Landscape and Urban Planning 91 (2009) 171–182

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

The role of computer visualization in the communication of urban design—A comparison of viewer responses to visualizations versus on-site visits

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ARTICLE INFO

Article history:
Received 26 March 2008
Received in revised form 9 December 2008
Accepted 17 December 2008
Available online 4 February 2009

Keywords:
Visual simulation
Computer visualization
Design communication
Urban planning
Spatial perception
Content analysis

ABSTRACT

Perception, attention, retention, comprehension and deduction are critical parameters in probing the adequacy of computer visualizations as means of communicating urban design proposals. This study investigates these parameters in the context of the remodelling of a large urban square in Vienna, Austria. Half of a total of 76 participants experienced the site after remodelling; the other half experienced a series of visualizations of the project proposal. Their responses were gathered by means of a qualitative questionnaire and content analyzed for similarities and differences in their cognitive, affective and evaluative aspects. Significant differences in responses were related to the limitations of the visualization medium in communicating aspects such as texture, movement, interaction and specific sensory qualities related to the design. On the other hand, visualizations were superior in communicating some aspects of the design in virtue of their ability to direct attention to centred or foreground pictorial elements. Visualizations can be successfully employed in design communication, yet more emphasis has to be placed on matching visualizations with the communication needs of the targeted viewers.

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1. Introduction

Computer visualizations are regarded as potent communication tools. They support planning decisions and allow for greater involvement of the public by providing explicit images of, e.g., the prospective state of a landscape (Pietsch, 2000; Bates-Brkljac, 2007). They are, however, criticized for possibly biasing the viewer's response (Sheppard, 2005). Therefore, it would be desirable to know how responses to visualizations deviate from responses evoked by the real world.

Research literature says little about the communication effectiveness of visualizations (Zube et al., 1987). Nor can one merely posit the viewer's ability to successfully interpret the visualization and understand the underlying intentions of the image producer as establishing the validity of the image as a representation of the issue at stake. Yet this assumption is often made in the context of design communication.

The present study aims to advance the discussion by providing a critical account of past research on viewer responses to visualizations in the frame of cognitive psychology and by showing how the present work fits with the existing knowledge. An experiment on perception and design communication will be presented that has been conducted as a practical application of the theoretical background.

1.1. Visualization as realism surrogate

Computer simulations are becoming more sophisticated and powerful tools for landscape visualizations, while the understanding of the impact on the viewer's perceptual and evaluative response is lagging behind. Yet, the importance of assessing aspects of human cognition in relation to the potential misuse was brought up already in the early days of computer simulations (Steinitz, 1991; Zube et al., 1987).

1.1.1. Response equivalence/representational validity

Visualizations were acclaimed of being able to act as valid and reliable surrogates for the real world in its various conditions. Therefore, the so-called response equivalence (Appleyard, 1977), or representational validity (Craik et al., 1980; Daniel and Meitner, 2001; Sheppard, 2005), has been considered a key criterion in the comparison. A valid simulated environment is thus defined as one that produces a cognitive, affective and behavioural response in the observer equivalent to the response produced by the real environment. Potential uses of such surrogates range from landscape quality assessment (Bergen et al., 1995), decision support in planning and design (Pietsch, 2000) environmental and natural resource

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doi:10.1016/j.landurbplan.2008.12.010

management (Bishop and Karadaglis, 1997) and even the provision of laboratory conditions for behavioural experiments (Bishop and Karadaglis, 2001). In spite of the efforts to account for as many aspects of the real world as possible in visualizations, it has been acknowledged that an error-free, unflawed representation of the complex real world was neither possible nor worthwhile (Ervin and Hasbrouck, 2001).

1.1.2. The realism discussion

The need for abstraction and simplification leads to an ongoing discussion on what is required to make visualizations look real. The question is how to empirically determine a 'good enough image' (Wright, 1990) and 'sufficient realism' (Appleton and Lovett, 2003) as the proper balance between a high degree of perceived realism and time and effort put into the modelling.

Sheppard (2001, 2005) concludes that this requires setting standards for the various quality dimensions or predictive indicators in order to optimally situate the result between realism, abstraction and accuracy. However, on closer examination the definition of realism proves to be a somewhat incongruent and loose concept. Sheppard (2005) distinguishes between 'actual realism', as being the "response equivalence or lack of bias in responses between simulated and real environments", and 'apparent realism', as the "degree to which the simulation appears to look like the real world when judged on the basis of the image alone". Similarly, Schirra and Scholz (1998) makes a distinction between 'realism' as "the property of a representation that gives an impression of a configuration of spatial objects that is or could be in the world" and 'naturalism' that "refers to the quality of a pictorial representation that evokes a visual impression as close as possible to that of the scene depicted". How the distinction is supposed to express itself operationally is not made very clear in either account. Appleton and Lovett (2003) sought to assess realism of visualizations by showing test persons a series of visualizations at different levels of detail and asking them whether they could imagine the corresponding real-world environment without having prior knowledge of it. In Sheppard's definition it is merely apparent realism that has been probed with this methodological approach.

