Architectural Design Development through Multimedia Interaction

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Abstract: This paper describes the development of a multimedia system aimed at architects and architectural students for the purpose of helping them to understand the basic concepts of architectural *analysis*. Analytical features in the system that we have developed include many design-theoretic concepts such as massing, balance and circulation. Other concepts are more directly related to the built environment and include elements such as lighting, structure and construction. The system illustrates architectural analysis carried out on a range of building types *dynamically*, and allows users to navigate architectural analyses *interactively*. Users can learn about the differences between buildings and their corresponding analyses in a supportive non-linear learning process, and can explore building types depending upon their own interests or needs. The prototype system contains analyses of three British building projects. They show different types of architecture in order to demonstrate important design theoretic and environmental differences. *Conceptual models* in the system show important aspects of a particular analysis simply, and each analysis is additionally described with text, animations, video clips and interviews with architects (talking heads). Most of the models were generated by the use of architectural CAD software. Animation techniques were used to describe the analyses of buildings clearly and dynamically. Users can visualise how whole buildings were designed from an analytical point of view, and the system illustrates *design thinking* by showing dynamic presentations of analyses. Users can structure their own design learning processes through a series of interactions. These interactions are supported with flexible cross-referencing mechanisms implemented in Macromedia Director 8.0 exploiting Frame Markers, Event Handling, Navigation, and Buttons in the context of the object-oriented Lingo programming language. The navigation component of this system has a logical matrix structure reflecting the fact that analytical information is interrelated across building types, giving rise to vertical and horizontal patterns of access.

The features of Director 8.0 can control this navigation in a flexible yet structured way. Users not only learn about analysis, but also how to present their own designs to the public through the use of different kinds of presentation techniques, particularly through the use of conceptual models. We intend that users can show their projects from their own analytical viewpoints instead of simply showing realistic images of final designs. Presentations can also be recorded in the system, and these can in turn be used as reference material for other users. This system is currently being developed further by storing presentations and translating them into different languages (e.g. Japanese) so that foreign users in other institutions can interact with these presentations. This system has been evaluated in the context of an undergraduate CAD course at the School of Architecture, University of Sheffield, UK. We are currently examining the usefulness of the system based upon an evaluation process, in addition to including more building types for future study.

1. INTRODUCTION

The essence of *analysis* in architecture is to understand what constitutes a building by categorising different parts in simplified detail rather than looking at whole buildings as complete objects. Analyses reveal the concepts of designs in particular categories, such as geometry, and structure [Clark, R. H. and Pause, M., 1985], for example. We are particularly aiming at the analysis of form in this paper [Baker, G., 1989]. Basic analysis of buildings using conceptual diagrams is an essential component of any multimedia system in order to describe analyses simply [Ching, F.D.K., 1996].

Multimedia CD-roms have to date been developed in various subject areas. Although teaching and learning through multimedia is an expanding area, it is also often one in which the technology of the medium undeservedly takes precedence over the pedagogical intent. We believe that this tendency should be reversed, at least in the case of applications for architectural education. There presently exists CAD software for designs, calculation programs for engineering, and software for presentation. Although there are multimedia CD-roms in architectural design, these are not always relevant for teaching and learning architecture, especially for the *analysis of form*. Our main objective is to introduce multimedia education in architecture to those who want to learn about the analysis of form.

2. ANALYSIS OF BUILDING FORM

The analysis of building form is concerned with understanding how buildings are designed by separating building types into particular parts and then investigating each of these in detail. Such an investigation may reveal how architects designed each part of the building, and how these parts are combined together in the final form. Analysis can show the design approaches of the architects, their techniques, use of materials, and so on. Therefore, it is necessary for students studying architecture to learn how to analyse buildings and to obtain ideas from analysis in order to develop their own design schemes. When students subsequently begin to work on their own design projects, they need to think in terms of their own design concepts, what kind of things they need to design, such as building type, space, elements, facilities, equipment, and functions. They need to have reasons for every part of their design. Analysing and understanding existing buildings may help them to develop their own design schemes by encouraging them to look at their own proposals in a more logical and rational manner.

