Designing multimedia resources for design and technology

Abstract

Multimedia resources are beginning to play an important role in the teaching and learning process. Yet the effect and impact which they have is poorly understood and principally anecdotal. Questions need to be asked concerning their use and value especially in a subject such as design and technology which is essentially practical in nature. Reliable answers can only be given if resources are designed specifically for a practical environment. This article examines a range of key issues and provides the rationale and thinking behind a series of CD-ROMs which might help provide these answers.

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The potential of multimedia

Multimedia resources have a potential, which if fully exploited, could have a genuine impact on both teaching and learning in a design and technology context. It is already quite apparent that even though technology is now available which enables the development of highly sophisticated interactive resources, there is no consensus as to how these teaching tools will be integrated and employed in our subject. Indeed it can be argued that the technology has created the demand, it has not arisen as result of research into pedagogical issues. It is important that a rational strategy is employed to investigate both the structure and content of such resources and their pedagogical effectiveness. There are many questions to do with the way both teachers and students use such resources which remain to be answered. There are no simple or cheap answers. Initially a variety of electronic resources needs to be developed so that judgements can be made which will inform future developments. Following the development of such resources a research programme needs to inquire into their value and effectiveness in a wide range of teaching and learning contexts. In the UK the Technology Enhancement Programme (TEP) is playing a central role in this evolutionary process and creating an expertise which will be of value to the whole of the design and technology community.

There are potentially three IT approaches which will have an important impact: the Internet, hypermedia and CD-ROM. Many organisations are establishing home pages and this medium is beginning to be used by schools as a means of communication, investigation and dissemination. The Internet has a powerful role to play as a research tool within design and technology and its integration into the curriculum alongside the more traditional resources will happen very rapidly. Intelligent routing and focused activities are essential if students are to capitalise on this immense resource in a manner which will enhance their practical designing and making.

Hypermedia has many distinctive features which perhaps make it more potent as an intelligent resource with which students can engage over the period of an extended project. Hypermedia offers students the flexibility of decision-making, allowing them to determine their own goals and pursue them by selecting alternatives. Additionally decisions can be reconsidered and modified in the light of fresh information. Hypermedia enables a 'user profile' to be established so that information can be structured to the user's needs and progress, which can be both recorded and tracked. Such resources, by their nature, have a clearly defined knowledge base, hence interactions with the resource are predetermined. This enables teachers to understand clearly and identify the learning outcomes, so perhaps hypermedia is best described as a 'flexible intelligent tutoring system'.

Problems and pitfalls

In the context of TEP the principal purpose of using electronic media is to enhance the practical designing and making activities undertaken by pupils and students. Recent evidence has confirmed that pupils' engagement with technological tasks and activities is frequently spasmodic. (Kimbell, 1994) Restricted access to the teacher results in frustration and a consequent drop in motivation. Independent learning systems may provide support and help prevent this. Such systems are frequently used to reinforce learning and are of value where the acquisition of knowledge is the key concern. But design and technology is primarily concerned with capability, consequently one of TEP's projects has focused on the development of empowerment tools – ones which progress the students by, for example, answering questions as they arise, providing appropriate strategies or describing

processes and procedures. A key objective of this research and development programme was to produce multimedia resources which would facilitate and enhance practical activity.

CD-ROMs have voracious appetites: their development requires substantial financial and intellectual resources. Commercial developers, such as Dorling Kindersley, indicate that an initial sum of half a million pounds is required. Consequently, they conclude, CD-ROMs must be developed on a global scale for a global market. This may well satisfy the 'edutainment' market but it is unlikely to produce resources which will meet the needs of a specific syllabus or curriculum. As learning tools, CDs of this type pose significant issues, as Thimbleby (1995) comments:

> "CDs are not only badly structured, but they have no memory. If a user is learning the contents of a CD, a day later they cannot continue. There is no one-dimensional notion of position: a user cannot come back and 'continue'. A good example of this is Dorling-Kindersley's otherwise excellent *How Things Work*. Having used this document, it is not possible to see just 'the rest' of the document. The document is always the same, and as it is used, the reader becomes increasingly frustrated that new material is harder and harder to find amongst the already encountered material" (Thimbleby, 1995)

