New Approaches in Architecture Education

Conclusion

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The explosion of computationally-oriented content into architectural design and making has generated curricular changes in architectural education. This paper describes an educational model developed following this changes. One of the important goals of the educational model explained in this paper is to introduce the knowledge of geometric assembly/disassembly planning to the field of architecture encouraging students of architecture to integrate this knowledge into the design process.

Keywords: *computational design, , design for disassembly*

Computation in all scientific and design fields made radical implications in the ways of reasoning. It caused the most radical shift of mental processes since modernism. The new ways of reasoning require a new epistemological approach. With "Computational design" there is no anymore talking about conventional design aided with computers but a completely new way to perform design activities, from research to evaluation, communication and education affirming that there is a new culture of design activity.

The integration of this new culture of design activity into architecture curricula has been investigated by many design educators through educational models. This paper will summarize one of this models conducted in "Computational Design" graduate program.

The educational model includes two modules with two courses in each. The first module run in fall semester includes Shape Grammar and Introduction to Computational Design courses. The second module run in spring includes Design Systems and Designing the Design courses.

The students enrolled in graduate program usually have good computerization skills. They are good in using the tools however, are not aware of computational logic and thinking involved in computational design making. The aims of the first module courses have been: to introduce design students with computational concepts utilizing shape grammar, and to create intellectual foundations for this new design culture. Due to their inherent algorithmic structure patterns are used as tool for teaching these new concepts of design. (Colakoglu, Atawula, Alkhoudari, 2014)

Once the students have learned to communicate and manipulate their designs using this new design language, than they are asked to apply them on 3D surface considering sun movement on defined location. Here, the angle between sun light and surface normal has been the determining factor of the pattern variation on the surface (Figure 1).

The first module has been prerequisite for the second module courses run in spring semester. The aims of the second module have been; first, to make students search for possible design systems that can optimize computational design making and then to develop designs considering the principles of these systems. Design systems course introduced "Design for Disassembly" (DfD) approach in design and construction. Designing the Design course engaged students with computational design making considering DfD strategies through real design problem. Here, culture pavilion for Kadıköy in İstanbul was given as design task. The design brief emphasized that pavilion design strategy should correspond to some of the principles of DfD.

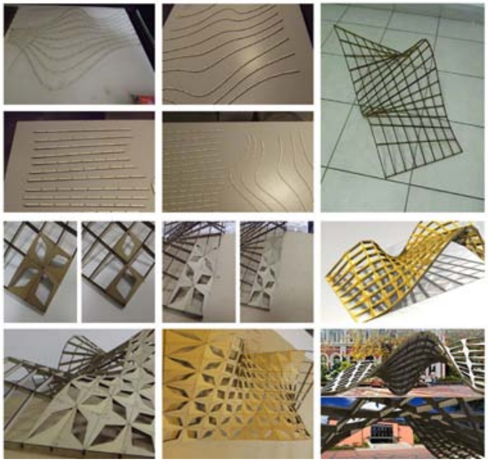

Figure 1
Application of patterns on 3D surface. The openings on the surface are designed considering sun movement.

DESIGN SYSTEMS-DESIGN FOR DISASSEMBLY

Design for Disassembly (DfD) is a new design method that introduces new design criteria. DfD was first applied in product design. It has been driven by well established regulations that cover sustainability issues. It is a new concept for the design and building community and is an important contributor to sustainable design. In this new design method a building is composed of different layers having different lifetimes. It may be expected that similar regulatory approaches applied in product design can soon be extended into the building industry. Although, buildings are not"product," they are composed of materials, components, and connections that are assembled.

Design for Disassembly is a method of design that supports future change; it allows buildings to transform and adapt either specified or emerging needs. This method of design simply creates conditions to recover, reuse, rebuild and reconfigure components and materials. It is the most promising method of optimization through; assembly, component connections, and systematic design. It changes craftsmen based building construction process to one of assembly. Kieran S. And Timberlake J. Point out that "Assembly differs from construction in that it requires very little skill; it does not rely on information passed on through experience or development through apprenticeship. Assembly comes from a hierarchical understanding of groups of assemblies that all connect through series of steps." The new design culture based on computational designing and making have changed craftsmen based building construction process to one of assembly. DfD returns to architect responsibility for the craft and quality of the construction through computational processes in construction and design. These new tools allow architects to explore and construct buildings digitally with extreme precision. Architects can simulate assembly processes prior anything is actually is build. By simulation model of a building architect can decide which components could be pre-assembled, and which should be assembled on site.

DfD systems provide the opportunity for a building to be dismantled (in part or whole) both during and at the end of its lifecycle giving building an ability to quickly adapt.

