

# The use of I.T. in Art and Design

A Selection of Art and Design Case Studies prepared for AGOCCG

It should be noted that these reports were scanned in before being converted to html format, and as such there may be a number of typographical errors.

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# Introduction

This collection of case studies from the art and design higher education community came about as a result of a meeting held at Loughborough University in April of last year. This meeting was held in response to an invitation to the art and design community from AGOCCG aimed at discovering the relevance of the activities of AGOCCG to this group of computer graphics users. Although this group obviously has a major interest in computer graphics there are two main reasons for lack of contact in the past. Firstly, nearly all art and design departments in higher education have existed as stand alone institutions or faculties within polytechnics and therefore only recently came under the remit of HEFCs, and secondly AGOCCG itself grew out of the scientific graphics visualisation community.

There was therefore little knowledge of each others activities, interests and preoccupations, and no clear indication of whether there could be any potential benefit for a closer understanding of the areas of mutual interest.

An outcome of the meeting was an open call for case studies in order to start the process of exchanging information.

A simple analysis of the studies that have been received by AGOCCG shows that the largest single category concerns the descriptions on the use of CAD systems in three dimensional design courses, closely followed by Hypermedia applications to design courses. After these two categories have been satisfied the studies become more individual and particular. There is a keen interest in the use of the World Wide Web, particularly among fine artists, and considerable discussion on the detailed merits of individual drawing\painting\modelling software, used by fine artists.

What has materialised is a very fair and representative cross section of the computer graphics interests to be found in the art and design sector of higher education. An early observation could be made that there is almost universal acceptance and use of application software, so there is a strong 'user' community without any strongly developed appreciation of the potential for software development. There is also a strong Macintosh using group which is a rarity in the 'old' universities, whose needs will need to be considered. I also sense that there is patchy technical support for art and design users whose needs may differ from the average users.

However it is much too early to come to any firm conclusions; I believe there is much to be learned and I hope that AGOCCG will continue to foster a debate which will serve to ensure that all aspects of the use of computer graphics are kept under consideration.

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**Next Report:** Intergraph MicroStation for 3D Industrial Design

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# Intergraph MicroStation for 3D Industrial Design

by Gill Chapman, Senior Lecturer in Computer Aided Design, School of Cultural Studies, Sheffield Hallam University. Intergraph MicroStation for 3D Industrial Design

In the summer of 1992 the CAD hardware and software in the School of Cultural Studies at Sheffield City Polytechnic (now Sheffield Hallam University) was completely replaced. The necessity of choice focused staff minds on their educational priorities for CAD and on the type of equipment which would best enable them to fulfil them. The major CAD users were industrial designers, but a range of CAD activities from engineering design to fine art had to be catered for.

At this time the industrial design section was putting in place a new strategy for IT teaching on the two courses BA (Hons) Product Design and BA(Hons) Design with Applied Technology. It was important that the strategy came first, at least in essentials, and the new equipment came second. This meant that the software and hardware were specified to fit the strategy rather than, as is often the case, the other way round. The strategy is described in detail in my companion case study 'Introduction of 3D CAD into Industrial Design Courses'. This case study looks at the reasons for our choice of Intergraph MicroStation as our main teaching software and describes three years' experience of using it.

## 1. The Existing Situation

When I took up my position four years ago the facilities were actually quite impressive by Polytechnic standards. There were 12 Apollo Workstations running AutoCAD, CGAL (a surface modelling and animation package) and IDEAS GEOMOD. The packaging design section had just invested in 12 Mac LCs running Aldus Pagemaker and Freehand, plus a Mac IICx running PhotoShop. These were heavily used for the large graphics component of the HND in Packaging. There was also a reasonably good word-processing facility provided on PCs by the Computer Services department of the (then) Polytechnic, which was hardly used by design students. The CAD facility was also under-used, due to lack of staff time and expertise.

Unfortunately it became clear as the new strategy began to be implemented that the existing hardware and software were not as good as they at first appeared. CGAL was very difficult to use, was not in general use outside the Polytechnics and would not communicate in any way with any other packages. GEOMOD ran very badly on our Apollos, which were out of date when they were bought and which were also unable to run current versions of standard design software such as AutoCAD 11. Money became available to upgrade the facility and it was decided that it should be replaced. Exhaustive research was begun into what should be purchased, based on our teaching and learning philosophy and our research needs.

## 2. The Underlying Philosophy

The first and most essential step when buying new IT equipment is to sort out exactly what is to be achieved when it arrives and how. If the underlying philosophy is not clear the new purchase is unlikely to be successful, however much money is spent on it. The decisions made by staff at Sheffield Hallam are described fully in my other case study, but it is worth summarising them briefly here.

The first priority was to emphasise three dimensional computing, both because we believed that this will be essential for students working in industry in future and because it has much greater educational benefit for three dimensional designers than does 2D CAD. It was also decided that all the students should be given realistic 3D CAD experience and not just the enthusiastic few. The use of this technology would be encouraged as an educational and creative tool and would be integrated as far as possible into the rest of project-based design learning.

### 3. Initial Problems

It is often suggested that the second step, after clarifying the underlying philosophy, should be to make a check-list of the various activities to be undertaken and create a software specification to accommodate them. If money was no object this would be good advice, but if resources are limited it may lead to much wasted time spent in creating a wish list that can never be afforded. It is probably better to have some idea of a realistic hardware platform at the beginning of the exercise, and this will also narrow down a bewildering array of software alternatives.

Because all students were to be given the chance to learn quite advanced computing it would not be acceptable to end up with less than the existing 12 3D seats, but the available resources would not run to replacing the old Apollos with other workstations. The choice was therefore between Macs and PCs. The Computer Services department, which would be looking after the facility, favoured PCs because they wanted to network them for management and security reasons. Luckily, 3D work was just becoming a viable proposition on 486 PCs and it was decided to look first at PC software. In the event, it was found that we could afford one or two workstations as well for advanced work, should that offer a significant advantage. Computer Services favoured Suns because they had experience with them and felt they offered the best value for money at the time.

Another problem was the nature of 3D CAD within industrial design and the lack of any kind of industry standard [1]. Industrial design spans a spectrum between art and engineering and ideally both ends of this spectrum should be available within one piece of software. It was obvious that this ideal would be hard to find because of the way CAD has grown up within different disciplines, all of which impinge on product design, but none of which have been specifically aimed at it. 2D draughting on computer has been primarily aimed at architecture or engineering. 3D surface modelling has often been added onto architectural draughting packages in a half-hearted and unsatisfactory way. Alternatively, 3D solid modelling has been available via the engineering profession, in which case it has also provided a link into CNC or CAM, but it has been very unfriendly to designers. The third route into modelling has been via packages aimed at computer graphics and animation. These surface modellers are very strong on the presentation side but they are not always sufficiently accurate for industrial design, nor do they have any way into CAM. This situation is no doubt one reason why the revolution predicted for product design within industry has been slow to take off [2].

### 4. A Software Spec.

Despite these difficulties, software had to be decided upon. A check-list of criteria was evolved which included:

- **1. The ability to create detailed and accurate models:** This criteria was put first, even above ease of use, because it has been found that students soon become frustrated with 'quick and easy' packages which won't allow them to achieve the complexity and detail which they want.
- **2. Ease of use,** to the extent that this was compatible with the above. 'User friendly' is a concept which needs to be carefully examined. Menus and icons are important, but even more important is allowing the user to work in the way s/he wants to. Software designers have been slow to understand this.
- **3. The ability to work in a 'sculptural' way with surfaces:** This is crucial to the way product designers want to work. Solid modellers should be able to offer it, but three years ago these were barely available on PC and they still tended to have designer unfriendly interfaces. As far as surface modellers were concerned, non-uniform rational B-splines (NURBS) seemed to be the key.
- **4. Industrial credibility:** Although those parts of industry which have taken 3D CAD on board do not generally work on such a low-cost platform it was still important to go for software which was fairly widely used, at least for 2D work.
- **5. Good rendering and animation for presentation work:** We had become accustomed to this with our old software and did not want to lose it. It would also be important for the fine art students who also use the facility.
- **6. The possibility of extending into CAM and FEA:** Another reason why we might want solid as well as surface modelling.

### 5. The Choice

As expected all this was not available within one package. The choice three years ago seemed to come down to two software providers, either AutoDesk with AutoCAD 11 and 3D Studio, or Intergraph with MicroStation 4 and ModelView, which had just come out for the PC. As a basic teaching platform, AutoCAD and MicroStation scored fairly equally on the first criteria of detail and accuracy. MicroStation scored much better on no.2, ease of use, and also on no.3 as it was the only software with NURBS then running on a PC. AutoCAD had more industrial credibility at PC level, but Intergraph was known within industry for their workstation software and they were also making progress with MicroStation. For basic rendering, MicroStation was better than AutoCAD, but for more sophisticated work, and particularly for animation, 3D Studio was far superior to ModelView. If we could afford one or two workstations it seemed to be an advantage that Intergraph provided software for these as well as for the PC, so that we could maintain contact with solid modelling within one suite of packages. We looked at Intergraph EMS running on a Sun, and at I/Design which had recently come out and was aimed specifically at industrial designers.

### Initial Perception of Software Performance

	MicroStation4	ModelView	AutoCAD	3DStudio
Detailed models	Good		Good	Poor
Ease of use	Good	Poor	Poor	Good
Sculptural surfaces	Good		Poor	Poor
Industrial credibility	Adequate		Very good	
Rendering	Good	Very good	Poor	Very good
Animation		Good		Good

(See section 7 for how these compared with our perception after extensive use).

It was eventually decided MicroStation 4 would be the main teaching platform, with four copies of ModelView for advanced presentation and animation of MicroStation models. One copy of EMS was put on a Sun Spark workstation, the idea being that some MicroStation models would be taken into EMS and edited using the solid modelling techniques available in that software. Four copies of 3D Studio were also purchased for the fine art students wishing to do animations, as their need for accurate models is not as great as that of the industrial designers.

There was already a A0 pen plotter in the graphics lab, as well as video output. For colour stills we take photographs of the screen, which is surprisingly satisfactory. Since the initial outlay, a PowerMac has been purchased, plus PhotoShop and a colour scanner. There is no problem with sending image files between the PCs and the Mac via the network.

The total budget over two years was  $\text{£}70,000$ , which included for the basic MicroStation facility:

	Price per Item (UK Pounds)	Total Price(UK Pounds)
12 x 486 PCs with 16Mg RAM, graphics cards, super-VGA screens.	2500	30000
12 x MicroStation 4	100	1200
12 x MicroStation 5	350	4200
4 x ModelView	350	1400
4 Gigabyte Server	8000	8000

## 6. MicroStation in Use

## 6.1. 3D Modelling Classes

MicroStation 4 was put to use with the first Year 1 group in the autumn of 1992. In January 1993 it was replaced by MicroStation 5. As there are two industrial design courses, the new teaching and learning plan has now run six times; twice on our old software, three times on MicroStation 4 and once on MicroStation 5.

All the industrial design students now do a 'Design with Computing' unit in their first year. The teaching methods are described in 'Introduction of 3D CAD into Industrial Design Courses', section 3. There follows here a description of the skills which the students learn in their classes, which will also give a flavour of MicroStation's capabilities. It has evolved somewhat with use, particularly with the upgrade to version 5.

Because MicroStation is reasonably intuitive for designers to use, the students are able to progress quite rapidly through basic 3D CAD modelling techniques. Before they start, they have had about six hours computer familiarisation and word-processing instruction. They then plunge straight into 3D. The majority of the students are able to cope with each session in two hours.

### Session 1 - Introduction

- Opening a 3D file. Learning about pull-down menus, which use word commands, 'palettes' which use icon commands and 'settings boxes' which use both. Palettes and settings boxes can be left open and moved around the screen as desired. 'Sub-palettes' can be 'torn off' the main palettes, giving access command modifiers - e.g., the length or angle of a line [Fig 1].
- Becoming comfortable with 3D space. Learning to rotate the views interactively [Fig 2], zoom in and out etc. Viewing in perspective.
- Starting to create 3D primitives (spheres, cones, cylinders, slabs). Drawing in different colours. A first look at rendering.

### Session 2 - Elementary Object Creation

- Using sub-palette modifiers on lines and 3D primitives. Creating a torus and a wedge (new primitives in version 5).
- Using 'tentative' snap - so called because MicroStation will try various options until the user accepts the correct one.
- Drawing accurate planar shapes using co-ordinates in x, y and z.

### Session 3 - Elementary Object Creation (cont)

- Different methods of creating circles and arcs.
- Creating 'surfaces or solids of projection' (these are not really solid, but objects with 'capped' ends). A planar shape is created in one plane and the thickness defined in the third dimension [Fig 2]. This is quite intuitive in MicroStation. A good feature is the ability to move between views, or turn controls such as axis lock on and off, in the middle of a command.
- Creating a solid of projection with a hole in it.
- Creating 'solids of revolution' - open or closed profiles spun round an axis [Fig 3].
- Setting 'active depth'. In any plane, this defines the drawing position in the third dimension.

### Session 4 - Elementary Model Editing

- Methods of object selection.
- The 'manipulate elements' sub-palette: copy, move, move parallel, offset, scale, spin and array.
- The 'modify element' sub-palette, moving a vertex, deleting part of the element, extending elements to intersection etc. Many favourite AutoCAD features, such as trimming with a 'cutting edge', are here.

### Session 5 - Managing the Project

- Using 'levels' ('layers in AutoCAD). Defining level symbology'.
- Using the dip-board to copy and paste between files.

- Saving plot files.
- Setting up 2D views of the model on a sheet. New and very easy in version 5.

For some groups, classes have stopped here in Year 1 and a two week project has been set using the commands used so far. After only ten hours work most of the students are able to start using the computer to create their own 3D designs (see Fig 1 in 'Introduction of 3D CAD into Industrial Design Courses').

With other groups classes have continued:

### **Session 6 - Complex Model Creation**

- Creating and manipulating B-spline curves in 2D. Control points for the curves can be easily picked up and moved.
- Creating B-spline surfaces. Creating 'B-spline surfaces by edges'. This is one of the easiest and most reliable methods of creating sculptural surfaces, as a series of patches each defined by up to six edge curves ([Fig 4], see also Fig 3 in 'Introduction of 3D CAD into Industrial Design Courses').
- Creating and editing edge curves in 3D space.

### **Session 7 - Complex Model Creation (cont)**

- Creating 'B-spline surfaces by network'. Another good method, giving more control over what happens in the centre of the patch [Fig 4].
- Creating 'tubular surfaces' - made by sending a cross-section along a path. Objects can be made using two different cross-sections (see Fig 2 in 'Introduction of 3D CAD into Industrial Design Courses'). A command to use more than two existed in version 4 but failed to work. It has been dropped from version 5.
- Boolean operations. New in version 5, these are not working well (see section 7).

## **6.2. Presentation Rendering**

Rendering facilities are much more sophisticated in MicroStation 5 than they were in version 4. Despite the lack of ray-tracing, they are as nearly as good as ModelView and much easier to learn. First year students usually find out quite a lot for themselves, but advanced rendering techniques are not actively taught until Year 2. Previously using ModelView and now MicroStation 5 students learn:

- Setting up a view with the camera. This is not as easy as it might be in either software.
- Surface finishes. MicroStation 5 has a wide range of surface finishes and others can be scanned in. There are many surface attributes which can be defined, such as the strength and quality of highlights, transparency, 'bump maps' etc.
- Lighting. There are six different types of light, aU with various controls. Getting the lighting right is the most important part of a successful rendering.
- Using shadows. As there is no ray-tracing, MicroStation uses 'shadow maps' which are very effective.
- Saving rendered images. The final render can be anti-aliased and saved in 24 bit colour.

## **6.3. 2D Draughting**

As mentioned elsewhere [3], 2D draughting is learned after modeUing, not before. MicroStation is a very good tool for the production of engineering drawings, at least the equal of AutoCAD in power and facility and considerably friendlier to use. For die-hard AutoCAD users it can be configured to look like their old favourite. After learning 3D, students teach themselves 2D with the manuals, or create drawings from their models.

## **6.4. Animation**

Because of time constraints, animation has not been generally undertaken until Year 3. Intergraph software performs reasonably well for 'walk-throughs' or 'fly-rounds', which are now available within MicroStation 5 as well as ModelView. For animating moving parts of a model, which is the main purpose of animation for industrial design students, the situation is not satisfactory (see section 7). The quite impressive results achieved by some students has been in spite of, rather than because of, the software.

## 6.5. CNC and CAD/CAM

Apart from work done on an individual basis by a few students this aspect of our stated aims is not yet in place. Last year one of the third year product designers took a design right through from a CAD model done on EMS to a stereo-lithography one, with the help of two different industrial sponsors. Taking MicroStation designs right through to physical models is the main content of our current IT development.

## 7. Successes and Disappointments

Inevitably, not everything that was hoped for from MicroStation has come about, but it has nevertheless proved its worth as a low cost modelling package. The most important aspect has also been the most successful, in that a high proportion of first year students have become confident in the use of 3D modelling on computer. They are therefore genuinely able to assess its merits and decide how far they want to extend their use of the tool. Compared with the old software, students now find this learning curve much easier to climb. When the use of CAD as a creative tool is looked at the benefits of the new software are even clearer. Very few of the first groups used the computer creatively, whereas several of the later groups did, even in their first computer project and after only ten hours of formal teaching.

The major problems encountered have come at later stages when students move on to more advanced work. The B-spline surfaces which really tipped the balance in favour of MicroStation initially turned out to be full of bugs in version 4 and it took several frustrating months to work out which commands were reliable and how to get round the various problems. In version 5 these commands are much more robust, however one command which would have been useful had it ever worked has been dropped altogether - an admission of failure, presumably. Similarly, the Boolean operations which are new in version 5 are very unpredictable. A proper solid modelling add-on package is now in the pipeline, which will hopefully work better. It seems to be the case that one can only rely on the commands which have been in the software for at least two releases. I gather that this is not so in the case of AutoDesk software.

Another problem has been that MicroStation does not really work well when run on a network. There have been endless problems which have been hard to diagnose because they could be the software or they could be the network. Many of these seem to relate to the way MicroStation uses temporary memory space on the hard disks. Our Computer Services department is continuing to work on these problems but they are still not entirely resolved.

ModelView has been a disappointment. The interface is confusing and does not relate well to the MicroStation interface. It is extremely clumsy for animating parts of working models, involving constant to-ing and fro-ing between the two pieces of software. It has also refused to run from the network, making the whole process even more fiddly and time-consuming. The situation has improved somewhat with the enhanced rendering and 'fly-through' facilities within MicroStation 5. As soon as we locate a satisfactory add-on package to animate moving parts of the model within MicroStation, ModelView will be dropped with sighs of relief all round

### Software Scores after Extensive Use

	MicroStation4	MicroStation4	ModelView
Detailed models	Good	Good	
Ease of use	Very Good	Very good	Very Poor
Sculptural surfaces	Poor	Good	

Industrial credibility	Adequate	Adequate	
Rendering	Good	Very good	Very good
Animation		Some	Poor

Apart from the excellent work of one student, EMS 2 has also been of limited use so far and is under review. Although simple MicroStation models can be transferred to EMS, models containing B-splines have proved problematic, and B-splines are heavily used by our students to create the shapes they want. It is hoped that EMS 3 and MicroStation 5 will work better together, but this has not been tested so far.

Our latest purchase has been two copies of Pathtrace CAM software which takes in MicroStation models and produces CNC code for the machine tools in our own and the engineering department workshops. This exercise is still at the testing stage. It is hoped that the students will soon have the option of taking their modelling skills either towards advanced presentation work, or towards CAD/CAM and more scientific applications such as FEA. They will then have spanned the art to engineering spectrum, if not with one piece of software. at least with one data model.

## Notes

[1] see 'Introduction of 3D CAD into Industrial Design Courses', section 1.2.

[2] as above, also 'The Management of IT in the Professional Practice of 3D Design', from the Art & Design Research Centre, Sheffield Hallam Universitys

[3] 'Introduction of 3D CAD into Industrial Design Courses', section 2.2.

## Illustrations

Fig 1: A MicroStation screen, showing menus, palettes and settings boxes.

Fig 2: A 'solid of projection', plus the interactive View Rotation.

Fig 3: A 'solid of revolution'.

Fig 4: B-spline surfaces, 'by edges' and 'by network'. Views I and 3 show the curves used.

# A Strategy for the Introduction of 3D CAD into Industrial Design Courses

by Gill Chapman, Senior Lecturer in Computer Aided Design, School of Cultural Studies, Sheffield Hallam University.

The introduction of 3D CAD into industrial design BA courses across the country has been patchy at best. CAD hardware and software has frequently appeared in institutions as a result of the enthusiasm of a few individuals who have used a particular CAD system themselves or been bowled over by an impressive demonstration. All too often, it is then left to languish largely unused because no-one has the time or the expertise to develop a clear strategy for its comprehensive introduction into the course. Sometimes a few keen students will manage to produce some impressive computer graphics which are much in demand by heads of department for New University prospectuses, but these rarely give an accurate picture of the experience of the majority of students.

At Sheffield Hallam University a conscious attempt has been made to evolve a coherent teaching and learning strategy for both our industrial design courses and to some extent for other art and design courses also. The two courses most closely involved in the strategy described in this case study are BA(Hons) Product Design and BA(Hons) Design with Applied Technology. Common problems which bedevil an exercise such as this will be investigated first, followed by a description of the major characteristics of the new strategy set up to deal with them. The teaching and learning plan will then be detailed and the results from three years experience analysed.

## 1. Problems for the Introduction of IT

The reasons why the introduction of computing into courses has tended to be problematic are numerous and varied. It was necessary to understand some of the problems before a strategy could be evolved to overcome them, while others became evident as the strategy progressed. Some are theoretical or even philosophical, while others are severely practical. Some of the problems relate particularly to industrial design, whereas others are shared more widely with other areas of art and design education. Michael Kitson, for example, suggests that an increasing gap is developing between what is actually taught in design schools and 'the expertise required of those pioneering and practising in the design industry' [1]. This view is supported by our own research [2]. But why is this?

### 1.1. Hostility to Technology

One of the most controversial problems and perhaps the most pervasive and difficult to combat is the almost subconscious fear and dislike of new technology which has bedevilled British design for more than a century [3]. This hostility is naturally reflected within design education, which is generally more comfortable with a craft tradition than a 'high tech' one. We see a threat to the former from the latter which may or may not be justified.

Joseph Wiezenbaum, in his seminal work 'Computer Power and Human Reason' [4] explains why this is so. Traditional tools have evolved over many years - in some cases centuries - to fit their function. In doing so they have taken on a larger role and come to 'symbolise the activity they enable'. It is not surprising that practitioners have confidence in these tools and see new and unfamiliar tools, such as computers, as a threat. In his recent study, Robin Baker [5] points out that we are still in a transitional phase in the development of a computer aesthetic similar to that in the development of the motor car when it was still seen as a 'horseless carriage'. Artists and designers are mostly using computers to do what they have always done and measuring their new tools against the old ones using the same criteria. We are only just beginning to see the computer as a new medium in its own right, which will lead to completely new kinds of activity. This, of course, is another threat to many people.

Fear such as this underlies the widespread feeling among many artists and designers that the computer should be used, if at all, as a 'dog's body' for boring and repetitive tasks and that it cannot be used creatively. Indeed, many feel that its use has a strongly negative effect on creativity. It is true that the results of computer art and design so

far have been of very mixed quality, but this is inevitable at this early stage in the use of a new medium. Robin Baker has 'been unable to detect any fundamental problem with [the computer's] imaginative use' and feels that its creative potential is now undeniable.

Both sides of this debate were (and are) represented within industrial design staff at Sheffield, and within the student body. Certainly, previous experience suggested that many students could see the benefits of the computer for presentation work, but few were using it as a creative tool, as a means of sparking their imaginations at the concept stage of a design. Opinions differed as to whether this was an innate limitation of the tool or a result of the difficulty students had in climbing the initial learning curve to the point where they could use it so freely that they really were in a position to discover its creative possibilities. By evolving strategies to overcome the initial difficulties we hoped to find out.

## **1.2. No Lead from Industry**

As well as concerns about technology and creativity those of us in education also tend towards a somewhat ambivalent relationship with the industry for which we provide graduates. As economic depression within design continues and jobs for our students become harder to get we have recognised that we must listen more and more closely to what industry wants, but we are uneasy about the loss of academic 'freedom' that this seems to imply. Part of this problem may be that we see our increasing closeness to industry too much in terms of following their lead and not enough in terms of supplying a lead of our own.

This is a particular problem for the area of CAD in industrial design, because there is no clear lead from industry to follow. The graphic design industry has embraced 2D computer graphics to such an extent that the practice of their profession is now almost entirely dependent upon the mastery of an Apple Macintosh. Education has had no choice but to go along with this and so graphic design courses are perhaps the best organised of all design courses in terms of their IT provision. Architecture has grudgingly accepted the benefits of at least computer aided draughting and few of their students have not been introduced to AutoCAD, although 3D CAD is still not universal. In industrial design the position is extremely confused, as our own research has shown [2]. Engineering drawings are usually done on 2D CAD systems, but these are produced by technicians not by designers. Large companies sometimes have 3D CAD systems, but again these are generally used by the engineers not the designers, and there is no clear industry favourite. Design consultancies can rarely afford 3D CAD, and they also have the problem of compatibility with the different systems of their various clients. The difficulty is as much one of the radical change in working practices demanded by new technology as of the technology itself. The buzz word for this new way of working is 'concurrent engineering', which is at least partly dependent on the ability to create a single 'data model'. It seems at present that industry in general is still teetering on the brink of making a full commitment to this revolution.

## **1.3. Doubts about Educational Value**

Debates about what technological skills students actually need shade into debates about the educational value of those skills. All agree that skills teaching should not only be an end of better design education but a means towards it as well. Drawing and modelling skills are taught not only because students need them, but because it is through the thoughtful exercise of these skills that they learn to become designers. If there are doubts about the creative potential of computers there will also be doubts about whether it is really good for students to spend much time on them. The fear of new technology that many staff feel is expressed in terms of concern about the time that IT teaching takes away from other activities which are perceived as being more essential to the learning process.

There is also concern over the way in which IT teaching is - or is not - integrated into the rest of design's project based learning. Computer based design usually takes place in a different place and at a separate time from other project work. Often, this problem is compounded because the teaching of such skills is in the hands of different staff from studio and workshop work, staff who may not even be designers themselves. These are very real problems which have to be addressed in any learning strategy.

## **1.4. Lack of Time and Expertise**

Even if it is accepted that students need to learn about certain computer based activities there are a number of practical difficulties that stand in the way. As we all know only too well, new university lecturers are coming under increasing pressure both to teach more students and to do more research. Three years ago less than half the industrial design staff in Sheffield had first-hand experience of CAD, and of those who did very few had extensive or up-to-date knowledge on which to draw. Even those who were enthusiastic lacked the time to develop their interest to the extent of writing or supporting new course units. It is likely that this was (and perhaps still is) a fairly typical situation.

The background of the students was also a problem. All children pick up basic drawing skills at an early age, and industrial design students usually arrive with at least some basic understanding of the workshop environment. Skills teaching is therefore building on a pre-existing base, rather starting from scratch. Basic computer literacy is generally higher among incoming students than among many staff and it is continuing to rise, but few of them have used CAD before they arrive and even fewer have worked in 3D on a computer. Some still arrive without ever having touched a keyboard, so any IT teaching programme would have to begin right at the beginning.

## **1.5. Cost**

The sheer cost of IT hardware and software seems to many people to be the major stumbling block to becoming seriously involved in teaching in this area. In the penny-pinching world of post-Thatcherite higher education how could we hope to keep up with the fast-moving and technologically sophisticated field of Computer Aided Design? It is certainly true that there is a serious resource implication for any new IT plan; however one of the aims of this report is to show that cost is not, in fact, the most important consideration and neither is it an insurmountable problem. The constantly falling price of equipment means that it is now possible to provide facilities for large numbers of students to learn the skills and concepts which they will need to operate successfully in the new environment, providing that priorities are carefully defined.

## **2. Major Characteristics of the New Strategy**

### **2.1 Mass Provision**

Confronting these problems clarified the areas in which decisions had to be made. Lacking any clear lead from industry as it is now, the only option was to try and look ahead and make an intelligent guess as to the situation which our students will encounter at some point during the next ten or fifteen years. We believe that industry will then need graduates who are competent with 3D CAD and able to work within the new environment that the widespread use of this technology will create. By following the lead of the small section of industry which is looking to the future we hope to keep our graduates at the forefront of developments rather than trailing behind them. We may even be in a position to provide a lead of our own.

One of the first and most important decisions which was taken, therefore, and it was one which we believe marks us out from most other 3D Design courses, was to provide IT skills at a high level for all the industrial design students and not just for a favoured few. But this would mean that a low-cost hardware and software platform would have to be accepted, while the areas of industry which have taken this route so far are generally in a position to spend millions of pounds on equipment. In this situation, the ambition to remain at the 'cutting edge' seemed ludicrous. As many people have found to their cost, it is never possible for educational institutions to keep up with the latest technological developments even if they settle for a small number of workstations, and the decision was already taken not to settle for a small number. The way out of this dilemma was to take a different approach and concentrate on the cutting edge of ideas rather than on the cutting edge of computer hardware and software development. When the real essentials were properly analysed and the options were fully examined, it became clear that an understanding of the place of CAD and the really quite basic skills necessary for exploring it can now be taught successfully using a low-cost platform.

When the opportunity arose to purchase new equipment it was decided that the basic teaching platform would be a PC network running Intergraph MicroStation, at a cost three years ago of approxa 45,000 UKpounds out of a total budget of 70,000 UKpounds (see my other case study, 'Intergraph MicroStation for 3D Industrial Design',

section 5). When the teaching and learning strategy was properly thought out, it became possible to concentrate on the cutting edge of thinking about the use to be made of the new tool rather than on trying to keep up with the very latest version of the tool.

## 2.2. Three Dimensional CAD

The second innovative decision that was taken was to put three dimensional CAD at the heart of the strategy. In many places 2D draughting is taught first and then followed, if at all, by 3D modelling. We decided to reverse this order and put creation of the model in first place. This was partly due to the 'Aeap of faith' already taken about the future of industry. Even more important was the fact that this approach has far greater educational potential for a three dimensional designer. Once the concepts of computer modelling have been grasped and the particular language of the software package learned the student should be freed to explore three dimensional ideas in ways which can often be quicker and easier than by conventional means. S/he is forced to think in three dimensions at every stage, something many students find hard if they design initially on paper. Once built, the 'working model' can be tested and analysed, altered and refined. Eventually it can be presented in a variety of imaginative ways.

Experience shows that teaching 3D before 2D also works better from the point of view of skills acquisition. It is important to encourage the students to see the screen as a window into a 3D world and not as another piece of flat paper to be drawn on. Once they are familiar with 3D the students found the drop back to 2D comparatively easy, whereas a year spent on 2D would make the transition to 3D seem unacceptably difficult for many of them.

## 2.3. Integration into Project Work

Studio and workshop skills are largely integrated into design projects and taught by the same people who are giving students guidance about their designs. It is arguable whether design can be 'taught' at all - it may be that it would be more true to say that we enable students to learn about design rather than that we teach it. In any case, it is often hard to detect where 'skills teaching' ends and 'design teaching' begins. The students learn to design at the same time as they learn their skills, and the former is at least partly dependant on the latter. Ideally, this would also be true of CAD skills, but the lack of staff time and expertise seemed to make this impossible. It was decided that a compromise would have to be reached, at least initially. The only way to ensure that a comprehensive IT strategy would be put in place and carried through was to create a new specialist post so that the responsibility for CAD development was given to someone who had both the right background and the time to devote to it. However, the eventual aim was still that IT teaching should be integrated into design activity as a whole, and it was therefore crucial that the post holder should have a design background as well as a computing one. I took the job in October 1990, with qualifications in both design and in computer graphics, and from the start I saw my brief to be to develop an IT strategy in consultation with existing staff, to integrate it as far as possible into design projects and to involve my colleagues with CAD teaching so that eventually it would be done by the same staff members who were working with the students in the studios and workshops.

## 2.4. The necessary skills

The main planks of our philosophy for CAD education were now in place. A lead would be taken from that (still small) section of industry that we believed was in touch with future developments and a lead would be provided for the rest. All our students would be given the necessary skills to cope with the challenges of the new environment, not just a favoured few. The use of 3D CAD would be central, and would be encouraged as an educational and creative tool. IT teaching would be integrated as far as possible into the rest of design learning. It was now necessary to think about what we wanted the students to learn, in practical terms, to achieve these aims.

- **Computer Literacy:** On the most basic level there can be little doubt that all students, and not just designers, now require computer literacy skills. Many students now arrive with these, but by no means all. It is no use expecting them to grasp sophisticated concepts of 3D CAD modelling if they are still feeling their way around a keyboard. Word-processing and basic DTP must be learned to the point where students can produce a competent project report or dissertation, illustrated if necessary.
- **3D Modelling:** Central to our strategy.
- **2D Draughting:** Still an essential skill, to follow on from modelling.
- **Presentation Skills:** These also follow on from modelling.

- **Animation:** A possible enhancement of presentation skills.
- **CNC and CAD/CAM:** These are also important because they are at the heart of theories about concurrent engineering and a single 'data model'.
- **Finite Element Analysis:** A further option for some students.

### 3. The Teaching and Learning Plan

What follows is a description of a typical student experience. It has remained the same in essence for three years, although some variations of detail have been tried over that time. See 'Intergraph MicroStation for 3D Industrial Design', section 6, for a description of the software used and more details of specific skills.

All the industrial design students now do a 'Design with Computing' unit in their first year. Because they are learning all, or many, of these new skills from scratch, we have found that the most efficient way to teach them is in formal classes until the basics are mastered, followed as soon as possible by some project work which shows the students how their new skills can be integrated into their designing while at the same time their skills are extended and enhanced. It is hoped that at some point in this process the students will find they are confident with their new tools to the point where they can begin to spark off new creative ideas. This is the point at which we feel we have succeeded.

#### 3.1. Graphic Design with Computers

This part of the unit is intended to:

- introduce all students to the range of facilities available.
- allow them to become familiar with both PCs and Macs.
- enable them to acquire basic word-processing and DTP skills.
- integrate the first principles of Graphic Design into their computer use.

It is taught in four weekly sessions of one and a half hours each, followed by supervised project work. Students are divided into groups so that they have a computer each. Computer familiarisation is followed by word-processing, page layout and text and graphic manipulation. At least part of the course is always taught by a graphic designer. The capabilities of drawing and painting packages are demonstrated and students are encouraged to explore these further in their own time. Students are assessed via a short project involving the combination of text and graphics, such as the production of an illustrated 'self description'.

#### 3.2. 3D CAD Modelling

This course is also part of the first year 'Design with Computing' unit and is designed to:

- enable the students to acquire basic computer modelling skills.
- assist them with three dimensional design thinking.
- enrich their presentation skills.
- allow them to assess the advantages and problems of this design tool.
- introduce them to further possibilities, e.g. CAM or animation.

The course consists of eight hours of formal class teaching followed by a two week design project in which the use of the computer is compulsory. For the classes, students are divided into groups of about twelve. The teaching method is a combination of class notes which the students work through at their own pace with formal demonstrations and discussion of the modelling principles involved. Classes were initially taught by myself, but some of them are now taught by other members of industrial design staff.

The project is a fairly free conceptual 3D design project, involving myself and the studio/workshop lecturers in overlapping roles. For example, last year the brief was to design a 'family' of candlesticks for use in a restaurant of the student's choice [Fig 1]. This allowed the students to explore three dimensional form and discover how the computer can assist in this task. Marks were awarded for the quality and appropriateness of the design and for the way in which students had used their computer skills to benefit their work.

Having completed the first year unit, students may choose to use CAD for any of their design projects. There is at least one project in the second year where a CAD model is specified in the brief as being an appropriate, although optional, alternative to a workshop model [Fig 2]. The students who choose to extend their skills in this way lay a strong foundation for further specialist work in the third year.

### **3.3. 2D Draughting**

As previously mentioned, 2D draughting is learned after modelling, not before. This is not only because this fits our philosophy better, but because experience shows that it works better educationally as well.

2D draughting is approached in two ways. Because the same software is used for modelling as for draughting [6], it seems to be the case that, once familiar with the package from their modelling course, any student can use it for traditional 2D engineering drawing with a bit of help from the manual and support from staff if necessary. At this stage their problems stem largely from a lack of understanding of technical drawing conventions rather than from difficulty with the computer. The second and more interesting approach is one that is still being worked on. Students are encouraged to take 2D drawings from an existing 3D model rather than drawing in 2D from scratch. We are constantly looking for ways of maximising the computer model in as many directions as possible, reflecting the use of a single 'data model' which is at the heart of concurrent engineering industrial practise.

### **3.4. Presentation and Animation**

Presentation techniques, touched on in Year 1, are extended and developed in Years 2 and 3. In Year 3 some students choose to learn some animation also, with the use of this technique as a means of demonstrating 'working models' to the fore. This part of the course has been bedevilled by technical problems (See 'Intergraph MicroStation for 3D Industrial Design', section 7), but several students have managed to produce excellent work despite these. It is a popular aspect of our computer work, providing the icing on the solid cake of the students' modelling success. It is also useful showcase material. In future, we hope to approach advanced techniques in a more structured way (see section 4.2).

### **3.5. CNC and CAD/CAM**

Apart from work done on an individual basis by a few students this aspect of our stated aims is only now being put in place. Last year one of the third year product designers took a design right through from a CAD model to a stereo-lithography one, with the help of two different industrial sponsors. Other students have pursued CNC and finite element analysis work for specific projects with the help of our Engineering department, and it has also been possible to do some small-scale CNC in the design workshops.

## **4. Results and Future Developments**

### **4.1. Teaching and Learning**

The first year unit has now run three times in more-or-less its present form and as I write, a fourth First Year is embarking on it. Most of the students completed the course satisfactorily from the point of view of skills acquisition, particularly those using the new software. Several of these began to use the computer creatively even in their first project, experimenting extensively with 3D form and coming up with designs which they would never have thought of had they been using conventional means. We were particularly pleased with this development.

From the point of view of further specialist work it is clear that the numbers of students choosing to use the computer for project work in their second and third years is increasing every year. The standards reached do not differ much with the kind of software used. Once the student has climbed the learning curve the results depend on the design ability of the student and not on the particular tool that is used, as is the case with any other design activity. As would be expected, the only difference is that when the learning curve is easier more students persevere with it.

## 4.2. Specialist Work

Although almost all the students succeed in mastering 3D CAD to the point where they will feel comfortable with it in the workplace, more specialist work is still done by a minority of students only. A compulsory CAD element in a Year 2 project has been tried, but has found to be counter-productive for those students who feel - not unreasonably - that they do not wish to specialise further in this area. On the other hand, those students who have persevered have often felt that their work load is too great in comparison with those who have not. There has not been sufficient space given to the subject in Year 2 for animation techniques or CAM to be properly taught, leaving keen students to pick skills up on an individual basis in Year 3. This is not an efficient way of teaching for staff who are constantly being asked to reduce student contact time.

This means that students still need to be exceptionally keen to progress to advanced computer work. Every year several Third Year students do produce impressive presentation and animation work, but only one of our students has so far completed a project which could really be said to be at the cutting edge of new technology and the resulting new practise of design. The fact that nearly all students are proficient at an unusually high level for BA work and that they are all aware of the possibilities demonstrated by those who have gone further mean that this is hardly a failure. Nevertheless, improvements are being sought.

Next year a new specialised CAD unit is to be introduced into Year 2, to run alongside other options within the industrial design degrees. This option will give students the opportunity to investigate the cultural impact of computing on art and design and its effect on industry. It will also give them time to develop their skills in either presentation and animation work or in CNC and CAM. Satisfactory completion of this unit, plus a high level of computer based work in the Third Year Learning Contract, will entitle the student to the degree of BA(Hons) Industrial Design (CAD) (subject to validation).

## 4.3. Postgraduate Development

A major spin-off of our new strategy, combined with the findings of our research project into the impact of IT on the professional practice of Product Design [2], has been the establishment of a new MA course, Design, New Technology and Project Management. In this course we hope to produce designers and other professionals who will be in a position to take a lead in the new industrial environment which we believe is coming. We believe our BA graduates also will be well equipped to take their place in that world.

## Notes

[1] Kitson, Michael 'Computer Graphics in Art-and-Design Education: the Problem of Planning for Change', Leonardo, Vol. 24, No. 5, 1991.

