Role of Studio Exercises in Digital Design Education

Case Study of the Nine-Square Grid

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Abstract: *This paper is about short term and contextually limited kit-of-parts exercises in architectural education. Studio exercises are one of the key educational tools in architecture, which should be reconsidered with the developing technologies. As design computing becomes the mainstream thinking in architecture, the need for not only renewed studio exercises but for new educational frameworks becomes an essential issue. Thus, in this paper we will be proposing a different perspective on digital studio education, by explaining the fundamentals of studio exercises and their digital transformation potentials. Our experience with one of the most common kit-of-parts exercises, the nine-square grid, as a computational design problem for the first year students will be presented here as a part of this on going study.*

Keywords: *Digital design education; learning models; studio exercises; the nine-square grid.*

Context

When a common teaching approach fails to meet the pedagogical requirements of a shifting paradigm, the search for new educational frameworks begin. This paper is about a similar transformation on contemporary architectural education, notably on design studios. Experimental digital studios in architecture are a fast developing research area in parallel to the associated theories and methods of design computing. There are significant studio experiments especially in the last decade (Oxman, 2008, Çolakoğlu et.al, 2008; 2007; Yalınay-Çinici et.al., 2008; Yüncü, 2007; Burry, 2005; Özkar, 2004; Celani, 2002; Brusasco et.al., 2000; Knight, 1999) that highlight the need for a new educational framework in architecture.

In this paper, we propose a down-to-top perspective on how to transform traditional studio tools and methods into their contemporary digital counterparts. The purpose of this perspective is to emphasize the importance of down-to-top pedagogy-focused integration of any theory into the educational studio, rather than a top-to-down theory-focused integration. The pedagogical intention of the studio instructor has a key role in this integration process. To crystallize this intention, we can be more provocative, by classifying studio instructors as "traditional studio instructor' and 'digital studio instructor'; and compare their design understandings.

It can be claimed that 'traditional' studio instructors heed the final product, whereas the digital studio instructors focus on and evaluate the **process of design,** This observation leads us back to think about the fundamentals of design teaching and design learning again.

Learning by cognitive construction in digital design studio

In this paper, we propose a transformation of a traditional teaching method based on a general learning model. In order to develop this; first, we should define the learning model by asking the above question of "how design learning happens?" This assumption would lead us to construct a teaching method, adding the question "when design learning happens?"

Contemporary learning models of Behaviourism, Cognitivism, Constructivism, and Humanism represent the fundamental assumptions on how and when human learning happens. It might be useful to translate these general assumptions into architectural studio context, while searching for a new teaching method. In contrast to the Behaviourist model, which defines "passive behaviour" as the cause and the only evaluation criteria of any learning activity, the Constructivist learning model claims that, learning is an **active construction of knowledge**.

In "My Pedagogic Creed", Dewey (1897) denotes the theme of modern education. He mentions that institutional systems should have a student-centered perspective. When architectural design education is concerned, this manifest means "learning-by-doing". Whereas it shouldn't be misinterpreted as "learning by creating physical artifacts", which points a behaviourist model in studio learning and evaluation. We believe, behaviourist learning model, focusing on the final artifact instead of the process itself, does not meet the requirements of contemporary digital design education Therefore, in order to develop a new educational framework, some of the studio concepts should be re-defined, such as;

- If we admit the reality of digital transformations on architectural design, the general assumption of "learning by doing" would not be enough to answer some of the fundamental questions of contemporary Digital Design Studios. One significant transformation in architectural design is the shift of focus from design objects, to design processes. Then, our first question should be "**how** design learning happens, without physically creating it?" If we assume the design process itself as a design output, we frequently translate above notion into "learning by designing the design process". However, this also won't help us on answering the cognitive learning question "how?"
- The educational method of "student-centered-studio" is also not enough; and can easily become a "studio-centered-student" conception. We should re-think about the educational setting of architectural studio, without any presupposition about "**when** design learning happens?"

Kit-of-parts: Parametric language of the Nine-Square Grid

Any Constructivist assumption about human learning does not direct to a single teaching method only by itself. One can pursue a highly didactic learning environment assuming a Constructivist learning perspective. However, when a design studio instructor realizes that students construct their own design knowledge, the first pedagogic step is usually dividing the studio structure into several modules, creating more explicit and isolated pedagogical parts. In this paper we call the tools used in these educational parts as short-term and contextually limited **studio exercises**.

