Applying Pro/DESKTOP at the Cutting Edge!

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Abstract

Training teachers to be competent in the use of Pro/DESKTOP software is obviously an essential factor in ensuring the success of the CAD/CAM in Schools Initiative. In the Centre for Design and Technology Education at Sheffield Hallam University, we welcomed the decision of PTC earlier this year to allow student teachers to become accredited within the terms of the scheme. This paper first examines the rationale for the introduction of Pro/DESKTOP software into design and technology teacher education. The subsequent focus is on efforts made within our ITT programme to explore the potential of the software and to begin to integrate it into an existing curriculum framework through a collaborative project with Swann Morton Limited. The article concludes with a consideration of the value of CAD without CAM!

Introduction

ICT and design and technology are inextricably linked. Ever since the first National Curriculum included information technology as an attainment target within design and technology, the synergy between the two curriculum areas has continued to develop. It comes as no surprise then that one of the most exciting curriculum developments in recent years should cement the relationship still further. The CAD/CAM in Schools Initiative looks set to build significantly on the supporting role of ICT within design and technology. Pro/DESKTOP in particular appears to offer both teachers and pupils the opportunity, for the first time, to develop computer-based simulations and virtual products, comparable with those developed by designers in professional practice.

ICT supporting design and manufacture – an industrial perspective

Design engineers in industry have used two-dimensional CAD software for many years, but the more widespread use of computers in various aspects of the product development process is a comparatively recent phenomenon. New product development, once a lengthy drawn out sequence of individuals working mostly in isolation, is now, in the more innovative companies, a far more collaborative effort. Today, multi-disciplinary teams of designers, engineers and marketing representatives work concurrently in the product development process, their efforts underpinned by powerful computer systems which now extend to support most aspects of the designing and manufacturing process. The advent of solid modelling and product data management software, combined with increasing accessibility and affordability of rapid prototyping technologies, has begun to transform professional working practice in the field of design and manufacture. (McCullagh, 1996 and Evans, 1998)

ICT supporting design and manufacture in schools

There has been much talk of late in political circles of the need to develop our manufacturing base and vital importance of creativity and innovation and in the knowledge based economy of the future. (Byers, 1999) Such discussion has clear implications for design and technology education in schools. Influential commentators have already begun to articulate the need for a more forward-looking design

Figure 1: The start of the project – a visit to Swann Morton Limited.

and technology curriculum, among them Dr David Barlex who suggests:

> 'Our design and technology curriculum needs to be modern. It just will not do to have lessons that are based on 'old' traditions. This does not require the values of those traditions to be lost but these values do need to be reinterpreted according to our current situation, constraints and the essentially forward looking nature of technology.' (Barlex, 1999)

This has also been recognised in the revised National Curriculum in design and technology, which identifies the importance of design and technology in preparing pupils 'to participate in tomorrow's rapidly changing technologies,' (DfEE/QCA, 1999). To achieve this, design and technology teachers must ensure that the skills and knowledge related to design and manufacture as taught in schools more accurately reflect contemporary practice in the wider world of industry and commerce.

The CAD/CAM in Schools Initiative is a timely development which aims to provide teachers with the resources to do just that. Since its launch in June 1999, the DATA/DfEE CAD/CAM in Schools Initiative has enjoyed considerable success, giving an increasing number of students (and their teachers!) access to extremely powerful resources that have direct relevance to contemporary design and manufacture. As a result of the initiative, the range of CAD/CAM applications within reach of the average secondary school is greatly enhanced and some exemplary work is beginning to emerge from schools in the pilot programme.

Pro/DESKTOP feature-based solid modelling software

At the heart of the initial phase of the initiative was the introduction of Pro/DESKTOP feature-based solid modelling software into schools. Early training efforts focused on developing competence in use of the software of teachers who were already 'in post'. However, as Breckon (2000) points out 'the single most important outcome to date from the pilot is that teachers need quality time to develop skills in using the software'. This suggests a need for immersion in the software that is not always feasible on top of busy teaching schedules. To counter this, it clearly makes good sense to ensure that new entrants to the profession are also introduced to the software at the earliest opportunity – so it was with great enthusiasm that we, in the Centre for Design and Technology Education at Sheffield Hallam University, welcomed the decision to allow trainee teachers to be added to the scheme. Hopefully mirroring what was

