Introduction to Architecture Studio: Geometry, Rules and Patterns

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Abstract. Introduction to architecture studio introduces students of architecture with fundamentals of design and design thinking. Here, the students learn: analytical thinking by constructive analysis of precedents; language of design by using basic geometric elements and operational/transformational principles among them; and principles of form making by engaging in constructing the form. The paper explains the process of the studio in which shape grammar methodology is utilized in teaching analytical thinking, language of design and principles of form making to architecture students.

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INTRODUCTION TO ARCHITECTURE STUDIO

Design studio has always been the major interest of design education research. Its aim is to teach “the creation of good design” in which “the understanding of the design process” is seen as “fundamental”. To understand design process means being directly engaged in the process of making things with ideas in them. The architect’s learning, depends in reasoning through making, with in this contexts the studio can be seen as a site of learning in which making plays an important role in understanding. The learning process in the design studio consists of different phases that reflect different modes of the learning cycle. Especially in design studio level 1 here named as “Introduction to Architecture Studio” the experience through a serious of different learning activities is crucial since the preliminary aim is to develop the perceptual skills of design students through an analytical and abstract way of thinking. The primary aim of the design studio introduced in this paper is to develop an understanding of what the design and design activity are, through a creative and analytical way of thinking. Here, the design students learn and practical new ways of thinking, new languages, and new skills.

To develop understanding of the design process the design activity from conceptual to concrete level should be conscious, selective and intelligent rather than habitual and coincidental. However, since the novice design student has not developed the perceptual and relational thinking skills for him/her intelligent design activity is a formidable task.

The aim of Introduction to Architecture studio described in this study is to develop awareness of design thinking, materiality and construction among the novice design students by engaging
them in making design artifacts. Analytical and abstract way of thinking, learning by experiencing, reflective thinking, and doing is emphasized throughout the studio. The studio is the first place where the students are introduced totally with a new world of design with its own values and attitudes. They learn a new abstract design language, the way of abstract thinking and practice some new skills such as designing and making artifacts. The studio introduced in this paper consisted of two modules: Understanding architecture through structured analyses, and understanding of design composition by the concept of pattern, and by prototype making.

**Understanding Architecture Through Structured Analysis**

At the very beginning of the studio before asking students to design anything, it was aimed to make them understand abstract thinking through design analysis in which geometry is introduced as abstract design language. The initial stage of this exercise was the reading of the architectural language of a building and understanding what has been read through visiting the building. Hagia Sophia one of the most significant building of architectural history constructed in simple Euclidean geometry is chosen as an example for this exercise.

First, the students are introduced with the basic elements of design language (point, line, face and solid) their operational rules and associative thinking and then with the rule based design analyses (shape grammar) method in architecture. Then they are asked to provide rule based analyses of Hagia Sophia through literature search by looking at its geometry, massing, plan to section relation, structure and layout composition.

Once they were able constructively to analyze Hagia Sophia from literature and extract its basic design principles then were taken to the actual building for on site analyses. They were asked to describe with rules the design principles of Hagia Sophia, by observing it. Each student individually worked on design analyses and rules of Hagia Sophia. Then the students were divided up into three groups for constructing 1/10 scale models of Hagia Sophia: massive (a), structural (b) and section perspective (c) models (Figure 1).

To comprehend the design of Hagia Sophia for novice architecture students is quite difficult task since he/she hasn't yet developed perceptual skills and relational thinking. Analysing the building with Shape Grammars method by extracting its geometrical composition rules in relation to its structure made students to understand that the abstract language of geometry is the language of the structure of the building. In their drawing analysis of the building they were able to explain the meaning of each line marked on the paper. After these structured analysis they were asked to make 1:10 scale massive, structure and plan to section models of Hagia Sophia following the rules of that they extracted in their analyses of the building. (Figure 1) It is observed that compared to previous years exercises where the students had been introduced to Hagia Sophia and analyzed it in conventional way, structured analyses of the building provided higher level architectural and structural understanding of the building.

![Figure 1](Hagia Sophia Models)
Understanding of Design by the Concept of Pattern, and by Prototype Making

The second exercises aimed to make students aware of the conceptual understanding of design by the concept of “pattern.” It consisted of two steps. The first step utilized shape grammars as graphical production method for 2D pattern generation. Shape Grammars provide a formal mechanism for generating 2D and 3D compositions based on shapes and their spatial relationships by specifying methods to replace parts of shapes with others.