After all, realistic [i.e. look real] images are not necessarily naturalistic [i.e. valid representations] and perceived realism reveals no more than how photo-realistic a representation is—with the photo being regarded as the most naturalistic of all static representations.

Even though the concepts of 'realism' and 'realism-perception' are confusing, they come up persistently in the scientific literature. The confusion arises because the choice of terminology is fuelled by different agendas: one tries to understand how visualizations compare to the real world; the other is about how one could pragmatically achieve the best possible realistic result under material and temporal constraints. To find a universal trade-off between all these demands is difficult since it depends largely on the purpose at hand (Pietsch, 2000; Paar, 2006).

1.1.3. Visual perceptual response to visualizations

Most empirical studies on the perceptual response to visualizations pertain to landscape quality assessment and restrict the evaluation of psychological responses of visualizations to that of visual perception. More precisely, they attempt to elicit how the imagery appeals to the viewer as compared to the real landscape, making no distinction between the emotional and perceptual dimension of the response. The appeal is mostly assessed in terms of preference ratings. Several studies reported considerable correlation between the preference ratings based on direct experience with the landscape and exposure to a surrogate (cf. Daniel and Meitner, 2001). Often the real-world stimulus is substituted by photographs (Bergen et al., 1995). Interestingly, the scientific attention has centred rather on 'how' the image has to look like to produce an equivalent response than on how to determine a valid surrogate.

This is achieved by a variation in the presentation mode of the surrogate:

(1) *Different static media; photographs, visualizations* were used. Oh (1994) compared four types of computer simulations with photographs of the site. (2) Test persons were provided with *different levels of detail or degrees of abstraction*. Lange (2001) presented different degrees of realism in the visualization to local and non-local experts and laypersons (cf. Daniel and Meitner, 2001). (3) The *visual angle or field-of-view* was varied. Meitner (2004) compared perceptual judgements based on slides and 360° panoramas as stimuli.

Few studies employed dynamic media and to the authors' knowledge a relatively small number of experiments used urban settings. One attempt in this direction was made by Bishop and Rohrmann (2003) who used an animated walk through a modelled urban park to compare perceptual responses to the model and the real environment.

One objection to these experiments is that if a person gives the appeal of the real landscape the same score as its surrogate, it does not necessarily mean that the motivation to rate the landscape and image equivalently is necessarily identical. The result might be due to a measurement scale, which is too little differentiated, or it might mean that different criteria are applied to the stimuli. What seems much more elucidating in this context, and what is mostly missed out by any experiment on visual preference, is to uncover what determines the observers' evaluation; whether it is indeed the same that they like or dislike in the depicted and the real-world scene.

1.2. Visualization as communication tool and planning decision support

It seems that the main concern of scientists in the field of environmental visualization is the adequacy of simulations to visually mimic the physical environment and that the discussion has shifted away from the actual virtue of visualizations which is to "improve communication of information and support for better decision making" (Sheppard, 2005). Two studies that assessed the communication effectiveness of (architectural) visualizations are Delucia (1979) and Bates-Brkljac (2007).

1.2.1. Bias on response and hence on decisions

The enormous potential of visualizations as planning decision support caused "genuine excitement and anticipation" among professionals from planning disciplines, whereas the "specific benefits of conducting such an exercise are often not clearly articulated" (Sheppard, 2005). Visualizations are promising in opening up the planning process to more participation (Pietsch, 2000), especially when communicating with people less familiar with traditional visualization methods such as plan views, etc.

At the same time, scientists are concerned about the possible misuse of visualizations. The main demur is the deliberate or non-deliberate bias they introduce in the context of decision-making. This objection is not new and was not imported from computational visualization methods (cf. Sheppard, 1989) as the bias can only partly be ascribed to the presentation mode. After all, visualizations are often used by planners to 'sell' a proposal rather than to make it more transparent and defensible.

Furthermore, scientists express concern that the photorealism of visualizations could produce a "Wow-Effect" (McQuillan, 1998) in the viewer as "that the power of the technique may override critical assessment of the content" (Pietsch, 2000). However, there is also evidence of inherent scepticism in viewers. The tendency was observed for people with less familiarity with computer simulations to rate perceived realism lower (Appleton and Lovett, 2003).

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