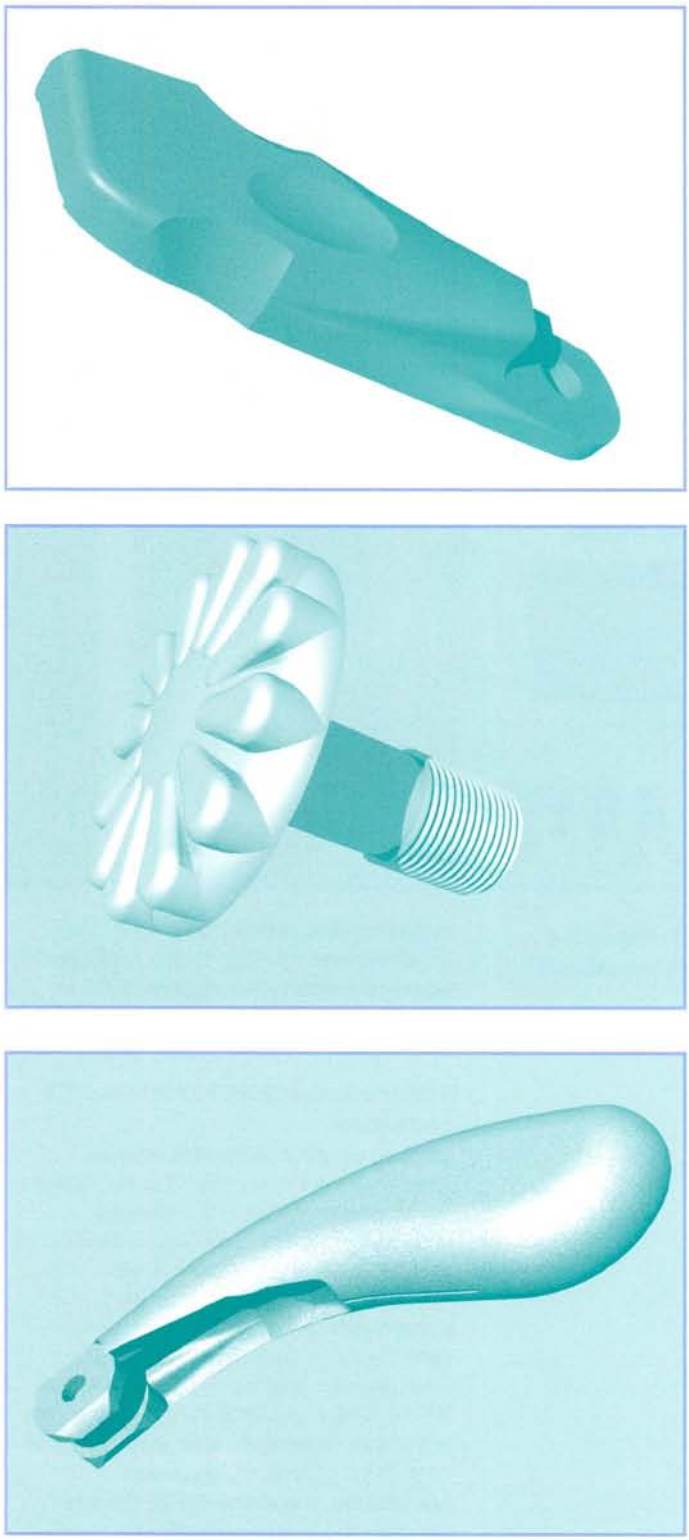


Figure 2: Examples of component design.

Figure 3: Putting the concepts into context.

happening up and down the country, we decided to move swiftly to take advantage of what was a tremendous opportunity to enhance the design and technology curriculum.

