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EDITORIAL

How Is Innovation Influenced by Logic, Emotion and Representation?

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Innovation plays a significant role in the knowledge-based economy for a nation. Based on the design creativity theory proposed by Nguyen and Zeng (Nguyen and Zeng, 2012), the designer's innovation in dealing with a design problem depends on the designer's stress level, which further relies on the cognitive workload perceived by the designer and the designer's capabilities. The designer's capability is defined by his/her knowledge and logical reasoning abilities to understand and solve the design problem as well as his/her emotional capability to cope with the stress arisen during the design process. A designer could be more creative and innovative if the designer's mental stress is kept at a medium level. Nguyen and Zeng (Nguyen and Zeng, 2017) analysed how design tools may contribute to the use of proper design knowledge in improving the creativity and novelty of the final design solutions. Zeng *et al*. (Zeng et al., 2004) indicated that sketching as a design tool would help designers be more creative by releasing their cognitive workload. In this special issue, four papers are selected to cover the four aspects that affect designers' capabilities to be creative and innovative.

The first paper, by Tianqun Pan and titled "Technological Innovation: A Balance between Indispensability and Feasibility", aims to explore the designer's reasoning in technological innovation by using modal logic. A technology is described as a set of action propositions whereas a technological innovation is regarded to form a new set of such propositions. An action proposition can be roughly viewed as a function or affordance, which are widely used in the design research community (Chakrabarti and Bligh, 2001; Gero and Kannengiesser, 2007; Hirtz et al., 2002; Maier and Fadel, 2009; Umeda et al., 1990). An action proposition is indispensable if regarded as necessary no matter how the technology involved is innovated. An action proposition is feasible if workable but replaceable in terms of achieving some effect(s). Hence, an indispensable action is more or less the function or affordance that a technology must deliver certain effect(s) (e.g. satisfying natural laws) while a feasible action can be seen as one of the alternative solutions to achieve an effect (e.g. satisfying human needs). The interaction between the indispensable and feasible actions constitute the recursive logic of design (Zeng and Cheng, 1991). Thus, a technological innovation constitutes a balance between indispensability and feasibility. Logics containing the operators of indispensability and feasibility are then used to draw inferences regarding technological innovation.

The second paper, by Stephen Ekwaro-Osire and Joao Paulo Dias and titled "Function and Aesthetics of a Product in Segmentation of the Sketch", aims to segment product sketches by considering the central characteristics of product design. The segmentation of design sketches can support the capturing of design rationale, which can be used as knowledge for future design projects. One important criterion for this

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segmentation is the impact of the interaction between functionality and aesthetics on the customer's emotional connection with the product. Two different segmentation procedures are proposed in this paper. The first is a low-level segmentation procedure which groups the sketch elements into larger components based only on their visual aesthetic arrangement by applying the Gestalt theory. The second is a high-level segmentation process which considers the prior-knowledge of the functional aspects of the product represented by the sketches. Results of the two procedures applied to the same sketches indicated that the low-level segmentation procedure, which requires less cognitive burden, can lead to components with specific well-defined functions as obtained through the high-level segmentation procedure.

The third paper, authored by Gaetano Cascini, Lorenzo Fiorineschi and Federico Rotini and titled "Impact of Design Representations on Creativity of Design Outcomes", investigated impact of different design representations (methodologies) on creativity of design outcomes. They aim to answer the following question: "Do designers get any creative advantage by the availability of design representations?" Two design representations were utilized for conducting an experiment among 30 engineering students: Functional Decomposition and Morphology (FDM) and Problem-Solution Network (PSN). The experiment was structured in three phases and the outcomes of design problems were assessed by measuring four metrics which are Quantity, Quality, Variety and Novelty. Quantity was introduced as the number of conceived ideas, Quality as the feasibility of an idea, Variety as the number of different principles in an idea, and Novelty as a function of the count of occurrences for an item in an idea. It was found that the novelty and variety of design outcomes are improved by utilizing design representations and students tried different idea generation paths by using FDM and PSN. The authors concluded that the availability of design representations from earlier conceptual design activities leads to the existence of creative advantage in design outcomes.