[2] See 'The Management of IT in the Professional Practice of 3D Design', from the Art & Design Research Centre, Sheffield Hallam University.

[3] e.g. Wiener, Martin J. 'English Culture and the Decline of the Industrial Spirit 1850-1980', Penguin, 1985.

[4] Wiezenbaum, Joseph 'Computer Power and Human Reason', Penguin, 1984.

[5] Baker, Robin 'Designing the Future', Thames & Hudson, 1993.

[6] See 'Intergraph MicroStation for 3D Industrial Design'

## **Illustrations**

Fig 1: Candlestick designed by a first-year student after experimenting with 3D form in the computer.

Fig 2: An example of second-year project work, to design play equipment.

Fig 3: A model of a Lawn Aerator designed by a third-year student,

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# A new approach to teaching computer-based design skills.

Tamasin Cole

## The author

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## Abstract

The author gives an account of an experiment undertaken with others in teaching computer-based design skills to Visual Communication Design vndergraduates. The experiment is set in the context of current pressures on Higher Education, and the report indicates ways in which simple, low-technology approaches might be used in teaching this high- technology subject. The learning methods differ strongly from those normally used, which tend to be staff-intensive and inefficient. An account is given of student progress and reactions, and a preliminary evaluation is made of the method's effectiveness.

## The landscape

### *Background*

Like the rest of Higher Education, Middlesex University has been required to expand over the past few years at a rate few of us would have imagined possible. The expansion has coincided wii a revolution in electronic design technology and increasing demand from students for experience of the new tool.

### *Context*

The BA Hons in Visual Communication Design takes students from a wide variety of backgrounds.

The School of Visual Communication Design (VCD) offers a specialised BA Hons awards in Visual Communication Design with pathways in Graphic Design, and General, Scientific, and Technical Illustration. These are organised as modular sets within the Faculty of Art, Design and the Performing Arts at Middlesex University. Students arrive from foundation, BTEC, HND and overseas courses; the intake each year is between 80 and 100. The first semester consists of a double module of genenl introductory studiabased work, primarily skills-based, with a single module of Art & Design History, after which students move on to the specialism of their choice.

Although at the moment few students take advantage of the University's modular system to combine disciplines, a general degree is possible in principle; the first semester programme in the Faculty of Art, Design & the Performing Arts is developing to provide the foundation for movement within the Facultya The acquisition of basic IT skills is a requirement of this first semester programme. This paper concerns the development of a new learning scheme to cater for the IT needs of VCD students in the first semester of their course.

### *The past*

Since the arrival of electronic design technology in the form of the Macintosh, there has been ever increasing demand from students who want to learn about it. VCD has progressed through a number of strategies, ranging from the early free-for-all, exploited by only a few unusually computer-literate students, to a policy of allowing no computing at all in the first year.

At the end of this transitional stage it was recognised that all students now needed basic computer literacy, that almost all would need to use computers for their work at some point and that the VCD course had an obligation to provide access to the electronic medium.

Until recently, much of students' learning was through working on design projects. However, it became apparent that too often their creative thinking was being destroyed by their limited knowledge of computers - not just the workings of the applications they chose to use, but their lack of ability to challenge the machine and find ways of making it do what they wanted it to do. 'Default design' was only too common. Many complained that they lacked the confidence to attempt any work on the Macintoshes at all.

To tackle this problem, a standard, practical introduction to basic computer skills was introduced, with students attending in groups of 10 or 12. These introductions were scheduled to last for 5 working days, and aimed to get all students to a common level at which they had confidence in their ability to use a machine.

## ***The problems***

With a student intake of highly disparate prior experience, increased class sizes and decreased contact teaching time, it became increasingly difficult to accommodate those with little or no knowledge alongside those with too much. Problems arose with the range of previous experience: some needed close attention in order to overcome their fear of touching a mouse before they could even think about opening a file; others thought they knew everything already and wanted to use their allocated time to explore advanced applications entirely unsuited to their level of visual understanding. The staffing requirement for resolving these differences is considerable, particularly if 'traditional' teaching and delivery methods are employed. Student time is wasted either covering ground already known, or waiting for help.

In addition, sound basic skills, general knowledge and good 'computer manners' need to be established before students can develop their own creative abilities through computers.

## ***The project***

The proposed solution involved the development of "Skills Units", each unit presenting a practical exercise covering one very small aspect of basic Macintosh skills. The units could be used flexibly: in a teaching situation with demonstrations by tutors or technicians for beginners, or independently by students with prior knowledge. The medium for these exercises is not electronic but paper.

Each student would be given a card listing topic units and making clear which were required to be completed by the end of Semester 1; identity cards (a local ID system for the use of the VCD electronic design area) would not be issued without completion of the specified basic units.

## ***Implications***

The scheme had a number of implications for the timetable and teaching style of the department. For those used to scheduling specific activities for clearly defined groups of students, and expecting attendance at such sessions, introducing a flexible scheme such as the Skills Units required a shift in thinking and organisation.

There were also practical problems in the light of the restricted equipment available in the Electronic Design Studio, and the availability of academic contact time.

## ***Perceived advantages***

Perceived advantages included the following:

- Time saved not teaching those who already know can be used to help those in real need.
- The distinction between acquiring skills and using them is made visible, with a requirement to be trained before using.

- The possibility of establishing sound 'computer manners' (shutting down the machine after use, clearing common storage areas etc).
- The chance to establish, from the very beginning, the practice of self-help.
- Flexibility of production: add-on units can be produced for topics as and when they are required.
- Flexibility of use: as well as the introductory training for new students, units can be used by staff who want to learn but need to fit it in with their own work-loads and as brush-ups for more advanced students who have forgotten particular aspects.

## **The practice**

### ***Unit details***

Each unit consists of an A4 sheet, an exercise on the front in the form of a series of instructions, and notes on the exercise on the back. The exercise itself leaves no room for creativity so that the result of each exercise can be checked against a master; the notes cover every new activity, but do not provide details - the emphasis is firmly on self-help, and students are directed to use Help Files, or pointed in the general direction and told to work it out.

### ***Timetable management***

The structure of the first semester has been changed slightly to accommodate the flexible approach required by the Skills Unit scheme, in that Friday afternoons (3 hours) have been designated 'Skills catch-up time'. Also available in the same slot are photography, silkscreen and letterpress workshop introductions. Groups of students are allocated three consecutive Friday sessions<sup>6</sup> in any of the areas they need, although Electronic Design is the only area they are all expected to attend.

### ***Student introduction / introduction***

The scheme is introduced very briefly during induction week at the start of the semester, but many students clearly suffer information overload and need further explanation later.

The main introduction takes place on the first Friday afternoon of their 3 session slot, where they are shown the record card and the system is explained to them. A sample is asked to complete an evaluation form, and all are asked to file the exercise sheets for future reference (students are provided with a ring binder during induction week).

At that point, those who feel they have enough prior experience to manage on their own are given some or all of the set of nine essential exercises and may take them away to complete them in their own time.<sup>9</sup> They are instructed to bring the results to any of the academic staff for checking, when the unit will be signed off on their card.

Students who are completely new to Macintoshes, or who require some help, can sign up for a demonstration taking about 15 minutes, and can then attempt the exercise with academic support available.

### ***Operation of the scheme***

Each exercise is designed to take no longer than 30 minutes, and can be completed by a student with prior experience in far less time. Thus the 9 essential exercises could be completed in as little as an hour and a half by a competent student, and should be completed by all well within the three afternoons allocated.

### ***Production of the material***

At the present time, three members of academic staff, none full-time, are involved in writing the units. A list of headings was compiled, and topics allocated by agreement. Once the format and structure of the exercises have been understood, and provided that the writer is familiar with the topic, an exercise takes between 2 and 3 hours to prepare. A template is available so that layout is consistent.

## ***Chronology***

The scheme was first proposed in the spring of 1994, but it was not clear until near the end of the Summer term in June if practical arrangements could accommodate it. General planning started in June, but the majority of the work has taken place since the start of this academic Autumn term in September. The first group of students to use the scheme started in mid-October.

## **First results**

### ***Observation***

Students accepted the proposition readily, even enthusiastically. Comments to staff indicated that they felt it gave them more control over their learning. It was noticeable that at the start of the first session many students, although they had been carefully briefed, failed to look at the notes when they got stuck, falling back on the age-old technique of asking the tutor to show them how to do it. By the second exercise, however, almost all had got used to the idea of looking at the notes and/or the Help File. We now suggest that students read the notes before starting the exercise so that they have some idea of what is covered.

There were occasional confusions with typographic conventions, and the terminology used in the exercises is not always consistent, although this did not appear to cause problems.

### ***Student feedback***

The first two groups of first-year students, 30 in all, were asked to complete evaluations of the units. Co-operation was excellent, and the results encouraging.

The shortest time taken to complete an exercise was 5 minutes, and one student completed all nine exercises in a total of 1 hour 50 minutes. Only one student consistently took 25 minutes or more per exercise, which may say more about the student than the exercises. Students' initial self-assessments seemed accurate; those who thought they knew how to do an exercise usually completed it quickly.

Generally the instructions were pronounced to be "quite easy" to understand, and the few expanded comments that were offered were supportive.

### ***Practical management***

This is an area which can probably do with some rationalisation. The necessity for feedback involved extra organisation in handing out, requesting and collecting in the evaluation sheets; even without this there is a lot of distribution and collection required.

The demonstrations appear to have catered for those who wanted them, being scheduled as demand arises through the Friday afternoon tutored sessions. Most students have only felt the need for demonstrations of the first few units, feeling confident enough after completing those exercises to continue on their own thereafter. A check has been kept on the progress of each student, and letters sent to those who are lagging behind; this is laborious. Successful completion Because this study is being written before the end of the semester (the official 'closing date' for completion of the required units) it is not possible to report on the number of students failing to complete all the necessary work. At the time of writing (November) most students had not finished all the units; however, as they know that they have until February to finish them, they may be aiming to finish the remaining exercises in their own time. Talking to some of them, this appears to be the case, and they do not seem to feel anxious about being able to complete the necessary work in time.

## **For the future**

Possible solutions to some problems encountered Clearly a revision of the existing material needs to be made once the first semester has finished. Points to be addressed will include:

- The development of a definitive terminology (eg application or program?, system fonts or resident fonts?).
- The development of typographic conventions (eg how does one present the text a student is to type - "word", word, ?), and the production of a "how to use these exercises" sheet.
- The resolution of various problems which have become apparent only as the scheme has developed (eg Word Processing exercises should not use specialist fonts installed with Suitcase - some schools do not use any other than the resident/system fonts).

On the administration of the system, consideration will be given to:

The possibility of handing out all the exercises in packs at the first session and requesting all the results back together when they are completed. Example of correctly finished exercises could be available for self-checking in the interim.

Instead of tutors recording students' progress, this information could be displayed publicly, thus making it the student's responsibility to inform him/herself of what he/she has yet to complete. Other areas to be looked at include any possible copyright problems with texts used.

### ***Extension of the project within Vxual Communication Design***

It is intended that the basic training scheme should be expanded.

There are already introductory units for HyperCard to address the basic skills required by students before they can tackle Design for Interactive Media. In future, completion of these units may be named as a prerequisite for entering the option.

Students wishing to use a particular application for a specific project will be asked to start by completing 3 or 4 introductory units before attempting a design job.

Activities that regularly cause problems, such as preparing scanned images for print, or colour specification for separation, will be covered in individual units. Some of these are already in use.

### ***Extension of the project within Art, Design & Performing Arts***

Several other Schools within the Faculty have expressed interest in the scheme, and the academic staff responsible for delivery of IT skills in those schools have been involved in very fruitful discussions, both about the specifics of the scheme, and about the different ways in which we teach the subject.

During these discussions, various different patterns of delivery emerged, which include:

- group lectures, followed by hands-on sessions unsupported by academic or technical staff;
- supervised exploratory sessions;
- formal supervised training sessions, expanded by independent work;
- sessions unsupported by either academic or technical staff.

All the schools whose representatives have been involved in these discussions have expressed interest in adopting part or all of the scheme. The modular structure seems to be adaptable to most styles of teaching, being suitable for use as practical back-up, core exercises to be expanded upon, or as an independent learning pack.

The units are also to be adopted by the Faculty's ILRS (Information and Learning Resource Service) as the core of their own training scheme which is available to any member of the University using the facilities. There are plans to extend the system to include PC skills training, and to add exercises in logging-on to the network.

In an increasingly flexible University structure there will be huge advantages in knowing that students moving between disciplines have a common set of computer 'manners' and have been educated to help themselves through using similar basic exercises. Students moving from Middlesex Foundation, or transferring between disciplines can have their experience accredited and will thus not need to take part in the VCD sessions.

Investigation into practical ways of reproducing and/or distributing the scheme will be necessary if it is taken up University-wide. The possibility of producing a version to be supplied electronically on the University network is attractive, but will probably require changes in the design of the material.

Several constructive suggestions were made by tutors from other schools, including the idea of a laminated set of exercises beside each computer for anyone to use, and the proposal of basing staff development around the material.

## ***Conclusion***

The general consensus from staff and students seems to be that the project is worth continuing. There are clearly areas which need further work and revision, but the general principle of flexible work units that can be used by staff and students to fit in with their work pattern seems to be sound.

It will not be possible to assess the project fully until the current first semester students have moved on to their second and third semesters, when they will need to put their computer skills into use. However, if they have, as requested, saved the exercise sheets for future reference, any revision they may need should be a relatively simple matter.

If the final results bear out the first evidence, perhaps one of the most important achievements of the Skills Unit scheme will be to have given students confidence and introduced them to the idea of self-sufficiency in an area which still alarms many. As a model for coping with some of the new problems posed by the expansion in Higher Education, it may well be useful in other areas which demand the learning of skills by student with very varied backgrounds.

However, such a system must never be seen as a substitute for contact teaching where skills are to be applied in a creative context. It can only be of use to provide a stable foundation of practical experience.

Tamasin Cole, 1994

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# Impact of digital imaging on fine art teaching and practice.

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**Impact of digital imaging as a subject within Fine Art .Is it becoming a separate discipline within the subject of Fine Art or has it attached itself to existing practices e.g.painting,photography and mutated them into hybrids .Does computer graphics/digital imaging bridge gaps bet veen design and fine arts or does the very closeness of computer art and design encourage a questioning and reassertion of their respective specificities .In what way does the design of soft vare effect this debate .To what extent does staff research impact on the way the above arguments articulate themselves in teaching practice .**

It is doubtful how interesting these questions about how digital imaging is impacting on the traditional disciplines of painting, sculpture, printmaking, photography(photography within Fine Art can now be considered to be situated within a tradition) are to those outside the academic section of the arts community; in a gallery/exhibition context one is supposed to focus on the subject of the work and not how the use of technology is redefining its discipline(I am being purposefully simplistic here) . It is, on the other hand, worthwhile to articulate these arguments in an academic context because, in this country at least, the main provider of this still expensive and esoteric technology for student artists and arts practitioners is the art college and university art department .It is within these enabling institutions, through the teaching of undergraduate, postgraduate, and through the mcreasing number of practice/theory research degrees that these practices are encouraged and their identity sought .There has always been this inextricable link between how a subject is defined by research and how the subject manifests itself (in this case in the art object and theory) in the work of students artists and emergent practitioners .This has become remarkably apparent with the introduction of digital technology within art departments. There has followed an obvious cause and effect relationship between the educational institution and what is eventually produced and exhibited outside of it in the wider cultural sphere .

It would be useful, at this stage, to consider practical and theoretical implications of computer technology on some specific disciplines within the subject of fine art .

Painting; across computing platforms there is software (Fractal design's 'Painter', Adobe's Photoshop' ) which simulates the painted mark, the chemical, physical, gestural changes are simulated algorithmically whilst paint which can be seen as the traditional bearer of illusion is itself given body and physicality through optical illusion (for example, the embossed or raised mark is simulated by repeating a brush stroke, slightly offsetting it in another colour and framing it on one side with shadow of a darker tone).An illusion of the physical substrate of the painting(canvas, textured water colour paper) is similarly arrived at and an infinite variety of 'paint brush' and paint combinations can be miraculously used in an orgy of simulation .Clever tricks can be used in programmes like 'Painter' to convert the tonality of a scanned photographic image into a 'painterly' equivalent, an automated painting of a photograph .Where this whole "joyful simulation" meets its hurdle is the limitation of the final printout.This is especially true for students who can not afford the more luxurious output afforded by processes like 'Scanner chrome' (Ink jet on canvas), 'Iris'(ink jet on a variety of 'art grade' papers) or the dye-sublimation process .The disappointment that is often felt in the difference between what artists see on the screen and what they can get in terms of printout is a frequent barrier to the use of the technology in this traditional interpretation of the activity of painting(the process of artists deliberately trying to simulate the use of paint using a computer).This is obviously also to do with the fact that images on screen depend on light illuminating them from behind rather than reflecting from the front .Another common problem which is bound up in the way that the image is shown on a screen is the difference in colour values experienced between monitor and printout and between monitor and other monitor. This is problematic in an educational environment where multiple use of different equipment means wildly different colour values between monitors (especially with eight bit colour) .Apple Macintosh repeatedly claim that they will soon have a solution which acts at system software level but at the moment the only way to reliably ensure the best colour matching between on screen display and printout is to calibrate a monitor using a test print of process colours on the paper that is going to be used .The settings can then be

saved. Unfortunately, according to the manuals, it is essential to maintain lighting conditions and monitor brightness and contrast settings; not always possible in a multiuse computer lab. I will try and describe some different forms of output at a later point which do not attempt to emulate what is on the screen. The obvious and ideal solution to those wishing to represent the qualities of the on screen display is to use a monitor in the exhibition of the work or have a slides made and then project them.

Alongside the illusionistic side of this practice, there is the expressive with its privileging of the autographic mark. The notion of expressivity makes the assumption that the mark is unique in itself corresponding exactly to the intentionality of the unique being, the artist. Digital painting obviously upsets these assumptions; marks and gestures are no longer unique they become both reproducible and, more problematic, constituted by a complex set of factors like the capabilities of hardware and the possibilities and limits of software which are, in turn, determined by other people; the autographic mark becomes a "team effort."

I have so far talked about a very obvious notion of computer art, one which attempts to simulate an existing practice. The frustrations inherent in this have been mentioned and there have been very few artists who have worked in this way with any sense of satisfaction. A notable exception would be the artist Rosalind Kunath, research fellow at the Royal College of Art, whose work is outputted as ink jets on canvas via the Scanner chrome process. Her work has managed to discover for itself painterly specificities particular to "painting" using a computer; a diaphanous multi layering of space with peculiar smoke-like trails which would be impossible to produce in any other way. Many others find the process useful to speculate and make decisions about their work, manifesting their ideas in more traditional means sometimes using elements of the computer generated (e.g. Simon Lewandowski has large woodcuts automatically cut with a C.N.C. router, these are printed on paper or canvas and then worked over). Colourists find the computers capabilities particularly useful (but infinitely frustrating) due the speed and ease with which areas and even the whole colour balances of entire image can be changed.

Where the impact of digital imaging has been more apparent has been at the other side of the discipline of painting. The practice which is not so much defined as being bound up in the process of applying paint but is more adequately described as a concern with picturing and representation and which includes working with the photographic, collage, text, etc. It is at this point that computer imaging scores highly. Programmes which were designed initially for photographic retouching have been extremely useful for artists. I am thinking specifically of Adobe's 'Photoshop' and 'Live picture'. Used in conjunction with the right hardware 'Photoshop' allows artists to manipulate and subvert photographic information extremely quickly and convincingly. It is extremely easy to learn and to teach with and its capabilities seem to allow possibilities rather than limit them. Unfortunately, the ease with which images can be manipulated often leads to volumes of gratuitous work in which images are subjected to a catalogue of processes, effects and filters. Students are often seduced by this novelty value and those lacking the self critical reflex tend to end up with an unfocused glut of "test pieces". This has been particularly true for first level undergraduate students who tend to be introduced to digital imaging as a discreet subject within the modular scheme. Very often work is produced to satisfy distinct assessment demands rather than to augment or contribute to a developing practice. Using the technology in a speculative way, allowing its possibilities to suggest inspire outcomes and constitute meaning can, if the self critical reflex is engaged, be constructive and even liberating; again this needs to be encouraged through teaching which has a theoretical and contextual content rather than just being purely to do with the acquisition of manipulation skills. To do this satisfactorily is luxurious as it involves having staff who have active engagement with the issues surrounding the use of digital imaging deal with the somewhat repetitious task of the dissemination of the basic skills. The best solution seems to be the workshop situation which demonstrates possibilities whilst talking about them from a critical perspective. This approach really relies on intensive, practical teaching to consolidate the demonstration and it takes a constant effort of will to remember to frame this practical teaching within a wider context. Manuals and interactive learning materials only solve part of the problem.

Software like "Adobe Photoshop", "Fractal Design Painter" and "Infini-D" really can hybridise existing practices like painting, printmaking, sculpture and photography allowing mixing of working methods and formal particularities both between elements of fine art practice and outside of what is thought of as fine art practice (for example combinations of images and music). It is now easy to 'paint' with photographic information, impregnate photographs with the 'hand drawn', create and collage sculpture into different 'photographic' contexts, wrap

photographs around 'virtual' sculptures, reproduce a manipulated photograph using an anachronistic print process . It would be useful to describe some cases where these sorts of cross disciplinary links are used to show how they activate discourses .

A number of artists have been working with digitised photograph subtly changing them and outputting them back them onto photographic material engaging the assumption that the photographic is real .On one hand this has led to an amount of 'spooof' photography (most notably was a faked air crash which was fed to Reuters and printed the next day on front pages all over the world) and on the other hand to bodies of work which make subtle changes which activate a sense of disquiet and encourage a questioning on the part of the viewer as to why something is constituted as being real .A recent third year fine art student took a set of stock "clip art" photographs of objects like a gun, a syringe and a shot gun cartridge and very convincingly mapped the logo of a well known multinational entertainment corporation onto them .This seemingly simple idea engages elements of the post modern discourse to do with the trans- mission of corporate power and identity through commodification .It was successful in doing so precisely because of its seamless ability to convince . Other students have used the software's ability to multi layer images and collage to make comparisons between physiognomies, make composites and engage in the psychologically loaded area of participatory fantasy, where the artist places them self in some sort of other context either by changing the way that they look within an existing representation or placing them self within an other space ( in a similar way to the way Cindy Sherman projected film backdrops into rooms and then occupied them) .This area of possibility positively encourages speculation and research about how identity is con- stucted, about questions of authenticity of the photographic and, as such, can be argued to be dle result of the deterministic and enabling capacity of the computer .However without the input, discrimination and intentionality on the part of the artist the work would not transcend its basic novelty value .

The criticism that it becomes impossible to apply objective criteria of quality to computer art because of the assumed tendency to homogenise all work which goes through its mechanisms is augmented by the more general problems of subjectivity in assessment of quality in art practice. The criticism about the computers tendency to homogenise which is not usually just argued as being a product of the uniformity of the output but as being bound up in criticisms about the general ease at which goals can be achieved can be countered, on one level, by examples of good practice which embody appropriateness of output and appropriateness of drawing skills used .In this case the term "drawing skills" means something quite different to a traditional understanding of the term; it means the ability to convincingly carry out intentions; for example, the grafting of a picture of a face onto a historical figure involves consideration of size, three dimensional mapping, similarity of colour, light and surface .An appropriate 'output' or resolution might be used to create a photo-etching of the image's printout through a "mezzo-tint" screen on an image setter Discussions of quality become centred around the appropriateness of means of production of the image and how well that encourages or allows dis- course .This illustration would seem to suggest a model of self consciousness about the image or artifact being produced, a controlled manipulation of commonly understood signifiers .This sort of methodology does, in fact, allow propositional testings of juxtapositions of objects / surfaces / representations and can go on to allow an almost "expressive" way of working with images which leads to gluts and pictorial voids as incessant overlay, juxtaposition, disruption of images achieve semantic disjuncture and loss of conscious meaning.

The impact of three dimensional modelling programmes like "Swivel 3D", "Hmi-D" has been less widespread amongst Fine Art students (partly because they are harder to learn and partly because their results are less immediately gratifying ) .Uses have ranged from artists mapping their work into 'virtual 'spaces and using it as a design tool to arrange exhibitions and installations, to work which exposes the arid, generic world that is typical of synthetic three dimensional modelling, producing spaces and objects which do not exist but which have that outward signs of occupying space and reflecting light . This type of activity does have the psychologically attractive appeal of allowing construction of private worlds and universes over which the artist has (almost)complete control .Worlds can be constructed which operate like the microcosm of the Metaphysical poets .The courtyard or the empty street of Giorgio De Chirico can be created and then entered into, travelled around and lit . Obviously this immersion in a private symbolic labyrinth can lead to an impenetrability but can also touch on some psycho logically penetrating image structures which, in this case, through their reference to technology and the almost mythic arenas of 'cyberspace' and lhe arcade game have a contemporary significance. Some considerable formal issues are engaged with this sort of work . Firstly work becomes possible which is interdisciplinary in its use of two and three dimensional concerns (images mapped into spaces or around objects / images made of three dimensional scenes and objects).Aligned to the new forms of formal enquiry activated by

this hybridity is a rebirth (sic) of Renaissance methods of depicting space . This is seen both in the perspective and the 'plasticity' with which objects are rendered in three dimensional modelling . One of the uses for which three dimensional modelling programmes is written is for the analytical design of objects for manufacture .

Personal research includes several areas which use three dimensional modelling technologies . Initially I used three dimensional programmes to generate wire frame diagrams of architectural spaces which removed particularities of time and space from the drawing . These drawings were drawn onto a large sheet of tracing paper by a plotting machine . The drawings were then exposed onto a sensitised silk screen . A 'stop out' varnish was then printed onto thin sheets of zinc or copper and the sheets immersed in an etchant so that the sheet of metal was etched away to leave the lines of the drawing constituted out of metal . A more recent use of the technology has been the creation of virtual sculptures which become photographically rendered and mapped into existing public spaces; a kind of propositional public sculpture .

Aligned to the criticism or observation of the perceived "homogenising" tendency of computer imaging is the related perception that as well as homogenising quality it homogenises differences between fine art and design . This is an obvious observation given that much of the software and hardware used within Fine Art departments came into being as a result of the economic imperative of the graphics and design industry (This has obviously changed as hardware capable of running graphics has been marketed for home consumption). The practices of Fine Art and Design do start to at least look as if they occupy the same territory; again well worn but not inappropriate arguments about different sorts of intentionality and function can be engaged along with their respective sets of cultural values; because of its assumed philosophical engagement with the world and its assumed disengagement with the business of making money art occupies the privileged cultural institutions where as design is assumed to occupy the everyday and functional . Simplistic distinctions like this become harder to make when the 'design' object is reproduced through the same medium as the 'art' object . Ultimately questions about respective qualities and specificities are forced rather than glossed over by the homogenising tendency of similar form methods of output . Quality image manipulation software and high quality printouts like Rainbow dye sublimation, Kodak XLS 8600 allows student work to have the patina and sophistication of professionally produced work . This is simultaneously educationally valuable and problematic; valuable as it circumvents the often painfully slow progress of development as students practical work lags behind its theoretical ambitions . In other words the works' conceptual aspirations can be talked without deference to future development of skills and methodologies, without the need to talk about skills. This facility becomes problematic because of its ease; if image manipulation skills are not acquired alongside the more traditional skills associated with fine art then there is an obvious danger of a limited understanding of the potential usefulness and relevance of traditional perceptual and making skills as well as a lack of understanding of their formal and historical status

Within Fine Art departments computer technology was very often initially brought in to printmaking departments . There seems to be an historical appropriateness to this given the relationship that the subject of printmaking has had to the technology of the dissemination of information in the past . Now, again, technology which was originally designed for the commercial print industry ( which as we all know uses technological advances made by the military) is subsequently reintroduced into the subject of printmaking . The proximity of means of exploiting the computer generated imagery which include photo-etching, silk screen has been another governing and useful interaction . 'Photoshop' is particularly useful in that it can take a colour image and separate it into grey scale versions of the constituent CYMK channels. Practically speaking, good silk screened results are possible even from laser printed output . Prior to the introduction of the desk top, scanner, computer and laser printer a separation would have been prohibitively expensive and time consuming to produce; the desk top computer system can replace many of the repro graphics camera functions like the separation, the posterisation, the creation of custom half tone screens and reversals from positive to negative . At the other end of the scale professional drum scanners and image setters can be used in a professional context to entirely supplant the function of the repro camera . Artists and fine art editing establishments have been quick to exploit the ability to reproduce the hand drawn through the media of silk screen, photoetching and photolitho and are now able to exactly reproduce the hand drawn image . This is a clear example of hybridisation which neatly uses old and new printing technologies . I have seen this technique used to particularly good effect by Lowick House Print Workshop in their collaborative work with artists like Sarah Mulhall and Anthony Davies both of whom were able to use existing drawings on paper as the basis of prints . Technology in this case does not constitute in any way the image but is used to make a new process from an anachronistic process . Opposite stances have been taken by artists such as Eric Great-rex who have scanned antique engravings, worked within their style sampling the texture and tonality

of the 'original' and using it to historicise more contemporary additions . The finished image is printed out using an 'Iris" printer and heavy, rag, printmaking paper at Cone Editions Press, Vermont . The quality of the output is extremely convincing as all of the signs of age (like mottled paper) and original drawing method were transmitted through the process to the final print .

What has often happened to this neat model of the digital technology slotting in to the existing practice of printmaking is that its own development has shifted it from a technology who's reason for being was to assist existing practices to a technology which has increasingly spawned its own formal modes of communication (e.g. interactive-multimedia) and its own potential for cross disciplinary working . An obvious correlation to make here is a tracing of digital imaging's relationship to the print media and a gradual advent of publishing in a digital form on either C.D.Rom or 'online' form .



# Audio: the missing element in multimedia

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## The author

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## Abstract

The importance of sound as a channel of communication is emphasised, and attention is drawn to some of its special properties. The sound capabilities of the Macintosh, as an example of an affordable multimedia computer, are briefly discussed, and are compared with the lesser capabilities of the multimedia packages which run on this platform. A work-around to an example problem is discussed, followed by an introduction to the use of MIDI from within multimedia packages. As an illustration of the potential and the difficulties of using sound within current multimedia packages, two projects are described, and a plea is made for sound to be given more serious consideration by developers both of multimedia titles and of the authoring software used to create them.

## The importance of sound

The use of sound within computer-based multimedia has mostly been subordinate to visual components-still images, moving imagery and text-only acting as a confirmation that an action has been carried out: a "click" sound accompanying the operation of an on-screen button, or a piece of music masking the delay of loading data or other such system operation. This approach to the use of sound has served to relegate the considerable powers of the user's auditory input, the sense of hearing, to a rather low and unsatisfactory level. The success of the music industry and the importance of sound and music to film indicates how a substantial element of our culture relies on our sensitivity to sound, both to provide information and emotional effect. Indeed, the prominent idea that an essential component in the functional design of multimedia is that there should be an "off" button for the auditory component indicates that sound is often used in a way which is not integral to the overall functionality of many multimedia products. This underuses an accurate, sensitive and emotive means by which the user may experience multimedia, via information received by the ears, and in doing so unreasonably restricts the bandwidth for communication.

## Sound control

Within a multimedia package, it should be possible for the designer to incorporate elements of auditory control which are as comprehensive as those of visual control. Functionality such as the panning of a stereo image, pitch shifting, tonal filtering, effects-processing such as echo, reverberation or harmonic distortion, synchronisation of discrete tracks of sound, variable quantisation of data-in fact, all the psychoacoustic techniques and data manipulation tasks that have been developed by the professional audio industry-should ultimately be at the disposal of the designer and user of interactive multimedia products.

The Apple Sound Manager (v.3)-whilst a relatively basic audio management system-offers 16-bit audio recording, multiple sound channels, stereo capability and audio processing in terms of level control over each channel. There are many third party dedicated audio systems which utilise the capabilities of the Apple Sound Manager, increasing the audio functionality of the Macintosh by the incorporation of discrete software and/or hardware.

However, multimedia authoring packages, and the multimedia products made with them, rarely take advantage of all the audio control possibilities of the Sound Manager, let alone adding any increased functionality by the incorporation of additional audio software into the product.

This report will consider the limitations in the provision of sound within Macromedia Director (note 1), a dominant multimedia authoring and delivery package for the Apple Macintosh computer (now also available for Windows), and will review the techniques used by the author and others at the Centre for Electronic Arts, Middlesex University, to overcome the control limitations of Director with regard to all but the simplest of auditory operations. This report will also endeavour to offer possible areas for development in the use and control of sound within multimedia, and as such should not be taken simply as a critique of Director.

## **Auditory control in Macromedia Director**

Macromedia Director is surprisingly limited in its audio capabilities. Whilst it offers much to the multimedia designer in the control of animation, text, objects and colour, the provision for the control of sound is meagre. Indeed, of around 200 functions capabilities provided by Lingo (the programming, or scripting, language used by the package), only eight deal directly with audio. These functions enable the setting of a sound file's playback volume, the channel in which it will play, commands to start or stop a sound, and functions to return rudimentary status information as to the operation of a sound file.

It could be argued that sound requires little more than these controls with which to operate, following the standard control interface offered by the magnetic tape recorder (though with the notable exception of a "pause" control). However, the possibilities for the provision of greater auditory functionality within multimedia are considerable. Why not make it possible for the sound to be reversed, under the control of the user? Or for the sound to track the cursor, using spatial psychoacoustic techniques such as stereo imaging or the subjective height of sound in relation to pitch to give the user a spatial image of the cursor position within the screen? Or to enable tonal filtering of a sound to take place, providing the user with environmental information from the sound they are interacting with? Or pitch-shifting? Or through the implementation of time-stretching, or other sound manipulation techniques exclusive to audio in the digital domain, to provide new interactive auditory experiences never before offered to the user? These possibilities would provide a wealth of creative opportunities to the designer of interactive multimedia, and subsequently to the user. And, whilst Director is very comprehensive in facilitating the control of visual components, and thus enabling an interactive visual experience of depth and substance, there is no such translation of component-level control to the audio.

However, we must first consider what should be possible in terms of auditory control given the present technical levels of popular delivery platforms like the Macintosh.

## **The possibilities for greater auditory control**

Within Director, visual components (PICT files, note 2) are kept in a small database as "castmembers", and called to the "stage" as and when required, following the overall "movie" metaphor of the authoring package. The audio components (typically AIFF files, note 3) are treated in the same way, being called as a castmember when required. AIFF files may also be stored externally from the Director movie. Sound can also be stored as a QuickTime movie, and replayed using QuickTime control methods, enabling the user to pause and resume playback of the sound without having to return to the beginning of the sound file as is the case with normal Lingo controlled AIFF playback.

A PICT file and an AIFF file are the same, in the sense that they are both digital data. However, there is a fundamental difference in the operation of visual and auditory components when presented to the user. They are complimentary modes of information, since, "Sound exists in time and over space; vision exists in space and over time." (Mountford, SJ, and Gaver, WW, 1990). Visual elements, once instigated, will remain seen until they are removed. Once an image has been put onto the screen in a particular place, no more is required of the computer's processors than to refresh the screen. Sound, however, existing "in time and over space", requires processing for as long as it is being heard. A sound file must be replayed in a linear fashion, and only when the sound ends will the requirements on the processors end.

Some of the previously cited examples of the possible control and manipulation of sound within an authoring package involve a great deal of real-time processing. Operations such as time-stretching (note 4) are particularly "processor-intensive", and as such are possibly beyond the capabilities of any current popular delivery platform, although the potential for some form of partial processing with audio could extend the limits of what is presently deemed technically possible in terms of speed and consistency of delivery. Other audio manipulation and control functions, such as the use of reverberation, whilst worthy of consideration, would possibly require the use of more sophisticated DSP (Digital Signal Processor) chips to work well enough to offer the designer and the user the flexibility, control and quality required to make such functions usable in "real time". Suitable chips will very probably be incorporated into popular computers at some point, and it is as well to consider their potential benefit to multimedia products at this stage in the development of multimedia. There are, however, auditory control functions that are quite within the technical limits of computers currently in popular use.

The demands of simple real-time processing of an auditory stereo image parallel that required to move a graphic image around the screen in real time, and should require little (if any) more processing. Already, the playback volume of a sound file can be altered in real time from Lingo, (making use of the Apple Sound Manager) indicating that a certain amount of processing of audio is quite within the capabilities of Director and the Macintosh. It would seem, then, that the lack of anything other than the most basic auditory control operations within Director is due more to oversight than to technical limitations, though this is possibly itself due to the lack of user demand for auditory control. The fact that the techniques described below actually work, is further indication that the real time processing of certain parameters of sound is attainable, and suggests that they should be supported as an inherent part of Director/Lingo operations.

## Experiments in greater auditory control

The techniques described in this section indicate how the control of sound can be used to provide a great deal of spatial and identifying information to the user, with particular reference to techniques developed for "A Three-Dimensional Audio Interface for Local Area Networks" (PGDip Project: Tom Dussek, Anthony McGaw, Nicola Wells, 1994). The techniques used to overcome the limitations on the control of sound within Director will be described. There were two approaches to this project, one which used AIFF sound files, and one which used MIDI (note 5) to control an external synthesiser.

An essential element of the "Audio Interface" project was the auditory communication of spatial information. This involved providing the user with stereo imaging for the x-axis, pitch-changing sounds for the y-axis, (following research into the subjective height of sound in relation to pitch by Peters (Peters, RW, 1960)) and using changes in volume level for the (virtual) z-axis. The x and z axes were therefore dependent on volume level changes, and the y-axis on discrete pitch-based instances.

The approach using AIFF files required adaptation of the basic audio control functionality provided by Director. To enable the control of a stereo image, whereby a sound can "pan" across the user's auditory perceptive field, for example making a sound travel from left to right, requires the attenuating and incrementing of the volume levels of the sound. In this example, the level of the sound on the left must decrease as the level of the sound on the right increases. This panning function is not provided by Lingo, and a solution must therefore be improvised. The Macintosh will play stereo AIFF files, but Lingo does not permit the alteration of the sound levels of individual tracks within the AISiF file. Only the level of the entire audio file may be adjusted. It would appear that whilst the Apple Sound Manager has "Stereo Mixing Capability", Director does not take advantage of this. If the user is to be offered control over the position of the sound within the stereo image, it is therefore impossible to set the balance of the left and right tracks at the recording stage. Our approach was to record the same sound into two AIFF files, one containing the sound on the left track with silence on the right, the other having silence on the left and sound on the right.

As both files are stereo, the Macintosh will replay them as such, and the overall result will be that a stereo image will be heard. The user's actions may then be used to adjust the volume level of one of the two sound files, and, if this adjustment is linked in inverse proportion the other file, panning of the stereo image is achieved. This stereo imaging technique indicates the possibility for real time parametric modulation of audio files from within Director.

However, this technique is not without its drawbacks. Firstly, it uses four playback channels to carry out an operation that should only require two, were Lingo to take proper advantage of the Apple Sound Manager. As Director and the Macintosh are limited to the number of audio channels which can be played at any one time, (the exact number is not indicated by any of the literature associated with Director, although it appears to be seven) this doubling of channel requirements severely limits the possibilities for this kind of stereo control.

The second major problem is that of synchronising the two AIFF files, since being separate files called by two discrete Lingo programme statements—they cannot be started in the same instant. If the sound is anything other than a continuous tone, (which may still be subject to a phasing effect if the two sound files are played together asynchronously) then the delay in the second AIFF file being triggered after the instigation of the first will cause a slight but very audible echo, as the second file is running behind the first. Our hearing is extremely sensitive to discrepancies in audio information (this is why a QuickTime Movie gives priority to audio playback, at the expense of constant visual frame rates, as we are more tolerant of visual than auditory inconsistencies) and the psychoacoustic effect of the stereo image is completely lost. Instead of the two files being interpreted as one sound bearing spatial information, they become two discrete sounds. To avoid this delay, a period of silence equal to the delay time in the second file being triggered was added to the beginning of the first AIFF file. Provided that the pre-delay of the first file was accurate enough, this technique resulted in the synchronous playback of the two files. The drawback with this technique is that the amount of pre-delay required is dependent on the speed of the delivery computer. If the computer were faster or slower than the computer on which the project was developed, the files would no longer be synchronised.

