How Does the Digital Environment Change What Architects Do in the Initial Phases of the Design Process?

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Some researchers have tried to answer the question: do we need to think differently while designing in terms of the digital environment? This methodological question leads to another question: what is the range of this difference, if there is one? This research investigates the range of changes in how architects conduct and develop the initial design within the digital environment. The role offered by the digital environment in visual design thinking during conceptual designing through shaping: concepts, forms, and design methods, is identified and explored.

Keywords: *Conceptual designing; architects; digital environment; design process; visual design thinking.*

Introduction

The research differentiates between the digital media with their broad meanings, concepts, and techniques, and the digital environments[1] as mere design environments through their help of modelling and transformation programs, and any other associated software and hardware.

The research focus is on the initial design phases of ideation, concept articulation, and visualization. Although creativity, among other arenas, for example style of design thinking, differentiates one architect from another, and affects cognition actions (Kavakli and Gero, 2001) and visual design thinking (Abdelhameed, 2004) that architects perform and employ, the research will not investigate these arenas of intractable ambiguous nature.

The research is concerned with conceptual-designing activities, and the processes of visual design thinking that are employed in these activities.

Nature of designing and the main processes of visual design thinking

There are many characteristics that classify designing within wicked or ill-problems. Wicked problems are subject to redefinition and resolution in different ways over time as their formulation depends on the viewpoint of those presenting them. Designing can hardly be seen out of these extents (Kunz and Rittel, 1970; Rittel and Weber, 1973; Buchanan, 1995). However, various responses have been proposed to the problem with rationality, which link design-

[1] This differentiation is because the research does not investigate some digital-media concepts (form-generation algorithms for example, through which architects have forms without performing the phases of ideation and concept articulation) that radically change the design process. The architectural forms of these concepts are mainly based on various computational methods, for example Parametric, Animate, Metamorphic, Isomorphic, Topological, Performative, and Evolutionary architecture.

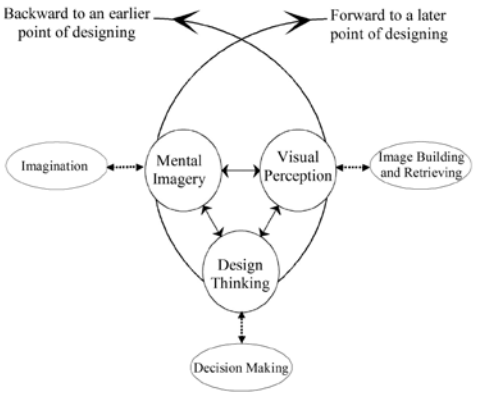
Figure 1
A cycle of visual design thinking and its main realms and processes

ing to human practices, contingency, sociality, and the rational basis of professionalism (Coyne, 2004). Designing is much more than problem solving, and the vocabulary of designing, especially in its initial/conceptual phases, is beyond the problem language of goal, rule, search, solution, and hierarchy, as some disciplines of ambiguous nature (for example imagination, creativity) are involved.

During designing, the designer goes back and forth through the linked cycles of visual design thinking, which results in redefining the design problem or its sub-problems or in abandoning some decision routes previously chosen (Abdelhameed, 2004). Designing is commonly regarded as tasks and activities representing the role of knowledge and representations in cognition design thinking. Although it is taken to be wicked structure, the nature of designing is commonly accepted into the arena of visual design thinking (Newton, 2004). Designing is linked cycles of visual design thinking (Faruque, 1984 and Zeisel, 1981 in Kellet, 1996) that needs representational environments to be performed and developed. This point of view emerges from the inevitable reciprocity between what can be perceived and what can be conceived (Abdelhameed, 2005), which relates activities and tasks of designing to the processes of visual design thinking.

Architects employ visual design thinking to visualize and understand the forms they work with. The research argues that visual design thinking encompasses three main realms: Visual Perception, Mental Imagery, and Design Thinking. Moreover, the research maintains that the three realms simultaneously and separately occur during the processes of designing in the mind of an architect (Figure 1).

Visual Perception of different representations has an important role in design thinking, imagining, and evaluating, which is used along with the design process. A final image in the mind of a designer transforms into shape after constant confrontation with past experiences in the process of imagination (Hagen, 1986 in Abdelhameed, 2005). In other words, the processes of mental skills of image building and



retrieving that differs from a designer to another, are simultaneously performed with the processes of visual perception (Figure 1).

Mental Imagery and the processes of imagining are intimately bound with visual design thinking, Figure 1. Our minds have different visual images that act as raw material, and different mental skills to employ this raw material in visual design thinking and designing. Previous researches point out that Mental Imagery and Visual Perception can often be considered functionally equivalent processes (Kosslyn, 1975, 1980; Finke 1980; and Shepard, 1984, in Kavakli and Gero, 2001).

