptops are now virtually obsolete and some schools have picked up bargains for as little as £250. These provide the same basic facilities as later machines but have a larger footprint (take up more desk space), more weight and the earlier type of screen.

Llanfyllin High School

Sharp laptops

Westlea Primary School

Research Machines Notebooks

Notebooks

Notebook computers are second-generation portables which represent the state of the art since 1990. They are telephone directory (A4) size and up to 50mm thick, and most weigh 2-3kg. A folding lid reveals the screen and keyboard inside. This is called the *clam design*.

Both laptops and notebooks have full-size 18mm square key caps. But some compromises have been made to fit all the functionality of a full-size keyboard into a much smaller space. For example, standard IBM PC function buttons like *Page-Down* may require two-key combinations on a portable.

Some A5 size notebooks have appeared during 1992. Typically the A5 size machines run MS-DOS on a 286 processor, have a 20Mb hard disc and weigh about 1kg. The cost is generally higher than for an equivalent specification A4 format machine.

Notebooks should run all the standard software which is available for their desk-top counterparts. There are three architectures relevant to schools: IBM PC compatible, Apple Macintosh and Acorn Archimedes.

Palmtops

As long ago as 1989, manufacturers were producing both laptops, the first of the new notebooks and also *palmtops*. Palmtops are handheld, pocket-size machines which have continued to develop as a separate, parallel market. These machines are sometimes termed *sub-notebooks*.

Virtually all palmtops employ the clam design although the whole machine has been shrunk to paperback novel size, typically 160 x 100 x 20mm. The keyboards are tiny and the conventional key mechanism has been abandoned in favour of touch-sensitive pads or micro-switches. Finger positioning is much more critical and tactile feedback is different.

Photo courtesy of Acorn Computers Ltd

Acorn Pocketbook on site

Park Hill Primary School

Olivetti Quaderno, A5 size Notebook

Palmtop screens are tiny too, usually supporting a 40 x 8 character matrix compared to 80 x 25 on a notebook or desktop class machine. This, together with the keyboard limitations, makes their use somewhat less general purpose: one would not be able to touch type, or wish to enter long documents or develop complex spreadsheets on a palmtop computer. These machines win where size is at an absolute premium: for example, when used as electronic personal organisers or for data entry in field work.

Low-cost word processors

Another kind of A4 size machine, quite common in schools, is the *low-cost word processor*. This class of portables includes the Tandy WP-2, the Cambridge Z88 and the recently launched Amstrad NC100. Unlike the more expensive notebooks, these machines do not have a folding lid, so the keyboard and screen are located on the top surface. The screen cannot, therefore, be tilted without also tilting the keyboard by the same amount.

These machines are each characterised by having a unique built-in software environment, letter-box shaped screen and operation without discs. The main use in schools would probably be for text entry, but these machines may also have simple spreadsheet, database, diary and address book applications software which are of value.

Low-cost word processors have long, narrow screens with an 80 x 8 character matrix. The screens are not lit internally and various other economies have been made to keep the street price well under £200.

Clearly there is a role for inexpensive machines, but you get what you pay for. The functionality and sophistication of their built-in software bears no comparison with the true notebook computers which run third-party industry-standard packages.

Amstrad NC100 low-cost word processor

Power to the People

Existing projects show that the introduction of portable computers can make quite an impact and bring about a number of positive changes in the school. If you are now thinking about the purchase of portable computers for your school, it is important to consider the wider implications for the school community alongside the exciting curriculum possibilities they offer.

The introduction of significant numbers of portables to a school will require careful planning and preparation between teaching and technical staff, governors, parents and the pupils. Portability of school IT resources can enable a new link to be formed between the school and the community, bringing with it a range of possibilities (and problems) not encountered before. The problems will centre around security, resource management, maintenance and technical support, whilst on the plus side, with well planned in-service training, the cross-curricular use of IT is set to increase, generating interest from the wider school community.

A management challenge

Depending on the type and size of school, it may be the head or an enthusiastic IT co-ordinator who is responsible for the integration of new technology in the school curriculum. Clearly, the purchase of portables needs to be an element of the whole-school IT policy. The cross-curricular and resource management issues surrounding portables are different to those of desk-top computers, and location, accessibility, security and compatibility with existing hardware are key issues. Whoever has this responsibility will need to provide leadership to develop shared aims and commitment from staff to manage the changes required to introduce new technology into the school. Time is needed for careful planning and extra support in the early days to ensure that maximum effective use of the new machines is realised.

Portable computers are, by their nature, suitable as a whole-school resource. Their use in different rooms, from laboratory to gymnasium can promote the development of the many diverse curriculum applications. Maximising their use whilst ensuring proper maintenance and security is a responsibility best allocated to a willing member of the staff team. The location and management will depend upon the scale of purchase and the mode of intended use: whether for the whole school, departments, or individuals. Various models of use are considered in the *Classroom Impact* section on page 27.

Professional development

Having made the decision to purchase portables, probably the most effective way of enabling staff to become familiar with the new computers is to organise a series of introductory workshops. Staff can learn together to use the technology before applying it in an administrative or classroom situation. The nature of portables then enables individuals to continue developing their skills in the privacy and comfort of home. Many teaching staff, once proficient, would welcome portable computers, for both personal and professional use: for recording assessments, report writing, designing worksheets and producing other necessary documentation, and the demand is likely to become heavy. The ease of moving the computer between home and school will be an important factor, alongside the freedom to have computing facilities in any area of the school, creating the advantage of working in familiar surroundings.

Portables can be a cost-effective way of providing INSET to develop confidence and competence with IT. To give maximum support and achieve maximum participation, individual schools and at least one county LEA are offering an INSET programme linked with a recognised national qualification as an added incentive. These initiatives give teaching staff

a clear goal in their professional development.

Where portables are purchased mainly for curriculum use, it is important that machines are as available to the staff as to the pupils. This ensures that teaching staff are able to explore their potential in the same way as their pupils. This will become increasingly important if pupils are allowed to take the portables home and begin to enhance their skills with computer-literate parents. Classroom teaching styles and materials will need to be adapted to reflect the numbers and types of computers available. New ways of working, providing multiple group activities and differentiated learning opportunities, will demand staff flexibility and development in terms of teaching methods. The necessity, in some schools, to book sets of portables well in advance will require better activity planning, whether in the classroom or in new areas of use around or outside the school.

Management information

All schools, except the smallest primaries, are committed to some form of school management information system (MIS). A large number use the SIMS package; the Phoenix software package is being sold bundled with Research Machines notebook computers. Some schools have used commercial software such as DataEase, Excel and Word to implement their MIS strategy. There are advantages in hosting MIS on a network fileserver because this provides simultaneous direct enquiries on shared databases from around the school. Portables, however, can be used in conjunction with a network and they enable copies of the information to be carried into meetings, taken home and merged easily into documents.

Some schools have supplied portable computers to the administrative staff first. The same staff development issues apply to administrative as for curricular use. Quick access to financial and organisational information wherever required, and in a malleable form, is of great value for reports to school managers, governors and parents. The importance of financial and administrative information is growing as the role and responsibility of governors becomes more complex. Access to, and display of, financial information will inform major decisions.

Assessment is another area where portability is a great asset. Several LEAs are trialling assessment software using the more sophisticated portable computers with optical mark readers. After some early problems, this is now easing record keeping, collation of statistics and reporting on National Curriculum targets.

With records of achievement, the majority of schemes depend on pupil/teacher conversations and the results are recorded on paper. New management strategies will emerge as powerful portables become more widespread and suitable software is developed.

Photo courtesy of Acorn Computers Ltd

Using Acorn portables in science

Pupils with portables

We already have large numbers of self-taught computer-literate pupils in our schools, many using games machines incompatible with school computers. Increasingly though, pupils have access to industry-standard machines at home that may be compatible with the school network. Increased access to powerful, compatible machines will stimulate the demand for portable computers to supply IT wherever it is needed, not just at home or in a school network room.

Pupils will often find the time to explore IT, and may become more proficient than the teaching staff, particularly if they have parents who are able to extend their skills. This pupil empowerment can be put to good use by sharing the skills and expertise that pupils develop and allowing these pupil experts some responsibility for helping others. Some schools are already harnessing this pupil expertise and organising accreditation for the training skill acquired. This formal recognition of the pupil expertise and allocation of responsibility can help to motivate and increase pupil confidence. Schools with considerable numbers of low-cost portables often allow pupils the discretion to book a machine for use in classes of their own choice. This pupil autonomy in learning is often a motivating force. Many schools using portable computers also encourage the pupils to take responsibility for battery maintenance.

Year 12 pupils at Biddulph High School, Staffordshire were allocated five RM Notebook computers to organise for school use. The pupils provided a report on the curriculum areas involved and the extent to which the portable computers were used. This covered many activities

A WHOLE-SCHOOL RESOURCE

The Managing Flexible Learning project, Mid-Wales

The MFL project in Powys is one of a number of TVEI initiatives funded by the Training Agency and has been running since 1990. Three schools at Llanfyllin, Llanfair Caereinion, and Llanidloes in the north of the county are involved. To maximise impact in terms of numbers of machines and flexibility, it was decided to purchase modestly configured, industrial quality IBM PC compatibles. Twelve relatively cheap Sharp PC-4602 laptop computers were supplied to each school. These had twin 720Kb floppy disc drives, and one computer in each set also had a 40 Mb hard disc.

One of the aims of the project was to increase staff IT literacy and competence by promoting cross-curricular use of IT. A second, crucial project-wide decision was made to employ a part-time resource assistant in each school who would be familiar with the machines and available in the classroom to assist staff and pupils when the computers were in use.

Decisions about the management of the computer resource were left to the individual schools and different patterns emerged, from their use in a room in the IT department of the school, to their availability as a bookable resource for both staff and pupils on request. One of the schools has purchased another 12 of these laptops using its own resources, getting a good bargain as the model was about to be superseded. The head commented that "getting the laptops was one of the best decisions we ever made".

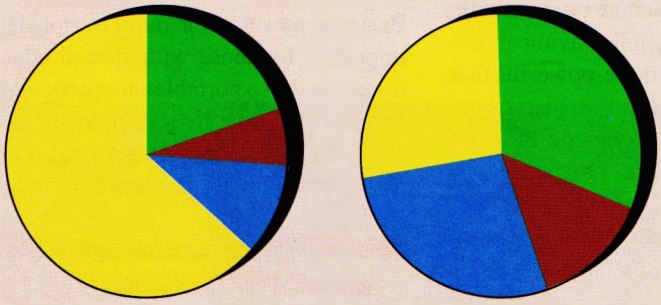
The laptops have a wide variety of uses ranging from databases in geography to Logo programming in maths. Older pupils are allowed to take the machines home, and many do so on a regular basis. There has been a substantial increase in staff IT literacy in all the schools, encouraged by some formal INSET plus the option of taking a machine home. The school at Llanidloes has surveyed staff and student competences using the RSA CLAIT criteria.