With the Three-Dimensional Audio Interface project, y-axis movement, which was not dependent on volume level, used pitch to indicate the height of a visual object. As there is no provision within Lingo to alter the pitch of a sound file, multiple AIFF files had to be recorded at different pitches, and imported into the cast of the movie. They could then be replayed from Lingo, switching between the AIFF castmembers to alter the pitch of the sound. This is very similar to multiple PICT file castmembers being used to create an animation. However, whilst it is reasonable to accept that the amount of processing required to manipulate an image in real time to generate animation is beyond the capabilities of current popular computer technology, thus necessitating the use of multiple pre-drawn discrete images, the same is not true of sound files. The only parameter of the file that must be processed to achieve pitch shifting is the frequency. This is done by relatively simple multiplication (or division) of the fundamental frequency of the sample rate, and, even when following the slight anomalies of the equally tempered tuning of western musical tradition, should provide little challenge to the processing capabilities of the Macintosh. There are considerations of audio quality in this, as the reduction of the sample rate to lower the pitch of a sample will cause the high frequencies of the sampled tone to be lost, and timbral factors such as the attack or decay of the sampled sound will alter in direct proportion to the sample rate alteration, resulting in unnatural modulation of the tone, but this may be rectified by the judicious use of a degree of multi-sampling and construction of a sound using separate components such as the attack, sustain, decay and release of the sound, following the principles developed by the music industry. Rectifying the problems of sample rate alteration is not an insurmountable problem, and the provision for pitch shifting sound files from Lingo would greatly increase the potential for more comprehensive control of sound within multimedia.

## **The use of external control functions with Director**

The use of additional hardware devices, triggered by external program modules attached to Director (X-Objects, note 6), demonstrates how more sophisticated control of sound provides an exciting opportunity to the multimedia designer in the use of sound.

The use of MIDI signals, transmitted under the control of the user to an external synthesiser, (which then generates the sound) is, for the purposes of this report, an example of the use of dedicated audio control functions within multimedia, as opposed to the use of synthesised sound.

Incorporating X-Objects (in this case a commercial product, "Hyper- MIDI", by Earlevel Engineering, California) enabled all the control parameters offered by MIDI to be accessed from Director. These parameters are comprehensive, as MIDI has developed from basic note-trigger information to offer many more functional controls. MIDI is a control protocol, and therefore does not process the actual sound, so direct manipulation of the sounds was not possible. Numbers between 0 and 127 (as required by the MIDI protocol) were generated from

Lingo by the user's interaction, and this was sent (along with the appropriate identification information) to the synthesiser which then responded to the control information. This enabled a comprehensive control system to be established. Note values (and thus pitch values) were easily altered, panning was easily attained, as was the setting of volume levels for a sound. Rudimentary equations were used to provide the receiving synthesiser with values based on the user's interaction, and the whole system worked very smoothly.

This use of external MIDI controlled sound generation is notable for the purposes of this report in that it demonstrates the functional advantage gained by a multimedia product from the use of dedicated sound control systems. Subsequent projects undertaken using this system, in particular "The Audio Playground" (MA Project: Dussek 1994), have explored further the use of sound as an interpretation of the physical actions of the user, in which the sound responds to the dynamics of the user's action with the mouse, by the setting of the velocity parameter within MIDI. Non-auditory responses (Davis, RC et al., 1955) triggered in the user by the use of sound-driven narrative structure were also explored, allowing emotive exploration, discovery and shocks. These projects required the comprehensive and accurate control of sound across various parameters, and resulted in an interactive experience which stimulated, excited and absorbed the users using sound as an integral component to the user's interaction.

It is clear what could be achieved with more comprehensive audio control within multimedia authoring packages, of which Director is only an example. The use of MIDI, whilst offering a great deal to the designer in terms of auditory control, is currently impractical past the prototyping stage, due to the requirement for external hardware. However, it does draw attention to the possibilities for controlling sound which packages like Director should begin to exploit. We can assume that hardware specifications will increase, with the greater use of DSP chips and the development of comprehensive but relatively cheap digital audio manipulation products by companies such as Yamaha, E-mu Systems and Roland (among many others). In the meantime, packages should make full use of the hardware and system software facilities which are already present so that the designer, and thus the user, is enabled to explore many more auditory possibilities

## **Developing the use of sound within multimedia**

If comprehensive audio capabilities were available to multimedia authors, would they be fully exploited? There is a clear need for greater attention to sound in both design and production (and this has implications for the way in which designers and developers are trained). Designers and developers must begin to include sound in a way which is more substantial and satisfying than has currently been exhibited if we are to experience the full potential of multimedia. Production staff should not tolerate the level of technical expertise that some now do in relation to sound. If we are to accept that most audio from a CD-ROM or other multimedia product will be replayed through the rather poor quality amplifiers and loudspeakers built into delivery platforms, then the audio should be recorded with this in mind. There is a parallel here with the television industry, where signal compressors, filtering and very high quality recording devices are used to ensure the highest possible standards from the domestic television's low fidelity sound reproduction system. In television, the end result achieves an acceptable degree of quality and intelligibility, yet in multimedia products the experience and knowledge of the professional audio industry is all too rarely used. Even where multimedia publishers are investing in recording studios to provide an acceptable level of sound quality within their products, what is subsequently done with the auditory component often remains pedestrian and uninspiring. The emotive use of sound in film, to build tension, to make us jump, to constitute, contradict or reinforce certain elements of the narrative, offers a wealth of finely crafted techniques, yet these seem to have been largely ignored. MacroMedia may well feel that there is little point in developing more comprehensive sound control functions for Director if multimedia designers show no desire to use them. A demand must therefore be created, and serious thought must be given to the use of sound as an integral component of the interactive experience. It is important to start considering how we may provide as much for the user aurally as we do visually: in its present stage of development, audio is still the 'missing element' in multimedia.

Tom Dussek, 1994

## **Notes**

### **Note 1**

This report deals with Director Version 3. Whilst version 4 is now available, its release is too recent to permit a fair appraisal of the package and its audio capabilities

## **Note 2**

PICT files are a graphic file format for saving information created in a paint or draw application on the Macintosh.

## **Note 3**

AIFF, Audio Interchange File Format, is a standard for exchanging sound information between applications, required for sound files which are played back from within Director.

## **Note 4**

Time stretching is a process whereby a sound sample is made longer (or shorter) in duration by the adding in (or removing) of estimated samples at regular intervals over the length (in time) of the sample. This alters the duration of the sample without altering the pitch.

## **Note 5**

MIDI, Musical Instrument Digital Interface, is a communication protocol for electronic devices, e.g. synthesisers, to transmit and receive control information.

## **Note 6**

"X-Objects" are modules of code which may be linked to Director to increase its functionality in some specific manner. The incorporation of "HyperMIDI" X-objects into Director allows MIDI information to be transmitted (or received) from Director, a function which Lingo is otherwise unable to perform.

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## **Advisory Group on Computer Graphics: Case Study**

# **Hypertext and Research Presentation in Art and Design Education**

### **Abstract**

Historical and theoretical studies is an integral part of virtually all courses in art and design education. In this educational context students are exposed to a wide range of visual media and courses and projects are designed to provide students with sophisticated two dimensional and three dimensional manipulative and visualisation skills. The introduction of hypertext into the theoretical studies curriculum is designed to introduce students to aspects of computing which are relevant both to theory and research based projects and to the practical, image manipulation skills associated with studio and workshop practice.

Theoretical studies departments in colleges of art and design, as with many humanities courses, usually demand that students present their ideas and the results of their theoretical researches by means of the strict linear narrative of an essay or thesis. However, with the advent of electronic interactive documents opportunities are available for the student/author to develop approaches to knowledge/text manipulation and presentation which can draw upon non-linear modes of thinking. The construction of documents in hypertext develops students' visualisation and design skills in ways that are not encountered in the linear narrative of the conventional essay or thesis.

This case study, examining research and text management through hypertext authoring, is specifically concerned with the relationship between theory and practice in art and design and with ways in which theory might be managed and presented using the visualisation skills derived from practice.

### **Educational Context**

In art and design education attempts are regularly made to identify new media which have genuine potential for creative authoring. Such media must possess features traditionally associated with art and design practice. They must show a high degree of flexibility so they can be moulded and shaped according to the intuitions, flights of fancy, or communication needs of the individual artist and designer.

Clearly in an educational environment where students are exposed to a wide range of visual media and where courses involve the development of creative visualisation and design skills the construction of graphic images provides students with familiar models for the interrelating of ideas, images and text. This makes students' graphic constructions valuable aids to perception, learning, data organisation, concept manipulation and communication. Such processes are also fundamental to the construction of hypertext documents.

Similarly, problems of navigation, mapping, management of multiple pathways which are intrinsic to hypertext systems are also central to art and design practice. The ability to create pictures, 3D constructions, diagrams, symbols, graphic signs, even simple box/arrow structures should give art and design students a ready purchase on the processes by which theoretical material is organised in hypertext systems. Furthermore It should enable tutors to approach students' theoretical material in ways which, from the point of view of critical discussion, have much in common with critical tutoring in studio and workshop contexts.

In schools of art and design courses in history and complementary theory enable students to extend and deepen their intellectual understanding of art and design practice, to develop their powers of critical thinking, to increase their visual and formal awareness of works of art, to gain a deeper insight into the social, political and ideological

factors which influence the production and interpretation of visual media and to generally introduce them to the knowledge and perspectives derived from a wide range of humanities disciplines. The case for introducing hypertext authoring systems into the theoretical studies curriculum is that it might enable students to manipulate information and concepts in ways which mal

The most obvious application of hypertext in the theoretical part of the art and design course is the representation and organisation of ideas and information graphically. This involves, not simply the use of visual images for illustration, but the creation of 'maps' or 'models' which describe a particular aspect of reality, organise information in relation to the development of a particular theory, or create and plot multiple pathways through a knowledge structure.

Sometimes described as 'concept mapping' this authoring device permits text based descriptions of ideas or concepts to be interconnected and displayed employing linking devices which show structural and functional relationships between discrete bodies of information.

The introduction of hypertext into the theoretical studies curriculum is designed to introduce students to aspects of computing which are directly relevant to theory-based projects situated in an art and design school where courses are predominantly devoted to the teaching of practical, image manipulation skills. Through the design of hypertext based concept maps the student author can deploy sophisticated graphic visualisation skills to enhance the conceptual management of the theoretical research material.

Such visualisation skills permit the design not only of categories and sub-categories of information as in conventional database design but of linking structures showing 'meaningful' relationships between categories of information. The degree of 'meaningfulness' would be directly related to the author's selection of elements for presentation together with the patterns of links by means of which the discrete elements are interconnected. A variety of terms are currently being employed in the various explorations of this mode of authoring. King (1984 p17) for example refers to similar authoring features as Frames:

*'A frame is a matrix or table which acts as a framework for representing knowledge... Frames are an example of spatial learning strategies which can be provided for the student or which the learner can construct for themselves '*

These are also processes fundamental to the construction of hypertext documents. The use of such teaching and learning techniques in the context of art and design education allows students to engage in theoretical investigations while deploying techniques and processes which have many formal similarities with their studio-based practical projects.

It might be argued that even in documents which consist wholly of text based information the devising of navigation routes relating to potential meanings becomes a problem of overview or map-making. Although graphic images might not be included within the body of information, the design and manipulation of the system as a whole could be dependent upon those object and image manipulation skills which are an integral part of art and design practice. If it is the case that information management in hypertext systems necessitates plans, maps, charts or diagrams for navigational purposes then clearly a fruitful relationship exists between theoretical research presentation in hypertext and the characteristics of art and design production.

## **Hypertext Software: Three Systems**

During the 1980's the advent of low priced computers (particularly the Apple Macintosh) and easy to use hypertext software made it possible to explore the potential for introducing students to a medium which seemed ideally suited to art and design courses. One of the first systems to be tried at Coventry was Filevision which is essentially a graphics based multiple linking system. Later Guide provided similar characteristics but was specifically dedicated to text handling. More recently students have been using HyperCard which permits the author to modify the system through its built-in programming language, HyperTalk. The following examples give an indication of the capabilities of the three packages referred to and illustrate some of the possibilities for their use in projects where students are taught to relate theoretical concepts and text to pictures, charts, diagrams and maps.

## **Filevision (Telos Software Products)**

Filevision is a flexible graphics-based data-base package designed for use on the Macintosh computer. The system's special feature is that it allows the user to put pictures and diagrams together with attached data fields. It thus encourages the user to organise data by means of graphic displays. Filevision helps the user to visualise ideas and bodies of information. It integrates graphics and information management.

The Filevision system enables the user to create, manipulate, store and retrieve information through a picture or symbol of what that information means in visual terms. Students learn to design a networked data-base or filing system through a picture, diagram or visual model of that information. The data is thus structured in the system in a way which represents, to the author, a recognisable aspect of the real world.

## **Guide (OWL)**

Guide is essentially a text based system which runs on the Macintosh computer. It has been described as a 'three dimensional outliner'. Although Guide allows a user to browse through documents following individually determined routes the student/author must pay considerable attention to the design and construction of the document.

Potential 'meaningful' routes have to be structured in advance of text production in order to allow the user to browse through the finished document. Guide can be used to create research presentations, proposals, instruction manuals, reports, works of fiction, poetic and dramatic narratives or any document where information needs to be communicated in some structured form. It is this process of designing and structuring which, from an educational point of view, can provide insights into the conceptual and intellectual problems associated with the development of an idea into some communicable end product.

## **HyperCard (Apple)**

HyperCard is an authoring system and an information organiser designed by Apple for the Macintosh computer. The author generates 'stacks' of information. HyperCard can be used to create, store and retrieve information - words, diagrams, charts, pictures, digitised photographs, statistics, etc., - on any subject the author decides. The 'stack' consists of any number of electronic 'cards'. The card is screen size and can hold graphics or text. Any of the elements of information on a card can be connected to any other piece of information (another card in the same stack, a separate stack or a document produced in a different application by means of 'buttons'). It is through the use of buttons that the author designs and generates the network of routes and pathways through the information system. It is possible for users to plot their own routes through a body of information based on the network of routes made available by the author of the document.

The key to HyperCard's authoring environment is 'Hypertalk'. This is a simple programming language built into the HyperCard system. HyperTalk will permit students who have little or no programming skill to design and build information systems which meet their particular needs or research requirements. In this way HyperCard can draw upon and develop the non-computing expertise of the author. It allows the student/author, trained in visual image manipulation skills, to construct elaborate knowledge structures relating to both visual and theoretical research projects.

It is now possible to use relatively inexpensive computer systems to design non-linear knowledge structures combining text and image within the one document. Hypertext is beginning to permit the introduction of such systems into education allowing students to engage in the visual mapping of specific bodies of research material. What remains is to examine carefully the real benefits of this electronic medium. Filevision, Guide and HyperCard are systems which have been the subject of the research work described in this case study. They have been examined for their appropriateness to the organising of theoretical material in art and design education. Currently numerous other examples of hypertext software - Intermedia, StrathTutor (Mayes, Kibby & Anderson 1990); Learning Tool, Semnet, FrameMaker (King 1994); ToolBook (McKenna 1994) - are being examined by other researchers for their special authoring characteristics in the education field.

## **Thesis writing**

Theoretical studies departments in colleges of art and design, as with many humanities courses, usually demand that students present their ideas, and the results of their theoretical research by means of the strict linear narrative of an essay or thesis. However, as described above, with the advent of electronic interactive documents opportunities are available for the student/author to develop approaches to knowledge manipulation and presentation which can draw upon non-linear modes of thinking. The construction of documents in hypertext systems develops students' visualisation and design skills in ways that are not encountered in the conventional essay or thesis.

Following the advent of recent debates on research methodology arising out of the conferring of PhD awards on art and design practice the place of theory, written documentation and research presentation has become highly topical. To what extent should practical work be accompanied by text based documentation? Do models for text based research presentation in art and design have to be imported from other disciplines whose models might be inappropriate for research in the visual arts? Can research presentation models be found which are sufficiently sensitive to art and design methodologies to enable the practitioner to engage in genuine research activity while still retaining the integrity of art and design practice?

It is not the aim of the research informing this case study to suggest that hypertext provides an authoring and presentation model which answers all these questions. Nevertheless, it is an ideal that art and design research practitioners should avoid drawing upon the potentially inappropriate discourses of other disciplines and should try to develop their own discourses and presentation methodologies which arise naturally out of the discipline itself - that is, the research and presentation models should have features in common with the basic characteristics of art and design practice.

Hypertext authoring is not seen as a replacement for traditional art and design media or the standard essay/thesis. However, its ability to bring together the qualities of a number of different media in one piece of work makes it exciting to students. There have been numerous instances where students who have already come to appreciate the potential of this new medium in the studio have asked if they could submit a hypertext document in place of an essay or thesis. It is evident from their work that analytical and theoretical work can be contained within hypertext, but no clearly established criteria currently exist for the assessment of such documents. Figs 1 and 2 are examples of different structural models devised by students in the production of hypertext-based essays.

It remains to be seen, as more art and design students are introduced to this new medium, whether it will indeed form a bridge between two and three dimensional image manipulation practices and the accompanying historical theoretical research components of courses. In the meantime it must be noted that the application of hypertext systems to theoretical research presentation raises some interesting problems for the assessment of students' theoretical research presentation.

## **Notes for Guidance**

Having looked at the institutional and educational context within which hypertext systems might fruitfully operate and having looked briefly at examples of available hypertext packages it remains to describe the way in which these systems might be made available to students through the devising of carefully prepared project guidelines. The following 'Notes for Guidance' model proposes a framework within which students might adopt a hypertext based model for the production of theoretical work.

### **Computer-Based Presentation**

It will be possible for students to present their research in the form of computer based structures. This will depend upon the availability of equipment and staff expertise, and on students' own understanding of the appropriate technology.

A computer-based presentation of theoretical research is not simply a matter of typing a normal thesis into a word processor and having a reader access it from the screen. There should be good reasons why the material needs to be authored and accessed electronically. There are a number of systems currently

available which permit text and images to be manipulated and presented in ways which conventional print on paper does not allow. The general term 'hypertext' has been attached to such systems, several of which could be appropriate to research presentation in the art and design context.

In general terms, hypertext refers to the handling of electronic information in particular ways. The handling of information in such systems extends beyond conventional information structures which employ linear narratives, lists, indexes and sequential card systems etc.

Hypertext systems do not require either the author or the user to follow predetermined structures and access routes through bodies of information. The body of data within the system can be repeatedly cross-referenced. Topics that might have relationships either for the author or the accessor can be directly connected even though in a conventional thesis they might be many pages apart. Elements of data within this type of presentation, then, become networked in such a way that fixed linear routing becomes unnecessary. The information system is 'designed' by the author in such a way that routing can be determined by the user. If the information system has been organised appropriately then multiple pathways and therefore multiple meanings can be created according to the disposition or needs of a reader. Thus, what might best be described as a three-dimensional knowledge structure is constructed allowing information to interact in an almost fluid way, depending upon the number of links and connections which the author builds into the system.

Hypertext systems can be particularly useful where an author wishes to establish links across traditional subject and discipline boundaries. For example, when studying a period in the history of art, where reference is made to a particular philosophical theory, a user might want to examine in more detail the philosopher referred to. One hypertext link could connect the historical period to the philosopher's biographical information. This information might be located in a separate document dealing with the history of philosophy as distinct from the history of art.

Similarly, other documents might be created which describe technical details of design processes, social and political events, etc. These can be 'stand-alone' documents so far as their location within the computer system is concerned. The effort on the part of a student/author will be invested in the design of the networked structure which permits the user to become an author through the possibility of generating multiple-pathways.

Finally, it should be emphasised that preparing a body of information and building it into a hypertext system can be extremely demanding both intellectually and technically and should only be embarked upon for a research project after detailed discussion with a tutor who understands both the system and the research subject proposed.

## Conclusions

Although many features of hypertext authoring in an academic context are now relatively unproblematic the particular characteristics of the software throw up some interesting issues which are currently the subject of ongoing research. The capacity of hypertext as an authoring medium, to bring together graphic visualisation skills and theoretical text management skills, is well recognised particularly in the design of interactive multimedia documents. However, the traditional research thesis, as evidence of individual scholarship, assumes the establishment of a 'point of view' or an 'argument'. In other words a thesis should be a uniquely authored and logically unfolding narrative. Since Hypertext documents specialise in multiple routing and are often designed to transfer control of narratives to users, difficulties may arise when attempting to assess quality of research in hypertext documents through evidence of personal authorship. The ESRC guidelines on research thesis writing state: (my underlining)

"Although it is not possible for a student to envisage at the outset the exact form and the subdivisions of the thesis, it should be possible, once the literature survey has been completed and the primary sources have been tested, for an outline of the eventual thesis to be prepared. This outline will be a map which, at the outset, will contain only a few major landmarks. But as the detail is assembled, some lines will

become more significant, and others less so. It is probable that the outline will still be visible in the final thesis but the preliminary design will be overlaid by subsequently assembled data. nevertheless, the outline should never be undervalued, since it provides the basic shape." (ESRC p.9)

Clearly the guidelines refer to features of research presentation which have much in common with the material outlined in this case study. Terms such as 'map', 'design' and 'shape' are part of the vocabulary of the designer and call upon basic visualisation skills. However, the same guidelines state that:

"Whereas the function of the first draft is to solve the problems of organising and presenting evidence, the function of the second draft is to improve the clarity of expression and to ensure that the thesis as a whole has been organised as a connected argument, adequately paced and expounded." (ESRC p.12)

The thesis as a whole should be organised as a connected argument. Such a model suggests a high degree of authorial control over the reader and the designing of a logical and linear narrative thread by means of which the argument with supporting evidence is unfolded from initial aims to concluding proofs. Perhaps the presentation of the 'research thesis' demands a form of authoring which cannot be non-linear, involving multiple routing and the transferring of route selection to the reader. Alternatively, the particular characteristics of hypertext documents might be highly appropriate to other forms of research presentation where the single linear narrative is not necessarily the norm. The author's research to date has shown, however, that the management of text and image in hypertext documents is ideally suited to the visualisation and design skills of the graphic artist.

A.Dyer November 1994

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# Defining the Limits of Metaphor.

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## Abstract

This case study examines a number of software applications available to Fine Art Students, and specifically those which are used in the School of Art, at the University of Brighton. Particular emphasis is placed on an examination of computer applications which are designed to provide on-screen tools and functions analogous to 'real-world' tools and materials used in traditional Fine Art practice.

## Background

At the University of Brighton's School of Art, within the Faculty of Art, Design & Humanities, there are seven individual BA programmes in Art:

- Critical Fine Art Practice
- Painting
- Printmaking
- Sculpture
- Dance with Visual Practice
- Music with Visual Practice
- Theatre with Visual Practice

It is an important educational objective within each specialist programme, and it is the policy of the School of Art as a whole, that all students should have training in computer-use, at least to a basic level of word processing and simple black-and-white paint draw applications

All students within the Faculty of Art, Design, & Humanities have access to a central computer pool: this pool has over twenty Apple Macintosh platforms, and has a wide range of software, scanners, and printers. There is also a word processing pool of about ten machines, and a Mac Quadra 950-based animation facility in the Learning Resources AV Media Unit.

There are also three dedicated pools for computing in specialist areas within the School:

- a. Music
- b. Printmaking
- c. Sculpture

## Methodology

The applications which were used for this case study were *Painter*, *Sketcher*, *Kid Pix*. These provide on-screen tools which are used as metaphors for physical equivalents used by artists: how do the students respond (react) to these? Are they appropriate within their specialise areas? Do they create limits or expand the borders of their perceptions? Alongside these particular applications there are others such as *SuperPaint* and *Photoshop* which use different icons and interfaces, but have similar or related attributes.

I decided to invite first year students who had not had a computer induction to participate in this case study, particularly students who knew little or nothing about computing. Ten students volunteered to act as guinea-pigs: three sculpture students, three painters, and four printmaker, with an equal balance of gender.

The applications they used were:

## **Broderbund:Kid Pix**

This is a children's paint programme, originally designed by Craig Hickman for his three year-old son, after seeing his growing frustration when faced with full featured art programs. He accidentally launched desk accessories, moved windows, and made random menu selections, in much the same way as my computer-illiterate students do, particularly when using system 7. The application was expanded from the original programme, and more 'fun' features were added, yet it still retains the original intention of making the interface easier to understand and apply. For example, the whole drawing/painting area is visible on the screen: there are no scroll bars. WYSIWYG when you print the window.

The metaphor for each drawing tool is very clear, and available on the left hand side of the screen, with no menus to open, no dialogue boxes, and with the use of sound adding a new dimension to their use. The options available for each action, and each drawing instrument, are clearly displayed at the bottom of the screen. Some tools have several sets of options. An arrow icon at the end of a set indicates that more options are available. Some tools and tool options behave differently if the options key is pressed and this is indicated with a star.

The tools have humorous titles: there is a *Wacky Pencil*, and a *Wacky Brush* (which can be turned into a *Leaky Pen*); *Drippy Paint*, which drips as you draw; *Splatter Paint*, which produces an instant Jackson Pollock. The *Electric Mixer* transforms the drawing by mixing it up in a variety of ways. With *Splats*: big blobs of paint are splashed onto the drawing; *Broken Glass* shatters it into many jagged pieces. The *Paint Can* fills areas with selected paint patterns. The *Eraser* tool acquires a whole new meaning, for apart from varying in size it can also turn into a *Firecracker* that clears the screen in one big blast, or a *Black Hole* that swallows everything up. Luckily the *Undo Guy's* at hand and will come to the rescue: click on his face and the results of your last action will immediately disappear. This works the same way as Undo in the standard Mac Edit menu.

There are many other features too numerous to list here, but including all the standard Macintosh GUI features. The Kid Pix menu, for example, is standard format, except that the items are seen as icons, as well as words and PowerKey options. A Sesame Street-style feature, obviously more relevant in the USA than in the UK, is dual Spanish/English capability. This application is obviously fun to use, for adults as well as children, but why give it serious study? One important reason is that software developers can easily overestimate the ability of users intuitively to grasp the functions and possibilities of a given application.

The advantage gained from encouraging students new to computer use in art to use Kid Pix obviously not intended for professional users - is that they very quickly become aware that, when working within more complex programs, similar multiple-option features can be found. The principles of menus and dialogue boxes, even scroll bars, rapidly become easier to understand: they learn how to search and explore within the interface.

## **Lebaset Fractal Design Painter 1.0 & 2,0**

(Painter 3.0 was not available for this study. We have a site licence for Letraset software)

Painter was the first program seriously to simulate traditional artists' tools and materials; it concentrated on this simulation and was not seen originally as an all-round graphics package. The palette system is very un-Mac like, no strips of tools down the left hand side, but eleven separate palettes, each of which can be opened and closed from the windows menu. The brush palette is the most innovative, a series of twelve inch-square icons, each providing a paradigm of an artists' tool: pencils, chalk, charcoal, calligraphic pens, felt pens, airbrush, crayons, oil paint and a range of brushes. Each tool performs in the same way as its actual counterpart, supposedly simulating traditional painting techniques. A range of pop of menu allows for other options: the application even gives the possibilities of mimicking the styles of Van Gogh or Seurat.

The colour palette is also unique to this application: a triangle with the hue at the apex, blending out to white at the top and black at the bottom, to give saturation and value components. This is a more obvious method of colour- management for artists to understand than the computer's native RGB.

Artists often prefer to work on textured surfaces, than on the featureless screen most paint programmes provide, and Painter allows the user to specify the surface, a scrolling palette gives a range of surface textures from fine cartridge paper to coarse canvas and a library of 'wild' textures and surfaces. These textures can be applied to the whole document or to individual tools as an applied variant. Additionally, each tool can be used in conjunction with various modes of added 'water', providing a further set of options. The different kinds of 'water' can be applied to the painting surface in advance, used with the tools, or added retrospectively. The tool box contains ten options familiar to Mac users: selecting, painting, filling, text, frisket and stencilling.

Another distinctive feature of Painter is the 'cloning' function, which bears a similarity to the Photoshop 'rubber stamp' tool, but which provides the opportunity to apply attributes such as those of oil paint, or crayons, for example, to a scanned photograph.

The application is most effective when used with a fast computer with plenty of RAM. Otherwise, when using painting modes of any complexity, there is a delay between each mouse or tablet action and its effect on screen, which obscures the immediate, intuitive nature of the programme, and inhibits any freedom of expression and movement. When used with a suitable platform, and with a Wacom pen and tablet, it is possible, through its pressure and velocity settings, to match the style, speed and direction of 'real' painting marks and strokes. Even the manual is designed like an artists sketchbook and the application comes packaged in a paint tin.

Unfortunately the students and I did not have the opportunity to use the newest upgrade of this application Painter 3.0; but judging from reviews, this version is seen as a major upgrade, and has been extensively rewritten and filled with new features. Apparently the significant feature of the earlier application - its ease of accessibility - has been lost and it has become a much more complex programme. The clear understanding of the metaphors for paint tools were seen as a very positive feature by the students, who found it very accessible and easy to use and understand. It is a great pity when programmers become more concerned with applying more and more complex features to applications, forgetting the earlier intention of the applications, and marginalising those people to whom they were originally designed to appeal.

## **Fractal Design: Sketcher 1.0**

Sketcher is a powerful grey scale paint image manipulation application and has some fine-tuning options such as image, flip, soften, sharpen, and 'Brightness/ Contrast' window. But with a few exceptions this program is basically a black and white version of Painter; it has all the similar attributes, interface and icons, although the brush palette is replaced with 'Art supplies' and the colour palette is changed to that of 'Shades Palette'.

One of the main problems with some paint programmes is that of resolution options. Because bitmaps contain a fixed number of pixels, governing the resolution of an image, the number of pixels-per-inch is independent of the size at which the image is printed. So when images are printed small the paintings appear smooth. When printed large they appear jagged unless the resolution is increased, thus increasing the file size. Painter has managed to resolve this by its special format of RIFF (Raster Image File Format).

A drawing program, on the other hand, features tools that have no real counterparts. The processing of drawing might be more aptly described as constructing, because the user builds lines and shapes point by point and arranges them in sets or layers to create the finished piece. Each object is independently available for editing. Drawing programs defines lines, shapes and text as mathematical equations, and conform to the resolution of the output. In other words the information is translated by the printer software into printer pixels. The printed drawing looks smooth and sharp regardless of the size it is printed. Paint-layer graphics are pattern of dots with no special relationship to each other - paint images have a "textural" look. This is similar effect as using drawing on a blank sheet of paper or canvas. Working in the draw layer is similar to cutting out smooth shapes and laying them out as collage. Generally the paint layer allows for options for creativity, while the draw layer provides smooth precision.

## Aldus: SuperPaint 3.0

This programme is a hybrid application combining both paint (or bitmapped) layer, and draw (or object-oriented) layers, allowing to freely mix text and other postscript objects with paint images. Both layers have various drawbacks but it is possible to move freely between each layer, taking advantage of the strengths of each. The 'Paint Brush' and 'Compass' represent SuperPaint's two layers, the icon that's on the top is the layer you're working in, clicking the icon switches layers. The layers are superimposed on the screen, and in the printouts, to produce a single layer.

*SuperPaint* makes no real effort to simulate real-world painting methods and doesn't appear to feel the need to compromise itself, to the extent that most of the images produced within the application, could not be anything other than computer generated.

In *SuperPaint* there are two types of palettes: floating palettes and pop-up palettes. The primary Palettes are 'Tools', 'Line and Fill', 'Frequent Fills' and 'Coordinates', and to reduce screen and palette clutter, sets of related tools and controls are displayed by with a series of pop out palettes, that can also be torn off and placed around the screen.

The 'Tool Box' gives the option of a basic range of simple 'Brush' and 'Pencil' tools, a rudimentary 'Marker pen', 'Airbrush', and the obligatory Mac-tools such as the 'Rubber', 'Paint Bucket', 'Grabber' and '~Magnifier'. The bitmapped 'Brushes' also offer a range of brush styles including, the 'Spin' and 'Sprinkler' the former produces an effect based on two lines of equal length spinning about an axis, the latter stamps a series of shapes onto the document such as 'Happy Faces', 'Hearts' and 'Balloons.'

The Draw and Paint 'Plug-ins' palette is available in both layers: which includes '3D Box', 'Allgon', 'XBubbles', 'Cycloid', 'Quick Shadow', and 'Spiral'.

*SuperPaint* only offers a simple range of image manipulations, not in any way as extensive as *Painter* or *Photoshop*. Its colour palette has a similar arrangement to that of *Painter*, but uses a continuous colour palette instead of a triangle.

This is a very versatile program and is unassuming about the range of options it has available within it. But once the interface is understood it offers the opportunity to work with a wide range of possibilities.

## Adobe: Photoshop 2.5

*Photoshop* has always been seen as one of the best image-editors, and with its many upgrades it now stands out from all other applications within this area. Although it might not be seen as an obvious art application, nevertheless my students regularly use it for a variety of purposes, which is why it features in this case study.

One of the strengths of the *Photoshop* 'Tools' icons is that they are very clearly displayed on the left-hand side of the screen; and although it is a very complex program and has numerous levels hidden within it, it appears initially very straight-forward. Its core painting tools are as easy to use as a (real) pencil. Alternately there are pixel-by-pixel draw and erase features; the pencil is the only tool that is not anti-aliased.

In addition to being simple to use, each tool is customisable, similar to the options available in *Painter*: 'Coloured Pencils', 'Airbrush' and 'Water-colours', for example. The main tool palette also contains icons for selection such as the 'Circular' and 'Rectangular' selection 'Marquees', the 'Lasso', and the 'Magic Wand'. One of the unique features of *Photoshop* tools is the 'Rubber Stamp' which is one of the most versatile tools in the tool palette; the option dialogue, besides giving size, opacity, spacing, and mode choices, offers a long list of additional options, for example applying texture, pattern. The other useful tool is the 'Blend Tool', it can be modified to fill to create some unusual effects. The 'Crop Tool' is self explanatory and is a more expanded version of the 'crop command' found in the edit menu. The other tools are: the '@Smudge' tool which has the concept similar to using your fingers to work into a shape. The 'Blur' and 'Sharpening' tool are self explanatory. The 'Paint' tools are very versatile and can be set to apply colour in a variety of ways, including lighten, darken, or colour only.

There are also a series of floating palettes similar to those found in SuperPaint, that can be moved into any position on the screen. They support the main tool palette: 'colour Picker' and 'Brush Shape' palettes as well as the 'Fill' command and 'Paste Control'.

This is a powerful paint application with strong image manipulation effects including a large variety of filters virtually unequalled by any other Macintosh graphics programs; 'Twirl', 'Spherize', 'Zigzag', 'Pinch', and 'Wave' for example; but with none of the gimmicks available in some of the other paint programs.

But it is also useful program to export work from other paint programs, because it supports CMYK system as well as the standard RGB and HSV and overall offers a greater flexibility for output than the more specialised paint programs. So it can be seen either in a paint program in its own right or used in conjunction with another application.

These are the questions the students were asked to address, with their responses, in order of decreasing occurrence:

**1. *What are your three main objectives in using this application?***

- a. To understand the applications.
- b. To investigate the different drawing effects available in the various applications.
- c. To investigate all the icons withing the various applications.
- d. To explore the various marks that can be made within the various applications.
- e. To draw with more control on to the monitor screen.
- f. To have more control over the mouse.
- g. To investigate layering effects.
- h. To investigate colour.
- i. To investigate tonal effects.
- j. To produce work for other studio work; Printmaking/Screenprinting.
- k. to help formulate ideas for work in other areas.

**2. *Which objective did the application most readily help you to achieve.***

They generally felt that they all achieved their objectives, particularly when they were able to use more than one application.

**3. *Did the icon for each tool give an accurate indication of its function?***

It was generally felt that they did; although one person felt that none of them were truly accurate due to the bitmapped quality of the line.

The ones they particularly identified as most giving an accurate indication of their function were found in a variety of applications.

a. The 'Twister' (SuperPaint) It randomly scatters the pixels under the tip of the tool. The effect diffuses and softens sharp edges and other areas of contrast.

b. The 'Truck' (Kid Pix) This is similar to a select tool found in other applications, it activates parts of the image and allows for it to be manipulated and displaced to another part of the screen.

**4. *Are the options assigned to each tool simple to understand and use?***

They all agreed unanimously that they were.

**5. *Do you feel that the general principles of Macintosh applications, governing the use of paint tools, are followed in this application?***

Most agreed that they were; although one person didn't understand the question, and another thought that its uses true only to a certain extent.

**6. *Did you think that the application was too simplistic, too complex, or about right?***

The majority felt it was just right, (or 'perfect' as one student wrote); only one thought that generally they were too obvious.

**7. *Does the use of colour in the menus/tool panels help with the ease of use of the application?***

The students who were working with colour applications, felt that it did, particularly a dyslexic student who felt that it made it easier to understand.

**8. *Does sound help to enhance the ease of use of the application?***

It was generally agreed that it does. One student felt it helped her coordination, another felt it made her feel intimidated (as it only seemed to make a noise when she did something wrong). The dyslexic student again felt that the multi-sensory feel of the applications was a great support.

**9. *Do you feel that the application will be of any benefit to your own work?***

Most agreed that it would; although two felt that it wouldn't be at present, and one felt it would be no good at all.

**10. *How directly did you feel you were able to control the application?***

All felt that they had difficulty to begin with, but with help and time they gradually felt more confident. One student likened the experience as similar to their working with an airbrush.

## **Summary**

This was very interesting case study to do and I feel that the students and I learnt a lot from the experience. Not only in the way that they learnt how to use computer applications, but also in the fact that they were able to analyse the applications, for what they were and for what they were being offered, which was 'provide on-screen tools, or metaphors for physical equivalents used by artist and functions analogous to 'real-world' tools and materials used in traditional Fine Art practice.

On a personal note I was surprised that the students felt so at ease with the different applications. Admittedly I was there to open up applications and to help them if things went wrong. This probably allowed them to gain in confidence. There is a slight naivete when first approaching computer applications, which makes the new user allow the application to set its own limits and boundaries. The problems only seem to arise when they have gained more in experience and want to apply a certain features to an application, without understanding various functions and options available. Because of this they get increasingly frustrated with their lack of knowledge and control over the application.

## **Conclusion**

Some of the paint programmes are becoming increasingly complex, and marginalising those people to whom they were originally designed to appeal. The ideal program would perhaps combine the simple 'Interface' of Kid Pix with the 'Icon' metaphors of Painter; combining the ability to work in both 'Paint' and 'Draw' layers of SuperPaint; and the image manipulation effects of Photoshop, and with its clear 'Tool' box.

The case should be made for applications, as they are upgraded, to become clearer and simpler, without adding more and more features. Perhaps applications can be designed with even more specialist audiences in mind, so that they can be individually programmed, with the facility to add special features as required.

# The Uses of Networking.

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## Abstract

This case study examines the present and potential use by artists of global networking for collaborative projects in fine art, with particular attention to the Internet, the World Wide Web (WWW) and the formatting tool Mosaic.

## Background

There have been a number of 'virtual galleries' set up all over the world. I have constructed one displaying my own work, based at the University of Brighton.

<http://snowwhite.it.bton.ac.uk/present/homepnce/main.html>

This is a very exciting use of new technology, offering the opportunity for some interesting collaborative visual projects that can be accessed from anywhere in the world. This case study examines the implications for artists, analyses some of the projects that have already taken place, and suggests ideas for future proposals.

## Introduction

The metaphor of the Internet as a 'Highway' that transports people to the locations of information and images, rather than goods, is an apt one. The implications for society (or at least that sector of society which can take advantage of the innovations) are profound, but the implications for the visual artists who can contribute to it actively and creatively are even more momentous.

The increasing ability to send visual images throughout the world, allowing access and exchanges, raises one of the crucial issues in the field of computer-generated art: the intangibility of the artwork. The work is essentially a freely available signal, rather than a visual artifact which can be packaged, marketed and sold. Another issue is that of authenticity: who 'owns' it- does it even exist? Computer-aided art in its purest form is not concerned with artifact but with communication and interaction. Issues raised will include the ontology of the art object, and the identity of the artist in relation to the work.

Up until now most artists have used computers mainly as a tool, employing prepackaged software that mimics the traditional media of an artist's palette: paper, canvas, paint, pencils; and allowing for image retouching, collage and combination of images and text. Calculations which once occupied hours can now be completed with greater accuracy in seconds, leaving more time for the purely human judgments which remain fundamental to art. Images can be reduced and enlarged, and edited pixel by pixel. Manipulation may include deleting and cloning, or combining parts of the image with different objects, changing their colour and brightness. Instead of the mixing of paint and substance it is replaced with the mixing of minute pixels of light and colour.

