How Useful is the Digital Sketch?

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This paper presents an experimental approach that examines human response to three virtual representations (sketchy line, non-photorealistic and near-photorealistic) of three similar architectural schemes (in terms of concept, context and scale) within a non-immersive large-screen projected virtual environment. Participant response is recorded utilising the factors of detail, spatial understanding, character and presence. By comparing data it should be possible to draw conclusions about aspects particular to non-immersive Virtual Reality (VR) activity as a means of architectural representation.

Keywords: Non-immersive virtual environments, digital sketching, non-photorealism

Introduction

In recent decades the design profession has been deeply affected by the digital revolution and the use of Computer Aided Architectural Design (CAAD). Technological developments during the last few years now facilitate the creation of dynamic and three-dimensional environments, leading the revolution from the static two-dimensional representation towards what is hoped will be a more fluent interface, and consequently more fluent design process. These technologies have the potential to enable the architect to explore and communicate design proposals in ways that have not previously been possible with any other media (Petric et al, 2002). VR models improve the quality of architectural representation, the digital environment providing an immediate feedback with tools that not only enhance the translation of design intentions (Schnabel and Kvan, 2001) but also broaden the boundaries of traditional perception (Petric et al, 2002). The use of digital technology in design has numerous advantages over traditional presentation methods, and preliminary observations within the architectural context indicate that VR techniques involving depth perception allow humans to convert relevant information more efficiently and with less misinterpretation in the virtual medium than with traditional techniques (Kalisperis et al, 2002). Traditional sketching techniques can now be implemented digitally within the early stages of the design process, augmenting some of the advantages of traditional creative sketching within the digital 3D modelling process.

Sketch

Designers place great emphasis on the sketch because it is thought to be associated with innovation and creativity (Purcell and Gero, 1998). The traditional architectural sketch has commonly been represented by the two-dimensional format of pen

on paper, and is often used during the early stages of design development to communicate the ideas of the architect to the client. Drawings and sketches involve freestyle and individual expressions of ideas, and the ways in which they are represented can have various impacts on the communication of architectural ideas and spatial thinking (Porter, 1997: Bassanino, 1999). Sketches are often unfinished, rough in appearance and convey their intentions without expressing completeness, allowing the individual to imply and interpret the image and its spatial properties.

Sketch Model

The notion of a sketch however is not limited to that of a two-dimensional representation on a piece of paper. An architect may interpret a drawing by reading it as one of physical space in the three-dimensional realm. For the non-architect however the drawing is real but the three-dimensional reference and the real world intentions of the drawing may frequently be lost. Indeed it is difficult for the non-architect to interpret and visualise space (Hershberger, 1969) and often the layperson will not clearly understand the intentions of a proposed development and consequently fail to engage in a mutually understood dialogue with design professionals (Hall, 1992). Third parties may therefore often prefer the physical model, because although representational it is less so than a drawing, and has an ability to relay three-dimensional spatial relationships whilst being easy to physically manipulate.

Computers and Digital Media

Computer graphics have begun to replace the role of the physical scale model in architecture, shifting from the mechanical paradigm to the digital and providing a freedom to rapidly explore and alter ideas without the need to completely rework drawings and physical models. Computer Aided Architectural Design (CAAD) gives designers the opportunity to generate specifically detailed, interactive and potentially complex architectural models, in contrast with the static images of traditional media that cannot represent the effects of movement and change over time (Kalisperis et al, 2002). The time-consuming and mechanical nature of digital techniques however has constrained their application during the early stages of design.

Free-form 3D creation

CAAD however is now not the only option available for creating 3D models. Free-form technologies including DDoolz (Achten and De Vries, 2000) Sketch-Up (@Last Software, 2000) and Digital Clay (Schweikardt and Gross, 1998) facilitate 3D computerised sketching during the early stages of design, quickly generating simple three-dimensional representations of digitally modelled space. Many methods of 3D freeform digital sketching immediately transform two-dimensional drawings into three-dimensional models and therefore bridge the gap between the two drafting tools. Others eliminate the two-dimensional interface altogether and immediately begin to model in three-dimensions. These technologies clearly illustrate an immediate visualisation of space, revealing geometry, line and composition, much as in the more traditional practice of drawing, and therefore have the potential to improve the quality of architectural representation. The question is whether the new techniques available to us are effective tools in the communication of architectural ideas, for in order to use new computer-based media efficiently it is important to understand how the individual (designer, client, or other third party) reacts to and interprets the digital visual images that are produced (Hershberger, 1969, Bassanino, 1999). This will allow one to make conclusions as to how appropriate these new free-form techniques are in conveying useful information to all parties involved during the early stage of the design process.