Analysis of well-known buildings may allow architectural students to anticipate the properties of materials or the effects of natural light, for example. Analysis also encourages architectural students to uncover known design theories, techniques, or solutions to their problems. Architects are in turn influenced by other architects even though they may criticise other architects' works.

There are many types of analysis in architecture, such as the analysis of energy use, structural analysis, the analysis of form, the comparison of alternative material possibilities, and many other forms of environmental analyses. Our current research work focuses primarily on the *analysis of form*, i.e. those aspects of a design scheme that have spatial characteristics. We are concentrated *with how the form of buildings is developed* in both two and three dimensional ways. We are particularly aiming at the analysis of form because we anticipate that this will encourage students to develop their own design schemes in the *early stages* of projects before progressing to the details of finalised schemes.

3. ANALYSIS THROUGH MULTIMEDIA

In our own application of multimedia to the analysis of building form, we have considered this to be a relatively new medium for the understanding of architecture, and have therefore given some thought to the development of the following.

3.1 The Introduction of Pedagogical Interactive Multimedia Systems

Multimedia technologies have not been applied to architectural design in the early stages of studio projects in spite of the fact that a vast range of resources are being offered to us in schools of architecture. We want architecture students to be able to understand a range of building types such as those that they commonly encounter in studio work (e.g. libraries, schools, theatres, museums, galleries, housing, etc.), and to develop their own design schemes from the particular building types that they have been analysing. We are aiming to develop a computer-based, educational medium for students, which can be used in addition to reading books, papers, and journals. We believe that the development of multimedia environments with dynamic exploration and navigation will offer better support to students and architects for the analysis of buildings.

3.2 The Comparative Analysis of Different Architectural Viewpoints

Discussion about architecture helps students and architects to improve their own design developments whether they think by themselves or argue with other students and architects.

" Arguments give opposing views or a comparative analysis." [Sabater, J. C. and Gassull, A., 1992]

The hyperlinking mechanisms within multimedia environments make it possible to show the relationship between one type of analysis and another. They also enable users to compare analyses across different building types. Views and analyses give users the opportunity to see various new points of view. They can discuss these points by criticising or comparing different architectural solutions to particular building types. For instance, users can look at museums designed by several different architects in different styles and analyses. These different styles and analyses of particular building types encourage users to compare and contrast different analyses, to discuss different points of view, and these discussions in turn lead to the users' own design developments.

3.3 The Use of 'Conceptual' Models

Conceptual models contain analyses of each building. They are simplified diagrams in order to show specific analyses such as structure,

massing, circulation, etc. Arrows, for example, such as those used in **Figure 1**, can show the direction of movement of people in a building.

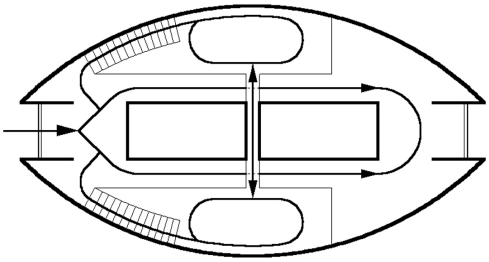

Figure 1. A conceptual model of circulation analysis

We believe that users can improve their abilities to analyse buildings by working more with conceptual rather than with realistic models, since conceptual diagrams can show the *essence* of particular building functions with clarity, and without the distraction of other elements. We believe that the use of animation in conjunction with two and three dimensional conceptual models will help students to visualise the forms of buildings in more realistic ways.

3.4 Relationship between Theory and Practice

Radford, in referring to Itten's basic course at the Bauhaus, emphasised the importance of:

> "the relationship between the theoretical and practical aspects" [Radford, A., 1992] , and stated:
>
> "The aims of a beginners' course on the making and interpretation of form, then encompass a combination of theory and practice in relation to design and the representation of designs" [op. cit.]