With the growth of the Internet, however, an emergence of the significance of the online presence of the artists and their work has implications for the future of art and its audiences, as well as for communication technology and its consumer. The world is undergoing a communications revolution. New digital tools allow previously unheard-of connectivity and access to an ever-expanding universe of information

The Internet has existed since the late 1960s in one form or another, growing in size, scope and ease of access since then. The 1990s are an exciting time in the evolution of the Internet, for we are witnessing the humanisation of cyberspace. Much of the research focus is now on Interface design, yielding sophisticated Internet navigation tools like Mosaic.

## **The Internet: background information.**

**What is the Internet?** It is a network of networks, with millions of computers potentially connected to one another. Although it originated in the USA, it is now a growing global network.

**Nobody runs the Internet** - at least not yet - so there is no central ownership of the technology involved in its operation. Users therefore have a great deal of freedom in the content of what is sent and received, and there is at present no commercial structure governing the availability or use of material.

## **Information Servers**

An Internet-based Information Server is a computer that runs a program to handle incoming requests for information. There are many types of Information Servers on the Internet, but the ones most commonly used are FTP, Telnet, Gopher, and Wide-Area Information Service (WAIS).

## **The Development of the World Wide Web and Mosaic**

The WWW is very similar in design to the Internet-based information servers. However it offers several unique advances, including a document-orientated view of computing that offers formatted text and graphics instead of menu lists. The Internet's 'heart of gold' is a hypertext system that spans the world.

## **World Wide Web & CERN**

The WWW originated at the particle Physics laboratory (CERN) in Geneva, Switzerland. The initiators used hypertext technology to link together a web of documents that could be accessed in any manner to seek out information. The Web does not resemble a hierarchical tree, but it allows many possible relations between any individual document to another on the Internet, no matter where the documents may have been originated.

## **The development of Mosaic at NCSA**

The National Centre for Supercomputing Applications (NCSA), based at the University of Illinois (UIUC), was funded by the National Science Foundation to provide supercomputing resources to the research community, and to build some sort of national infrastructure.

*Mosaic* was developed by a student at NCSA during 1993. He was involved in building tools for scientific visualisation, and developed *Mosaic* as one of these tools. When he first developed Mosaic he looked around the WWW and discovered the HyperText Mark-up Language (HTML), that had been developed at CERN. It soon became evident to him that Mosaic offered a great deal more: with its easy-to-use interfaces and navigational links to the web, as well as the ability to show images, Mosaic could make the internet accessible to a wider audience. It was soon highly acclaimed by the government, the press and the Internet users' community, and NCSA expanded the development of Mosaic and made it freely available "for academic research and internal business purposes only".

Anyone can make a copy of Mosaic, and different versions have been released for different computing platforms. The WWW entails authoring documents in a particular format defined by the system. Because of the specifications, anyone can build a 'Client' or a 'Server'. Both factors encourage people to contribute to it, and like most things on the Internet it has turned into one vast collaborative project.

Features of Mosaic include:

- The ability to display electronic text in a variety of fonts.
- The ability to display text in bold, italic, or strike through styles.
- The ability to display layout elements such as paragraphs, numbered and bulleted lists, and parenthesised paragraphs.
- The ability to display characters as defined in the ISO 8859 set (it can display languages such as French, German, and Hawaiian).
- Interactive electronic forms support, with a variety of basic forms elements, such as fields, check boxes, and radio buttons.
- Support for interactive graphics (in GIF or XBM format) of up to 256 colours within documents.
- Support for movies (MPEG-1 and QuickTime formats).
- Support for sounds (Macintosh, Sun audio format, and others).
- The ability to make basic hypermedia links to and support for the following network services: ftp, gopher, telnet, nntp, WAIS.
- The ability to extend its functionality by creating custom servers (comparable to XCMDs in HyperCard).
- The ability to have other applications control its display remotely.
- The ability to broadcast its contents to a network of users running multiplatform groupware such as that of NCSA.
- Support for the current standards of HyperText Transfer Protocol (HTTP), and HTML.
- The ability to keep a history of travelled hyperlinks.
- The ability to store a list and retrieve a list of Units of Resource Location (URLs) for future use.

It has proved so successful that commercial software developers have become interested in taking the development of Mosaic further. Because Mosaic is copyrighted, anyone wanting to modify it must seek a license. In August 1994 NCSA announced an agreement with Spyglass, Inc. to be the licensing agent for Mosaic. In the meantime several of the original developers of Mosaic have left NCSA and developed their own version: Netscape, which is receiving very favourable response from the Internet community.

## **Artist's use of the Internet**

I make no apologies for this case study being based on my own personal discipline of using the Internet, although it includes much from the experiences and information gathered from other artists I have met during my journeys around the Internet.

In setting out to make this study I am aware that it is impossible to assemble a definitive list of the kinds of use that artists make, or might make of the Internet and its many Networks: it is out of date as soon as it is written down, as the WWW grows bigger with every second.

## **What specific uses can Artists make of the Internet?**

### **1. They can exchange E-mail**

This is a useful means of exchanging information to other individual artists throughout the world. My E-mail address is: [scg@bton.ac.uk](mailto:scg@bton.ac.uk)

### **2. They can belong to Newsgroups**

Mailbase discussion groups, exchanging information and advice on a variety of art-based topics, ideas, exhibitions, collaborative projects etc. The particular group that I belong to is: ARTNET  
[mailbase@mailbase.ac.uk](mailto:mailbase@mailbase.ac.uk)

### **3. They can receive information about their professional art practice.**

Lists give information on forthcoming exhibitions, which are inviting submissions; relevant conferences, and calls for papers; collaborative projects; Virtual Galleries; and other information to be found on the WWW.

At present I receive this information from three main sources:

**FineArt Forum: ART + TECHNOLOGY NETNEWS**

To subscribe to FineArt Forum email digest E-mail to: [fineart-request@gu.edu.au](mailto:fineart-request@gu.edu.au)

**Art DEADLINES list:**

To subscribe to art deadlines subscriber list E-mail to: [rgardener@charon.mit.edu](mailto:rgardener@charon.mit.edu)

**ISEA: THE INTER-SOCIETY FOR THE ELECTRONIC ARTS** To subscribe to ISEA NEWSLETTER E-mail to: [isea@nl.sara](mailto:isea@nl.sara)

## 4. They can obtain information for research and scholarly activities.

Using the help of various database on the WWW. These enable a search of the Internet by a given subject, file or name. These are some useful URLs:

**Internet Directory**

<http://home.mcom.com/home/internet-index.html> This is an Internet Directory. Actually, this is more like a directory of directories as there are many directories - organised in a variety of different ways - on the Internet.

**World-Wide Web Servers**

This directory is organised by country and state.

<http://www.w3.org/hypertext/DataSources/WWW/Servers.html>

**Internet search**

If you're trying to find a particular page on the Internet, you can use one of the many available online Search Engines. These Search Engines allow you to search for information in many different ways.

<http://home.mcom.com/home/internet-search.html>

**Internet resources.**

<http://www.ncsa.uiuc.edu/SDG/Software/Mosaic/MetaIndex.html> This document is intended to be a loosely categorised meta-index of the various resource directories and indices available on the Internet.

**Web Crawler**

<http://www.cs.colorado.edu/home/mcbryan/WWWW.html> The Worm scours the Web for resources and provides search capabilities on its database of 300,000 multimedia objects.

## 5. They can obtain access to free Software, Shareware, Demos and Commercial Software updates.

There are probably thousands of FIP sites offering freeware/shareware, but the two main ones for the Mac are Umich and Sumex, both of which are in the USA and are exceptionally busy. To ease matters they are mirrored (ie all the material on them is copied) at Imperial College.

These are two UK sites:

Imperial college - ftp or gopher to: [src.doc.ic.ac.uk](ftp://src.doc.ic.ac.uk)

The Higher Education National Software Archive: [micros.hensa.ac.uk](http://micros.hensa.ac.uk)

## 6. They can communicate with other Artists in a Virtual Community

*"I spend my days in a room, physically isolated. My mind, however, is linked with a worldwide collection of like-minded (and not so like-minded) souls: My virtual community. If you get a computer and a modem, you can join us."*

Howard Rheingold  
h1r@well.sf.ca.us

### Virtual Communities" WHOLE EARTH REVIEW, Winter 1988

<http://www.concourse.com/wwar/default.html>. Organised by The Ohio State University at Newark, Art Gallery, attempts to compile all available arts information that is available over Mosaic and also internet.

#### Art Source

<http://www.uky.edu/Artsource/artsource> A gathering point for networked resources on Art and Architecture. The content is diverse and includes pointers to resources around the net as well as original materials submitted by librarians, artists, and art historians, etc.

#### Art World

<http://www.wimsey.com/anima/ARTWORLD> The Multimedia Cultural Information Service. ART: Events - Support- Systems- Links-Tools-Technologies-Expressions.

(A larger list of Art Sources to Galleries and other information, these give hyperlinks to art resources on the web, can be found in Appendix I to this paper)

## 8. They can access and explore Art Sites on the World Wide Web

### Museums and Art Galleries on the Web

The Web is particularly suited to image-intensive displays. It has a great number of Virtual Galleries whose objects are freely available for the personal use of the viewer: Newsites for viewing images appear daily.

There are a number of Museums and Art Galleries on the Web. Both traditional and electronic media are represented. One can distinguish between them as saying some of the Galleries are purely archival, with a certain selectivity involved within them. There are other sites where a whole range of artists are asked to exhibit their work with no common factor apart from having links on the page, so are self selecting.

My own Untitled Gallery:

<http://snowwhite.it.bton.ac.uk/present/homepage/main.html>

-is typical of many Virtual Galleries on the WWW

The images are low-resolution digitized print saved as a JPEG format. Each image is represented by a small thumbnail version saved as RAW, which is clicked or selected to retrieve the full screen version. The Untitled Gallery also contains a biography, a list of recent exhibitions I have participated in, plus a list of public galleries which own my prints, and a recent statement on my work.

(A list of some of the Galleries on the WWW that I consider interesting for one reason or another can be found in Appendix II to this paper.)

## 9. To boldly go.....Hot Wired

<http://www.hotwired.com/login/>

### **What Is HotWired?**

HotWired is new thinking for a new medium, a cyberstation, a suite of vertical content streams about the Digital Revolution and the Second Renaissance with an integrated community space. While HotWired is currently bound by technological limitations that restrict bandwidth, it represents the genetic blueprint that will evolve into the overarching media environment of the next century.

### **Summary:**

This has been an extremely interesting case study to do, and I feel that having embarked on this voyage of cyber Art space, that there is so much more to find out and explore that I feel rather loathe to draw it to a conclusion. But this is probably the beginning of a much larger more intensive survey of the 'uses of the Internet for Artist's', as many of the sites need to be visited regularly over a period of time to see how they develop and progress.

On the negative side it seemed a pity that many of the online galleries offer digitally rendered versions of existing (analog) artwork, or digital images created for screen display. Some did have interactive elements, to navigate through various exhibits, to select images from a list, or to link to other online Galleries. Others provided forms for purchasing the artwork in its original, non-digital state, or allowed users to leave comments or access artists' biographies. Many of the home pages were also not very visually stimulating, and showing too much text. The use of the Web as an inexpensive means of exposure is an innovation in its own right, but there is a dearth of truly experimental installations. Most sites only use the Web as a new place to hang pictures, and I include my own Untitled Gallery, as being a typical example of this.

If today's artists can achieve so much with the limited computer technology that's currently available can we look forward to a new renaissance as we move into twenty first century. The image information product in the form of electronic codes is open up to most unlimited possibilities; manipulation storage and transmission. Visualisation will still provide the potential of manipulating vision, but what happens within a virtual space - it could be one of the most exciting challenges artists have ever faced. It would seem a great pity if artists did make use of this new technology, the opportunity for global collaborative projects. We must jump out of the frame into this new space.

## **APPENDIX I: Art Sources to Galleries and other information.**

These give hyperlinks to art resources on the web

### **Access Art**

<http://www.mgainc.com/homepage.html>

Medium for Global Access, Inc. Drop by our Information Center, Access Art. The way artists and collectors connect.

### **Art Home**

<http://heiwww.unige.ch/art/>

This service will give you access to the work of some artists. It is possible to add your own work to this Gallery.

### **Art on the Net**

<http://www.art.net/Welcome.html>

Join fellow artists in sharing and creating works together on the Internet. Enjoy visiting artists' studios and roaming the gallery.

### **ATLAS**

<http://www.wimsey.com/anima/ATLAS>

Arts and Technology Resource and Reference An information map of ideas, tools, organisations, people and sources... ATLAS exists to provide information resources to help bridge the information gap between artists and technologists in the wide-ranging area of creativity in new media. As a result, the material contained here covers a wide spectrum, from interface design to analysis of the social issues of technology, presented in a variety of formats.

## **FineArt Forum Directory of Art Related Web Resources**

[http://www.msstate.edu/Fineart\\_Online/art-resources/](http://www.msstate.edu/Fineart_Online/art-resources/)

This directory is meant to serve as a resource and jumping-off place for people interested in art, and in the possible relationships between art and technology.

## **Otis**

<http://WWW.OTIS.ORG/> The OTIS Project: online gallery and collaboration experiment

## **NEXUS: Network Projects by Artists**

<http://www.wimsey.com/anima/NEXUS>

Investigation of aesthetic and critical issues on the interface between art and technology. . . NEXUS supports exploratory projects by artists, theorists, and researchers in avant-garde and leading edge developments in the use of telecommunications as both content and medium of, creativity. These projects vary in scope and intent, from the literary and critical to the expressive and visual.

## **THE ART GALLERY**

<http://www.phlab.missouri.edu/~cckirk/art.html>

WWW art gallery. Here you will find various online art galleries and groups interested in the interaction of art and technology as well as announcements of upcoming events.

## **Webweavers**

<http://www.wimsey.com/anima/WebWeavers.html>

The WebWeavers are a networked virtual group of artists and creative computer professionals dedicated to the promotion and development of multimedia applications of the Internet. Not based on industrial but information age organisational methodology, the WebWeavers operate on synarchist principles. We are a flexible coalition forming in time/space and assembling on an as and when needed basis. We are involved in design, production, training and consulting activities in applications

## **APPENDIX II: Sites that I feel are worth visiting:**

### **1. Individual Galleries**

These could be seen as artist's studios open to visitors rather than as commercial galleries.

#### **The Place**

<http://gertrude.art.uiuc.edu/ludgate/the/place.html>

Manifesto:

In The Place there are no objects, spaces, or bodies. Remember these things are not sacred in themselves. The Place explores the boundary between tool and myth, instrument and concept (to see the ways in which they mutually constitute each other). In the Place, the translation of the world becomes a problem in coding. The Place requires new constructions of bodily reality. Never fail to recognize the difference between self and other. Avoid any confusion of boundaries. The Place will not be appreciated by all. But it presents its own seduction. The Place is inhabited by random memories, dream-addicted mercenaries, and second-hand scraps of excitement.

## **Nathan Wagoner's Digital Studio**

<http://heiwww.unige.ch/art/wagoner/>

Statement:

These pages are an attempt to mirror my studio in 'real' space. They hold electronic work as well as work made in traditional media. The newest addition is the complete series of allegorical paintings, from photo-cd. New work is added as it happens, though I try to make major additions around the beginning of the month. You are invited to stop in anytime.

## **Art by Ruth Kedar**

<http://www.art.net/Studios/Visual/Kedar/>

Statement:

I work with a variety of media, from Monotypes to Digital Art. Since I am particularly interested in variations, patterns and developing new visual languages, the choice of the above media is self-evident.

My fine arts portfolio, as well as all other projects I have been involved with, concentrate on the above areas of interest. After struggling for a while on how to curate my internet studio, I have decided to divide it into four major themes: Digital Art, Monotypes, Mixed Media, and Playing Cards .

## **KIYOTEI'S DEN**

<http://www.art.net/Studios/Visual/Kiyotei/>

Statement:

The artist has been lurking online for over a year now and the art displayed here can be found echoing around cyberspace. All pictures were drawn completely on the computer (not scanned) from a tiny brown grotto somewhere near the Pacific Ocean. The exhibit is divided into three rooms: Native American Indian Influences, Collages, and Grab Bag .

## **2. Group Galleries**

### **Holmes Fine Art Gallery Action Experimental Art**

<http://www.art.net/TheGallery/Holmes/>

Statement:

An evolving exhibition devoted to Art & Technology. This exhibition presents the work of seventeen artists whose work explores the frontier of the new media and technology. On exhibition will be a diverse selection of works including Digital Art, Digital Photography, Machine Sculpture, Interactive Multimedia Installations, Artificial Environment... and other stuff that moves and blazes.

### **Art Crimes**

[http://www.gatech.edu/desoto/graf/Index.Art\\_Crimes.html](http://www.gatech.edu/desoto/graf/Index.Art_Crimes.html)

Statement:

This is a gallery of graffiti art from various cities. It's called "Art Crimes" because in most places, painting graffiti is illegal. Many of these pieces no longer exist in the real world. Each little picture in the gallery is a link to a bigger, better picture. If you want to see one, just click on it with your mouse.

## **3. Institutional Galleries**

### **Virtual Gallery: Design Research Centre, Derby**

<http://dougal.derby.ac.uk/gallery/>

The Design Research Centre was established in 1992. It is located at Derby University, UK

Statement:

This gallery aims to showcase exciting new work produced by artists and students in the UK. The first completed "wing" of the gallery - The Electronic Wing - consists of a wide variety of work produced using various technological methods ranging from computer-aided image processing and computer-generated imagery to a more limited (but by no means less creative) medium, the colour photocopier.

## **The @Gallery**

<http://gertrude.art.uiuc.edu/@art/gallery.html> Affiliated with the School of Art and Design, the University of Illinois at Urbana-Champaign.

Statement:

In February of 1993, an electronic gallery ad319 was born, from the simultaneous efforts of three artists trained in traditional mediums, all of whom were attempting to embrace new digital technologies. The idea of working as a collective seemed an effective way to pool our knowledge, and an efficient means of addressing the issues we face as contemporary artists and educators. One outgrowth of this collaborative approach has been the @art gallery.

## **4. Museums**

### **Musee du Louvre**

<http://meteora.ucsd.edu:80/~norman/paris/Musees/Louvre/>

### **The Andy Warhol Museum**

<http://www.warhol.org/warhol/warhol.html>

Statement:

The Andy Warhol Museum is essential to the understanding of the most influential American artist of the second half of the 20th century. It is also a primary resource for anyone who wishes to gain insights into contemporary art and popular culture. More than 500 works of art and extensive displays of related archival material are shown together and offer the visitor an integrated presentation of the development of Warhol's work with emphasis on specific thematic concerns.

### **Krannert Art Museum**

<http://www.ncsa.uiuc.edu/General/UIUC/KrannertArtMuseum/KrannertArtHome.html>

Statement:

The Krannert Art Museum and Kinkead Pavilion, located on the campus of the University of Illinois at Urbana-Champaign, houses a collection of more than eight thousand works of art, ranging in date from the fourth millennium B.C. to the present in nine permanent galleries. Four additional galleries offer a variety of special exhibitions, changing frequently throughout the year.

### **The Ohio State University at Newark, Art Gallery**

<http://www.cgrg.ohio-state.edu/~mkruse/osu.html>

Statement:

The Ohio State University at Newark, Art Gallery has been established since 1968. The gallery finally moved to its present location in Le Fevre Hall in 1994. The space has been increased 10 fold and is suitable for exhibiting all forms of art. The Art Gallery is excited to make its exhibitions available to a world wide community by committing itself to exhibiting local, national and international artists of all statures. By making the space available to all types of art, The Art Gallery hopes to further the arts and art education in Licking County, Ohio as well as in the national and international arena.

Other exhibitions such as the one at the Guggenheim Museum in 1994 and the exhibition planned at The National Gallery in Washington D.C. for this fall or the Wexner Center for the Arts in September 1995 may include some of the works exhibited in this show. However, many of the works exhibited here will probably not be shown to the public again.

The first exhibition featured Roy Lichtenstein Pre-Pop, 1948-1960 . The famous American artist has been creating works for well over four decades. However, his close connection to The Ohio State University during this time makes this exhibit of utmost importance to the Newark Campus of The Ohio State University

## **Exhibition Images, Roy Lichtenstein**

<http://www.cgrg.ohio-state.edu/Newark/images.html>

Statement:

The images included in this selection were actually on exhibit at the Art Gallery at the Ohio State University at Newark. Private collectors and public museums have graciously made these works Available for viewing. However, none of the images can or shall be reproduced, or be used in any other way, without the written consent of the owners or museums.

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# CAD Studies for a Modular Design Degree Course

**Author: Nick Higgett**

## Abstract

The School of Design and Manufacture's modular design degree Scheme at De Montfort University, Leicester is the largest of its kind in the UK with over 1000 students currently studying a variety of design related courses including:

- BA (Hons) Fashion and Textile Design
- BA (Hons) Three Dimensional Design
- BA (Hons) Graphic Design
- BA (Hons) Multimedia Design (new for 1994/95)
- BA (Hons) Design Management

The author is responsible for the management of the School's Computer-aided Design Laboratory (CADLab) and module leader for all the Information Technology (IT) and Computer-aided Design (CAD) modules available to students doing these design degrees. In this case study the author will discuss the following issues:

- Overview of School's modular design degree scheme and the role of the IT and CAD modules
- The philosophy underlying the IT and CAD modules including their aims and objectives
- The structure and general content of the IT and CAD modules including the teaching and assessment methods employed
- The CAD hardware and software used

## Introduction

The school's modular design degree scheme has now been running for 3 years. It has allowed students to create a personal pattern of study, within certain constraints, leading to one of the following BA honours design degrees:

- BA (Hons) Fashion and Textile Design
- BA (Hons) Three Dimensional Design
- BA (Hons) Graphic Design
- BA (Hons) Design Management

For the academic year 1994/95 the school scheme is being integrated into a new university wide modular degree scheme. With this integration, a new degree in Multimedia Design has also been introduced and the Graphic Design degree has been transferred to De Montfort University, Lincoln. These significant changes are allowing all modules to be reviewed and if necessary rewritten. However this case study is based on the practical experience of the last three years.

## The Modular Design Degree Scheme

All students on the school scheme will normally do the equivalent of 8 single modules per year over two 15 week semesters. The students will normally do this number of modules at each of levels 1, 2 and 3 over their 3 years of full time study. The scheme itself comprises of three types of module from which the student chooses a combination from each as follows:

- Specialist design modules
- Elective modules

## Core modules

The specialist design modules relate to the modules for a specific design discipline e.g. Fashion and Textiles Design or Three Dimensional Design. The elective modules relate to the wide variety of specialist technique, media, materials and process modules needed by a professional designer e.g. Textile technology, Spatial design theory or Photography. The core modules relate to those common modules which are suitable for all design students regardless of their main design discipline. They include:

- Business and management of design
- International studies
- Communication for design
- Conceptual basis of design
- Information technology and computer-aided design (IT/CAD)

It is the philosophy, structure, content, assessment and delivery of the IT/CAD modules with which this case study is concerned.

## The Underlying Philosophy

The level 1 IT/CAD, level 2 and level 3 CAD modules have been designed to complement each other and to progressively develop the IT/CAD knowledge and skills of all the design students. These modules have also been designed to complement the students other modules, in particular their specialist design modules allowing them to integrate CAD into the design process. In this students will be better prepared for their chosen design career paths where an appropriate understanding and experience of IT/CAD is today considered to be essential.

### Level 1 IT/CAD

The first aim of this initial module, which is compulsory, is to give all the design students an introduction to the basic theory of computing and a broad appreciation of how computers are used in design and manufacture. The second aim is to give students hands on experience of a range of basic computer software in order to build a foundation for a more detailed study of CAD at level 2.

Even over the last 3 years it is noticeable that more and more of the students who have enrolled onto the design courses have a greater knowledge, experience and interest in computing. This module is therefore, currently under review in order to ensure that it accommodates these students. However a majority of the design students still seem to have completed their prior education either without using a computer or having developed a strong dislike or even fear of it. These students with only elementary knowledge or computer phobia still therefore need to be catered for.

### Level 2 CAD

The main aim of this module, which is optional, is to develop the students understanding of how CAD is used within their own design specialisation and how it is linked to the manufacturing process. The second aim is to give the students practical experience of several CAD systems appropriate to their design specialisation and to teach them how to use CAD as a design tool within the design process.

### Level 3 CAD

The aim of this final module is to give the students the opportunity to apply their newly acquired CAD knowledge and skills to either a major design project or to a major investigation into some aspect of computing and design.

## Module Structure, Content and Assessment

### Level 1 IT/CAD

The students are introduced to the basics of computing and its use in design through a series of 12 lectures to groups of approximately 100 students at a time. The size of the group is dictated by the lecture rooms available. This programme, which includes the history of computing, basic computer-aided design hardware and software, is assessed through a computer based multiple choice test at the end of the year. The students are given experience of using a computer and some basic computer software through a series of weekly practicals. These practicals are in groups of approximately 40 students, the size being dictated in this case by the number of suitable machines available. The students are initially introduced to the computer system's graphical user interface (GUI) and also spend some time, if necessary, using a basic typing tutor in order to gain keyboard familiarity. They are then introduced in turn to word processing, colour painting and drawing and desktop publishing software. The student's ability to use these packages is assessed through 3 related practical assignments. Students will also get practical experience of using both black and white and colour printers and colour scanners. Besides these formal weekly practical sessions the students are allowed casual access to the school's computer laboratories to do computer based work such as word processing from any of the other modules.

## **Level 2 CAD**

This module consists of a weekly practical or seminar in groups of approximately 20 students. The level 2 CAD groups unlike the mixed level 1 IT/CAD groups comprise of students of a specific design discipline either graphic design, fashion and textile design or three dimensional design. The group size is a direct consequence of the number of suitable CAD systems available. Students will examine the nature of CAD and the application of CAD in their particular design discipline through a number of seminars. They will gain practical experience of several professional CAD systems relevant to their design specialisation through the laboratory practicals. The student's understanding CAD and their ability to use it effectively is assessed through a number investigative and practical assignments. The students are also actively encouraged to use CAD, where appropriate, as a design tool in their specialist design modules. This is again achieved through student casual access to the school's computer laboratories.

## **Level 3 CAD**

In this module students negotiate their own learning contract. This takes the form of either a major CAD practical project or a major investigation into some aspect of computing and design. The agreed project gives the students the opportunity to apply, further develop and refine the CAD skills and knowledge that they have already acquired on the previous 2 modules. Projects that integrate with work the student is doing in their specialist design disciplines are positively encouraged as this integration is a major aim of this module. The module itself takes the form of weekly supervised practical workshops and individual tutorials. These are complemented by independent student CAD work. The work is assessed through a written report and presentation of either the CAD practical work or the investigation.

## **CAD Hardware and Software**

The School of Design and Manufacture has a centralised Computer-aided Design Laboratory (CADLab). The CADLab comprises of 2 adjoining computer rooms, supported by both CADLab academic and technical staff. The CADLab's academic staff are responsible for the delivery of all the School's taught IT and CAD modules with technical staff supervising casual access. The 2 computer rooms include an IBM PC laboratory and an Apple Macintosh laboratory. These consist of the following hardware and software:

### **Hardware**

The IBM PC laboratory consists of 30 386 SX 16MHz 4Mb/40Mb computers, 9 486 DX 33MHz 8Mb/250Mb computers and 9 486 DX2 66MHz 8Mb/500Mb computers. Peripherals include 8 black and white inkjet printers, 2 colour inkjet printers, 1 monochrome laser printer, 2 A3 colour thermal wax printers, 1 A4 colour dye sublimation printer, 1 A0 plotter, 2 A3 plotters and 2 A3 colour scanners. The Apple Macintosh laboratory consists of 26 LC 6Mb/40Mb computers, 4 11 CX 16Mb/40Mb computers, 1 11 X 16Mb/80Mb computer, 4 Centris AV 660 16Mb/500Mb computers and 4 Performa 630 16Mb/350 Mb computers. Peripherals include 2 monochrome laser printers connected to an apple talk network, 2 colour inkjet printers and 1 colour scanner.

## **Software**

### **Level 1 IT/CAD**

All design students will be introduced to the following software in the IBM PC laboratory.

Word processing: Microsoft Works (Minimum requirement 386 SX)

Painting and drawing: Corel Paint and Corel Draw (Minimum requirement 386 SX)

Desktop Publishing: Aldus Pagemaker (Minimum requirement 386 SX)

### **Level 2 CAD**

Graphic design students will be introduced to the following software in the Apple Macintosh laboratory.

Advanced Drawing: Aldus Freehand (Minimum requirement LC)

Advanced DTP: Quark Express (Minimum requirement LC)

Image Manipulation: Adobe Photoshop (Minimum requirement 11 CX)

Multimedia Authoring: Macromedia Director (Minimum requirement 11 CX)

Digital Editing: Adobe Premier (Minimum requirement 11 CX)

Three dimensional design students will be introduced to the following software in the IBM PC laboratory.

2D and 3D Draughting : Autodesk Autocad and AEC (Minimum requirement 486 DX)

3D Modelling and Animation :Autocad 3D Studio (Minimum requirement 486 DX)

Fashion design students will be introduced to the following software in the IBM PC laboratory.

Advanced Painting and Drawing : Corel Paint and Corel Draw (Minimum requirement 386 SX)

Pattern Design, Grading and Lay Planning : Ormus Fashion (Minimum requirement 386 SX)

Printed Textile Design and Fashion Illustration : Tex-design (Minimum requirement 486 DX)

Texture Mapping and Draping : Tex-dress (Minimum requirement 486 DX)

3D Shoe Design : Clarkes Shoemaster (Minimum requirement UNIX Workstation)

### **Level 3 CAD**

See Level 2 CAD

## **Conclusions**

As already mentioned, with the move to a new university wide modular scheme, all the IT/CAD modules are currently being reviewed. However this review process needs to be an ongoing one due 3 important factors, as follows:

the rapidly changing nature of CAD technology

the changing CAD expertise of the students

the changing requirements and changes in the nature of the design industry

## **Acknowledgements**

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## **Further Information**

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# Free/shareware Image Manipulation programmes for the Apple Macintosh.

**Alan Leavy. IT Coordinator. Loughborough College of Art and Design**

Programmes reviewed

Escher Draw (Freeware)

Colour Knit (Shareware \$15)

Imagic (Freeware)

GreyStation (30UKP)

Since Apple introduced the Mac 128k and included MacPaint with the deal, many programmers have designed alternative drawing, painting and image manipulation programmes that are either free or shareware. In some cases the programmes have been labours of love and dedication that have provided a cheap and effective alternative to the commercial tools such as Adobe Photoshop and Letraset Painter. In other cases, the programme has filled a niche requirement that is not available commercially.

This case study examines four freely available programmes that attempt to solve typical image-related problems in a cheap if not necessarily, cheerful manner.

## ESCHER DRAW

A small programme of 99k, that offers repetitive pattern designing in black and white. Escher Draw would be useful to students studying textile- design or fashion who wish to develop, or experiment with, simplistic, repeating designs. The programme is simple to use and offers only a few basic features of pattern designing which is used in conjunction with a chosen symmetry from a list of 17. These Above: The main drawing window showing the include parallelogram, square, hexagonal and rectangle. The user chooses a symmetry and draws using a basic, one width tool, on a given pattern size. As the drawing continues, the pattern is repeated to show the development of the overall design. The user may edit at any stage. There are some limitations of Escher Draw, notably the inability to apply a symmetry to a design 'after-the-event' This narrows any free-form or happy-accident creative potential. The programmer also admits to the print feature being a bit buggy and suggests saving all work before printing!

### The bottom line

For people looking for repetitive design on the cheapest possible budget - free! - Escher Draw might be what you're after. Used in conjunction with a colour paint programme such as Imagic (reviewed later) that allows importing of patterns from Escher Draw and subsequent colour adaptations, the designer would have the basis of a useful and quick pattern generation facility.

Escher Draw V1.0 by Wam Development. Available via anonymous ftp from a number of Mac ftp sites.

## COLOUR KNIT

Another one for the textile designers !

On running this programme one is presented with what seems a simplistic, painting-by-squares drawing programme. However, Colour Knit provides comprehensive facilities for textile and knitting pattern designers that don't seem to be covered by commercially available programmes - at this cost anyway !

Paul Duffy a weaver and the pr~ ie of Colour Knit has provides features for colour choice, knit gauge and weave style as well as providing the ability to 'evolve' a design in an organic manner similar to the game of Life that many older users of computers will be familiar with. The programme is very stable and ran happily on colour Mac's from Mac II to the new Performa 630.

As can be seen from the examples, the user has a variable grid that can be set up for all common stitch gauges and a bar that offers simple drawing tools. Part of the tool bar is used to 'push' the grid around and to reflect or mirror the image. A help menu is also available direct from the tool bar as well as the comprehensive text file supplied with the programme. Brush size is variable and there are three palletes of colour to experiment with as well as the ability to choose your own colour ways. Colour Knit works well with other programmes and uses the common Pict file method for transferring images. There is also a useful preview feature.

## The bottom line

For the student of textile or knitting design, or the professional working to a tight budget, Colour Knit might present you with an opportunity for quick mock-ups or visualisation of projects that traditionally might take longer. The bonus is the ability to evolve and mature designs 'on-the-fly' and this feature could provide inspiration that is not possible when working with pencil and graph paper.

Colour Knit V3.0 by Paul Duffy. Available via anonymous ftp from a number of Mac ftp sites.

## IMAGIC

Ok. So you can't afford Photoshop and it's too complex anyway. And all you want to do is some retouching of a colour photograph. Maybe you're a geography or physics student who wishes to manipulate the colour balance of some surface temperature scans to bring out some hidden detail. Well this is for you !

## The Features

- Many different colour tables. :
- Comprehensive tool bars and palletes.
- Filters for enhancement of images. :
- User-defined Contour making.
- User-defined 3D facility.
- Cropping and flipping tools.
- Labelling and image density tools.
- Macro recording and playback.
- Basic painting and type controls.

From this list you'll see that Imagic has been given the right kind of name. However, it's not really the kind of programme that you might choose for photo-retouching as in many ways it's power is best used in a scientific or technical project where interpretation of an existing image is called for. Imagic allows many types of interpretation to be applied to images. One of the most useful is the programmes ability to change the colour balance and colour table. This can bring out hidden features or emphasise difficult to see areas of an image. These different areas of the image can be checked for density and then labelled. A quick density graph can also be obtained and presented - the density relating to the colour value in the range 0 - 255.

There are basic drawing and selecting tools and these can be useful for making minor amendments to photographs and the enhancement menu can provide the means to increase contrast or polarise an image.

Imagic can import and export in three formats: pict, image and raw format. Raw might be useful for users working on types of platform other than the Mac. Additionally, there are External Functions that can be used to write your own Imagic functions and if you know how to programme in C, then documentation is included in the package. Also, a Save Selection as Text. . . command has been included in the File Menu. When you make a selection, you may save the pixel values out as an Excel text file. This allows you to take your data and put it into the Spreadsheet for direct calculations if you're that way inclined.

## The bottom line

Imagic is a powerful tool that has developed over time into a scientifically-oriented programme suitable for image enhancement but it also has features that would be useful to designers who wish to experiment with particular kinds of image manipulation or three-dimensional imaging. The addition of a Macro feature for repeating often-used steps speeds up the use of the programme and Imagic's ability to use many colour tables is a major feature for geographers and physicists.

Imagic by Brian Powell V0.9 Available via anonymous ftp from a number of Mac ftp sites.

## GREY STATION

This programme is fairly new and with its sister programme Colour Station, provides high-quality, cost-effective, mono and colour image editing for the amateur or professional designer. The illustrations show the straightforward and modern 3D interface that control many features of the programme.

Editing and retouching of images is controlled through the simple, iconic toolbar that allows pixel-based editing, painting of larger areas, filling with greyscale colour, air brushing and deletion. Also incorporated are basic drawing tools and effective selection and type tools. Each of the tools has a 'hidden' parameter control panel accessed by double-clicking the tool. The programme is quick when selecting contiguous areas with the magic wand and this particular tool has very fine control over the type of area to be selected.

Grey Station comes into its own when printing to postscript printers. There are controls for calibrating specific printers by printing grey-scale test strips and the programme has its own methods of dithering images to obtain the highest quality printing from the average LaserWriter or image setter.

## The bottom line

For day-to-day, grey-scale, pixel-level editing that is quick and provides a good quality printing facility, Grey Station is fine for the job. For those people who want image manipulation and/or contrast controls look to alternative programmes such as Imagic.

Grey Station by Le Pixel Available via anonymous ftp from a number of Mac ftp sites.

## Conclusion

This case-study covers only a few of the many free or shareware image-manipulation programmes available for the Mac. Apologies if I've left out your favourite one or you're a Windows or DOS user.

I'm sure that with the advent and development of the 'super' programmes like Photoshop, Illustrator and Xpress, there is room for individual developers and programmers to fill the niche areas of design that are often overlooked by the big boys in their moves to cover the more popular and commercial vertical markets.

Without the likes of Imagic and Colour Knit the potential users of these programmes would be left out in the cold or have to revert to expensive commercial programmes that might require another platform to run on. If you use these programmes- or others - support your 'local' developer and pay the shareware fee or send a note of gratitude if you liked the programme.

# A comparative review of HyperCard and Director as tools for time-based expressive work

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## Introduction

I have pointed out elsewhere [*Supporting Postgraduate Work In Digital Media*] that individual artists have become much more interested in producing time-based expressive work in recent years than ever before, partly because relatively cheap software tools have made the complex and expensive processes involved more accessible.

Most of the work produced falls within the definition of "multimedia", in that it incorporates some or all of the following media components:

- text
- graphics
- sound
- digital video (or the controlling of analogue video)
- animation

I have also pointed out that the artist producing time-based expressive work may adopt one of three basic approaches:

1. Produce pieces in a manner analogous to traditional cel animation (without programming). In this approach, the computer is used to orchestrate, and perhaps create, various elements but final output is likely to be to video in order to obtain proper continuity and synchronisation with sound.
2. Produce pieces by programming the computer. As in the first approach, final output is likely to be to video for the same reasons.
3. Produce interactive work. In this approach, programming is essential for all but the simplest interactions. Interaction may just control computer-generated movies, or trigger external devices if analogue video or hi-fi sound is required.

This study compares two software tools for creating such work, HyperCard and Director. The headings under which the tools will be compared are:

- concepts and terminology
- setup costs
- handling of the various media components
- programmability
- performance of finished pieces
- learning to use the tools

The study does not attempt to provide instructions for using either tool, though detailed description of some aspects of operation is included where necessary for purposes of comparison.

## Software tools for time-based expressive work

Computer-based tools for time-based expressive work must have certain capabilities and characteristics. The main ones are that they be:

- accessible to visual artists
- usable by visual artists
- capable of handling all media components
- capable of being programmed
- able to output to video

Certain other characteristics, for instance availability across common computer platforms, are much less important to artists than to designers. For the artist, the fact that a work can only be seen or used on one particular computer system is not likely to be a deterrent to the use of a tool. Furthermore, interactivity has not yet proved as interesting to visual artists as some predicted. For most, it will therefore be the way software tools handle the creation of pieces that are essentially cinematic that will be the main basis for choice.

Both pieces of software under consideration in this study have all the capabilities and characteristics listed. They handle all media components. They have been available for some time and run on widely-used types of personal computer, so they are accessible to and usable by visual artists. They are in use at many sites, and hence are fairly well understood and supported in both academic and commercial life. They can be programmed (and extended) to perform complex operations. The next section looks at their history to provide a context for more detailed comparison.

## A context for title comparison a brief history of the software tools

HyperCard (and an earlier innovation, Guide) were the first generally available software embodiments of the concept of "hypermedia": media which enabled associative links to be made between entities, on the lines propounded by Vannevar Bush in the 1940s. Both were produced for the Macintosh, though an MS DOS version of Guide soon appeared.

The purpose of Guide was to allow an author to hide detail and provide navigational aids in electronic documents. It provided means of designating text or pictures as links to other material. A pointer moving across a link changed shape to indicate the nature of that link: expansion button, pop-up note, or cross-reference. A companion program, Guide Envelope, allowed developers to distribute copies of their products to people who did not possess Guide because it built a "stand-alone" or "run-time" version. A recipient could thus view and interact with a Guide document but not build one of their own.

