A study of digital presentation techniques in architecture

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Abstract

Since the successful application of computer animation in the film and video-game industries, we have seen a rise in the general education of people in the areas of graphics and audio-visual media. In contrast, the average level of understanding of architectural representation is still much lower than it is with regard to other visual media.

Architectural presentations are of great importance in revealing how the built environment is conceptualised, constructed and perceived. As media types may vary, their contribution to the creation of the built environment differs too. Writings allow readers to envisage images in their minds, while perspectives and computer graphics provide more realistic and objective images, although still restricted to flat surfaces. Contemporary technology permits architects and clients to virtually visit 'the buildable'. The core problem of these presentations, however, is how to interpret them, as they represent different motivations, attitudes and values.

There has been no clear conception or definition of the nature and consistency of architectural space. The need for its representation and mass diffusion perhaps has consequently not been exploited as much as it should have been. This paper investigates the nature and characteristics of architectural presentation in the context of contemporary computer graphics technology.

Keywords: presentation, representation, visualisation, virtual environments, animation

A Brief History of CAAD Development

Pen and paper are the traditional tools used by architects to present their design ideas in 2D form. Architects then build 3D models to explore possible designs at smaller scales. It was not until the late 1960s/1970s with the introduction of computer graphics that architects could start drawing their designs in computer generated formats, and then build full-scale mock-ups in a space which is not constrained by physical conditions.

A mainstream of CAAD work in the sixties was based on graphics systems such as Sketchpad developed by Sutherland, and other pioneers such as Coons, Ross & Rodriquez and Johnson. Building modelling research was established in the late sixties at Liverpool with Arthur Britch, at Edinburgh with Aart Bijl, and at Strathclyde with Tom Maver. They were joined in the seventies by groups at both Cambridge, Leeds and Bristol (Willey, 1999). These approaches to CAAD were based on the idea that computers would *represent* the whole of a design project previously held in the designer's mind. This representation would be used by specialist design analysis programs that would access the representation and produce accurate predictions of costings, lighting values, heating requirements, structural calculations, in addition to all design drawings and bills of quantities.

The problems of *representing* building geometry with associated materials within an integrated system capable of modelling any building, became the main research focus, and soon led to attempts to reduce this complexity by *restricting* the building types or the building systems that would be modelled. By the late seventies, it was clear that these modelling systems were not making the crucial breakthrough from research tools within restricted environments into the world of general architectural practice. That breakthrough occurred with *dumb* drawing systems that allowed 2D drawings to be stored, amended and reproduced using mini-computer systems linked to high quality graphics workstations. Aart Bijl wrote his seminal critique of integrated CAAD systems in 1979 (Willey, 1999). Thereafter, the Edinburgh group began to search for ways in which to provide computer systems with more flexible and intelligent characteristics that better matched the professional orientation of the architect.

The microcomputer was well established in the early eighties, but the impact of low-cost personal computing transformed architects' offices during the late eighties and early nineties. Architectural practice became digital.

In the early eighties, a large subset of CAAD research became involved with the complexities of Artificial Intelligence and Expert Systems. Papers were published that demonstrated the potential of CAAD techniques developed from those already established in Artificial Intelligence. Development also continued of complex environmental programs that depended upon their own representations consisting of only those features that were relevant to them (Maver, 1982). Such packages are an established part of engineering consultancy. However, despite architects now working within a digital drawing environment, the products of the CAAD research community have still not been widely adopted.

CAAD research has attempted to use computers to aid architectural design. During the last 30 years, an impressive amount of research effort has been made, but the impact on practice was still very low. Most of the CAAD systems used in practice were simply not good enough to replace traditional design media and technologies. Therefore, it is not surprising to see that most CAAD systems used nowadays in practice are still only for drafting purposes. According to the "Business and IT Survey 1998/9" published by the Chartered Institute of Building; 93% of primary use of CAD was for 2D drafting, and a mere 4% for 3D surface modelling.

Another possible answer to why CAAD research has had relatively little impact on practice is because much of CAAD research was largely focused on using the computer as a design tool. No argument will be made in this paper for the ability of computers to aid in the *designing* of architecture. But as design itself is a very intuitive activity on the part of the designer, it is rather difficult to develop a 'tool' which can actually correspond to every individual designer's ambiguous design process.

