Chapter 9
Investigating Effects of Psychophysical Metrics on Fidelity in 3D Space Visualization

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ABSTRACT

Previous research tests and experiments have provided evidence for the disparity between human perception of space in the physical environment and the 3D virtual environment. This could have dire effects on the decision-making process throughout the whole construction lifecycle of an asset due to non-precision of perceived spaces. Results have shown an infidelity in displaying the actual dimensions of the space in the 3D virtual environment, and previous research by the author has identified the magnitude of this disparity. However, there has been inconclusive reasoning behind the causes for this disparity. This chapter aims to investigate and highlight different psychophysical factors that might cause this difference in perception, and compare these factors with previously investigated research.

INTRODUCTION

Digital space representation in the construction industry is essential to demonstrate prospective buildings to clients, and visualise spaces in way that is as truthful to reality as possible. Such endeavours by designers and architects include 2D CAD designs, 3D parametric representations of spaces and objects using 3D geometric

DOI: 10.4018/978-1-5225-5625-1.ch009

models. In parallel, GIS (Geographic Information Systems) allow non-graphical attributes to be linked to geometric representation through grids or matrices. The current method of depicting visualisation in the construction industry is using 3D Building Information Models (BIMs), which can be linked or federated together or with GIS, with rich non-graphical information attached inside them or to external databases (Isikdag, 2011). The visualisation can either be a solitary model or inside a virtual environment / world e.g. Second Life.

According to Parsons (1995), with these visualisation tools, both quantitative and qualitative information can be represented about spaces. Quantitative information expresses spatial relationships among people and objects e.g. length, height, size etc., in an absolute or numeric manner, while qualitative information provides a "sense of place", e.g. architectural style of building, sounds, urban characteristics (Pereira et al., 2013). However human perception of 3D models' virtual space sizes, represented by this quantitative information, has been evidenced to differ from human perception of the same space in reality that this information represents, as explained subsequently. Typically, 3D visualisations and simulations are chosen by designers to communicate with their clients – illustrating space design ideas, functionalities and sizes. However, if those digital visualisations do not portray size and dimensions of a space truthfully, this gives the client a false perception of what the space would actually look like once built. This might result in wrong decisions at design phase based on incorrect information, which would only be realised after construction is complete, rendering it impossible or expensive to change, causing both usability and financial losses. For example during planning stage, local authority might reject new development permissions due to the 'uncertainty' factor in the appearance or design. However, with realistic and accurate 3D animation and visualisation, the uncertainty can be eliminated to gain approval and building permits more easily (Triveldi, 2013).

Other applications / advantages of fidelity in representing real-life spaces is in 3D flight simulations and driving simulations for crash avoidance training or to assess the effect of distracting tasks on situation awareness. If a training pilot or driver is trying to develop sensitivity in taking split-second actions/reactions based on proximity, environment or dimensions/altitudes of spaces in the simulation, then this can be detrimental if this does not represent real-life dimensions when he actually is flying or driving; as delayed or premature life- threatening decisions can be made (Tian et al. 2012). Even an everyday application such as the Global Positioning System (GPS) device has shown problems where users misinterpret distances shown on it to those in reality and take turns on the road which are either too soon or farther than required. This is extremely inconvenient especially for those who have hearing impairment and cannot rely on the audible instructions with the GPS device (Greenberg & Blommer, 2011).