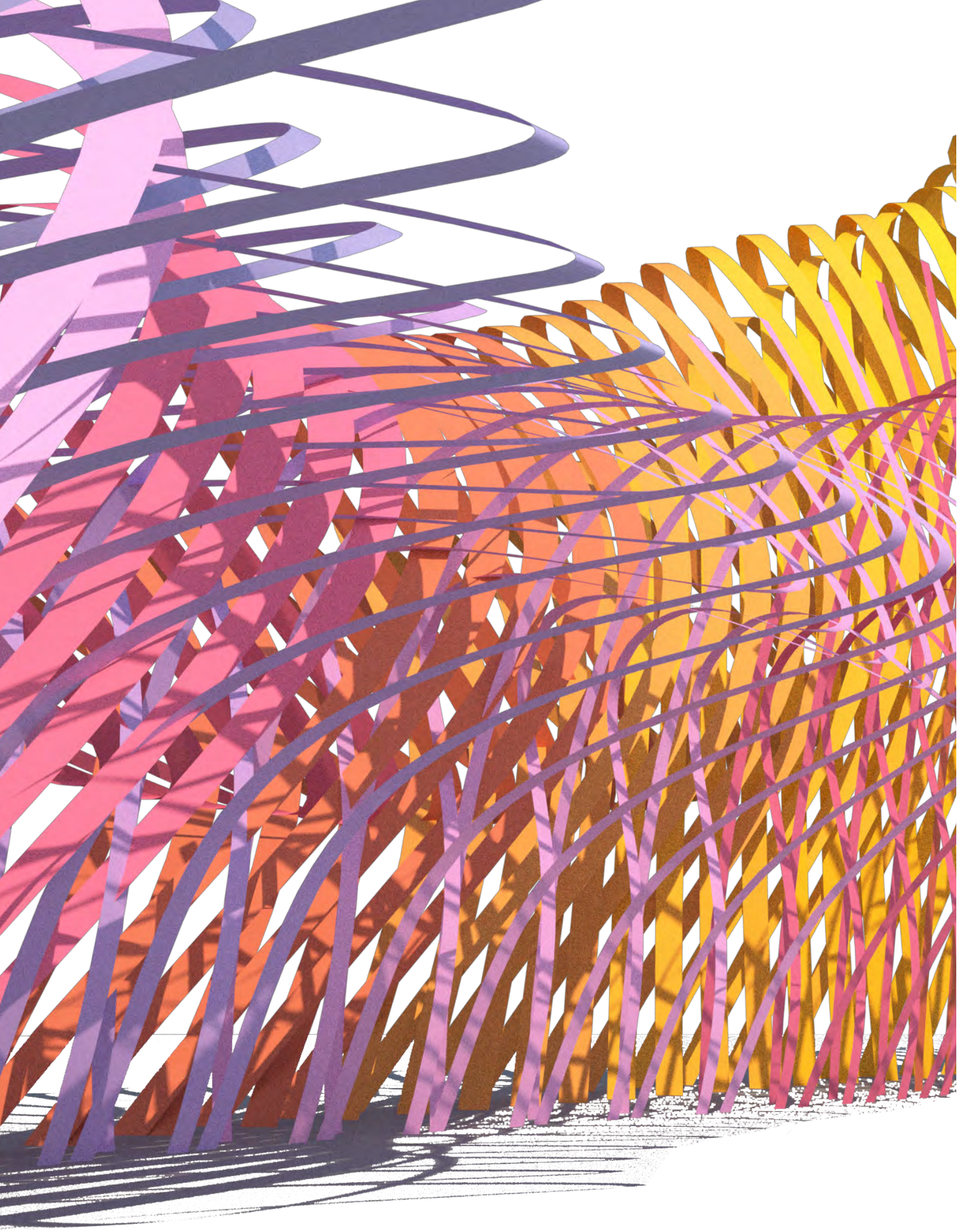

Point Clouds, Constellations, Coordinates, and Other Lists

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Architecture has a complicated relationship with shape. Our discipline has loved shape, hated shape, trusted and mistrusted shape, sometimes violently destroyed shape.[1] Shape has been understood as a discrete entity—defined either by a two-dimensional profile or a three-dimensional envelope—or, in recent times, as a shifting figure we glimpse in aggregations of varying intensity, heretofore known as "fields."[2] Let's face it: fields are alluring. They are often visually rich and intricate and can even register movement. But they are problematic, too, because of their ill-defined limits and lack of hierarchy. Some recent tendencies in design attempt to reconcile figure and field and manage the relationships between them. In this paper, I will describe my methods for organizing and visualizing data in efforts to mediate between figure and field, part and whole, system and component.

In developing some recent projects, I find I have a particular interest in various descriptions of points in space- point clouds and their coordinates- and I have started to present them to myself as sets of constellations. In astronomy, constellations are collections of stars that describe the shape of a person or animal. Each is based on a configuration of discrete points in space and a shared mythology about the character, but constellations also rely heavily on the power of the imagination to complete suggested figures in our minds. I am interested in the potential for discrete sets of information (whether stars in the sky or points in space) to suggest nuanced and evocative figures. In the case of celestial constellations, the figures are often human and animal. In architectural constellations, this is less often so.

The role of constellations in my work is to represent partial information—it is complete enough to be suggestive (of shapes, trajectories, etc.) but not so complete as to define an envelope or a closed perimeter. It is a way of limiting control so that design decisions may be made with more reflection. Seeing work as a group of points in space, or constellations suggestive of shapes, and alternately as defined figures allows me to oscillate between what a project is and what a project could be. This is especially useful in digital processes, when the tools themselves can be somewhat tyrannical over design.

There are several related questions guiding my research. What kinds of organizations can yield shapes that have the visual allure of part-based systems (fields)