Integrating Pro/DESKTOP into the ITT curriculum

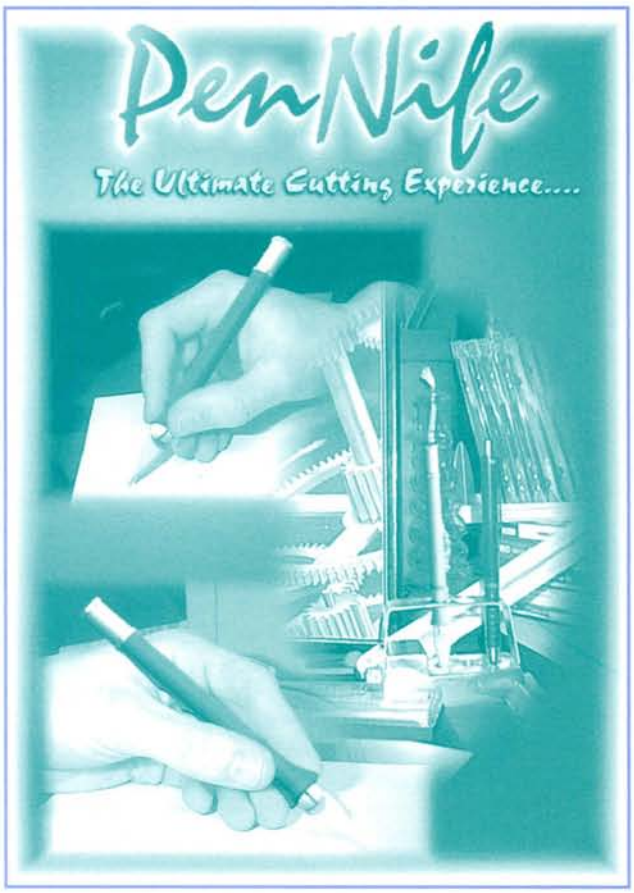
To build progression into the teaching programme and thus ensure that the students are adequately prepared to obtain full accreditation in their final year of studies, we decided to introduce students to the Pro/DESKTOP software progressively through appropriate units of work in the earlier years of their course. From our undergraduate programme, the unit 'Advanced ICT in Design and Technology', which aims to build on foundation skills in using ICT to support the process of design and manufacture, was deemed to be the most suitable vehicle for an introduction to the software. After some discussion, a computer aided design project with an industrial focus emerged as the most appropriate task to set for the trainees.

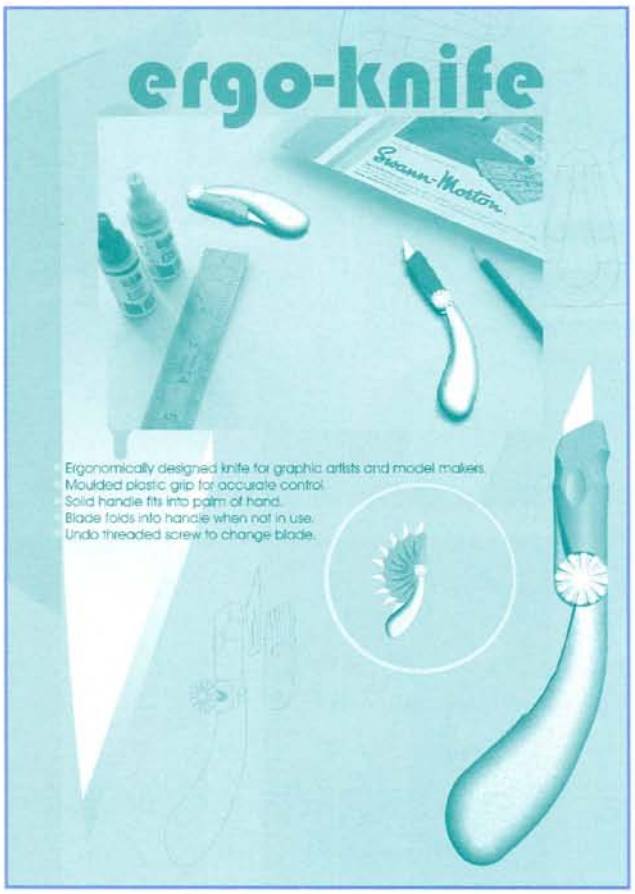
It was envisaged right from the start that the outcome would be confined to a 'virtual product' simulated on the computer screen. The university does have computer aided manufacturing equipment, but in common I suspect with many other institutions, the 3D manufacturing capability required to deal with the more complex of forms created in Pro/DESKTOP is still beyond our reach!

Using CAD without CAM – a valuable educational experience?

Circumstances forced us to consider quite carefully the value of producing virtual products as a project outcome. There are a number of processes that can translate the digital output from 3D solid modelling packages such as Pro/DESKTOP into physical forms, using the rapid prototyping technologies of stereolithography, laminate object manufacture and selective laser sintering. (Wohlers, 1997) Unfortunately from the point of view of the education market, most of these technologies are oriented towards industry and mass production, making them, for the time being at least, prohibitively expensive.

