Parametric Intention: Embodying a Thorough Design Ideology

Troy Mock, Yixiao Wang, So-Yeon Yoon

Design+Environmental Analysis, Cornell University, Ithaca, New York, USA

Abstract

The parametric design method differs from more predictable paths of form representation because it follows logic structures based on modularity and systemized thinking. Introducing parametric modeling to existing design curriculum necessitates an alternate way of thinking based on input-output logic. Despite its promising potential of scale, materiality, and context in the field of interior design, parametric design has not been widely incorporated into interior design curriculum. In this paper, we propose a three to four-week module within an intermediate level design studio, offering both the introduction and implementation of parametric modeling with feasible scale exercises including a partition, wall treatment, and 3D standalone installation. The module aims to build student understanding of logic-based thinking and encourage further exploration of the parametric design method.

Keywords

Parametric design, interior design, architecture, graphic design, computational thinking, and more

---

1. Introduction

For interior designers, innovative form-finding techniques can inspire and provoke an emotional response within the ambient environment (Baker, 2002). Parametric modeling, with its focus on modular simplicity and step-by-step logic, is an apt design tool for developing innovative form. However, interior design curriculum has not systematically adopted the parametric design method due primarily to differences in cognitive thinking styles. This paper describes a method for introducing parametric modeling as both a design tool and a medium for logic-based thinking.

2. Background

Generating unique form is an important challenge for interior designers. The experiential and proximate qualities of an interior space require solutions where materiality, context and structure are closely integrated (Hildebrandt, 2001). In recent years, computational design methods have offered an innovative way to generate form, where logic structures determine relationships of form rather than more predictable paths of representation. While parametric modeling is synonymous with computation design for intricate curves and complex geometries, the fundamental ideas behind parametric modeling— designing a systematic and elegant logic within a defined solution space— have great implications to design education (Jabi, 2013).

Direct benefits of parametric modeling are the ease at which complex geometries and rapid prototypes can be generated. Logic structures define relationships of input and output values so design changes can be made iteratively. Coupled with modern fabrication techniques, complexity can be brought to physical form more easily than with traditional fabrication methods.

Traditional form-finding methods based on personal inspiration can approximate a specific logic, but the form is not fundamentally generated by the logic. In this way, parametric modeling can more closely follow an original design concept. Additionally, the scale of interior design projects allows for rapid prototypes that can be interacted with and understood at the 1:1 human scale. There are obvious examples of parametric modeling at the architectural scale such as Zaha Hadid's futuristic forms. However, most examples of parametric design for interior applications are from architecture-focused firms. For example, Aidlin Darling Design's undulating ceiling installation of their Wexler's restaurant renovation bridges a modern interior with a historical exterior facade. Firms like dEEP Architects also integrate parametric forms into interior space with innovative and even articulating wall facades reminiscent of a living, breathing organism.

With its apparent benefits, why isn't parametric design more widely explored in interior design curriculum, when it is common practice to teach parametric modeling as a form-finding tool in architecture school? It seems that parametric design is far better adopted by Spatial Visual Processors and logical thinkers (architects and engineers) than Object Visual Processors and holistic thinkers (artists and designers) (Blajenkova, 2009; Choi, 2007). Traditionally, interior design practice strays away from math-intensive or logic based processes. Interior design curriculum often requires math and science courses outside the major, but these courses are not focused enough to change thinking patterns. Therefore, introducing parametric design can be intimidating to interior design students unfamiliar with computational thinking processes. However, it is not an obstacle but a great opportunity for logical, step-by-step thinking to be directly integrated into interior design curriculum. The goal of this paper is to set the groundwork for such a module.

The difficulty of implementing parametric modeling to existing interior design curriculum is that it necessitates a different approach to problem solving. The "input" and "output" language of algorithms is unlike traditional design methods. The complexity in geometry can easily overwhelm someone who is unfamiliar with the step-by-step logic of computational thinking. An approach based on modular simplicity and systematized thinking is required, akin to computer programming (Jabi, 2013).

We propose a viable approach to incorporating parametric modeling in interior design studio curriculum. Our approach provides knowledge of a relevant design tool that can aid and foster innovative design and open doors for further exploration of logic-based computational thinking. Sample parametric design projects following the proposed model will be presented to demonstrate how parametric design methodology can be adopted to communicate ideas of elegance, modularity, and readability.

