Cognitive transformation mediated by VR 3D sketching during conceptual architectural design process

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This study has been motivated by the existing literature reflecting the shortcomings of current design tools in conceptual architectural design process. The literature claims shortcomings of conventional manual sketching interfaces in articulating new comprehensive global projects (e.g., Madrazo, 1999, Marx, 2000) and failures of current CAD tools in replacing the manual sketching interfaces (e.g., Bilda and Demirkan, 2003, Kwon et al., 2005) due to their inherent problems which hinder designers’ spatial cognition. Hence, there are still parts of design which are handled by freehand sketches (Suwa et al., 1998) while most other parts are being done digitally. This transition is known to interrupt the continuity of a design process (Kwon et al., 2005). However, the integration of whole building design process has since been suggested by Fruchter (1998) since she believes that it can better support collaboration among team members besides having major advantages in decreasing labour and material costs within current comprehensive production procedures. In summary the aim of this research was to facilitate digitization of conceptual architectural design process. This is expected to serve integration of whole building process besides the possibilities for improving designers’ cognition and collaboration during conceptual architectural design process.

Therefore, this research proposes novice designers to employ more flexible and intuitive digital media to overcome above problems. The aim is achieved by developing a new design methodology based on Schön’s (1983a) “reflective practitioner” theory, Fitts’ (1964) “motor learning” theory and then verifying its effectiveness with empirical data. This paper presents findings of a feasibility study for using VR 3D sketching interface in order to replace current non-intuitive Computer Aided Design (CAD) tools. For this purpose a sequential mixed method research methodology including a qualitative case study research and a cognitive-based quantitative protocol analysis was conducted.

In this research, during the development of the theoretical foundations of the study, the employed qualitative approach provided a broad and deep understanding of the current state of design interfaces and interactions during conceptual architectural design phase. In addition, the new empirical assessment techniques which are utilized in this study led to the possibility of investigating design protocols in a quantitatively manner (measures of diversity, time-related events and derived design processes) besides the using standard statistics possibilities when dealing with design protocol data.

The first qualitative part was a case study research which employed ethnography for data collection and artefact and protocol analysis for data analysis. Units of analyses for this part of study were design artefacts of a 2nd year architectural design studio at a local university comprising 37 students and four studio mentors. Taking into account the nature of the building project that they examined, the study adopted judgment sampling method (Kumar, 2005) to choose the sample population among our different studios. Homogenous conditions were expected since all subjects had undergone the same architectural training at the design school and they were all at the same design...
level. The design project that the studio undertook was a handicraft arcade (defined for purposed collection of similar shopping stalls) for a town in the East Coast of Malaysia. The gatekeeper during the data collection phase was the Studio Master of the design studio. This part aimed to answer the first and second research questions by identifying the characteristics of current design media and collaborative design culture of conceptual architectural design process. Consequently, the recommendations of the case study research helped us to develop theoretical foundations of the study. The purpose of the quantitative part was to provide objective and empirical evidence for the subjective view that proposed VR based 3D sketching interface improves the designers’ spatial cognition and collaboration during conceptual architectural design phase. Here the traditional sketching method was selected as a baseline to be compared to a proposed 3D sketching design methodology. Five pairs of 5th year architecture students experienced with the traditional design and CAD systems were selected as participants for this experiment. During the experiment, protocol analysis methodology (Dorst and Dijkhuis, 1995, Ericsson and Simon, 1993, Schön, 1983a) was selected as a research and data acquisition method. It evaluated the designers’ spatial cognition at four different cognitive levels: “physical-actions”, “perceptual-actions”, “functional-actions”, and “conceptual-actions”. It also evaluated the designers’ spatial cognition in two different collaborative levels: “cognitive synchronizations” and “gestures”. The results and confirmed hypotheses showed that compared to traditional design interfaces, the utilized VR-based simple and tangible 3D sketching interface improved novice designers’ cognitive and collaborative design activities during conceptual architectural phase.

In summary this paper presents and documents the assessment of conceptual architectural design process and influences of current external representation tools on designers’ cognition and collaboration. Moreover, the paper presents the necessary theoretical foundations for cognitive and collaborative aspects of implementing VR 3D sketching interface for future implementation. In conclusion, this paper contributes towards transforming conceptual architectural design phase from analogue to digital by proposing a new VR design interface. We believe that this transformation can fill in the existing gap between analogue conceptual architectural design process and the remaining digital engineering parts of building design process hence enhancing the streamlining of digital design process. It is envisioned that the findings of this study can help the development of cutting-edge information technologies for design or education in the architectural field. Moreover, results will guide in the creation of future professional training programs to enhance capacity and capability of multidisciplinary professionals in using digital interfaces due to increasing global practice.

References