Studio exercises are highly productive and continuously evolving educational tools with numerous interpretations on various studio settings. Generally, they are used to conduct a Constructivist learning environment that tends to focus on limited issues such as formal and spatial reasoning, functional relations or building performances. Short-term or contextually limited studio exercises are usually developed at introductory years, to develop the basic design capabilities of students. One of the most influential aspects of these exercises is the requirement for spatial reasoning, based on abstract form relations. **Kit-of-parts** is the conception emerged from this Gestalt, which reflects the relationship between abstract parts and the spatial composition as a whole.

The nine-square grid is one of the most common kit-of-parts exercises in design studios since more than 50 years. To explain briefly, the nine-square grid exercise is based on the transformation of a nine-square grid into a series of alternatives, using a pre-defined kit-of-parts and a set of rules. It is an open ended educational application with a limited but flexible context, which can have infinite interpretations to meet various studio objectives. The nine-square grid exercise is developed by Robert Slutzky, John Hejduk, Colin Rowe and Lee Hirsche, instructors with revolutionist spirits, along with their colleagues in a short, but inspiring educational program at Texas University School of Architecture between 1954 and 1958. Since then, numerous interpretations of this exercise have been carried on at design studios all over the world (e.g. Gür, 2003; Subotincic; 2007).

Caragonne (1995) describes the exceptional educational atmosphere that created the Nine-Square Grid exercise. According to him, Slutzky, with a painting background and special interest in Gestaltic enclosure, developed a two-dimensional basic design exercise using an already known frame base. Later, Hejduk, one of the most active members of this energetic group, discovered the spatial potentials of this exercise, interpreted verticals and horizontals as post and beam, creating the fundamentals of the Nine-Square Grid (Figure 1 and 2). Love (2004) emphasizes the two sources, who influenced the exercise. One of them is Wittkower, who analyzed the Palladio's villas in basic three-by-three diagrams, a nine-square grid. The second source of this exercise was Arnheim, who developed the psychology of form based on the principles of German gestalt theory (Arnheim, 1954). Love (2004) argues that, the nine-square grid is the ideal geometric format for understanding the interrelation between building components regarding their spatial qualities. Although the effects of Mies and Le Corbusier on the developers of this exercise is obvious, its new potentials and emerging possibilities are surprisingly open ended. Kalfazade (2004)

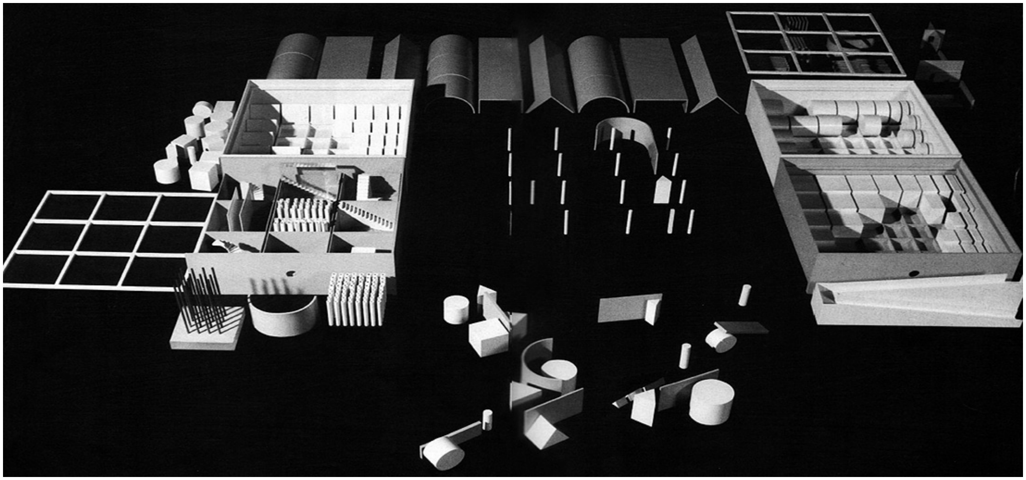

Figure 1
Kit-of-parts exercise, the Nine-Square Grid (Hejduk, 1999)

describes its diagrammatic potency as "infinite to generate form", although its essential elements are limited by pedagogical intentions.

In this paper, the digital potentials of the nine-square grid exercise will be emphasized, as a case study of kit-of-parts conception in studio, which are based on our experiments and observations with various interpretations.