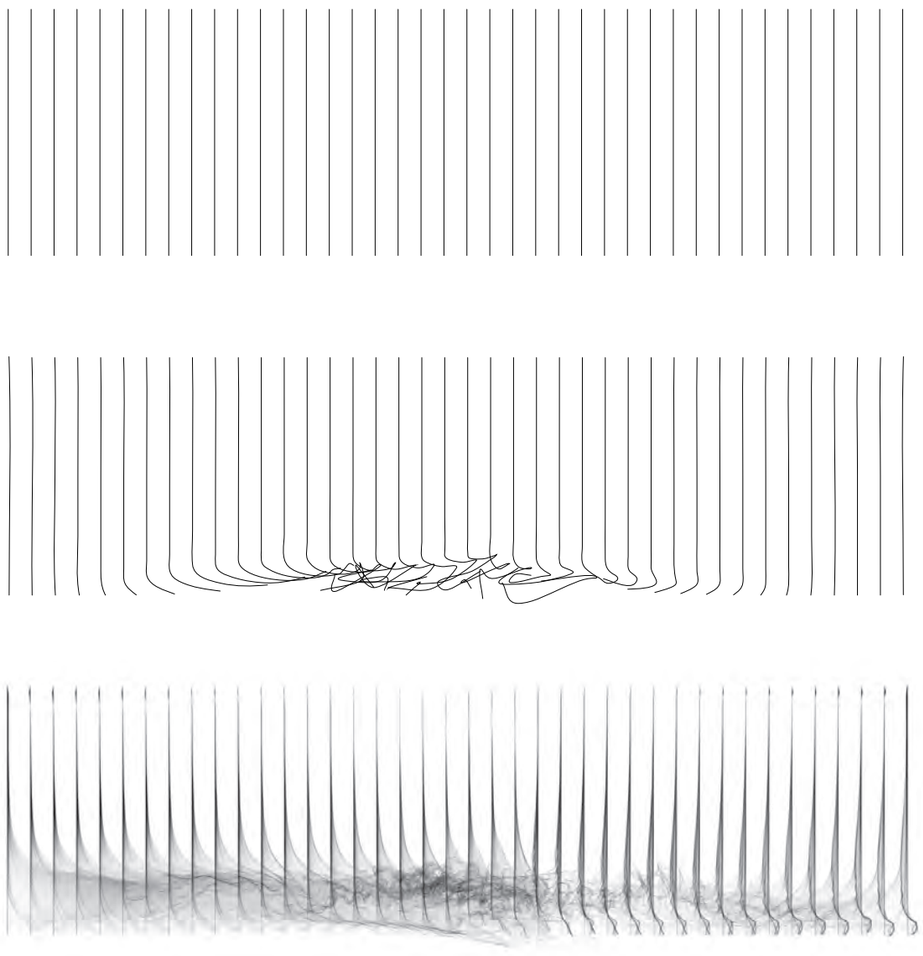


Figure 1: Emily White, Long Piano (drawing and diagrams), 2009.

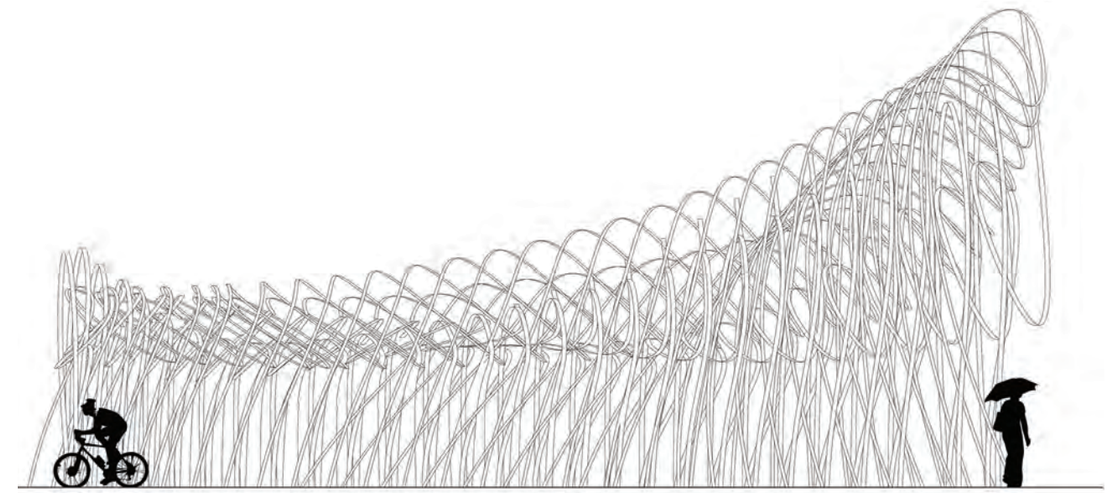


Figure 2: Emily White, Masonic Zoom (elevation), 2014.

and are also bounded, manageable and constructible? When working with points in space, are Cartesian frameworks necessary? Are they limiting? What degree of control is productive in design? When does too much control make a project predictable?

I will use three related projects to examine the implications of constellation-based organizations. Two are speculative, and the third is currently in development. This series of projects started with an interest in how drawings can be expanded into volumetric constructions and how visualizing information can influence that process. In each case, line is more important (and more legible) than shape because lines can belong to multiple shapes simultaneously.

The first project I will describe is a drawing that uses simulated physics to shape curves in two dimensional space. It has no material. The second is a proposal for an urban installation that is translated out of a drawing and designed as a series of extruded lines. It was proposed as a sheet metal structure. The third project is a suspended ceiling installation for the Fort Lauderdale International Airport, to be fabricated in sheet metal. In each case my tendency is to use points (a group of which is called a point cloud) to suggest lines, and lines in turn to suggest volume.

LINES MADE FROM POINTS: DEFINING CONSTRAINTS AND CONTROLS

The first project is useful to layout some terms and concepts, the most important of which is the difference between constraints and controls. I made the drawing with the software Processing, using the Traer physics engine plug-in to simulate physical forces of particles in space.[3]

The code assigns gravity and drag to particles as they move around based on forces applied as the code is executed in real time. I used those particles to draw curves, assigning some as anchors, or end points, and some as inflection points. The anchors are static, and the inflection points are dynamic, moving according to the "physics" written into the code (fig. 1). The dynamic information (moving points) allows the project and its form to be controlled, whereas the static information (properties of "physics") constrains movement. Constraints are set first; controls are manipulated over time. Controls can be manipulated according to an evolving aesthetic or formal agenda.