The module aims to build student understanding of computational thinking through parametric design. Student confidence is first developed by clearly demonstrating how complex geometries are both broken down and built from basic geometries such as points, curves, and surfaces. A simultaneous introduction to parametric design software teaches the fundamental foundation of the program syntax. The course is aimed to showcase the parametric method as a way of expression to present the student's concept in a logically pure way. Finally, students will have a strong enough understanding of computational thinking to explore further possibilities with the method. The course module reflects the clear methodology carried throughout the design ideation and representation processes.

3. Parametric Design Module

Using Rhino 3D modeler coupled with the Grasshopper plugin provides a versatile entry point into parametric design. Grasshopper, which is seamlessly integrated with Rhino, requires no previous knowledge of programming or scripting, and is open source with abundant online resources. Grasshopper is comprised of visual "building block" functions that, when linked with inputs, create consistent relationships following pre-set associative rules. The premise of this education proposal centers around custom-built modular "Macro Units" of composite Grasshopper functions.

To implement this pedagogical method of using "Macro Units", we propose three steps:

1. Creating Understanding in a Familiar Way:

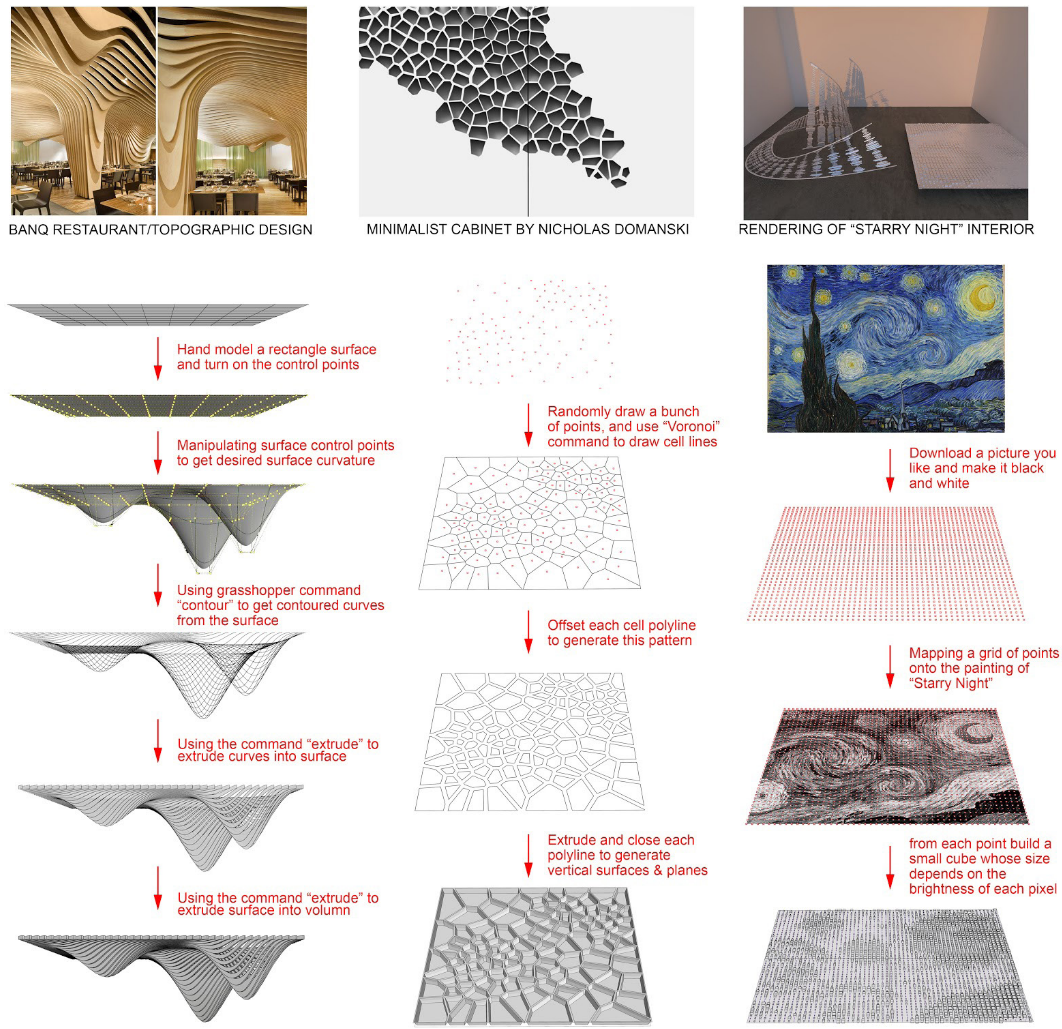
Many interior design students find the projects created through the parametric modeling method organic, beautiful and appealing. They would like to express their design concept in the same manner; however, the complexity of parametric geometries is intimidating in its seeming complexity. For most students, this geometric complexity becomes a hurdle that discourages them from exploring design concepts more freely and creatively. Therefore, we must first encourage students and help them to see through the logic of complex geometries in a clear way.

