

Designing a Learning Environment for Three Dimensional Thinkers

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Introduction

It could easily be argued that multi-media is currently “owned” by graphic designers. There are an increasing number of industrial designers, however, who use multi-media in ways that a graphic designer would not.

Graphic designers and Industrial designers come from distinct design cultures, which affect both groups' ways of thinking. The conceptual model for a graphics product tends to be two-dimensional while the three-dimensional nature and context of an industrial product's point of use together with the added elements of users and modes of use, tend towards three-dimensional, often time-based, conceptual models.

Both models have their pros and cons.

It would be fair to say that Industrial Designers view design in a very different light to their counterparts in 2D disciplines. They are accustomed to designing in three dimensions; they study modelmaking, ergonomics and the presentation of three-dimensional design concepts in two-dimensional form. They use abstract models & diagrams to structure & re-examine problems & to test possible solutions. They are accustomed to building rigs and soft

models to test & develop their theories. The ability to view a concept from various angles and to **touch** it is very important.

It would be equally fair to say that it would be difficult to over-estimate the contribution of Graphic Design to the creation of the dynamic web environment that we see at the beginning of the 21st century.

Industrial Design has a contribution to make however. Among the advantages of Industrial Designers' approach is that they can use skills learned in subjects like Information Ergonomics, Rig Building and Modelmaking to produce "three-dimensional" environments that better immerse the user in the designer's virtual reality.

Although there are those in the field who have been using multi-media for some time, there are many industrial designers who have yet to realise the full potential of the tools available. One of the reasons for this is that the current state of technology offers little encouragement.

Industrial designers edging their way into web-based design are in an excellent position to benefit from the advances & developments made by graphic web designers over the years. But is it necessary to ask why they have not made a greater contribution before now? The answer lies in the rate of technological progress. As early as 1973 one of the authors was involved

in examining ways in which 3D designers could use computers¹. It was almost another twenty years, in the late 1980s before the advent of computers powerful enough to facilitate useable 3D CAD finally made it a viable proposition for professional designers.

In the year 2000, software houses are developing products that allow objects to be viewed in three dimensions over the Web. The power is now available to allow Industrial Designers to explore the skills they have learned in traditional areas and bring them to bear on web design & multi media. Unfortunately we are still in the early stages of this process. The limiting factor now is the technology linking the World Wide Web rather than the power of the computers attached to it. All web-based design is limited in what it can achieve because of the consideration given to the speed that information can be sent down a conventional phone line (2.8kps on average). The problems are worsened when another spatial dimension is added.

In this paper we discuss a web-based environment designed by Industrial Designers. We look in particular at how that environment that uses many of the major principles of Information Ergonomics, taught as a matter of course to under-graduate Industrial Design students.

¹ Computer Modelling Techniques, Science Research Council, Department of Design Research, Royal College of Art, London, 1973-74

The expanding role of the Industrial Designer

Many would argue that the 'Apple Macintosh' has been a mixed blessing for Graphic Design. A casual observer of the appointments pages in the Design Press will have noticed that advertisements for "Graphic Designer" have gradually been replaced by "Graphic Designer/Mac operator" and sometimes even "Mac Operator". As a profession, Graphic Design has been quick to meet the threat and move itself onwards, embracing Multi-media and acquiring new skills.

In our own field of Industrial design, solid and surface modelling software programmes such as I-DEAS Master Series, Pro-Engineer, Alias Wavefront and 3D Studio deplete the usefulness of traditional skills such as rendering, model making and even technical drawing.

Like Graphic Design, Industrial Design has been faced with the necessity to embrace CAD and exploit the potential for further technology-led opportunities. One of the areas that might benefit from Industrial Designers' traditional skills is the field of multi-media.

The Cardiff Model

One of the ways in which we have chosen to stretch the boundaries of Industrial Design at Cardiff is through the medium of *Systems Design*. We define a System as a number of products that operate together, no single element of which will work on its own. Lego bricks, for instance, are a System; although each brick is a product in its own right, it performs no useful function without a number of others. A tram is a product but it can't perform a useful function without a number of other trams, a network of rails, tram stops etc.

A high percentage of Systems projects, chosen by the students, tend to look at the way hardware & software interact to form a system. This in turn often means that the traditional Industrial design activities tend to be displaced in favour of Graphical User Interface (GUI) design, based on Information Ergonomics.

When the Systems project was first introduced, the results of students' endeavours tended to be displayed communicated using pages of paper with screen images, flow charts etc. Not surprisingly this lacked the impact of a real product. More recently students have begun to use software such as *Corel Draw*, *Director* and *PowerPoint* to produce more realistic results.