One of the schools has twenty pupils with special educational needs statements, of whom ten have access to a laptop computer explicitly on their statement. The machines are being used to help some pupils with poor coordination which affects their writing ability. The production of word-processed documents is seen as a way of increasing self-confidence in these pupils.

An overview of the impact of these machines across the three schools suggests that:

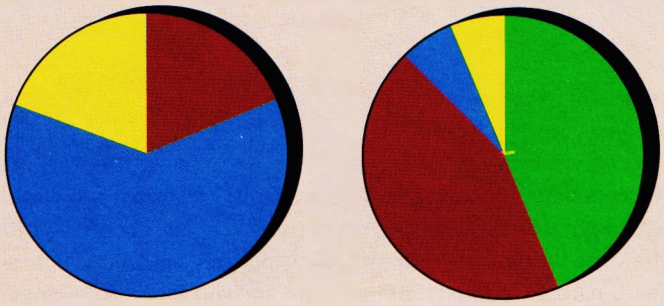
- the laptops are more popular than the network with the less frequent IT users
- there is no gender bias
- the laptops appear more popular with the younger children
- word processing is the dominant use although significant spreadsheet and database work is being carried out
- the laptops have significantly increased staff and pupil IT competence.

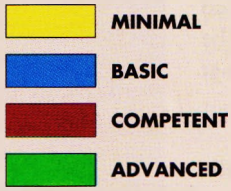
November 1990 May 1992



Staff skills in word processing

November 1990 May 1992





Pupil skills in word processing

including word processing, data collection during field work, and academic research.

The report indicated extensive use by their peer group, with 90% of the 52 lower-sixth students involved in school use, and 82% in home use. More than 50% had requested machines which were unavailable either through prior booking or machine failure.

Priority of access for use in school went to students who had little or no computer experience, were working in curriculum areas where they had not previously used computers, or for completing work already started. Access out of school was prioritised from Year 13 down to Year 10, followed by staff.

The students had discussed access and security issues and devised an automated booking system which enabled them to know the location of the machines. A maintenance log was built into the system and an evaluation scheme which requested users to respond before completing their activity.

Discussions with pupils from a variety of schools suggest that some pupils were motivated to produce their work on the machines because they liked the professional and tidy appearance of the finished product. This particularly applied to pupils who felt that their handwriting was poor or untidy.

Year 10 and 11 pupils and sixth formers preparing coursework often wanted to word-process GCSE and A level assignments and found the opportunity to work quietly at home an advantage. Less confident pupils enjoyed the privacy afforded by the portable computer which could be used in their own workspace, whether at school or home.

Attitudes to the acquisition of typing skills varied: some students who had home computers appeared very proficient, though their skills were self-taught and hence very individualised, whilst younger pupils needed to be allowed extra time to find their way round the keyboard. In general, students found that easy access to thesauruses and spell checkers was useful.

Parents, the home and the workplace

Most parents are enthusiastic about their children using new technology, realising the educational potential and advantages that it confers. Having trained the staff, and once the machines are into the classroom, a workshop for parents could be a useful opportunity to help them to develop their IT awareness, and to offer a forum where they can share any reservations or concerns that they may have about the introduction of portable computers into their home environment.

It is a good idea to try to anticipate some of the questions that might arise, such as those concerned with insurance cover, costs of recharging batteries at home, and the fact that it is normal for computers and chargers to become warm in use.

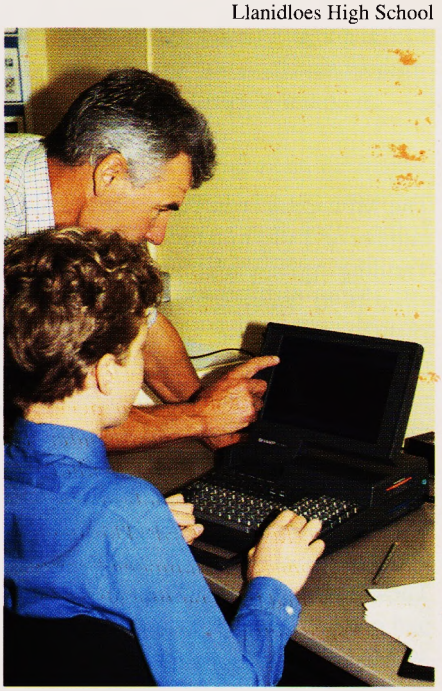
Schools have adopted various ways of dealing with the insurance situation: some use LEA insurance where available, take out whole-school insurance policies and maybe ask parents to provide a contribution, or investigate the scope of their home insurance policies.

The arrival of portable computers in the school is likely to generate some degree of parental purchasing in the same way that calculators did a decade ago. The diversification of machine types, and the possibility of some pupils having greater access to machines more powerful than are provided by the school, are issues that schools will need to be aware of as the price of portables comes down.

It is also likely that parents will begin to approach the school for advice on suitability of particular computers. Parents may want to make purchases that allow them shared use of this computing facility, where compatibility with their workplace is just as important as with school equipment.

The IT gulf between education, the home and the workplace is narrowing. Closer liaison with businesses and work experience placements for secondary school pupils will enable them to put their skills into practice. This will extend the partnership between the school, parents, pupils and local employers.

Llanidloes High School



Special needs tutoring

Special Needs

A more difficult area of parental advice is maintaining a clear perspective on broad-sweeping claims that spell checkers and computers are panaceas which will overcome dyslexia and other difficulties. Clearly some pupils do gain a great deal of confidence from IT. Staff need to be aware of which problems computers can assist with and how much benefit can be reasonably expected.

Bringing power to the pupil is especially important for those with special educational needs, so portables are particularly appropriate. But no less than in other areas, the acquisition of personal portables leads to other questions:

- How does the class teacher manage printing and connectivity?
- How is effectiveness measured?
- What training and support will the teachers need?
- How is the finance provided?

Sensory-impaired pupils need to work at their own pace. Very specific, and often individual, solutions are needed in terms of hardware and software. Assessments usually need to be carried out by experienced personnel.

A year 5 pupil in a suburban primary school has learning difficulties and his Statement of Special Needs provides for two hours' support teaching per day. He has recently begun to understand what reading is about and is beginning to write. His fine motor skills are poor and an inability to form recognisable letters has inhibited the development of writing skills.

One of the main stimulants for writing has been through his recent access to word processing on a BBC computer. He is now beginning to type individual letters rather than rely on whole-word entry from an overlay keyboard. This conceptual development has happened partly by being liberated from putting all his effort into forming letters.

There is one computer for every two classes in the school and it has been difficult to give him meaningful access without depriving the rest of the class. The approach the school has taken is to withdraw him from corporate activities such as assembly (which he enjoys) and his lunch break when the machines are free. This situation is unsatisfactory because it is beginning to isolate him socially and it stops him from writing during class activities other than whole class use. It is not giving him a strategy for coherent development – but there is no doubt that a personal portable would.

A profoundly deaf pupil at a mainstream comprehensive school is receiving help from the Special Needs Department and visits from the peripatetic teacher for the deaf. He has a radio aid. His written work shows many of the elements of delayed syntax common to hearing-impaired pupils. Most of his work has been drafted, talked through with the teacher and then rewritten.

With the pressure of GCSE project work at regular intervals, he has found this process too time consuming. In addition, redrafting has often introduced new mistakes, and his self-worth was being steadily undermined.

Following consultation with staff, he tried a Z88 computer to take notes in class which were then redrafted at home. Special access to a printer had to be arranged within the school. Print-outs were made before and after editing. As his confidence grew, so did the quality of his work. His first drafts still showed all the expected errors, but he began to realise that mistakes were not irrevocable and that he could easily correct them himself, producing a clean and tidy final copy. Without the computer, he could still have completed his course work, but the computer encouraged his independence and enabled him to become more positive about his own ability.

Working at home

The type of keyboard used by the visually impaired is important. Blind or partially sighted students are taught to touch type on industry-standard keyboards. Most portables, however, do not have standard keyboard layouts and often there are unusual function key combinations. This can lead to obvious confusion.

The quality of the screen is crucial, but this is an area where portables vary considerably. High-resolution LCD colour screens are still too expensive. Many of the cheaper monochrome models do not have back lighting and require the user to sit at the optimum viewing angle and away from strong sunlight but with sufficient diffuse room light. The latency of LCD screens makes the mouse pointer more difficult to find, although some systems can enlarge and enbolden it. Moveable windows with a zoom facility have clear advantages. Connection to a conventional external monitor may solve the display problem, but this renders the computer desk-bound.

With the physically handicapped, important hardware factors to consider include the weight of the machine, robustness, availability of keyguards, connection of external devices like switches, ease of opening and switching on (with possibly only one hand), unusual key press combinations. The availability of predictive typing and wordbanks are important for efficient text creation. Scanning software is also useful for acquiring printed text for incorporation with notes and other written work.

Whilst it is often clearer with physically handicapped students as to whether they would benefit or not from a portable computer, it is also more problematic in matching aids to needs. Specialist assessment needs to be sought which will involve a multi-disciplinary approach.

Whilst there has been little coordinated research to date, there is considerable anecdotal evidence from advisory and support teachers. They have no doubt that portables can give students with special needs the necessary support to enhance their learning potential.

Skills for Student Teachers

Initial teacher education has always been based on a close working partnership between schools and teacher training institutions. This partnership is designed to provide practical opportunities for students to gain experience of teaching in schools, together with knowledge of their chosen specialist subject and general education issues affecting teaching and learning.

ITE needs to prepare students for current practice in schools with particular emphasis on those schools where they might be placed for teaching experience. Students also need to be aware of developments taking place in education and the effect these might have on schools in the near future.

Every teacher training course must enable students to make effective use of IT in the classroom and provide a sound basis for their subsequent development in the field. All students must be trained to make confident use of IT in their subject and age specialism, to put into practice schemes of work involving the use of IT and be knowledgeable about how this changes the nature of teaching and learning.

As portables are being purchased by schools, students will need to be confident in their use and management, and aware of their potential as well as difficulties that may arise. Portables offer the opportunity to overcome one of the major problems that students face in developing their IT skills: access to IT resources. If a school has portables then students should be able to have the opportunity of using IT in their teaching, wherever that may be in the school. It is easier too, with portables, to provide students with access to computers to prepare and practise lessons for pupils.

Access to resources that can be deployed in a variety of situations allows students to explore different classroom organisation strategies for IT. At present, many students only experience IT in computer suites in secondary schools, or with a single machine on a trolley in primaries. Portables are providing opportunities to develop the use of IT in other forms, such as working in groups, or as independent learners, within and outside the school. Portability and compactness bring advantages in raising the rate of equipment utilisation. Having the opportunity to tackle technological ignorance in private is important too.