Previous Work

Previous research undertaken by the CAAD research unit (CAADRU) at Liverpool University in-

cludes a study by Bassanino (1999). The overall aim of this work was to offer an approach for all parties involved in the design process by ascertaining the interpretation of two-dimensional digital images and their effectiveness in communicating architectural design ideas and information.

Method

The research tested the static computer-generated two-dimensional image, using ten different architectural schemes represented by plan, elevation or perspective. Each of these schemes was rendered using a variety of techniques ranging from the photorealistic to surrealistic, the mechanical line to loose edge line, using paper, a computer monitor or a projection screen as the display device. The participant groups of architects and non-architects were tested.

Outcome

This study concluded that architects differ from non-architects in their perceptions of static computer-generated, two-dimensional images. Building industry professionals and lay people expressed higher values for mechanical drawings, whilst architects preferred loose edge line images that gave the impression of being hand drawn. Architects also had a preference towards monochrome rather than coloured photorealistic images, and towards those images with photorealistic rather than photosurrealistic qualities. The display medium also had an effect upon the perceptions of different image
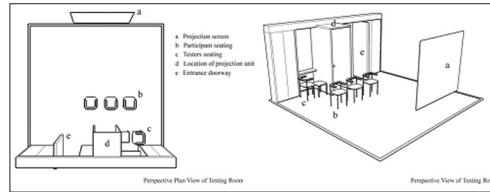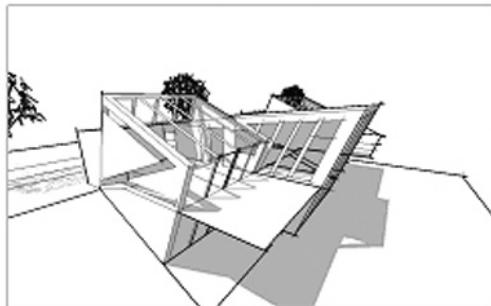
types, as did the effects of education, experience and gender.

Pilot study experimental testing procedure

This work is extended from the previous testing media of static, two-dimensional images towards a three-dimensional method of representation using digitally animated architectural schemes. Eighteen non-architects were tested at the University of Liverpool's School of Architecture Virtual Reality (VR) Research Suite, illustrated in Figure 1.

Approach

Limitations of perception and cognition suggest that non-photorealistic representations might have a place in the designing and overall manipulation of the built environment (Schmitt, 1987). The research therefore examined three animated digital representations of similar architectural schemes (in terms of concept, context and scale) within a non-immersive virtual environment. Each three-dimensional architectural scheme was differently represented using the rendering methods of sketchy line, non-photo-
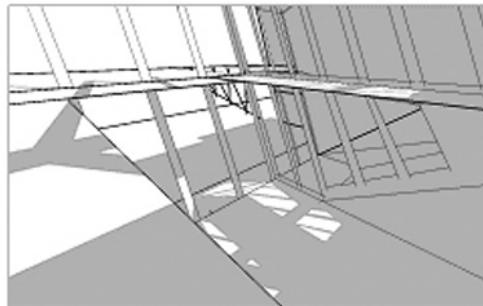
realism and near-photorealism and were presented in the following order.

Scheme 1 - Sketchy line

This model is presented as a monochrome, hidden line drawing with extended edges and shadows. The animated walkthrough incorporates both egocentric and exocentric views of the internal and external aspects of the three-dimensional environment.

Scheme 2 - Non-photorealistic

The model and animated walkthrough are identical to that of Scheme 1 with the exception of the monochrome appearance being replaced with colour.

Scheme 3 - Near-photorealistic

The model differs from that used in Schemes 1 and 2 and is rendered to incorporate shadows and material elements to near-realistic precision in order to give a real world impression of the environment. The animated walkthrough incorporates egocentric views of the internal aspects of the environment.

Questionnaire

Participant response was recorded utilising the factors of detail, spatial understanding, character and presence. At this stage it is only possible to make conclusions with respect to a non-architect population.

Findings

Sketchy line

There are widely differing responses to be observed with regards this scheme. There is also a high level of division between responses when analysing the effect of gender upon perception, as illustrated in Figure 3.

The sketchy line representation is much more open to interpretation that the non-photorealistic and near-photorealistic methods of representation (Table 1). However, when compared to these other two methods of representation less importance is placed upon the level of realism in the sketchy line scheme in understanding the environment.