HyperCard started from a different set of priorities, aiming to provide users with a "software tool kit" with which to build their own applications. HyperCard's originator, Bill Atkinson, listed being "a cassette player for information" as one of these applications. Information had to fit within HyperCard's model of the world, where entities called cards were arranged in the manner of a Rolodex. These cards were at first limited to the 9" diagonal size of the original Macintosh screen, which was monochrome. A collection of cards was called a stack, though the arrangement was in fact a loop. Cards could contain entities known as buttons and text fields, along with black and white bit-mapped graphics. Any button or field could be linked to any other card or stack to make an associative link and there were built in visual effects such as dissolves to mark the activation of a link.

There was no means of extending Guide's inbuilt capabilities but HyperCard included a fully-featured programming language, HyperTalk. Simple interaction could be created using only menus and mouse clicks to activate small HyperTalk programs, or "handlers", supplied with HyperCard. Users could also write their own HyperTalk programs. These were known as scripts and could be used to define new procedures, as well as make use of those built in. Procedures which were too complex for efficient coding in HyperTalk could be written in lower-level languages like Pascal or C and called from within a script. HyperCard could therefore be extended almost indefinitely.

This approach was inferior to Guide from a commercial point of view in that there was no provision to build a stand-alone product: users needed HyperCard itself. Apart from incurring extra expense, stack users could therefore pull a product apart, given sufficient time and interest.

Neither of these software tools supported sound or animation originally, though in HyperCard simple "flip-card" animation was possible and bitmaps could be moved under script control. A new wave of products, touted as "multimedia" software, soon appeared which did accommodate these elements.

The first of these was for the Apple Macintosh because it offered better support for graphics and sound in standard form than either DOS or Unix machines. The program was called VideoWorks and was the forerunner of Director. It was aimed at the business presentations market but went beyond such products as Persuasion and PowerPoint in allowing the incorporation of sound and animation into a piece of work. It also introduced the novel idea of orchestrating elements on a "stage" by means of a "score", thus providing a direct visual representation of both the construction and the construction process along with the instant playback facility also found in HyperCard.

However, there was no means of providing interactive capabilities as in Guide or HyperCard. When VideoWorks metamorphosed into Director, some elementary programming capabilities were eventually bolted on in the form of the Lingo scripting language. This was initially neither as fully-featured, nor as well integrated with the host, as in the case of HyperTalk and HyperCard but it has been developed substantially with each new release. It has taken until 1994 for a DOS/Windows version of Director to appear, so other programs have had the market for "authoring" software on that platform to themselves. However, there has been a "movie player" for DOS for some years.

Over time, the two tools have become much more alike in terms of their capabilities but there are still some striking differences. The tools will be compared in the next section, under the headings listed in the Introduction. The detailed comparison will be followed by a brief resume of user experience at Coventry School of Art & Design. This will include a short description of the making of the same sample piece with both tools.

## Comparison of the software tools

### *Concepts and terminology*

HyperCard still uses the card metaphor as the basic building block, where Director uses the stage. HyperCard projects are built up from stacks, Director projects from movies. In HyperCard the user navigates from place to place on a card, from card to card, or from stack to stack: in Director all action takes place on one stage and navigation is from frame to frame or movie to movie.

HyperCard uses several add-ons (ADDmotion, ColorTools, QuickTime Tools) to provide facilities for time-based work whereas Director has always included these facilities, apart from a sound editor, in the main program.

ADDmotion uses actors and props where Director uses castmembers, sprites, and backgrounds. ADDmotion actors consist of one or many cels and they can be animated along a path. There is a high degree of control over paths and they can be stored in a library for re-use or modification, as can actors and props. Props cannot be animated, but they can enter or leave the action with various visual effects. Actors and props can be created or edited in the ADDmotion paint system or imported as PICT or PICS files.

A Director sprite is an "instance" of a castmember and it inherits its properties. However, it can be given different properties, or made to behave differently, if required. Any sprite can be animated in Director, whether it forms a backdrop to the action or not.

The equivalent of ADDmotion's multi-cel actor is the filmloop: any sequence of frames can be made into a filmloop and then used as a single entity. Path creation and control facilities are not as sophisticated as in ADDmotion and there is no library facility, though the fact that castmembers are templates for sprites is an equivalent. It is also possible to set up a "Shared Cast" movie containing any element common to several movies: all movies in the same folder as the Shared Cast then have access to its castmembers. This makes it easy to split large pieces into smaller, more responsive, movies and make changes with relative ease.

ADDmotion uses a media controller with two modes and a timelines window to create and control animations; Director uses a cast window and a score window. The Director controller sets tempo and background colour, as well as controlling the position of the play head. Both approaches allow many events to be incorporated and for the play head to be seen in motion as the movie runs. There are many additional windows in Director, and dialogue boxes in ADDmotion, that may obscure the screen but which are used much less frequently.

Both tools support all the media components likely to be required in time-based expressive work, that is:

text graphics sound digital video animation

and both support the control of external devices such as videodisc players, VCRs, and CD-ROM drives. The next section looks at how they handle the various media components: there has not been time to investigate the control of external devices.

### *Setup costs*

HyperCard is now in version 2.2. It has had a chequered pricing history. It was initially developed by Bill Addnson (one of the original Macintosh programming team) and, at his insistence, given away free with every computer sold. It was later taken over by Claris, Apple's application software spin-off, who supplied a basic version free but made a charge for the full development toolkit. It is now back in the Apple fold and, much extended, retails for under 150.00 UKP complete with development tools.

Hardware requirements are relatively modest, though not compared with the original which ran happily on a floppy disk Macintosh with 1Mb RAM. The current version requires over 1Mb RAM for the program alone. To run the animation add-on, at least 2Mb are required. HyperCard itself, the ColorTools, and ADDmotion will together occupy 2.5Mb of disk space. A complete installation occupies 10Mb but that includes 4Mb of ready-made stacks; HyperCard and HyperTalk reference stacks, and ADDmotion tutorial material. Running with both add-ons enabled and a relatively simple stack open, HyperCard occupies between a third and a half of a 4Mb block of RAM.

Large and complex stacks with extensive use of colour and animation will of course consume more resources and require more powerful hardware to perform properly. Allocating 6Mb to 8Mb of RAM to HyperCard is probably more realistic for serious time-based work: this implies a machine with at least 12Mb of RAM, since the operating system will need around 4Mb in most situations. All in all, a minimal hardware platform will cost around 1,000.00 UKP at October 1994 prices.

Simple sound editing tools are provided, so minimum setup costs to use HyperCard for time-based work will be around 1,200.00 UKP including hardware but only 150.00 UKP if a suitable machine is already available.

Director costs are in a different league. Macromedia, the developers, now offer a stable of programs for the creation of time-based work. There are three packages in the line-up apart from Director: for accelerating movies where no interaction is required (Accelerator); for three-dimensional modelling and rendering (Macromedia 3D); and for sound recording and editing (SoundEdit Pro, SoundEdit 16, or SoundEdit 8). Director itself is available for both Macintosh and DOS/Windows machines.

Director 4.0 for the Macintosh costs 999.00 UKP; Accelerator 175.00 UKP; Macromedia 3D 1,195.00 UKP and SoundEdit between 149.00 UKP and 279.00 UKP. As a minimum, one of the SoundEdit packages will be required in addition to Director itself. Software alone will therefore add up to about the same as a complete HyperCard and machine setup. Hardware requirements are similar at the bottom end: a complete installation, with 4Mb of extras including tutorial movies, occupies around 8Mb of disk space and Director requires at least 8Mb of RAM. However, movies eat up disk space and Director will require lots of memory for serious work: consider 20Mb RAM and a 500Mb hard disk the desirable minimum.

There is no sound editing facility built in, so initial setup costs for Director work will be around 1,200.00 UKP: double that if no suitable machine is available.

Neither HyperCard nor Director offer a one-stop shop for generating time-based work: it is likely that at least one two-dimensional graphics package will be required in addition to the paint systems built in. 3D software might also be required for use with either. Prices range from around 200.00 UKP for a simple 2D package to well over 1,000.00 UKP for 3D modelling/animation (e.g. MacroMedia 3D at 1,195.00 UKP).

Productivity can be increased with second monitors to hold the various construction windows. Standard 14" colour monitors cost less than 300.00 UKP and extra display cards range from less than 100.00 UKP to almost 3,000.00 UKP depending on the colour depth and speed required. Extra memory will enable larger projects to be undertaken: prices fluctuate but are currently around 30.00 UKP per megabyte. Faster machines are of course desirable if the money is available but second monitors, extra memory, and some means of taking back-ups are probably more cost-effective.

*Handling of the various media components*

## **A. Still pictures and animation frames**

Both HyperCard and Director have built in paint systems for creating flat graphics. HyperCard's is still monochrome but the animation tool, ADDmotion, has its own 24-bit colour system. All three paint systems allow bit-mapped graphics to be created with the usual array of tools and transformed by rotation, scaling, and distortion.

The painting tools are no match for those in dedicated paint or image manipulation software such as Painter or Photoshop. For example, anti-aliasing is rather clumsy in both packages. Having said this, some features of these systems are actually more convenient: the selection tools, or the facilities for the creation of "in-betweens" by automatic rotational and scalar transformations from given start and end values, for example. However, the registration and sizing of rotated images can be a problem in both systems (see the example later for more details).

Colour handling within ADDmotion is straightforward if basic but in HyperCard itself it is very odd. This exposes the fact that HyperCard was never meant to be other than monochrome. Bill Atkinson could certainly have catered for development in this area if he had chosen to, as he did in other areas such as HyperTalk. Indeed, as the mind behind MacPaint he virtually defined the Macintosh paint program for many years afterwards. Thanks to his efforts, Macintosh users have grown used to palettes of tools, colours, and patterns for painting and drawing. They might have expected the HyperCard toolbox to add colour to its capabilities eventually, without much fuss, but that is not what has happened. Instead, colour capability outside an animation is provided by a separate ColorTools stack, which installs resources into a user's stack on request.

The ColorTools appear to live in a separate world, even after installation. Certain operations become impossible while the tools are active. Loading and unloading the tools takes time. The printed documentation makes no mention of "colour" or "ColorTools", apart from a five-line paragraph in the readme file. In its words, users of ColorTools can "apply colour (using a 256 colour palette) to buttons, fields, cards, and backgrounds ... import PICT graphics from the desktop, place them anywhere and resize them ... display 24bit colour graphics ... use over 20 colour transitions to make solutions visually attractive". That is as far as it goes: the colour which is applied cannot be modified or used by the normal paint tools and there is no facility for customising palettes. The elegance of Atkinson's original functional design is quite lost.

Another oddity is that, while ADDmotion can import various media types (including PICT and PICS files) into animations, the ColorTools handle the importing of PICT graphics into stacks without animations. The only other way PICT files can be imported is via the Clipboard from the Scrapbook or another application. This method of transferring material, revolutionary in its simplicity when the Macintosh first appeared, is now impossibly tedious for aD but the odd transfer. The only graphics which can be imported directly into the HyperCard paint system are MacPaint format bitmaps. There are only a limited number of uses for these as such operations as re-sizing or rotating produce poor results due to the mathematics involved.

Director handles colour and graphics in a much more straightforward manner. PICT, PICS and MacPaint files can be imported into the cast, a folder at a time if required, as well as graphics from the Scrapbook. A number of colour palettes are built in, in addition to the Macintosh and Windows system palettes. Transitions between palettes can be specified as dissolves. If the imported graphics do not use the currently selected palette, the user has the option to re-map the colours or install the new palette as a cast member. In many situations, the best solution is to use a paint program to create a custom palette from a collage which incorporates all the colours likely to be required and import that.

In addition, bit-mapped cast members can be created or modified with the built-in paint system. Again, this works in a much more straightforward manner than the HyperCard/ ADDmotion equivalents. Features such as a familiar set of tools; the option of displaying single or multiple cast members in the paint window; simple double-click selection of a cast member opening the paint system, and auto-transform for creating multiple cast members, make creation or modification of cast members or background artwork relatively painless.

A separate window holds tools for creating QuickDraw text and simple shapes directly on-stage. These objects can be scaled and printed out without loss of quality and the text is anti-aliased. Unfortunately, QuickDraw text objects animate more slowly than bitmapped cast members but all QuickDraw objects can be converted to bit-maps if required.

Both paint systems have some ingenious features but neither approach to handling flat graphics is all-embracing. In fact, the goal of providing built-in facilities is questionable as it leads to compromises in other areas. Unless a user is prepared to live with the quirks and limitations of these internal paint systems, they are likely to use at least one other graphics package. That being so, it might be better to make importing easy and forget the built-in paint systems altogether. However, it can also be argued that users want to be able to create work without recourse to external programs. If that is so, then some painting capability is essential.

## **B. Sound**

As with flat graphics, HyperCard has a two-layer approach to handling sound. There is an audio palette available in any stack that will allow recording through the Macintosh sound input port and simple cut/copy/paste editing of the result. Sounds are saved only as System 7 sound resources in the open stack: although they can be saved to another stack as resources, they cannot be saved to a named disk file. However, ADDmotion has its own sound import and export facilities, so sounds can be saved as disk files in System 7 SND format. These can be opened and edited in SoundEdit Pro and then saved as both Audio IFF files, which can be used by Director, and System 7 SND files.

Director's approach to sound is much less confusing. There are no recording or editing features: all sound preparation is done "off-line". The results can either be imported into the cast and placed in the score or played from disk under script control. Two sound channels are available and sounds can be faded up or down as well as started and stopped abruptly, so fairly sophisticated sound tracks can be created, especially if stereo sound is imported. HyperCard ADDmotion animations can incorporate many separate sounds playing at once but neither HyperCard's own audio palette nor ADDmotion's rather more capable sound tools can edit stereo sound. Off-line editing will almost always be required for advanced work in either Director or HyperCard.

## **C. Quicktime digital video**

Both programs can import and play QuickTime movies as part of a piece. Neither allows editing: the frames cannot be separated and re-assembled as in Premiere or other digital video editing programs. Director movies and HyperCard stacks can be exported as QuickTime movies.

The HyperCard mechanism for incorporating QuickTime video is to use the separate QuickTime Tools stack to create a button to show or hide a QuickTime window and specify preferences for that window. The Director mechanism is simply to import the movie into the cast and place it on stage. A complex score can be reduced to one cast member and one frame, with the play head looping on that frame until the movie is finished.

## D. Text

Both programs have two ways of handling text as bit-mapped, "painted" text which cannot be edited once in position; and as the contents of a field. Text in HyperCard fields can be edited, and then locked if required to prevent tampering. Text in Director fields is locked while the movie is playing, unless explicitly declared as "editable".

It may seem strange that neither handles hypertext links very well. Where Guide had a cursor which changed automatically when it was over a "hot-spot", HyperCard and Director require rather roundabout operations to create a similar feature. Whole blocks or fields of text can be made into buttons and scripted to initiate action (including changing the cursor) quite simply.

Alternatively, chunks of painted text can be styled and then covered with invisible scripted buttons. Producing an action conditional on rolling over or clicking a designated word in a scrolling field of text is more difficult. It is slightly easier to do this in HyperCard, which has a facility for designating a chunk of text as "hot" and then automatically underlining it in grey, than in Director but in either case some programming is required.

Controlling the appearance of text is not entirely satisfactory either. HyperCard has improved its handling of typographic specification of fields and buttons but Director still requires a lot of repetitive menu operations. Both have only limited control of typographic features. Painted text is crude in appearance compared to the results obtainable in Photoshop.

### *Integration with other software tools*

The user will need both programs to cooperate with other software tools from time to time. Director integrates far better, with its support for common file formats and simple import and export capabilities.

### *Programmability*

There is little to choose between the two tools in this area. Although HyperCard had the edge until recently with HyperTalk, it was pointed out by a contributor to the Internet forum on Director that "Lingo, if it was well documented and supported, would be an excellent first language for budding programmers ... Lingo is truly object-oriented programming, whereas HyperTalk is only "object-oriented" like (Simon Biggs). Both scripting languages can be extended with external code written in lower-level languages, so their programmability is limited more by the skills of the programmer than by inherent qualities.

### *Performance of finished pieces*

There is more information on this in the next section, "User experience at Coventry School of Art & Design".

### *Learning to use the tools*

Documentation and tutorial software are important aids to learning how to use any program. Poor or non-existent documentation can hold a product back as there is now fairly widespread resistance to buying software only to have it sit on a shelf because it is hard to learn to use. Supplier after-sales support, in the form of courses or help lines, is also important. Finally, knowledge within the user community represents an invaluable resource and there is increasing use of networked forums to give and receive advice and technical support.

The original documentation for HyperCard was rather meagre and a large number of third-party books appeared to supplement it. Apple now provides much better documentation for HyperTalk, together with good help software. Ready to use sample stacks have always been provided, making the product useful straight out of the

box, and these can also be used for tutorial purposes. There is also good on-line documentation of most aspects of the software and the add-ons. Two third-party books are still available in the UK, one specialising in programming in HyperTalk.

There are still problems with the documentation: the ADDmotion software is bought in and has its own manual. This harks back to an earlier generation of Macintosh software documentation, being one slim perfect-bound volume short on detail. However, there is a reasonable tutorial stack and an excellent (though graphically crude) introduction to the principles of animation. All in all, the new user has a reasonable amount of help in getting started.

Director documentation was also widely perceived as deficient but only one third-party book appeared and that did not deal with Lingo. The Version 4.0 manuals are much improved and one or two new books are on the way. The tutorial examples are not as good as those for HyperCard but there is still a large amount of material to work through which will help new and more experienced users alike.

#### *Supplier and user community support*

As far as I know, there is no supplier after-sales support of HyperCard. Macromedia do support Director, mainly in network forums. They also provide courses but I do not know of any in the UIC. Both products have good help systems: Director's is slow but easy to use; HyperCard's is quicker, slightly opaque but more detailed. There are active conferences and supplies of public domain and cheap software on-line for both products: networks are certainly the best source of after-sales support.

## **User experience at Coventry School of Art & Design**

Everyone who has to learn about software for a living eventually develops a strategy for coming to terms with a new product. Mine is to look at all supplied documentation to get a picture of what the software is supposed to do; work through some or all of any tutorials supplied, and then embark on some work of my own. For this study, I therefore set out to create the same piece with both tools after completing the preparatory work.

It took some days of part-time work to complete the tutorials, making notes all the time. I then decided to make a short movie based on some old studio work which used simple step and repeat transformations. A square element containing an alphabetic character would appear on screen, move to the right, and come to rest in row one, column one, of an invisible four by four grid. A second element, rotated ninety degrees, would appear in the same place as the first and move to occupy column two. A third element, rotated a further ninety degrees, would then appear and move to column three. Finally, a fourth element, rotated a further ninety degrees, would appear and move into place. The next row would then be started, with the element for column one rotated ninety degrees from the one in the previous row. These systematic transformations would continue until the grid of sixteen elements was complete. A simple looping sound accompaniment would then be created, with punctuation as each element appeared for the first time. Both movies would be compared as to size and performance and then exported: first as QuickTime movies and then as standalone applications.

#### *Using HyperCard*

I started with HyperCard/ADDmotion. The first problem was creating the elements. I had already made one original animation after completing the tutorial example but neither movie used precise geometric shapes. ADDmotion's paint system, incorporating facilities for creating multi-cel "actors" and viewing the previous cel while working on another, had no obvious way of ensuring precise registration for rotations. It proved impossible in the time I had to make a square and rotate it about its centre with sufficient accuracy to fit it with others in a grid. I resorted to Photoshop and created the four elements I needed.

The process of orchestrating the visuals was fairly simple, though laborious, once the elements were created. The use of libraries, dialogue boxes, and the timeline was easy to understand but involved a lot of repetitive actions. Director definitely has the edge in this sort of work, with good facilities for replicating and then modifying frames of a movie, although its score can be harder to read than ADDmotion's timelines.

The sound required was simple enough in this case but neither the HyperCard nor the ADDmotion sound editing facilities were sufficient on their own. Again, I resorted to another tool: SoundEdit Pro. Orchestrating the sounds created was very easy as it is possible to have many soundtracks in a timeline. Director is limited to two sound channels, so mixing percussive events with continuous sound is more difficult and any multi-layered soundtrack must be built up off-line.

The finished movie exhibited very rapid fall-off in performance as the elements slid into place. By row four, the frame rate had fallen to less than a quarter of its original value. The manual offered no clue as to why this might be and playing about with the number of actors and sounds made no difference to performance.

### *Using Director*

I was more familiar with Director, though not with Version 4.0, when I started to recreate my sample movie. I built the movie in about the same time, discounting that taken to re-orientate after using ADDmotion. However, I was no more successful in creating the elements. Director's paint system rounded the 66 pixel square elements to 66 x 65, 65 x 65, 65 x 66, and 66 x 66! Again, I had to resort to the elements created in Photoshop.

Although complex movements cause Director movies to slow down, I had no trouble with mine and it ran appreciably faster than the HyperCard version. The Director documentation is full of tips on optimising performance, whereas the HyperCard documentation does not even recognise the existence of ADDmotion, but in neither case could I find any explanation for the difference in performance. Perhaps it is due to coding efficiency: the finished HyperCard movie was 1,092Kb, whereas the Director movie was only 400Kb. The difference was even larger in the case of exports as QuickTime digital video: the HyperCard export was 1,008Kb, the Director export was only 280Kb. The two standalone applications were much closer in size, with the HyperCard one at 340Kb compared to 688Kb for the Director movie.

My own experience is similar to that of colleagues and students at CSAD. Prior to the release of version 2.2, HyperCard was used wherever interaction was the main feature of a project and Director wherever integration of media components and/or output to video was the most important aspect. HyperCard was not used for expressive work after Director became established in the late 1980s.

This year a colleague, who was also a part-time student on the postgraduate course I teach, produced the first exploratory expressive piece using HyperCard seen for some time. Interestingly, he did not use ADDmotion, though he did make use of the sound and colour tools. All other expressive pieces (both interactive and cinematic) produced since I took up my post in 1991 have been executed with Director. This tool has also been the one chosen most often for information, education, or entertainment products. A colleague used Director to produce a CD-ROM exploring the sources of the world's major religions, despite the fact that HyperCard had superior control of interaction, because of its handling of the media components. Students and former students employed in multimedia development are using Director without exception, though it is sometimes used only for prototyping.

## **Conclusion**

Time-based expressive work can be produced with either of these products. Neither product copes particularly well with pieces employing precise geometry. Pieces employing cartoon imagery or multi-layered collage work much better.

Director offers better integration of the media components and superior performance; HyperCard provides a lot of functionality at a very low price. Both have similar hardware requirements. Learning to use either product is difficult and time-consuming; partly because there are still many flaws in the tutorial documentation, partly because both are complex pieces of software for performing inherently complex operations.

Although HyperCard in its original form was an elegant design and offered better interactive capabilities than Director, much of the elegance has now been lost. The interactive and time-based aspects are not well integrated, exposing the fact that the architecture of HyperCard and its add-ons is rather unsound. As well as leading to clumsy operation, it discourages the use of other tools. It is also likely to limit future development.

The final choice will depend on personal circumstances as much as the nature of the work undertaken. The artist working in an educational establishment is likely to have access to both: the individual working alone is less likely to have access to Director. If HyperCard does what is required as it stands, then it offers a cost-effective solution for creating time-based expressive work. However, Director is likely to be the most rewarding choice in the long run, provided enough money is available. Integration of the various functions and co-operation with other tools is better and there is more scope for development than in the case of HyperCard. In the end, I suspect that Director will continue to dominate the market thanks to its cohesiveness and smooth handling of various media types.

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# Supporting postgraduate work in digital media: a review of hardware software and organisational requirements

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## Introduction

In 1987 the authors of a chapter in "Information Technology in the Humanities" [Dyer, Howard, Richards; Chapter 12, "Art and Design"; ed. S. Rahtz; Ellis Horwood, Chichester, 1987] dated the first use of computers in UK art and design education as 1969. Most of the activities described in that chapter first took place at postgraduate level. This study concentrates on supporting work at that level, in part because we have seen that postgraduate concerns tend to filter into lower level work over time. This has certainly happened in the period from 1969 to the present day. Even if it were not to be true in future, the likely increase in the numbers of courses and students will bring more institutions face to face with the special demands of postgraduate work.

This study attempts to identify the essential requirements for supporting such work, with the aim of stimulating exchanges of views and information between the staff and managers of existing and proposed courses in digital media.

## Organisation of the review

The review will first outline the range of activities encompassed by the phrase "postgraduate work in digital media". It will go on to explore and define the support requirements for different types of work in terms of hardware, software, and organisation. There will then be a description of how postgraduate work in digital media at Coventry School of Art and Design has been supported since the course started in 1986. The final part of the review will be a summary and conclusion, incorporating a checklist of support requirements.

## Postgraduate work in digital media

Dyer et al [1987] defined the activity of art and design education institutions as teaching students "to produce images/models/objects in response to explicit, or implicit, functional requirements, which reflect their growing understanding of cultural, aesthetic and ideological attitudes". This definition has some minor deficiencies: e.g. it appears to leave out the development of craft skills in producing "images/models/objects" and the use of the phrase "functional requirements" might seem to exclude the production of expressive work. However, it will serve to establish the context for this review.

The authors went on to point out that the practice of art or design could be broken into four elements:

1. Analysis and formulation of the task
2. Generation and visualisation of potential solutions
3. Production of work
4. Research into ideas and information, which provides extended

understanding of both the activity and the object produced

Postgraduate work might be categorised as that which demands and develops a higher level of understanding of these four elements of practice than has been acquired on completion of a first degree or higher diploma.

The authors' analysis of the use of computers in these four elements has stood the test of time: there is still relatively little use of computers in analysis and formulation of tasks; rather more in the visualisation of possible solutions, and uneven use in research. What has developed to a great extent since 1987 is the production of work in digital media. Furthermore, it is now common for undergraduates, as well as postgraduates, to have significant access to production facilities.

Digital media are used in a variety of ways. First, there is the situation where computers are used simply as studio tools to produce familiar artefacts. In this situation, for example the production of printed pages, digital media are used as a supplement to or replacement for "traditional" media, such as photographic paper or ink. Working methods change, perhaps radically, but the final outcome may well be indistinguishable from that produced by other means. A development of this use of digital media is to make explicit the nature of those media: for example, by deliberately producing heavily pixellated images or designing typefaces for very low resolution output devices.

The second significant use of digital media is in the production of time based work. This is work with an inherent element of progression, which might derive from the inclusion of animation or video, or from progression through a succession of still images at a rate too slow to create the illusion of movement. Such work might be presented as a fixed sequence or it might respond to action by the viewer. Work in the latter category is usually called "interactive" (for the purposes of this study I will ignore the argument that all successful art creates an interaction between viewer and art work). Although much of the language of such work might be called cinematic, it is at least arguable that this use of digital media is producing a new class of work which will in time develop its own language.

Whether the work is interactive or not, it will include some or all of the following media components:

- text
- still graphics
- animation
- sound
- video

The components will have been orchestrated, and in some cases created, on a computer. The finished work might be presented on a computer or it might be presented as video footage. The former will be essential if there is to be interaction with the viewer; the latter if playback speed and synchronisation with sound are crucial to the success of the work.

Incidentally, the terms "hypermedia" and "multimedia" have been avoided up to now, even though many postgraduate courses in digital media are using "multimedia" somewhere in their title. I believe that these terms have been so heavily used by vendors to promote disappointingly ordinary products that they have become devalued. However, "multimedia" has become accepted shorthand for computer-generated time-based work incorporating several media components and a degree of interaction with the user: it may therefore be used from now on.

The third type of work in digital media employs the programmability of the computer to generate imagery. Such work may be based on anything which can be expressed algorithmically: for example, numerical or geometrical systems, biological growth, or aspects of linguistics. Such work would also qualify as multimedia, provided it incorporated several media components.

Work in any of these categories may be utilitarian or expressive, ie be produced by people acting as designers or as artists. Utilitarian work would include visualisation for all manner of products, as well as prototypes or finished products for information retrieval and presentation, education, and entertainment. Expressive works might be primarily cinematic; primarily interactive; or electronic equivalents of such things as paintings, prints, or sculpture.

We might expect that students embarking on postgraduate work in digital media would display a high level of craft and technical skill in manipulating those media. As stated above, we would expect the distinguishing characteristic of postgraduate work to be "a higher level of understanding of [the] four elements of practice than has been acquired on completion of a first degree...". This would certainly be the case with postgraduate work in fine art or design: we would not expect to be confronted by first attempts at using new techniques.

However, digital media are not yet used extensively on undergraduate courses. Consequently, we still see a high proportion of students starting postgraduate courses with very limited understanding of digital tools and techniques. Courses have a tendency to become defacto conversion courses, though validated and examined as equivalent to courses in established media and traditions. This tension between expectation and reality makes postgraduate work in digital media different from that in other areas of art and design. The difference will persist until undergraduate use of digital media is widespread.

## **Exploring the support requirements**

The Summerson report on art and design education led to the now established practice of introducing students to industrial and commercial processes. Facilities for these processes have been installed, often at great capital cost, and specialist technical support staff hired. Supporting process-based activities has always been expensive but although the recurring cost of staff salaries has become an acute problem in recent years, skills requirements have tended to remain stable and equipment has usually had a long life, so capital costs have been absorbed over considerable time.

Supporting work in digital media is even more difficult and expensive than supporting established processes. Dyer et al [1987] pointed out that resources often have to be taken from other activities to introduce new ways of working. They also noted that curricula must change and that staff support for change is by no means universal.

These problems would be serious enough, especially in an era of ever-reducing funding, without the additional burden of rapidly changing technology. This leads to equally rapid obsolescence. Although initial costs are as high as or higher than those for workshops, printing machinery, photographic and video equipment etc., there is no correspondingly long life. Most digital equipment is out of date long before it is worn out and is impossible to repair in-house. All staff involved in supporting work in digital media also face an endless process of re-training as one technological development succeeds another.

The notion of keeping students up to date with commercial practice in relation to digital media has all but been abandoned in many institutions, simply because the resources required are not available. There is virtually no prospect of developments in model-making, colour reproduction for print, or digital video editing, for example, being incorporated into art and design education without wholesale redirection of resources. This is true for all levels of work. Undergraduate work poses particular problems because of the ever-decreasing per capita funding and the very large numbers of students: postgraduate work poses particular problems because students, staff and examiners expect "advanced" work to be produced and this cannot be done with low-level (and inexpensive) equipment.

We can see that postgraduate work in digital media encompasses quite disparate activities. There is, for example, almost nothing in common between the making of images or pages for print and the production of a computer-generated animation, other than the fact that computers are used. Support requirements are therefore equally diverse: they are defined in more detail in the next section.

There is, however, one factor in common and that is the nature of a postgraduate student population. Postgraduate students are older and more familiar with institutional life than undergraduates. They are often self-funding and may well have family responsibilities. If part-time, they may have to juggle employment and study demands. They therefore tend to be quick to spot inadequacies in provision; intolerant of inadequate support and able to express their dissatisfaction forcefully.

## **Defining the support requirements**

*Differences between the types of work*

Three different types of activity were identified earlier:

1. Using digital media to produce familiar artefacts such as printed pages or images.
2. Producing computer-generated time-based work.
3. Producing work which derives from the execution a specially-written computer program.

The main difference between these types of activity is that in the first the student is acting in a familiar capacity and simply using new tools and techniques, whereas in the other two the student is acting in an unfamiliar capacity.

In the second type of activity, the student is typically attempting to move from producing static work to producing dynamic work while also adapting to new tools and techniques. Thinking about continuity, transition, movement, and interaction requires a "paradigm shift" for most students. Programming any interaction may also require the development of algorithmic thinking. Furthermore, the second type of activity often requires teamwork and this is unfamiliar to many art and design students.

In the third type of activity, the student is also attempting to think algorithmically but this time such thinking is at the heart of the work. This way of thinking is completely different from the intuitive and holistic approach typical of many art and design students. Specialist teaching may be required and it may take time for work to exhibit sufficient maturity and development to qualify as postgraduate.

These differences translate into different support requirements. The first type of activity requires industry-standard equipment and staff with up to date knowledge of industrial practice. As pointed out above, it is becoming increasingly difficult to provide these. There are also organisational requirements: working digitally typically brings several stages of a process together and it is therefore necessary to determine what this means in terms of curriculum change, staffing, and location of equipment, as well as the provision of hardware and software. In the case of time-based work there is virtually no history of providing industry-standard facilities because of the enormous expense involved, so there is little demand to provide it now. The main requirement in equipment terms is that the convergence of computing and video technologies be reflected in video facilities. Again, organisational requirements are at least as important as those for equipment because of the changes to working practice. Media production facilities should be grouped together, for example. This is especially important in relation to computing and video: the two areas are separate in some institutions and this can cause many problems.

The third type of activity also has special requirements. It does not matter what computing systems are in use, provided program development environments and support for programming activities are available. There will also have to be some output device(s) for the finished work. Output may be to screen, paper, or film, so any of the devices normally installed in art and design institutions will do. Whatever the type of activity undertaken, students need to learn something of the underlying mechanics of digital systems in order to be "future-proofed" against the changes in technology yet to come.

#### *Hardware and software requirements*

The requirements for hardware and software are impossible to define in detail, since every case will be different. In general terms, the type of work that is to be undertaken should first be decided. Software capable of supporting that work should then be selected, followed by hardware capable of running that software. The activities to be supported will be some or all of the following:

- electronic image generation and manipulation
- electronic typesetting and page composition
- two-dimensional animation
- three-dimensional modelling and animation
- generation and manipulation of digital and analogue video
- programming of interaction
- programming of complete works
- use of wide-area networks

In most cases, off the shelf hardware and software will be available to support these activities. It is unlikely that postgraduate work in digital media in any one institution will involve large numbers of students. This is fortunate, as hardware specifications will be quite high and it will not therefore be feasible to buy enough workstations to accommodate large numbers. Once the base level specification to support the chosen software is identified, careful thought should be given to productivity issues. Large displays, second displays, specialised input devices, accelerator cards, and so on can all increase throughput and thus minimise the time students need to spend working with machines. Working and long-term storage requirements need special attention: this area is often overlooked since it is unglamorous and does not apparently contribute to "front-line" capability. Shortage of storage space is a major cause of inefficient working methods, lost or mislaid work, and student dissatisfaction. Software specification and purchase poses additional problems. Compliance with the law relating to software licensing is difficult and expensive and the law itself is unclear. Microcomputer products are tending to be made "network aware". The widespread practice of buying one copy and then sharing it, on the grounds that it is only in use on one machine at any one time, is therefore becoming inconvenient as well as of doubtful legality. Multiple copies may soon be essential. Some products are available in "lab packs" at a reduced price per copy but others are not. Interpreting software piracy laws strictly could prove very expensive.

The input and output peripherals required will range from A4 monochrome page printers up to large-format multi-colour printers through slide recorders, scanners, and digital cameras. There will also be a requirement for video recording and editing equipment. This is increasingly likely to be digital and therefore to require powerful host computers with large storage capacity.

Most of the points made in this section refer to microcomputers since there is little or no use made of UNIX-based minicomputer workstations and centralised computers in art and design. There may be specialised requirements which can only be met by minicomputer workstations. Be aware that every aspect of purchasing and operating these is more expensive. Basic hardware, extra memory, additional storage devices, output peripherals, and software sometimes cost ten times their microcomputer equivalents. Specialist support staff will also be required in most situations and maintenance agreements will be almost essential.

Central computer facilities will be required for such activities as use of wide-area networks. If centralised facilities are used, the costs may be met from central "top-sliced" funds. Otherwise, the operating unit will bear all the costs. It is therefore a pity that it is not at all common for centralised services to supply or support the specialised facilities required by art and design students.

#### *Organisational requirements*

Some of the staffing requirements have been mentioned above. No one institution will have all the academic staff required to cover the full range of possible types of postgraduate work. Successful organisation therefore implies matching staff expertise to the range of work actually undertaken or envisaged. Technical instruction is also fundamental to work in digital media and there is sometimes a need to develop new approaches to staffing, in which technical support and "academic" teaching can be provided by the same person.

Once staffing issues have been resolved, attention can be devoted to those matters of detail which can be the cause of great dissatisfaction if badly handled. Access time, technical support, and the availability of documentation are all potential flashpoints.

There are no easy answers. For example, if only one copy of a piece of software has been purchased, there will only be one set of documentation. Copying this is illegal. Placing it in the library means it is never on hand in the studio when required. Somehow, a solution which secures the documentation but keeps it close at hand must be found. Access arrangements must be workable and be seen as fair, while maintaining the security of equipment. Technical support must be properly managed, with well-trained staff on hand when needed and adequate budgets for consumables and equipment servicing.

A decision will have to be made about the ratio of workstations to students. Offering each full-time student their own workstation may be an advantage when recruiting. However, we are moving out of the era of the general-purpose workstation. Different activities require very different configurations and a functional division of workstations may be preferable. Students will then move from machine to machine, according to the work being undertaken at the time.

Pooling resources with other programmes, including undergraduate courses, is sometimes advocated. This may make it possible to spread the cost of such things as colour printers or digital video editing suites. However, there are risks in this approach. Access requirements may conflict and complex timetables for access to facilities rarely work. Finding staff time to police them is difficult. Once timetables and schedules are seen to be abused, the stage is set for misuse of facilities and consequent student dissatisfaction.

Whatever policies are adopted, organisation is the key to successful support of postgraduate work in digital media. This is true whatever work is undertaken and whatever the level of funding available. Lavish provision of hardware and software will not ensure success. Conversely, good organisation will make efficient use of scarce resources and thus help to ensure that work is of a good standard and student satisfaction at a high level.

## **Supporting postgraduate work at Coventry School of Art and Design**

The postgraduate course at CSAD, a linked Postgraduate Diploma/MA Degree in Electronic Graphics, started in 1986. It was the first of its kind in Europe. The course was re-validated in 1991 for a further five years.

The focus initially was on videotex, typesetting, and solid modelling for animations. Although the course was based in a graphic design department, students were drawn from all branches of art and design. Dissatisfaction with centralised facilities was established by 1986 and the equipment base was IBM-compatible personal computer workstations with graphics table and framestores. Output was to screen, pen plotter, or analogue video. There were ten workstations, one for every full-time postgraduate student. The equipment was also accessible to undergraduates in the School. Apart from the computer workstations, there were photographic and video production facilities available.

During the late 1980s the focus began to move to the production of interactive multimedia work. This was based on Apple Macintosh computers and there was close collaboration with Apple on the "Renaissance" project, which investigated and promoted multimedia technology. There was substantial investment, assisted by Apple, in Macintosh hardware and software.

Staffing was initially organised on a matrix, with many specialists supposedly contributing small amounts of time. This arrangement never really worked. No proper budgetary arrangements had been made for the use of photographic and video facilities and this was also unsatisfactory. Dissatisfaction was widespread. Eventually a full-time course tutor was appointed and access to photographic and video facilities put on a proper footing. There was a period of upheaval, marked by further student dissatisfaction and critical reports from external examiners, between 1990 and 1991. This followed the departure of the course tutor and was exacerbated by the re-organisation of technical support in the School, which led to a long period of uncertainty.

A new course tutor and assistant were appointed in the Spring of 1991. The course was re-designed and shortened from a year and a term to thirteen months. A modular framework was adopted but not fully implemented. Multimedia production gradually became established as the main area of interest. There has been little interest in still image-making, typography, or page composition since 1990 and no interest at all in algorithmic work.

The course team have concentrated on encouraging individual, self-initiated work, partly because they do not have the resources to manage team projects and partly because of the demand from students to be involved in all aspects of the production process. Recruitment targets have remained at ten full-time and ten part-time students. In the three years since 1991, course management has been overhauled and the curriculum developed. New technical support arrangements are in place and there are now production facilities dedicated to postgraduate work. Results continue to be good, with a high proportion of students obtaining relevant employment within six months of graduation. It seems likely that new courses will go through a similar process of refinement of initial aims, objectives and organisation as they mature.

## **Summary checklist of requirements**

Experience suggests that supporting postgraduate work in digital media requires the following:

1. Effort to be clearly focused. No course can support the full range of activities.
2. Development of a coherent programme, taking account of point one.
3. Unambiguous documentation of the programme. Anything which raises expectations that cannot be met should be eliminated and phrases such as "state of the art equipment" and "no prior knowledge of computers is required" avoided unless well justified.
4. Realistic assessment of the resources required.
5. Provision of appropriate hardware and software. Media production facilities dedicated to postgraduate work are highly desirable.
6. Identification of staff expertise required. Any shortfall must be made good by recruitment or staff development.
7. Appropriate organisation of staff and physical resources, taking account of the points above. This is at least as important as the provision of hardware and software.
8. Close cooperation between academic and technical support staff. A team approach is essential.
9. A mechanism for receiving and acting on student feedback.
10. Top management commitment to postgraduate work. The resources required are disproportionate to numbers and fee income, so this is essential.

