Information Technology in Design and Technology: a Discussion Paper

A. R. Hodgson,
C. D. Mockford,
P. W. Wormald,
N. P. Zanker

Department of Design and Technology, Loughborough University of Technology

This paper was first presented at the DFE Conference at Ettington Park on the GEST Initiative in November.

The opportunity which Information Technology (IT) presents for enhancing pupil learning in the curriculum area of Design and Technology is considerable. This is largely as a result of the pedagogy inherent in the subject area of design and technology, where activity and subsequent learning are largely centred upon a task-focused approach.

The role which IT can play in creating a rich learning environment has been clearly highlighted:

> When engaged in tasks which include the use of IT, pupils generally exhibit more positive attitudes to learning, accept more responsibility for their own learning, exercise greater initiative and have more opportunities to discuss issues and problems in a constructive manner with their peers. (Scottish Education Department, 1987)

Information Technology in Design and Technology should be concerned primarily with the use of IT to support the development of Design and Technology capability. One of the main reasons why the effective use of IT is not widespread in schools concerns the difficulties teachers have encountered with the implementation of Design and Technology as part of National Curriculum Technology. Where IT is seen as a means of positively supporting pupils' designing and making activities then it will also be seen as a means of supporting the introduction and development of National Curriculum Technology.

The Design and Technology Perspective

Design and technology has a distinctive pedagogy. Coupled with practical task engagement, a distinctive learning environment is created. For design and technology teachers, the challenge continues to focus upon the utilisation of IT within design tasks, so that IT enhances the learning opportunities evident when pupils manipulate ideas and materials.

One way towards meeting this challenge is to consider the potential of IT in a number of specific categories of activity relating to design and technology: graphics, modelling, manufacture, control, and information use.

Graphics

Taking ideas that have progressed through a series of refinements and extrapolating the data from these decisions to the manufacturing stages extends further the range of learning to which pupils are exposed. Many 2D graphics packages are particularly good at manipulating images, but notoriously difficult to use for generating an original image. Computer images, manipulated rather than originated by the pupils, linked to appropriate output, represent a potential contribution of IT in graphic design work. The emphasis concerns the need to move towards the manipulation and refinement of ideas.

Modelling

Simulations can, with increasing accuracy, represent technological systems. In many instances they take users into a domain where they can change system parameters and observe the results of these changes. Electronic circuit simulations are typical of these applications, providing the means to model theoretically the input and output of an electronic circuit. In many instances the increasing sophistication of such IT tools has changed the approach taken to designing. Simulating the operation of an electronic circuit or system is now an accepted method for prototyping a design. It reduces lead times and costs prior to moving to a hard wired assembly, by which stage the design should be near to its final iteration.

However, there is a danger that learners can be placed in an unrealistic situation: they have neither the basic concepts nor sufficient support through engagement with the simulation to inform decision making appropriately. When these forms of simulation are linked to practical design tasks, the introduction of a real context reduces this over-dependence on IT.

Solid modelling tools would appear to be afford an appropriate opportunity to use IT in design and technology. These applications are commonplace in the studios of professional designers. Software which allows pupils to manipulate and refine their ideas in a similar manner to that identified with graphics applications exposes a new style of working. However, many modelling packages are particularly difficult to learn. This is a barrier to their use in schools.

Above: A large number of plastic clips were required as part of a construction kit for use with garden canes. The injection moulding tool (centre) was machined on a CNC miller from data supplied by the CAD drawing system (bottom).

■ Manufacture

Computer Aided Manufacture (CAM) has suffered from many misconceptions concerning its application in school. The potential of CAM lies in its ability to enable manufacture which would otherwise be impossible (or very difficult) for pupils to achieve by applying CAM techniques to many similar components and to increase the speed of manufacture whilst maintaining accuracy.

In relation to the experience of designing, a key feature of the appropriate and successful use of IT concerns its dominance and relative prominence during the process-led activity of design. If the IT tools appear transparent to the pupils during the task engagement, viewed as a natural resource to achieve a specified outcome, then the designing and learning experiences will be enhanced. Correspondingly, if the focus of teaching is the technical aspect of the IT tool, learning tightly sequenced goal-directed command sequences and general operating characteristics, then the outcomes in terms of learning will be relatively poor.

