Designer as a Casual Coder

Overview of an Experimental Design Studio

Birgül Çolakoğlu[1], Tuğrul Yazar[2]
[1,2]Yıldız Technical University Faculty of Architecture, Turkey
[1]bigi@alum.mit.edu, [2]tyazar@computationaldesign.org

Abstract: *This paper presents an experimental work on integrating parametric modeling into design studio. First the aim and the scope of the studio structure is described then, the design phases conducted in the studio is defined and then, three student projects are analyzed. The last part opens discussion on theoretical and pedagogical aspect of parametric modeling in design.*

Keywords: *Digital design methods; design studio; scripting; computer-aided manufacturing.*

Introduction

In recent years, computational approaches in architecture started to change the scope of the architect's work. He/she is not any more a passive tool user instead, became a casual tool developer. Conventional CAD systems that focus on geometric representation of a designed artifact, are transforming into systems in which the design is represented as a parametric process. By increasing utilization of these systems in architectural design process, parametric modeling is integrated not only as a new medium of design representation, but also as a design method. As Aish and Woodbury (2005; 2006) points out, parametric systems increase the complexity of tasks in a design process, while designers must model not only the artifact being designed, but also a conceptual structure that guides variation. Integration of these methods in architectural education requires a new set of skills and design domains different from that required in non-parametric methods. This requirement is valid for both students and studio instructors.

Parametric representation of a design artifact requires explicit definition of the problem, (goals and methods) *a model*, a mathematical representation of both goals and systems and an algorithm capable of generating model solutions and variations (Saunders, Grace, 2009).

This paper introduces an integrated approach on parametric modeling and digital fabrication in architectural education. This is the latest step of a series of courses in computational design graduate studios at Yıldız Technical University Faculty of Architecture, conducted since 2005 (Çolakoğlu, Yazar, 2007a; 2007b; Çolakoğlu, Yazar and Uysal, 2008). The parametric modeling studio titled "Designing the Design" is developed over these years, lately focusing more on the digital fabrication.

Parametric modeling in design studio

Designing the design implies designing the *design procedure* on geometric and on procedural level. Parametric methods force procedural representation in which the resulting form is the end result of a *designed procedure*. Parametric modeling methods require a higher level of abstraction than in traditional processes of designing. At the representational level, a designer must understand new concepts such as the logic of computer programming, parametric diagrams of a generative process, and a set of mathematical tools such as descriptive geometry and linear algebra. He / she must explicitly develop relationships between design components and code them into the abstract diagram. Any parametric modeling process requires a great deal of explicit knowledge and effort upfront to create a parametric diagram which defines relational structure of the design components. This approach educates the student to be an active rather then passive learner by providing a mechanism to structure his / her thoughts.

Case studies

This paper introduces an experimental design studio titled "Designing the Design". It aims to teach the complex skills and knowledge required in a parametric modeling process. The main task of the studio is to achieve explicit design variations along with a generative structure. During the early phases of the studio, the students are introduced with computational design thinking and programming logic through seminars hold by invited experts. However, most instructional effort is given to one-to-one sessions with students on their specific design problems. These sessions are based on *an analytical explorations of design steps* rather than *a subjective perspective of design critics*.

The studio plan includes two modules. The first module introduces the students with basics of algorithm design and associative thinking. Here, as design exercises the students developed 2-dimensional parametric star patterns utilizing a scripting language, generated variations of it and adjusted the scripts to meet the requirements of a direct file-to-factory fabrication. In this introductory module, the students developed basic skills required for a more complex parametric modeling of an architectural design problem.

The second module is a real design problem (a metro entrance cover) located in a specific context (with qualities of a historic place and limitations of a specific building plot).