At the beginning of the module, we show examples of beautiful and complex structures from interior projects. Through a brief diagram (see Diagram 1), we explain to the students that these parametric examples are geometric transformations of simple geometries such as points, curves and surfaces, which can be very easily created in 3D modeling software such as Rhino. The purpose of this introduction is to build up confidence for the students and to pave the path for introducing the concept of "Input & Output".

2. Introduction to "Input, Operation and Output" Logic

To generate the complex and beautiful structures as shown in project pictures in Diagram 1, we need to introduce the logic of "Input, Operation and Output". In class, we review inspiring parametric models and discuss the logic of generating these models from basic geometries. In this step, students grasp the unique concept of "Input", "Operation" and "Output" for the parametric design process.

Figure 1: Three Interior Projects using Parametric Modeling Methods



2.1 “Input”

“Input” is the starting point of the geometric transformation. To initiate the transformation, we provide the computer software some information, such as geometries, so there is a starting place to transform from. An easy way to understand these two concepts is to refer to the three examples in Diagram 1. In Diagram 1, all the simple geometries (rectangle surface, randomly drawn points, and a picture of Van Gough’s “The Starry Night”) in the second row are “inputs”. “Inputs” in Grasshopper are usually simple geometries which can easily be built in Rhino 3D.

2.2 “Operation”

“Operation” is the geometric transformation process from the starting point of the “Input”. “Rotate a geometry”, “move a geometry to a certain position”, and “duplicate a geometry” are all examples of simple “Operations”. The “Operations” used in the Diagram 1 are marked with red arrows and texts, such as “manipulate surface control points”, “offset each cell polyline”, etc. “Operations” can be very simple, but can also gain complexity when multiple simple “Operations” are integrated together and perceived as one complex “Operation”. However, this also means that no matter how complex one “Operation” may seem, it can always be decomposed into simple “Operations” step by step.

2.3 “Output”

“Output” is the transformed geometry after performing a certain “Operation” on the “Input”. A simple example can be after you “Input” a “cube” into the “Operation” of “rotate 30 degrees”, the “Output” you get will be a “30-degree rotated cube”. All the geometries after second row in Diagram 1 are “Outputs”, and consequently, the final “Outputs” are in the last row of Diagram 1. To keep things simple, we only introduce these three concepts in this class for parametric modeling. Through in-class discussions and hands-on experiences, students can begin to grasp the essential concepts behind the parametric modeling method. Once the students become interested in and enthusiastic about parametric modeling, they can further explore this domain by themselves.

3. “Macro Units” for Rapid Prototyping:

“Macro Unit” in this paper refers to a set of logically integrated operations fulfilling a specific and useful function relevant to interior designers. We won’t ask students to create a “Macro Unit”; instead, we will provide multiple “Macro Units” for students to experiment with. Each of the parametric modeling examples in Figure 1 can be achieved through a “Macro Unit”, which is given to the students as Grasshopper files together with explanations outlining the required “Inputs” and final “Outputs”. Through the hand-on experiences of playing with these “Macro Units”, students can become interested and more enthusiastic about creating their own parametric designs. Figure 2 shows one of the “Macro Units” given to the students together with “Input”, “Output” and step-by-step explanations.

