A Swell Project: Between Parametrics and Fabrication

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Abstract

As a case study, S*well* (Figure 1) serves as: 1) an investigation into architectural ornamentation using a contemporary framework, as directed through specific modes of research, 2) a study in fabrication materials and methods, especially through the realization of form, and 3) as a pedagogical tool, loosely assembled through real and virtual space. This essay will focus mainly on the fabrication methods in terms of *why* and the pedagogical research initiatives and reactions that went into the design of *Swell*. The project was conceived through a summer studio which was formed to investigate tools and methods available at the Texas A&M Architecture Ranch and to further the local pedagogical direction toward fabrication in architectural design at Texas A&M University as a whole. That is to say, there was no specific agenda toward parametrics, form, research, technology, or the like. At the same time, as the research continued, certain decisions were cast in terms of technology, sensibility, site, etc. informed by research, iterative processes, or parametric evaluation that ultimately formed the project as it exists today.

Figure 1. The digital fabrication project Swell as built showing two systems: the hard yet porous system (CNC milled surfaces) against a soft interior using laser cutting techniques. Texas A&M University July 2009.

Introduction & Criteria

Initially, the studio focused on research into sensibility. The project had to be manifested as form, but what form? How do you construct criteria to make that decision? But more importantly how to understand that which is conceived internally within the construct of Architecture in itself. Therefore, students were encouraged to seek research that was based mainly on architectural precedent in addition to non-architectural transitional objects. The group focused in on certain detailing generated by Louis Sullivan, namely the more opulent ornamentation about buildings such as the Guaranty Building. The interests for the students were in treatment to the architectural condition, aperture/porosity, feeling or emotional aspects of ornament, materiality, etc. all framed within a contemporary framework, using contemporary tools and fabrication methods. The students framed Sullivan's work in terms of a Baroque sensibility, that of surface investigation, levitation, tension, and anticipation. Ultimately the Guaranty Building's cornice detailing was employed as a platform for investigation: a condition in architecture worth reevaluating in terms of ornament and surface treatment.

In looking through Sullivan's work, the group noted certain porous conditions which would have to emerge within the project, and that these openings in a surface must seemingly be influenced by a force internal to the object itself. The difficulty with internal forces is a) they must react without literal movement and b) the aesthetic realization of the reaction. This was apparent in much of Sullivan's ornamentation, as sinewy geometries framed certain voids, seeming to stretch parts of the terracotta

or metalwork against other geometries aggregated and recessed back from those being stretched. *Swell* was to accommodate these sensibilities: a stretched, aggregated, porous condition which; contained and was stretched by other geometries in one way or another. Thus, another directive arose in that the project should act in a dual manner – one condition should stretch over another.

Once general criteria had been established, as defined by the students, a parallel study was undertaken: one group began to investigate the formal implications of the research, while others began to investigate materiality in terms of affect, durability, cost and other technical properties.

Investigation

How then to create the desired effect? The criteria had been established - but then how to test, design, and ultimately realize that design? Initially, the group relied on analog models to investigate the stretched, porous treatment, the implications of various fabrication methods, and the relationship between the two aforementioned conditions. It was soon realized that the project would need to delve into digital investigation for the sake of iteration and variance of patterning studies, which were crucial to the design. The group used RhinoScript to develop a method for creating porosity based on a general surface logic, implicit to any form. This script employed a method of geometry analysis which; informed the porosity condition about a surface based on certain mathematical constraints or parameters. Figure 2 shows an example of the script as applied to a series of panels.

As a pedagogical initiative, it is crucial to encourage investigations into iterative design processes, as it enables architects today to understand design implications in a broader context. That is to say, more investigation can happen in the same period of time, leading to a richer understanding of design. Algorithms break down the elusive and sometimes problematic phenomena of shape. Shapes are never unwilled figures. Deep within them is a struggle between the predilections of the architect and the inherent properties of the geometries encountered. The algorithm mediated between these two acting as a kind of solvent to liquefy and create the potential for crystallization. (Aranda/Lasch, 2006) Generally speaking, architects today apply new strategies that draw on the field of mathematics, genetic engineering and biotechnology, in such that they generate processes which are in so many ”ecologies,” understood as material behaviors resulting from the same digital matrix. This radical paradigm shift in the history of architecture has moved us from representation to calculation, from form to code. (Andrasek, 2009) For designers like Alisa Andrasek, it is a matter of moving from “abstract information to material creation”.