Another aspect of supporting students during their training is the communication of information between the student, school and ITE institution from the viewpoint of student, mentor and tutor. Records of achievement are often employed where a collaborative report is prepared: portables provide opportunities for sharing this information and entering regular updates.

A major task for students is planning and preparing lessons. The advent of word processing, desk-top publishing and high-quality laser printers has encouraged many students to produce very attractive materials. Portables support students in collecting and merging information from a variety of sources, including CD-ROMs. Even modest machines are useful, particularly when the data can be uploaded to powerful desk-top machines for page design:

> *"I used the laptop for planning and evaluating every lesson I taught, taking advantage of WordPerfect's style facility to create a standard format which could be downloaded at the start of each lesson plan. I used macros for standard phrases, document windows to switch between two open files, append to copy blocks from file to file, and comment boxes to remind me about things to be added to incomplete lesson plans."*

It is hardly surprising that the student who made the comment above intended to use the portables in the class with a focus on composition rather than mere presentation of text. If the teacher is confident

with IT, then the children will usually cope. The issue of teacher confidence seems crucial to the development of IT in schools, and this should be built from the outset of teacher training.

All students need to keep careful records, and traditionally these have been notes on paper in a loose-leaf file. Portables, particularly those with discs and hierarchical directories, are encouraging a more structured approach and better organisation of notes to form the basis of assignments.

Recent years have seen significant changes in the student population in higher education. Increasing numbers and flexible approaches have resulted in more mature students entering the profession. The evidence shows that these students are more likely to embrace IT than those who have not had work experience. This is useful since mature students often cannot work on a 9 to 5 basis and need to carry on with their studies at home, working around their other commitments. Portable computers, then, can reduce inequality of opportunity that mature students may suffer:

> *"I valued the portable nature of my laptop . . . since I was able to set it up in the warmth of my kitchen, and spread my papers around my large kitchen table – and remove everything quickly and easily at mealtimes. The laptop allowed me to draft my work directly on the screen."*

The increasing number and shift in the demography of the student population is having an effect on teaching and learning styles. There is a shift toward lecturing with large groups followed by tasks set for individual or small group study.

Portable computers can support institutions which seek more open, flexible and distance styles of learning whilst enabling better communication between student, partner school and ITE establishment.

PUTTING IT IN ITE
North Riding College, Scarborough

North Riding College at Scarborough bought 220 Tandy WP2 computers for its 1991 first-year primary student intake. The machines were used for both college-based work and also on teaching practice. The aims were to increase student familiarity with IT and word processing, to develop positive attitudes and therefore to encourage future use of IT. An evaluation of the effectiveness of the initiative was also an integral feature, and initial student attitudes to IT revealed that male students were more likely to be positive about its use (46% compared with 38% of female students). A higher proportion of science students were positive than were arts or humanities students – but science students were also more negative. Not surprisingly, students who had been employed were also more likely to feel positively about IT.

The WP2 had been modified to charge up nicad batteries internally, after the college had tackled the initial problem of charging 220 sets of 4 batteries. Students uploaded WP2 files in plain ASCII to an RM network of 5 Nimbus PC 386 stations with 300Mb of filestore and over 300 user directories. File transfer was via a cable and serial interface. WP2 files were imported into Microsoft Word for Windows on the network, formatted and then printed.

Student training, user documentation, and involvement of the college staff was encouraged via an IT newsletter and presentations. Many staff now require student assignments to be submitted in electronic form.

About 30 students took up the offer to purchase their WP2 at the end of the year at a competitive price and with finance options. The other machines have been redeployed in 1992 for classroom projects and short loans to students and staff.

University of Warwick

Library-based research

Across the Curriculum

Information Technology appears in many areas of the National Curriculum. Illustrative examples to the Statements of Attainment and Programmes of Study of many of the core and foundation subjects use IT as integral element. IT also has its own Attainment Target (AT) and Programme of Study (PoS) within the Technology document. Thus schools have a statutory requirement to provide pupils with frequent opportunities for experiencing and using IT in a broad range of curricular activities. Portables can increase these opportunities and at the same time, introduce new perspectives.

The PoS and Non-Statutory Guidance (NSG) for IT Capability emphasise the importance of IT as a cross-curricular dimension. The PoS state that *'pupils should develop information capabilities through a range of curriculum activities'*, while the NSG states that *'pupils should be able to use IT across the whole curriculum'*. Ideally IT will be taught and used through all appropriate areas of the curriculum to develop and enhance the learning experience of the pupil.

The most striking difference between a portable computer and a desk-top computer is the ease with which the former can accompany the pupil in a task. No longer does the pupil have to go to the computer to work with it – the pupil takes the computer to the work. Pupils can take the computer into the library or reading area to make notes, they can take the computer from one group to another to compare work or they can take the computer out of the classroom to wherever data is to be collected. Work developed in one area of the curriculum can be adapted and used in another area with a different scenario. Pupils can take the computers home to continue work begun at school. The ability of the portable computer to go to where the best use can be made of it represents a radical change in how one manages the use of these computers, and the full implications and effects of this change in emphasis have not yet been realised by teachers and educationalists. Pupils given every encouragement to relate their use of IT to its use in the outside world will consider the wider implications of what they are doing. Because it is relatively easy to use a portable computer in the course of everyday school activities, pupils should have more time to reflect on their use of IT, and form their own judgements on when the use of IT is appropriate.

Cross-curricular delivery of IT removes the focus of the experience from the teaching of IT skills *per se* to learning how to *apply* IT through a variety of curriculum settings. The convenient and unobtrusive nature of portables assists classroom integration. Portables do not dominate the workspace in the same way as desk-top computers and this preserves the ethos of the working area. This approach supports the development of transferable skills as the use of IT becomes focused on applications rather than on the hardware and software itself.

Developing transferable skills

The development of word-processing skills will be enhanced by increased familiarity if the facility is available, via portable computers, throughout the school timetable. This is also likely to encourage acceptance of the word processor as the appropriate writing tool for many tasks.

Compatibility of portables with the school network or desk-top computers is essential to extend and enhance some of the work that is carried out where pupils may ultimately feel the need for a larger screen, a different software package or the facility to merge several files prepared separately on a collection of portables.

Compatibility is also important to enable printed copies to be produced. Word-processed text can be imported into a desk-top publishing package to create a page layout. The style of the finished product is determined by the desired outcome.

Access to, and creation of, databases can be developed in a range of subject areas from geography to physical education. Interrogation and information handling skills will accumulate from one subject to another, and encourage the development of independent learning. Similar benefits will derive from the use of spreadsheets in mathematics and design and technology, simulations in history and science, and the use of data logging for information collection in science and geography.

It can be seen from the projects described that cross-curricular use is a developing theme, sometimes initiated by the staff and, particularly where larger loan collections are accessible to them, by the pupils. The cross-curricular delivery of IT is facilitated when:

- the machines can be used in the regular timetabled teaching space
- the use of computers in the normal teaching area gives access to other resources such as maps for geography, laboratory equipment in science or sports and gymnastics equipment in PE
- computers can be set up in rooms where there would not be space for a similar number of desk-top machines, and that space can be recovered for other uses when the computers are not needed
- pupils can continue their work at home
- the computers can be taken to the school library to be used to collect information from print sources or CD-ROM or make notes as required
- the portables can be taken out of the school for fieldwork.

Low-cost portables can be used to free more expensive desk-top machines for a wider variety of curriculum use. They can also be used in teaching areas not geared to mains electricity and be transported up stairs and between buildings.

The successful integration of portable computers in the curriculum will depend upon their easy availability and the perceived ownership of the resource. Some schools have clearly designated the portables as a whole-school resource by siting them in the school library and organising the loan system from this base; other schools have included the machines in the totality of the IT resources which are the responsibility of the IT coordinator. Both systems can work in practice and machines can be booked in advance for classroom use by teacher or pupil. Models for use in the school are discussed in the *Classroom Impact* section on page 27.

Cross-curricular IT

In order to make the details of attainment target 5 of the Technology document more accessible and digestible, the NSG has identified five aspects (or *strands*) of IT capability. These are:

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

This division into strands is designed to simplify the planning and implementation of IT, even though there is some overlap between the strands. The fifth strand, applications and effects, is best taught in combination with at least one other strand.

The integration of IT with the wider curriculum is best achieved by mapping the five strands into subject areas. There will be areas, such as art, that are more appropriately supported by desk-top machines particularly where the large colour screen is crucial. In other areas, the portability and small size of the portable are the deciding factor.

There are many publications available from NCET and other publishers that look at the use of information technology to support children's learning. The sections below highlight a few areas where portable computers can support children's learning and assist with the development of transferable IT skills by considering the five strands and giving illustrations where appropriate.

Developing ideas and communication

This strand is largely exemplified through word processing. For many teachers the main problems here are that it takes a long time for pupils to type meaningful quantities of text into a computer, whatever level they are working at, and the computer cannot be used by other pupils while this is happening. Some teachers see the purchase of significant numbers of low-cost portables to be used largely for text entry as one solution. It is possible to get more computers and thus more pupil access for a given amount of money.

Unfortunately, it is not as straightforward as this. The cheaper portables have such a small text window that 'real' word processing, involving fair quantities of text, cutting, pasting and merging, become very difficult. Importing and exporting text to and from other computers via cables is not always a simple task on cheaper portables; there are also likely to be file level incompatibilities too. Fully compatible portables with floppy discs, on the other hand, will allow the easy transfer of data, and with proper full-screen editing they offer other advantages over a desk-top machine.

Production of newspapers is becoming more commonplace with the increasing access to computer facilities. Primary schools may have a computer in the classroom. Most secondary schools have a network or cluster of machines at some point in the school. But access to portable computers brings the opportunity for a new approach. The information can be collected in the field with pupils out and about acting like journalists. For example, a group of pupils produced a newssheet during a ferry crossing to recount their journey vividly to the children that they were visiting abroad and to pupils in their own school upon their return. This exercise in creative writing captured the atmosphere of the journey in poetry and prose in a way that would have been difficult to produce from rough notes or memory.

During a geography lesson, a group of primary school pupils were investigating their journey to the local swimming pool and used a portable word processor to describe the places and buildings that

CLASSROOM SETS
The PLAIT project, Northern Ireland

The PLAIT project (Pupils' Learning and Access to Information Technology) was launched in November 1991 and ran until June 1992. It was commissioned by the Department of Education for Northern Ireland and the work was carried out by the Queen's University of Belfast.

It is a carefully designed piece of research, backed up by detailed statistical analysis, to evaluate the educational potential of portables, their capabilities, suitability for schools and relevance to the Northern Ireland Curriculum. Nine schools around the province were involved in PLAIT, with about 250 pupils with machines of their own; a similar number of pupils without portables were used as matched control groups within these schools.