Non-photorealistic

The results for the non-photorealistic scheme follow general expectations, falling between those of the sketchy line and near-photorealistic schemes. The introduction of colour both makes the environment seem more realistic and gives the impression of the

Scheme	No. of responses following expected trend	No. of responses against expected trend	No. of responses with overall divided opinion	No. of responses similar for gender	No. of responses divided by gender
Sketchy line	4	12	6	8	12
Non-photorealistic	7	8	1	11	6
Near-photorealistic	15	4	2	16	4

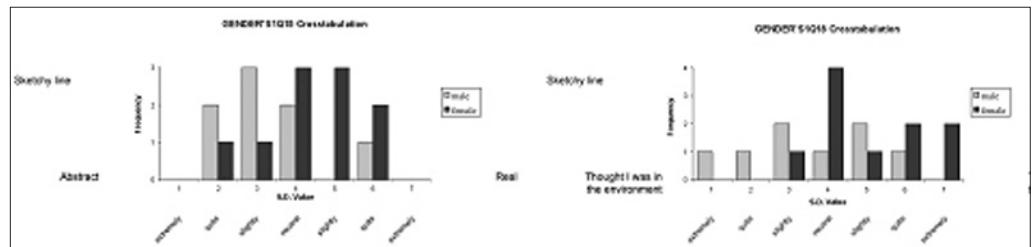*Table 1*
Short summary of results.

Figure 3
Examples of effect of gender upon perception.

environment being more definitely fixed. However, one would have expected that the introduction of colour would have a more dramatic influence upon the perceived realism of the environment than is indicated in the results.

Near-photorealistic

The near-photorealistic scheme is the most predictable in terms of participant response and is regarded by the respondents as being the most consistent with real world experiences. Similarity in response by gender is also very evenly matched for most questions.

Results that do not follow the predicted trend, and that are of most interest, concern those questions describing the character of the spaces (figure 4). This is because the near-photorealistic scheme is perceived both as being expressive and dynamic, attributes one would expect to be associated with the sketchy line scheme.

Adjectives concerned with the character of the spaces - comparisons with Van Bakergem and Obata (1991)

The pilot study data for the questions concerning the character of the spaces frequently contrasts that of Van Bakergem and Obata (1991). In this study the participants described squiggle line drawings as being soft, flexible, expressive, unfinished etc. whilst those of the traditional laser plot were described as hard, fixed, precise, static etc. However, the pilot study results in many instances indicate an almost complete reversal of perception with regards all methods of representation.

Levels of realism

There is a conflict between the requirements for understanding a general overview of the environments and understanding the more specific elements contained within them. With regards being able to understand the whole environment all of the schemes were easy to interpret as being three-dimensional, indicating that an increase in realism is not essential. With regards the understanding of individual elements however, an increase in realism (in terms of colour and an indication of surface textures) is necessary in order that the elements can be fully understood.

Discussion

Sketches play a key role in the early stages of design. They are an essential tool for quickly formulating and communicating architectural ideas, and free-form technologies now give us the opportunity to pursue sketching activities within the three-dimensional, digital realm. It is essential however that these technologies be developed effectively, so that they have a positive impact on the development of design and its communication and understanding (Tovey and Porter, 2003).

The results from the pilot study test indicate that this may not be a straightforward process, for the observed wide differences in perceptions towards different methods of representation (sketchy line, non-photorealistic, near-photorealistic) should be accounted for in the development of new approaches to digital 3D sketching. Generally digital environments are becoming more concerned with
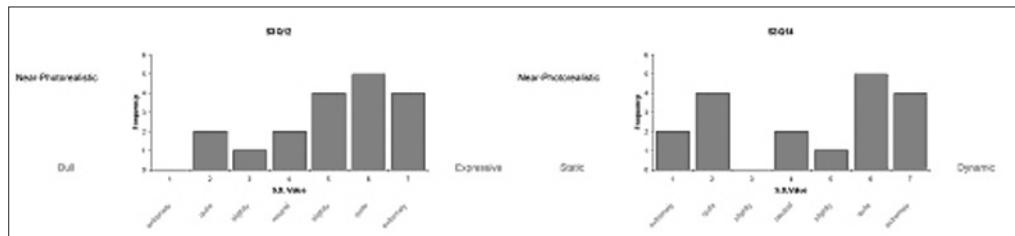

Figure 4
Perception of non-photorealistic scheme as expressive and dynamic.

photorealistic depiction, yet the pilot study results indicate that non-photorealism as a method of representation is also a valid and useful technique for communicating architectural ideas. Indeed the incorporation of this method of representation may make digital design tools more effective. Future experimental studies will therefore be used to both determine how best to represent early-stage digital architectural designs to all groups involved in the design of buildings, and suggest directions for the development of free-form architectural design tools.

Acknowledgements

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