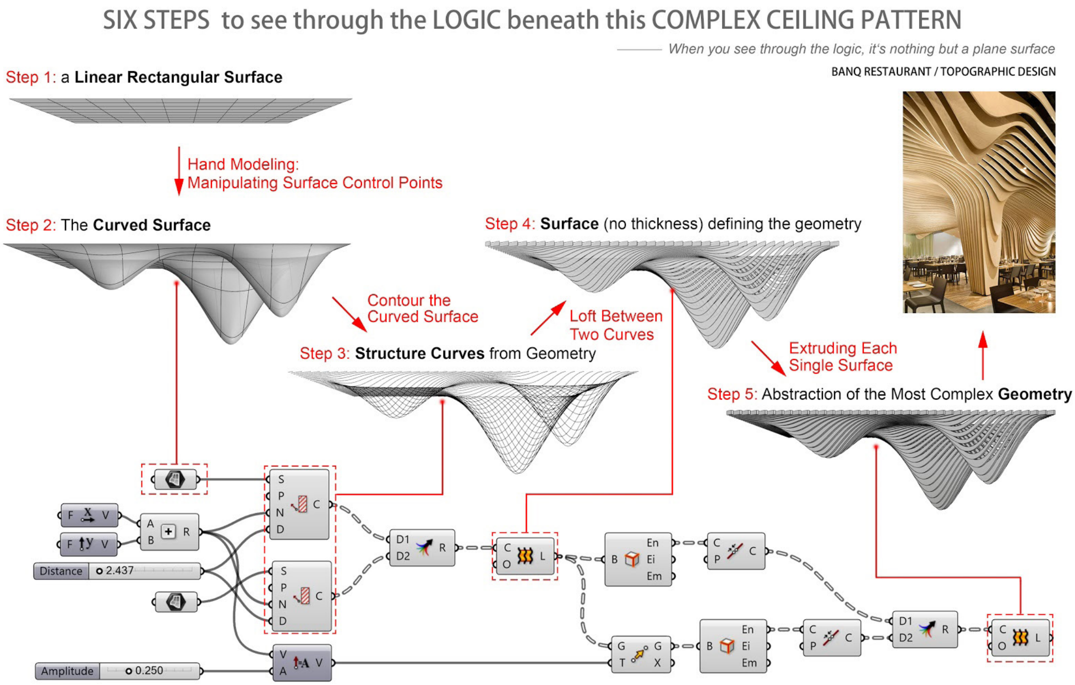
Figure 2 illustrates six general steps to represent the logic of generating planar topographical patterns, and how to apply this logic to parametric modeling using Grasshopper. “Step 1” represents the starting point as a planar surface, which is transformed into a curved surface as the input parameter of the program in “Step 2”. In “Step 3”, we generate the contours according to the curved surface. These contours become the most important geometric elements helping us to define the curved surfaces in “Step 4”. “Step 5” simply gives thickness to the surfaces in “Step 4”, transforming the surfaces into volumes. “Step 6” shows how the geometries generated by the previous five steps can be applied to a real project, such as the wood ceiling for the interior of a restaurant. With a basic understanding of the program, students can change parameters by themselves to generate their own topographical patterns for their own design concepts and projects. This hand-on experience can potentially make the parametric modeling process more understandable and exciting.

4. Discussion and Conclusion

This paper introduces a viable approach to incorporating parametric modeling in interior design studio curriculum, providing knowledge of a relevant design tool that can aid and foster innovative design. The module attempts to teach parametric design thinking from a variety of angles– by reviewing the step-by-step logic, the program syntax, and computational prototyping. However, the module does not provide systematic lessons for each aspect of parametric modeling, and it would be out of the scope of the module to do so. To truly implement parametric modeling in the toolkit of an interior designer requires much more time than the duration of this module– rather, the module’s goal is to allow students to understand the logic behind parametric modeling, and to gain enough rudimentary knowledge for further exploration and self-study.

Beyond the differences in cognitive thinking styles between interior designers and engineers, there is another aspect that makes parametric design adoption difficult– studio culture that stays away from

Figure 2. 6 step approach for generating planar topographical pattern



mathematics and rigid structures of logic thinking. In the timeframe of the module, it will be difficult to overcome the tendency for students to fall back on more familiar design methods.

In an ideal curriculum, there would be a subsequent studio specific to computational-based design methods where students can further explore innovative relationships to form. By cultivating a close relationship between computer and physical model, the development of form can be grounded in real-world constraints such as gravity, context, and materiality, all vital for interior designers and educators interested in exploring innovative design grammars.

5. References

Baker, J., Parasuraman, A., Grewal, D., & Voss, G. B. (2002). The influence of multiple store environment cues on perceived merchandise value and patronage intentions. Journal of Marketing, 66(2), 120-141. DOI: 10.1509/jmkg.66.2.120.18470

Hildebrandt, H. (2001). The rise of a profession: The evolution of interior design. Perspective (Journal of the International Interior Design Association), NeoCon 2001 issue, 74-81.

Jabi, Wassim. (2013). Parametric Design for Architecture. London, UK: Laurence King Publishing.

Agkathidis, Asterios. (2015). Generative Design: Form-finding Techniques in Architecture. London, UK: Laurence King Publishing, 8-11.

Blajenkova, O., & Kozhevnikov, M. (2008). The New Object-Spatial-Verbal Cognitive Style Model: Theory and Measurement. Applied Cognitive Psychology, 20, 239–263.

Choi, I., Koo, M., & Choi, J. A. (2007). Individual Differences in Analytic Versus Holistic Thinking. Personality and Social Psychology Bulletin, 33(5), 691–705.