Several relatively low cost alternatives are available in the form of 3D millers, routers and modellers, capable of converting the output from Pro/DESKTOP into physical models. Unfortunately, stringent constraints exist on the complexity of forms that can reasonably be achieved with these machines, governed by tooling requirements and lengthy machining cycles. This means that, for large





teaching groups at least, 3D CAM output has to be restricted to quite simple forms. Not wishing to place the trainees under such constraints on this exercise (and in many ways allowing them to mirror the approach of the designer in professional practice), I encouraged them to explore the full potential of the software unhindered by the need to manufacture but mindful of issues determining the products' eventual 'manufacturability'. With this approach, I believe it is possible to provide a meaningful educational experience that makes use of CAD without CAM, particularly for older pupils. Of course it would only work as an integral part of a broader design and technology education that prepared pupils to understand those issues governing manufacturability in the first place!

Project background

The project had two principal aims; the first was intended to raise students' awareness of the importance of forging of sustainable links between the business and education communities with a view to providing real contexts for school-based work in their future careers. Student teachers, many of whom come directly from school themselves, often have a rather narrow view of industry and commerce and need to learn how the 'work related curriculum and its synergy with design and technology,' (Morris, 1998) can provide them with a rich seam to 'mine' for future project work.

The second aim was to make effective use of the new resource in a relevant context and meet the immediate challenge of integrating the Pro/DESKTOP software into an existing curriculum framework. As this would be the trainees' first experience of the software it was decided to focus on the teacher competences associated with CAD/CAM in the wider context, and in developing personal competence in the use of Pro/DESKTOP, leaving aspects concerned with curriculum implementation until later in the course.

To develop trainees' knowledge of CAD/CAM in the wider context, I decided to encourage them to explore the potential of the new software in supporting new product development through the use of a real industrial context. There are several ways in which a real industrial or commercial perspective can be brought to the development of a product in the classroom, studio or workshop, but perhaps the best of all is a visit where students can gain first hand experience of design and manufacture. Looking around for a company who would be willing to participate in such a collaborative venture, I