Our intention in the teaching of architectural analysis through the medium of multimedia is to encourage design students to:

> "relate theoretical ideas about the metaphor of design-as-language to the practice of design" [op. cit.]

We have already mentioned that we are incorporating *conceptual* models in our system according to the previous principle, and also that our system will lead students to discuss and develop their own design schemes. Then this makes it possible for students to realise their own design theories in terms of practical designs. This process enables students to think about the relationships between theory and practice. If students encounter problems

with either theories or particular practical problems associated with individual building types, such as method of construction, for example, they can then return to our system and look at particular issues in more detail. Structure, for example, is a primary concern in our system requiring special treatment. If students want to know the structure of a room with a large span during their own design process, they can open the *structure* section of our system and look at various large span structure examples. Design students can then learn about this particular element of buildings and develop their design theories accordingly.

3.5 Dynamic Interaction

A central feature of our own framework concerns the ways in which users can interact with the system allowing them to explore an architectural world effectively. We are aiming to provide an interactive multimedia teaching environment, in which it becomes possible for students to develop a greater awareness and understanding of a range of architectural types and design principles. This non-linear learning system allows users to pick up any one of the analyses they are interested in. The structure of this multimedia system is the next important thing to discuss.

4. MULTIMEDIA TECHNIQUES

"There is no right or wrong definition—it is a continuum of applications and technologies that allow for a wide range of experiences. In its most basic definition, multimedia can be thought of as applications that bring together multiple types of media: text, illustrations, photos, sounds, voice, animations, and video. A combination of three or more of these with some measure of user interactivity is usually thought of as **multimedia computing**." [Haykin, R., 1993]

Multimedia enhances traditional text-only computer interfaces and yields measurable benefit by gaining and holding attention as well as interest [Myren, B., 1994]. Multimedia information is a more effective way of understanding than through more conventional means because of the combination of sounds, voices, animations, and videos. When users themselves have interactive control of the process, they can be really become involved in the learning process. Multimedia stimulates the eyes, ears, fingertips, and, most importantly, the head. [op. cit.] An important feature of some, but by no means all, multimedia systems is the quality of dynamic interaction which enables users to navigate through information freely.

Within a free navigation system, hyperlinks are used to link pieces of information to each other.

4.1 Multimedia interaction

Multimedia is a medium within which users obtain information interactively.It is a non-linear rather than a linear information resource in which users can explore and navigate in order to obtain the information they want. They have choices of where to go according to what kind of information they need and how deeply they need to see the subject. The interface design will orient the user to the overall experience or message of the project. A transparent interface is one which is so subtle and quiet that users do not perceive an interface at all. In other words, coherent, easy to use *control and feedback* interfaces between users and computer need to be developed to let users navigate successfully through the system. [Cotton, B. and Oliver R., 1992]

4.2 Hyperlinks

In order to let users navigate through a multimedia system, hyperlinks connect information in the system depending upon what kind of links are needed. For example, buttons are used for browsing, opening images and video clips, and hyperlinked text makes connections to other related texts and to relevant images. Often, within multimedia environments such as web browsers, for example, these choices can have the effect of users being *lost in hyperspace*. In the implementation of our system called ADMIRE (an Architectural Design Multimedia Interaction Resource for Education), which will be described in subsequent sections, we attempt to preserve the flexibility of choice making within a flexible multimedia environment, whilst at the same time making the structure of the system itself explicit and transparent [Mishima, Y. and Szalapaj, P., 1999].