The design phase of the second module is structured in seven steps;

1. Early design decisions and definition of fundamental parameters,
2. Geometric modeling of the early design decision using primitive components,
3. Parametric modeling of these components in a relational construct, utilizing scripting, (Possible returns to steps 1 or 2).
4. Exploring variations within this relational construct, (Possible returns to steps 1, 2 or 3).
5. Deciding a final design choice, (including the type of structure and materials) (Possible returns to steps 2, 3 or 4).
6. Modifications for production. Revisions on the relational construct (script) to fulfill the production issues, (Possible returns to steps 3, 4 or 5)
7. Production of a CAM prototype. (Possible returns to steps 4, 5 or 6)

In the early stages of design the students explored basic forms and relations for metro entrance and their constructability in conventional studio set up drawing sketches and building physical models. This was necessary to precisely state design problem, (goals and technical systems). The design process gradually transitioned from physical modeling to computer modeling, and then, computer programming during the course of a project. The 3D modeling tool (Rhinoceros) is utilized in preliminary design stage. Parametric modeling effort in Rhinoceros began in conjunction with the development of the physical model. After the early design decisions, Rhino scripting is used to develop generative design algorithms. Here design ideas began to appear as codes on the scripts. Scripting functions slowly enter to design conversations at the studio. This transformation showed that, studio instructors are challenged to manage such conversations in such a way that, the students wouldn't be affected much by the available functions that the scripting platform presents, forcing "the tool" to be dominant factor in the process. Instead, the students should be encouraged to explore this "new design language" and possibly develop their own custom design tools. At this stage, the design solutions became generative constructs with potentials of transforming into a series of alternatives under different parameters.

The final stage of this process is the fabrication of a scale model. The students modified the generative design algorithms (scripts) they developed to create a physical output. At this stage, design solutions are affected both by the available fabrication methods and the structural decisions.

In the second module of the studio three different examples of students work that incorporated different approaches are discussed below;

Case 1

The work in the first example is focused on an effective kinetic model based on a generative algorithm.

This work is based on the assumption that in a parametric model, exploration potentials should be achieved with less parameter. As an early design decision, a kinetic shell structure is developed. The generative algorithm of a shell structure is developed using a scripting language to explore variations of the shape and size of the shell. The algorithm calculated dimensions of shell components and automatically created necessary outputs for digital fabrication (Figure 1).

Here the students experimented a parametric design for the first time. In the processes, it's observed that parametric design learning requires incremental knowledge acquisition, through which the students are introduced to new design methods starting with basics regarding to geometry, associative thinking, algorithmic complexity and formal approach. These introductory basics make them aware of what they are doing, and allowing them to follow up their own thought process.

Case 2

The work in the second example was conducted by a student who did not have any programming background. Therefore, coding experience was the dominant factor for the student. She focused on this issue and aimed to develop a "complete design tool" for her specific design solution.

After design explorations developed in the early stage of the design using conventional methods such as sketching and drawing, the student focused on converting her design sketches into a generative design algorithm using a scripting platform (Figure 2). Then, she made modifications on the design algorithm in order to implement structural and material choices and created a solution that generates file-to-factory outputs. This process continued until