Presentation/Representation

In order to further discuss presentation techniques, the definitions of *presentation* and *representation* need to be clarified here. It is important to note that these definitions

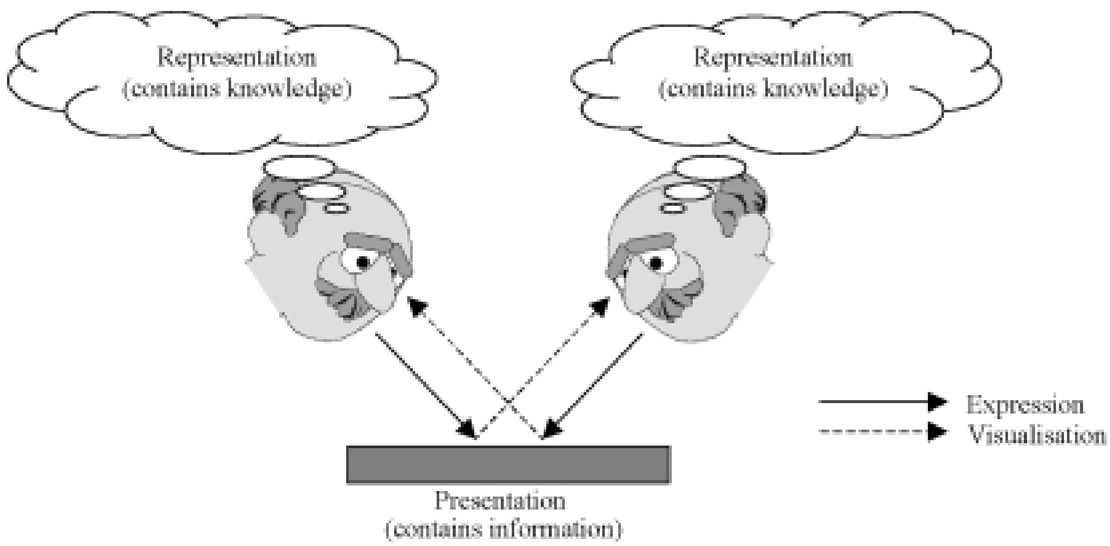

Figure 1 Presentation and representation by people

need to take into account the communicative and interpretive contexts provided by *people.* According to Bijl (Bijl, 1989), *representation* is something within people's minds and cannot exist in the outside world. When we look at a *presentation* – ie, thorough visualisation – information is internalised as the representation of knowledge in our minds. Using the same method in the opposite direction, knowledge is externalised through expression to become presentations in the form of artefacts outside of our minds.

Figure 2 Process of presentation and representation

Therefore, we can say that presentations give us the motivation to represent information through a process of internalisation, and representations give impetus to the presentation of information through externalisation.

Visualisation

Before computers can actually aid in the *designing* of architecture, we should investigate how we can use computers to aid in the v*isualisation* of architectural design. The word visualisation here means the process of observing a presentation, through visual perception – eg images, models and animations – of a design project and then internalising the information received from the observation to generate a representation in one's mind.

The applications of visualisation as presentation tools now used in practice are largely involved with producing photo-realistic images and/or animations generated from a computer 3D model (Brewster, 2000). Individual views can be captured, and even the site context can be photo-montaged (Figure 3) to its designed building. Photo-realistic presentations are routinely made irrespective of whether or not they can actually help clients to understand the designed buildings. An argument raised here is what is the future trend of producing photo-realistic images? To be more real? Are the produced images *too good to be true*? This argument is already happening in practice. Since architects have full control of presentation, some clients think architects only present the good side of a scheme whilst hiding its dark side.

Another trend is to rethink the use of digital techniques for visualisation purposes and to present the *designing of architecture* but not *designed architecture*. An important point here is that we often think and then use computers to present the results of our designing, rather than the process of our design. It is not easy to see architects using computers to generate images or animations to express their design process. The definition for realistic images here may need to change to how thinking in mind is being truly depicted and visualised.

The reason that we place the main focus on discussing visualisation in a paper entitled presentation techniques is because we have applied a reverse way of thinking in order to find out how we visualise architectural presentations, and then produce presentations in that manner.

Figure 3 Photo-montaged images give a perception of the future built form.