4.3 Macromedia Director

Macromedia Director is a sophisticated multimedia authoring software with an interface that lets users combine images, sound, video, and other media in any sequence and allows them to add interactive features through Lingo, the program's scripting language. Director is based on the metaphor of a theatrical production. A metaphor allows someone to understand and experience one kind of interaction in terms of another more familiar kind. Use of metaphors allows users to have a set of expectations that they can

apply to the multimedia environment. [Haykin, R., 1993] All the action takes place on the stage, and the cast appears on the stage as **sprites**, according to a timeline called the **score**, which tells cast members where to be and when to be there. A Director file is called a movie. Each movie, cast member, sprite and frame (thought of as a point in time) can also have its own script. Sprites are objects that span a range of frames. When you move sprites in the score, you move every instance of the sprite. The Director score provides a visual interface at every moment in time. According to Marc Canter, the founder and later director of VieoWorks:

> "Combining the time-line score and WYSIWYG (what you see is what you get) layout capabilities, you create a intuitive system for multimedia composition" [Allis, L., 1997]

Like a theatre production, a Director movie needs a **cast**. Each cast can have its own unique set of cast members which are media elements, such as graphics, sound, digital video, texts, or other Director movies.

5. STRUCTURE OF OUR SYSTEM

5.1 Information Types

The basic structure of our prototype ADMIRE system involves three building types (bridge, office, library) and three general categories of description. One of these categories contains general information about the buildings. Another category *Architect* includes the architect's biography and design influences. Location, site, plans, elevations, and sections are contained in the *Building* category. The most important category, however, which we especially concentrate on, is that of the *analysis* of the building types in terms of fifteen different analytical criteria which are typical criteria used in design-theoretical approaches [Clark, R. H. and Pause, M., 1985; Baker, G., 1989; Ching, F.D.K., 1996]. Many other types of analysis are possible, and other analyses will be included in further developments of this system (e.g. proportion).

We use various kinds of media, such as text, images, video clips, and talking heads. This information is structured in an x-y grid system in order to make the user-interface logically transparent to use. (**Figure 2**) The number of either analytical criteria or of building types can eventually be increased by extending the x-direction for buildings and the y-direction for the criteria.

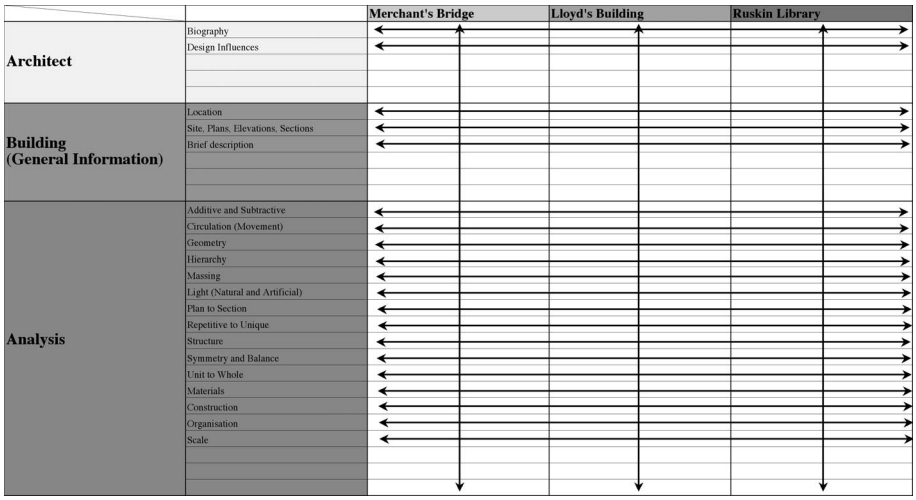

Figure 2. Grid system outline for navigation

5.2 Navigation

We expect that architectural students will use the system in such a way as to compare information across both building types and analytical criteria. There is no restriction on users to choose particular information in our system. Horizontal arrows in the chart of **Figure 2** shows the method of this comparison. Another way of learning is to see one building in terms of different analyses. Users can look at an analysis, visualise how the building is designed, and extract from the analysis essential components or ideas that can potentially be transferred onto their own design schemes. The vertical arrows in the chart illustrate the simple grid-based structure of navigation.

5.3 Interaction

We combined all the information types under the structure and navigation described in section **5.1** and **5.2**. Although the structure and its associated navigation system has a linear arrangement, the system gives free access to users so that they can start with whatever element they are interested in. However, once in a section, there are varieties of information such as animated diagrams, architects talking about how they designed, etc.