Purpose

Our arguments about the relationship between Digital Design methods and traditional kit-of-parts exercises include:

- Short-term exercises are educational tools based on a Constructivist studio setting, which focuses on the studio process rather than the final artifacts. Therefore, their evaluation criteria are also process-based.
- Regarding computer programming paradigms, kit-of-parts exercises represent the object-orientation, which is one of the foundations of parametric modeling in design computing today.
- Short-term exercises are common studio tools, with numerous experiences at the schools all over the world since more than 50 years. It basically seems to be an "open door" for a down-to-top transformation of pedagogy in architectural education. Because when we use the term, "transformation of pedagogy" the most significant element of this process seems to be the down-to-top transformation of the design instructors.

Method

In order to activate the potentials mentioned above, we propose a **digital transformation process** of traditional studio exercises. Objectives of this transformation are:

- To benefit from the past experiences of architectural education. We define a **down-to-top** transformation of traditional design exercises, as an alternative to a top-to-down approach of today's computational exercises such as the "Shapers" introduced in the last decade.
- To benefit from the digital technologies in creating studio tools, regarding their virtual capabilities that overcome the **physical constraints** of their traditional counterparts.

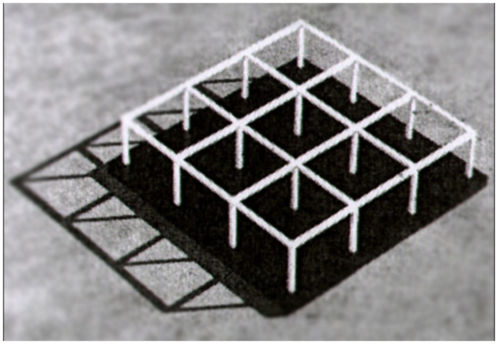

Figure 2
Frame of the Nine-Square Grid (Caragonne, 1995)

The proposed digital transformation of a studio exercise can be analyzed in several phases. They are the computerization phase, computational integration phase and metamorphosis phase. There is also one alternative transformation method that includes the computational integration without a computerization process. These phases are briefly explained below:

- The computerization phase is the basic simulation of a traditional studio exercise in a computer software. On this phase of transformation, original exercise is analyzed into its **kit-of-parts** and **kit-of-rules,** then synthesized into a computer-aided version utilizing the object-orientation as a basis. Our first working prototype of this phase is a scripted algorithm, created within a contemporary visualization software in order to benefit from its ready-implemented functions (Figure 2). The GUI shows our intention to create a basic tool with easiest perceptual qualities (Figure 3).
- The integration of computational methods includes various alternatives that emphasize the parametric underpinning of the exercise. Amongst the preliminary potentials, we may count the implementation of rule-based, agent-based and evolutionary algorithms, perfor-

mance analysis and kinetic compositions. However, they might not create amazing graphical outputs, but these implementations may create and preserve the necessary focus on these issues, using the one of the most fundamental spatial characteristic of architectural design, a simple pedagogic frame.

In this down-to-top transformation, the metamorphosis of an exercise is regarded at a point that the main characteristics of the original exercise totally transform, creating a totally different exercise. The main characteristics of the nine-square grid can be interpreted as a geometric system or the design domain of spatial reasoning. When the transformed exercise extends its limits, it can be regarded as a totally new exercise.

Preliminary findings

First experiments on this on-going research project include the simulation of the Nine-Square Grid by computer software. This "computerization" process immediately showed us new potentials, triggered by the inevitable transformations on representation medium. Undergraduate students of architecture experimented both computerized and original versions of the nine-square grid within an introductory studio structure (Figure 4), revealing the basic advantages of the computerized version in terms of rapid design exploration. The first observations indicate that, the integration of computational thinking into the exercise has great pedagogical potentials.

Figure 3
Computerized Nine-Square Grid GUI

Discussion

Abstraction of form and limitation of context are powerful constructivist educational approaches in studio. The parametric version of the Nine-Square Grid exercise experimented in this paper showed us a new way of integration of digital design thinking and methods into design studios, utilizing and transforming these approaches. The integration of computational thinking in contemporary architecture depends on such improvements not only with new tools and techniques used in the studio, but also new developments on the pedagogic formations.