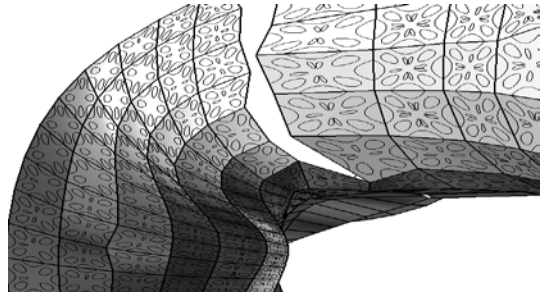

Figure 2. Geometry resultant of the script. Because the script produces a great deal of geometry, it is necessary for the user to do the splitting and trimming in sections to avoid crashing the system. Once trimmed, it is then possible to “unroll” the surfaces onto the X-Y plane so that they can be prepared for the CNC mill.

Technical Determinations

With the use of parametric design ornament becomes once again an important architectural element worthy of discussion. It is important for young architecture students to learn about ornament and abandon all the “modern myths” polluting its application. Sullivan himself neither thought nor designed along dogmatic modern premises during the peak of his career: he often accentuated the plain surfaces with eruptions of lush “organic” ornament,

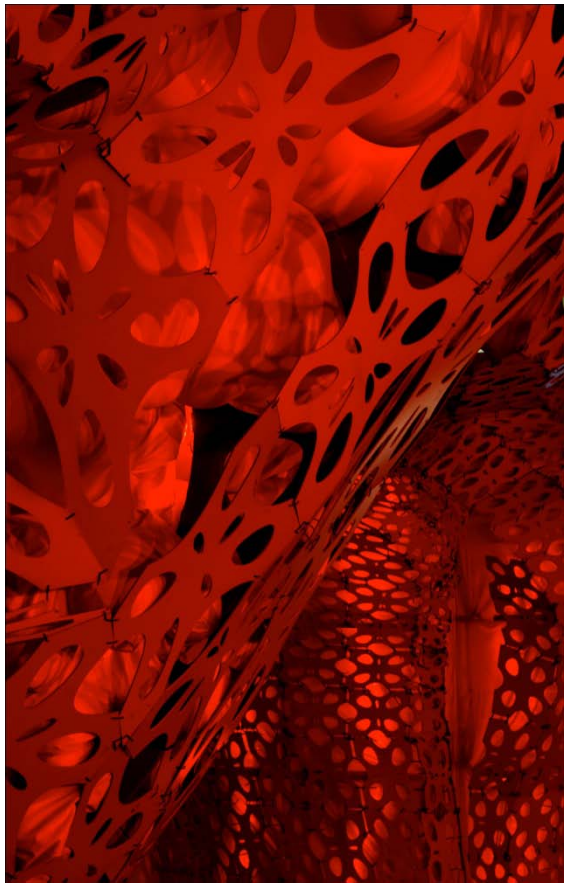

Figure 3. Tessellated surface against a swelling softbody.

usually cast in iron or terra cotta. It is the reinvestigation into both material studies as well as contemporary technology that allowed the group to reframe Sullivan in that way. For Sullivan, terra cotta was lighter and easier to work with than stone masonry. Sullivan used it because it had a malleability that was appropriate for his ornament. Similarly, *Swell* was supported through a series of non-regular castellated sections, which supported the object, but whose weight was mitigated through the removal of excess material.

At the same time the geometry/aesthetic was being developed, more technically driven aspects of the work were being resolved. Interestingly, there was a mutual reliance on both modes of work, as they defined each other, or placed certain constraints upon one another. The algorithmic data are connected and constrained by the physical limits of the machine's capacity. (Andrasek, 2009) These models of tectonic systems set up limitations in materiality, fabrication technique and program used in response specific instances within a general set of design parameters and constraints. A good example of this was in the fabrication method chosen for the project, which was perhaps under a more "technical" facet to the project, but certainly was defined by a certain aesthetic. Before deciding which would be the final technique to be selected. A brief account of this interaction is as follows:

1. Sectioning

   Rather than construct the surface itself, sectioning uses a series of profiles, the edges of which follow lines of surface geometry. The modeling software's sectioning or contouring can almost instantaneously cut parallel sections through objects at designated intervals, effectively streamlining the process of making serialized, parallel sections. This method denies serious surface articulation in favor of structure or mass through aggregation of layers and thus failed to address the specific needs of the project, namely the expression of tension (expressed through porosity), and it's used in

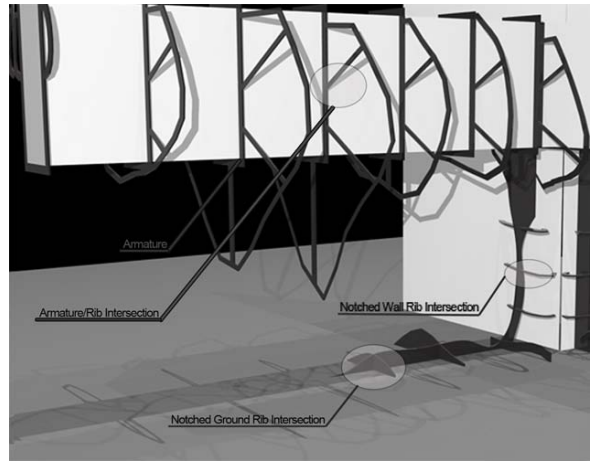

Figure 4. Sectioning as a structural strategy

this project was relegated to constructing the structure that supported the skin (Figure 4).

