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Does CAD Really Encourage Creative Behaviors among its Users: A Case Study

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Abstract

This paper describes a case study in exploring the potential on capturing designers’ creative behaviours whilst engaged in Computer-aided Design (CAD) activity. The protocol analysis approach was undertaken to collect data in one of the CAD designing session of the participants. The Creative Behaviours Framework was used as a tool to capture the emergence of designers’ creative behaviours. The video data were analysed using “Transana” software, and the findings were clarified through post-interviews with the participants. From the analysis and findings, the study suggests link between the emergence of creative behaviours and the use of CAD in designing.

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1. Introduction

Computer-aided Design (CAD) has been going through a rapid technological evolution in terms of its capabilities, and roles in designing. Its widespread adoption by designers has led to a range of views on the significant consequences it could bring for individual design ability and efficiency, and the quality of the output. Spendlove and Hopper (2004) suggested that CAD ‘should therefore be seen as a set of tools, which can be adopted as and when they are appropriate within the broad creative process. It has been a long debate since the introduction of CAD whether this software has any implications to creativity in designing (e.g. Robertson and Allen, 1991; Robertson and Radcliffe, 2008; Charlesworth, 2007). Although there have been indications that the research agendas concerning CAD and creativity are linked (Robertson and Radcliffe, 2008), however, there has...
been a lack of systematic efforts to articulate and clarify what the nature of the links might be (Lawson, 1999). This paper presents an attempt in a case study to investigate the possible link by exploring the potential on capturing designers’ creative behaviours whilst engaged in CAD activity.

2. CAD and Creativity

Computer Aided Design (CAD) enables designers to graphically model their ideas on the screen as a complete design proposal. This technology, according to Hodgson (2006) improved the quality of student output in the form of visual images and product realization. CAD is widely used in design and engineering area especially in product design and manufacturing. Zeid (2005) stated that CAD has been utilized in many ways including drafting, design, simulation, analysis, and manufacturing. It plays a great role, in the designing including styling, conceptual design, simulation, product design, detailed design etc. The increased use of digital media such as CAD to facilitate design activity has led to the need to consider what the impact it has to designer’s performances. (for example see Fraser and Hodgson, 2006; Bhavnani et al, 1993; Robertson and Allen, 1991).

There has always been a tension between designing and its associated technologies, and much debate about whether knowledge of such designing supports or inhibits the designer. Due to this, Kimbell et al (2002) suggested that the used of the Computer Aided Design (CAD) tool by designers are sufficiently profound to warrant careful research. There have been growing concerns that using complex CAD software might have detrimental effects on user performance (for example ability, creativity, output), and Bhavnani et al (1993) studied these concerns in relation to three different levels of CAD users’ experience (for example novice, regular, and expert). It has been known for some time that both the perceptions that users have of CAD systems and their expertise can significantly influence their performance. More recent studies have begun to look beyond the designer’s performance with the CAD system itself towards its broader designing context (Charlesworth, 2007; Robertson et al, 2007).

The study by Charlesworth (2007: 35) concluded that CAD “has little or no value as a stimulus for ideas”. It was claimed that CAD had less significance as a designing tool and suggested that it was only appropriate as a finishing tool to finalize design proposals. This implied that CAD is encouraging creativity in designing. Meanwhile, Lawson (1999) has made arguments on whether CAD would affect individual creativity through experiential examples from a number of architects. He implied that CAD could support designers in exploring design ideas and give freedom to visualize their creative imagination. Although expressing concern about the quality of the design outcomes, he clearly agreed that CAD enabled designers to produce “convincing and original designs”.

3. Creative Behaviors Framework

Based on the published literature relating to cognitive psychology, a number of creative behaviors have been recognized (for example, see Cropley 1967; Gilchrist 1972; Amabile 1983; De Bono 1994; Balchin 2005). These have been grouped into seven categories which are novelty, appropriateness, motivation, fluency, flexibility, sensitivity, and insightfulness as shown in Figure 1. No attempt has been made to select or rank these creative behaviors; they have simply been noted and classified. This framework is used to observe and capture such behaviors that were previously reported by cognitive psychologists. However, Barlex (2002: 12) notes the necessity to provide “objective criteria” that can be utilized to identify creativity aspects (or creative behaviors). Hence, to explain the meaning of the seven terms chosen, each of the creative behaviors was assigned three descriptors.
4. Methods

To consider an appropriate research approach, in this context, would involve seeking a method that allows useful data to be captured while designers were engaged with CAD for designing. Designers illustrate their design thinking through modeling (such as 2D sketching, 3D sketch modeling, CAD modeling) which established design outcomes as a result of such interactions.

Since creativity is a very complicated subject, a case study approach was considered appropriate as it “represents a disciplined mode of inquiry that can be organized around issues” (Smith and Strahan, 2004: 360). By definition, Blatter (2008: 68) noted that “a case study is a research approach in which one or a few instances of phenomena are studied in depth”. Case studies could provide descriptions of what CAD users, in particular industrial designer students do and say when using CAD during the act of designing.

In this context, protocol analysis was used to analyze the data gathered through video recording by the researcher, and own on-screen video recording by the participants. The enthusiasm to capture and accurately describe design activity “in the way designers experience it” (Dorst & Dijkhuis, 1995: 264) has seen an increase in the number of research projects using protocol analysis as the research methodology (for example see Gero and McNeil, 1998; Suwa et al, 1998; Suwa and Tversky, 1997). Hayes (1986: 352) suggested that protocol analysis could be used “to justify the use of verbal reports as data, especially data regarding thinking” that appear in designing (examples 2D sketching, 3D sketch modeling, CAD modeling).