Of course, working in two-dimensional digital space

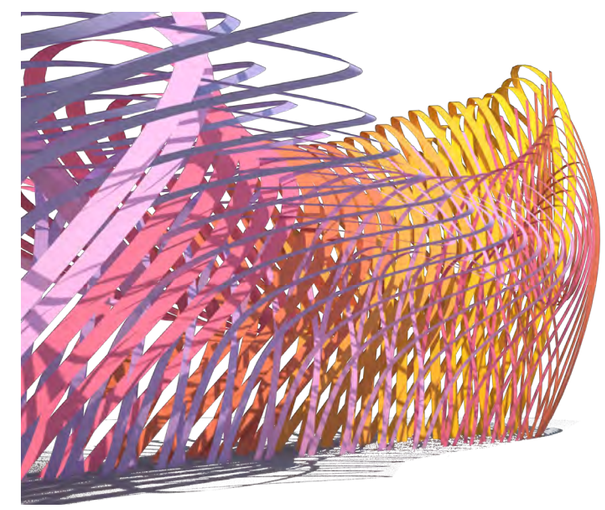


Figure 3: Emily White, Masonic Zoom, 2014.

Figure 4: Ramiro Diaz-Granados, Go Figure, 2012. – photo by Josh White

Figure 5: Ramiro Diaz-Granados, Go Figure (detail), 2012. – photo by Ryan Martinez

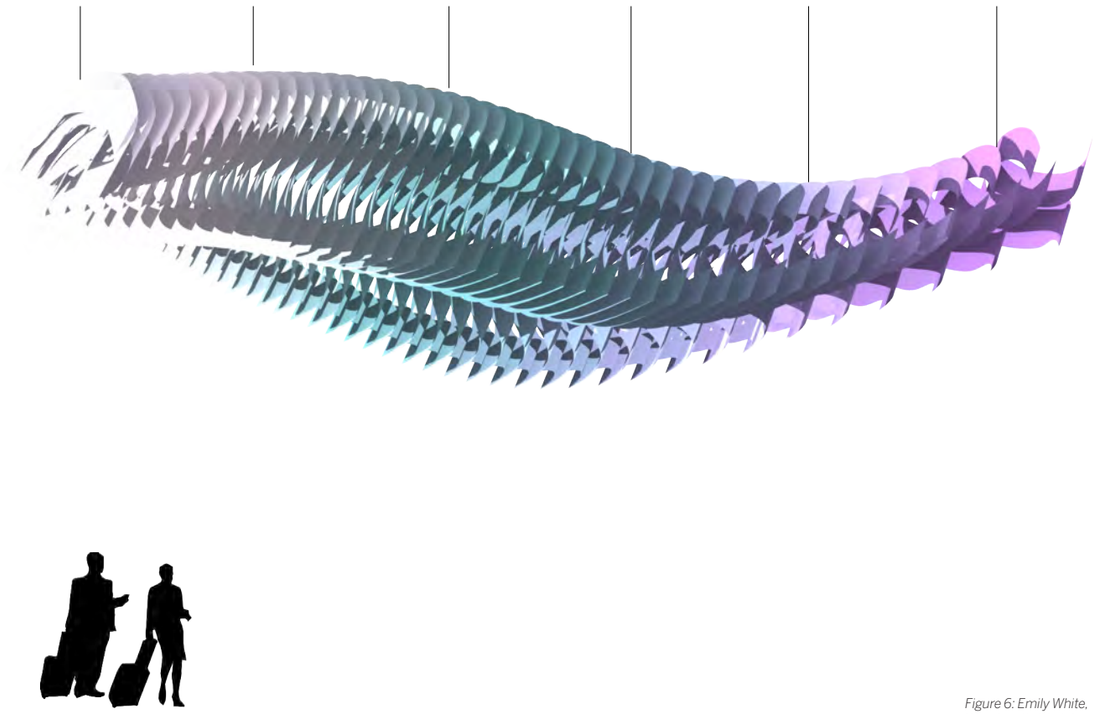


Figure 6: Emily White, Wavelength (sketch model), 2015.