Design Thinking manifests common characteristics of different individual styles of decision-making (Rowe, 1987), although creativity acts as a main discipline in the processes of mental imagery and design thinking. The goodness of decision-making processes requires: informative formulation, clear evaluation, and quick reformulation (Kam and Fischer, 2004). The quality of decision making depends on its information basis. According to its pertinent decision contents, the processes of decision making result in various options and alternatives, which consequently lead to good decision routs. The better value of decision–making process is attained through the simplicity of the reformulation process, and the large number of the created alternatives (Kavakli and Gero, 2001).

Processes of mental imagery and processes of visual perception activate many of the same brain areas (Kosslyn, 1994 and Finke, Ward & Smith, 1992). It can be concluded that not only the realms of visual design thinking are simultaneously preformed but also their inherent processes: imagination, image building and retrieving, and decision-making (Figure 1).

The foregoing discussion, especially of visual design thinking and decision making, highlights the role of design environments that architects use to explore, create, develop, and evaluate during designing. The next part of the research is concerned with what architects do in the initial phases of the design process.

Initial phases of the architectural design process

The design process does not have any algorithmic paradigm or step-by-step technique. Suwa and Tversky (1997) classify the contents of what designers see, attend to, and think of into four information categories: depicted elements and their perceptual features, spatial relations, functional thoughts, and knowledge (Suwa & Tversky, 1997). Visual information is presented in the first two, while non-visual information is presented in the last two. Suwa et al. (1998) categorize the cognition actions of designers to: conceptual, perceptual, functional, and physical (Suwa et al., 1998 in Kavakli and Gero, 2001). With the same token, these four categories of cognition actions can be classified into two processes: conceptual articulation, form creation. The way in which conceptualization interacts with form creation through the processes of visual design thinking can be described as design methodology.

What architects do in the initial phases of the design process is commonly classified as conceptual designing. Initial phases of the design process have activities that define the design problem. The priority of this design phase is to collect and sort through information related to the program. Much of this information comes in the form of non-visual information (such as words, numbers), and a little comes in the form of visual information (such as images, plans, maps). As a next stage, the relations among building components are studied, and the relations between the building on one hand and its surrounding context on the other hand are evaluated and formulated.

Designers explore the problem spaces as well as the solution spaces (Maher, 1996 in Akin, 2004). Designers, therefore, use design environments such as drawing, modeling, etc. to develop their design thoughts and design ideas, through concept articulation activities that are summarized in extracting and finding design concepts.

All the results of these processes and activities are edited to create design concepts, which represent the conceptual framework of formation and massing. Form creation and massing is the first stage through which architectural design literature is formulated in forms. These tentative forms are evaluated and reformed in later stages.

Many researches were concerned with the streams from which architects create an initial point for their design ideas. The research is not focused on this area; however, in short, design concepts and forms may emerge from different streams, such as:

1. inside or outside of the design-problem context,
2. subjective or objective interpretation of the design-problem ambit, or
3. creativity.

Without venturing much in the activities of conceptual designing (the initial phases of the design process) and in the cognition actions of designers, we can summarize and encompass all the previous discussion in that designers during designing attempt to create new concepts, forms, and design methods through the design environment used and visual design thinking employed. The concern of the next part of the research will be answering our question: what is the range of this difference?

The digital environment and the initial design phases

Designers use media, design environments, not as a passive mechanism merely to represent their design ideas, but rather to actively involve in forming these design ideas and to proceed in introducing new design paths.

Attempting to explore the role of the digital-design environment in the relationships and processes, illustrated in Figure 1, which are used in the initial design phases, the following observations are evident:

In imagination process of mental imagery

Although there has been a tendency amongst 20th century analytical philosophers to deny the connection between imagination as creativity and imagination as the production of imagery, mental imagery and creativity are intimately bound up with one another (Warnock, 1976; Robson, 1986; Brann, 1991 in Thomas, 1999); this point of view is shared even by recent psychologists seemingly little burdened with Romantic ideology (Finke, Ward, & Smith, 1992; Weisberg, 1986).

The medium that a designer uses during imagination and imagery production has a key factor in shaping these processes. There are powerful tools introduced by the digital-design environment that help our imaginings in representing and presenting complex and curvaceous forms. Ambiguity in sketching may be an advantage for distant associations and, therefore, may support the discovery of implicit spaces (Fish & Scrivener, 1990 and Mitchell, 1990 in Soufi and Edmonds, 1996); however, structure in digital modeling recalls the thoughts of functions and supports the occurrence of associations.