Digital transformation of a studio exercise not only means a change of representational medium, but also an intellectual and pedagogical shift. Studio exercises are powerful tools that can be utilized for the integration of contemporary design thinking to architectural education. Design exercise in architecture is an old but important field because of its flexibility and potential of evolution. We suggest the emerging field of interdisciplinary tool development for architectural design in general, should also include an educational framework. New design exercises should be developed in order to meet the requirements of new design thinking and practice. Managing this framework is important, regarding a down–to–up integration of the new design paradigm into the contemporary constructivist digital design studio.

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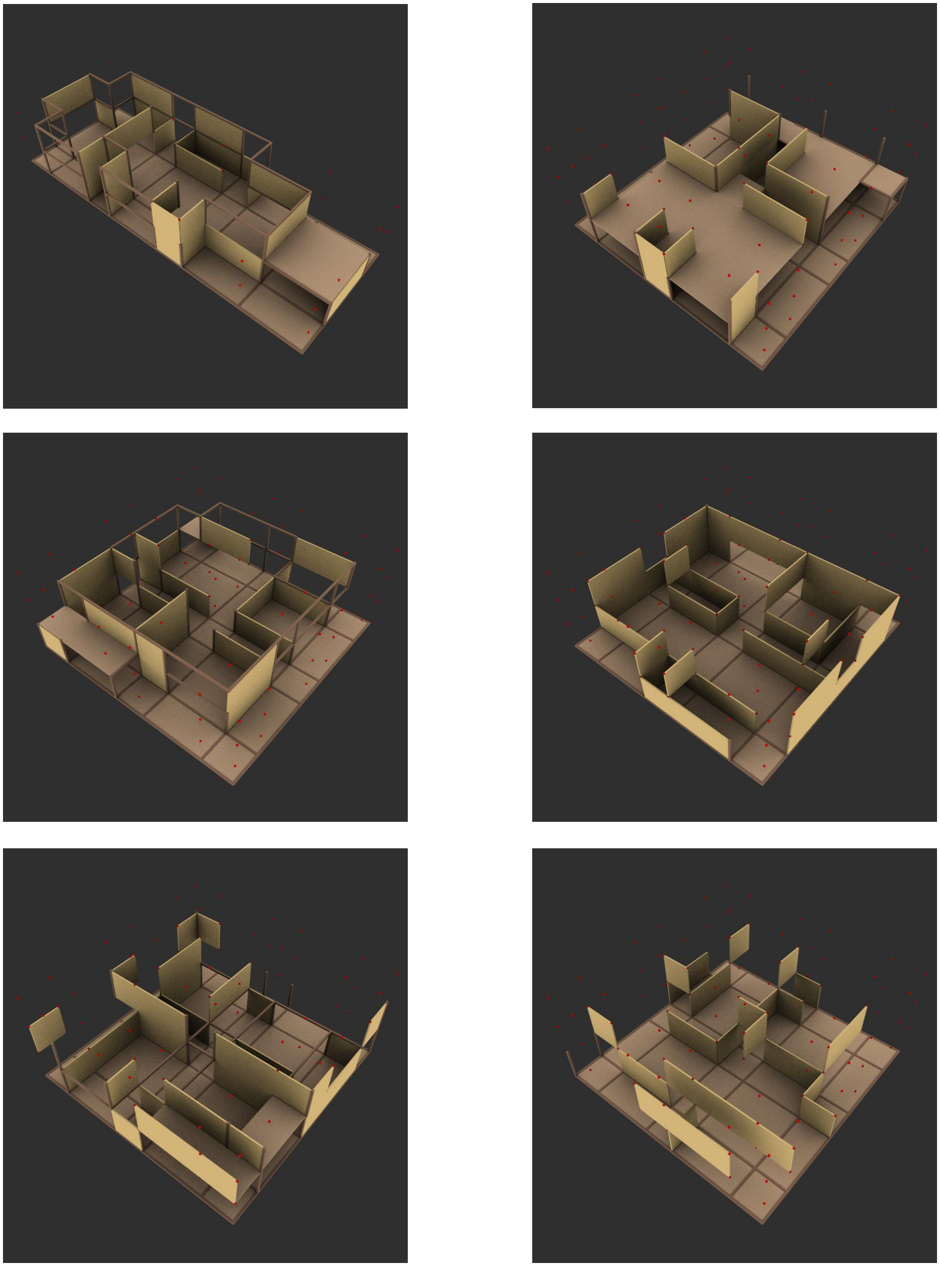

Figure 4
First student experiments of the tool

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