Beyond physical restraints, virtual environments allow architectural presentations to engage movement, transformation, and alteration. The inclusion of the time element within architectural presentations reveals a new and unfamiliar language for this profession in which presentation based upon *static* objects has been the norm. The fundamental nature of animation is its *dynamic* image giving a sense of movement. A conflict then appears here begging the question of what do we want to move? The long tradition that first comes into architects' minds is that we can move around a digital model as we do in the physical world. In this type of presentation, viewers define themselves as avatars in the virtual environment which have the ability to move and to observe the proposed design scheme. Research has even looked at the computer game industry to see the possibility of applying the game playing metaphor for architectural visualisation purposes (Richens, 2000). This immersive experience certainly gives a higher level of information richness compared to 2D images or 3D physical models. The *time element* in virtual environments provides architects with a new realm through which to explore proposed design schemes in which it was previously difficult to give immersive experiences.

Further to this argument, once the time element gives viewers the ability to move in virtual environments, can we then apply it to our digital models to present deeper design information? From the classic examples in which Rasmussen (Rasmussen, 1959) mentioned in his book *Experiencing Architecture,* of which rhythm, solid and cavities, scale and proportion, daylight, etc, all play an important role for someone to *experience* architecture. Moving on from traditional architectural presentations, viewers need to be trained in order to observe the possibilities of those techniques based upon architectonic ideas when applied to in an architectural models. Using digital models in virtual environments, architects can then apply those techniques to architecture by involving motion for the transformation and manipulation of digital models. These techniques of presentation can then assist in design process development. Therefore, the time element for enabling movement in virtual environments applies not only to the viewers exploring the final designed product, but also to the actual generation of digital models for demonstrating how this final design product was developed.

Case Study: Merchants Bridge

To demonstrate the possibility of using digital models to present design idea and development, a bridge design project was chosen to do this experiment.

Merchants Bridge, designed by Mark Whitby and Des Mairs, partner and associate respectively, with consulting engineer Whitby and Bird, is a curvaceous sickle-shaped arch which arcs both horizontally and vertically. The deck of the bridge is held by 13 tapering hangers that incline upwards to the bowing arch overhead. These two mutually compatible parts counterbalance the overall structural system of the bridge (Figure 4).

Before starting to build a model of this bridge, we first have to ask what is the intention of our presentation? A theme for this presentation is first constructed: to