Figure 5. Students testing the hard exterior system, the softbodies, and the sectioned ribbing structure.

2. Forming

It involves the generation of multiple parts from a small number of molds or forms. In architecture this translates into the realm of building components. Using a variation of five basic laser cut fabric forms can create a specific definition of a form producing a kind of rustication and ornament.

Because of the desire for a sense of levitation, while maintaining some level of economic control, forming became an option that was not feasible for the exterior development. However, because forming creates mass it worked well in the development of the interior system – the stretching object, which was inclusive of the research (see Figure 6).

3. Aggregation

Aggregation argues that the whole is greater than the parts, and that there is validity in serialization and multiplication of an object in terms of size, scope and scale. While on a superficial level, aggregation works in a similar way to tessellation. However, it is distinct in its fabrication method, especially in terms of detailing. In addition to forming, aggregation can be cost prohibitive in that it requires a multitude of parts to be successful. Although considered initially, a method of aggregation could not satisfy the material constraints required of the project, nor does it readily allow for precise control over the object, instead aiming to overcome this constraint through an additive attrition of objects. In a way, the interior of *Swell* was created through aggregation of "softbodies" or the interiority of the project. However, because of the softbodies size, density, and spatial relationship, the actual method would not be readily defined as aggregation, nor was aggregation a tool employed in the development of the interior system.

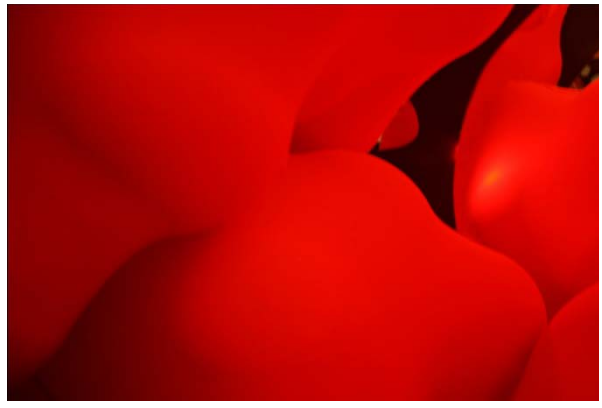

Figure 6. A swelling interior.

4. Tessellation

Depending on the tessellation resolution, approximated surface can be smooth and precise. When evaluating tessellation strategies, if the aim is to calibrate the initial form with a constructional system, it is better to determine the size and resolution of the tiles relative to the overall geometry and design

intention as well as material considerations.

Digital technologies have revitalized the design world's interest in patterning and tessellation because they afford greater variation and modulation through non-standard manufacturing, even as they provide an inherent economy of means. Working digitally enables movement from one representational format to another – for example, from digital model to vector line file to manufacturing method. These series of translations allows for more fluid fabrication process while significantly reducing the labor associated with taking one type of design medium and turning it into another. *Swell* was fabricated using tessellation primarily because of the ease of defining the patterning about the surface, the ability to provide for a dual (exterior/interior) system, and the availability of machining methods to help in tooling out the various pieces and parts.

In addition to the exterior treatment, the condition of the interior was still somewhat indeterminate. As the research continued, it was concluded that if the project was to have a sense of levitation, and that the interior was to work in a pseudo-aggregated manner (if such bulbous bodies could be considered as such) then they must be as light as air, though visually dominate a large portion of the interior of the object. The team used large sacks of air that were inflated and inserted into the exterior of *Swell* before it was completed (see Figure 5). In this way, the surface could appear to be stretched and deforming under a load – a load that was mitigated for the sake of material constraints (see Figures 1 and 6).

Conclusion

While other methods of fabrication did not suit this particular analysis of Sullivan's work, there are certainly opportunities to work with ornamentation within the context of the early modernist (or Architecture at large) using other fabrication methods or techniques. It is only through these investigations that Architecture can continue to refine itself, to redefine itself, and to emerge into our era of tooling design into production.

In retrospect, *Swell* should be considered pedagogically successful in that the students, in an abbreviated summer schedule, went through the entire process of research, design, fabrication, and presentation – with all the design decisions laid out for discussion. In the case of fabrication, there is no rendering or drawing that can cover up mistakes or thoughtless acts – the object is naked for the critic. Therefore, through the completion of the project, its reception, and through the retention and continued interest of the students, projects like this will continue to dominate architectural pedagogy well into the future.

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