In order to address these issues education must be involved in the design and development of these resources. Commercial CDs are designed to appeal to a broad spectrum and consequently are context-free. Arguably, context is one of the key aspects of effective educational CD-ROMs as Hodgson suggests:

> "The most important criterion, in my view, is that a system should enable learning within an identified context ... Identifying the learning context, and specifying appropriate software requirements, is an important first step which helps to clarify the relevance and priority of any further criteria used for development and evaluation." (Hodgson, 1992)

The TEP's series of CD-ROMs dealing with Engineering Product Design has been designed specifically for prescribed contexts, ones which support practical designing and making. However, it must be recognised that, as with traditional printed resources, there are many different formats or structures for CD-ROMs and the first stage of the process must be the development of a structure, a robust architecture which achieves the stated educational objectives. Many CD-ROMs can be described as 'reference' in format. They allow a large quantity of knowledge to be presented with relevant links and relationships between words, pictures and sounds. They enable students to undertake research and seek answers to questions but they do not prompt and progress the student engaged in the practical aspects of a designing and making activity. What should set an educational multimedia resource apart from one designed for the high street is that the author has a concept of the context in which it will be used. Because the CD-ROMs featured in this article have a clearly defined context it is hoped that they will meet the requirements of Lillie, Hannum and Stuck:

> "...it is imperative that the product offers what teachers and students need. If it does not teachers and students will be left wondering how they can use it. Designers need to assure a match between the content covered and the curricular needs and practices of teachers and school systems." Lillie, Hannum and Stuck (1989)

Many CD-ROMs allow the user to wander aimlessly, moving from one topic to another at will. "Off the wall" learning surely takes place but it is inconsistent, aimless and cannot be documented. In a controlled teaching and learning environment there are sound arguments for a resource with recognised routes and signposts which enable travel in all directions but ensure relevance is maintained and location indicated. In addition a clear set of potential activities needs to be established at the outset. The project which developed the TEP suite of discs involved three research and development phases. In the first a small scale demonstration was produced to illustrate the interaction of content with

animation and video in relation to a production process, injection moulding. This was used both to secure funding and as a research tool to gauge user reaction in relation to interface and structure. The second phase was undertaken with a group of MA students following an MA course at Middlesex University's Electronic Arts Centre. The aim of this stage was to investigate a more complex architecture, the use of more sophisticated animation and image and style of screen presentation. These phases were essential in developing an overall concept of what could be achieved in the final product.

Designing the structure

This suite of CD-ROMs attempted to incorporate a wide range of potential user requirements in order that subsequent research could assess the potential of multimedia in tackling such issues. The potential uses included:

- disassembly of products
- product evaluation and comparison
- design and technology in an industrial context
- empowerment of pupils engaged in designing and making tasks
- comprehensive engineering database
- self-directed learning in relation to design strategies
- self-directed learning to provide an underpinning of scientific principles
- opportunity for cross-curricular links, e.g. business studies, science and history
- the ability to extract both text and pictures
- worksheets to focus pupil activity.

These CD-ROMs are based on a common precept that designing frequently starts from an understanding of the made world and how it came into being. An understanding of the made world provides insight and knowledge, but additionally it confers relevance on the practical project which emerges from a case study. A case study gives the user the opportunity to explore all aspects of a common product: a ball-point pen, a power drill, or an electric bicycle. Although each of these case studies focuses on different aspects of the product, each includes an industrial visit which provides the user with the opportunity to meet those responsible for all aspects of the design and manufacture of the product. This was achieved using specifically commissioned video footage. The three projects are also exemplars of three different scales of production: mass, batch and custom; this provides an extra dimension.

