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Models for Concept Derivation and Materialization in Design Management

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ABSTRACT

Design is a process that oscillates between visualization and materialization. Within this process, products usually start their lifecycles as abstract concepts that transmute incrementally from raw mental presentations in the inner world of their creators into physical objects in the external world. A framework and associative models for concept management, processing, formation and transformation are introduced and discussed. The framework comprises a set of major phases of concept development from primitive mental images into final materialized products. Concept derivation represents the core of the concept processing framework. Consequently, it is represented as the main nexus between knowledge abstraction and product materialization in design. Nine methods of concept generation and eight elements of concept translation into tangible design products are described and discussed. The concept generation and translation process are illustrated by examples of model implementation.

KEYWORDS

Concept Formation, Design Conceptualization, Design Management, Ideation, Knowledge Visualization, Materialization Channels

1. INTRODUCTION

Representing the main link between planning and actualization, design is widely considered the major activity in architecture and engineering disciplines. Typically, design evolves through a recursive process that encompasses various cycles, phases, layers and tasks. Moreover, it is widely recognized that design does not have a particular definite approach, method, process or solution. In addition, design can be considered a knowledge-driven act of oscillation between perception, cognition and action. Throughout any design processing cycle, knowledge visualization is essential to all stages, and particularly more significant in the early stages of design conception.

Designers and theorists have produced many scholarly works to unveil the mysterious aspects of design (e.g. Aspelund, 2010; Bartholomew, 2013; Eilouti, 2010, 2012, 2015; Panero and Zelnik, 1979; Pressman, 2012; Sully, 2012; Thompson and Blossom, 2015). Some of these works are concerned with the process of designing. For instance, Dodsworth and Andesrson (2015) describe the design process as a malleable structure in which different tasks are adaptable to each project's unique nature. Design for them represents an iterative cycle that starts with the client, from whom the whole process

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evolves, and moves to the concept proposal preparation which includes the planning and sourcing stages. Subsequently, the design is developed and presented to the client to be finalized, detailed, supplemented with schedules of quantities and specifications and finally implemented. Within this cycle that starts and ends with a client, concept derivation is proposed to be a result of listing and selecting some adjectives that describe a desired experience which is concluded from the client's brief to inspire the design. Similarly, design for Pressman (2012) is derived through a cycle that starts with defining a problem and moves to information collection, brainstorming and analysis of ideas. Subsequently, the generation process focuses on the development of solutions, as well as on the presentation of ideas and improvement of design. This cycle has three major phases: inspiration, ideation and implementation. Along the same line of thought, Smith and Smith (2014) explain the various aspects of design process, culture and making as well as the idea generation and development process in design. They describe design as a non-linear process that moves forward and backward between the various forms of knowledge and experiences to imagine the future product. This process applies a combination of a retrospective strategy to explore the resources, and a prospective one to visualize the product. Design process represents also the main concern of Cross and Roozenburg who focus in their study (1992) on the interdisciplinary comparison of design process in engineering and in architecture to reintegrate the models of the two to improve design education and practice in both disciplines. While the previous examples are concerned with design process, the major concern of some scholarly works is the composition of design and its constituent components (e.g. Ercan and Elias-Ozkan, 2015). In addition to literature in design process and composition, some studies focus on design methods such as evidence-based design (Yilmaz et al., 2016) and user-centered design (Miaskiewicz and Kozar, 2011).

Before any product sees the light, it starts as a concept in the mind of its designer. Generating a design concept can be visualized as building a bridge between the inner world of the designer and the outer world of everybody else. As such, concept can be considered a tool of knowledge visualization the manifestation of which represents an activity of transformation of the mental abstract images in the designer's mind to tangible design products in the real world. Formulating a concept is one of the most challenging tasks in design processing. In engineering design, this task is even more difficult since it is associated with numerous forces and drivers, such as aesthetics, function, performance, materialization, durability, constructability and maintenance.

A wide range of definitions can be identified in design literature for the term "concept". Among these, concept is defined as "the figure of an object, along with other representations such as attributes or functions of the object, which existed, is existing, or might exist in the human mind as well as in the real world" (Taura and Nagai, 2013: 13). Concept also refers to the mental representation that the brain uses to denote a class of symbols that are inferred from the physical objects (Carey, 2009; Murphy, 2002). In this research, concept is defined as the mental map and the inner blueprint that guides the design process in creating a design product (Eilouti, 2018a, 2018b, 2018c).

In design literature, concept is studied in terms of its context as a design medium (e.g. Eilouti, 2009; Smith and Smith, 2014), its association with creativity (e.g. Sternberg and Lubart, 1999), its visualization tools (e.g. Eilouti, 2010, 2012; Eilouti and Vakalo, 1999) and the various aspects of its management and processing (Eilouti, 2015). In the domain of concept processing, a wide range of research areas can be identified. These include the various methods of concept generation (e.g. Cross, 1997; Toh and Miller, 2015), techniques of concept generation (e.g. Jensen et al., 2009), concept selection (e.g. Pugh, 1996), and concept evaluation issues (e.g. Lopez-Mesa and Bylund, 2011). Concept translation represents another major area of research in the designing process field. Addressing this area, Tomes et al. (1998) discuss the translation from verbal interpretation into visual representation and expression. In this context, they consider the main goal of design process is represented by an acceptable visual translation of the verbal design brief.

Few examples highlight the stage of concept selection as a major phase by itself (Eilouti, 2018a, 2018b). Among these, Toh and Miller (2015) study concept generation including brainstorming,

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