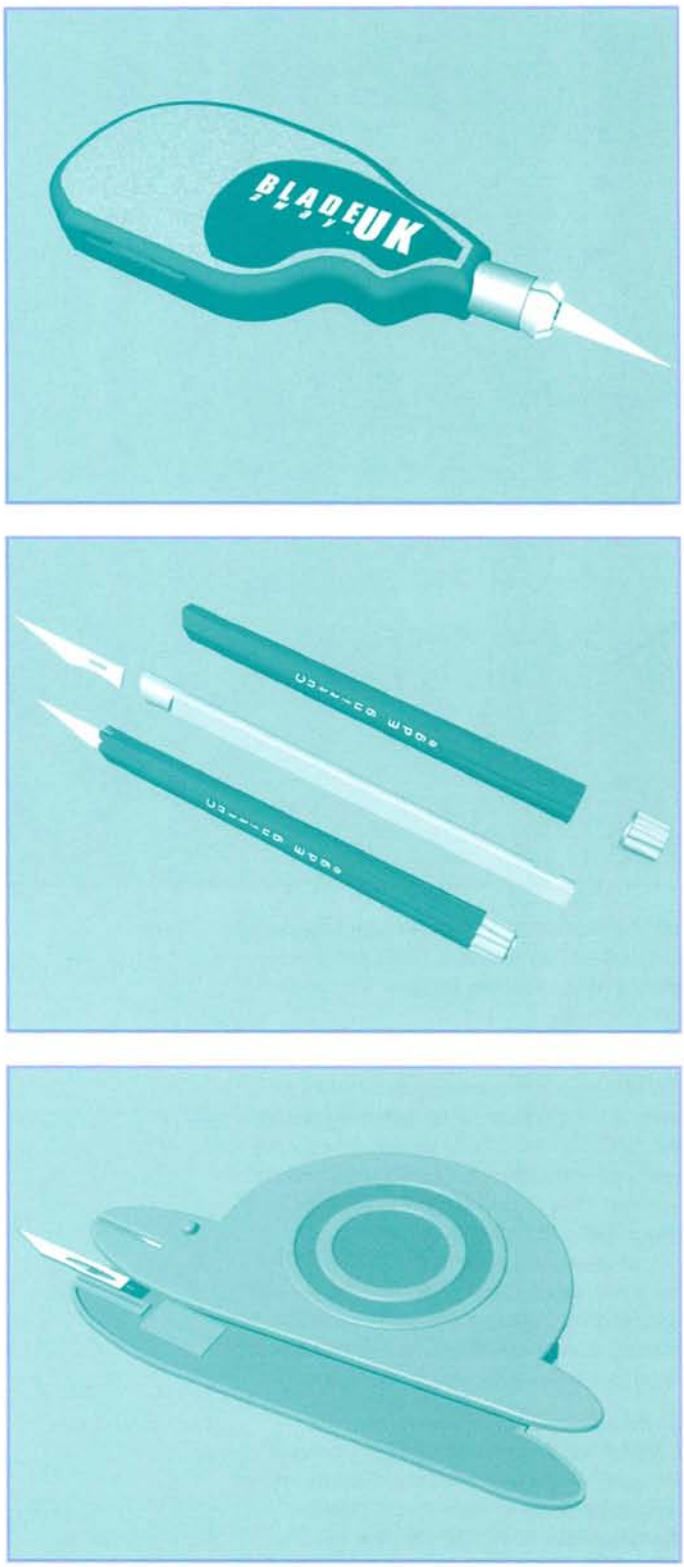


Figure 4: Examples of concept proposals.

settled on Swann Morton Limited, a local company with an international reputation for excellence.

The visit

Swann Morton is one of the world's leading manufacturers of surgical blades, its undoubted success based on among other things a willingness to embrace new ideas and technology. An informative and enjoyable morning was spent in the company of the Managing Director, Works Director and Marketing Manager. After a brief introduction to the company the students were taken on a tour of the factory. Here the trainees were able to see, at first hand, precision manufacturing techniques and contemporary quality control procedures, as well as finding out more about the company policy on new product development.

The visit concluded with a question and answer session back in the boardroom, which turned out to be a very valuable exercise. Trainees and company executives engaged in frank discussion, which challenged many of the trainees' assumptions, highlighted the constraining factors governing new product development in this particular field and provided the trainees with a sounding board for their proposals.

During the briefing given prior to the visit, the trainees had been encouraged to consider improvements in blade holding mechanisms, safety, storage options, aesthetics and ergonomics as well as the possible use of new materials and new or multi functional applications. Many of these aspects were also discussed in some detail with the company representatives. Before leaving, the trainees were given a sample pack of Swann Morton freebies and a personalised certificate of attendance as a memento of their visit!

Project outcomes

Back at the university, their interest and awareness of the context having been raised by the visit, the trainees began their response to the brief. The company is usually given to only incremental improvements, mostly customer driven, to what is essentially a very successful product range. However, in their own publicity they make it clear that they are always looking to develop and widen their range of products. This provided a perfect opportunity for trainees to work on a hypothetical client-based brief, in which they would suggest innovative additions to the product range.

Work on the project started in earnest with collaborative work on analysis of existing products. Strategies used included

disassembly, user trips, client interviews and research into specific focus groups.

The students then began to formulate their individual responses. Among the contexts chosen were primary school applications, geometric shape cutters, ergonomic improvements (including non-handedness) and design for longevity/upgradeability.

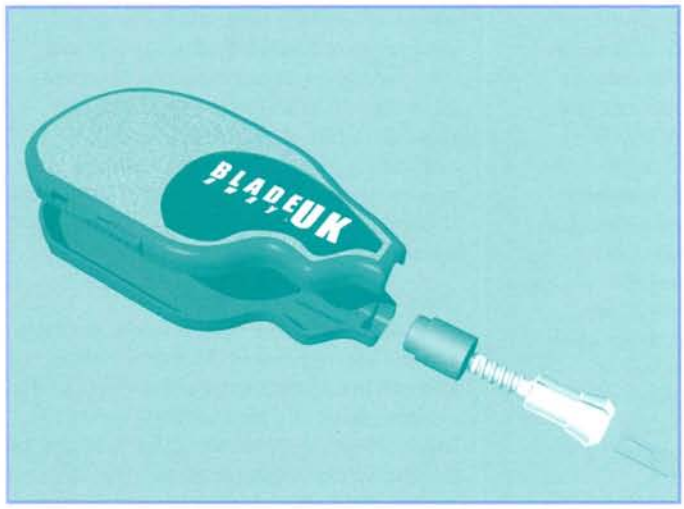
Putting the Pro/DESKTOP software through its paces