Through another use of the digital environment, CAD systems of computational modelling of emergence help in structuring and manipulating emergent shapes, which are important for imagination in opening new avenues of mental imagery.

In image building and retrieving of visual perception

Perceptual activity theory accounts for imagery via a common mechanism, but without assimilating imagery to discursive thought (Thomas, 1999). Designers engage in a rapid sequence of micro-perceptions and micro-reactions, almost simultaneous as far as consciousness is concerned (Damasio & Damasio, 1992 in Thomas, 1999). Through this attentive process of building up, searching out, and retrieving the distinctive features and feature complexes of the images or forms, which designers creatively come to recognize and categorize, designers not only perceive them as whatever they may be but also may conceive them according to their own creativity. In this conceiving process of image building and retrieving, the factor of the digital-design environment demonstrates itself clearly.

Although the monitor-based processes of visual perception are different from the paper-based processes (Abdelhameed, 2004), images and models introduced through computer can be manipulated and transformed easier than paper based images and models. Using modeling and transformation programs, therefore, helps image building and retrieving processes employed in visual perception.

In decision making of design thinking

Both processes of pertinent information basis and quick reformulation help designers construct various options and alternatives of the matter at hand.

The digital-design environment introduces more clarity in the processes of pertinent information basis, quick reformulation, and various alternatives production, especially in the visual knowledge. The ways offered by the digital environment for designers to access the visual information and data, may even alter our understanding of this information. The goodness of decision-making processes, consequently, should be better.

Visual design thinking is inextricably related to the design environment used during designing, as the research in another place above argued that vi-

sual design thinking has to be performed and developed through representational environments. After the previous investigations of the realms and processes of visual design thinking, and the potentials of digital-design environment offered through/for these processes, the research attempts to shed more light on the factor of the digital environment in conceptual-designing activities.

The range of difference in what architects do

The role of the digital environment in conceptual-designing activities can be illustrated in helping designers to construct design concepts, tentative forms and design methods (Figure 2).

Design concepts

In the tasks of concept articulation, much imagination, conceptualization, and interpretation are employed. During the evaluation activities, however, criticism, analysis, background knowledge and decision-making are more required and employed. Concepts and conceptual frameworks not only construct the interpretation of the design problem and vice versa but also guide the design process. They form the architectural configurations in three dimensions and the spatial sub divisions within masses.

Higher performance of the digital-design environment in cognition activity may be dependent on the richness of representational structures and pattern goodness, while poorer performance of the manual-design environment may be due to a representational mismatch between imagined and

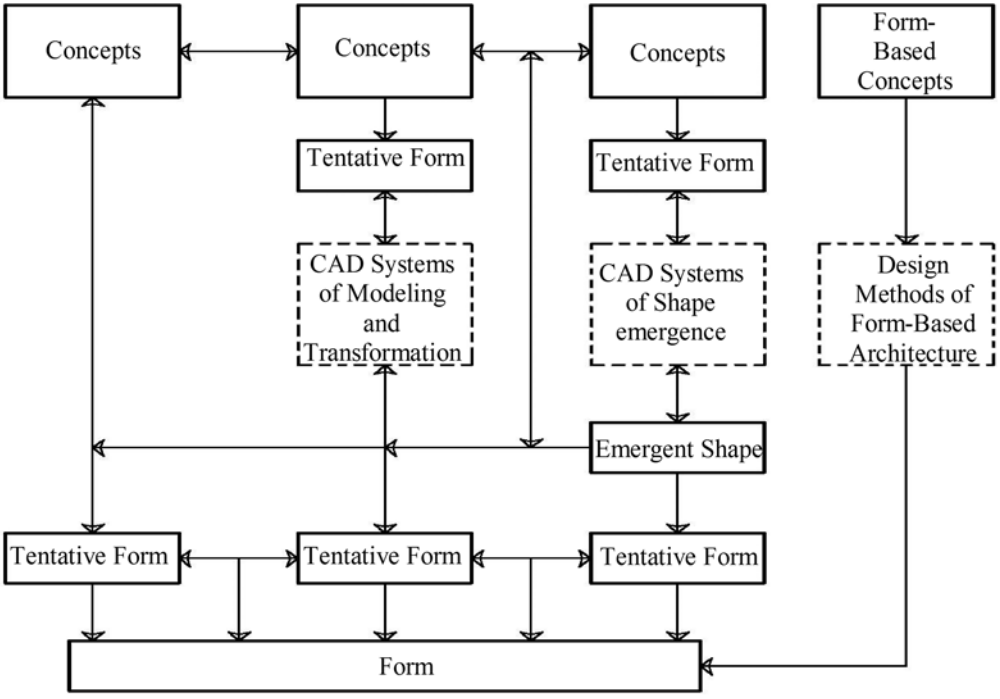


Figure 2
The role of the digital environment in conceptual designing activities

perceived stimuli (the tentative form). During concept articulation, the perceived images may lead to a number of associated interpretations as humans can combine mental images in various ways (Finke, Ward & Smith, 1992). The role of the digital environment appears in these processes with different ways, through:

- CAD systems of modelling and transformation: Scrivener (1982) argues that such systems require designers to pre-generatively structure a computer image and then limit understanding and manipulation to this structure. Consequently, they are inappropriate for the early creative stages of deign during which ideas are often vague and incomplete, like their drawn representations (Scrivener, 1982 in Soufi and Edmonds, 1996). However, modelling and transformation in the digital environment opens new potentials not only for formalization but also for conceptualization. As previously investigated, manipulations through such systems affect the main realms of visual design thinking and their processes of imagination, and image building and retrieving.
- CAD system of computational models of shape emergence: In general, initial concepts play the main role of the validation and appropriateness of ideas during design development. The modified and subsequent concepts in later stages do not have the influential impact of concepts derived from the initial design ideas, which are appropriated from outside the immediate context of a given design problem (Simon, 1979). In other words, shape emergence may lead to or generate concepts that may be very effective on designing (Figure 2).

Tentative forms

Architects express their concepts and conceptual frameworks into architectural formal propositions and compositions. This initial form is often restructured later. Restructuring the form does not always lead to the generation of an entirely new alternative. The digital environment is a main factor in these restructuring processes, especially in the evaluation processes of form creation.

According to Soufi and Edmonds (1996), computational models of shape emergence have been introduced using both hypothesis-driven and data-driven searches, based on: infinite maximal lines in two dimensions by Gero and Yan (1994), and infinite maximal planes in three dimensions by Gero and Damski (1994) (Soufi & Edmonds, 1996). Moreover, a theoretical framework for the computational modelling of emergent shapes based on multiple shape representations (pixels, endpoints, regions, line segments) has been presented by Soufi and Edmonds (Soufi & Edmonds, 1995). In a parallel applied line, there are other approaches in the representation of shape more concerned with shape algebras (Krishnamurti & Stouffs, 1993) or shape simplicity (van der Helm & Leeuwenberg, 1986) than with emergence.

Emergent shapes introducing alternative solutions during form creation may effectively help designers in creative processes of designing: exploration, evolution, and decision making. CAD systems of computational modelling of emergence, thus, have to be more responding to designers, especially in three dimensions, in structuring and manipulating emergent shapes (Figure 2).

Design methods

Design methods are ways of the interactions between concept articulation and form creation within potentials of the design environments. Although the potentials introduced by CAD systems of modelling and transformation are highly appreciated, such potentials do not play a significant role in the traditional design methods. They are like a telescope through which architects see what is already exist but previously not apparent.

CAD systems of shape emergence are useful even if they do not account for all possibilities. An intermediate representation enables new shapes to be discovered and leads to more structures being seen in a given pattern (Soufi & Edmonds, 1996). The se-

quence of the processes of concept articulation and form creation through CAD systems of modelling is not affected as it may be as through CAD systems of shape emergence. These two kinds of CAD systems, which may be simultaneously used, have effectiveness in creating not only forms but also concepts and design methods.

The digital environment produces novel design methods that may radically change our architectural form and the conventional design process (Figure 2). Some architects and scholars maintain that these novel design methods of architecture herald the end of modernity (Oasterhuis, 2003 and Palumbo, 2004). In other words, this form-based architecture (if we may describe it) is produced by the formalization potentials of the digital environment. Formalization has the priority in this kind of architecture, as even its conceptualization is derived from form bases.

Conclusion

The main realms of visual design thinking and their inherent processes: imagination, image building and retrieving, and decision-making, which are simultaneously preformed in the mind of an architect, have been explored.

There are changes introduced to the initial design phases of ideation, concept articulation, and visualization by the digital-design environment. The range of changes in the processes and activities of these phases has been explored. Some vital matters of the research concern have been highlighted:

- CAD systems of modelling and transformation do not have a significant role in the traditional design methods. The digital environment through such systems reopens formal relationships and logic available to the designer.
- Emergent shapes that introduce alternative solutions of form and new avenues of concepts may effectively help designers in creative designing. CAD systems of computational modelling of shape emergence, thus, have to be more responding to designers, especially in three dimensions, in structuring and manipulating.

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