The study focused on the IT requirements in the core subjects of mathematics, science and English. Machines used in the project were the Apple PowerBook 100, Research Machines NB200, Tandy WP2 and Toshiba T1000SE. The IBM PC compatible machines ran Microsoft Works; Claris Works was used on the Apple PowerBooks; the Tandy portables have their own applications software built in. All these provided an integrated user environment with word processor, database and spreadsheet programs. In planning the project, an analysis of curriculum requirements revealed that access to integrated software not only provided the facilities needed to achieve Curriculum targets, but also offered additional benefits through integrating data from a variety of cross-curricular sources.

Other research questions included the implications for teaching and learning styles, teacher education, and the effect on pupils' (and in particular, girls') attitudes to computer technology.

The study combined methods of enquiry such as observation, questionnaires and interviews with internal school-based action research. In support of the qualitative observations there was some pre- and post-testing of the pupils, with and without the laptops, to look at their general reasoning and the three core subjects. With a particular exception in science, reasoning tests which were administered over the relatively short period of one school year did not show any statistically significant gain in scores. The research found that a high level of access to IT enhances the learning of the more able pupils. The less able enjoyed success with word processors, although they experienced some difficulty with databases and spreadsheets. Pupils with physical learning difficulties showed particular gains in self-esteem, motivation and quality of work.

Building up teachers' IT literacy is a prerequisite for innovation in their teaching methods. Clearly focused INSET combined with ample access to IT resources, does much to help the planning and preparation of IT-related classwork.

A report on the project, Portable computers in the curriculum: The PLAIT research project, was published by NCET in 1993.

they passed. Back in the classroom, in discussion with their teacher, they used a large scale map to help them identify the places and buildings en route. The text was then retrieved and the sequence cut and pasted to match. Here, access to IT supported an investigation, a key approach in the geography National Curriculum.

Handling information

When using a desk-top machine for handling data the pupils will often have no choice but to gather data in one place and then go to the computer room to enter the data. Whilst this can lead to good design of data-collection sheets, it can also lead to unnecessary duplication and to potential errors. With a portable computer, and a database or spreadsheet designed in advance, data can be entered directly the application program wherever it is collected: during an interview, a science experiment, a field trip, on the playing field. It might be possible to analyse data as it is being collected and to modify or refine what is being sought in the light of an instant analysis. This approach could represent a significant advance in the application of IT to problem-solving.

Commercial databases including census data for history, global statistics for geography, information on mammals or space travel for science, can be incorporated into wider classroom work to offer differentiated learning experiences, if available on a portable computer.

In history, pupils starting on database work with a portable can use data collected from peer groups or their families to build up information-handling skills and develop historical enquiry. Information from primary sources, such as a gravestone survey, can be entered directly into a database enabling pupils to construct queries and begin to look for patterns to inform further enquiry. The incorporation of their results into a word-processed document enables pupils to produce attractive pieces of written work integrating graphical presentation of data. The choice of software package and the style of the final presentation can be selected to broaden and complement pupils' other writing experiences.

The use of IT in physical education has only been investigated relatively recently in many schools. One of the inhibiting factors has been the lack of computer equipment and mains power in the gymnasium or on the sports field. Portables open up new cross-curricular possibilities, including the theme of health education. Spreadsheets and databases can be used to store sporting records, to collect and analyse performance, both routinely and also on school sports days.

As a means of monitoring and assessing fitness, a database created from information collected in the gymnasium can en-

Photo courtesy of Toshiba Ltd

On the sports track

courage pupils to begin to think about themselves and their performance. Information can be collected about body dimensions, body composition, joint mobility, aerobic capacity and other factors. Performance at tasks and exercises can be recorded. The interrogation of the database and interpretation of the results can be used to encourage pupils to reflect on their lifestyles and establish routines to improve their fitness and health.

Pupils can use their developing database skills to collect information in the locality, including clubs, leisure centres and public transport timetables with details of times, places and cost. This local information database could be regularly updated as a school resource.

Modelling

Programs which model real or imaginary situations often require the full facilities of desk-top machines such as large memory, colour and graphics. But portables are the answer on field trips for modelling work outside school. It is the ability to take the computer to the investigation which represents the educational advantage of the portable over desk-tops.

A group of primary children took a portable computer on a residential visit to Wales. The children collected information from the local farmer about his crops and why he selected them. They asked a whole range of questions and recorded the answers in a spreadsheet. On returning to their school in Lincolnshire they made the same enquiries locally and treated the information in the same way.

The children then went on to use the spreadsheet to investigate crop rotation, the possibility of alternative crops and, at a later date, the effect of the weather on crop production. Using a spreadsheet enabled a whole series of 'what if. . .?' questions to be posed.

A spreadsheet was also used in an advanced chemistry class to teach the equilibrium law. The experiment used various mixtures of ester, water and acid catalyst. Each student prepared a mixture and analysed it and complex calculations were carried out using a spreadsheet. The spreadsheet enabled the students to carry out calculations whilst the experiment progressed, and to extrapolate their results for different conditions.

Measurement and control

Portable computers have a role to play in the automatic capture of data from sensors. Often it is not practical – or even possible – to locate a desk-top computer near the source of the data.

Too often in science lessons, collection of data is the overriding concern of many pupils, and understanding what is happening in front of them can become a secondary issue. The ability to log and plot data on the laboratory bench provides instant feedback and enables conditions to be changed meaningfully as the experiment is progressing. Concentration is focused on exploring the system rather than on data collection.

Data collection in the high street

ONE YEAR'S EXPERIENCE
Hertfordshire & Cleveland

A project in 1988–9 was centred on two groups of pupils, all with Cambridge Z88 computers: a class of 22, mixed ability, first-year entrants in Bedwell School, a comprehensive in Hertfordshire, and four individuals from fourth year to upper sixth in different schools in Cleveland.

The Cleveland pupils had all had up to three years prior computing experience because they had writing difficulties: one following a badly broken wrist, one following paralysis in a swimming accident, and two who had fine motor difficulties associated with cerebral palsy. These pupils used the computers routinely in school every day as personal word processors. They got on well with the machines, regarding the portable as a friend that helped overcome their difficulties: *"Rechargeables. I've three sets... one in the machine... one in my pocket... and one at home on charge... I've always got two sets ready... They last well... with a heavy work load two or three days"; "I've got fond of this now. It's took us a long time to get used to it but I understand about everything now"; "I love them, I really do."* They all mastered the technology to the extent that it was transparent to them.

Bedwell School emphasised writing, particularly in English, maths and science lessons. The pupils were responsible for recharging the batteries and, as far as possible, ensuring the accessibility and maintenance of the computers. The pupil comments indicated that repeated loss of work with the Z88 was commonplace: *"It's not us, it's the computer"; "It gets on your nerves when you keep losing work"; "You have to keep charging batteries up and then sometimes they just go out straight away"; "I lost everything twice in one day once"; "Everyone in the class has lost stuff. But it's better now."*

Handwriting remained popular for the production of relatively short peices of work with those pupils who had a choice. It was suggested that this might alter as pupils become more proficient at entering text via a keyboard. Editing was not always done efficiently, though this skill may develop in time. Pupils were convinced that they wrote more when using a word processor and the available quantitative evidence suggested that the children's writing had improved.

The head of English at Bedwell commented: *"If I could wave a magic wand over the whole project, leaving apart the whole school curriculum issues and so on, first and foremost it would be to get a machine with a really simple user interface, real reliability and a big screen."*

This account draws on recent interviews at Bedwell and a published paper which was based on pupil assessments made after two full school terms: Peacock M and Breese C (1990), Pupils with Portable Writing Machines, *Educational Review* (42) 1.

In a science laboratory, pupils investigated simple harmonic motion with a pendulum, and then moved on to look at the effect of changing amplitudes and damping. Initial work to measure the period of a simple pendulum can be done using a position sensor and examining a graph drawn in real time on the computer screen. Extended activities could include plotting the time period for any initial amplitude.

A portable computer used as part of the apparatus offers pupils the means to observe and measure a range of responses and the effect of changing system variables, such as pendulum mass and dampers.

Fully weather-proofed machines are available (at a price) for outside use, but ordinary portables can, with care and an eye to the weather, be used outdoors. This opens up whole new areas to apply IT in technology, science and geography.

Applications and effects

Pupils must be given every encouragement to relate their use of IT to its use in the outside world, and to consider the wider implications of what they are doing and learning through IT.

Because it is relatively easier to use a portable computer in the course of everyday activities, pupils should have greater opportunities to reflect on their use of information technology, to consider when the use of IT is appropriate, to consider the consequences of using IT, and to choose when not to use IT.

As part of a rapidly developing technology, portable computers are enabling new ways of working in a wide range of areas. These include, for example, data collection from gas and electricity meters, and instore stocktaking in supermarkets. It is possible with many of the new computer systems to set up a link with the business network to collect information or update files from remote areas. Market researchers using portable computers are using increasingly sophisticated questionnaires which route the researcher through prearranged pathways depending on responses; modem links then facilitate the rapid assimilation of the information and speedier publication of results.

The collection of case study notes by social workers, and transport of business or military information for display at meetings is now commonplace. Work that has been started out of the office can be continued on return and conversely, office work can easily be continued at home.

The effects of this personal, business and military information being transported on public transport or in private cars could have considerable repercussions if the computer were lost or mislaid, and security which is necessary in all computer systems takes on a different perspective when using a portable machine.

Primary Lessons

The query "Miss, please Miss, is this alright?" is regularly heard in primary classrooms. The child asking it may well be standing by his or her teacher, holding up a pie-chart of favourite foods, today's weather report, a logo pattern, or a poem about a dinosaur – except that today, it could well be on the screen of a portable computer.

This scenario is not common in primary schools as yet, but it is not that far off. Microcomputers in schools are themselves only a recent phenomenon, portables are only just beginning to appear, and very few of those are reaching the primary classrooms. Those that do appear tend to be used predominantly with key stage 2 children rather than key stage 1.

However, on a national scale there are some projects investigating the educational potential of portables, and a very small number of primary schools have themselves taken the plunge. Hence the overall picture is rather patchy and anecdotal, though evidence and reports are steadily accumulating which indicate that portables already need careful consideration as a powerful IT resource within the primary curriculum.

It perhaps ought to be reiterated that the introduction of *portable computers* into the classroom has precisely those two important effects: one is the increased access to IT in general terms that the extra systems bring, and the other is that of the portability itself (and not just for multi-storey schools or mobile huts). In some respects, these two aspects are not always easy to disentangle from each other.

Communicating Information

In terms of the primary curriculum, the major use of desk-top micros is word processing and, for the time being, the introduction of portable micros is doing nothing to change that picture. Indeed some portables, such as the Tandy WP2, are produced mainly as word-processing systems. The injection of extra hardware clearly improves the ratio of micros to pupils, and with it the amount of time pupils can have at the keyboard. How this is used to advantage will depend on the skills and imagination of the teacher. At the very least, it will mean more pupils will gain greater experience of computers and keyboarding skills at an earlier stage. Moreover, in terms of both English and the communicating information strand of IT capability, it would mean that more children would be able to explore, experiment with and experience for themselves the nature of text in its electronic form.