## Conclusions

There is likely to be continued expansion of provision for postgraduate work in digital media in the future, partly because interest in these media is growing and partly because more people are seeking postgraduate qualifications as first degrees become more common. The range of activities encompassed by postgraduate work in digital media is quite wide and support requirements differ considerably. Digital media present more problems in some areas of postgraduate work than in others. Capital and staffing demands are disproportionately high but must be met if work is to be of an appropriate standard. Staff and equipment will need updating frequently as there is still no sign of slowdown in the rate of technical change.

Digital tools and techniques frequently collapse a number of separate processes into one and new working practices have to be adopted. Tools may make it possible for one person to execute work which would formerly have required a team of specialists, but this is not necessarily desirable. If the specialists go, so does their expertise and judgement: without benefit of their advice and experience, work can look amateurish.

The vast majority of activity in art and design education still takes the form of individual effort but activities such as multimedia design and production require teamwork. Expressive work might continue to be produced by individuals but utilitarian work will have to be a team effort in future. The formation and management of production teams is still problematic. Postgraduate recruitment, course organisation, curricula, and staffing will all have to move away from the typical art school practice in order to accommodate this development. Film, television, and performing arts courses will probably provide appropriate models.

Organisational aspects of supporting postgraduate work in digital media are at least as important as the hardware and software aspects and the problems of working with digital media must be overcome. Interest in these media has been fuelled by falling equipment and software prices, which are now within department, subject area, or even individual budgets. It is likely that interest will continue to grow and educational establishments will be expected to respond.

There is a need for the exchange of ideas and information about the support of postgraduate work. Organisations like AGOCC and conferences like CADE 95 should be used to establish good practice and help ensure the quality of existing and future postgraduate programmes in digital media.

# Computer Aided Concept Design for Vehicle Stylists

Dr Samantha Porter

## VIDE

### Coventry School of Art and Design Coventry University

This piece of research was carried out on grant number GR/H5171 2 from the Control, Design and Production Group of the EPSRC.

It is commonly accepted in the manufacturing industries that the earlier concurrent design and engineering are able to occur the greater the reduction in both design lead time and the cost of the design product cycle is reduced. A basic requirement of concurrent design and engineering is a simple 3 dimensional (3D) computer model. This piece of research was concerned with the production of 3D models from the traditionally 2D concept design stage of the design cycle with a focus on vehicle styling/design.

The main aims of the project were:

- To establish procedures for computer-aided concept generation and design evaluation for vehicle stylists.
- To devise and perform experiments for evaluating various combinations of concept generation and evaluation techniques.

To allow these aims to be achieved it was first necessary to examine the relationship between concept creation and concept evaluation. During each state of concept design, the designer will evaluate what has been created and iteratively develop it. At the end of each stage, there are larger-scale evaluations when the design team or management assess the proposals. For this reason in considering concept creation it was necessary to also consider its evaluation.

Previous research (Tovey,1991) showed that a concept design method should allow a designer to view a design proposal as a three-dimensional entity as early in the process as possible, and that the traditional lateness of the move into 3D is based on cost and difficulty. New computer-assisted methods may overcome these constraints. The research has concentrated on methods which give fast, early, development to 3D, and the validity of this approach has been demonstrated through collaboration with vehicle designers.

## The context of sketching in concept creation

The industrial designer has two particular functions:

- To visualise the product concept;
- To represent alternative design solutions.

The purpose of sketching a major and continuing part of the design process is to help designers to arrive quickly and easily at a stage where a satisfactory design can be specified for development for manufacture. Representing a proposal visually is a fundamental part of industrial design. The representations are conventionally 2D drawings or 3D physical models, depending on when in the design process they are to be used. We characterise the presentation requirements by considering the management intervention points. Automotive styling design can be considered as two consecutive processes:

- concept design, which conventionally uses theme sketches and dimensionally-constrained sketches;
- design development, which conventionally uses tape drawings, scale models, and full-sized models.

A concept sketch was defined as "A collection of visual cues sufficient to suggest a design to an informed observer". These sketches are used in two ways: free theme sketching, and package constrained sketching.

The theme sketch is the initial expression of how a proposed design is intended to look. For such sketches to be useful in the design process there must be enough visual information in them for an informed observer to:

- understand what they imply about the design proposal
- understand the visual impact of the implied design as a whole
- understand its specific visual characteristics.

The package representation of a proposed design is a collection of visual cues sufficient to communicate the fixed dimensional parameters of a design. We similarly define a package-constrained sketch as one using a package representation to constrain and guide the designer's sketching. It allows an observer to:

- understand the dimensional constraints and proportions of the proposal
- understand the fit or interference of the theme proposal with the package.

For a developed system to be truly useful in the design process it was necessary that the designers' sketches could be used directly as a source of evaluable and developable models. Those models, produced almost as rapidly as the sketches themselves, would allow for 3D evaluation of a concept much earlier in the process than is traditionally possible. The availability of a 3D model would also allow much earlier access to other disciplines and allow the possibility of very early concurrent engineering.

## Specification of design requirements

Any concept design system must accommodate both the needs of stylists and those of management.

### Stylists' needs

The requirements of designers using computers have been analysed by Robert Aish (1990) and this list has been modified to apply more particularly to concept sketching.

These modified criteria are:

- rapidity: the speed at which the concept can be represented;
- versatility: the range of tools and techniques available;
- modifiability: the ability to modify a representation once created;
- visibility: the degree to which the representation can be assessed, both in itself and in relation to other representations.

Form creation for concept design must have the following characteristics (Tovey, 1992):

- Inputting geometric information must be quick
- Geometry must be easy to specify
- Representations must not be overly precise
- Geometry must be easy to modify
- Reviewing alternatives must be readily possible
- Visual display quality must be adequate for evaluation
- The overall interface must be user friendly.

### Management's needs

The management needs have been defined previously (Birtley, 1990), and are as follows:

- that the presentation technique facilitate the design process
- that it allow others to participate in the process (such as design managers, other members of a design team or the client); and

- that it communicate the completed design proposal to others; this will be to the client,

Once both stylists and management needs had been defined it was possible to investigate the possibilities for Computer-Aided Concept Design System.

## Identification of Practical Methods for Concept Design Experiment.

The initial approach was an identification of practical methods for concept design.

The framework shown below was developed to enable a formal exhaustive analysis of designers working methods.

<b>approach</b>	<b>View</b>	Orthographic Perspective
	<b>context</b>	Freehand Informed
<b>Medium</b>	<b>Technique</b>	Line Area
	<b>Enviroment</b>	2 Dimensions 2 1/2 Dimensions 3 Dimensions
<b>Result</b>	<b>Intelligence</b>	Simple Informational

The matrix reduces the concept design process to a series of five abstract categories with a number of alternative parameters. The previously gathered working knowledge of design practice, summarised below, allowed the identification from the total possible combinations from the matrix a number of abstract categorised methods which accommodated the requirements of designers in concept design.

In a series of concept design sketches, the designers will:

- Usually work in both Orthographic and Perspective categories of view.
- Usually work in both Freehand and Infommed categories of context
- Within the technique aspect. Area on its own is unlikely to support anything other than
- Simple intelligences.
- In a developmental series of representations, be working in an environment of 2D, 2.5D or 2D
- on 3D at the start, and would want to progress into, or be working in some semblance of 3D at the finish.
- Intelligence will always include Simple, and may include Information-bearing.

The nature of the styling process means that sketching will always be a primary activity and a number of practical investigations were carried out in three areas using existing hardware and software packages.

- 2D sketch related techniques
- 3D sketch related techniques
- matching and combining sketches

## Practical Investigations

Equipment

The materials used in all the experiments were: Silicon Graphics Indigo and Indigo2 workstations running Alias Studio, Showcase, and Movie software; an Apple Macintosh running Photoshop; and a Canon scanner. Where subjects were required MA Automotive Design students were used.

## 2D sketch related techniques

A number of possible methods were examined and the following conclusions drawn:

The investigations involving the Automotive Design students where subjects were required, a number of possible methods:

- (i) Paint programs can be used for concept sketching even if the interfaces are not ideal.
- (ii) 3D modelling packages can also be used for concept sketching though it was not possible to paint onto a modelled surface.
- (iii) Paper sketches can be satisfactorily scanned in as images to paint.
- (iv) Geometry can be extracted from such freehand sketches although not completely
- (v) It is useful to use underlays when sketching freehand to ensure geometric accuracy
- (vi) With limited practice it was possible to use a computer based system for productive sketching though the differences of technique required often led to a different sketching style.

## 3D sketch related techniques

As previously stated to allow concurrent engineering a 3D model is a requirement. One of the limitations of traditional sketching is that it only produces two-dimensional representations of three dimensional concepts. It was established that no method was available to sketch non-planer lines (this would create automatically a 3-D model).

This was done by using geometry-extraction methods to create 2D profile lines from sets of 2D orthographic sketches, and then using a combination of extrusion and projection techniques to produce the implied 3D base models. An attempt was also made to produce styling-line models from perspective sketches, as styling-line models represent concept forms with greater fidelity than the orthographic base models.

The investigations established a number of possible solutions:

- (i) Orthographic sketches of a concept can be imported to a modeller and placed in the correct relationship to one another. It is more efficient to extract the geometry from sketches and position that, rather than the sketches themselves. If the geometries are mutually correct, as is the the case when assisted with the use of underlays, the implied 3D line can be constructed from them. In this way simple models can be produced from sketches in 20 minutes, though these models are fairly crude.
- (ii) No existing way of constructing 3D styling line models from sets of perspective sketches was found. A possible method was explored but was found to be too slow to use practically without software support (and none of the packages examined gave this). The method was validated by taking a 3D model, projecting it to make pseudo-sketches and then reconstructing the model from those. The resulting model was a good geometric match.

## Matching and Combining sketches

The base models, while representing the design concept in their geometries, look nothing like sketches. It is already established that the tentative appearance of a sketch is an important factor for concept designers, and therefore ways were sought of adorning the base models with sketch-like surfaces. This set of studies examined several ways in which both orthographic and perspective sketches could be applied to simple surfaced models, such as the base models.

The following procedures were established:

- (i) Mapping orthographic sketches onto 3D objects proved possible if solid textures were used and gave good results if solid textures were used.
- (ii) Sketches, even with underlays, are inexact, because stylists tend to draw what looks correct, even if it is not strictly accurate, making it hard to extract accurate data from complete sketches. This is as counteracted by exploiting the midline symmetry of the car. This had the added, and unexpected benefit of

effectively trebling the producible models by using each half, mirrored, as well as the original sketch. The sketch models produced in this way generally had the approval of the designers who had made the sketches.

(iii) The procedure for matching perspective sketches to models is similar to that for orthographic sketches, except that view matching is more difficult. This problem was solved by using templates derived from perspective views of the base models, so that projection characteristics were known and an inverse perspective mapping to apply the sketches to the object. A problem with peripheral distortion when mapping perspective sketches was discovered exploiting the symmetry techniques that had been developed before solved this problem. This technique gave models that looked 'good' and had designer acceptability. These practical investigations lead to three techniques for building models from sets of either orthographic or perspective sketches. These are described below.

## Proposed Computer-Aided Concept Design method

The method uses the work designers currently perform at this stage in the design process, essentially sketching and uses the orthographic and perspective sketches to develop 3D sketches for initial evaluation and then developing the styling line model (identified in the CAVS research as the start for an engineering model).

### *Sketch mapping*

- Produce and import orthographic sketches to a 3D modelling system;
- Relate the sketches to appropriate views in the system;
- Extract line information from the sketches and develop into surfaces;
- Assemble the surfaces into a model and map the sketches onto the surfaces;
- View and evaluate the rendered model.

### 3D

Sketch mapping is the process by which line information is taken from orthographic sketches and used to create a simple surface model, which is then combined with those orthographic sketches to give the first stage sketch model with the implied feeling and detail of the orthographic sketches and the additional spatial attributes of a three-dimensional model. As in the conventional process, theme sketching will generally be followed by package-related sketching. The progression from the sketch to the model involves the following:

It is possible to move from a theme concept to a package-constrained concept, by either scaling the sketches to match the package constraints as 2D sketches before making a model, or by scaling or otherwise modifying the model to match the package constraints after creation.

### *Sketch projection*

- Using the model from the sketch mapping stage produce underlay views
- Sketch modifications using the views as underlays; and import them to the 3D modelling system;
- Relate the sketches to appropriate views in the system and map the sketches onto the appropriate surfaces;
- view and evaluate the rendered model.

**Sketch projection** is the second process where the designer uses the simple surface model created in the sketch mapping process as an underlay for perspective sketching. these sketches are then combined with the model to create the second stage sketch model for further evaluation.

### *Sketch combination*

- Take the perspective sketches already created and matched to views;
- Extract the line data from them
- Combine 2D line information into 3D styling lines;
- Create surfaces from the styling lines;
- Map the sketches onto the appropriate surfaces;

- View and evaluate the model.

**Sketch combination** uses perspective sketches to create styling-line CAD models which can be surfaced later. Assuming the results are satisfactory in design terms the designer then uses Sketch combination where line information is taken from the perspective sketches created for the perspective projection process, this line information is then used to create a styling line model. These computer assisted methods will support both theme and package-related aspects of concept sketching, with the proviso that the resulting computer models are dependent on the quality of the sketches; a loose free theme sketch can only provide a loose free-theme sketch model. If surfaces are subsequently created, the sketch projection technique can then be used on the model to develop details.

The three dimensional models needed to be evaluated for their usefulness/ acceptability to designers as a visualisation and evaluation tool needed to be investigated. In order to do this a multi-media presentation of simulations of the techniques was developed and tested as both a pilot study and three case studies.

## Pilot Trial

### Introduction

Individual designers and managers were invited to take part in the pilot study which was conducted in the VIDE Visualisation laboratory. They were given an introduction and general background to the research, followed by the presentation data were collected by a combination of structured interviews during the presentation and completion of the checklists by the subjects. The checklist following areas for each of the techniques:

- Original sketch match to model
- Understanding of model
- Ability to make design judgments about the model
- Use as a design tool
- Use as an evaluation tool
- Speed of the approach

Feedback was positive about all aspects and the checklist was refined for use in the case studies.

## Case Studies

### Introduction

Three case studies were undertaken with Rover (an automotive manufacturing company), Styling International and Krafthaus two design consultancies). The two texture mapping related techniques were investigated. We hoped that the case studies would give a greater insight into the effectiveness of the procedure, since designers would be able to input their own 2D sketches, about which they would have a better understanding of the expected 3D outcome.

### Aims

To examine designer reaction to working with the procedure developed for creating 3D concept forms on a computer. Although the procedure for creating the forms was the same in each case, the method and background of each case study differed.

### Rover

Four designers working in a manufacturing company with no prior knowledge of the procedure evaluated the sketch projection technique using perspective sketches.

Styling International techniques.

A designer working in an automotive design consultancy with a good background knowledge of the procedure tried both the sketch mapping and projection Krafthaus

As above, but the designer only evaluated the sketch projection technique.

### Materials

The materials used in all the experiments were: Silicon Graphics Indigo and Indigo workstations running Alias Studio, Showcase, and Movie software; an Apple Macintosh running Photoshop; and a Canon scanner.

### Method

The designers were asked to make perspective concept sketches over underlays, except that in one case (Styling International) the designer was also asked to produce freehand orthographic concept sketches. In all cases the designers completed their tasks. These were transformed to 3D sketches and the designers evaluated the results. The appropriate parts of the checklist developed earlier were used for the collection of information.

### Results

All the designers who produced sketches were shown them combined with the underlay model. Results were generally favourable. The 3D models appeared much as the designer had anticipated and in all cases felt as if they had gained a better understanding of their own concept designs and were able to make subsequent design decisions based on the model. One other major benefit was highlighted. Putting concept designs into 3D at this very early stage in design allowed the designers to communicate their 3D ideas to other members of the development team e.g. engineers allowing them 3D comprehension of the idea.

The success of the case studies allowed a Computer aided Design to be specified.

### Specification of a CACD system

Each of the three concept design techniques requires certain capabilities from the system in which it is to be performed. While many CAD programs each provide some of these capabilities, no one system of which we know provides them all; indeed, in the case of inverse perspective projection, none provides it.

### Working environment within the 3D modelling component

The modelling component must support simultaneous multiple perspective or orthographic views. Management of multiple windows on the screen at the same time will involve referencing the views with a facility to retain those references, and to return to them at will, as well as the ability to lock a view to stop it being changed by accident. The user must be able to work in any window and be able to perform any of the actions necessary to the process in that window.

### Image Creation

The system should allow sketches to be created externally and imported to the system, or to be created within the system, and it must allow transfer of the information to 3D programme.

### Image transfer and the 3D world

The modelling component must allow the importing of pictures into both orthographic and perspective views. Once a sketch is imported there must be a facility to support matching the sketch to an appropriate view in the 3D world. There must also be a facility for converting the picture to line information, for example by manually tracing the sketch or by having the computer automatically trace the sketch.

### Image manipulation

Since a concept will be represented by many sketches, there must be a facility to match these multiple perspective sketches together; in other words the user must be able to scale the imported sketches and to position them correctly in the 3D world.

### 3D Development

The modelling component must support parallel projection of line information to combine 2D lines into 3D lines, as well as parallel projection onto a surface. Once created, the surface lines must be usable to trim the surfaces and to create new ones, as well as to support fillets on the trimmed intersections of surfaces.

It must also support perspective projection using the view vector and projection angle to create the projection characteristics, and the use of this projection to allow a similar combination of information, as above

### Texture mapping

Our proposals require that a sketch can be mapped onto a model surface which involves treating a sketch as a cross-section of an extrusion. This extrusion method must be supported by both orthographic and perspective projection techniques in the modeller.

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# The Use of Ergonomics Software in Industrial Design Education

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Products are made to be used and as such are expected to function, to be usable and to be safe. It is only possible for designers to achieve this in their designs if they have some understanding of both the physical and the psychological human characteristics. The tools and data of ergonomics and their use, in particular those of anthropometry (the measurement and collection of data of body dimensions), are an essential part of industrial design education. Students need to understand both how to apply the data appropriately and the limitations of the use of such data.

The anthropometric databases which are used have traditionally been available in tabular, pictorial/diagrammatic form (eg Pheasant 1988) and also as design recommendations (eg. Dreyfuss, H., 1967; Diffrient, Tilley & Bardagjy, 1978; Diffrient, Tilley & Harman, 1981a & b). They are all designed to provide information which allows the designer to base their designs on apparent fact; the size of particular body dimensions of very small (2.5 or 5th percentile) & very large (95th or 97.5 percentile) females & males.

There are both content and presentation differences in the different forms: the tabular and pictorial forms both provide data which the designer is responsible for selecting appropriately for his requirements (ie. in terms of age, gender, nationality, clothing etc. as well as choosing the correct body dimensions for the particular design); the designer is given the responsibility of ensuring the data chosen is the correct data. Recommendations, however, appear in a form where those assumptions have already been made on behalf of the designer and consequently must be regarded as more general, or in some cases more specific, guidelines from which to specify a design. All provide a useful starting point on which to base the dimensions of any design but are limited in their usefulness in that they they provide no further information about the way in which any individual may interact with or feel about a product.

These types of information are now available relatively cheaply in similar forms as computer databases (eg. Ergobase - available for a number of years and People Size - a new package only recently available) and also as ergonomics evaluation tools (eg. Mannequin) which remove the necessity for extensive mock-up stages in the design process and are ideal for exploratory investigations in the early stages of design. All are available to Transport and Product Design students in Coventry School of Art & Design.

It has, however, been observed that students are reluctant to use these facilities; in some cases at all and in others in an appropriate fashion. Ergobase has tended not to be used, Peoplesize as yet remains an unknown quantity and Mannequin is used mainly as a visualisation tool only. The facilities are made known to students in both Ergonomics and Computing modules and they use extensively the traditional forms of data/recommendations. It is thought that there are a number of reasons for this:-

- i) the forms in which the data are presented. It has been noted, by academic and library staff alike, that design students prefer to use the more visual forms of either traditional anthropometric data or recommendations eg. Human Scale which is particularly popular because it provides visual recommendations. Designers are also visual communicators who find the terminology of anthropometry (derived from an anatomical root) obscure; not all the packages clearly or simply address this issue.
- ii) it is often not possible to source the data for particular dimensions. The correct use of anthropometric data is dependent upon knowing the source (how, where & when it was collected).

iii) the students have not up to this point, had enough ergonomics practice, or do not consider ergonomics to be their responsibility (shouldn't an ergonomist do this?), particularly given the short timescale of many of their design projects to be motivated to use the evaluation tools. These educational issues are being addressed and consequently may change in the future.

The discussion of these issues is based upon a combination of interviews with MA students, following a practical session where they were required to use all three packages to produce recommendations for a driving package for a world population and staff opinion. Ergobase and Peoplesize are compared directly whilst Mannequin, because of the different nature and potential use of the package, is considered separately.

## Data Presentation

Ergobase is easy to use for the novice user but the data appear in a dry scientific tabulated form described in anthropometric terminology; explanatory diagrams are available but they are difficult to comprehend and do not appear on the screen automatically. This causes a problem if the user is unsure of anthropometric terms (designers often are) and is designing from scratch. Resorting to a traditional data source, where the data is explained both pictorially and verbally, is often easier and more satisfying.

In contrast Peoplesize offers a pictorial/diagrammatic representation of all measurements that are contained within the database as a starting point; the user can choose from the representation a measurement which looks appropriate, the measurement is then explained in order that the user is able to be sure that it is the correct one before the data is given. The students found this generally much easier to interact with, as relatively naive users, than Ergobase.

In the case of Mannequin the user is able to choose a 3D "person" of any percentile value and alter body dimensions to a different percentile value as required. The constructed "person" can then be used to assess the environment for that size of user. The "person" is easy to construct and changing a particular dimension is also straight forward. The package allows the assessment of worst case situations eg. a driving package for the individual with very long legs (seat in rearmost position) and relatively short arms (unable to reach the steering wheel adequately?). The students enjoyed the ability to produce "people" of different body sizes but found designing the driving package itself very difficult because the anthropometric data was opaque. Building the environment was easier using a traditional anthropometric database as a data source or basing the design on recommendations eg Diffrient et al(1978) as a starting point. Visually the package was very popular with students perceiving it as an easy and acceptable (computerised and therefore "state of the art") way of producing the human form.

## The Anthropometric Data Source

It is vitally important that if one is to use anthropometric data correctly that the data source is understood. The data must be estimated from measurements of a population of appropriate age, gender, nationality, specific nature of the measurement (the specific posture adopted whilst the data was being collected - slumped or upright?) and clothing type for the product being designed. This is true whatever the form of information.

In all three packages it is not easy to identify the details of the population. In the case of Ergobase there is a wide range of ethnic origin data available but no details are given of the nature of the measurements. If one resorts to the literature accompanying the package there is a bibliography of sources but no details of how the individual sources relate to particular dimension data.

Peoplesize again offers a wide range of ethnic origins, gives the clothing allowances which have already been made and offers recommendations for the amount of extra space which may need to be considered for clothing. Again the literature accompanying the package offers a bibliography of sources but no details of the individual sources or the particular data sources for particular dimensions.

The same problems described above exist with the data which is used in Mannequin. These issues make appropriate use of the data at best awkward and at worst incorrect for the application.

Because the students chose to use recommendations as the source for building their driver's package in Mannequin it made them very aware that they are the easiest source on which to base a design. However designers tend to use recommendations with the assumption that they are correct although they actually require the same assessment to be made of their appropriateness as anthropometric data. For example, the Human Scale recommendations are based on US only anthropometric data and to design a vehicle for a world population also requires anthropometric knowledge of the more diminutive Japanese population; it is imperative that the designer questions the details of the recommendations before use. There are also a number of different sets of recommendations available and the information between sets rarely concurs absolutely; a number of sources should be cross-referenced before use in design. The students, although having been warned of these issues, allowed the convenience of use factor to dominate their choice of tool.

Hasdogen (1992) found both designers and ergonomists very critical of anthropometric data. The ergonomists however, are still willing to use the data as a starting point for design (accepting its limitations) whilst designers tend (because of these limitations) to not trust the data and to base their designs on internalised knowledge/experience which they assume to be correct. One only has to look around the market place to know that products are not always designed with the user populations' needs, abilities, skills and preferences in mind; designers do sometimes get it wrong. This informal finding concurs with the beliefs of Pheasant(1988) who lists the five fundamental fallacies, commonly held by individuals in the design profession, as:

- (i) This design is satisfactory for me - it will therefore be satisfactory for everybody else
- (ii) This design is satisfactory for the average person - it will therefore be satisfactory for everybody else.
- (iii) The variability of human beings is so great that it cannot possibly be catered for in any design - but since people are so wonderfully adaptable it doesn't matter anyway.
- (iv) Ergonomics is expensive and since products are actually purchased on appearance and styling, ergonomics considerations may be conveniently ignored.
- (v) Ergonomics is an excellent idea. I always design with ergonomics in mind - but I do it intuitively and rely on my common sense so I don't need tables of data.

Such beliefs clearly interfere with the process of successful design for "human use" and also suggest that ergonomists simply haven't got it right where the presentation of the tools they believe designers should use are concerned.

## **Ergonomics Practice**

Whilst the students seem willing to comply with an educational requirement to use ergonomics data as an initial starting point for their designs they do not use Mannequin as an ergonomics evaluation tool. It is used as a visualisation tool ie to show a vehicle interior with passengers (any obvious ergonomics faults would be picked up eg a roofline which is too low) but not to actually evaluate a product. Mannequin is fairly powerful in that it allows a "person's view", so the visibility of controls and displays could be assessed for different percentile individuals, as well as the more fundamental issues of fit to be evaluated.

Another fundamental problem with the use of the package would seem to be that whilst students are required to use ergonomics a majority of their marks in design projects are given for other aspects of design. The package does require some knowledge of 3 D modelling and the students find it difficult to find sufficient time within the academic timetable to acquire the skills; time is a big constraint for all but the most enthusiastic. They feel that they cannot afford the time to produce both a good aesthetic design which is well presented and do a thorough ergonomics evaluation. If they do want to conduct an exploratory (quick & dirty) ergonomics evaluation they prefer to build a basic "experimental rig" because they can also use it to investigate other subjective issues such as ease of ingress/ egress which it is difficult using a CAD package such as Mannequin. The use of such experimental rigs does indicate both a responsibility for the input of ergonomics and a sufficient level of ergonomics skills to be able to use Mannequin if motivated. Essentially although the students feel a responsibility to get the ergonomics "right" they perceive other aspects of the design process as being much more important.

## Conclusions

There appear to be a number of reasons why students do not take advantage of the ergonomics computer packages on offer in Coventry School of Art & Design:

- The packages are not designed with product designers in mind. Designers are essentially visual and not verbal individuals; they rapidly lose interest if a package requires them to use additional information to that which is part of the package. In this respect Peoplesize is a more "user-friendly" than Ergobase.
- Some of the information which is required to use anthropometric data successfully is not available or difficult to access eg age, gender, nationality, specific nature of the measurement (the specific posture adopted whilst the data was being collected - slumped or upright?) and clothing type in all three packages. This makes them not as useful as some of the traditional sources on which they were based. Again
- Mannequin is popular as a visualisation tool but not as an ergonomics evaluation tool. Students seem happy, on longer projects, to tackle real world ergonomics investigations which allow them to collect subjective data alongside more objective data, but generally feel that the time frames within which they work do not allow such a concentration on ergonomics. The fact that students will use it as a visualisation tool indicates that their curriculum allows them to develop the necessary skills if they are sufficiently motivated.

The above findings pose an interesting challenge to ergonomists designing tools (computerised or otherwise) for designers. Can they get right for the designers as well as the ergonomists?

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# Cinegrams: interactive animated systems diagrams for technical documentation.

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## Abstract

This case study describes the design and production of a hypermedia technical document. The term 'cinegram' has been coined to refer to this new time-based and interactive document type. A prototype is currently being developed under HyperCard 2.2. The application domain of the prototype cinegram is the oil system of Rolls Royce's new Trent 700 turbo fan engine. Rolls Royce plc in Derby is a collaborator in this research project.

Unlike printed technical documentation, cinegrams can show processes in motion, e.g. oil flows, valve operation, temperature changes, etc.

In printed documentation the standard approach is to present a text supported by subordinate diagrams. The proposal here for hypermedia documentation is to reverse the relationship. In cinegrams, the user navigates through the system via interactive, animated diagrams which can show components in different states and point at a network of associated pictures, animations and words (as print or speech). The idea is to illustrate the functioning of components in several ways: through navigation (browsing and searching), sequential presentations, and embedded interactive simulations.

Where computer based systems for creating, storing and retrieving technical documentation have been introduced commercially to date, these have largely used the structure of the traditional book as the model for organisation.

The cinegram approach utilises the interactive and time-based capabilities of the computer which can offer far more than mere electronic page turning. This throws up many interesting questions about possible ways of using this new technique and the responses to them by users.

## Technical documentation

'Technical documentation' is a generic term used to refer to a range of visual materials that describe how things work and how to use and maintain them. The things can be mechanical equipment, computer software, or industrial processes of all sorts. The documentation can be in the form of training materials, operating instructions, maintenance guides, illustrated parts catalogues, etc. Whilst the paper-less office is still some way off, more and more companies are following the trend of putting their technical documentation into digital form. In view of the growing complexity of products and accelerated production cycles, electronic (possibly on-line)

documentation techniques offer a number of advantages. They are expected to reduce information access time, facilitate the creation and updating of documents, enable automation of repetitive and book-keeping tasks, and facilitate document exchange, conversion and the production of different versions.

The existing applications in this area are mainly text-based. For the sake of consistency, they often retain the structure of printed documentation since both electronic and printed documentation are still expected to be used interchangeably.

Typically printed documentation comprises two principal modes of communication: text - or 'verbal graphic language', as Twyman (1982) would have it - and images - or 'pictorial and schematic graphic language' (ibid).

It should be noted that, despite the maxim 'a picture is worth a thousand words' diagrammatic representations are usually used in < subordinate role to the text, which provides the principal access structure to the document, through its organisation into chapters, heading, sub-headings, summaries, indices, etc. The diagrammatic material is usually arranged to support and amplify the written word, and the reader is directed to it through the text (as we are doing now! ) See figure 1. Biderman (1980 p232) has noted the 'segregated and subordinate status of graphics' [diagrams] and compared them to the cultural roles of minorities.

The dominant role of text is generally maintained when the digital form is used. If pictures and diagrams are included at all then they are not usually interactive. The potential of animation and digital video have only recently begun to be exploited in interactive technical documentation.

With the availability of animation and digital video for interactive computer systems, the design, implementation and expected usability of mixed-mode or active hypermedia documents that can contain time-based media have become topics of research interest (e.g., Feiner and McKeown 1993; Fischer and Richards 1993a, 1993b, 1994; Hardn.an et al 1994; Thomas et al 1994) .

Much current research is focused on the technical integration of time-based media into space-based informational structures (Horn & Stefani 1993) . An important example is the development of the SGML-extension 'HyTime' (Newcomb et al 1991) and the development of the IETM (Interactive Engineering Technical Manual) standard (cf. Mil-M-8726 GCSFUI 1992) .

## **The development of the cinegram**

This report describes the development of the concept of the cinegram and the current cinegram prototype developed in the Visual and Information Design (VIDE) research centre at Coventry University. Cinegrams are a document type which use interactive diagrams to point at a hypermedia network of composite nodes. Each of these nodes can call up a number of data files such as pictures, animations and text. The separation of data from the actual application allows for selective updating and potentially, distributed storage of the data. In other words, a cinegram could act as as transparent interface to data kept and maintained on remote servers.

The cinegram development started with a week-long attachment to the department of Visual Communication at Rolls Royce, Derby, during which many informal meetings and interviews took place. The overall impression concerning document design and use at Rolls Royce was that because of the size, complexity and segregation of the organisation a co-ordination of information even on the trivial level of document exchange formats poses huge problems.

During this explorative stage of the design process, one document type caught our attention since it appeared to be both popular and used in very diverse contexts. The document type is that of systems diagrams, also called Dunwells (after the inventor) or ETGs (for Engineering Technical Graphics). Systems diagrams show an entire engine sub-system, (such as the oil system) in a lot of technical detail, mostly using component cross-sections linked together through the colour-coded flow of oil (see figure 2a) . However, systems diagrams are not part of the standard documentation handed out to the airlines. The standard documentation is developed according to a hierarchical catalogue sequencing standard used throughout the airline industry and certified by the ATA (Air Transport Association) . The main reason why systems diagrams are so useful is that they provide a level of integration non-existent in ATA-certified documentation. Systems diagrams emphasise functional unity and are

thus very useful whenever a general understanding of system behaviour is required - whether they are used in system familiarisation training courses or as troubleshooting aids where they can help solving a particular problem by visualising the larger system context.

The multi-purpose character, functional complexity and visual richness of systems diagrams seemed to render them a good starting point for the development of hypertext documentation. The prototype design was informed by regular visits to the departments of Visual Communication, Technical Publications, Customer Services, and the Customer Training School. We often presented and discussed the developing prototype, and many people made useful suggestions. We realised that what people expected from the system varied greatly according to their working background. The notion of a 'core cinegram' based on the structure of the physical engine emerged. We thought of the core cinegram as a framework which could be amended for different purposes and contexts of use. For example, the training school might utilise the possibility to create tailored sequences out of the cinegram material which could be used as a presentation medium in instructor-led training courses, while Customer Services might use an animated cross-section of a bearing chamber as a point-and-click access tool to data on oil pressure, temperature and low speed under various operating conditions.

We also thought cinegrams should allow customisation by individual users who would be able to add to the cinegram pointers to documents they were currently using, and 'get rid of' those bits that were not needed.

## **The relation between reference system and cinegram**

In designing the cinegram prototype, we have used a variety of sources, like systems diagrams, the engine manual, schematics, photographs and technical reports, which all in some way refer to the reference system, i.e., the physical engine. In selecting relevant aspects of the reference system and reconstructing these as a cinegram, design decisions are undeniably biased towards a particular kind of anticipated use. Another constraint that has a strong impact on design decisions is the layout of the source material. For reasons of economy (and also in order to secure consistency with the printed oil system diagram), the cinegram designer would be ill-advised to attempt a complete redesign of the laboriously produced technical illustrations serving as the source material for the cinegram animations. An example may illustrate this constraint and also show how the diagrammatic purpose can inform particular spatial re-constructions.

The technical illustration underlying the pressure pump and filter component animation (figure 3) shows both pump and filter in one diagrammatic cross section. In fact, these two functionally independent components are again part of an even bigger ensemble also housing all scavenge pumps. For the design of the overview map (figure 2b), this poses an interesting question: should the overview emphasise spatial or temporal relationships? While pressure pump and scavenge pumps are far apart in terms of temporal flow cycle, they are placed in the same case and even driven by the same gear shaft.

The technical illustration itself (on which the animation in figure 3 is based) is actually an ingenious montage: two different cross sections are combined into one image in order to emphasise the functional relation within the overall assembly of the pump casing. The view focuses on those technical details that contribute to an understanding of the function. While it is conceptually precise, it modifies the actual physical arrangement.

## **The cinegram structure**

The term cinegram has been coined to refer to interactive hypermedia diagrams that include time-based media such as digital video or animation. The cinegram approach is distinctly different from the traditional text-to-diagram relationship used in books and their digital equivalents. In contrast to a text-oriented approach, an animated diagrammatic representation of the physical system (in our case the oil system of the Trent 700 engine) is used as the principal means by which readers access information (See figure 2b, 3 and 4).

In a cinegram (as in Hypertext in general) the designer can first of all translate his or her conceptual model of the reference domain into a network of interconnected nodes. The resulting structure can be dynamic and account for more than one decomposition. The possibility of tucking away large amounts of information reduces the information overload and visual noise found in many diagrams which compress a detailed view of rather complex system into a single field.

Cinegrams are then based on a simple hierarchical structure. The top level is the respective system itself, e.g., the Oil-, Fuel-, or Heat Management system. Each system then contains a number of components, and each of these components can be shown in a number of different states and presented in a variety of document types, like animated cross-sections, photographs, or line drawings. In terms of prototype implementation in HyperCard, systems correspond to stacks, components to backgrounds and states to cards.

Basically, cinegrams can be used in three different modes:

- 1) The user navigates through the hyper-document in a more or less constrained manner. Hypermedia is based on the notion of interactive access to documents by means of navigating links, i.e. through browsing or search mechanisms. The basic pattern is in many ways similar to looking something up in a traditional encyclopedia. The temporal unfolding of information in the process of interaction with the document (and/or other humans, sources, etc.) is in the hands of the user. In a future implementation, history mechanisms and dynamic maps may provide navigational feedback on request, while user configurations (like link bases) may generate particular cinegram instances. Results of user interaction may be saved in some way, e.g. for versioning control or for performance assessment in interactive courseware.
- 2) The user interacts with dynamic simulations of particular system aspects. Some cinegram elements are responsive in a way different from simple links. For example, looking at a diagram of the heat management system, the user might change the oil temperature through a simple point-and-drag operation over a thermometer icon. The system will then respond by animating a chain of events leading to the further opening or closure of the air modulating valve of the air-oil heat exchanger.
- 3) The user selects 'canned' sequences showing important processes within the system (e.g. the effects of a fault, component function, or maintenance procedures). The most general sequence would include all system components and arrange them along a linear path in the order in which they are traversed by the oil flow: from the oil tank to the bearings and finally back to the tank

Time-based media do not sit comfortably in an interactive frame- work because they carry their own temporal definition: they conform to a presentation paradigm rather than the interactive paradigm. Once triggered, they tend to suspend user action; the user stops interacting and just watches the sequence. Most current systems constrain interaction with time-based media to the few actions which have crystallised in the video panel scheme. In cinegrams, we want to explore the affordances given in timed embedded controls. How can the availability and functionality of embedded links be signalled to the user? But more fundamentally, how can a process be broken up into discrete segments, and how can invisible aspects (like oil pressure or flow speed) be visualised?

## Examples of cinegram sequences

One sequence of pressure pump and filter component view (figure 3) demonstrates the application of cinegrams for the instruction on maintenance procedures. The animation shows the functioning of an invention that makes life easier for the flight mechanic. When the filter element is removed, an anti-leak valve is automatically closed to prevent oil spill (figure 3b).

The schematic drawing of the component shows both states of filter on each side of a vertical dividing line. Some technical imagination is required to complete the other half for each state and mentally perform an 'in-between' between both states. A static technical illustration might show both states separately. An animation has the advantage of showing the transition between both states over time. This way, the functioning of the automatic shut- off mechanism becomes immediately obvious.

Another sequence shows the development of a fault condition (see figure 4). Fault conditions can cause cascade effects that rapidly propagate beyond the system boundaries to affect the whole engine. Regular maintenance ensures that those conditions rarely become reality. But the very fact that such conditions are rare and consequently rarely observed indicates that cinegrammatic presentations of those conditions and their effects may help the people who fly and maintain those engines to get a better conceptual understanding of the system.

The fault sequence shown in figure 4 explains the blockage of the scavenge filter through debris in the oil. The clogging of the filter element results in a pressure drop past the filter and pressure rise before the filter. When a differential pressure of 13 psi has been reached, a differential pressure meter sends a signal to provide flight deck indication of impending by-pass (figure 4b). At 20 psi, the spring-loaded pressure relief valve is blown (figure 4c) to let the oil bypass the blocked filter element (figure 4d).

The entire fault sequence falls into two different processes on both sides of a peak in the sequence: the slow building up of pressure until the signal is sent, and the blowing of the valve shortly after. The first stage may take two weeks of operation during which the filter gets increasingly clogged; the second may take only a fraction of a second until the filter bypass state is reached.

The animation takes considerable license in its treatment of time. In order to accentuate the relatedness of both stages, it radically accelerates the first stage and to some lesser degree, slows down the second state.