In order to function, all CAM equipment requires some form of program data, Computer Numeric Code (CNC). Entering CNC code directly is an example of inappropriate learner activity. Pupils should be provided with the means to link between CAD and CAM. Appropriate computer applications will generate CNC code directly from a graphic image or drawing, removing the need to engage in tedious time-consuming programming and data entry.

■ Control

The most effective applications of IT in learning and teaching have been those which reflect and harmonise with developments in curriculum and pedagogy. Over recent years, design and technology has experienced considerable change regarding both of these aspects. Learning and teaching should avoid the potential problems of concentrating on the technological function of control at the expense of encouraging application, in a task centred, increasingly student led approach.

The use of IT should also, wherever possible, be concurrent with the engagement of pupils in the design task. It is not sufficient to have IT-focused tasks, where learning to use the IT tool becomes the primary objective. IT is best

learnt through location within a task, supporting and informing design decision making. This is not always the case in schools, where experience of IT is generally gained through short skill-based courses. (DES, 1992)

The teaching of computer control should be located within a design and making environment, developing a general capability with systems in addition to the specific requirements of control programming and interface connection. The use of low-level software tools allows pupils to move easily from system design to outcome more effectively than the high level programming techniques so often associated with computer control. The powerful computers that are available in the classroom provide a platform for the more effective low-level software, encouraging the integration of control applications in design project work.

Information Use

IT has significant power to provide information which can be used to inform decision making. Access to a whole variety of resources is currently available, both locally on CD-ROM or nationally by access through networks. The network, and the concepts and issues associated with remote co-operative working, is a current topic of interest. The virtual library, accessed through local or wide networks is within reach. Technical data available through information searches, reference books, technical books, databases and other sources are all aspects of IT which educationalists will have to manage and integrate into an ever more dynamic information framework.

For design and technology, it is essential to maintain a consistent link with fundamental concepts that underpin the subject area. Abilities in the identification and interpretation of appropriate data, the exercising of judgement, both in relation to information acquisition and manipulation will become increasingly important. Merely placing pupils in an information-rich environment is not an appropriate strategy.

IT also enables pupils to make greater use of the information they have gathered as a natural part of their designing and making activities. A database where individual pupils can share the information they collect as part of their design research, allows groups to collate information more effectively and draw conclusions from a wider range of sources.

In many instances, whilst sophisticated IT resources have been placed in schools, the associated pedagogy has not evolved to ensure their effective use in learning and teaching. Throughout all Key Stages many technological design situations provide opportunities where IT can offer improvement in both learner and teacher performance. In many cases, this can be achieved with simple IT based tools: it is not necessarily a function of sophistication or complexity. Considerable inventiveness on the part of the teacher can be needed to exploit a particular computer program to the full.

Whilst the most immediate need is to exploit the emancipatory nature of IT in design and technology, there is also a need to consider how pupils' designing and making activities may be developed through the use of Computer Aided Learning (CAL). This use of IT will be more instructional or revelatory in nature, helping to develop design thinking processes, simulating the outcomes of design decisions and providing information and instruction to individual pupils to enhance and support their knowledge base.

Designing and making activities can be difficult for teachers to manage. This is particularly so when the activities lead to a wide variety of individual solutions. CAL has considerable potential for supporting pupils, on an individual or small group basis, at the point of need. It enables more flexible modes of learning, presenting information or developing skills which may be required by an individual pupil but which are not relevant to the whole class. Once pupils become used to working with CAL resources, then teachers can increasingly be released to work with pupils on their individual design work, instead of repeatedly providing basic information. CAL may be one of the means by which pupils acquire information outside the core content of D&T programmes of study.

For new minds, these tools may suggest a lead to new methods of working. Allowing exploration, through IT, of design ideas in computer model form provides opportunities for the development and exploitation of different approaches to using IT. This is an important aspect of the pedagogy of IT within design and technology. Some may wish to maintain the dominance of accepted methods, but there is a new generation of pupils to be encouraged to identify the ways in which these

tools can be applied and the associated methodologies which emerge.