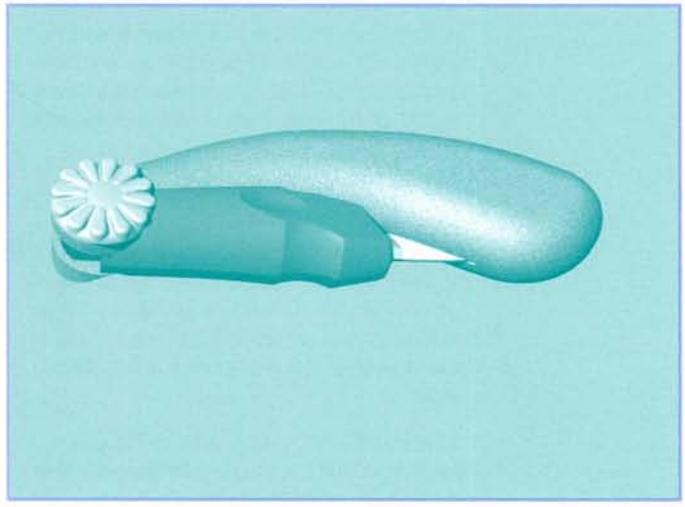
Before this assignment, the group had been introduced to the Pro/DESKTOP software through focused tutorials which included sessions on sketching and feature-based modelling, photo realistic imaging in the album interface and the use of the drawing interface to produce working drawings. Once the trainees had begun to think about possible concepts for the blade holder, it was interesting, as an observer, to see how the Pro/DESKTOP software was used. Research into the use of product simulations and virtual prototypes at Brunel University has suggested that the simulation of virtual models on the computer screen significantly reduces the need to produce a physical model to verify design concepts, at least in the early stages of conceptualisation (Sharp and Wright, 1996). This was borne out in my observations of the trainees at work. The feature-based solid modelling system allowed them to experiment quickly and effectively in the design interface, to arrive at a realistic visualisation of their proposed product. They were able to play with ideas of form as well as manipulate more functional elements such as jointing methods and component fit. The production of photo-realistic models in the album interface allowed for subsequent aesthetic refinements in terms of colour, shade and texture and all was done in a fraction of the time it would have taken to produce physical models of a comparable quality.

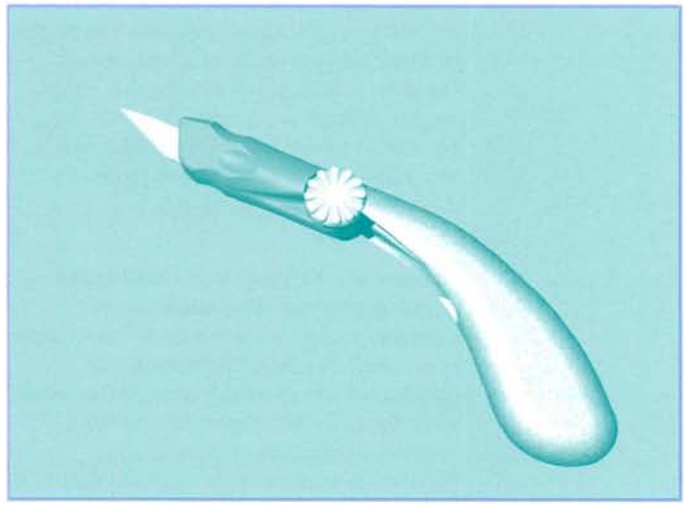
'Contextualising' the concepts

Having developed a suitable virtual prototype, trainees were then set the further task of placing their proposals 'in context'. Just as the size, shape and quality of a space have a significant effect on the way we perceive the objects that are placed in them, placing a virtual prototype in context allows the designer and/or client to visualise the finished result and thus make judgements about its suitability. In addition to allowing the designer/client to evaluate appearance, the resulting images can also be used in consumer research and promotional material.