The last paper, authored by Bettina Minder and Astrid Heidemann Lassen and titled "The Designer as Enthusiast - Facilitating an Open Innovation Approach", discusses the influences of a designer's presence as an enthusiast in an innovation process. This paper aims to understand the impact of designers' enthusiasm on non-designers' mental capacity through analysing different aspects of enthusiasm. Openness, confidence, collaboration, entrepreneurship, personal interest and fun are defined as different dimensions of enthusiasm. Openness is described as the designers' belief in the existence of people who can help generate ideas. Having belief on the possibility of developing a better solution, exchanging ideas, and capability of establishing new ideas are presented as the meanings of confidence, collaboration and entrepreneurship, respectively. Sense of ownership and capability of adding fun are also considered as the definition of personal interest and fun dimensions. In order to investigate changes of the aforementioned factors in the presence of a designer, an experiment is designed. In this experiment, four groups are coached with two non-designer tutors and one designer tutor for developing new concepts in their projects. Groups' enthusiasm and process performance are assessed through conducting surveys, interviews and interactive design games. The empirical results extracted from tracking of the aforementioned dimensions show that the designers introduced new ways of organizing conversation across disciplinary boundaries by introducing new objects and practices. The paper reports that the designers' enthusiasm, their optimistic views, their capabilities to focus on more favourable side of events, and their driving forces, can promote more open-design approaches throughout the developing process of innovation. Beside the aforementioned conclusion of the paper, it claims that a medium range of enthusiasm in each group is necessary to achieve optimal results.

Modelling the underlying mechanism of innovation and creativity is becoming a more and more important topic in design research. This research relies on a transdisciplinary effort that calls for the collaboration from diverse communities such as philosophy, psychology, linguistics, neuroscience, mathematics, computer science, engineering, education, and management science. The journal welcomes more reports on both experimental and theoretical investigations into the factors that influence innovation and creativity. Particularly, experimental research driven by theories and theoretical model evidenced by experiments are welcome to contribute to the establishment and advancement of a new kind of design science. It is the major objective of this present journal to nurture the growth of the transdisciplinary design science, in which process can be viewed as a product of design and design itself is a process.

References

Chakrabarti, A., Bligh, T.P., 2001. A scheme for functional reasoning in conceptual design. Design Studies 22, 493–517. https://doi.org/10.1016/S0142-694X(01)00008-4

Gero, J.S., Kannengiesser, U., 2007. A function-behavior-structure ontology of processes. Artificial Intelligence for Engineering Design, Analysis and Manufacturing: AIEDAM 21, 379–391. https://doi.org/10.1017/S0890060407000340

Hirtz, J., Stone, R.B., McAdams, D.A., Szykman, S., Wood, K.L., 2002. A functional basis for engineering design: Reconciling and evolving previous efforts. Research in Engineering Design - Theory, Applications, and Concurrent Engineering 13, 65–82. https://doi.org/10.1007/s00163-001-0008-3

Maier, J.R.A., Fadel, G.M., 2009. Affordance based design: A relational theory for design. Research in Engineering Design 20, 13–27. https://doi.org/10.1007/s00163-008-0060-3

Nguyen, T.A., Zeng, Y., 2017. A theoretical model of design fixation. International Journal of Design Creativity and Innovation 5, 185–204.

Nguyen, T.A., Zeng, Y., 2012. Theoretical Model of Design Creativity: Nonlinear Design Dynamics and Mental Stress-Creativity Relation. Journal of Integrated Design and Process Science 16, 65–88.

Umeda, Y., Ishii, M., Yoshioka, M., Tomiyama, T., 1990. Function, behaviour, and structure. In Applications of Artificial Intelligence in Engineering 177–193.

Zeng, Y., Cheng, G.D., 1991. On the logic of design. Transaction of SDPS: Journal of Integrated Design and Process Science 6, 1–28.

Zeng, Y., Pardasani, A., Dickinson, J., Li, Z., Antunes, H., Gupta, V., Baulier, D., 2004. Mathematical foundation for modeling conceptual design sketches. Journal of Computing and Information Science in Engineering 4, 150–159.

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