Video recorder was used to record the designing events in CAD since it allows close scrutiny and access to the data for further reassessment or re-evaluation by the researcher whenever necessary.
4.1. Sample of Study

A series of campaign have been undertaken to encourage as many participants as we can to participate in this study. Potential participants who are among final year students of Loughborough Design School (or previously known as Design and Technology Department) have been approached, and informed about this study. They have been briefed on how they could participate, and contribute in this study. Two undergraduates who were doing their final year design project had volunteered to participate.

This kind of sample recruitment is categorized as purposive sampling type approach. Participants were carefully recruited to make sure the data collected was relevant (Palys, 2008). They were invited and recruited based on the following factors: has CAD background and has intention to use CAD in their project. The participants were anonymously identified using alphanumeric pseudonyms (for example P01 for participant 01). Both participants were undertaking two different projects namely self administered vaccination packs for people in remote areas, and a new concept for a musical instrument.

4.2. Procedures

The protocol analysis approach was undertaken to collect data in one of the CAD designing session which carried out by each participant where the time and venue it going to takes place were pre-arranged. This approach was carried out in order to allow the participants to feel comfortable to voice out their design thinking and feeling while performing CAD activity.

Participants were also required to carry out their own on-screen videoing at least in one of the other CAD session using CAMTASIA software. The software has a recording feature that enables the on-screen CAD activity to be captured easily by the participants themselves. The aim was to provide the data in less obtrusive surroundings to the participants as they would choose the sessions that were going to be recorded. The licensed software was provided by the Department of Design and Technology, Loughborough University to each participant in order to facilitate the data recording activity.

The Creative Behaviors Framework was used as a tool to capture the emergence of designers’ creative behaviors. The data in the form of video recorded data were then transcribed, and analyzed using Transana software. The findings were then clarified through post-interviews session with the participants. The data were presented based on time of event and creative behaviors identified including the observation and verbalization text if any.

5. Results and Discussions

The video data and the video transcriptions were analyzed and some of the examples of the findings are shown in Table 1. The observation and interpretation were based on CAD activities demonstrated by the participants which were recorded by the researcher using video recorder, or through own on-screen recording by the participants using CAMTASIA software.
The analysis has identified six creative behaviors except novelty, as shown in Table 2. The results showed the emergence of these behaviors through the identification of any descriptor from each category. The novelty behavior is expected cannot be identified during designing, and this was suggested by Mustaamal et al. (2009) who stated that ‘novelty is essentially related to the evaluation of design outcomes and would not therefore be expected to feature in data gathered during designing’.

Table 2. Creative behaviours identified from participants’ CAD activities

| Creative Behaviours | Design Activity | P01 | P02 | CADvid | CADcam | CADvid | CADcam | Total |
|---------------------|-----------------|-----|-----|--------|--------|--------|--------|-------|
| Novelty             | Uncommon/ unexpected/original | 0   | 0   | 0      | 0      | 0      | 0      | 0     |
| Appropriateness     | Useful           | 1   | 0   | 1      | 0      | 2      |        |       |
|                     | Sensible         | 0   | 2   | 1      | 0      | 3      |        |       |
| Motivation          | Enthusiastic     | 0   | 0   | 0      | 1      | 1      |        |       |
|                     | Determined       | 3   | 2   | 2      | 0      | 7      |        |       |
|                     | risk-taking      | 5   | 3   | 5      | 3      | 16     |        |       |
| Fluency             | Spontaneity      | 0   | 2   | 1      | 1      | 4      |        |       |
|                     | open to new ideas| 3   | 1   | 2      | 1      | 7      |        |       |
|                     | fluency of ideas | 0   | 0   | 0      | 1      | 1      |        |       |
| Flexibility         | exploring possibilities | 4   | 3   | 5      | 3      | 15     |        |       |
|                     | continuous reflection | 7   | 7   | 11     | 2      | 27     |        |       |
|                     | associate remote ideas | 0   | 1   | 0      | 0      | 1      |        |       |
| Sensitivity         | understand problem | 0   | 0   | 1      | 0      | 1      |        |       |
|                     | display curiosity | 0   | 0   | 1      | 0      | 1      |        |       |
|                     | seek perfection  | 4   | 6   | 5      | 3      | 18     |        |       |
| Insightfulness      | organizing information | 2   | 0   | 0      | 0      | 2      |        |       |
|                     | intuitive decision | 3   | 0   | 0      | 0      | 3      |        |       |
| **Total**           |                 | 33  | 27  | 35     | 15     | 110    |        |       |

Notes: CADVid – CAD activities video recording
CADCam – CAD activities recording using CAMTASIA software
The discussion on how novelty could be identified and captured in the designing process will be presented in future publication. From the data analysis, in total 110 creative behaviors descriptor were captured when designer engaged in CAD activities. The Creative Behaviors Framework has shown its capability in facilitating the observation and the identification of creative behaviors when designer using CAD for designing.

6. Conclusions

This study is attempted to provide empirical evidence on the potential links between CAD and creativity when in designing. The data were gathered through qualitative research approach which is protocol analysis from a case study undertaken within industrial design undergraduate. From the analysis and findings, the study suggests link between the emergence of creative behaviors and the use of CAD in designing. This was supported by the emergence of creative behaviors descriptors except for novelty descriptors. This was probably due to data gathering and analysis methods used in this study unable to capture these descriptors. Further research is needed to explore into this issue. As a conclusion, the research has provided indication that CAD might potentially encouraged creativity in designing.

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