Clearly more micros means more opportunities for more children to be involved with writing for a variety of purposes and audiences. More children can be closely involved with making stories for their younger peers, or jointly preparing alphabet books: '*Greedy George the Giraffe gratefully gobbles green grass in great gulps*'. Reception children can use them to write for their own private purposes, to explore characters and text, perhaps before they can form letters themselves. They might even incorporate portables into their role play, taking them into their 'office' to write their messages and reports.

"I like the long stories you get 'cos they go on the wall," said Sarah.

"And the weather reports", added Jo. "When you make a mistake on the computer, you don't need to go and get a rubber from a table. You just need to press a button and it will go away."

Older children have worked in larger groupings, across schools even, each writing a chapter of a mammoth story, or different versions of the same story. Groups of children have also co-operated in producing their own nursery rhyme books, recipe books to sell for charity, and of course school newspapers, where the individual articles have been transferred to a desk-top publishing package for final editing and page layout. Indeed,

WORD PROCESSING FOR PRIMARY PUPILS

The SCET Laptop Project, Stranraer

This project was set up in 1989 by the Scottish Council for Educational Technology to investigate the claims that were being made for word processing as an aid to writing in schools. It focused on a composite year 5/6 class of twenty-four children in a small primary school with a teaching head and three staff. The project was designed to run from summer 1989 to April 1991. The school was equipped with 30 Tandy 102 computers which had been modified by the manufacturer for recharging their internal nicad batteries whilst running from an external power source.

The aim of the project was to examine the consequences of universal access through the provision of computers to a whole class, and to look at what evidence could be found for improvements in writing if word processing was constantly available. An initial questionnaire disclosed that eleven children already had a computer at home for games and writing.

A good deal of planning and preparation went into this project which received support from LEA advisers and guidance from a project steering committee. The LEA centre also assisted the school by dealing with equipment repairs, cabling problems and so forth. There were few technical problems besides minor trouble with power supply sockets which was soon fixed by the manufacturer. The LEA devised staff INSET and also pupil/parent training using a progressive series of exercises which built up written materials on Robert the Bruce. The machines were introduced in December 1989 and the computers were taken home during the Christmas break. Most pupils completed the induction programme at home without further assistance.

There was freedom to choose the medium in which to produce their written work across most of the curriculum. It became an established pattern that all pupils voluntarily chose to use the computer as the main medium for writing. Initially, trading slow typing for speed of amendment, pupils began to generate more text than previously and after a few months material was being produced more quickly than handwriting. Another school commented that "it was impossible to keep up with the stream of communications which was emanating from St Joseph's." The use of the computers was integrated with classroom work, field trips (for example to the docks, police station and local newspaper offices) and tasks at home. Pupils continued to collaborate for planning and writing tasks and a number of children organised themselves to produce an extended piece of writing in the form of a novel. Pupil motivation was high throughout the duration of the project.

The portables could be linked to a desktop PC compatible with a hard disc. There were also five floppy disc drives for the portables, and five dot-matrix printers. The practice that evolved, however, was to carry the computer to a printer to make hard copy. Three printers in the classroom proved sufficient. File transfer to the PC and making copies of files on floppy disc did not really develop, partly because of the temporal nature of pupils' work.

The project had some unique electronics: a one-way data network, built by SCET, which enabled a teacher file to be loaded into all the children's computers simultaneously. This eliminated some of the file management problems associated with computers which lack floppy discs. Also, rather than have large numbers of mains sockets and adaptors near pupil work areas, SCET installed one large, wall mounted, low-voltage power supply unit and distributed low-voltage feeds to pupil desk clusters (together with the data feeds) via ceiling trunking and descending curly cables.

Folios were kept of children's work with particularly detailed records being kept for a core group of children. Changes in technical accuracy and length of script were noted. Alongside these folios, the class teacher maintained a class log which recorded her thoughts and observations. At the end of the initial phase it was established that pupils wrote more, and at higher speeds. There was evidence of some improvement in technical accuracy such as spelling, punctuation and grammar. An appreciation also developed among some of the pupils that the same text could be manipulated and reworked for different audiences.

the complementary technologies of portables and desk-tops have a very powerful role in combining individual or small group work and transforming that work into another format for a common purpose.

Another advantage of having more systems in the classroom is the opportunity for what one teacher called *burst writing*, that is encouraging children to get things down at that very moment when they are bursting to write, without feeling the compulsion of concentrating on presentation. With computers, there is the added bonus of saving the work for later additions and alterations.

Above all, the advantage of using portable computers is that you are not so restricted to time and place. Pupils can go out and write their reports or ideas in the library or elsewhere. Where acceptable, pupils could go round the school with their prepared questionnaire already loaded into the portable and enter the answers from children or staff there and then. The data can be analysed and displayed later. One group of Year 2 children took their portables into the hall at Christmas time to write at first hand about the Christmas tree there decked out in all its colourful trimmings. Another small group of Year 3 children were taken on the bus to look at the oldest building in the centre of their city and the new swimming pool nearby; they jotted down their immediate thoughts and reactions, which were edited and printed off later. Both teachers thought that the standard of work was better than expected.

Creative writing on location

On another occasion, some Year 5 children even took their Tandy WP2s camping on Mersey Island. Again, the teacher with them felt that the quality of their work was very high. The children seemed well motivated to observe and listen closely to what was going on. (Indeed, one problem was that they tended to carry on writing and redrafting so much that the machines ran out of memory.) This group now plan to take the portables with them to France in the summer!

a christmas tree has got bollbolls on it. on the top thar is a dove and at the bottom you have presants. when you are in bed santer puts the presants on the floor

soraya

my chistman tree had a fereay on the top and some chroklut and a brscit with frfury christman and some crkols on it and it had some christman feaing

Sarah

Examples of early years work on Christmas

One way in which many, though not all, portables differ from many of the earlier microcomputers in primary classrooms lies in their extra power. They can be faster, with more memory and therefore run more powerful software. One example is the increasing availability of spellcheckers and thesauruses as part of a built-in word processor. For some reason, stand-alone spellcheckers do not seem to have made much of an impact on schools to date. Style and grammar checkers are on their way too in the more powerful machines. It should be quite evident, however, that they do not *teach* spelling, grammar or new vocabulary. They may offer reminders or allow children to investigate the rules by which the systems operate, thereby extending knowledge about language. But it should be noted that these features are extremely new, and to what extent or in what way they have educational value has yet to be clearly established.

In the case of most spellcheckers currently available, unnecessary repetitions or words correctly spelt but syntactically wrong are not picked up, for example: *we liked there nice hats*; or *were are you going?* Children may have to choose from a list of five or fifty suggested alternatives, for words the program does not recognise. But often there is little help for children's common mistakes, e.g. *hoo* might not offer *who*, or *tae* for *tea* or *cach* for *catch*. Attempts such as *desadid* and *instrukshuns* came up with no suggested alternatives for one seven-year-old girl, which she found very frustrating.

Of course, the spellcheckers and thesauruses themselves vary in their range and complexity. They are often based on American usage and aimed at adults too, but in general you seem to get what you pay for, with the most expensive being the most useful. Anecdotal evidence indicates that children may quite happily accept the non-judgemental nature of the portable's 'suggested alternatives', and

the more able children can capitalise on the synonyms offered. However, more research is needed to show if or how these features could enhance children's writing.

There is nothing new to primary children, especially the younger ones, about making good educational use of concrete, immediate experiences. What is important is the extra, additional potential that portables offer in harnessing the motivation and power of IT to such learning activities.

However, teachers will need to have IT skills too, in order to teach IT capability. For example, children often seem unaware of the advantages of word processing and that they do not have to concentrate on producing the appropriate form and style of language at the first attempt. The notion of note-taking, brainstorming, jotting down thoughts, ideas or experiences for later revision and redrafting requires specific input from teachers. There is much more to word processing than just keyboard skills and copy typing.

Obviously, word processing ability plays an important part in a child's learning, and within a school policy it may be a valid reason on its own for using portables in a cross-curricular way. However, this does not cover all aspects of IT capability and one must consider the provision of other generic software tools like databases too. It is in areas such as handling information, for example, that portable computers really come into their own.

Handling information

As part of a project on Ourselves in a class of Year 1/2 children, one activity involved working in four smallish groups, measuring and weighing themselves and entering the information into a database that had been designed with them. The files were subsequently merged by the teacher and the full version returned to the groups for them to search and explore. The immediacy of the results made a significant contribution to their motivation and understanding.

Taking portables to the edge of the playground or to a busy street (with appropriate supervision) for a traffic census also becomes a very effective practical learning activity. A group of Year 5 children put the information into the database they had set up and were able to see almost instantaneously the effect that one more lorry had to their statistics and the graphical representation. Indeed, at one stage they were concentrating so much on the graphs that they almost missed more traffic passing by!

In a Year 2 class, four children were grouped round a notebook computer, entering the final data for that week's weather, using Clipboard, a database program. They then produced charts and graphs to compare the current week's weather with the last, which they presented to the rest of the class at the end of that morning session. Again, what was striking was the children's confidence in placing the computer where they wanted to work, the enthusiasm for their task, then moving it back to connect a printer, managing the whole activity for themselves quite competently and independently. Even during the presentation of their results to their peers they displayed the graphs they had printed out and demonstrated how these actually appeared on the screen, as if to convince their peers that screen and paper versions were in effect the same.

Similarly, groups working on several portables in the same Year 5 class were engaged in building their own decision trees (using Idelta, a hierarchical database) to identify individual shapes from the class set. At the end of the activity they were able to compare and contrast results, and gain a deeper understanding of the importance of asking effective questions. This is a skill which needs active encouragement. As an inspector put it: "How do you know what a silly question is until you've asked it and got a silly answer?"

Other curricular uses

Control, sensors and data logging could also become far more prevalent with the introduction of interfaces for portable computers. Taking a portable to the fairground model in the hall, or to the sports field, or measuring the outside temperature during the day have obvious advantages.

Some portables can already run a variety of software, including Logo. The opportunities for learning when three or more groups of children can work together and share their ideas and findings and then build on their joint discoveries is remarkable. A Year 5 teacher felt that this activity using IBM PC compatible notebooks enabled her to develop what the children had already done but take them much further and quicker than with just the one desk-top computer they had before.

For early learning skills, the lack of a colour screen will be an important issue for the immediate future. Colour and shape matching, or seriation and discrimination programs, for example, may be difficult to use if not impossible. Adventure programs, and framework programs such as Collage or My World are also almost ineffective. Graphics programs are generally out of place, although some do have features for symmetry and repeated patterns, where the enforced monochrome restriction may occasionally offer a useful exercise. One key stage 2 teacher printed out a colour key for her class to show how the various shades on the screen would appear when printed from their portables, but felt that the results were not very successful.