6. IMPLEMENTATION

6.1 Three British Buildings

We chose three British buildings for our system. The Merchants Bridge in Manchester designed by Mark Whitby, is a case study which encourages users of the system to focus on more engineering-oriented analyses such as *structure* and *balance*. The Lloyd's building in London by Richard Rogers represents an office building type. *Unit to Whole, Repetitive to Unique, and Plan to Section* are typical significant analyses of this building. The Ruskin Library at Lancaster University by Richard MacCormac is an example of library building type. The effects of *lighting* constitute an important analytical criterion for this building. Each building, therefore, has a different purpose and function, so that comparison of the analyses reveals different viewpoints.

6.2 Analysis of the buildings

We analysed each building in terms of the *conceptual models* described in **3.3. Figure 3** shows the geometrical analysis of the Ruskin Library.

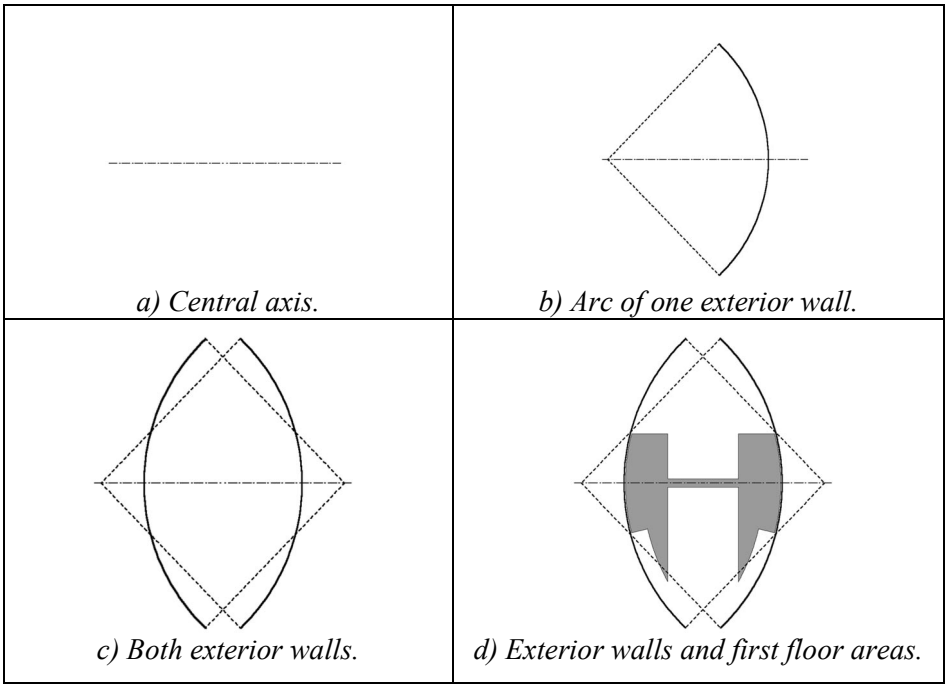

Figure 3. Geometrical analysis of the Ruskin Library

This diagram illustrates how the walls of the building are created from one single horizontal reference line. It also shows how the edges of the floor end at the points between the walls with lines for arcs. It is difficult to find this geometrical analysis in fully drawn plans. These simplified models clarify the method of design. The conceptual models enable us to show three dimensional analyses as well. The analysis of hierarchy is revealed with the model shown in **Figure 4**. Strength of colour (or shading) corresponds to the important areas in the building.