Touch screens have enabled us to further blur the line between real & virtual product design. Our students can now design a product (system or otherwise)

& produce an on-screen visualisation. The combination of software animation techniques and touch screen technology make it possible to create virtual products in an undergraduate environment. Users can then interact with the virtual prototype in a manner that approaches more nearly the experience of interaction with the real product. In this way we are able to view, with far greater clarity, the quality of work that the student has undertaken. Likewise the student is able to test the product much more effectively and deliver a design of greater depth & subtlety than before.

Industrial Designers employ tactile skills naturally. Much of the qualitative assessment of a product is by quality of touch, weight, warmth & finish. Many of these aspects can be explored through traditional techniques: weighted rigs, soft models, facsimile models etc. Multi-media models open up other areas. One of those that can be explored far more effectively, using the new tools available, is Information Ergonomics.

Sound can be added, for example, so that a switch will make a satisfactory click when it is activated; reassuring the user that the operation is completed; another tool with which to affect the user's interactive experience.

This "psychology of sounds" is not new; it has always been part of the industrial designer's stock in trade, but it has been difficult to produce the results pre-production without very sophisticated and expensive facsimile models.

Industrial Design graduates who are conversant with these languages & other Information Ergonomics related issues will have a better chance of success in an increasingly competitive sector of the job market.

Multi-media design by three-dimensional Designers

In this section we explore the difference between 3D & 2D design approaches.

As any Industrial Designer will tell you, the most efficient way of designing an effective, useable, GUI is to make it's use *instinctive* to the user. In this case the definition of *instinctive* is a method of use that triggers a meaning learned & so often reinforced during the individual's life that they no longer have to think about it. One of the basic methods of instinctive languages commonly used in GUI design is the *spatial analogy*.

Spatial analogies are an excellent example of the value of three-dimensional thinking for good interface design.

Example 1: A two-dimensional space analogy

Picture the layout of a computer keyboard. As the reader will know, modern computer keyboards have a collection of buttons with arrows on them that allow the user to move a cursor or an object anywhere in 2 dimensions. *See*

Figure 1

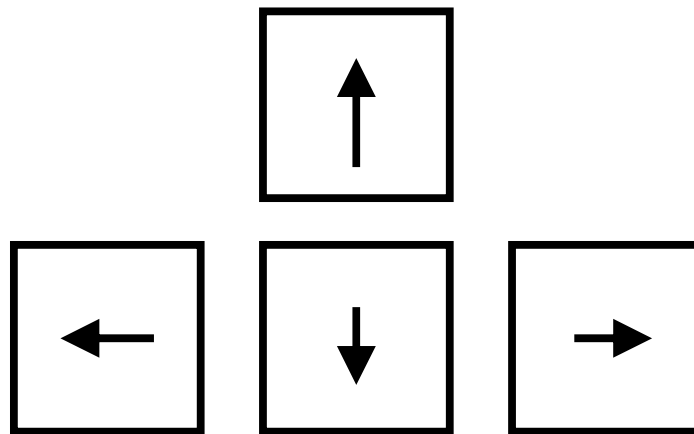


Figure 1: computer keyboard direction keys

The keyboard sits horizontally on the desk so that the arrow on the isolated key is pointing away from the user. The user is looking at a vertical screen and knows that although the arrow is pointing away from them, if it is pressed the selected item on screen will move *up*. The user knows this will happen because this type of spatial analogy and its transposition from

horizontal to vertical is a convention and over time it has been so reinforced in his or her mind that it has become *instinctive*.

So: a forward pointing arrow means up.

Example 2: A three-dimensional spatial analogy

Picture the same keys displayed in *figure 1* being used on the same computer keyboard as the controls of an aircraft running flight simulator software.

We know from the two-dimensional spatial analogy that the forward arrow can either mean forward (in its horizontal mode) or *up* (in its vertical mode).

If the user wished to make the aircraft go *down*, which key would they press? Surprisingly, the answer is the *forward* arrow. To explain why, we must move from two to three dimensions.

