Visualizing making: Shapes, materials, and actions

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The increasing interest in materiality currently challenges the long existing traditions that consider visual thinking as the primary actor in design creativity. Shape grammars offer a formalism to represent visual reasoning in design, which is never purely limited to the visual aspects of design processes. Aiming to develop ways to explicitly include material manipulation in a computational formalism, we report on an ongoing exploration of how shape computation extends beyond abstract visual shapes to incorporate material shapes that have a physical existence. We present a materially informed process with shape rules and show that we can apply these rules creatively to explore the physical character of the material.

Keywords: material computing, computational models, design activity, parametric design, reasoning

Making in design can be defined as a computational process. Firstly, computation can be understood as a general reasoning process, beyond the use of computers. Secondly, design is a reasoning process with aspects that can be traced through computation, in particular visual computation. Thirdly, making is not a discrete stage of design but an integral part of a design activity; hence, it can be defined as a part of a computational process. In this paper, we first outline the terms making, design, computation, and the relations between the three to subsequently argue for new types of computational formalisms to include material aspects of design additional to the visual ones. Our particular focus is on the *dukta* case as we attempt to formalize a series of physical interventions. Dukta is a novel technique in which sheet materials gain variable flexibility by regularly staggered incisions. Physical manipulation (that is, stretching, compressing, twisting, rotating, bending) of the incised surfaces result in emergent textures or different three-dimensional configurations of the cut parts in space.

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Developments in digital fabrication technologies and materials science over the last decade have fostered an increasing interest in materials, materialization, and production processes in design. This interest is currently challenging

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the understanding of design as a visual thinking process. The distinction between design and making is reconsidered as the available computational tools provide new opportunities for designers to work with actual materials in full scale. Design is associated mostly with the production of abstract representations – drawings or models – to be materialized afterwards. Now making has a renewed role in design thinking. Within an environment enriched by the multifaceted and ubiquitous discussions around the use of digital fabrication technologies, it is necessary to define a framework for making in design that considers its mediating roles between the ideation, representation and materialization processes.

1 *Making and design*

According to the distinction of design and making in the Renaissance, design is an intellectual and immaterial activity. For Alberti, design is a 'product of thought' requiring 'the mind and the power of reason' and 'it is quite possible to project whole forms in the mind without any recourse to the material, by designating and determining a fixed orientation and conjunction for the various lines and angles,' possibly with the aid of drawings (1988 [1452]: pp. 5–7). Robin Evans (1997: p. 156) observes that architects, even five hundred years later, 'never [work] directly with the object of their thought, [they] always [work] at it through some intervening medium' which is almost always 'the drawing'.

With the technological innovations in tools and modes of representation in the Renaissance, drawing became essential to design practice early on. The widespread use of paper and pencil as drawing tools and the invention of planar geometric projection and perspective as modes of representation introduced a fundamental change in the concept of design and in the role of the designer. It was possibly the beginning of an ocularcentric tradition, with the eye becoming 'the centre point of the perceptual world' (Pallasmaa, 2005: p. 16). By 'intensifying the intellectual labour over manual labour' (Hill, 2005: p. 14), drawing replaced the master builders with designers. Master builders were artisans such as carpenters and stone masons working directly with the objects of their thoughts, while designers represented their ideas for three-dimensional forms with drawings accurate enough to be executed subsequently by workmen.

The physical model is another type of visuospatial representation frequently used by designers. Working with physical matter to represent design ideas introduces certain material aspects beyond representational purposes. Although always with some level of abstraction and simplification (Dunn, 2007), physical models, beyond the material undertaking of a design idea, serve as design tools that promote thinking as well as communication between the designer and the design (Smith, 2004). These aspects can be employed for a variety of reasons. Alberti (1988 [1452]: p. 34) for instance, points out the use of the