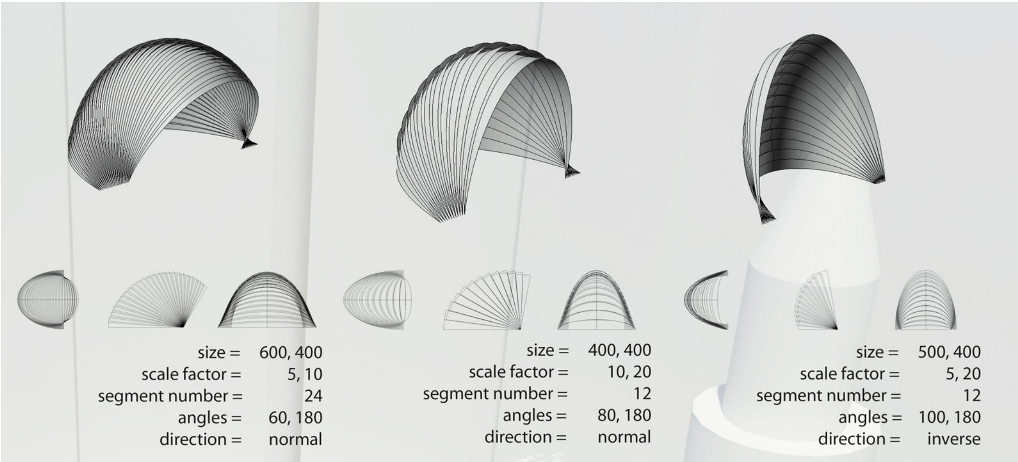

Figure 1
Student work; a parametric shell structure

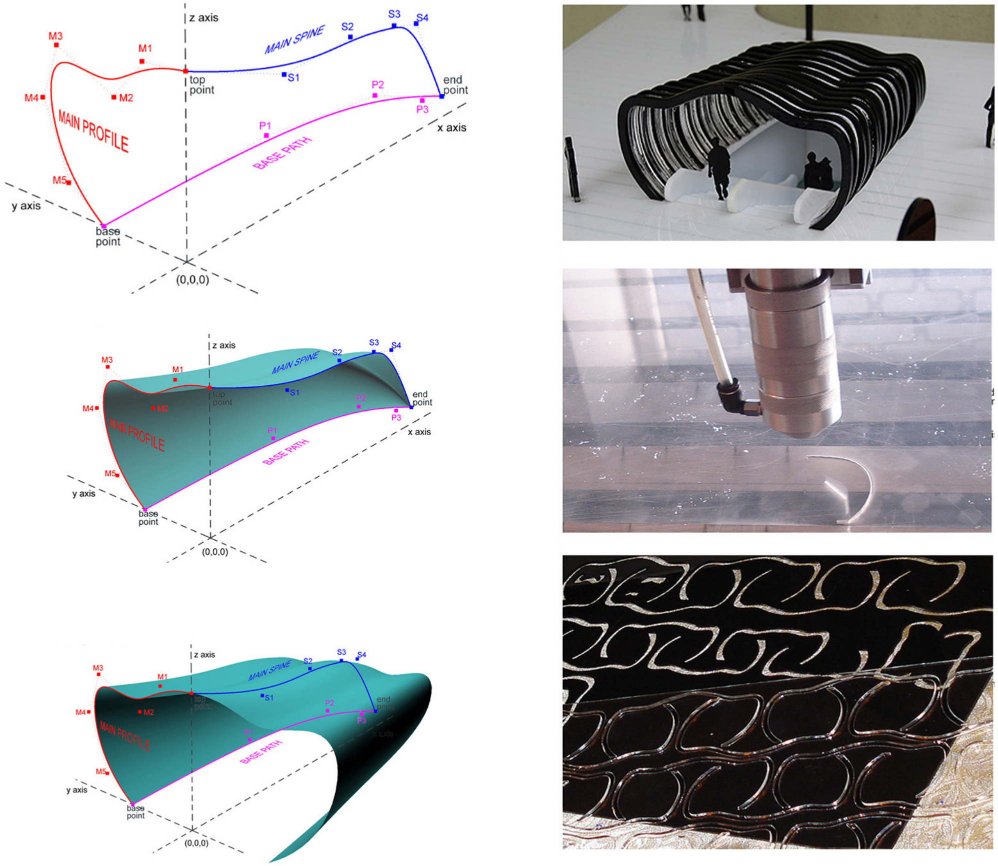

Figure 2
Student work; Parametric definition at the early stage of design, exploring the variations, and final CNC cut model

she was convinced with the generated outputs of the algorithm.

The advantage of developing "a custom design tool" is that, the representation and fabrication issues are all solved within one process and do not need extra effort. Once the solution is accepted, the fabrication of a physical model can be realized without any loss of geometric qualities. The disadvantage of such a process for a designer is an extensive use of the tool, in which he/she can easily lose control of the design process to the available procedures of a scripting platform. Therefore, in an educational studio, only the students who have experience in coding should be encouraged to experiment such complex approaches.

Regarding the balance of time and effort, this approach seems to be an effective one, as the designer can easily create the physical outputs of multiple alternatives, evaluate the design idea using them, and return back to the script to manipulate the design if necessary.