Design systems course elaborated DfD model of design and construction for architecture. It investigated development of design through parametric model integrating DfD principle applicable for architecture.

DESIGNING THE DESIGN

In the second module two courses are run in parallel. Design system is required course for the students that have taken Designing the Design course. In the first one, the students elaborated DfD method of design and construction, and in the second they applied this new approach in real design problem - culture pavilion design for Kadıkoy bay area (Figure 2).

Figure 2
Kadıköy bay area

Kadıkoy is one of the 32 districts of Istanbul. It is located on the Asian side of the city, consists of 28 neighborhoods. Kadıköy is ranked as the cultural centre of Asian side of Istanbul with, its theatres, cinemas, culture centers distributed throughout the neighborhoods.

However, the analyses conducted in Kadıköy showed that there is more need for culture spaces especially for temporary culture activities in Kadıköy waterfront and bay area. Designing the Design course is structured around this real design problem. The students are asked to develop culture pavilion designs for Kadıkoy bay area considering DfD principles.

The key to successful DfD lies in maintaining flexibility within assemblies, easy component separation and easy access to parts. The design brief required to cover some basic DfD principles integrated with architectural requirements:

Architectural requirements:

- Multifunctional pavilion design, (transformable at least into two different functions)
- Environmental responsive design, (sun movement, wind direction, ect.)
- Architectural expression,
- Structural, spatial, technical transformability,

Some basic DfD principles:

- Simplified connections between components for easy assembly and disassembly,
- Minimized components in assembly, (without compromising the structural integrity or function of the design)
- Minimized material types in assembly,
- Separated components into modular subassemblies
- Minimized number and type of fasteners in the assembly,
- Standardized fasteners,
- Easy accessible fasteners,
- Easy separable components,

First, context and environmental factors of Kadıköy are analyzed. Kadıköy old market and the streets surrounding the market area are famous with street art and various cultural events that are taking place on the streets. In order to locate these cultural events in specified areas throughout Kadikoy, location map for pavilions is defined. In this map, specific location in Kadıkoy bay area has been chosen for culture pavilion.

The foot print of the culture pavilion is developed from Fibonacci spiral (Figure 3). It is generated by drawing quarter circles inside the squares that are generated by drawing small squares on top of each

Figure 3
Fibonacci spiral and nature examples

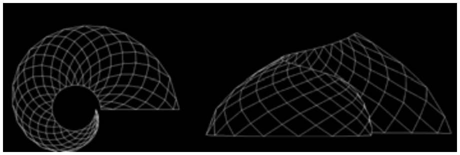

Figure 4
Pavilion is created by gradually increasing the height of the spiral.

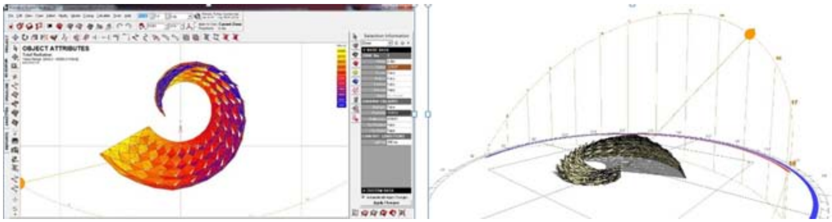

Figure 5
Figure 5: Kadıkoy culture pavilion Sun and wind analyses.

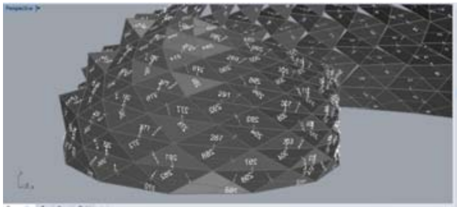

Figure 6
Grasshopper model of pavilion

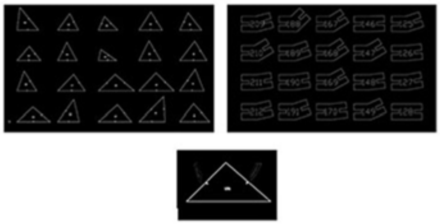

Figure 7
Panels, joints-connections

Figure 8
Grouping the panels

other and adding a sequence of growing squares counter clockwise. The length of the square sides in the order generates sequence 1,1,2,3,5,8,13,21, of Fibonacci numbers.

These numbers are find in many spiral constructs in nature (Figure 2). The pavilion is created by gradually increasing the height of the arcs that generate the pavilion. In other words by extrusion of spiral in 3D. Here the height of starting arc is 1.2m and ending arc is 5m (Figure 4).

