

# Thinking difference: Theories and models of parametric design thinking

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*The paper examines the uniqueness of seminal parametric design concepts, and their impact on models of parametric design thinking (PDT). The continuity and change within the evolution of design thinking is explored through review of key texts and theoretical concepts from early cognitive models up to current models of parametric design thinking. It is proposed that the seminal role for parametric schema, as a strategic medium of parametric design thinking, is formulated at the intersection of three bodies of knowledge: cognitive models of typological and topological design in architecture; process models of digital design; and tectonic order of material fabrication design (MFD).*

*Differentiation is introduced as a key design strategy of PDT and is demonstrated through classification of prominent case studies.*

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Beyond being another tool for modeling complex forms, parametric design is emerging as a unique and distinctive model of design. Both research and praxis in parametric design are influencing the emergence of parametric design theories that are currently undergoing a re-formulation and an epistemological shift. In parallel, the development of current tools and practices of parametric design are beginning to impact forms of parametric design thinking (PDT). Current parametric design systems are adapting to changing context under the impact of a new generation of scripting languages and techniques (Burry, 2011), relational topological schema, associative geometries, and re-editing processes (Woodbury, 2010; Jabi, 2015) and computational process models of digital design (Oxman, 2006).

This theoretical review of *parametric design thinking* (PDT) is motivated by the need to explore the uniqueness of parametric design methods, techniques, media and tools within the field of design studies in order to understand the impact of parametric design on the emergence of new ways of thinking in design.

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continuity and change in relation to accepted paradigms widely recognized scientifically as ways of design thinking. The first scientific foundation of design as a way of thinking appeared as a problem-solving paradigm in *The Sciences of the Artificial* (Simon, 1969). A body of ideas presented by Robert McKim in *Experiences in Visual Thinking* (McKim, 1972) focused on new visual aspects of design thinking. Ways of thinking in the discipline of architectural design were demonstrated by Bryan Lawson in *How Designers Think* (Lawson, 1980), and by Peter Rowe in *Design Thinking* (Rowe, 1987). These works presented theories and methods of design that were considered basic research in design studies. In the following years, design research has developed the relationships between design, cognition and computation, which have become an important topic in design studies (Oxman, 1994; Oxman & Gero, 1987; Oxman & Oxman, 1992).

Design thinking has been defined as a process of ‘creative strategies which designers utilize during the process of designing’ (Visser, 2006); it has recently been proposed as ‘a process of exploration and creative strategies’ in all design domains and has been recognized as a new field in other emerging design practices (Dorst, 2012). Following the evolution of cognitive and computational design research, the present study seeks to formulate the relationship between selected models of design thinking and the impact of currently emerging computational media. This is in order to characterize and evaluate the influence of novel digital design tools and technologies of parametric design in producing distinctive novel forms of thinking in design.

In order to formulate the uniqueness of parametric design thinking, a systematic theoretical study is presented below comparing selected cognitive concepts in both traditional paper-based models of design thinking and current computational models of parametric design. The systematic analysis and definition of a chronological process of evolution of models of design thinking is presented as part of the continuity and change in the evolution of models of design thinking (from cognitive models to computational models to models of parametric design thinking). Derived from this evolutionary framework of design thinking, the key concepts and principles of parametric design thinking are introduced, defined and illustrated. The process of tracing the transformation from traditional paper-based media to computational media-related models of design thinking has enabled the systematic identification of current seminal concepts and principles in parametric design thinking. The body of generic concepts that have been found to be associated with media-related strategies of design creativity in prominent models of design thinking have also provided new perspectives and understanding of thinking processes in design (Section 1).

As a result of the comparative study, unique cognitive concepts and principles in models of parametric design thinking such as: *Generic Schema*; *Relational*

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