Modular Flow; hard on parametrics

Arturo Lyon
Pontificia Universidad Católica de Chile
alyon@uc.cl, http://arq.puc.cl/

Claudio Labarca
Pontificia Universidad Católica de Chile
clabarca@uc.cl, http://arq.puc.cl/

Abstract. *The design and fabrication of an exhibition display project was taken as an opportunity to explore parametric design with a group of students in Chile. This article presents the experience of a design studio workshop exercise by addressing the introduction of parametric design principles and the development of a built academic project through a team based design and fabrication process. The strategy followed by the team was to utilize parametric models as a mean to materialize driving variables of the project into unexpected geometries to be deployed in different public spaces in Santiago. Context, time scale and available technology resulted in a non-obvious combination of advanced digital design and fabrication techniques and low-cost mass-produced materials.*

Keywords. *parametric, prototypes, experimental, architecture, Chile*

Umbrales 09

This paper addresses a design project undertaken from parametric design techniques and digital fabrication processes realized by undergraduate students of architecture at the Pontificia Universidad Católica de Chile. The case was the design and construction of the exhibition display for a selection of projects done at the schools of Architecture, Design and Urban Studies, to travel to different academic and public spaces in Santiago along the year. The exercise aimed to produce an exhibition capable of promoting interdisciplinary work across the university and a mean of communication with society expressed by the name of the show: Umbrales 09. Arquitectura, Diseño, Ciudad y Sociedad (Architecture, Design, City & Society).

In this project we were interested in exploring the potentials of parametric design techniques through a specific design and fabrication exercise, to be developed by a group of students without previous knowledge on this field. We took this academic experience as an opportunity to trigger collaborative design processes in an academic environment and as a design methodology to generate form through the computation of variable parameters, producing aggregations of differentiated components.

Today parametric design is often regarded as tool to rationalize forms, incorporating constructive criteria to make free-forms possible to build. Therefore pre-design and post-rationalization strategies always restrict the potential of parametrics, constraining it to a problem solving tool after an original scheme has been determined. By contrast, the counter model we wanted to explore with our students was based on the integration of architectural strategies and computational possibilities implemented through relational models capable of adapting to parameters, constrains and possibilities of variation inherent to a project.

Another context for Parametric Design

The introduction of contemporary digital design techniques in the design studio was undertaken from the point of view of two authors whose work appeared particularly relevant to our academic perspective. We looked a way to make understandable and operational (in a short term) a design exercise within the terms of parametric architecture. This is currently a complex and broad discussion with multiple definitions and takes on how it can be applied in architectural design. Along the design process it became an opportunity to review initial concepts of parametric design and to re-think them towards the specific needs of a project.

The first author referred is the Italian architect Luigi Moretti with his the proposition of an “Architettura Parametrica” in the 1940´s and 50´s that aims for the integration of parametric equations and architectural design, as a mean to produce performance driven form. He exemplifies the problem as the resulting geometry of a football stadium based on the best visual conditions for all the spectators (Oosterhuis, Feireiss, 2006).

The other author is Marc Burry with the translation of Antoni Gaudi´s design methods into parametric design software that has become a keystone in the construction of the Sagrada Familia Cathedral. Talking about Gaudi´s work on a lecture at the Architectural Association (2005), Burry referred to parametric design not as a condition defined by a software developer but as a state of mind towards design, which was presented on the ruled based geometries and structures developed by Gaudi. This parametric state of mind aims to take a step forward from freeform design, setting up coherent relationships between geometry, structure and construction processes.

Both authors represent initial application of parametric design in architecture that share a particular clarity in parametric behavior of design systems and their relevance to a given project, which was a key issue when explaining the use of parametric design tools to the context we were facing.

Along with the broad spread of scripting, 3d modelling and animation packages in architecture, radically different approaches appeared on how the potential of these methods should operate in architecture. On one hand it has been demonstrated to be an efficient method for modeling and rationalizing free form geometries, making buildable what before was impossible. On the other hand different architectural statements attempt to define a new architectural paradigm based on re-tooling the discipline as an effort to achieve continuous differentiation and adaptive components, proposing, as in the case of Patrick Schumacher´s Parametri cism Manifesto (Schumacher, 2008), the emergence of a whole new style in architecture. In this context, the understanding of parametric design goes beyond the initial performance driven

form stated by Moretti, and aims to describe a broader potential of computation in design as defined by Michel Meredith (Meredith, 2009); “parametric design is a process based on not fixed metric quantities but on the consistent relationships between objects, allowing changes in a single element to propagate corresponding changes throughout the system.”

This definition establishes common ideas with Manuel de Landa´s text on “The Use of Genetic Algorithms in Architecture” (de Landa, 2002) by enunciating the potential of computation in design as a process able to spread virtual properties (or genes) across populations (or systems), exploring the use of intensive properties and non-fixed metric quantities. Therefore these common principles on the genesis of form shared by both design methodologies allow for the revision of the claim made by de Landa; “a particular field of art needs to first solve the problem of how to represent the final product in terms of the process that generated it”

In the contemporary discussion on parametric architecture, and responding to the claim made by de Landa, the initial applications of parametrics in architecture as proposed by both Moretti and Burry appear relevant. We approached an understanding of design as the inherent relations between systems and criteria; state of mind and performance.