Sound is another feature that is often missing from portables, so music software is currently not viable. However, this does not prevent nearly all of them from having the ubiquitous beep, warning you that the batteries are getting low.

Home and school

There is some evidence beginning to appear of changes in attitude when children are allowed to take their computers home. On the one hand, parents tend to show a greater interest in their children's activities. This may be partly because the children are no longer seen as using computers just for games, but also partly because they themselves begin to appreciate some of the advantages of IT (if they were not already aware of them), which the children are starting to utilise and benefit from. For the children, there is a further blurring of the distinction between home and school work, and the ever-increasing awareness, particularly, that work done at home is valued.

Classroom Impact

The focus of this section is teachers' classroom management of their students' learning, looking at a number of contrasting models of classroom use of portable computers.

The management dimensions of a classroom in which all the students have their own low-cost word processor are totally different from those of one in which two high-specification notebooks are being shared by a handful of students engaged in a science experiment, although the total hardware costs might be similar.

Portability, versatility, quantity available and degree of access to the machines are all important factors constraining use. Control of the machines, for all practical purposes, may be vested in the pupils, the teaching staff, a department or the institution. The teacher's motivation in using portable computers may have varied causes, including a desire to:

- take advantage of the mobility of the machines
- increase the number of students with easy access to IT
- broaden the range of uses of IT for students.

Possible benefits to the teacher could include increased familiarity with IT and convenience of lesson preparation.

Mobility

It may seem a paradox to include a heading on mobility in a report on portables, yet in the business world there are instances of such computers never leaving their owners' desks. The ability to remove the computer from the top of the cluttered desk and put it away in a drawer, for example, may be the sole portability requirement. Equally, many business portables are purchased so that they can be used at the office and at home, rather than in transit between the two. Portability is most truly exercised in the area of selling, where it is not felt inappropriate or embarrassing to open a briefcase and pull out a notebook computer to produce a complex quotation.

Many educational institutions have purchased portables for reasons other than mobility. Nevertheless, the ability to move the portable computer safely and easily around the classroom, within the school, into the high street, sports field, and to the student's or teacher's home, is one of the key factors that engages the enthusiasm of teacher and student alike, and is a key to both improved access and increased range of use.

Access

There is an argument that says increased mobility leads to increased access for students. At the simplest level, the fact that a portable computer can be moved safely from room to room within a school means that it will get more use than its desk-top equivalent. Experience suggests that when a computer is fixed in someone else's resource area, it is likely to be used for a portion of the teaching day and technically 'available' for others to use at other times. In practice, the need to arrange room swaps, or to push trolleys around the school, limits the amount of take-up.

There has also been concern among some teachers about the risk of damage to hardware or themselves, particularly where stairs or the outdoors makes the trip with a trolley hazardous. Portables circumvent this problem neatly – although they need to be complemented by equally portable printers to solve the problem completely. Equally, in crowded classrooms, the small size of portable computers is an added advantage in that they take up less space.

Access is not exclusively about getting computers into the same rooms as the students. Even when computers are read-

ily available in the classroom, some students are more confident and determined to use them than others. If one of the teacher's major classroom management functions is to ensure sufficient exposure to IT in a curriculum context, then being able to move the computer to the student rather than encouraging the student to move towards the computer has significant advantages. The teacher's intention to equalise opportunity for contact with IT equipment cannot so easily be disrupted by a handful of highly motivated students employing the finer techniques of competitive queuing, for example.

Not only is it easier to guarantee access to the hardware for those students who are inclined to hold back, the small size of portables and the lack of clutter can make them altogether much less intimidating machines. Indeed, early years children have been known to take the portable computer to the teacher much as they would have done an exercise book, and some assume that such small machines must have been designed with them in mind. Equally, the more private nature of their use – with compact screens that can often only be clearly read at the ideal viewing angle – reduces the fear of public embarrassment for inexperienced users.

Portability beyond the four walls of the classroom opens up further horizons of computer use. The sight of a group of infants with their own portables writing a description of the spring flowers actually sitting beside the garden they planted, or of an older pupil taking a loan portable home on the bus to complete coursework, begins to hint at the huge potential these machines have for extending the opportunities for the purposeful use of IT.

MODELS OF CLASSROOM USE

Issues associated with the curriculum use of portable computers have been highlighted in preceding sections. The discussion below puts forward three models of classroom use, all drawn from current practice:

- one portable computer in the classroom
- small numbers of portables
- one computer per student.

One portable in the classroom

Some educational institutions have bought single portable computers for classroom use – perhaps as a trial with a view to purchasing more. In many respects, the management of a classroom in which there is a single portable is not very different from the management of a classroom in which there is a single desk-top or trolley-bound computer. Indeed, if the portable is an industry-standard model with the facility for running an external colour monitor so that it can be used for whole-class demonstrations, there is little to distinguish the two. All that the desk-top computer can do, the portable can do too. However, the portable extends the range of opportunity, because it can be used in a wider variety of ways.

Whole-class demonstrations aside, the fundamental impact on classroom management is that use of computers will usually involve individuals or small groups at the most. So the teacher must have the ability to handle several simultaneous activities in the classroom.

This means that activities are planned so that they are more or less free-standing and do not require frequent teacher input to run successfully. The teacher's role can productively be that of trouble-shooter, and occasional planned intervention can take place so long as it does not tie up the whole of the teacher's concentration and attention for too long at a time. Otherwise, at the least, some students are likely to be kept waiting unproductively to obtain the teacher's help while, at the worst, large numbers of students may be off-task and unchallenged for considerable periods of time.

Many teachers are perfectly comfortable with various concurrent activities taking place in the classroom – indeed there are many for whom this is the norm. In general, though, these teachers are thoroughly conversant with all aspects of the work they have set, have prepared instructions with great care, and they feel confident to handle anything they have not already anticipated going wrong.

Given the extra scope for complications with unfamiliar equipment, new software, or malevolent machines, teachers are well advised to spend time using the computer and working through the exercises or activities themselves – until they reach the same level of confidence they feel with their other teaching resources – before putting the computer into classroom use. The great advantage of portables in this respect is that they encourage and enable teachers to do their preparation for classroom computer use in their normal place for such work – be it in the classroom, the staff room or at home.

One unique feature of the portable further complicates lesson management, in that the portable may well not be inside the classroom, but elsewhere in the building with a student group. Provided that this is an accepted practice within institutional policies and norms then this need not become a problem.

However, in some instances, the arrival of a portable computer may force into the open assumptions which have been made (and never previously tested) about what is acceptable behaviour. Aspects of safety will also need to be considered, for both computers and students. As highlighted earlier, the fact that students can often work with portables at their normal desks may offer advantages over desk-top machines for technophobic students.

There is no doubt that increased privacy in operation and the smaller physical size of portables, when added to the sense that they are machines adults use in business, can help with motivation. The countervailing point to this, though, is that a smaller screen and more critical viewing angle can make it more difficult for pairs or groups of students to work together at a single machine.

Among the most exciting possibilities is that of integrating the use of the portable with other technologies. In one residential special school, pupils used a portable computer to create the text of a fax which was then transmitted to a local library, requesting that the librarian carry out a search on CD-ROM on the pupils' behalf and fax a reply to them. This work was done by pupils who would not normally have found composing a written request an easy proposition, and the portable's built-in thesaurus and spell-checker were valuable aids to composition.

Small numbers of portables

Some institutions hold a central collection of portable computers which can be booked as a classroom resource. This represents a halfway house between putting one permanently in a classroom, at one end of the scale, and issuing one permanently to a student, at the other. Few schools are likely to be able to afford to adopt this latter approach in the immediate future, so the 'bookable resource' model is perhaps one which will become widespread as the number of portable computers in schools increases.

Advantages to teachers include the opportunity to gain access to an increased number of machines for a particular preplanned curriculum task and the ability to integrate their use within their normal classroom practice without the need to move all or part of their teaching group to a specialist area or network facility.

A teacher managing a classroom containing, say, six portable computers is likely to face group-work activity such as:

- six groups using one computer each – an example would be the collection of statistical data from within the group itself about height, weight, size of family etc. in health related fitness, and the subsequent charting of that data within a spreadsheet package
- six individuals using the available portable computers while the remainder of the class do other work.

The social aspects of group working are desirable and, it is widely held, educationally beneficial so long as groups do not become uncomfortably large in number. Careful thought needs to be given as to how the availability of the portables will be governed and how activities will dovetail. Students who are not using the portables feel like second-class citizens and become a source of annoyance as a result. Teachers will need to take care that the non-computing work is just as intrinsically motivating.

On the surface, it might seem to be a simple enough matter for the teacher to send the students with the portable computers into another part of the school environment, and teach a class lesson at the same time. However, this might result in some students missing vital work, and planning needs to take account of this. Sixth-form and further education colleges face similar problems when students need to word-process their assignments, were it not for the fact that they usually have timetables which allow them to access computer resources.

To summarise: for most practical purposes, the teacher's ability to lay hands on half a dozen portable computers compounds potential classroom management problems. In those classrooms where well-structured group work is normal practice, however, there is little about the nature of portable computers *per se* to generate complications.

Provided that technology management procedures (for batteries etc.) are well-established, computer-focused group work should run as smoothly as other kinds of group work when carefully planned and administered by the teacher. Support in the form of another adult in the classroom is especially desirable in the early stages of the introducing portables and the classroom management problems are then substantially simplified.

One computer per pupil

Not every technological advance means an advance in learning – thirty children sitting at thirty desks working at thirty 'electronic slates' is no way forward. To quote David Chandler: 'The microcomputer is a tool of awesome potency which is making it possible for educational practice to take a giant leap backwards into the nineteenth century.'

Of the three styles of use under consideration, this is the one which has been the model for most research projects. There have been a number of projects in which education establishments – usually, but not exclusively, secondary schools – have received funding to provide a 'portable computer rich' environment for students.

In some cases, the portable computers have been sophisticated notebooks while in others they have been humbler, low-cost word-processors with very limited file storage in RAM. It has been common for projects to supply each student in one particular class the same model of portable computer on permanent loan, which more or less eradicates non-technical classroom management problems.

This simplification of the classroom management aspect is potentially liberating, but carries with it the risk that portable computers might be used inappropriately just because they are easily available. It is unrealistic to expect schools to procure and deploy portables a class at a time, creating privileged groups. In practice, their introduction will be more gradual with a variety of models purchased over time by the institution, and others by parents and pupils, leading to a technological mix.

Collaborative work in the one-per-student scenario carries with it some associated difficulties concerning ownership of ideas – a version, if you will, of intellectual copyright. In an extreme case, a group of students could create independent notes towards an essay, share them electronically with one another and then go on to create marginally different final drafts using cut and paste techniques.

Socially and technologically this may be most desirable, but more than in the case of its handwritten equivalent, the question 'whose work is the finished product?' is thrown into relief.