The final structure employed can be viewed in one of two ways. In a simple model it is merely dendritic with obvious branching routes. (See figure 1; see also TEP 'News and Views' for a visual representation of this model). This is how it might be viewed by the user. However, from the perspective of the total architecture each CD-ROM selects particular aspects of the total in an intelligent and focused way in relation to each case study and project. An holistic model, which incorporates the three CD-ROMs currently available and any future ones, might be spherical (see figure 2). (The central core contains content, the knowledge and skill which is generic to design and technology; the outer skin, the

Figure 1

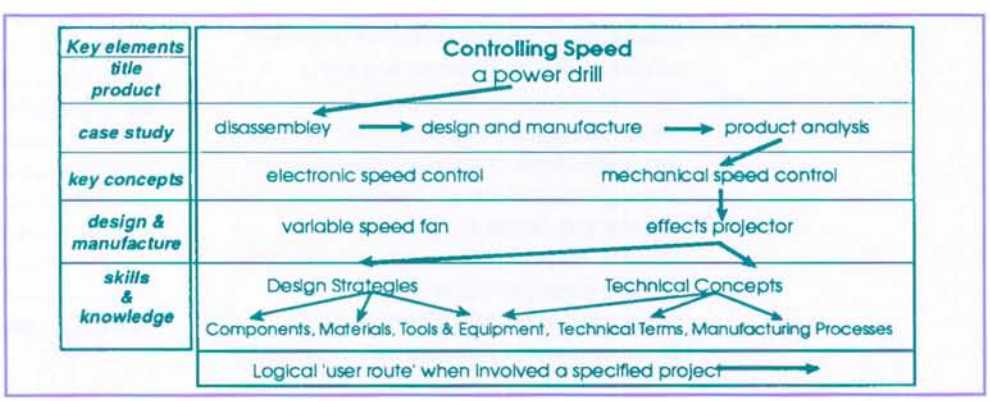


Figure 2

made world, consisting of the products which the student has the opportunity to disassemble and investigate; in between there is the zone of student activity, the projects. This is where the student interacts with both the core and the skin, designing and making new products. Each project is linked to a case study which provides relevance and selects the appropriate elements of the knowledge and skills, the engineering library, which will probably be required to resolve the task.

Across the three CD-ROMs there are six design and make projects. The manner in which the projects are linked to the case study is best explained by giving an example. One CD-ROM is entitled 'Controlling Speed' as it contains two projects dealing with this key engineering requirement. Both projects are linked to the case study of a power drill which uses both an electronic speed control unit and a gearbox to provide variations of speed, torque and action. The case-study provides real applications of electronic speed control and a gearbox which are then the focus of two separate student design and make projects. Each project explains the principle of each system and how it can be constructed to provide different outputs. Students are then provided with a context in which to use this technology. In the case of the electronic controller, a variable speed fan and in relation to the gearbox, an effects projector.

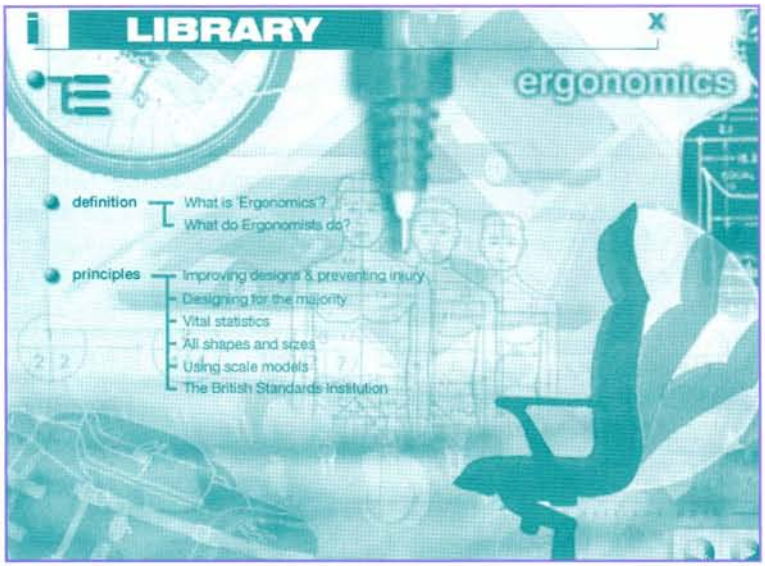
Despite the extensive TEP library of publications and illustrations a vast amount of material had to be commissioned specifically for this project. This included conventional media such as illustrations, photography and text, but also video, animations and simulations – essential if the full potential of interactivity is to be exploited. New editing strategies had to be investigated and trialled in relation to the video. Telling a story in a number of two to three minute sections requires a different approach from that of a conventional video. These video clips will provide students with the opportunity to explore the design and manufacture of the key components and discover something of the product's evolution. The intention is to meet the objective described by Florin (1990) of:

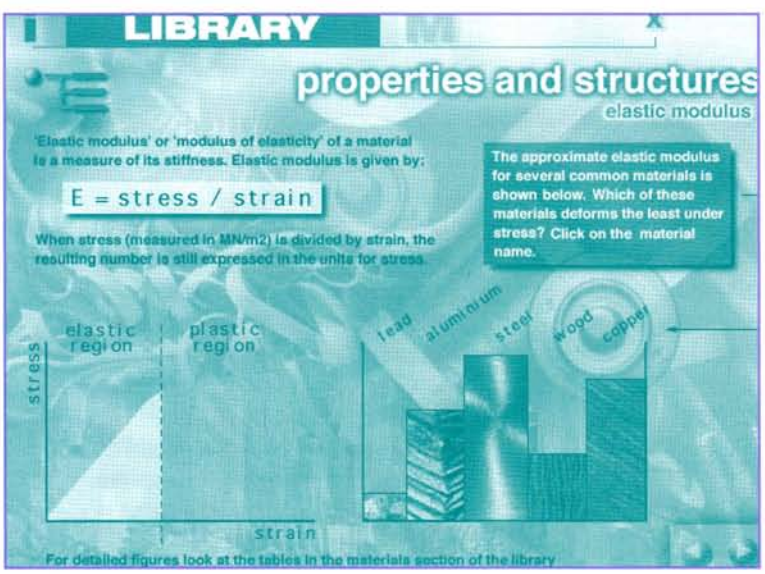
> "taking the user to places that they could not ordinarily go, and enable them to do things that they could not ordinarily do."

The extensive library on each CD-ROM can be used by students as they progress through their project. A particular feature of the library is the interactive workshops on electronics, mechanisms and materials technology. Along with the design strategies section they provide independent self-tutorial units.

An important issue, requiring extensive research is the visual aspect of the user interface. There are many questions which need to be answered, for example:

How does the user read the screen? Are the conventions of reading a screen similar to those of reading a book, i.e. left to right and top to bottom. What is the effect of a flashing button, an animation or a video sequence on the user's perception? What amount of information can be contained on a single screen? How does the user navigate a screen? What kind of visual images, including backgrounds, appeal to users in an educational context?





There are many researchers currently looking at these questions and providing operational advice. Decisions had to be taken in developing these CD-ROMs based on small scale trials but there is clearly a need to look further at their use and reach conclusions.

These CD-ROMS have been produced and are being used. It will be valuable to monitor their use and effectiveness both from the perspective of the teacher and the student. This information will provide a practical resource which will contribute to future multimedia developments in this area. It is unlikely that these first attempts will be 'right first time' but whilst developing these resources we have striven to heed Cates' (1992) sound advice:

> "... technology cannot revolutionise education; students and teachers can. When teachers and students are supported by well-designed instructional material, education can move forward. We need to avoid focusing too much on the wonderful small acts of magic that technology enables us to accomplish, the bells and whistles of technology. Developers need to recognise that bells and whistles are only impressive when they are attached to an impressive engine.... Concentrate on the content; make it solid; provide powerful tools to teach it well."

If you use these CD-ROMs (Engineering Product Design at Key Stage 4) I would welcome your comments and observations on their effectiveness. Please contact me at: Richard60@mdx.ac.uk.

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