IT and School Policy

Each school's IT policy should have been determined by the teaching and learning requirements of National Curriculum Technology Profile Component 2, Information Technology Capability (currently identified as AT5). Within a school policy, each department should include statements relating to how IT and its assessment will be incorporated into schemes of work. Reference should also be made to progression.

> In formulating departmental IT policy, account should be taken of the lack of opportunities for modelling, control work and data handling which were identified by HMI (DES, 1992).
>
> Schools will need to ensure that a coherent and consistent policy for IT exists within the curriculum, so that pupils' experiences are complementary and not unduly repetitive, and that the IT knowledge, skills, understanding and values are related to the broader principles and processes of IT (DES and the Welsh Office, 1988)

In practice, most schools have worked hard to produce an IT policy but the coherence needs to be examined in relation to pupil experience and repetition.

A commonly perceived model of IT describes five strands of IT Capability (AT5): Handling Information; Communicating Information; Modelling; Measurement and Control; Applications and Effect. Whether the school IT co-ordinator matches subject requirements according to the model of AT5 or by consideration of most appropriate applications, the outcome should be the same: a cross-curricular balance where each subject identifies and addresses the IT activity closest to the philosophy of the subject. In the case of design and technology there is a primary link to modelling and control, whilst handling and communicating information constitutes a secondary, but major, focus.

What is required are instruments to aid the construction of a whole-school IT policy which reflects a broad, balanced and relevant entitlement across all areas of the curriculum. These should be available to provide a school IT Co-ordinator with tools that allow the identification of where, when and how the strands, or applications, of IT Capability will be delivered and assessed in a coherent and consistent manner. Similarly, these, or additional tools, should be available to provide the Heads of Department with illustrative examples, perhaps as case accounts of recognised 'good practice', to identify which strands are of primary and secondary importance in their areas of responsibility.

One of the problems with 'good practice' is that criteria are required to describe it, and it is difficult to define these criteria. For example, teachers often declare that an activity is good practice simply because the pupils enjoyed the work, that it required no additional resources, or it was easily achievable irrespective of the background of the pupils. A further problem with good practice is that it should be replicable in all schools. If this is so, then good practice will always be controlled by the lowest common denominator, which for IT is the availability of resources.

An Industrial and Commercial Perspective

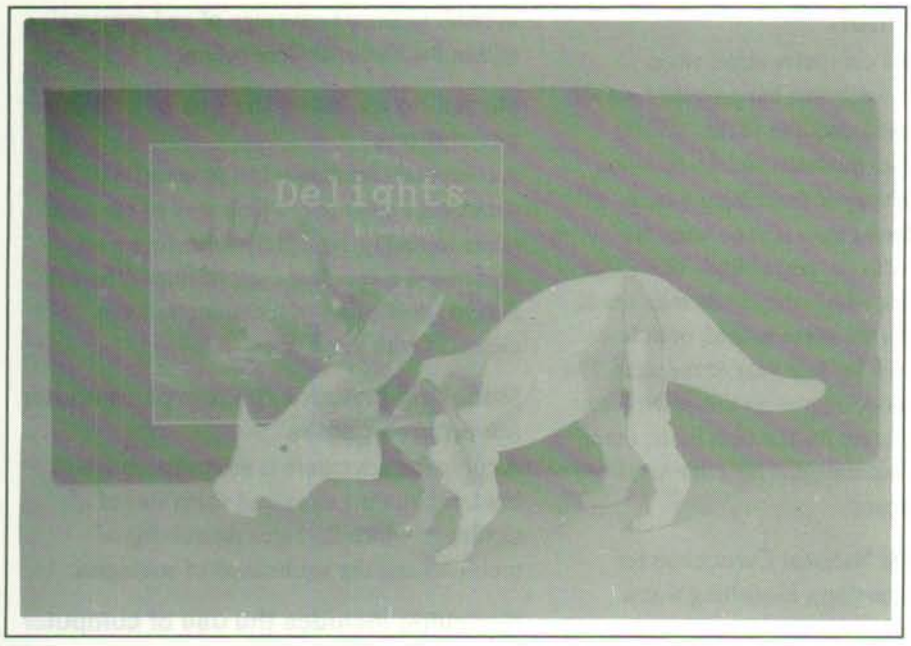
The use of IT, particularly computer-related IT, is commonplace in current industrial and commercial practice. There is little doubt that its use will increase significantly. Increased usage will not be restricted to those professions traditionally associated with technology.