Source material can also be obtained from CD-ROM and other electronic publishing media, last year's pupils' essays and so on. From the point of view of a coursework moderator, the problems of determining authorship far outstrip any concerns with the propriety of making use of an electronic spell-checker or thesaurus.

Against this must be set all of the advantages to students of using IT for their own learning: increased access to the curriculum, and development of a real sense of ownership of their work. Easy access to portables will also extend the opportunities pupils have to continue schoolwork at home and gain familiarity with software. Above all, pupils are more likely to develop confidence and competence in using IT.

Managing the Technology

A grasp of the technical issues, careful planning and well designed procedures will smooth the installation, day-to-day operation and maintenance of portables.

FILE MANAGEMENT

Important classroom management issues pertain to pupil files. There are two basic approaches: one computer *or* one floppy disc per person or group.

With floppy discs, user files are kept on a personal disc which is retained after the machine is relinquished to another user. Discs cost about £1 each, so issuing or selling one, or several, to every pupil is quite practical.

Without floppy discs, you will experience potentially serious file management problems – unless you can afford to give each person their own machine. This is because RAM files, used on low-cost word processors, mean that each person's work is locked inside one particular machine. The same applies to those few up-market machines that have a hard disc but no floppy disc. When these machines are shared in a user community, one user may accidentally or deliberately delete, copy or peruse another user's work. Pupils might delete other people's files simply to free up space to store their own work. When resuming work, they must find the very same machine they had previously – because that, hopefully, is where their work still is. Of course, this problem is less likely to arise when each user has a personal machine.

Some low-cost word processors have a second battery system which is an extra line of defence for RAM files. It is, however, an all too common experience with single battery systems that work is lost following battery failure. A few users may come to accept this happening, and even in their ignorance regard it as normal or an acceptable irritation. But for many children, the total loss of their work is a traumatic experience that does long-lasting damage to their attitude to IT.

MEDIA COMPATIBILITY

The current standard is high density (HD) 3.5" diskettes holding 1.4Mb of data. These discs are marked 'HD' and have two square holes in the case. Earlier 720K discs have just one hole, which may be slid open for write-protection. Many schools already own desktop computers fitted with the earlier 5.25" 360k or 1.2Mb floppy disc drives.

If you have mixed disc drives, be prepared for media compatibility problems. Only one type of disc is suitable for each type of disc drive. Find out which one it is and then keep to it, because mixing media often leads to problems of disc integrity.

SCREENS

LCD screens can be difficult to read if the user is not positioned at the ideal viewing angle. This can make shared, simultaneous use in groups of more than two quite difficult. Some machines are much worse than others in this respect.

Some thought should be given to both natural and classroom lighting, particularly if screens lack internal lighting. LCD displays can be damaged by heat, for example strong sunlight. Screens can also be damaged by impact and sharp objects.

BATTERY MANAGEMENT

As noted earlier, in machines with RAM files, battery management is a crucial issue. Rechargeable batteries for portables are, in the main, nickel cadmium (nicad) cells. Some early portables have

lead acid batteries. The computer should have the ability to recharge the batteries quickly while running on its mains adaptor, but not all do.

Charging regimes for different battery technologies and sizes vary: the correct charger must be used. Rechargeables do not last forever and a lifetime of 2–4 years or 300–500 cycles can be expected if the batteries are properly maintained. A peculiar problem with nicads is the *memory effect*. If, on a regular basis, nicad batteries are not used fully *before* recharging, quite soon they remember this pattern of use and the capacity reduces to match what has become normally expected of them. It is wise, therefore, to run down nicad batteries fully at least once a month.

Given that a set of rechargeable batteries in a notebook may last only 2–3 hours – much less than a working day — you must either provide replacement batteries or revert to using the mains adaptor at some point during the day. Battery endurance is improving with the new nickel hydride cells, low power electronics, smart software and so on, but a genuine endurance of eight hours is still some way off. So who recharges and looks after the batteries? Some schools leave it to the pupils to recharge batteries overnight at home; others have a technician. Some schools get round the problem completely by using mains adaptors most of the time.

Low-cost word processors and palmtops usually run on alkaline primary cells, such as the Duracell brand, giving tens to hundreds of hours of use. These batteries should not be recharged. Initially they provide 1.5 volts per cell. Some computers regard 1.1 volts as the end point when there is still life left in the battery for other purposes. Many schools are put off alkaline cells because of the retail price: about £3 for 4 AA-size cells in a bubble pack. However, bulk purchases of 500 or more in a no-frills box from the manufacturer can halve the price and their shelf life is several years. There are advantages in selling alkaline batteries to pupils, rather than issuing them, since these batteries also fit personal stereos and toys.

AA-size nicads also have a tendency to vanish and care is needed with issues and returns. They provide only 1.25 volts initially, so the computer may see a fully charged nicad as if it is a half-used alkaline cell. The nicad discharge curve is fairly flat until close to the end point, when it plummets. From the user's point of view, nicads do not last anywhere near as long as alkaline cells and they fail somewhat more rapidly.

Parents may be concerned about the cost of recharging batteries at home, and they should be reassured that it is very small. The heat produced by some chargers and mains adaptors under quite normal conditions may cause adverse comment.

CABLING

Two kinds of cabling are commonly needed: low-voltage feeds from mains adaptors and printer leads. We will look at power supplies here and printers in the next section.

Mains adaptors have certain attractions over batteries: they are inexpensive to buy (about £10), the running cost is minimal, and all battery management problems disappear. On the down side, you will need one mains socket per computer installed near to pupils' desks or work areas. There could be a lot of loose cable which is unsightly, a nuisance and a potential hazard. Some schools have solved this problem by running mains trunking along the ceiling and dropping a cable down to a multi-way outlet above pupil areas.

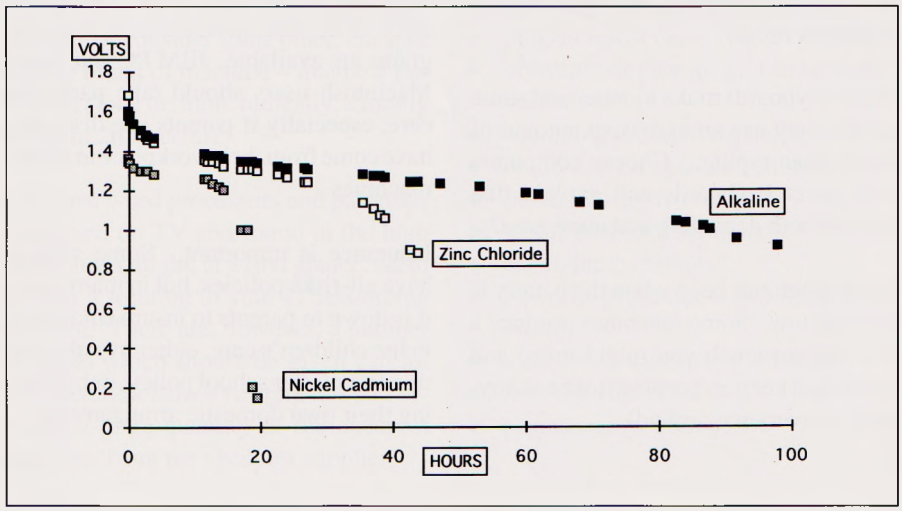
Alternatively, a mains cable can be run, under a thick rubber cover, from a wall socket to under each desk cluster where it terminates in a multi-way mains socket block. Each pupil has his or her own mains adaptor plugged into this block and low-voltage feeds are routed up tidily to the working surface via the middle of the work area.

Many schools arrange portables on tables around the edge of the room because this is where mains trunking is easily installed, and also where computing (using desktop machines) has traditionally been done, especially in laboratories. This strategy disadvantages pupils by placing them at the edge of the room and facing outwards toward the wall. It also ignores the potential of portables to bring unobtrusive computing power to the user's own desk.

PRINTERS

With many more computers than printers, access to printers has to be shared. With many more users than computers, the computers need to be shared. Some schools have networked printers and if the portables are also networked, the printer-sharing problem is solved. But this scenario is unlikely due to the high capital cost; normally some other way is needed to get the data from the computers to the printers.

Provided your machines have floppy discs, you can dedicate one computer to the printer. Users take their files to this machine on a floppy disc, so there are no cabling problems and no need to carry computers around. The printer station can be in a corner of the classroom, or in a corridor, or other communal area. This



Discharge curves of different battery types

can bring extra flexibility by giving users access to printers outside the class, resulting in higher utilisation of the equipment, fewer queues, better use of time and export of noise.

Without floppy discs, the user must carry the computer to the printer and connect the printer interface cable. Some schools whose computers have floppy discs have also chosen this strategy to save time and effort writing floppy discs and loading the relevant applications software on the printer's computer. Remarkably, schools which have adopted this strategy have had few problems with dropped machines or wear and tear on cables and sockets.

Contention boxes which share one printer between up to six computers via direct cabling are also available at around £100. Laser printers produce high-quality copy quickly, at a similar cost to photocopying. Bubble-jet printers are slower and less expensive to purchase, but usually cost just as much to run, and sometimes more than a laser printer. Dot-matrix printers are the cheapest, noisiest and usually the slowest in operation.

There is a good case for using printers with A4 sheet feeders to avoid problems with sprockets in loading and tearing off print-outs. Also, A4 can be filed more easily than continuous form stationery.

NOISE

The noise from dot-matrix printers can be intrusive and unpleasant even if people learn to ignore it. It is often better to choose quiet printers, or at least to position printers carefully, to minimise the impact of noise.

Some keyboards make a clatter and some people may use an excessive amount of force when typing. Choose computers with quiet keyboards and explain that force is both damaging and unnecessary.

Some machines beep when the battery is running low. Some machines produce a few beeps (which you might miss) and others just keep on beeping (to the annoyance of everyone around).

SECURITY

Portability brings both benefits and problems. On the one hand, machines can be transported easily and stored out of sight in a secure room or cupboard; on the other hand, they are attractive to steal, being high value, lightweight, compact and easily concealed.

A child openly carrying a computer in the street could become a target for crime: theft, vandalism or assault. If computers are to be carried around, some thought should be given to concealment, particularly in districts where crime is prevalent.

When buying portables, do not forget about buying a case too. These can sometimes be included in the price, given a little firm negotiation with the supplier. A rigid case is better for schools use than the soft, padded kind favoured by business. Remember the computer is not going to treated lightly – it may be banged in the bus queue, poked with a pencil or hit with a football.

As with all computers, making back-up copies of user files protects against hard disc failure, and loss or damage to floppy discs. Back-up discs should not be kept in the same location as the computer itself, in case of fire or theft.

Computer 'viruses' (rogue programs which may cause wanton destruction of files) are becoming commonplace. These programs hide themselves in innocent-looking software and boot programs on floppy discs, spreading from machine to machine. Everyone should be vigilant in avoiding software from untrusted sources and booting machines from anyone else's discs. Virus detection and treatment programs are available. IBM PC and Apple Macintosh users should take particular care, especially if parents use discs that have come from their workplace in school machines.