Hands on!

Developing an exhibition display project in four weeks with low cost materials (plywood and cardboard) was the scenario to introduce parametric design techniques and principles to our students. In this context the approaches to parametrics stated by Moretti and Burry, turned necessary and even self-explanatory as the need for fitness between design processes and final representation. Taking a parallel approach of techniques + design became an opportunity to test a parametric design within a local context and expressed on a concrete project.

Within this academic commission, two questions appeared to be relevant and need to be answered. First, what can parametric design achieve in this context? If a parametrically driven project enables the articulation of locally driven rules and overall cohesion, the resulting aggregation would work as a materialization of driving variables into an unexpected geometry invading different public spaces and influencing flows of people around it and engaging them in a provocative manner. Secondly, which relations could be established between computed parameters and design strategy? The idea was to speculate on rejecting vertical boards and horizontal models through the deployment of components that could negotiate between these two extremes, and reflecting the potential of adaptive components into the architectural proposal.

Following this idea, the parametric behavior of the system should relate angles of inclination in relation to multiple observers, defining a non-fixed metric component able to define geometry as a media between material restrictions and specific programmatic conditions. The thought of reading a unique project within an overall configuration of boards and models captured our interest in relation to parametric design in architecture. The design issue we wanted to address was how to create an overall integrity together with the uniqueness of each exhibition board as a “continuously differentiated” part.

Through the following three weeks the students were organized into collaborative teams experimenting with ruled based design components for the exhibition, coming up with different configurations which could interact with visitors and flow of

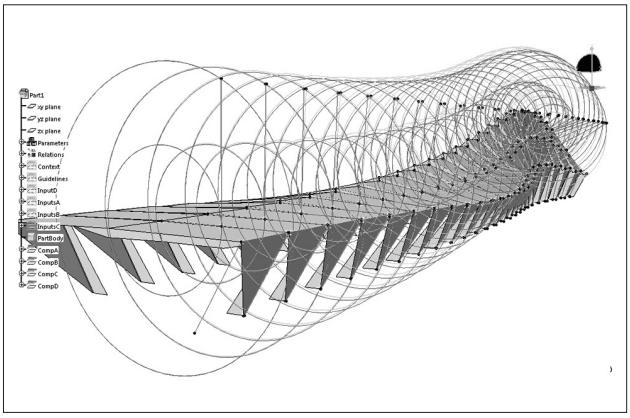

Figure 1. Parametric Model developed in Digital Project

Figure 2. CNC fabrication of 890 differentiated components

people. The different teams merged during the next 10 days until one common proposal was undertaken by the whole group combining the different approaches in one project to be entirely design, fabricated and assembled within the studio.

The parametric behavior of the system consists on a prototypical component that changes in height and rotates accordingly to become always perpendicular to people passing by the exhibition. This geometrical “mechanism” proliferated across the whole field determines the behavior of the overall configuration and engages the visitors in different manners and allowing the display of models and boards.

Each component is driven by this changing parameter and scripted reactions that determine its behavior according to the condition of its neighbors, shifting geometry from different possible setups. The component was designed in response to constructive systems (plywood and cardboard) and the need to transport the whole installation. All these aspects were tested on several scaled prototypes and incorporated at the component level. The completion of the project was only possible by combining scripting and parametric modeling to deal with a large amount of different parts and the need to produce constant updates along the design and fabrication process. In 6 days the 890 different components were fabricated and labeled in a CNC router machine at the Prototyping Laboratory and assembled by the students on site. The exhibition will be travelling in the coming months through the different campus of the University and public parks as a way of promoting multidisciplinary work.

Figure 3. Ensemble process at Centro Extension UC

Figure 4. Umbrales 09 exhibition display project

Figure 5. Opening day at Centro Extension UC

Figure 6.Visitors engaging with variable components

After thoughts

Context, time scale and available technology produced a non-obvious combination of advanced digital design and fabrication techniques, with low cost mass produced standard materials and collaborative work scheme as an academic exercise. The connection between specific conditions of the project and the potential of parametric variation has produced a piece that interacts with public space engaging non fixed experiences on the visitors, where complexity emerges out of simple parameters involved in the system. In this manner the exhibition support in itself has became central part of the presented material describing unexpected bodies that invade spaces stimulating the reaction on people.

Approaching parametrics not only as digital design tools but also as a state of mind towards design allowed driving architectural strategies based on relevant variables of a project. This vision opens spaces for further exploration on design strategies as physical and spatial evidence of design criteria, involving observers with design processes and criteria with built form as a continuous feedback.

Acknowledgments

This exercise was developed at the “Intensive Structures Design Studio” at the Pontificia Universidad Catolica de Chile, taught by Arturo Lyon and Claudio Labarca. Assistant: Diego Pinochet. Students: Joseph Abaud, Juan Jose Aldunce, Felipe Ariagada, Maria Jose Bisbal, Fabio Cruz, Tomas Correa, Nicolas del Valle, Ignacio Errazuriz, Gonzalo Hevia, Elisa Izquierdo, Jose Melo, Daniela Meza, Jose Miguel Martinez, Raul Rencoret, Nicolas Rojas, Tomas Romero, Gustavo Santibañez, Kenneth Sweet and Jose Vial.

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