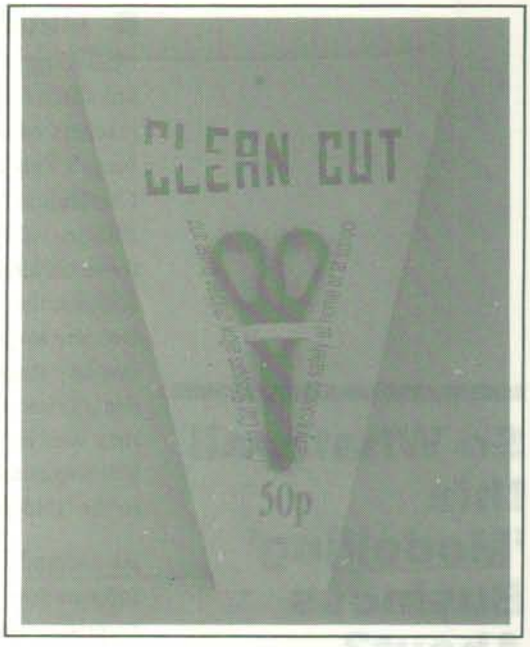
Many systems of everyday human experience — shopping, watching TV, communications, leisure and entertainment, as well as people's working environment — will become increasingly dependent on computer technology. Employers increasingly expect a level of computer literacy to be achieved as a core skill of the school leaver and graduate.

The development of new products from manufacturing industries relies heavily on computer models of that product. From computer aided draughting to rapid prototyping, computerised stock control to world-wide databases of products, IT plays an essential role in a successful manufacturing company.

Recommendations

There are several ways forward within the current IT framework which, we feel, will provide an opportunity for enhancing the current pedagogy. Consideration should be





A range of products which were designed and made as part of a 'mini-enterprise' project, and which focus in the use of IT in D&T. The products were made using CAD/CAM equipment and the packaging printed from 2D graphics applications.

given to providing a series of courses on the use of IT in learning and teaching in design and technology. This would be designed on the 'training the trainers' principle to provide training to key staff in education. Participants would be engaged in design and technological activities which required and encouraged authentic use of IT in order to support design decision making within a task context. Throughout the task, and subsequently through reflection, participants would be encouraged to consider the identification and selection of appropriate criteria which could be used to classify and judge good practice.

By taking this approach, good practice would seek to be clarified and a suitable framework established for subsequent use in design and technology education. Support materials, in the form of exemplars, would be documented to illustrate and encourage the effective implementation of IT. These materials would be curriculum led and directed, not simply technical guides to applying specific IT.

What is currently lacking are the instruments to identify, establish and disseminate examples of good practice on a national basis. Schools and LEAs have been left to their own ingenuity to construct whole-school policy based on subject teachers' own particular interests. Training needs to focus on the potential for IT in each subject or curriculum area.

From the teacher's perspective, the skills that are required concentrate predominantly on pedagogy rather than on the technical aspects of IT. Whilst technical competence and confidence are important, the prime goal is the exploitation of the IT resource rather than the acquisition of full technical competence.

References

DES and the Welsh Office, (1988), *National Curriculum Design and Technology Working Group: interim report,* London: HMSO

DES, (1992), *Technology Key Stages 1, 2, and 3: A report by HMI on the first year, 1990-1991*, London: HMSO

National Curriculum Council, (1993), *Report on National Curriculum Consultation Technology*, York: National Curriculum Council

Scottish Education Department, (1987), *Learning and teaching in Scottish secondary schools: The use of microcomputers,* Edinburgh: HMSO