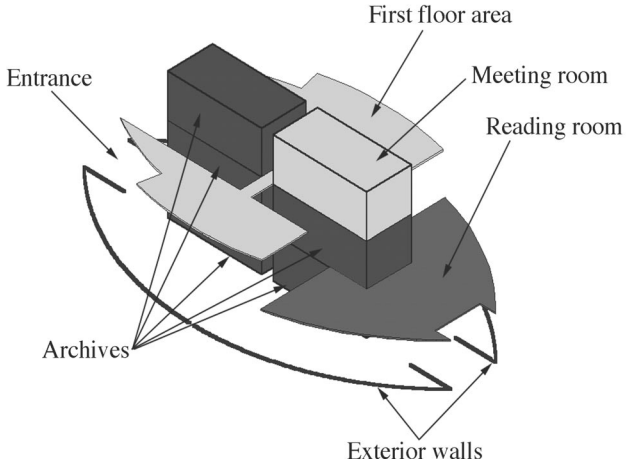

Figure 4. Hierarchy analysis of the Ruskin Library

6.3 Information Use

Each building type includes video clips associated with specific analytical criteria. The video clips that appear within individual analytical categories tend to give the user a more realistic understanding of the building type to complement the more conceptual types of analyses. In other words, they help users to map the theoretical ideas of the building onto actual built form. We also interviewed each architect and asked questions relating to the analytical criteria so that we can combine these two forms of presentation together to make forms of visual presentation more refined.

6.4 Dynamic interaction with the system

We use Macromedia Director 8.0 in order to accomplish the type of multimedia interaction we require. Director not only combines multimedia elements into a portable movie, but also supports them with Lingo,

Director's own interactive scripting language. The users interact with any of the media elements presented, and navigate through volumes of information. Users of our system have choices of information about the analysis of each building in the menu screen (**Figure 5**). This basic screen is reflected from our structure described in section **5**. An analysis of the building, which the users choose, is explained in the first page (**Figure 6**).

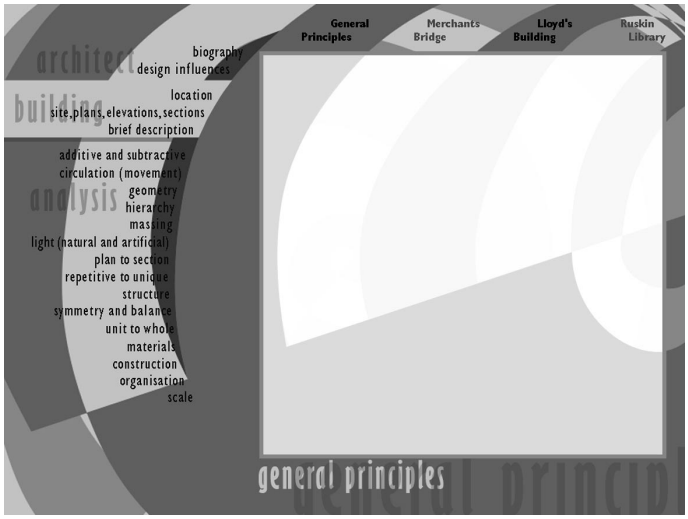

Figure 5. Basic ADMIRE system menu screen

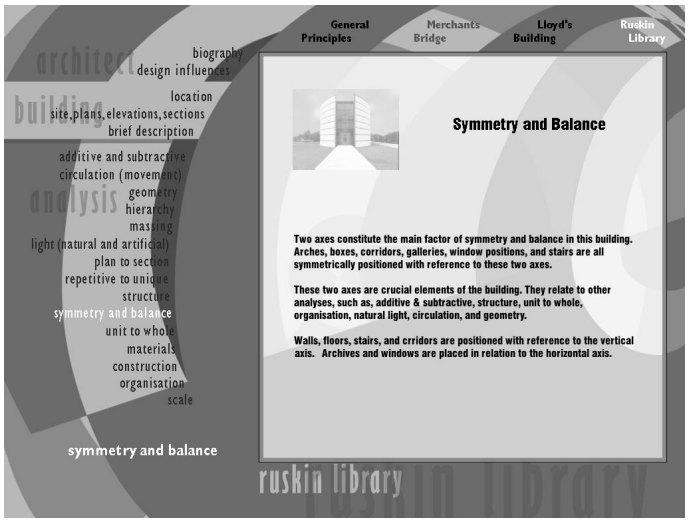

Figure 6. Introduction to the analysis of Symmetry and Balance in the Ruskin Library