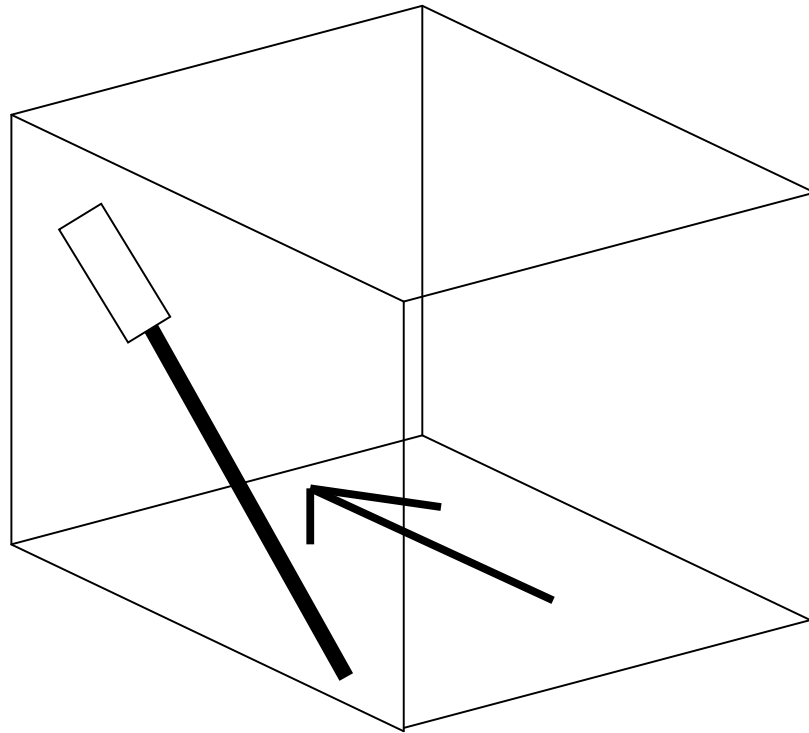


Figure 2: Three-dimensional representation of space

If the bottom face of the cube in *figure 2* represents the plane on which the keyboard resides and the back face represents the plane on which the screen resides, let us look at the scene from the left-hand face of the cube.

This face has a diagram of an aircraft control column on it. When the forward arrow is pushed, the users mental model is of a control column being pushed in the way shown in the illustration

So why was the control column designed the way it was? This is another example of a spatial analogy.

The reason control columns work the way they do is because they are an excellent example of a sophisticated three-dimensional spatial analogy and are therefore used instinctively. (See figure 3)

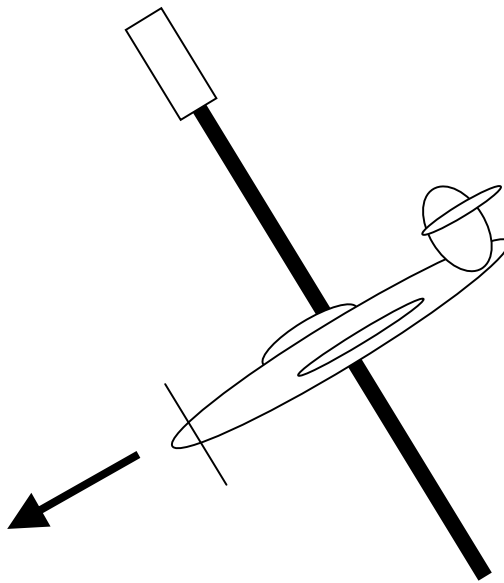


Figure 3: Joystick spatial analogy

If one were to place a model of the aircraft on the pivot of the control column, the model would faithfully reproduce the spatial movement of the aircraft. The mind employs this mental model in order to control the

machine. It is an exemplar of good three-dimensional design ergonomic practice.

Case study: A multi media product by an Industrial Designer

Since December last year, we in Cardiff have been involved in the design of a new Virtual Learning & **Communication** Environment (VL&CE) for use by both staff & students.

For a number of years, like those in universities the world over, we have had access to excellent on-line learning materials, databases, e-mail, staff web space etc. With the possible exception of e-mail, these are so far under-utilised.

There are a number of excellent VLEs available already: "*The Nathan Boddington Building*" at Leeds University to name but one.

The *Nathan Boddington* model allows students to work in seminar groups, sit tests on the World Wide Web, belong to seminar groups, retrieve lecture notes, etc. It is a very sophisticated model and is utilised by academics and students across the university.

The Cardiff model aims to emulate many of these functions, but we are also attempting to

- Create a social environment that connects staff & students with other parts of the university
- Harmonise the VL&CE with the real world environment.
- Tackle the social aspects of learning
- Make information retrievable by the individuals with moderate to poor IT skills

In this section we examine the design of a multi-media learning environment by an Industrial Designer and discuss the Design principles that it brings into play.