Insurance is important. Some schools have all-risks policies, but in many cases it is down to parents to insure equipment in the children's care, either by subscription to a master school policy, or by making their own domestic arrangements.

COPYRIGHT AND LICENCES

Portable computers must have properly licensed software, just like any other computer. However, software producers are beginning to realise that portables often represent second machines for many business users. Some enthusiasts, not fortunate enough to own a portable, may have a desk-top size machine at home and carry discs back and forth between home and the office.

Early software licences, and indeed many current ones, stipulate single installation. If that is the case, you should buy two copies – one copy for the office machine, and another copy for the portable or home machine.

Recent licences may be phrased to allow you to make multiple copies of the software so long as you only run one copy at a time. Some licences now say specifically that you can install the software on your office, portable and home machines so long as you are the principal or sole user.

Many organisations buy site licences which allow unlimited copies to be made for use on a single site. It may also be an economy of scale to network all your machines, including the portables, and buy network-wide software licences. Some producers now realise that network machines may be portables and operated away from the network, so they allow temporary copies of software to be made from the master copy on the network file server for this specific purpose. Copies are usually for *temporary* use, however, and should not be passed to other machines or users.

Software licensing is a complex area and mistakes can be expensive and embarrassing as well as offences under copyright law. Never forget when planning the purchase of portables to allow for software in your budget. And once your systems are up and running, maintain vigilance to prevent illegal software from migrating between the school, the home and the office.

Choosing and Buying Portables

This final section looks at how to select and purchase portables. First, you should consider the fundamental questions on the right. Clearly, the answers will, to a large extent, determine the type of portable you can consider buying. For example, computers with small keys are unsuitable for heavy word processing. The class of portable you need (laptop, notebook, palmtop or low-cost word processor) depends on the intended modes of use. The next level of choice, where a choice exists, is the system architecture of IBM PC compatible, Apple Macintosh or Acorn Archimedes.

There are no second sources of Apple and Acorn machines, but there are a large number of PC-compatible manufacturers: not only well-known names like IBM, Compaq, Toshiba and Sanyo but also a host of little known Far Eastern companies. Do not be put off the latter because of their name: many of the components and sub-assemblies inside the machine are from the same sources as in many of the well-known makes.

Next, you will need to consider technical features. Some of the technical qualities highlighted on the right are trade-offs, and some may be mutually exclusive. Really well designed, technically excellent and attractive machines come with a hefty price. You may not be able to afford to buy very many of them, and this may stop you realising your IT goals. The way forward may be to make your goals more realistic, or consider some other, cheaper kind or brand of machine – maybe a Far Eastern clone or, more radically, a totally different architecture.

Low-cost word processors and palmtops advertised on TV and found in the high street shops might, at a first glance, seem to offer a solution to your IT resourcing problem. There are, however, a number of issues which should be given careful consideration before rushing out and ordering a large quantity of the cheapest machines from the cheapest supplier.

FUNDAMENTAL QUESTIONS

- Why use portables?
- Which pupil and staff needs will be addressed?
- What are the curriculum aims?
- Who will use them, and where?
- How will their use be managed?
- Is compatibility with existing systems a requirement?
- How many are needed?
- What training would be required?
- How much finance is available, and when?

TECHNICAL FEATURES TO CONSIDER

- solid construction
- compact, ergonomic design
- good keyboard layout and feel
- light weight
- clam design
- good carrying case
- external interfaces (parallel, serial, mouse)
- large, bright, clear, tilting screen
- high-resolution graphics (e.g. 16 grey scale VGA)
- high-capacity floppy discs (e.g. 1.4Mb 3.5")
- hard disc (e.g. 40Mb minimum)
- plug-in RAM cards (e.g. PCMCIA)
- pointing device (e.g. tracker-ball, mouse)
- sound input/output capability
- durable, rechargeable batteries
- power-saving features
- mains adaptor operation
- expandable memory
- powerful processor (e.g. 386SX minimum)
- a choice of third-party software
- network capability
- printer compatibility.

Your choice of equipment should be influenced by what you already have: it is desirable to be compatible, so long as your existing equipment is up to date and has a place in your future plans. If your existing computing base is either old or mixed, it may be better to start looking to the future now rather than at the past. If this is the case, considering a new system architecture for your portables is sensible.

APPLICATIONS AND SYSTEM SOFTWARE

All the cheaper machines, low-cost word processors in particular, come with built-in application programs. Since document handling is still the major curriculum use for computers, you might well feel that this strategy would save money on software purchasing and free your more expensive desk-top machines for other more elaborate uses. But there is a training and performance penalty: your users will have to learn and remember how to use one lot of software on the desk-tops and something completely different on their portables.

The capability, and ease of use, of the built-in software in some of these cheap machines is limited, however. For example, selecting blocks of text may be a complex procedure, cut and paste may destroy the format of subsequent paragraphs. Since the software of these machines is built in, you cannot change your mind later and replace it with better word-processing or other generic software from independent vendors. In other words, you are stuck in a closed system.

Whilst an investment in cheap machines can be one way of easing your resourcing problem in terms of numbers of machines, you will introduce incompatibility with desk-top computers in terms of software and file formats. New operating systems and supportive user environments, which will be established by the mid-1990s, can only run on modern industry-standard machines: this is where the commercial sector is heading. Long-term strategic purchasing now, even if it has to be on a limited scale, will maintain the relevance of your IT investment to practice in the wider world for years to come. There is an argument for using multi-platform industry-standard software applications like Microsoft Word and the Excel spreadsheet. These are available on both PC and Apple platforms. It is then relatively easy for users to switch machine types as they do not have to re-learn the software packages.

EFFICIENCY AND EFFECTIVENESS

The cheapest machines are simple text entry devices, not sophisticated word processors. If used exclusively, they will not enable your school to deliver Attainment Target 5 of Technology in the National Curriculum. In order to develop IT capability, pupils need to have experience of word processing, spreadsheets, graphics, databases, simulation and control, and to be able to compare various problem-solving approaches. So if you decide on purchasing a bank of cheap machines, you will also have to consider how to deliver the wider aspects of IT on other machines, and the ramifications of pupils working on different kinds of incompatible machines.

WARRANTIES, MAINTENANCE AND SUPPORT

Most portables come with a one-year warranty. A very small number of suppliers give a three-year warranty. Warranties do not cover accidental damage, and if the machine has simply 'stopped working' it is not always easy to establish if the cause is a manufacturing fault or bad handling. Who gets the machines repaired? Where are repairs carried out: your site, a local depot or abroad? How long do repairs take: same day, next day or no promises at all? Who pays?

You may be able to get support from your local education authority, or resource centre, for a limited range of machines. You may get better service from UK manufacturers and suppliers who specialise in educational computing. When purchasing portables remember that the lifetime cost of machines is considerably more than the purchase price, and sooner or later you will need maintenance and support.

GETTING A BARGAIN

There are huge variations in the price of portables. Products are developing very fast, and the choice is vast, so we cannot advise you about particular models and prices. The table opposite, based on some currently popular models, suggests features to look for and yardsticks for making comparisons.

If buying new, the price (in mid-1992) for an entry-level IBM PC compatible, 80386 with 40Mb hard disc and 2Mb RAM would vary between £1800 list price to £900 on the Tottenham Court Road in London. Newly obsolescent machines (like the 80286 in mid-1992) can be bought for about £500 as a one-off purchase and even cheaper in bulk as dealers off-load their stocks. 'Bulk' in the context of portable computers can mean as few as a handful of machines.

Commercially obsolete technology such as 8086/8088 portables with no hard disc, and one or two floppy disc drives, can be bought for as little as £250-£300 and less in bulk. Such machines may be very useful in education and worth considering because of the flexibility of having floppy discs – especially when compared to personal word processors and cheaper palmtops, currently in the £130-£250 range.

Establish your knowledge of the current market and position yourself as a smart buyer: you do have negotiating power, whoever the supplier is, whatever the product is, so use it. Price up the whole system: computers, software, cables, and cases and negotiate the bottom-line figure.

It should be remembered that bargains are not always good value for money in the long term. A supplier who offers a high standard of technical support for educational users and makes life easier by bundling, and perhaps installing, software, may not be cheapest at the time of initial purchase. Support has to be paid for one way or another and without it you are unlikely to get the best from your equipment.

NOTEBOOKS

Manufacturer & model	weight (gms)	overall size	screen size	keys	lid	lit	system software	RAM cards	3.5" disc	Hard disc	Processor & speed	Price Guide
Acorn A4	3020	297x210x53	182x137	83	yes	yes	RISCOS*	no	yes	60Mb	ARM3 24MHz	1399
Apple Powerbook 145 4/40	3080	286x236x57	214x135	63	yes	yes	Macintosh*	no	yes	40Mb	68030 25MHz	1255
Olivetti Quaderno	1035	210x148x32	140x105	93	yes	no	DOS	yes	no	20Mb	8086 type 16MHz	400
Research Machines NB380	3250	277x217x53	177x132	80	yes	yes	DOS	no	yes	80Mb	80386SX 25MHz	1099
Toshiba T1800	3200	300x214x57	194x147	96	yes	yes	DOS	no	yes	64Mb	80386SX 20MHz	865

PALMTOPS

Manufacturer & model	weight (gms)	overall size	screen size	keys	lid	lit	system software	RAM cards	3.5" disc	Hard disc	Main battery	Back-up battery	Price Guide
Acorn Pocketbook	280	164x85x23	97x38	58	yes	no	own	yes	no	no	2xAA	yes	199
Atari Portfolio with 128K RAM card	465	200x102x27	114x40	63	yes	no	DOS	yes	no	no	3xAA	no	212

LOW-COST WORD PROCESSORS

Manufacturer & model	weight (gms)	overall size	screen size	keys	lid	lit	system software	RAM cards	3.5" disc	Hard disc	Main battery	Back-up battery	Price Guide
Amstrad NC100	1140	294x208x26	216x34	64	no	no	own	yes	no	no	4xAA	yes	169
Cambridge Z88	1015	292x208x22	248x28	64	no	no	own	yes	no	no	4xAA	no	175
Tandy WP-2	1125	295x208x25	213x34	62	no	no	own	yes	no	no	4xAA	yes	159

NOTES

These machines are examples of each type, and there are many others that could have been illustrated. The inclusion of products in this table does not imply any endorsement by NCET, nor does absence imply the opposite. New and improved models are being developed all the time and whilst every effort has been made to ensure the data is correct at the time of writing, buyers are advised to contact manufacturers and suppliers for the latest product information. The price guide is the educational price (excluding delivery and VAT) quoted to NCET by manufacturers or major dealers on 9/2/93.

414/2–93/30K/GRN

*These systems can also run DOS under emulation.

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