Parametric Translations

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Abstract

The aim of this paper is to understand the outcomes of parametric methods in beginning design projects and their impact on rethinking digital technology in current design education. In order to realize comprehensive results, in this paper i) conceptual and formative projects are presented to describe specifications of a parametric design at OSU School of Architecture; ii) for OSU SOA, we plot pedagogical objectives and evaluate how we have interpreted and applied novel digital technology into the design process; and iii) Cultivate parametric design as systemic and organizational design. Along with unit-based, component design, expand the use of digital tools to become the discipline and domain of the creative culture. How digital tools are integrated into early design education through a collaborative studio project will be the focus of the study. Through the experimental exercises, we can begin to explore how the digital process can be integrated at a fundamental level.

Initiation of Parametric Thinking in Formative Studios

As technology is constantly evolving around us, we have a unique opportunity to educate students in novel design processes. Parametric Design is transforming the design process, as a means of translating ideas between the human and the digital. In the article *Design* by Anne Balsamo (2009), Design as a verb refers to a set of actions: Imagining, Creating, Representing, Negotiating, Prototyping, Fabricating, Building, Evaluating and

Iterating. *The notion of design* reflects the ideas and principals of the parametric thinking process. What is the specific contribution of Parametric Design in the process of making beyond the ability to simply make expressive and complex forms? The discussion continues to be challenged by the idea of digital design as a visual communication skill.

This paper positions how the perception of digital media is changed by tools like parametric modeling. In the current realm of digital technology, Parametric Design Language has become a dominant geometric expression tool as well as an efficient project delivery solution (Ceccato, 2010). It is crucial to introduce new design procedures like parametric modeling to schools which maintain a traditional approach, using the computer as little more than a drafting tool (Monedero, 2000). The National Architectural Accrediting Board (NAAB) still refers to digital design as a graphic skill:

"Realm A: Critical Thinking and Representation

A. 3. Visual Communication Skills: Ability to use appropriate representational media, such as traditional graphic and digital technology skills, to convey essential formal elements at each stage of the programming and design process (NAAB's Student Performance Criteria)."

How can we go beyond satisfying these criteria - using digital technology as a representational tool- and begin to integrate it within the design process? The idea of parametrics lends itself to one pathway of developing 'digital thought' processes. Parametric, as a word, describes a boundary or variable in a functional relationship set forth to describe something. It derives from the word *parameter*, which in mathematics is a constant or variable term in a function that determines the specific form of the function but not its general nature, as a in $f(x) = ax$, where a determines only the slope of the line described by $f(x)$. With this concept of variables coming together to describe an object, we set out to investigate how this idea of variables could be multiplied to define one larger object, utilizing both digital and analog processes.

In OSU's Introduction to Computers course, two projects were given in a series as a part of this beginning exploration: Abstract Machine (AM) and Exoskeleton Barricade (EB). This class is a required course for both Architecture and Architectural Engineering pathways, and gives students an introduction to digital tools and processes. As an introductory course, students were learning to use the digital tools while exploring the digital design process within these projects (Figure 1.).

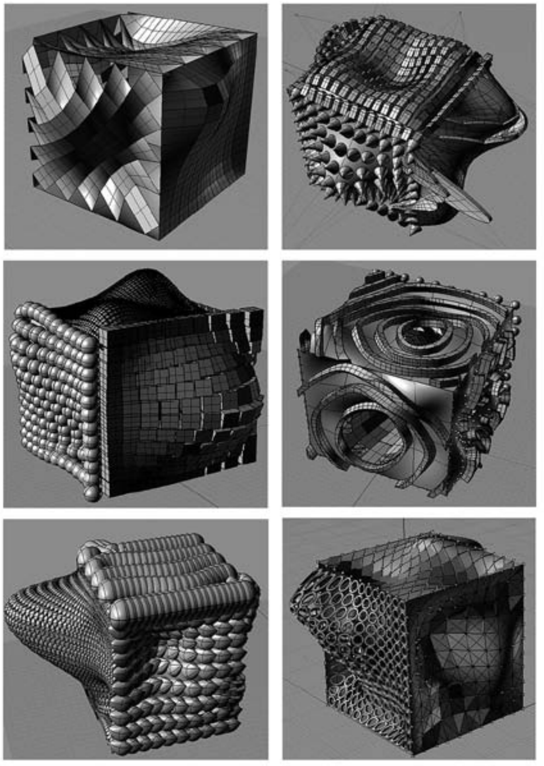

Figure 1. Abstract Machine_1: Using the paneling tool in Rhino, students created semi-parametric objects, based on a cube.