## Plans for cinegram evaluation

The primary aim of our planned evaluation is to assess the usefulness of cinegrams as documentation tools and learning aids. Beyond that, we will concentrate on the way users interactively unfold system relations and processes. We want to explore how the affordances of the cinegram interface relate to the user's understanding of complex systems. The evaluation will happen in three stages:

- 1) Formative interface evaluation with novice users (students of technical communication) confronted with the system for the first time; the user is asked to carry out a simple task, e.g., describe the main functionality of the oil system while witness protocols are taken and analysed. The results will inform the prototype design so that some usability problems will be sorted out before the next stage of evaluation.
- 2) A group of inexperienced users (students of technical communication) will be given a basic introduction to the function of the oil system and a demonstration cinegram interface. The users will then be asked to find and write down in a given amount of time answers to a number of written questions all of which presuppose some conceptual understanding of the system. A control group will use written documentation (the 'system description and operation' section from the Trent engine manual). A third group will have access to both types of documentation. Witnessing documentation use of the third group will reveal the turning points at which the information seeker may abandon one medium and turn to another, and to show when and why different media are used in conjunction. Users will be asked to write a short free-form statement immediately after the session, and additionally, to fill in a short questionnaire covering usability aspects of the cinegram which might have been left out in the free-form statements. Witness reports and user statements will be compared and analysed. The written answers to the problems and the results of the questionnaire will provide some 'hard' facts which we hope will provide an indication as to the usefulness of cinegrams as a documentation tool.
- 3) A number of expert users in the technical support department at Rolls Royce will 'play with' and comment on the system. This will reveal what they would expect the system to do in their specific context. Possible tasks are accessing pressure, temperature, and flow speed values within one bearing chamber under various operating conditions. Users will be asked to write a short note on the problems they encountered; additionally, the time it took them to arrive at the answer could be measured and compared with the time for accessing this information using printed and CD-based engine manuals.

## Comments on the design process

The aim of research was to explore potential applications of multimedia technology for technical documentation. The design process has indicated that the success of any design - its usefulness - will not primarily depend on the current state of technology but on the organisational background, i.e. the history of information requirements and documentation design and use in quite diverse working environments. We see the cinegram development as a pilot design project which has indicated some of the issues and opportunities of collaboration with industrial partners in speculative research of this kind.

The contact with Rolls Royce was frequent and generally fruitful. The nature of co-operation was relatively informal and since the concept of cinegram was not a response to any clear-cut actual problem of any particular client within Rolls Royce, there was some hesitation in recognition of its potential usefulness within the documentation strategy of the company.

Nevertheless there was much enthusiasm by those who saw demonstrations of the developing cinegram prototype. It was clear from the start that the emphasis was on pictures and diagrams as primary access structures to information; an approach many engineers (who tend to flip through bulky documents searching for pictorial and diagrammatic cues, and only read text if they have to) felt very sympathetic about.

However, there is a major technological (and perhaps cultural) divide - while we are using Apple Macintoshes for the prototype design, Rolls Royce, like most industrial companies, use PC's and Unix workstations almost exclusively. One of the most frequent questions was 'Can you run this on a PC?' The answer, sadly, had to be 'No, not at the moment.' This divide continues to contribute to the difficulty of evaluating the prototype - people experience the prototype on a machine they are not familiar with and currently does not fit easily into their normal working context.

All this can present difficulties if an iterative design process requires the evaluation of early versions of the prototype under realistic conditions. The potential benefit of the design project needs to be clear to the industrial partner if the necessary commitment of resources is to be made for trials.

The collaboration entered a new stage when desk space for a researcher was arranged in the Department of Customer Services and therefore access to both documentation and communication with employees was facilitated. This has proved extremely beneficial to the development process.

## **Conclusion**

This case study has described the development and function of a new hypermedia document, called a cinegram, which uses diagrammatic techniques in order to show the functioning of complex technical systems. Cinegrams include aspects of navigation, sequential presentation, and interactive simulation.

The cinegram prototype described here is still under development. The concept is sufficiently general to allow application to a variety of other domains, but much further research is necessary in order to investigate the potential and scope of their application. In developing the concept of cinegram, we intend to reformulate the wealth of information design techniques found in the diagrammatic tradition (Richards 1984, Pedersen 1988, Tufte 1990) within an interactive and time-based framework. Thus we expect that the concept of cinegram will contribute to the development of future dynamic hypermedia environments.

## **Acknowledgments**

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The prototype makes use of a number of different XCMDs and XFCNs: Hilite XCMD, LocalToLocal XFCN, UpdateWindow XFCN Rob Bevan 1994; Say XCMD, Pollocks XCMD Sam Deane 1994; QTmovie XCMD Ken Doyle, Apple Computer 1994; WindowScript 1.5 XFCN Heizer Software 1993; Textoid XCMD, Pictoid XCMD, Listoid XCMD Frederic Rinaldi 1994.

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# The design of a multimedia calculator and its use in teaching numeracy

This case study was prepared in November 1994 for the (AGOCG)Advisory Group on Computer Graphics  
Technical Report 26

## Clive Richards and Sue Flynn

**Keywords:** Interactive; calculator; numeracy; Dienes blocks; dyslexia; mulitmedia learning package.

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**Note:** Certain features of the multimedaa calculator described here are subject to a patent application by Coventry University.

## Introduction

Dyslexia usually implies problems with literacy. A large proportion of dyslexics however, also have some problems with mathematics. It has been estimated that 6% of the school population has serious problems with arithmetic and often there may be little provision for helping these children, especially if they have behavioural problems as well.

The research reported here is a continuing project being conducted in the Visual and Information Design research centre of Coventry University. The aim has been to design an interactive multimedia learning package for teaching numeracy to specific groups of pupils. A long term objective of the project is to investigate the applicability and potential of multimedia systems for such tasks.

The focus of this particular project is the numeracy difficulties of 8 to 11 year old children.

Generally, structured learning materials like Dienes blocks<sup>2</sup> and Cuisenaire rods<sup>3</sup> are used to concretise the concepts of number. Together with considerable overlearning and the careful use of language, these materials provide a multisensory experience which enhances the learning process and enables the accurate recall of information from the long term memory.

It may be possible to provide the equivalent stimuli in one package using multimedia. The intention of the current investigation is to demonstrate that a multimedia application can present this multisensory learning experience in an efficient and effective way.

## Background

Within the context of special learning needs there is an abundance of software for teaching literacy but less for teaching numeracy. In the past, the emphasis has been placed on reading and writing. Many parents are known to say, "Oh well, I was never any good at maths either!" but rarely heard saying, "Oh well, I was never able to read and write!" It is only comparatively recently that deficiencies in number skills are being properly acknowledged. Our society is becoming more dependant upon number based technologies. Therefore, it is necessary for effective teaching of numeracy to reach all groups of children, in order that they may be integrated successfully into society.

Observations conducted as part of the present research in several middle schools during the mathematics lesson showed that this area of the curriculum needs to be addressed. 8 to 11 year pupils of mixed abilities and from a broad range of socio-economic backgrounds have been studied. It has been possible to identify amongst the pupils

a set of problems, some of which are indicative of specific learning difficulties, including dyslexia. These problems appear to be compounded by the use of calculators, now a component of the National Curriculum for all schools.

A design audit of a range of conventional, four function calculators has informed the development of the multimedia calculator interface, described here later, which aims to address problems identified. Through the use of multimedia authoring tools, in this case Macromedia's "Director Interactive", it is possible not only to design a prototype working calculator but also to incorporate within the interface access to representations of multisensory teaching aids, like Dienes blocks. Investigations at special needs schools have reinforced the value of multisensory teaching reported by teachers<sup>4</sup>. The teaching routines used with Dienes blocks are rigorous and combine the language and actions of the four basic mathematical operations. It was therefore considered appropriate to integrate these established teaching routines into the proposed multimedia learning package.

It is anticipated that a multimedia package can simulate these very teacher intensive learning methods and may provide economic advantages. Such a multimedia package could provide other advantages for the child with difficulties who may lag behind his/her peer group, e.g.

the program can be paced and the learner can work at their own speed;  
the learner can repeat parts of the program as many times as necessary;  
through the use of audio feedback, it is possible to reinforce the actions with the language of mathematics in a consistent way;  
immediate, positive feedback can provide the learner with confidence and motivation. This could prevent the frustration of waiting to have work corrected by the teacher.  
the activities of the pupil are traceable by a management system which provides the teacher with useful information on progress.

## **The design features of the conventional calculator**

It is the design and operation of 4-function calculators, commonly used in schools, which have become a key feature of the research. It would appear that through their use in the classroom difficulties with arithmetic are compounded for pupils with problems associated with dyslexia, e.g. short term memory deficit<sup>5</sup> and difficulties with transferring ideas, verbal labelling and abstracting information.<sup>6,7</sup>

When used for teaching elementary numeracy, certain features of standard calculators are not helpful for such pupils. Some of these features are listed:

- Following the selection of an operator key, the subsequent input of a number removes from view the previous number, thus the user has to store strings of information in the short term memory;
- no assistance is offered by the display to those who have not developed a concept of place value;
- usually there is no audio feedback to indicate key depressions;
- usually there is no facility for editing the LCD display;
- it is virtually impossible for a teacher to identify mistakes by pupils as there is no record of key depressions.
- the order of operations does not reinforce algebraic logic as most primary calculators are based on numerical logic. e.g.  $3+4 \times 5 = 23$  and not  $35$ .

## **The multimedia calculator**

A multimedia calculator<sup>8</sup>, which is mouse operated, has been designed and prototyped using Macromedia's software "Director Interactive 4.0". The animation capabilities in this authoring tool have been utilised to simulate the calculator operations and manipulations within the various windows such as the Dienes block arena.

The calculator has been designed to address the problems indicated in the previous section. It has other features aimed at supporting learning by dyslexics and attention has been paid to the visual styling of the interface which is regarded as being of great importance to the likely success of the package. (See figure 1.)

It will be noted that the layout of the key pad for the multimedia calculator is the same as that for the telephone, viz:

1 2 3  
4 5 6  
7 8 9  
0

Research findings show that less errors are made using this layout, which is also faster. We believe that this layout is more likely to correspond to children's expectations than the standard calculator layout:

7 8 9  
4 5 6  
1 2 3  
0

These two formats are used internationally, but why this difference exists is uncertain and may be due to the original mechanical configuration of adding machines. The multimedia calculator has three modes of operation. In the first mode it performs in the same way as a conventional four function calculator, returning the correct answer when the 'equals' button is depressed.

The basic difference between the display of the multimedia calculator and the display of most conventional calculators is that the complete vertical algorithm is displayed in the window step by step for each of the four basic mathematical functions: +, -, + and x. Each number is displayed in columns and the chosen operator is placed to the left of the sum. The answer is returned below a line, which appears when the 'equals' key is selected. The answer to a division sum can be displayed as a quotient and remainder if the numbers input do not contain a decimal point, otherwise the solution is displayed as a decimal value.

The display layout, in columns, is representative of the formal notation expected in the classroom and should help to reinforce the concept of place value. This may assist those who have difficulty with the accurate notation of their sums. This design is not reliant upon a good short term memory as is the conventional calculator where only the last digit input, or the solution is displayed. Relief of overload on the short term memory could mean that the user will be able to concentrate more clearly on the basic arithmetical task.

In the second mode, the design provides a means for 'guessing' or estimating the answer to the problem. By selecting the 'guess' key a numerical keypad pops-up, which is colour coded to match the 'guess' key and the 'guess' display (the smaller display area of the calculator interface). Digits input using the keypad in this window are automatically entered into the 'guess' display. The correct answer is accessible by selecting the 'equals' key on the calculator. The two answers can then be compared.

The third mode of the calculator is the 'work out' mode. If the input sum is addition or subtraction, selecting the 'work out' key will pop-up the Dienes work area, (see figure 2). The Dienes area is fully interactive and can be used for either addition or subtraction. This area has been designed to conform with good teaching practices mentioned earlier and gives the opportunity for the pupil to experiment with virtual Dienes blocks in various ways, similar to actual Dienes blocks. Through the concrete operation of manipulating the blocks, the answers to addition and subtraction problems can be obtained. Research has shown that a key learning feature for the user in such operations is the exchanging of units into tens and tens into hundreds, together with the reverse processes. These processes are critical to the understanding of place value and the exchange should be initiated by the user. The computer prompts the user to do this by the use of colour. If the user wishes to exchange a hundreds 'tile', for ten 'rods' of ten, then he/she has to select the 'exchange' key. This action will result in the current 'tile' breaking into its ten component rods and changing colour from yellow to blue, blue being the colour of the tens rods. The change of colour, but not position, (i.e. the rods stay in the hundreds column), indicates to the pupil that the rods have to be moved out of the hundreds column into the tens column. When the pupil has completed all transactions and arrived at a solution, he/she can enter the solution into the 'guess' display and compare it with the correct solution on the calculator.

At every stage throughout the calculator's various modes, there is audio feedback and voice reinforcement. This use of sound is important to ensure that the correct language is used with each mathematical process.

If the 'multiply' or 'divide' keys are used on the calculator and then the 'work out' key is selected, one of the interactive multiplication squares pop-up (see Figure 3.). These windows are examples of 5 x 5, or the 10 x 10 multiplication squares and are interactive. The teacher is able to preselect which multiplication square appears, using the preferences window described next. The purpose of the multiplication square is to provide prompts for users who may not have the necessary number facts to complete a multiplication problem. According to Miles<sup>2</sup>, this is a particular problem for dyslexics.

Both the Dienes work area window and the multiplication square window appear partially overlaid on the top of the calculator. It is important that the user does not lose sight of the main calculator screen whilst working in the various modes. Using these overlaying methods for presentation, the original problem input and displayed as a vertical algorithm on the calculator remains visible as a reference in the same place on the screen. The use of familiar metaphors, which operate according to real world environments, are expected to lead to intuitive use of the package<sup>3</sup> 4. Within the package the user can either click on the top left hand corner of an overlaid window, or click on the calculator behind, to make the calculator active again.

## Preferences Window

A survey of teachers' preferences indicated that they would like to have a calculator on which they could limit the access to the keys. The 'preferences' window (see figure 4) enables the teacher to disable any keys on the calculator. The teacher can create a new file for each pupil, which is written onto the hard disc of the computer, save a file or print a file. The file is a track record of the pupil's activities whilst using the multimedia calculator. The sound can also be adjusted in the preferences window, a useful facility when one has a classroom full of children with computers!

## Evaluation

At the time of writing, the prototype calculator interface is fully functional and has been informally trialled.

These informal trials were carried out in the classroom with a group of pupils. Each user was video recorded and any remarks and comments noted. These trials sought to establish if the application was easy to use, whether pupils liked the look of it and what their expectations of it were.

The results of these trials were interesting and some expectations were exceeded. In particular, a studented dyslexic, who has a very short attention span and is a disruptive influence in her class, spent a quiet twenty minutes accurately completing a series of calculations using the multimedia calculator. Compared with her previous performance using various hand held calculators, there was a significant improvement in the quality and accuracy of her work. The possibility of a novelty factor should not be overlooked in this instance because the children were excited by the change of routine, etc., although it could be argued that novelty alone is unlikely to increase one's competence in mathematics.

## Conclusions

The results of the initial tests of the design are encouraging and will inform the further development of the prototype and its more formal evaluation.

# An Interactive package for constructing personal portfolios and its Mac-to-PC conversion

This case study was prepared in November 1994 for the Advisory Group on Computer Graphics (AGOCG)  
Technical Report 26

## Clive Richards and Simon Turner

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**Keywords:** Interactive; personal portfolio; curriculum vitae; action plan; personal statement; information design; Mac-to-PC conversion

## Introduction

This case study deals with the design and Macintosh-to-PC conversion of a software package which enables students, particularly adults returning to education or to employment, to construct and print out a personal portfolio. This portfolio can comprise:

- an action plan
- a curriculum vitae
- and a personal statement

The package, entitled 'Learning For Tomorrow', was developed on an Apple Macintosh in Macromedia Director and converted, using translator software, into a PC version. Distribution is via a single CD containing both PC and Mac versions of the software, since the client (Coventry's four FE colleges) requires both versions.

The project was originally initiated by the local education authority in Coventry using seconded college lecturers who teach portfolio preparation, and the city's own computer programmers. However this team did not have access to the visual and interface design skills of the Visual and Information Design (VIDE) research centre at Coventry University, nor access to the appropriate authoring tools.

The University was able to undertake a commission to produce the package, and the trials with target users have shown it to be very successful. The software requires no tutor intervention, because a video presenter - Nicky' - acts as the guide and explains the software, showing her own portfolio as an example of what is achievable. Users are invited to assemble interactively on screen a lifeline of key events. Using this, Nicky asks for further details from which a CV, personal statement or action plan are automatically compiled.

Following this introduction there are two principal sections to this report. The first briefly describes the design of the package. The second deals with the process of conversion from Mac-to-PC format.

## I. The design of the package

### The client-developer relationship

The Coventry University Visual and Information Design research centre spent a considerable amount of time with the client on developing the software specification. It is necessary in projects of this sort that all concerned are as clear as possible about what is to be produced, how its satisfactory completion is to be measured and how and when payment is to be made. The ownership of the intellectual property rights is an important issue about which

all parties must be clear. An eight page specification document formed an integral part of the contract and took several weeks of negotiation to agree. This resulted in a project plan which required the client to sign-off key stages of the work on its completion. The time spent in this careful preparation was well spent and resulted in the relatively smooth progress of work.

## The design approach

From a computer science point of view creating software of this sort can often seem to be principally about the configuration of a database and the writing of code to manage it. The user interface is looked on as the means by which relevant data is input at the right time.

By contrast, what may be described as an information design approach was used for producing the Learning For Tomorrow package. Such an approach sees the problem as focussed essentially around the operation and look of the interface. It places at the centre of concern the needs of the users, and, most importantly their expectations. That is to say that as far as possible the interface should behave consistently in a way users expect. To develop an interface which does this the designer should have a clear view, a model, of the users, and, as far as practicable, be able to evaluate prototypes with sample users as part of the development process. This latter activity - evaluation of prototypes - is rarely budgeted for properly, if at all, and consequently is usually only done towards the very end of the development process, when there is little scope for change. This was certainly the case in respect of the project reported here. This places considerable reliance on the ability of the designer to see things from the user's point of view from the outset, and to develop a functional structure for the software which is easy to operate and attractive.

## The users

The proposal for the interactive software described here arose from the need to find a more efficient means of carrying out a programme of learning which was already undertaken in the traditional lecture room manner, ie: the lecturer addressing a group of students and then working with them individually. There were therefore two classes of user; lecturers and their students. The designer of the software spent a long time talking to the lecturers about their students and the way their teaching was carried out. Through these interviews a picture of the range of users was developed, and in respect of the students a number of points emerged including the following:

- They may not have had any previous access to education since school, which itself may have been unsatisfactory for them.
- Some may be undertaking further education after a long break without any formal educational experience.
- They may be unaware that they have developed skills which could be of interest to future employers, and these have to be coaxed out of them.
- Some students may be very self-conscious, and the need for confidentiality must be accommodated.
- They may or may not have used computers before.

## Key features of the package

Using the information gathered from the lecturers, the Learning For Tomorrow package was designed and developed, and has the following key features:

1. Every stage in the operation of the software is explained to the student by a video guide called Nicky. Her presentation can be simply curtailed by students who have used the package before and if preferred Nicky's voice can be replaced by text. Having a video guide allows anyone with reading difficulties to operate the package and having a talking head overcomes the problem of unease some users report when a disembodied voice is used. Users may be able to identify with the presenter, who describes the process of constructing a personal portfolio using her own as an example. As students come from a wide range of ethnic backgrounds there was much discussion with the client before choosing a young, white woman as the guide. See figure 1.
2. When the software first starts, Nicky asks: 'Would you like to begin a new portfolio, or do you have a portfolio to open from a disk?' See figure 2.

3. Following the introductory stage users are offered the chance to find out more about the three documents in a portfolio by clicking onto the appropriate graphic. When a document is chosen, Nicky tells the user about hers, while the appropriate part of that document is shown on screen. Nicky also suggests approaches to making one's own.

4. An important feature of the process is the construction of a lifeline. The lifeline is something that lecturers currently develop on paper with students. The interactive version, like this paper version, represents key events in the life of the student. The primary function of the lifeline is to encourage students to acknowledge the things that they have done, both in terms of formal jobs and qualifications, as well as informal activities and voluntary work.

Before offering the student the opportunity to make a lifeline, Nicky explains what a lifeline is and an animated sequence shows the student how to create one. Nicky then invites the users to select from a set of options, and drag them with the mouse onto their own lifeline. See figures 4 and 5. A completed lifeline is shown in figure 6.

5 Once completed, the lifeline takes on a second function, being used as the basis of the student's CV and personal statement. It is especially helpful because it breaks down the daunting task of making these documents into a series of specific, personalised questions. For example, if a job was placed on the lifeline, Nicky asks what the job was, when it started and finished, and offers a range of job skills from which the user may select those acquired during that period of employment. This sort of information, together with other details (name and address etc.) enables the system to automatically generate a CV, personal statement or action plan, all of which the user can then edit if necessary.

6. At any stage in the process the users may return to a previous stage, move forward to the next, update their lifeline, store to disk work completed, print out a document or quit. Figures 7 to 9 show some of the navigation aids which facilitate.

7. The overall styling is deliberately cool and unobtrusive. Colour is used in a restrained way. An index card atmosphere is used as the principal screen background in the interactive sections. Animation is used in explanatory sections. Figure 10 shows a typical CV produced using the package.

## Evaluation

During the development of the package, a four day trial of a prototype was conducted with a sample of 30 students, using both PC and Macintosh versions of the package. This revealed the basic design to be sound, but revealed a number of small software bugs. With the exception of those students who got into difficulties because of these bugs, virtually no lecturer intervention was required from the commencement of work, to the production of a printed document. On average a student was able to produce at least one of the three possible documents within their allotted one hour test period.

The debugged version was later used in a training session with lecturers, for whom a 23 page user guide was written. This describes what sort of computers are needed and how they should be set up, as well as giving a brief overview of how the package operates and describes how to maintain and erase files etc.

No user guide is necessary for students, as the software has so far proved entirely self-explanatory.

## II. Macintosh-to-PC conversion issues

This section of the report deals with the process of converting the software, developed using Macromedia Director 3 on a Macintosh, to run on an IBM-compatible PC. The conversion software for Director 3 is called Director Gaffer, and 'gaffer' Director movies play under Player For Windows on the PC. Using Player For Windows it is possible then to turn gaffer'ed movies into projectors, which are stand-alone applications that don't need Player. As this project neared completion, Director 4 was released for Windows as well as for Macintosh. At the time of writing this is an unknown quantity, so problems in using Director 3 and Player may or may not apply to the new

version of Director. The means used to transfer files to the PC was the cable and software combination MacLink Plus. The final objective of conversion was that the software runs from a CD-ROM containing both Macintosh and PC versions.

Broadly speaking three kinds of issues have arisen during the transfer procedure. These are - issues related to the inherent differences between the two platforms; issues related to transferring files physically from one machine to the other; issues related to differences between Director running on the Macintosh and Player running on the PC. A further list of all the discovered anomalies in Player is in an Appendix which follows this text.

## **Issues related to the inherent differences between the two platforms**

1. PCs are less standard than Macintoshes. That is to say - one can assume with reasonable safety that anything but the oldest/lowest Macintosh will have 8-bit sound, and be capable of displaying 8-bit colour. One cannot do this with PCs. Most PCs don't have sound, many can only display 16 colours, and many don't even have Windows installed. Users must therefore have installed Windows, a soundcard and a reasonable video-card as well as the CD-ROM drive necessary to play the CD itself. All such cards can cause conflicts with one another, and on a PC these conflicts currently have to be resolved by the user (or the user's technicians). On a Macintosh the installation of cards for basic functions like video and sound is unnecessary, and when necessary, much more transparent than on a PC. For instance; at the time of writing we have been unable to resolve a conflict on our PC between a SoundBlaster soundcard and an Adaptec SCSI adapter. These two cards are amongst the most popular of their respective types, and yet they won't work together.

Whilst we have been able to get the job of conversion done successfully, it remains debatable whether one can ever be entirely sure that the software on the PC is robust, since there is a potentially infinite number of ways an end user might have configured their system.

2. The other side of this coin is that a fault with the configuration of a system may only come to light when using a certain piece of software, leading the user wrongly to blame the software rather than the system. Precisely this occurred when we began running QuickTime video on the PC, as it was noticed that the sound was running out of synchronisation with the images. Several calls to the suppliers of QuickTime and of related products failed to produce an answer as to why QuickTime was not dropping frames, as it does on the Macintosh when the computer's processor cannot keep up with the video frame-rate. Eventually the trial of the same QuickTime movies on other (slower) machines led us to conclude that the machine itself was at fault. In fact the hard disk driver- software which the suppliers had installed was incorrect, and this had led to troublesome reading of the video information. The installation of the correct driver cleared up the problem. An end user with a similarly set up machine would presumably blame our CD-ROM rather than their machine.

3. On the Macintosh QuickTime is near to being a standard system extension, and is supplied with all new machines. On the PC it is rare-to-nonexistent, and therefore has to be supplied with, and installed by, our software. As a consequence of this we have to licence QuickTime for Windows from Apple in the United States. Furthermore to make a QuickTime movie available on the PC one has to 'flatten' the data fork using an Apple utility. This is because the PC must have both the sound and video in the same fork, rather than the two that the original QuickTime produces. These flattened movies are still usable on the Macintosh, but any alteration to the original movie means that it must be flattened again (and transferred to PC again). One must also give all movies the filename extension '.MOV' for the PC to recognise them. This is something not mentioned by the Player For Windows manual, and not done automatically by the flattening software.

4. Unlike on the Macintosh, where QuickTime is a single file in the System Extensions folder, QuickTime for the PC is a collection of 20 or so different files. These files can be installed so that the machine is globally aware of QuickTime, but this form of installation is only possible with the purchase of a full stand-alone version of QuickTime. Our copy of QuickTime came as an integral part of Player for Windows, and was installed automatically by that package. With this setup, QuickTime movies can only be played by an application that is in the same directory as the QuickTime files. In other words, Player

installs the QuickTime files in the same directory as itself, and only applications in this directory can use QuickTime. Therefore in order to make QuickTime available to our projector when one distributes it on CD-ROM, one needs to identify the QuickTime files in this Player directory, and cause the CD installer to install them along with the projector into a directory on the host machine. This has been problematic, since there was no documentation provided with Player to enable us to distinguish Player files from QuickTime files.

5. On the Macintosh there is rarely much of an elaborate installation process, because the icon of a CD-ROM will appear automatically on the screen, and because QuickTime is usually on the machine already. On the PC however one must create an icon for the CD by making a Program Group (the visual equivalent of a Macintosh folder) and putting a Program Item (the icon itself) within it. QuickTime on the PC must also be installed (see above). In consequence it becomes necessary on the PC to use some third-party installation software.

We used a shareware program called Install/Easy. This software allows us to generate our own installer which will prepare the host machine - placing files into directories, creating Program Groups and so on. Testing this installer is difficult, however, as it would be prohibitively expensive and time-consuming to keep pressing trial CDs until the installer worked satisfactorily, what one really needs is an external drive that can be set up as if it were the CD drive (with the same drive letter). An external drive not being available, we had to use cut down versions of the installer on floppy disk, and attempt to infer the way it would behave when used on the CD. In fact only one error in preparation of the first test CD occurred, and this was spotted and altered at the time, leaving a successful installer on the second CD that was pressed.

## **Issues related to transferring files physically from one machine to the other**

There is one basic issue in this category - time. Because of differences between Director on the Macintosh and Player for Windows, one cannot normally use the Macintosh version of a Director movie as the basis for a Player movie (see 'Issues related to differences between Director 3 and Player for Windows'). Therefore every time an alteration is made to a Macintosh movie, the same alteration must be made to the PC version, and this must then be converted and transferred to the PC for checking. All this is time consuming, since even the fastest method of file-transfer takes about 10 minutes per megabyte.

## **Issues related to differences between Director 3 and Player for Windows**

Generally speaking, Player For Windows operates as it should, and offers a straightforward way of running Macintosh movies on a PC. Nevertheless we have come across an array of minor differences and anomalies whilst using Player for this purpose. Some of these differences are linked to inherent differences between Macs and PCs, others seem to be faults in the PlaYer software. The major problems are as follows:

1. Neither Director 3 nor Player For Windows have adequate printing functions (Player has no print function at all). This means that one has to use third-party external software (known as X-Objects') in order to print out files. There is to our knowledge no print X-Object which works in the same way on both platforms. Of the two X-Objects that we used, the PC will only print a page at a time, and the command to print a second page whilst the first is still printing is ignored. Conversely the Macintosh X-Object prints multiple pages in one batch.
2. Since fonts on different machines can vary, and since the standard Windows fonts are not the same as the standard Macintosh fonts, text gets displayed differently on a PC to how it does on a Macintosh. To get around this Player requires a file known as an 'INI' file. This would be a file named after a projector but with the suffix '.INI', and placed in the machine's Windows directory. This file is a text file which lists any font-substitution that one wishes to be used by that particular projector. Font-substitution is then a matter of trial and error until an acceptable substitute is discovered. For the record, we found that Geneva was adequately emulated by Lucida, and that despite the presence of Courier on the PC, Courier had to be substituted by Courier New because Courier on the PC displays and prints poorly.

3. A further difference between Director and Player is found in the respective ways that they handle QuickTime movies. Using Director on the Macintosh one has the option of making QuickTime movies partially obscured behind other images, whereas QuickTime movies running in Player on the PC can only appear on top of all other images. Obviously one has to settle for the lower specification of the PC version if the Director movie is to look the same on both platforms.

4. Finally, pathnames are a problem on the PC using Player. On both a Macintosh and a PC it is necessary to specify where the machine will find a certain file. This is done by specifying the path. The path lists the directory hierarchy from the drive that a file is on, down through the directories to the file itself. However the Macintosh and PC specify pathnames differently. Player has an internal conversion facility that means that a gaffered Macintosh Director movie with a script that reads go to movie 'Macintosh HD:Movies:MyMovie' will work on a PC despite the correct pathname on a PC implying that the script should read: go to movie 'C:\Movies\MyMovie:

In fact Player won't tolerate the correct DOS pathname, and insists that pathnames are left in their Macintosh form. This would be acceptable if Player's conversion facility worked consistently, but it appears that it does not. If Player is told to go to a movie called 'MyMovie' it will on occasion object that it cannot find a movie called 'EMyMovie'. In other words Player seems to read the back-slash '\' (which it generated for pathname accuracy) as part of the name.

## Conclusions on the conversion process

Whilst many of the problems encountered during the conversion process were trivial, these problems were exacerbated by the impossibility of directly altering Player movies. The release of Director 4 for both Macintosh and PC would apparently cure this (indeed when endeavouring to get advice from Macromedia about the anomalies in their Player software, we were told that Player was obsolete, and we should upgrade to the newly released Director 4). However, it remains uncertain whether even Director 4 movies would be absolutely compatible across the two platforms. A brief experiment with Director 4 has already revealed a difference between the two platforms in the way that they respond to the closing of a window. That said, Director is a hugely powerful authoring tool, and there are few viable alternatives to it. Hypercard stacks can work on the PC using ToolBook, and Macromedia's own Authorware is fully cross-platform, but the former provides only an approximate equivalence, and the latter is intended only for more straightforward multimedia projects.

## Appendix - Other Player anomalies

It should be borne in mind that Player does not claim to include every facility of Director. However the following are anomalies not mentioned in the manual, and without obvious explanation. Some of these anomalies are trivial, yet they do mean that scripts which work happily on the Macintosh inexplicably don't work on the PC. All of these problems were revealed as a direct result of trying to run Macintosh movies on the PC.

- If one has two lines of text in a text field on any computer there will be an invisible character at the end of the first line called a Return. A Return in a Player text field on the PC results in two characters in that field instead of one. This means that a field with two lines of text in it on a PC will contain one more character than it does on the Macintosh, and hence the character numbers of the second line of the text (used, for instance, to identify the starting point of a word or phrase) will be one greater on the PC than on the Macintosh.
- Declaring a global variable on the Macintosh gives the variable a default value of 0. On the PC it is void (it has no value) as a default.
- If a Director sprite channel is made invisible on the PC, the PC doesn't recognise any QuickTime movie in that channel of the score (this is not the case on a Macintosh).
- The script delete field fieldname' works on the Macintosh (it deletes all the characters in that field), but not on the PC. However delete char 1 to (the length of field fieldname') of field Cf eldname' which means the same thing, does work on both platforms.
- If an editable text field is scrollable on the PC (for instance because it contains more text than can fit on-screen), then clicking on that field results in the scroll bar moving to the right and the field getting 10 pixels or so shorter. This is a bug not a design flaw.

- The scroll bar of a text field on a Macintosh uses only the colours black and white, which are always available. On a PC, the scroll bar also uses colours 7 and 248 of an 8-bit palette. The assumption is that these colours will be grey (as they are in the standard Macintosh system palette). Obviously the scroll bar can look very odd if one does not reserve these colours when preparing palettes.
  - The Labellist is a constant in Director which contains the names of all of the score markers. On the Macintosh this ends with a Return, so that there is one more line in the Labellist than there are labels, and this last line is empty. On the PC the last line of the Labellist contains the last label name, and hence the Labellist is a line shorter than on the Macintosh.
  - Transitions between movies (where a fade or wipe effect is generated between the current movie and the first movie of the next) only work on the Macintosh. However transitions between frames of the same movie work on both platforms.
  - It is possible on the Macintosh to put some scripting instruction into a text field, and then invoke this script with the line do field fieldname'. On the PC this doesn't work. However, the two lines put field fieldname' into variable I do variable (which comes to the same thing) will work.
-

# DesignNet: Transnational Design project work at a distance

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## Introduction

In Design, computers are often seen as offering new forms of media, image making, and information resource, for example virtual reality, three dimensional modelling, painting systems and databases. Working with computer-based media is different to working with pen and paper, paint, models or the like, and design practice is bound to change as practitioners learn to deal with both its limitations and possibilities. This is understood to the extent that most design courses now include modules dealing with information technology, computer aided design, computer-based image making and design databases. Important as these uses of the computer are, there are equally important applications of computer-based technology that should be considered by both designers and educators.

Although design is often taught as individualistic activities, in practice it usually involves collaborative work of some kind. Computer-based technology can assist communication about work, and can be used to organise group work; in other words computers can provide an infrastructure for mediating collaborative design. When computers are used in this way the final artefacts, even their visualisation and representation during the design process, may be largely non-digital and produced using conventional media and tools.

Computer systems that support team communication and collaboration are usually called Computer-Supported Cooperative Work, CSCW, or Groupware systems (see Scrivener and Clark, 1994a, for a review of CSCW systems). This application of computer-based technology is likely to have a great impact on design practice as digital media, modelling, and database tools and yet at present there are few instances where this technology is used in practice or in the curriculum.

As noted above, in practice design is often a collaborative or collective activity in which individuals with different skills and expertise work towards a shared goal. Furthermore, design is increasingly an activity with a global dimension; products are being designed for international markets. A future can be envisaged in which designers work as part of international teams supported by computer- and electronically-mediated communication and CSCW tools. It will be important to prepare designers and students to work in this way. Indeed, we hope to demonstrate how this technology is not only something that students should understand and know how to use, it is also actually a way of making it possible for students to work together as part of multi-national and multi-disciplinary teams; educators can use the technology to bring such students teams together. Very importantly, the students do not have to be brought together in a given country - it is the technology that brings them together.

This case study report describes the DesignNet project where computer- and electronically-mediated communication was used to enable multi-disciplinary, transnational students groups separated by distance to work together on a shared design project in order to produce an agreed outcome.

## Experiences of computer-mediated design at a distance

Does design by computer-supported dispersed teams offer any benefits? Scrivener and Clark (1994c) argue that there are at least five potential benefits (see also Scrivener et al., 1993b):

- 1) Time-efficiency - where team members must otherwise travel long distances to meet, as is frequently the case in large international companies;
- 2) Access to the best available expertise - where it may otherwise be logistically impractical or expensive;
- 3) access to specific knowledge of technological, cultural, social and earthly contexts - for example, where local knowledge of availability and practicality is key to successful design;
- 4) The hermit-worker - where, in essence, each team member "carries" their workplace to group work sessions (instead of the more typical portfolio or briefcase);
- 5) The super-real meeting place - where the affordances and limitations of the "meeting" place are not constrained and determined by its particular physical resources and geography.

However, the geographical isolation of team members may incur problems, such as (Scrivener et al., 1993b; Scrivener & Clark, 1994b):

- 1) Technology support - does each dispersed-group member or site need a team of technologists to handle technical problems?
- 2) Diminished usability - can any CSCW tool be as practical, flexible, and intuitive as pencil and paper?
- 3) Cultural conflicts - involving everything from status to language.
- 4) Limited interaction potential - for example, time zone differences may restrict the real-time working to small and fixed time-windows, or the communication medium may not support the rapid exchange of messages.
- 5) Design data base transfer - how easy is it to transfer information generated using one technology (say pen and paper) into another (say digital displays).

Before proceeding to describe the DesignNet project, we will briefly describe three earlier studies of design-at-a-distance undertaken to explore some of these issues and the primary learnings obtained (a fuller account of the collected learnings from these projects and a number of others can be found in Scrivener & Clark, 1994c)

## The ROCOCO Project

The aim of the ROCOCO project was to establish the communication requirements of designers working at a distance (Scrivener et al., 1993b). The project began by studying the communication between six design student dyads working with pen and paper on a design brief for an hour in a studio-like environment. Verbal, non-verbal and graphic communication was coded and the results were used in the design of a CSCW workstation called the ROCOCO Station. In its full, All-on, configuration this workstation allowed designers to see each other (via a video link), to talk to each other (via telephone), and to share drawings, using a synchronous (same time) shared drawing system, called the ROCOCO Sketchpad.

The pattern of communication between designers was then observed under four different ROCOCO Station configurations: All-on; Video-off, being the same as All-on but without video, hence the designers couldn't see each other; Speech-off, being the All-on condition minus the telephonic link; and finally Drawing-surface-only, where they could only communicate using the ROCOCO Sketchpad.

Two ROCOCO Stations were used for the studies, each located in a separate room in the same building. The Sun-SPARCs were connected by Ethernet, and high-quality audio and video was sent over cable.

Each condition was tested using five different product design student -dyads, twenty pairs in all. Each pair completed a questionnaire designed to assess both the usability and the task-appropriateness of the configuration used (see Scrivener et al., 1992, 1993a, and b for details of the project and results).

All the ROCOCO configurations used synchronous computer- and electronically- mediated communication. No other forms of communication were used by the designers during the design sessions which, as noted above, lasted around one hour.

## **The Loughborough-Adelaide Link**

The ROCOCO Station configuration was later exploited in a study that replicated the Video-off condition, but this time linking workstations sited in Loughborough, in the United Kingdom, and Adelaide, Australia. Each workstation was connected to a local Ethernet network, in turn connected to each other by basic-rate ISDN (i.e. two 2B+D lines - 128K bits per second). Telephone was used for the audio link, the only unusual feature being that the designers at each end were provided with head-set telephones.

Again, product design students took part: two pairs each taking part in three one-hour sessions over three days. Obviously, in this case the design students had not met each other. This study allowed us to test the ROCOCO Sketchpad using standard narrow bandwidth (compared to the ROCOCO project proper) communications (see Scrivener et. al., 1992 and 1993a, and b for further details).

## **The Derby-Sydney Link**

The ROCOCO and Loughborough-Adelaide studies limited the design work to one hour. Clearly, this is not a very realistic test of this kind of working since an extended period is usually required to complete a design project. The primary aim of the Derby- Sydney study (Scrivener and Clark, 1994b) was to investigate the use of both synchronous and asynchronous computer- and electronically-mediated technology to carry out a project requiring an extended period of work.

Six fashion designers in Derby volunteered to work with six fashion designers in Sydney. The twelve students are organised into three groups of four (two Derby students plus two Sydney students). The brief was designed such that the UK students were required to design for the Australian market and vice versa for the OZ students. Synchronous-remote, or real-time communication, was mediated between the students in two ways: by a telephone connection for verbal communication and via a groupware package produced by Group Technologies Inc, called Aspects, that allows users at both ends of a link to simultaneously write and draw on a common worksurface. The groupware package runs between a pair of Apple Macintosh computers - in the case of the Derby-Sydney study, between one computer located in the UK and the other in Australia. The Macintoshes were connected via a second telephone line and standard computer modems.