A pattern is generated from a shape grammar by beginning with the initial shape and recursively applying the shape rules. The result of applying a shape rule to a given shape is another shape consisting of the given shape with the right side of the rule substituted in the shape for an occurrence of the left side of the rule. “Rule application to a shape proceeds as follows: (1) find part of the shape that is geometrically similar to the left side of a rule (2) find the geometric transformations (scale, translation, rotation t mirror image) which make the left side of the rule identical to the corresponding part in the shape t and (3) apply those transformations to the right side of the rule and substitute the right side ‘of the rule for the corresponding part of the shape.” (Stiny and Gibs, 1972) The generation process is terminated when no rule in the grammar can be applied.

The students were asked to chose initial shape from Hagia Sophia drawings and define rules for 2D pattern generation as illustrated in Figure 2.

The second step utilized shape grammars as graphical production method for 3D pattern generation. Here, Frobel grammars (Stiny, 1980) a constructive approach is utilized for 3D pattern generation. 3D patterns are defined from scratch by rules and are constructed by means of shape grammars in 5 stages:

1. A vocabulary of 3D pattern is specified. The shape provides the basic building elements of 3D pattern.
2. Spatial relations between vocabularies of shapes are defined.
3. Shape rules are specified in terms of shape relations.
4. Shape rules apply to initial shape(s) recursively to construct 3D patterns.
5. 3D patterns are specified in terms of shape rules and vocabulary of shapes.

Here the application of the rules is not deterministic: multiple choices can be made in each stage. Specific possibilities in one stage may lead to multiple possibilities in a succeeding stage. Multiplying possibilities from stage to stage in the construction allows for increasingly finer spatial distinctions to be made and therefore provides constructive machinery to define patterns with precision and control. (Stiny 1980)
Figure 3 illustrates 3D pattern construction by means of shape grammars using Frobel blocks as vocabulary elements.

Once the 3D pattern is constructed, then it is transformed by adding some initial vocabulary to the composition as illustrated in figure 4. (White blocks) The students than were asked to interpret generated 3D grammar composition as base for exhibition stand design. The transition from abstract composition toward the concrete design occurred through building 1/10 scale prototype models. In this working model the students explored the behavior of the materials, structural stability, connections interfaces and spatial possibilities. The difficulties of constructing the actual
design with chosen material (wood) were discovered in prototype model. Therefore, in the next step the students constructed the design in 1:5 scale instead of 1:1 scale as shown in figure 3.

In shape grammar the shapes are manipulated according to their visual structure. As a result the designer is free to manipulate description of his design in a manner that reflects the interactive freedom often associated with sketching. When a designer manipulates parts of a design, emergent patterns and associations can be discovered which suggest new features and relations. The structure of the design can be reinterpreted according to these emergent patterns. Such reinterpretation is a vital element in the exploration of designs.

The third example of 3D rule based design was “shell project” constructed in 1:5 scales. In this Project the students first worked on conceptual model through which they defined the basic components and the design principles of shell structure as shown in figure 5a. Then they constructed working model in 1:20 scale, as shown in figure 5b, they explored relations between the components, material properties and structural stability of the shell project.

The students redefined components and construction principles of shell structure through working model and group discussions. They learned about design making through constructing it as shown in figure 5 and 6.

CONCLUSION
Introduction to architecture studio emphasized five points: 1- Understanding architecture through structured (shape grammar) analyses, 2- Shape grammar...
as abstract form generator tool, 3- Learning through constructing, 4- Material property of design artifact, 5- Collaboration and communication in designing and building.

The presented studio work aimed to develop in-depth awareness of the design process in the beginning level of design education by utilizing structured computational design method of shape grammar in design artifact development. Here, the craft of making functioned as a vehicle for thinking ideas in concrete matter. The studio emphasized a process in which fabrication is inseparable from the conception of design. It allowed for experimentation, learning and collaboration. Here the dual roles of thinking and making are symbiotically joined.

To conclude it, the development in technology tools that join thinking, designing and fabricating are changing the way how architects work. The studio education in architecture schools has to adapt to these changes not only with technology integration but with the new ways of thinking and doing that these new changes are bringing. Level 1 studio here named as “Introduction to Architecture” plays a crucial role in this adaptation.

REFERENCES