Case 3

In the work of third example the student chose to use a hybrid process, including both the traditional design and computational methods. He developed

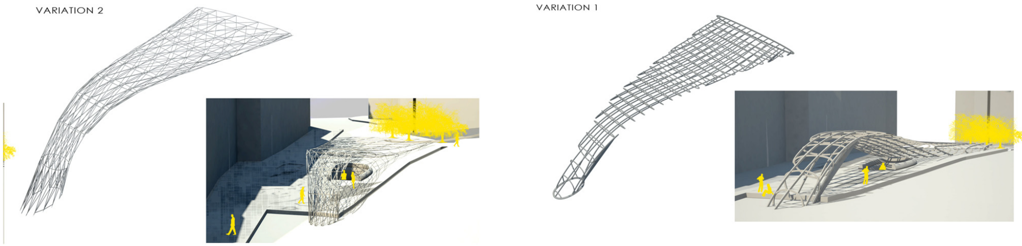

Figure 3
Student work; exploring different fabrication methods for the designed form

the main design decisions in the early design stage using conventional design methods scuh as sketching and drawing. Thinking about the structure of his design played an important role in the transition process from conventional methods to computational ones. As he became comfortable in computational methods, he worked as "casual coder" and developed design alternatives utilizing new design methodologies.

In this approach, the student explored various structural alternatives for the same form (Figure 3). Later in the process, he started to apply some parametric variations to the form itself, while exploring the structural optimization.

This work is a good example of pragmatic approach utilizing a parametric CAD system in design process.

Discussion

There are many experiments conducted and many discussions made on architecture, and parametric modeling. However, neither the theory of parametric modeling, nor the required pedagogical approaches are well understood yet. The study presented in this paper is an addition to one of these experiments. It aims to investigate the theoretical and the pedagogical aspects of new design methodologies in architecture education. It searches for the answers of; what is the cognitive ground of parametric design process, and how and when it should be learned and how it can be evaluated?

The cognitive transformation process of design knowledge into a precise algorithm transforms a designer into a casual coder. However, intuition that drives creative design process does not disappear rather it transforms from unknown to known. These issues and the outcomes of experimental design studios will be elaborated in forthcoming publication.

Acknowledgements

The studio explained in this paper is supported by Axel Killian with a seminar and workshop titled "Models based on Computational Construct" conducted between 27-28th of November, 2008 at Yıldız Technical University, İstanbul. We also thank to our graduate students Anıl Bayburtluoğlu, Fırat Aksakal, Serdar Köroğlu and Yeşim Çiloğlu.

References

Aish, R., (2005), "From Intuition to Precision", Education and Research in Computer-aided Architectural Design in Europe, (eCAADe) 23. Conference Proceedings, Jose Duarte (ed.), pp. 10-14, Lisbon, Portugal.

Aish, R. and Woodbury, R., (2005), "Multi-Level Interaction In Parametric Design", International symposium on smart graphics, vol. 3638 (??), pp. 151-162.

Çolakoğlu, B. and Yazar, T., (2007a); "An Innovative Design Education Approach: Computational Design Teaching in Architecture", METU Faculty of Architecture Journal, vol 24, issue 2, pp. 159-168, A. Cengizkan (ed.), Ankara, Turkey.

Çolakoğlu, B. and Yazar, T., (2007b), "Algorithm in Architectural Education: Studio Works", Gazi University Faculty of Architecture Journal, vol 22, issue 3, Ankara, Turkey.

Çolakoğlu, B., Yazar, T. and Uysal, S., (2008); "Educational Experiment on Generative Tool Development in Architecture, PatGen: Islamic Star Pattern Generator", Education and Research in Computer-aided Architectural Design in Europe, 26.eCAADe Conference Proceedings: Architecture in Computro: Integrating Methods and Techniques, M. Muylle (ed.), Session 17: Shape Studies, pp. 685-693, 17-19 Eylül 2008 Antwerp, Belgium.

Saunders, R. and Grace, K., (2009), "Teaching Evalutionary Design Sysetms by Extending "Context Free", in Applications of Evolutionary Computing, pp.591-596.

Terzidis, K., (2006), "Algorithmic Architecture", Architectural Press.