The first problem the designers were faced with at the start of this project was how to make students and staff want to interact with the environment we were creating. Three major principles were agreed upon.

1. The learning curve should be short and flat (instinctive)
2. The system should be entertaining to use
3. The system should be mutually reinforcing of real world information the users already have
4. Information should be easily located and retrieved
5. The System should facilitate better communication between staff and students in all areas of the University

1. Shortening the Learning curve

One of the first decisions the designer had to make was how to shorten the learning curve. A fundamental principle adopted to do this was to equate the environment to a product. While there are a number of people in the western world who are still computer illiterate, the chances of a student reaching university without having used a range of consumer products was thought slight. Consumer products embody a number of basic man-machine interface rules and the concept was that these could be used to help the user feel more at ease in the virtual environment. Thus areas where text appears have been displayed as screens, buttons have been set into surfaces, and instrumentation has been designed to reflect the appearance of real world products. Other product icons used are more symbolic. An example of these is the doors. With the exception of the map page each "room" has a number of doors that allow the user to exit. These have been included because of their real world connotation and appear as symbols within the symbolic (virtual) product.

Another method used to shorten the learning curve was to use a spatial analogy that both students and staff were already familiar with. That way creating a conceptual model of the virtual world in the mind of the user would be easier because it used information they already held.

It was therefore determined that the University campus should be used as the spatial model for the project. Sites would equate to rooms, each room connected to the others in the same manner as they were in the real world and

each given their real function. In this way (it was intended) students would be able to get the information or person they needed by simply asking themselves where they would look in the real-world model.

A campus map therefore forms the opening page (*see figure 4*) of what has tentatively been named the *Virtual School*. A number of convenient conventions have been used. For instance, the real scale of the campus has been entirely abandoned. Building plans have been simplified and re-sized and unused spaces reduced dramatically (a concept first devised by graphic designer Harry Beck in 1933 and used on the well-known London Underground map). Other conventions have been dropped too. The map does not align with the viewer's viewpoint, nor is there any association between "Up" & "North".

The user navigates by pointing the mouse over the areas where he or she expects to find rooms. When a room highlights, then he or she clicks the mouse to travel there. A room index exists to back up this system.

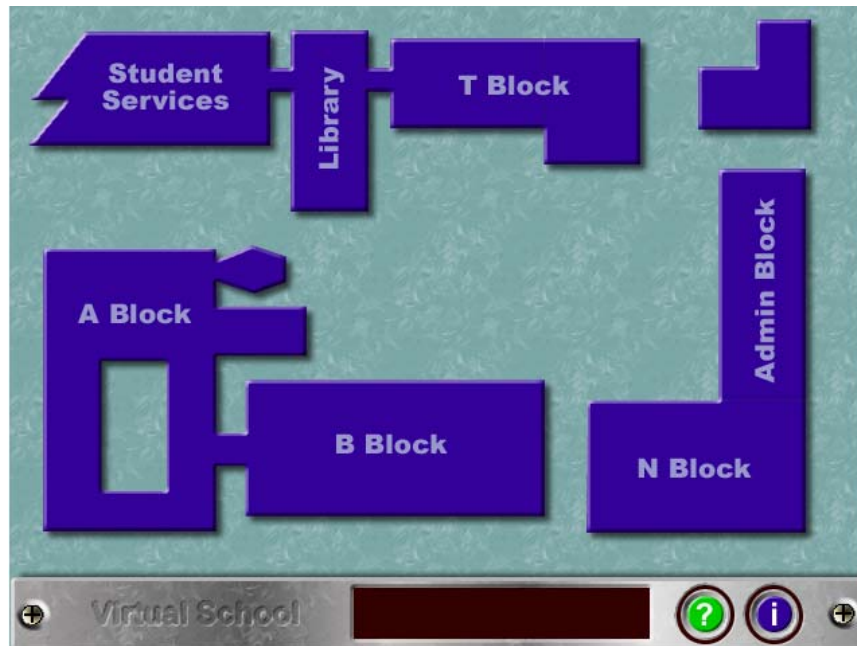


Figure 4: Virtual School opening page

The user can now travel where he or she wants. If for instance they wanted to contact a member of staff, the most obvious place to do so would be that staff member's staff-room. (See figure 5)



Figure 5: Virtual School Staff Room

2. Making the Environment enjoyable to use

Another basic principle the designer was keen to adopt was that the environment should be stimulating to use. Aside from the creation of a product simulation mentioned above, there are a number of ways in which this goal has been addressed. A good example of this is the e-mail facility. If a user wishes to e-mail someone within the VLCE they move the mouse over that person's image on the screen. The person then turns towards the user, and speaks, asking to be e-mailed. The user has only then to press the mouse button and an e-mail window will appear. The extra effort required to create the necessary rollovers and sound bytes, not to mention the extra webspace occupied by such functions has to be balanced with the undoubted pleasure

students get from using a device with this level of feedback. The project must firstly and foremostly be concerned with encouraging students to utilise the resources contained in the new environment.