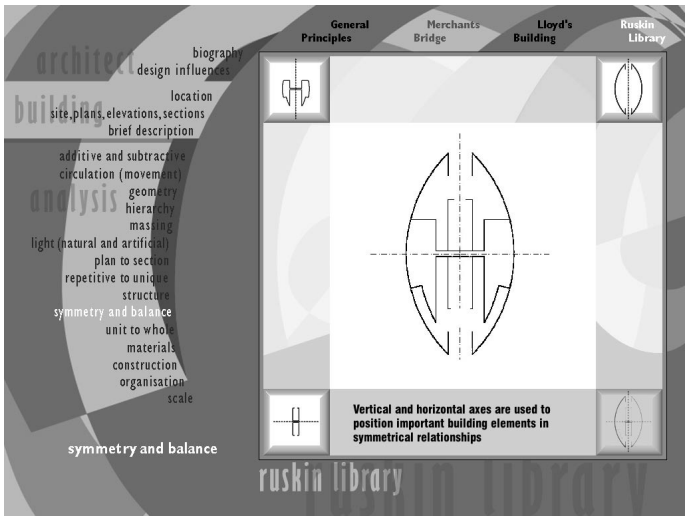

Figure 7. Conceptual diagram showing Symmetry in plan for the Ruskin Library

When they proceed to the next page, analytical conceptual models described in **3.3** are shown with text so that the users can see the building simply but also detailed (**Figure 7**). Realistic video clips of the building support the ideas of how this specific design scheme is applied to the final project (**Figure 8, 9**).

