Architecture by Tools: The Syntax of Drawing and the Creativity of Thought

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ABSTRACT
This short paper summarizes a PhD research in progress as titled in the heading. The research investigates the effect that design tools have on the method of drawing and creativity in early stages of architectural design with an intention of contribution to the procurement of CAD tools. Currently into the second year of the PhD, pilot protocol studies have been executed and new propositions for coding schemes and method of analysis are being tested.

Keywords
Drawing; creativity; CAD tools; protocol study

INTRODUCTION
Based on the premise that there is a connection between the bodily act of drawing, conceptualization and creativity, there have been two kinds of approaches in designing Computer Aided Design (CAD) tools that bring drawing by CAD closer to drawing by hand. One approach is concerned with the physical experience of free hand drawing and takes into account, the speed and liberated movements that can be applied. This approach has led to the development of pen-based input tools such as the digital napkin [,4]. Another approach which focuses on simulating a similar cognitive experience to free hand drawing, emphasizes on sustaining ambiguity and imprecision through the process. This approach has mainly led to developments in shape grammar and improving tools to recognize patterns of emerging shape [2]. This research searches for an alternative approach to inform the design of CAD tools by understanding how freehand drawing compared to CAD tools structures the distribution of information in a creative process. In particular it focuses on computer based drawing tools which are increasingly being used in early stages of architectural concept development and their affordance for creative reasoning is debatable. For this comparison, cognitive structures under the influence of a NURBS based tool, Rhinoceros 3D, and a geometric modeling tool SketchUp will be compared to freehand sketching. The research questions the relationship between the syntax of drawing and creativity. It understands design actions (verbal and physical) as patterns that are connected together in a hierarchical order, for which the sequence of their occurrence in a process, can affect the possibilities of access to higher order patterns within that cognitive system. This in return should change the amount of information each pattern carries and the designers' ability in both generating ideas and cohesively making links between them; hence a measure for creativity.

Currently the coding schemes used in current research suggests the effect of design medium on creativity to be rather insignificant [1,6]. In particular since design is considered as a reflective in action process and related studies have valued the situatedness of cognition, a gap in the method of analyzing and coding data from protocol studies was identified in this research. There forth attention is drawn towards distributed cognitive theory, which describes cognition as an aggregation of functions constructed by internal and external constructs of a cognitive system [5]. In this sense tools as part of the external construct are not mere peripheral aids to cognition but part of the structuring of cognition. Zhang and Norman [7], in their seminal study on 'representations in distributed cognitive tasks' had identified a similar gap in cognitive studies. They assert on the necessity of decomposing the representation of a task into its internal and external components so that the different functions of internal and external representations can be identified. Accordingly the internal and external representational spaces together form a distributed representational space, which is the representation of the abstract task space. In the case of this research the assumption is that current coding schemes analyze design activity at the abstract level of cognition and therefore cannot elicit the direct effect of external/internal variables on creativity. The research therefore intends to employ Zhang and Norman's approach to develop a scheme which expresses the process in terms of a series of internal

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and external patterns which could be useful in the procurement of future CAD tools.

METHODOLOGY

Central to the research is a protocol design study which records design actions (verbal and physical) in controlled lab conditions for a specific study group to compare their behavior through segmenting and coding the data. The theoretical framework which tailored an understanding of the theory of distributed cognition and representational analysis to design studies was developed in the first year of the PhD and led to the following structure for the protocol study:

- Protocols to be recorded by concurrent verbalization. The process of verbalization to be instructed such that the generation of patterns within either internal/external constructs can be easily distinguishable and subjectivity in coding minimized;

- Participants to be from same educational background and of equal design and tool operating skills;

- Tasks to be of isomorphic structure.

Two pilot studies with different groups of students have been carried out so far to test the appropriateness of the task and experimental structure and to reduce the effect of confounding variables such as learning effect. At this stage, the pilot studies mainly focused on analyzing the processes at the abstract level and so forth used the FBS (Function-Behavior-Structure) [3] coding scheme. Based on the results, the research is assessing the potential of its proposed scheme (at early stages of development) and has developed a modified step-by-step protocol study plan for the main study. The results of the pilot study will be further discussed; meanwhile the modified plan is as follows;

- Participants: nine architecture students from the University of Nottingham to be studied in three groups of three by undergoing three isomorphic tasks with two weeks intervals in between.
- The order of tasks within each group is as follows
  Group A: freehand-SketchUp-Rhino
  Group B: Rhino-Freehand-SketchUp
  Group C: SketchUp-Rhino-Freehand
- For each task:
  1. A short movie of the sites is shown which reads the brief. Participants are then given two minutes to recite any information remembered from the brief. This acts as an indication of patterns housed in the internal construct.
  2. The brief and some images of the site are given to the student to re-read and to discuss the importance and relevance of those information and any initial ideas, to elicit the primary patterns within the external construct.
  3. The participants engage in the act of design with the sole use of the provided tool for 40 minutes and no reference to the brief.

RESULTS

In the pilot studies, the design tasks were successive and executed in one design session. The tasks were sub-tasks of one design brief. Results from one study with two students showed highest measure of creativity in the third task, although different tools were used. As a result, less new patterns are generated and the cohesiveness of the external construct increased. However using the FBS scheme, this change in distribution was not explicit. Moreover no significant difference between the distribution of design issues that deal with the formal structure of the design was seen throughout the processes when analyzed by the latter scheme. Students also designed their first task with different tools which comparatively affected performance in the second task for which the tool used was the same. The student who freehand sketched in their first task displayed a weaker idea generation but stronger cohesiveness in their second task. The pattern structures helped in explaining the reason for this outcome. Despite similar number of patterns for both student in the second task, the student who hadn't freehand sketched in the first task, produce twice as more new patterns in this task. This student was also able to show a higher frequency of internal activity and although his frequency of external activity was similar to the other student, he produced three times the number of patterns that the other student had externally.

NEXT STEP

1-In pilot studies: To calculate the amount of information each pattern carries in the cognitive system and deduct a relationship between design actions specific to a tool and the probability of occurrence of patterns. To demonstrate how a particular sequence of patterns affects the complexity of internal/external constructs. Investigate the possibility of creating algorithms simulating students' cognitive activity.
2- Make a conclusion on the most suited method of segmenting and coding main study.

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