The absolute ease with which impressive photo-realistic images can be exported from Pro/DESKTOP as JPEGs, TIFFs or Bitmaps,







This is the first article to be published in the Journal depicting work produced as part of the CAD/CAM in Schools Initiative. The Editorial Board will be pleased to consider any further articles based upon this scheme, for future editions. Please refer to 'Guidelines to Contributors' for further details.

combined with the availability of a digital camera (recently identified as the ICT tool with the highest impact rating on the quality of attainment in design and technology, [Fischer Family Trust, 1999]), made it possible for trainees using digital image manipulation packages such as Photoshop and Corel Draw to present their final proposals in a variety of exciting and dynamic ways.

Summary

All that remains from this particular project is to close the loop and invite representatives from Swann Morton to view the results of the exercise, some of which certainly appear to have commercial potential. This is planned for the start of the coming academic year. The trainees themselves were extremely impressed by the ease with which Pro/DESKTOP has extended their design capabilities and many were quick to spot its potential for use when presenting work for other units in the course programme, particularly in self directed open project work.

The advantage from our point of view is that we now have a cohort of trainees about to enter the Professional Year (in which they will spend a substantial amount of time on school placement) who are now conversant with the software and can thus reflect on how best to use it in their own curriculum development work.

This is definitely going to be an interesting challenge, and not just for our trainees. The availability of 3D modelling software undoubtedly creates a dilemma for all design and technology teachers. Students may be able to create impressive 3D solutions on the computer screen, but converting this into a tangible artefact is presently beyond them, as for many schools, the link to CAM is too expensive, time consuming and prone to difficulties arising from system incompatibility.

But need this be a problem? Creating and 'interrogating' virtual products on the computer prior to commitment to manufacture is now well established in professional practice, so why shouldn't our students follow suit? Does this still constitute a valuable educational experience? After careful observation of the trainees on this project I believe it does. The CAD/CAM pupil competencies, drawn up as part of the CAD/CAM in Schools Initiative acknowledge that at best, we can only expect to raise pupils' awareness of developments at the high technology end of manufacturing. Practical experience of rapid prototyping may be some way off but many schools now have access to high specification 3D CAD software – clearly we should be encouraging the older students to use it at its full potential and not limiting its use to designing only that which can subsequently be manufactured.

This is not to suggest that 3D CAD should be regarded as a wholesale replacement for some of the more traditional working methods at the heart of design and technology education, such as sketching and modelling and ultimately making products. The need to acquire skills and knowledge related to the manipulation of materials also remains. Pupils obviously need to know how materials behave before they can put them to use in design solutions, whether the computer screen is the medium or not.

What the new generation of 3D CAD software does offer pupils is a powerful vehicle for experimentation, enabling them to develop ideas of a quality that previously would not have been feasible. In many cases, subsequent manufacture may continue to follow more traditional routes, for the time being at least, but it should not prevent us from capitalising on what is a major educational asset in the field of design and technology.

References

Barlex, D. (1999) 'Preparing Design and Technology for 2005 – Moving Beyond the Rhetoric', The DATA Lecture, NEC Birmingham, November 1999

Breckon, A. (2000) 'DfEE/DATA CAD/CAM in Schools Initiative – A Success Story so Far', *The Journal of Design and Technology Education*, Vol 5, Number 2, Wellesbourne: DATA

Byers, S. (1999) *Manufacturing in the Knowledge Driven Economy*, DTI White Paper

DfEE/QCA (1999) *The National Curriculum for England – Design and Technology*, DfEE/QCA

Evans, M. (1998) *The Potential of Computer Aided Industrial Design to Act as a Catalyst for Greater Professional Collaboration*, ASIS Mid Year '98 Proceedings

Fischer Family Trust (1999) *Software Best Practice Survey*, www.fischertrust.org – visited July 2000

McCullagh, K. (1996) '3D Computer Modelling in Industrial Design', *Co-Design Journal*, August 1996

Morris, E. (1998) Keynote Speech to the DATA Conference, Birmingham 1998.

Sharp, J.A. and Wright, D. (1996) 'User Testing with Virtual Products', *Co-Design Journal*, August 1996

Wohlers, T.T. (1997) 'Worldwide Trends in Rapid Prototyping Proceedings', International Conference on Manufacturing Automation, April 28-30, Hong Kong: University of Hong Kong