Exploring the Impact of Rule Algorithms on Designers' Cognitive Behaviour in a Parametric Design Environment

By

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(Rongrong Yu)

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Abstract

Parametric design has been increasingly applied in the architectural industry in recent years. Researchers have studied the designers' behaviour in parametric design environments using various methods. However, there is a lack of empirical evidence to support the understanding of how parametric design affects designers' ways of thinking.

This research aims to explore the impact of the rule algorithm feature in parametric design environments on designers' behaviour. To achieve this, a protocol study was conducted comparing designers' cognitive behaviour in a parametric design environment (PDE) with their cognitive behaviour in a traditional geometric modelling environment (GME). Eight professional architects participated in the experiment in which each of them was required to complete two design sessions with design tasks at similar complexity level, one in each environment. A "think aloud" method was used to collect data during the design experiment. By employing protocol analysis, the collected data were coded and analysed using the function-behaviour-structure (FBS) ontology.

From a comparison of the protocol analysis results of designers' behaviour in the PDE and the GME, there are limited differences found between the two. From these results, we can infer that designers' high level thinking does not vary significantly in response to the tools they use. That is, whatever environment they are in, their design thinking shares some commonalities in how they approach design. However, in terms of the impact of rule algorithm use in the PDE three major differences have been revealed by this study as follows.

First, designers express an exchange of cognitive behaviour between the two levels of activities – design knowledge level and rule algorithm level. The results indicate that the design knowledge-related activities dominate the parametric design process for all cognitive issues. Therefore, we can infer that in the parametric design process, designers still expend most effort on design knowledge; parametric scripting is mainly used to support their intention of generating models.

Second, by calculating the transition probabilities between FBS design issues, we found the transition probability from F to S is much higher in the PDE. F to S is a typical design pattern which is derived from designers' existing knowledge/experience. That is, designers tend to use the existing design patterns more frequently in the PDE. Three types of design patterns in the PDE have been identified and discussed.

Third, in parametric design environments, the design problem formulation is more tool-oriented. Based on the division of two levels of design activities, and by calculating the frequency of transitions between the design problem and solution spaces, characteristics of problem-solution co-evolution processes in the PDE have been discussed. For example, the co-evolution process typically occurs at the individual design knowledge level or rule algorithm level, and only relatively infrequently do transitions occur across the two levels. The most representative activities of parametric design (activities on the rule-algorithm level)

seems to play more important roles in design in the later stage of the design session. Based on these findings, a model which illustrates the main co-evolution process in the PDE has been proposed.

Results of this research enhance our understanding of parametric design: although parametric design tools have many advantages related to its rule algorithm feature, such as flexibility, and efficiency, architectural design knowledge is still essential for defining/formulating the design problem. The design patterns identified from this cognitive study could be deliverable to students, which could possibly assist in learning parametric design more efficiently and systematically. Results of this study also imply that the way in which designers use parametric design tools is a critical point determining whether parametric design would benefit their design processes. The proposed research outcome will be beneficial for design educators, designers, design researchers, and also software developers.

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