For asynchronous(different time) -remote communication a number of channels were exploited. In the first place overland mail was used to exchange contextual information such as degree show videos, fashion magazines, newspapers, drawings and letters. Fax machines at each site were also used for similar purposes. Images were transferred electronically using FTP and email was available for support staff. A number of single user software packages, such as Photoshop, were available at each site. There was a scanner and printer at each site for image capture and display. Unlike the ROCOCO studies, where only the ROCOCO Sketchpad was used for design work, in the Derby- Sydney link only proprietary single user and groupware applications were used; in other words the link used off-the-shelf computer, communications, and application technology.

## **Primary Lessons about User Behaviour**

These studies - representing four years of CSCW system design, test, and evaluation experience - revealed a number of insights.

In terms of medium and method of communication, the ROCOCO project All-on condition was far richer than the Drawing-surface-only condition. Indeed, we anticipated that some users would find it impossible to complete the design task in this condition. However, somewhat to our surprise, none of the pairs using the ROCOCO Station in this configuration complained about the inadequacy of the system for the task. Indeed, no significant differences were found between these conditions (i.e. when the usability/task-appropriateness questionnaires completed for each condition were compared). This result strongly suggests that if a task can be completed with the resources at

hand, then users will do their best to complete it, irrespective of the quality and diversity of the CSCW tools at their disposal. Indeed, users will radically and rapidly adapt their working methods in order to compensate for basic inadequacies in communication medium and method (as evidenced by the users' performance in the Drawing-surface-only condition).

The least favoured condition in the ROCOCO project was the Speech-off condition, the condition where users could see each other via the video-link, but couldn't talk. Non-verbal communication in collaborate work helps to accentuate and illustrate verbal communication. In this sense, non-verbal communication facilitates the verbal discourse. In the absence of a verbal channel video is largely redundant. The fact that this Speech-off condition was least preferred was perhaps due to frustration arising from an inability to coordinate non-verbal and verbal communication (Scrivener et. al., 1993c). This suggests that the complete absence of a method/medium of communication may be more satisfactory to the user than an insufficient one.

The Loughborough-Adelaide Link subjects were more positive about the system than the Video-off ROCOCO subjects. This was a surprising result given that the communication channels were of higher bandwidth in the ROCOCO project, and hence the Loughborough-Adelaide setting was more impoverished in comparison. We put this down to the greater realism of the Loughborough-Adelaide trial in that the system allowed the distance designers to work in a way that would otherwise have been impossible by virtue of the distance between them. This suggests two things: first, that we should be cautious about the results of trials in which users carry out artificial tasks, or tasks that the users are not truly excited by or committed to; second, CSCW systems should be evaluated in conditions that mimic as closely as possible the conditions under which the system will be used and the environment in which it will be used (Scrivener et al., 1992).

The ROCOCO project seemed to indicate that video was not necessary (although the All-on condition was preferred to the other computer-mediated conditions) the task-focused nature of the interaction made the shared drawing surface the main focus of attention. However, it became clear early on that the design students would have liked a video link as a means of achieving some intimacy with their distant partners. In fact we got round this problem in a number of ways. We captured video clips of the UK designers and transferred them to the OZ computer for display. The OZ designers sent photographs to their UK partners. This indicates that users will employ any methods and mediums of communication at hand in order to satisfy what is perceived as being a necessary task requirement (Scrivener and Clark, 1994c).

Although the designers had a shared drawing surface at their disposal this was hardly used. We concluded that the design brief did not require work that necessitated the use of this facility. This suggests that users of a CSCW system will only use those components of a systems necessary for a task.

## Summary of User Behaviour Learnings

In summary these learnings about CSCW system usage lead us to postulate the following:

- 1) Users' will be committed and motivated to complete a task if it is perceived to be purposeful and valuable;
- 2) Users' motivation to complete a task will drive them to exploit the resources at their disposal, even if this involves radical changes in work and communication methods;
- 3) Users will choose what they perceive to be the most efficient and effective means at their disposal in order to complete a task;
- 4) Users will choose from the resources at their disposal those they perceive to be necessary and sufficient for the task in hand.

## DesignNet

The DesignNet project was partly funded by the Commission of the European Community's, Task Force Human Resources, Education, Training and Youth, as part of the preparatory phase of the Arts Education and Training Initiative. This initiative will seek "to enhance transnational cooperation between education and training establishments in the European Union Member States in the field of the Arts, to increase mobility of students and teaching staff in this field, to promote the use of innovative techniques through measures to enhance

dissemination of information and good practice, to encourage international masterclasses and the production of special modules and courses which add a European dimension to education and training in the arts, and in general to support activities which, through the medium of European cooperation, enhance the quality of education and training in the arts throughout the European Union". The Commission prepared for the initiative by commissioning a number of demonstration projects. DesignNet was one of these projects (No. UK/M/Des 0047/48: Interactive Design Work Using Electronically-Mediated Open- and Distance-Learning Techniques).

## Primary objectives

The aims of the project, as set out in our proposal, were:

- 1) To share the experience of and evaluate the Derby/Sydney electronic link project;
- 2) To explore the interaction and transition between two-dimensional and three-dimensional objects;
- 3) To explore computer- and electronically-mediated distance communication and how design is communicated across language barriers through visual discourse;
- 4) To demonstrate how electronic links can support communications between collaborating transnational Universities and enhance the student learning experience.

Other objectives were to test further our postulates (listed above); to develop further our ability to organise and complete this kind of project; to obtain research data; to gain additional insights into the problems, and educational/learning benefits arising from distant-design projects; to gain insights into the benefits of computer-based technology, as compared to, say, fax and phone; and to identify costs.

Much data was collected during the project and in due course this will be analysed in detail and reported. The conclusions presented in this report are based on observations during the project, and student and staff feedback at the end of the project

## Project overview

### The Partners and disciplines

DesignNet involved four institutions: Applied Arts, School of Art and Design, University of Derby, Derby, UK; the Ceramics Institute, Bergen College of Art, Bergen, Norway; Faculty of Industrial Design, TU Delft, Delft, The Netherlands; and The Centre of Art and Design, Escola Massana, Barcelona, Spain. Ceramics, industrial design, jewellery, and graphic design staff and students took part in the project.

### The project

As noted above the aim of the project was to set up a number of links that would enable students in one country to work with students in another on a common brief using computer- and electronically-mediated communication tools. Six teams were formed linking Derby with Derby, Delft, Barcelona and Bergen, and Bergen with Barcelona. In all but one case, Derby-Derby, the links were transnational All six links are shown in Table 1, together with the number of students (S) involved at each end. Two teams were all female, the remaining four being mixed gender; seventeen female and eight male students took part in the project, making a total of twenty five.

**TABLE 1: LINKS BETWEEN CITIES**

LINK	CITY A	S	CITY B	S
A	Derby	2	Derby	2
B	Derby	2	Bergen	2
C	Derby	2	Barcelona	3
D	Derby	2	Barcelona	2

<b>E</b>	Bergen	2	Barcelona	2
<b>F</b>	Derby	2	Barcelona	2

## The media and technology

The technology available to each link is shown in Table 2. The first three columns identify the kind of communication offered by each medium, where S means synchronous, SS semi-synchronous, and AS asynchronous. Some media can be used in either asynchronous or semi-synchronous mode. For example, fax is generally used asynchronously, meaning that a user can send information when they want, whether or not the intended recipient is actually there to pick the fax up or not. Alternatively, a fax machine can be used semi-synchronously if the parties on each end of a connection have agreed to be there at the same time. In this situation, a fax can be considered by the recipient while the sender waits, the recipient producing a faxed reply there and then. In this way, a kind of dialogue can take place.

The last six columns of Table 2 show the communication technology available to each link. "Talk" is a computer application that allows users present at the same time at each end of a link to "talk" by means of typed messages. Several users can simultaneously enter messages or simultaneously contribute to a single message. "Talk" can therefore either be used synchronously or semi-synchronously depending on the protocol adopted by the collaborators. As noted earlier, Aspects allows users at both ends of a link to simultaneously write and draw on a common worksurface. The video connection was achieved using CUSeeMe which allows multiple users to share video. In the Derby-Delft link, the pair in Derby were able to see on a separate monitor from that showing Aspects and "Talk" a copy of the image of themselves seen by their Delft partners and an image of the Delft partners: in other words they could see what could be seen of themselves and they could see their partners. Eudora was available for electronic mail and file transfer; and additionally files could be transferred by FTP. The other communication resources need no explanation. From Table 2 it is clear that some teams had more resources to choose from than others. Fax and telephone was the primary communication resource in four of the six links. The other two links were computer-supported: Derby-Derby and Derby-Delft. In the first case the connection made by means of a 14.5k modem link, in the latter by Internet. The Derby-Delft link was the richest in terms of communication and shared-working resources.

**TABLE 2: MODES OF COMMUNICATION AND LINK TECHNOLOGIES**

MEDIUM	S	A	SS	AS	A	B	C	D	E	F
<b>Fax</b>	-	*	*	*	*	*	*	*	*	*
<b>Telephone</b>	*	-	-	-	*	*	*	*	*	*
<b>"Talk"</b>	*	-	-	-	-	-	-	-	-	*
<b>Video</b>	*	-	-	-	-	-	-	-	-	*
<b>Aspects</b>	*	-	-	-	*	-	-	-	-	*
<b>Email</b>	-	-	-	*	-	-	-	-	-	*
<b>File Transfer</b>	-	-	-	*	-	-	-	-	-	*
<b>Post</b>	-	-	-	*	*	*	*	*	*	*

## The brief

Appendix 1 is a copy of the brief distributed to students. The brief was open-ended, identifying a set of concepts, materials, and physical properties. The students were instructed as follows:

"As a group communicate your ideas and design an object/objects/installation using these [identified in the brief] elements. Consideration should be given to colour and objects that are ready- or self-made, transportable and ready for assembly. The 'objects' will then be fabricated to be displayed within a 2m cube defined by string or wire. Objects may be suspended."

The brief permitted two ways of working to be explored:

- "1. OBJECT AND SPACE - where four students make four different objects which are integrated when they come together within the defined spatial cube"
2. OBJECT - where students make four objects from the same 2D design brought together and displayed in the defined spatial cube."

By chance it turned out that three groups chose to work together using method 1 and three using method 2. Three requirements of the brief are worth noting here: three-dimensional design; fabrication of objects; and installation.

## The Process

In practice, the DesignNet project began on September 8th 1994 and finished on November 29th 1994. All activity between the beginning of February, when information on the Arts Education and Training Initiative demonstration pilots was first received, was directed towards gaining the funding needed to carry out the project. In this respect the Commission's support was crucial; the prospect of this funding made it possible for us to consider a scale and set of activities that would have been impossible otherwise. Project proposals had to be submitted to the Commission by 28th February 1994, the Commission anticipating final reports by the end of September 1994. However, since the University of Derby was, quite naturally, unwilling to formally commence the project before the receipt of an official announcement, which was not dispatched from the Commission until July 1st 1994, completion of the project during the 1993/94 Academic Year proved impossible. Hence, taking the vacation period into account it was not possible to start the project before September.

Overall, the project comprised three primary stages: the planning workshop; the design and fabrication process; the final exhibition and feedback workshop.

### *The planning workshop, Derby, 8th-10th September 1994*

The planning workshop ran over a three day period. Participants arrived in Derby on Thursday 8th of September. Friday 9th and the morning of Saturday 10th were used for the business of the meeting. The workshop provided the first opportunity for all design, research and technical staff to meet and get to know each other professionally and socially.

From experience, we knew that it would be necessary by the end of the project to agree: the brief, the number of links, the technological resources available to each link, the project task and schedule, and the final project event. We also knew that it would be important to have detailed these things to a high degree as there would be little opportunity and it would be difficult to obtain details from the partners once they had returned home. This detail went to the level of determining fax and phone numbers and their accessibility to students. In this type of project it is important for collaborators to cross as many Ts and dot as many Is at the first face to face opportunity, since it is not good practice to be working out the details of the project while the students are engaged on practical work, and it takes longer to work out these details when the "stake-holders" in the decisions are separated by distance.

Following the workshop, a report was written documenting all the agreements reached and the information obtained and circulated for approval to all partners. The major points agreed were (Scrivener, 1994):

1. That links will be point-to-point (i.e. connecting two sites).
2. Derby will have a point-to-point link with all sites, and also an internal link.
3. Bergen and Barcelona will also establish a point-to-point connection.
4. Real-time links will be phone/computer- or phone/ fax-mediated depending on the resources available at each link point.
5. Four students will make up a team: two at one site and two at another.

- 6 The practical work will run over four weeks: in the first week students will be able to use the links for scheduled real-time communication, in the second for fax exchange and impromptu real-time communication, the third week for scheduled real-time communication, and the fourth week for site-independent making-up of objects.
7. The project will result in an exhibition and meeting at Derby, attended by both staff and students.
8. The brief was agreed (see Appendix 1).
9. Two methods of working will be explored: object and space - where four students make four different objects which are integrated when they come together within the defined spatial cube; object - where students make four objects from the same 2D design (which they agree) brought together and displayed in the defined spatial cube.
10. The project will focus on life-style, cultural factors and the interaction of design influences and objects."

Major considerations in decision making were: Is the proposal likely to work, do we know how to achieve it, and how much is unknown? It is worth explaining how some of these decisions were influenced by these considerations. The decision to only establish point-to-point links was partly due to lack of multi-point experience but also concern that the students would find it difficult to manage a three- or four-way link. In theory, computer-mediated links could have been established with Bergen and Barcelona. Each college had the necessary equipment and probably the expertise to configure and use it. However, given that the project planned to go "live" in early October we concluded that time did not allow us to consider computer-mediated links with Bergen and Barcelona.

Experience of previous group project work indicated that problems can arise with student groups of three or more unless the project is designed such that each group member has a clear role and contribution to make in respect of the group as a whole. This implies student selection; again given constraints of time this did not seem tractable. On the other hand, the Derby-Sydney link had involved pairs at each end of the link and we had found that a co-located pair was self-supporting when problems arose. Taken together these factors led to the decision to have student dyads at each end of a link. The decision to hold an exhibition at the end of the project was expensive but offered many positive benefits, inter alia: it would enhance the social experience for both staff and students; it would motivate the students, particularly those travelling to Derby; it would allow extra activities, i.e. the shared preparation of the installation; it would provide an opportunity to see, document and evaluate all of the work; to obtain feedback from both staff and students; and would provide a fitting conclusion to the project.

One overriding consideration was that we should not be over-ambitious. Given, the short duration of the project, Table 3, it is perhaps clear why we needed to contain ambition. The project schedule was prepared with costs and accessibility of resources in mind. Since five projects would be running from Derby using only one fax machine, we thought that it would be necessary to schedule and limit the use of this resource. Essentially we were agreeing in the plan to guarantee access during the weeks 2 and 4. During weeks 3 and 5 communication would be permitted, but not guaranteed.

**TABLE 3: THE PROJECT SCHEDULE AGREED AT THE PLANNING MEETING**

WEEK	BEGINNING	PRIMARY OBJECTIVES
0	10th October	Test links
1	17th -	Initiate project, preparation, student briefing
2	24th -	3 hours on-line/communication per pair
3	31st -	Off-line preparation work
4	7th November	3 hours on-line/communication per pair
5	14th -	Making up objects and travel preparations
6	21th November	Meeting and exhibition at Derby

## What happened in practice?

Broadly, the schedule was adhered to. The start date of the final workshop was shifted to 25th November for logistical and not project-slippage reasons - although obviously the extra week was beneficial. However, it did not prove necessary to rigidly prescribe the communication technology usage. As two of the Derby teams used computer-mediated communication, this meant that only three of the Derby teams made heavy use of fax and telephone. In practice, each team was able to organise resource usage as dictated by the dynamics of the project. Generally speaking, the students used the technology for both synchronous and asynchronous exchanges throughout the project. Although cost was in our minds at the outset of the project, in the event no constraints on the use of telephone and fax were imposed on the students; they used them when and as they needed to.

## The Final workshop: exhibition, evaluation, and feedback, Derby 25th-29th November, 1994

Non-UK students, and most staff, arrived in Derby late Thursday 24th November. Prior to their arrival, two metre steel-frame cubes had been constructed, one for each team. On Friday 25th each team installed their exhibit in a cube. On Monday 28th each team was asked to give a presentation about the work and the experience of the project. They were briefed for the presentation as follows:

"Your presentation should be a reflection on your experience including descriptions and analysis of the project and the process of working collaboratively at a distance from conception to installation.

suggestions to start you off!

- how did ideas emerge?
- what influenced your choice of concepts and materials?
- how did ideas develop and how successful was the communication of ideas to your partners?
- how did you organise yourselves?
- when and how were key decisions made?
- how did you resolve choices as a group and discuss design possibilities?
- how did you overcome difficulties?
- what were the frustrating aspects of working at a distance?
- describe the 'cohesion' of the group, how well you worked together.
- what are the important cultural and social factors, what did you discover/learn from each other?
- give an account of your meeting this week, was it what you expected?
- if you participated in a similar project again, how would you change it?"

Each presentation lasted around an hour and took place in the presence of the students' work. These sessions were video recorded. In each case, following an initial report by the team, a discussion followed in which members of the audience asked questions to which the students responded.

On the morning of the 29th November the staff met to exchange their views on the project and to begin initial discussions on a future project. Two questionnaires were also produced for the students to complete on the 29th: the first dealt primarily with the technology and collaboration; the second with cultural factors. The final session was used for a collective feedback and discussion session involving all staff and students. Following this the students dismantled their exhibits and a final social gathering took place to round off the whole event.

## The Costs

At the moment of writing the full direct costs of the project are not known. Table 4 lists the primary sources of direct costs (additional to those normally incurred for a student project).

### TABLE 4: PRIMARY SOURCES OF ADDITIONAL COST

HEADING
---------

Travel
Subsistence
Hospitality
Fax calls
Telephone calls

We estimate that the project costs were in the region of €6,000. We know that travel, subsistence, and hospitality costs were in the region of €4500; the fax and telephone costs are unlikely to have exceeded a further €1500. If these predicted costs turn out to be close to actual costs, this means that the project cost around €240 per student.

## The outcomes

As indicated above, the DesignNet project has generated a considerable amount of data. For each team we have the following data: all the drawings produced and faxes exchanged; a feedback/evaluation video; and questionnaire's. In addition, the exhibition was documented. Our plan is to analyse this data at a later date. The following sections are based on observations of the projects, the exhibits and the feedback sessions.

## The electronically- and computer-mediated communication

All teams were satisfied with the media available to them. This evidence supports Postulate 2 above; users adapt their behaviour to accommodate for technological impoverishment in order to complete the task in hand. For example, the students who only had fax and telephone did not express more or less dissatisfaction with the technology than those who also had video and email. Some students commented that while installing the work for the final workshop they came to realise that some misunderstandings had occurred as a results of communicational impoverishments but they also agreed that they did not, at the time, associate these problems with the communication media. In other words, in all cases, the student were able to exploit the media in ways they perceived satisfactory. Put another way, users will accept communication impoverishments if they can find ways of completing a task to their satisfaction. What is remarkable is users' robustness; they seem to be able to accommodate very severe impoverishments.

Adaptation of working method was clear: the teams developed protocols and practices geared to their conditions of working. For example, one group described how they pre- prepared for a synchronous meeting (i.e. of fax exchanges), how they made a telephone connection to agree the agenda for the meeting, and how at the end of the meeting they would summarise the agreements reached during the meeting. It appears that each group devised different strategies for coordinating their activities (closer scrutiny of the data should reveal the details of these strategies).

Given the analysis to date, it is too early to state categorically that the addition of computer-mediated communication resources led to qualitative enhancements in either process or outcome as compared to those obtained using only electronically-mediated communication. However, the Derby-Delft students displayed a strong sense of team commitment and identity. Of all the projects, this was probable the most integrated and unified. Had one not known otherwise one would have thought that the work was produced by a single hand.

Some caution needs to be exercised because there were many factors that might have influenced outcomes in the DesignNet project: communication media; language; method of working; interpretation of the brief. The Dutch designers were fluent English speakers, and this group chose the first method of working, object - space, from the brief. One other group that chose this method also made a conscious decision to emphasise cultural differences; thus although they produced a highly integrated piece it was also designed to reveal differences. Thus, we should be cautious about drawing conclusions at this stage. However, on the evidence of the exhibition and presentations, its reasonable to hypothesise that computer-mediated communication of the kind used in the DesignNet project offers positive advantages over electronically-mediated communication, such as fax and phone.

Observation would suggest that the Derby-Delft communicated more than the other groups. For them, video was very important as, although of very low bandwidth and hence poor visual quality, they were able to gauge gesture and facial expression. Interestingly, they didn't use the telephone very often, although one was available. First indications are that this reflected a strategy rather than a preference: it seems that they decided to do as much as they could using the computer. Neither did they use Aspects, but this is hardly surprising as the network latency of Internet makes drawing difficult.

To summarise so far, design at a distance mediated by electronic and computer technology is perfectly feasible. Students are able to adapt both communication and working strategies to accommodate technological impoverishments. Initial evaluation would suggest that computer-mediated resources, such as video, synchronous text exchange, email, file transfer, and shared worksurfaces offer positive benefits in comparison to fax and telephone.

## **The method of working**

The brief permitted two ways of working. The first required a team to work together to develop what was essentially an agreed installation; the second required the designers to agree on an object to be produced by each individual. Three teams chose to work in one way and three in the other. The different methods of working were clearly represented in the outcomes: the agreed-installation method leading to single, unified pieces; the agreed-object approach to mini-exhibitions of individual pieces, the obvious connection being a common starting point. Perhaps not surprisingly, the teams (apart from one group which we will come to later) adopting the agreed-installation method appeared to have a stronger sense of team identity than those choosing the latter. When they presented their work they did so as a team, each member speaking for the team and seeking agreement from other team members about statements made on their behalf. Teams adopting the agreed-object method tended to report as two national teams. Interestingly, the agreed-installation teams appeared to be more positive about the whole experience overall.

## **Task meaningfulness**

Perhaps, the reason for these apparent differences in the value attached to experience by different groups is related to the purposefulness of the task. If you are being asked to work as part of a team perhaps the production of an agreed-installation seems more purposeful and more valuable than being asked to work on an agreed-object. Clearly, if the intention behind the latter case was perceived by students as being to see what different individuals produced when given the same starting point, initial agreement about the starting point is not really essential - the agreed-object could just as easily have been defined in the brief. In the agreed-installation case teamwork is unavoidable.

Perceived purposefulness and value (Postulate 1 above) perhaps explains why the Derby-Derby link, an agreed-installation project, worked less successfully from the team working point of view than the other two agreed-installation projects. Obviously, things could have been arranged such that the students in Derby worked together, for all or part of the project. Both options were essentially prohibited as students were asked not to work face-to-face. Postulate 2 predicts that users will be less tolerant of communication impoverishments when they lack motivation; Postulate 1 suggesting that the perceived purposefulness and value of the task is a strong motivational factor.

## **Multi-disciplinary and transnational team working**

Generally, students found the experience of working in multi-disciplinary and transnational teams rewarding. Where problems arose between teams this seemed to have little to do with the communication media or language. Indeed students seemed highly tolerant of problems of this kind. Personality seemed to be an important factor in determining successful group dynamics. One student found it difficult to work with other people, and this caused problems for the group as a whole. Generally, students were able to give and take, even when they wanted to retain a strong individualistic element in the work. Interestingly, when questioned about the quality of the work produced by groups with good team dynamic, the highly independent student admitted to being very impressed. One feature that did emerge in support of multi-disciplinary teams is that team members found it easy to

accommodate another team members contributions when they concerned experience and skills not possessed by the others. Finally although individuals agreed that compromises had to be made they regarded this as generally enhancing rather than diminishing the outcome.

## Language

Generally speaking teams were able to overcome language problems (although in the case described above, the team did not share a common language and this may have exacerbated matters). In the Derby-Derby link English was the natural language; in the Derby-Delft link fluent English was the common language; in the Derby-Bergen and one of the Derby-Barcelona links, at least one of the non-UK members was fluent in English; in the other Derby-Barcelona link there was no common language - however, as indicated above this was probably not a cause of major problems. The Bergen- Barcelona link was interesting with respect to language. This team chose English as the common language as each member of the team had some English; in this sense they were equally disadvantaged by choosing to communicate in English.

## The work

It is difficult to say whether transnational multi-disciplinary team work leads to better outcomes. What we can say with reasonable confidence is that the work produced for DesignNet contained elements that reflected both the combination of different skills and different cultural viewpoints. It is tempting to believe that these conjunctions and unifications enhanced the quality of the work; they certainly produced interesting and novel results

## The final workshop

During discussion it became clear that the students placed a high value on the final workshop. Clearly, this can be partly explained by the fact that it provided an opportunity for travel (for some students) and socialising. Students also valued it as a natural conclusion to the task, i.e. the construction of the installation, and a necessary aesthetic experience. In particular, the Spanish students expressed the need to see, sense, and touch the objects produced by the team as a whole. For them, the experience would have been too cold and clinical without physical and human contact. It may be possible to design projects that don't include collective meetings of the DesignNet kind; however, a satisfactory project "closure" will remain a key element in the student experience. One other benefit of the final workshop was that it determined an immutable termination to the design and fabrication work - students in Bergen, Barcelona, and Delft had to complete these activities before they left for England. This fixed deadline focused minds and prevented drift.

## Conclusions and future work

We have suggested that design at a distance involving multi-disciplinary, transnational teams is likely to be an increasingly common feature of design practice. Electronically- and computer-mediated communication and collaborative work technology may enhance design practice - this remains to be determined. However, what cannot be disputed is that this technology enables design at a distance. It has to be recognised that collaboration using this technology is impoverished in terms of media, communication, and work pattern possibilities as compared to working in the same place at the same time. On the other hand, design at a distance offers potential benefits that may counterbalance or override these impoverishments. The primary aim of our previous studies of design at a distance and the DesignNet project was to investigate the problems and potential of this way of working with a view to establishing ways of minimising the problems and maximising potential. The DesignNet project extended our earlier work in a number of ways, the most important being the differences in culture, language, and discipline of the collaborating individuals.

The overall aims of the DesignNet project were successfully realised. Both staff and students found it a purposeful, meaningful, valuable, interesting, and enjoyable work and social experience. The students gained experience of unfamiliar technology, communication and work methods; and multi-disciplinary, transnational group- working. Feedback indicates that students were able to overcome the problems of technology, language, culture, discipline and group-working, and to draw out positive learnings and insights from the experience. Indeed,

many expressed the view that they would like the DesignNet project to continue - and we will be doing our best to ensure that at the very least students can maintain computer-mediated communication by email. Staff also gained insights into the benefits and limitations of this kind of working.

Initial analysis of DesignNet project data supports and enhances earlier findings about the desirable features of a design-at-a-distance project, such as a purposeful, valuable, and meaningful task; valid, task-related reasons for collaboration; cooperative individuals; good group dynamics; and a shared goal.

We would like to suggest that there are additional educational benefits to be derived from an electronically- and computer-mediated design-at-a-distance project. In the first place, student resistance to new technology may be reduced since a design-at-a-distance project cannot easily be completed without it. Thus students can gain experience of new technology in a non-threatening and meaningful context. Having used new technology in this context they may be motivated to explore its potential in their day to day activities. Secondly, computer-supported communication and work may provide a means of maintaining regular interactions with linked institutions, especially if technology is available to support routine project work forming part of the curriculum.

Often, the success of institutional links depends on the enthusiasm of staff and the availability of resources to enable staff and student exchanges. Staff mobility and fluctuations in resources can cause collaborative links to go into abeyance. Routine design-at-a-distance projects, of the DesignNet kind, would enable an on-going and constant level of interaction to persist as the foundation of other perhaps more changeable forms of interaction. Furthermore, such projects may provide a sensible precursor to staff and student exchange as they allow staff and students in each collaborating institution to gain some prior knowledge and practical experience of the people, place, values, and working and learning methods of their partners. We might expect that this would assist the assimilation of exchange staff and students into the host organisation. At present, transnational projects between electronically- and computer-mediated communication may prove to be too expensive to run on a routine basis. However, the Derby-Delft project, which used Internet, demonstrates that once the equipment is in place the cost of running projects is minimal - this must be the way forward.

Concerted Europe-wide effort will be needed to run and evaluate computer-supported communication and work projects in order to establish educational and practical benefits and limitations and guidelines on good practice. However, none of this will be possible unless the technology is in place to carry out the work. As noted earlier, throughout Europe the computer-base in Art and Design schools, academies, colleges, and institutes is underdeveloped, and the art and design community has largely missed out on the national computer and computer network infrastructure available to other academic disciplines. Concerted action is needed to rectify this technology-resource imbalance so that art and design can also benefit fully from the possibilities offered.

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## **APPENDIX 1: THE DESIGN NET STUDENT BRIEFING DOCUMENT**

The Design Net project is based on interactive design work using electronically- mediated open- and distance-learning techniques.

### Overview of the project

Participants: University of Derby, UK Bergen College of Art, Ceramics Institute, Norway. Delft University of Technology, Netherlands. Escola Massana. Barcelona.

- 1 . Links will be point-to-point.
2. Derby will have a point-to-point link with all sites, and also an internal link.
3. Bergen and Barcelona will also establish a point-to-point connection.
4. Real-time links will be phone/computer- or phonet fax-mediated depending on the resources available at each link point.
5. Four students will make up a team: two at one site and two at another.
6. The practical work will run over four weeks: in the first week students will be able to use the links for scheduled real-time communication, in the second for fax exchange and impromptu real-time communication, the third week for scheduled real-time communication and the fourth week for site-independent making-up of objects.
7. The project will result in an exhibition and meeting at Derby, attended by both staff and students .

### The project Brief

The project will focus on life-style, cultural factors and the interaction of design influences and objects.

Keywords are:

CULTURAL, CLIMATIC, HABITAT, FOOD, SHELTER, UTENSILS, LEISURE. (select 2)

As a group select 4 from the following concepts and materials list:

- clay; 25 kilos max
- rod; 1 metre length of diameterbetween 1mm and 100mm
- flexible sheet
- vessel
- eating implement
- toy
- light
- swinging motion
- alarm (sound)

As a group communicate your ideas and design an object/ installation using these elements. Consideration should be given to colour and objects that are ready- or self-made, transportable and ready for assembly. The 'objects' will then be fabricated to be displayed within a 2m cube defined by string or wire. Objects may be suspended.

Either of these methods of working may be explored:

1. OBJECT AND SPACE - where four students make four different objects which are integrated when they come together within the defined spatial cube.
  2. OBJECT - where students make four objects from the same 2D design brought together and displayed in the defined spatial cube.
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# Hypertext authoring in the context of fine art practice.

**Dick Whall**  
**Head of Fine Art**  
**Coventry University**

Edgar Allan Poe's Man of the Crowd "gazes through the window [of the coffee house]n before, as Baudelaire<sup>2</sup> observes "hurl[ing] himself...in pursuit of an unknown, half-glimpsed countenance...", where, with the skill and ease of the flaneur, he perambulates "through as it were an immense reservoir of electrical energy. In 'Some Motifs in Baudelaire', Benjamin<sup>3</sup> suggests that the flaneur is an accomplice, who, as Arendt<sup>4</sup> believes, "purposelessly strolls and receives the message".

Documentum de transmutatio is the title of a PhD research project registered in 1992 with Coventry University; it is also the title of an art-work that is installed within the digital environment of hypertext.

The principal focus for the research is located within the field of fine art practice and is based upon the author's own creative work, where this forms, as a point of origin and reference, a significant part of the intellectual enquiry.

The work is founded upon the belief that the methods involving the conceptual and spatio-structural assembly of gallery-circumscribed art-installation are analogous with those employed in authoring hypertext. The hypothesis for the research project involves two assertions, namely that transmutation of elements selected from art-installation, into the digital environment of HyperCard 2.0v2 is practicable, and that transmutation does not lead to a loss of characterisation. For research degree purposes (and not fine art purposes), the work is required to conform to the usual scholarly conventions; to be clearly presented in relation to the argument of a written thesis and set in its relevant theoretical, historical and critical context.

The research has been conducted in the studio of the artist/researcher on 'bottom-end' low-cost hardware involving an Apple Macintosh Classic, a OneScanner, a d2 170 external hard-disk and an Apple StyleWriter 11. Software employed for the generation of the art- hyperdocument has included HyperCard 2.0v2, HyperScan 2.0.1, MacWrite 11 (1.1v1) and MacPaint 2.0. The project has been assisted by a Research Grant from the Coventry School of Art and Design of Coventry University.

Documentum de transmutatio ( 1992-1994) is an art- installation authored and assembled within the digital environment of HyperCard 2.0v2, consisting of fourteen conjoined stacks drawing upon 23,000K of disk space.

The following ideas have prompted the research project. It is believed that

- Art-hypertext enables the concomitance of disparate materials including images and text, where correspondences, if properly correlated, preclude the need for interpretative or explanatory commentary.
- Art-installation assembled within the infinite electronic environment of hypertext is capable of exceeding the physical and material constraints of traditional gallery-circumscribed installation.
- Networking provides a democratising factor, enabling simultaneous access to a multiplicity of reader/authors.
- For scholarly purposes, the argument of the written thesis may be presented concurrently within the art-hyperdocument.
- A digitised installation enables containment within a miniscule space.

The gallery-circumscribed installation employed as the source from which the digital art-work has been constructed is L'Appareil pèdaqoqique avec ses apanages, or the enigma machine together with its bombs, (Whall D 1969-1994). This is an on-going heterogeneous art-installation, conceived as a life-work, sensitive to pedagogical oscillation and responsive to the theoretical and critical discourse surrounding fine art practice. L'Appareil has been exhibited in gallery spaces in the UK/EU and overseas throughout the past three decades.

Transmutational method in the instance of the fine art research project has involved a radical revision and change of morphology and structure. Where sculptural components, drawings, photographs, maps and geological specimens for example, have been searched within the archive of L'Appareil, and as a consequence of digital conversion, the material has been transmogrified and re-located within the environment of hypertext.

Initially it was considered necessary to capture two drawings selected from the archive of L'Appareil. The first entitled Cultural Sedimentation 841mm x 594mm (4.1981) employs cartographical conventions to describe a section of an appropriated symbol<sup>5</sup> for the concept of transference or correspondence. The second, entitled Planarmetrical Drawing 1330mm 1000mm (1984) features the same line of correspondence, but in this drawing the diagrammatisation describes the delineation of a sculptural component entitled Long Line 7620mm (9.1979). This element is observed to traverse a plan<sup>6</sup> representing the 'landscapism' or ground-work for the installation. The Ready-made Long Line was included within the installation as an object-sign for the symbol for the concept of transference. The sign was aligned spatially and referentially to conjoin the designated points [A] and [B]<sup>8</sup> within the English landscape.

The process of capturing the two drawings (whose scales are different) utilised photocopies made from the originals, where a quadrant grid was superimposed upon the replica (actual size) photocopy and 'windows' measuring 181mm x 120mm were cut and subsequently captured (HyperScan) for assembly as a simulated pan within HyperCard 2.0v2. Clearly the original drawings could not have been used for this purpose without subjecting them to irrevocable damage.

The orientation of the two drawings within the overall schema, the positioning of the superimposed window-sized quadrant grid upon the drawings, and the direction of the line of transference [A]-[B] described by the two drawings, were determined by the scale of 1: 50 000.

An extension of the section of line [A]-[B] within the Cultural Sedimentation drawing was projected to point [A] and to point [B], where OS maps were used to provide information for scanning purposes. The planarmetrical representation of line [A]-[B], with point [A] synchronised to coincide with the geo-cartographical representation of the line of transference at [A], was then extended beyond the (northern) boundary of the Planarmetrical Drawing to meet with point [B] (the co-ordinates for which were previously determined by the Cultural Sedimentation drawing extension). The extension to the Planarmetrical Drawing was achieved by capturing sections of the object-sign Long Line (a length of black cord).

With locations [A] and [B] defined, there followed the introduction and construction of a further conjunction [A]-[B] "tending towards [a] pure geometrical line without thickness".

Fig.1 (p6) features a wall-assembly of photocopy material and hard-copy, comprising 391 windows (181mm x 120mm) and containing the three [A]-[B] pathways (geo-cartographical, planarmetrical and geometrical). A palimpsest occurs where each of the three lines of transference coincide at [A] window A3, and [B] window P-17. Fig.1 also features a replica sculpture (resin and glass fibre) entitled Apple Macintosh Plus Frame (1992), and in addition a MacPlus PC (supporting the Documentum de transmutatio hypertext) and the artist/researcher posturing as a wayfarer.

The Schema of lines of transference, 416.3cm x 204.0cm, (11.1992-7.1994) Fig.1 (p6) functions as a wall-guide; a navigational aid for the reader-wayfarer.

Fig.2 (p6) features a miniaturised on-line navigational aid in which the three lines of transference constitute the "geographic and geological landscapism", and where, in the case of the digitised installation, this represents the platform upon which the rhizomatous linking model is assembled.

A system-controlled scripted simulated pan was written for each of the three [A]-[B] configurations. Interactive (reader-controlled) inter-line cross-over links were introduced between the three lines of transference. Interactive rapid-track and through-way scripts, and a turn-around orientational capability was also introduced. The orientational options will be observed to facilitate traversa, of a kind analogous to that experienced by the visitor to the gallery-circumscribed assembly of L'Appareil.

Fig.3 (p8) features an on-line simplified diagram of the Schema of lines of transference, in which 'pylons' supporting "context information" and data nodes have been assembled. The cross-way, turn-around, pan and "context information" trigger points are identified on routes 2 and 3. It will be observed that there is a navigator aid (p6) trigger, and a change of mode trigger for each of the three routes. The orientational options, text node [A] and text node [B] triggers are opened in Fig.4 (p8).

Fig.4 (p8) features the same diagram as Fig.3 with pop-up boxes containing the orientational options, the text-node links and cross-references. A diagram representing each of the modes of transference (each of the three routes) has been installed, each with pop-up boxes identifying the

Each mode of transference enables different orientational options, but each mode of transference facilitates access to the same collection of data nodes associated with [A] and [B]. From the diagram featured at the bottom of p8, it will be observed that each of the texts triggered from [A] are cross-referenced within the group of text nodes associated with [A], and each text triggered from [B] is similarly cross-referenced within the collection of text nodes associated with [B]. The transference texts associated with [A] and [B] are cross-referenced. All texts may be accessed from all modes of transference. Additional exemplar texts may be accessed from Route 1 and Route 2 at v[1] and v[2], and [vi[1] and vi[2] respectively.

In addition to the 12,000 word exemplar text (consisting of quotations, each with a comparative critical evaluation) associated with [A] and [B], the context information also contains photographic nodes, map and chart nodes, and geological specimen nodes. All are cross-referenced with specific points on the lines that form the "landscapism" or schema of transference, and also with the contents of the text nodes.

[A]-[B] the appropriated symbol for the concept of transference originated as a path for the conveyance of [b] to [A].

Fig.5 (p10) features a specimen of [b] located within the P-17 window containing [B] and a representation of a palimpsest of lines of transference conjoined at [B]. An impression of [b] (following a scripted 'wait' of 5 seconds) is conveyed by the reader/wayfarer along [B]-[A] to [A] along one of the three modes of transference by employing one or other of the orientational preferences' 3.

Fig.6 (p11) features window H2, a detail from the Planar-metrical Drawing, illustrating in plan (see footnote 6) the termination point of the Long Line caused by the spatio-physical limitations of the gallery. The art-hypertext enables the Long Line to be extended in order to achieve its full length [A]-[B].

The method and form of assembly that enables the projection of point [A] through the incident involving termination (at H2) to [B] is quite obviously advantaged by the dematerialised environment of hypertext. [A] is projected as a line of transference through the Corner Incident to reach [B], enabling the conveyance of an impression of [b] along [B]-[A] to [A].

In the gallery-circumscribed model, irrespective of whether transference is obstructed, the narrative that determines the spatial orientation of the line and the conceptual correlation of that line with other elements within the installation, has always remained obscured. However, as a consequence of the significance attributed to the use of metaphor in the installation that is located in hyperspace, it will be recognised how the characteristic of passage is given additional prominence. In the digitised installation a collection of scripts involving objects, message passing paths and handlers" are employed initially to prescribe and then to facilitate the multiplicity of actions, correspondences, succession of graphical appearances and the cross-referencing of materials. In the electronic assembly, passage might similarly be observed to be the primary contributory factor that influences the illusion of flaneriel for the wayfarer.