In other areas too, deliberate sacrifices have been made in order to maintain an entertaining environment. In order that the user will always know his or her location within the VLCE a navigator has been provided that resides in the lower left hand side of the screen. The most efficient manner of presenting this information would probably be as a simple text message. A dial was chosen however because of its connotations of quality & solidity and to add to the "quirkiness" of the environment.

Still more effort has gone into maintaining the illusion that the user is using a product rather than a web page. When a user wishes to leave a "room" he clicks on the appropriate "door" The door will then obligingly open before the user proceeds to their chosen destination. Lights illuminate, buttons depress and screens light up with their messages; all adding to the illusion of a real three-dimensional product-based environment.

3. Making the Environment mutually enforcing

The system is mutually reinforcing in number of ways. The first of these is that it is "face-based", meaning simply that people can be contacted if you know **any two** of the following:

- Where they work

- Their name
- What they look like.

Students and staff can learn to associate names either through real-world contact or through the virtual environment. This and the fact that they can also learn that person's location, through either medium, form one of the basic principles of the VLCE.

Other mutual reinforcing principles include real world "hints" such as the mimicry of symbols used in the real world in the virtual environment. A good example of one of these is the "1" in the top right hand corner of the 1st year studio "room" (see figure 6). The same symbol appears in the same position of the real 1st year noticeboard. The presence of this in conjunction with the drawing pins on the corners of the notices is designed to act as a clue to the space's use.



Figure 6: Virtual School 1st Year Studio

4. Information should be easily located and retrieved

In order to make it easy for users to retrieve information, the system allows webmasters to filter that information before it reaches the user. For example, in the real-world model, Industrial Design 1st year students share their studio with the 2nd year. Although they share the same physical space they are following a programme of lectures, visits, etc. that is entirely different from those in the higher year. In order to remove extraneous information each student is asked to login before entering the Virtual Environment. This allows the system to give them only the information relevant to them. A first year entering the Main studio (see figure 6) will see different information

from that seen by a second year but will have all the same services available to them.

The same system allows for better access to useful web addresses, databases, search engines, on-line learning materials etc.

6. Facilitating better communication

The last of the fundamental goals of the VLCE was that it should facilitate better communication between students and academic staff, and that it should provide a vehicle to link various components of the university and make them available to their customers.

One of the areas addressed was the services of the Campus nurse. A new building had recently been opened at Cardiff and the nurse had been moved into it as part of a drive to provide students with improved facilities and service. Unfortunately it was noted that the number of students making use of the service actually declined when it was moved to a higher profile area. The reason turned out to be that students were frequently embarrassed to be seen, visiting the nurse, in this more public environment.

This was an area then that the VLCE could tackle (see figure 7): students could get in touch with the nurse easily and virtually anonymously. If the required advice could not be dispensed by e-mail then an appointment could

be made, but the difficulty of the first approach was softened by the method in which it could be made. Information about the services available is also included in the "room" and this further aids the communication aspect.



Figure 7: Virtual School Nurses room

3. Future Developments

The Virtual School project is presently in its prototype form. Its present functions have been detailed above. There are a number of developments planned for the future however.

Design students at Cardiff already have a great deal of web support: Project briefs are available on-line, PowerPoint presentations can be downloaded

from the web as can a number of other resources. The Virtual School, when it comes on line will become the portal for all these functions and (it is planned) a great deal more besides.

Analysis of the prototype has demonstrated that the face-based geographical model works well and a number of the planned developments are based on this facet. There are already projects underway at universities such as Northumbria and Brunel (*See Nam, T & Wright, D. (2000) Observations of team design process and the impact of collaborative technologies, Proceedings of Co-Designing 2000, Coventry, UK*)

looking into collaborative working using the web. This work may have a direct bearing in this arena and it is one of the areas the team is keen to explore.

Some of the limitations of the Web have been detailed above, but software from Macromedia, Apple and JulyNet Co are providing methods with which to explore 3d objects from a number of 2D images. There are a number of uses we are currently investigating for this type of platform.

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