The environmental conditions, wind direction and sun movements of Kadıköy bay area is analyzed utilizing Vasari software in design development phase (Figure 5).

These two environmental factors are considered as challenge during the development of design concept. After the design concept and methodology is selected, grasshopper is used to generate the design solution space and to calculate the openings of the façade according to the angle of the sun with surface normal (Figure 6). Some generated design solutions are examined in Vasari for solar movement and wind analysis.

Culture pavilion is designed for two functions; as an info desk during the day and as performance stage at night.

One of the design purposes of the project was easy assemble and disassemble of design components. To realize this aim, pavilion structure is panelized and divided into 20 groups, each one defined as stripe, consisting of 16 panels (Figure 7). During the assemble process, these groups are put together separately, then connected to each other to build the pavilion. The disassemble process are the opposite. Mechanical joints were used rather than chemical joints to make the process of reuse and reassem-

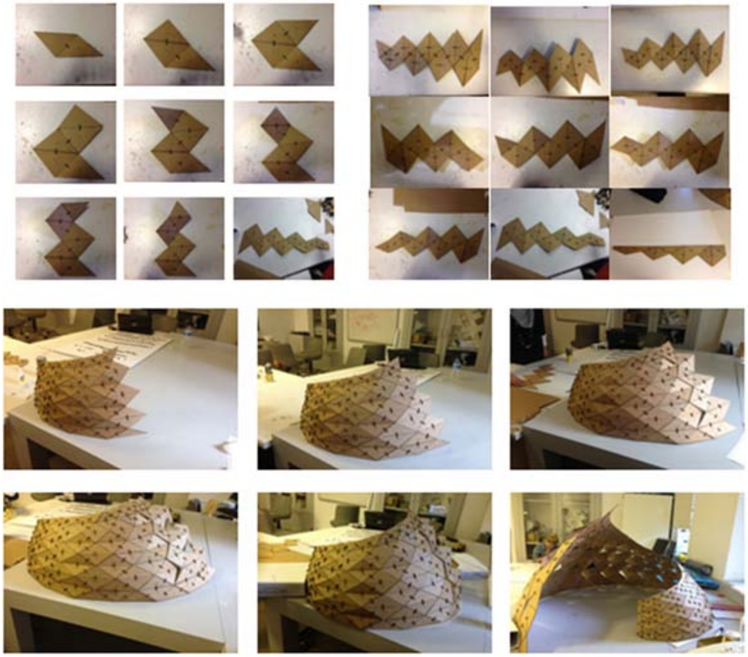

Figure 9
Culture pavilion model construction.

Figure 10
The openings on the pavilion are constructed according sun movement in Kadikoy.

Figure 11
İllustration of Culture pavilion on site. Design work: Düzgüneş.Ç, Özen G, Yönter U, Atawula E, Alkhoudari L.

ble more efficient. The use of dry connection details made the dismantling process and reconstruction possible with limited waste.

Each panel of the pavilion is different; therefore they are numbered before fabrications according to the group numbers for easy assemble.

Joints are made according to the angles between panels. The joint element located in the middle of the intersection line of the panels also defines the opening direction of the panel. During the assembly process, the joints and panels are separated in to groups and assembled separately (Figures 8, 9, 10, 11).

In this educational model, a new process which constructs wooden panels with mechanical fasteners is explored. The process creates joint details in members and generates the assembly sequence. It introduces the fundamental knowledge of geometric assembly planning to the field of architecture. This knowledge is essential to the research of automated assembly process in architecture.

CONCLUSION

Profession of architecture combines multiple disciplinary skills into a single mind-set that requires integrative thinking.

The most significant pedagogical challenge in explored educational model was to make students integrative thinkers. The educational model constructed in two modules. First run in fall, second in spring semester. Both modules consisted of two parallel run courses. The students were required to implement learning's of one into another. At the end of first module the students gained comprehensive understanding of operational logic of computation in design. They had good grasp of procedural structure of computational approaches in design.

The second module that was implemented first time has been partially successful. The students were required to grasp many new subjects and integrate these new subjects in real design problem. Although their design solution full filed most of the requirements of design brief related with DfD, integrating all subjects in a sounding architecture remained as challenge. The main constrain was luck of integrative approach (integration of architectural program with design and construction system) in students design thinking process.

In today's climate of constant change and relentless competition, the key skill of an architect is to know how to lead its profession. This needs integrative thinking. Integrative thinkers

embrace complexity, tolerate uncertainty, and manage tension in searching for

creative solutions to problems. Architects of future in order to lead their profession need to be educated and trained in this manner. This is a challenge in education of architecture that forces it to change.

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