Pedagogical Objectives

With the Abstract Machine (AM), we used parametric methods in somewhat different terms. Instead of declaring the parameters to generate a form, the form constructed the constraints. Within these parameters, intentionally, students were given immense freedom to generate form and fabricate the form into the physical models while they are learning Rhino as a modeling tool for the first time. Using Rhino, students generated variations of forms. Using repetition, transformation, datum, rhythm, symmetry, void, volume, thickness and so forth, students explored creation of tower forms. The given spatial limit was a volume of 6"x6"x24"(Figure 2.).

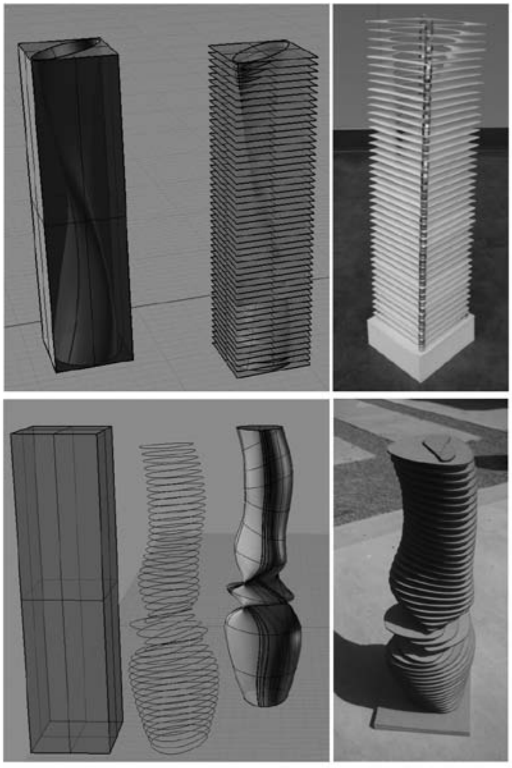

Figure 2. Abstract Machine_2.

This initial project became a beginning to investigate the parametric thinking process in simple terms. Each student's work was produced as a series of variations by using the same procedures but varying the parameters. This parametric modeling exercise produced variations of forms which show the design process as an improvement of designed artifacts (Barrios, 2005).

The final class project, Exoskeleton Barricade (EB), was a collaborative project, building on the ideas explored in the first project (Figure 3.). Because of the introductory nature of the course, students were provided with a 3D model of a curvature structure which constrains how each form is generated by students. Students each chose one of the grid components to design & construct. Each design represented a variation of the overall design. Based on the geometry they chose, students designed a complex form while maintaining the shape and scale of their grid component. The forms were volumetric, with each form having at least one complete opening to allow light to pass through. Each form was fabricated into a physical model for use in the larger structure. Students explored how changing the parameters of their forms and openings impacted the quality of light, and the collaborative nature of the project required students to study the impact of their designs on the neighboring forms. Students are constantly asked to be flexible with their designs for the universe of possible solutions within a given time. This is the iterative search process of variations of a design idea (Barrios, 2005).

Figure 3. Exoskeleton Barricade: Fabricated and assembled by students.

Students were required to illustrate their component design to explain the process of how each component was designed and assembled. They used the laser cutter to fabricate their designs, and then assembled their components. For the final part of the project, accuracy was the critical element. After constructing each individual component, they assembled the cubes together. The precise fit of the pieces required students to confirm their construction accuracy with adjacent components (Figure 4.).

Beyond Form Making

Using the parameters given, students were able to go beyond working within the variables of one project to explore the impact of decision making and formal expression on a broader scale. In parametric design, it is the parameters of a particular design that are declared, not its shape. By assigning different values to the parameters, different objects or configurations can be created (Kolarevic, 2003).