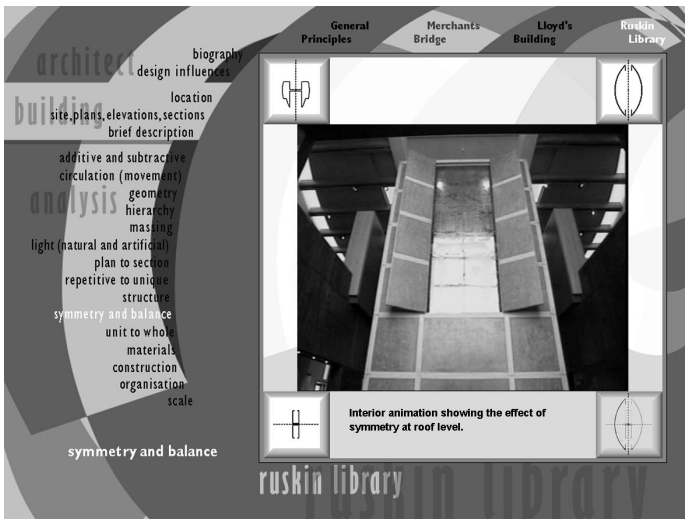

Figure 8. Realistic interior video clip illustrating wall symmetry at roof level

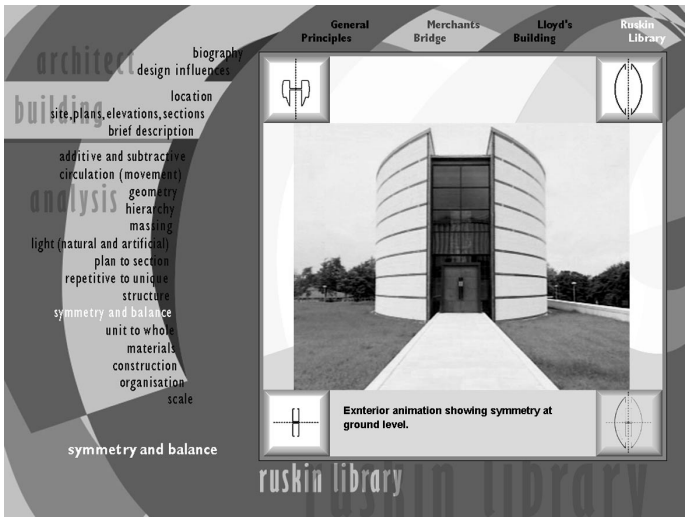

Figure 9. Realistic exterior video clip illustrating wall symmetry

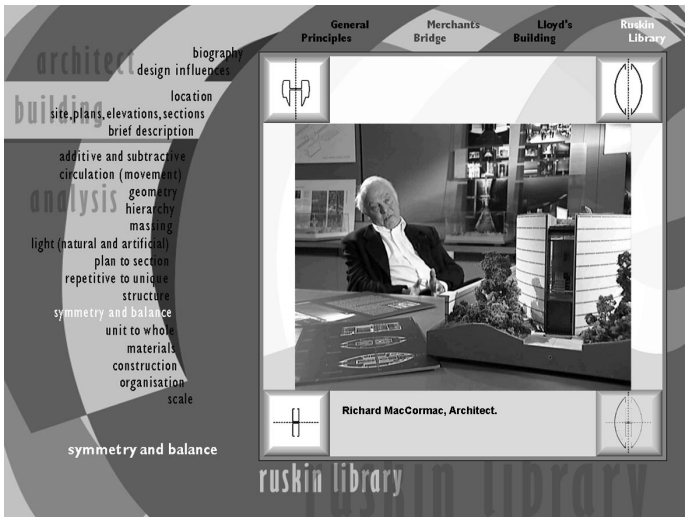

Figure 10. Talking head of Richard MacCormac describing symmetry

Listening to the architect talking about the design of the building reveals the range of ideas the architect had in the process of his or her design approach (**Figure 10**).

7. CONCLUSIONS

The advantages of interactive non-linear presentations for architectural education: Our multimedia system is based on the principles described in Section 4 which allow architectural students to build up a *context* for their own design schemes. These contexts will include various types of building, analysis, architect, etc. As the information increases within the context of a project, students have the opportunity to compare and contrast various new kinds of analyses. These analyses in turn encourage students to improve their own design theories.

User-centred learning: The system allows users to work at their own pace regarding the viewing of analytical descriptions. They are free to return to previously viewed analyses in order to reflect upon the information content. Since the ADMIRE system is available in CD-rom format, this work can be carried out outside of normal lecture and studio time.

Connecting the design studio with computer-based applications: *Conceptual* models show the main principles of buildings very simply. Our system clarifies these underlying principles, and the *conceptual* models can also be referred to by students for their own design presentations.

Bringing to life real buildings in real time: Students can also include their own design schemes in the system. These schemes can then be contrasted with the schemes of well-known designers in crit situations, for example. This system can ultimately become a collection of student work for schools of architecture. We are currently implementing a CD-rom teaching resource, in which students can interactively develop design ideas.

Evaluation of the system: We initially evaluated an earlier version of the ADMIRE system developed using HyperCard on a Macintosh computer in 1999. We found that second year students preferred less textual, and more visual information, as well as a more integrated system although the existing logical structure of the system was appropriate. We are presently compiling questionnaires that will elicit from second year architectural students their impressions of interacting with this new improved version of the ADMIRE system which currently contains three comprehensively analysed building types across fifteen analytical criteria. Our questions are aimed at getting reactions from students that indicate:
whether the system has presented them with understandable analytical information; the extent to which they are interested in investigating analytical possibilities; their criticisms of and observations of the user-interface of the system, and their suggestions and comments for the further development of the system.

In addition, we have implemented a function (using the Lingo scripting language) in Macromedia Director 8.0 to trace how the users explore and

navigate through the information in our system. This *tracing* or *history of use* mechanism allows us to monitor the amount of time that students spend within individual elements of the grid network, together with the connections they make themselves between the available analytical criteria. The responses of the questionnaires together with our investigation of exploration will be helpful for further development of the system, and the results of our evaluation will be published in future research proceedings.

We are also planning to carry out a long term evaluation lasting up to one year after students' use of the system, to investigate how the system has influenced students in the development of their own design schemes through studio project work. We expect to find a greater use of analytical diagrams, models and explanations not only as part of their final presentations, but also during the process of their design work.

8. ACKNOWLEDGEMENTS

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