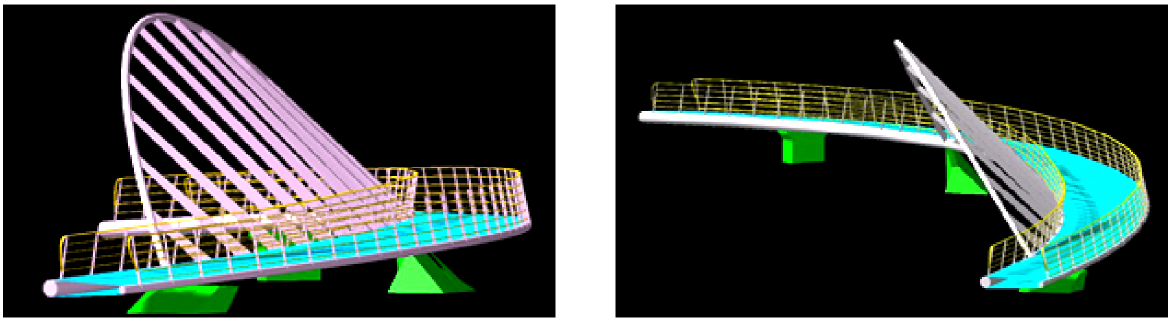

Figure 4 Geometry and structural system of the bridge

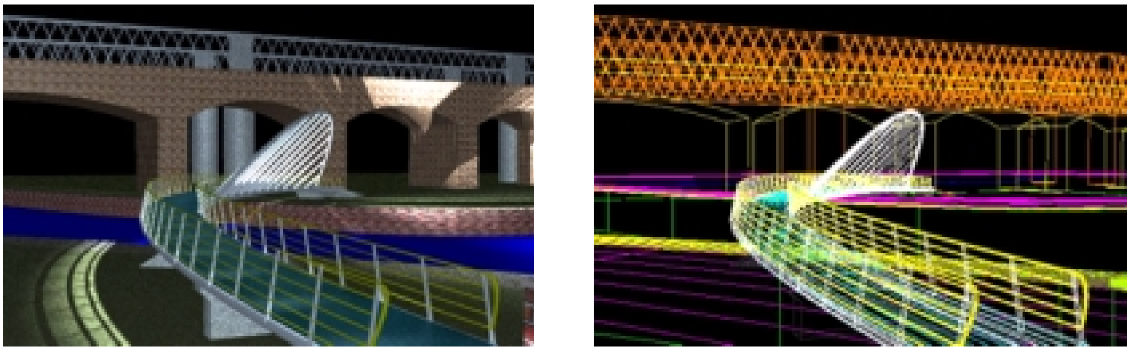

Figure 5 Contextual CAAD models of the bridge scheme

demonstrate the sophisticated geometry and structural system of the bridge. Viewers will be able to visualise the virtual model, experiencing the geometry of the bridge and retrieving information regarding structural analysis. Secondly, we have to set up the virtual environment in order to present this theme. The techniques we used to present the theme of this bridge design scheme were based upon a 3D-motion model (walk-though & animation) together with real-time navigation. It is possible, therefore, for users to interactively control, in real-time, their viewpoint and position within any animation.

Another important aspect of this scheme requiring presentation is its context, particularly the site, but other factors as well including the history of the site. The bridge is situated at the junction of the Bridgewater Canal and the Rochdale Canal in Castlefield which was a heritage site for the industrial revolution. This context is illustrated in Figure 5.

The design idea of this bridge was inspired by several influences. In an interview with the structural engineer Mark Whitby he mentioned:

> "We have bending, shear and tension worked out but we have yet to make use of torsion In the aerospace industry, they know about torsion and its effects on the fuselage and wings of a plane." (Ridout, 1994)

The result of adding torsion to the design is to weld the deck with tapering hangers which incline upwards to the bowing arch. Therefore, in order to represent bending, shear, tension and torsion of the structure of the bridge, an animation explaining the structural analysis is needed. Our solution was to produce a more conceptual and less realistic form of presentation as indicated by the sequence of animation images in Figure 6. Other design ideas of this bridge are to create a horizontally curved path closely following the desired line of movement; and that the visual as well as physical weight of the deck should be as light as possible to delight pedestrians crossing over it.

A group of students in the School of Architecture at Sheffield University participated in an evaluation of our VR presentations. An animation of the bridge which contains sources of inspiration in the design of the bridge and pre-recorded walk-throughs were shown to the students. Also, students were invited to carry out real-time navigation of the virtual bridge model. Our preliminary observations show that when we were trying to express a thought process – analysing the distribution of shear, bending,

Figure 6 Sequential images showing a conceptual torsion force in a strip element.

tension and torsion forces; creation of the geometry; light deck – students preferred to observe abstract representations and models. When we tried to express the content of thought (or the artefact of human mind) – the final geometry of the bridge, atmosphere around the bridge, construction of the bridge structure; actually walking on the bridge (the artefact), viewers expected to see more realistic models. Also, 3D-motion models are appropriate for presenting the process of thought and real-time navigation is more applicable for experiencing the content of thought.

The Future

This paper has studied and summarised a brief history of digital presentation techniques for architecture from their inception until the present time, and, with case studies and examples, has investigated the possible tendencies of such techniques in the near future. The analysis of architectural representation that this paper has covered should give us insights into how these tendencies might develop and how they might be applied to architectural design.

A central contention of this paper has been that there are already available techniques visual presentation that are relatively underexploited in architectural design practice, but that are richly developed in other artistic areas such as in films and video games. Architects still think in terms of the physical ways of presenting architectural models in virtual environments. They still cannot escape from the long tradition of building a model as real as possible, locating it within a context (eg, in virtual environments), and then observing it. We believe that this traditional approach is only the most basic level that computer graphics can provide to this profession. On top of that, the next generation of computer graphics to be exploited by the architectural design profession should look deeper into the use of computer graphics for the presentation of design ideas and for the process of design development.

Another focus of ours has been to move away from trying to represent design ideas computationally, and instead to provide designers with a presentation environment based upon the aforementioned techniques which are under the control of the designer, but still relevant to architectonic presentation. In other words, computer presentation environments for architectural design work should not attempt to *prescribe* representations in advance of designers' use of these environments.

We hope that this paper does not conclude any argument, but rather opens a debate on a new trend for the future of CAAD developments. Computer graphics has been known to the architectural design profession for the last 40 years, but the exploitation of it is still in its infancy. The video game and film industries are also beginning to have a significant impact upon what computer graphics can do. Perhaps we don't need any new tools to aid architectural design. What we need is to rethink a new direction of using computer graphics to present architectural ideas, and to use our hands with mouse and keyboard to make those ideas *visual*.

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