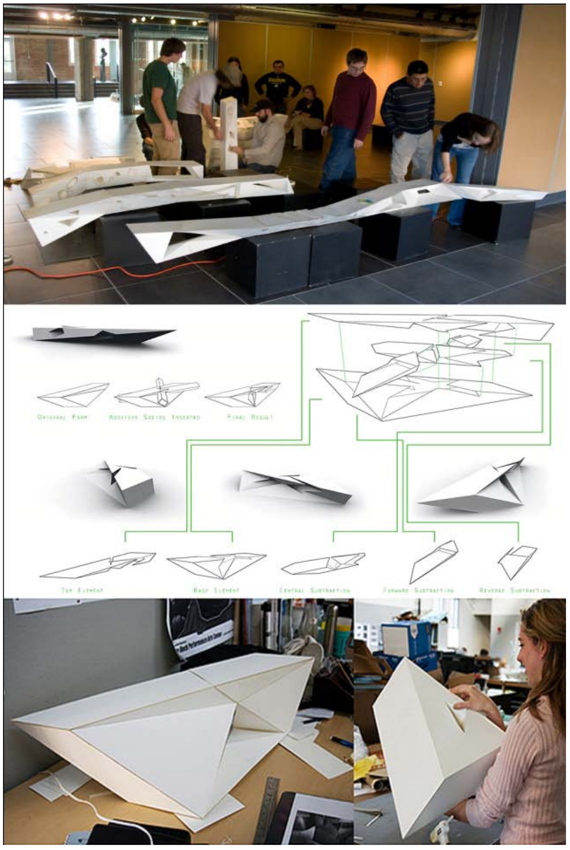

Figure 4. Exoskeleton Barricade: Fabricated using Bristol Board and Laser cutter and assembled by students.

Working together with analog mock-ups, students explored the relationship between their variations and those of their neighbors in the grid. They used digital tools to manipulate their forms to respond to the changing shapes around them. Using digital tools to mold complex geometries became an efficient vehicle for students to explore expressive form. The complex forms fabricated with Bristol board using a laser cutter also challenged us to adapt the thought process of hand making. Integrating parametric thought into architectural thought supports a design process which can grow with technological innovations.

Using the Design procedure by Carlos Barrios (2005), the process illustrates the same dependency relationship between EB and tessellation of surface. The initial shape was a quadrilateral geometry which consisted of convex quadrilaterals: parallelograms. These shapes were produced by parametric modeling tools: Rhino and Grasshopper, which allowed a multiplicity of quadrilateral forms.

Constructing the parametric design through a physical model was also a valuable part of the exercise. Going through the steps of making a large scale model allowed the students to recognize constructability issues and the value of collaboration(Figure 5.). Pedagogically, the design process and accomplishment of each step demonstrated the realization of digital design through physically built form. Both analog and digital media embrace the idea of repetitive process of making within projects done by a group. The connection between physical and computational modeling is a critical element of the course because exploration through modeling allows for an intuitive spatial development (Szalapaj, 2001).

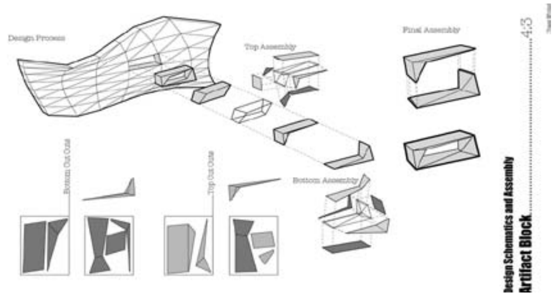

Figure 5. Exoskeleton Barricade: Descriptive presentation for how each component is designed and assembled.

These projects serve as a platform for further study and initiation of use of parametric modeling methods. While time and logistical constraints did not allow for more parametric exploration of larger surfaces in EB, the next planned step in this progression will be to introduce a group project where perhaps the parameters of each grid component surface could be altered.

The Future: Cultivating SPC with Variation

> *"Computerization is about automation, mechanization, digitization, and conversion. Generally, it involves the digitization of entities or processes that are preconceived, predetermined and well defined. In contrast computation is about the exploration of indeterminate, vague, unclear and ill-defined processes; because of its exploratory nature, computation aims at emulating or extending the human intellect (Terzidis, 2006)."*

How will parametric design affect the end result of each design and ultimately the future of design? Parametrics are transforming the design process, facilitating quicker, more efficient explorations. They are allowing for the integration of design process components into a more fluid approach to creating. As a communication vehicle, parametric design will allow for group exploration of project variables, on a small or large scale. The possibilities for collaborative design are endless (Figure 6.).

Figure 6. Exoskeleton Barricade.

> *"The future of digital tools rests on the extent to which architects can accept that exemplary architectural designs can be created in a computer-mediated environment and that digital thinking is indeed architectural thinking (Mahalingam, 2003)."*

Parametric design is one tool for helping us to translate between the human and the machine. As the digital becomes more fully integrated at all levels of design education, the translation of information and conversion of processes becomes more and more rapid. The scope of digital technology has to overcome 'computer-aided architectural design' to become digital design as a whole (Mahalingam, 2003). In order to strengthen digital tools' relevance to architecture, they must naturally and simply become a vehicle for students to create.

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