removes a lot of physical and material constraints that might influence a project. Processing is a great design tool for exploring isolated formal relationships. I was interested in questions like: At what point did these big curve networks take on figural characteristics? Was there ever a defined perimeter? I looked at these issues in the next project.

LINE INTO VOLUME: THE QUESTION OF ENVELOPE

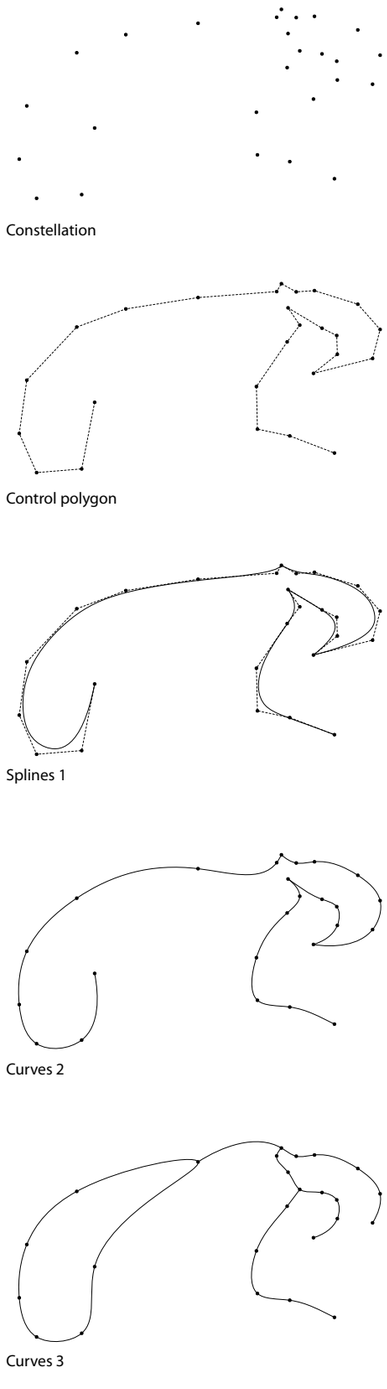
The second project involves translations from drawing into volume, which necessitates an envelope, or at least an implied envelope. It is a proposal for a structure marking the beginning of a new section of San Francisco's growing network of bike paths. [4] It started from a drawing that alluded to textile operations with strands knitted together in varying densities (fig. 2). As the project developed from drawing to model in digital space, it maintained a loose, strand-like quality (fig. 3). But of course, as we began to model it in physical space, the issue of stiffness came up. Stiffness, the ability to hold shape, is essential to managing the relationship between figure and field. Without stiffness, there is no figure.

Folding is a tactic that designers often employ to stiffen sheet metal. I was interested in a couple of other projects of roughly similar scale that shared a vocabulary of line rendered in metal and had clever approaches to stiffness. Some of the installation-scale work of Oyler Wu Collaborative maintains the lightness and looseness of drawings, and I was particularly interested in the project Go Figure by Ramiro Diaz-Granados, installed in the SCI-Arc Gallery in 2012, which is explicitly about the spatial figures latent in line drawings (figs. 4 and 5).

Diaz-Granados created a triangular section from three faces of aluminum that were thin enough to read as curves, meandering loosely around the gallery. There was a friction-fit finger joint running along each of the three seams. Each side was powder coated with a different color so the thin sweeps derived from his design drawings—the figure—could be more legible.

In Masonic Zoom, too, we did not want to make our lines bulky by folding for stiffness. We set up a system

Figure 7: Emily White, Wavelength (diagrams), 2015.



of lamination and mechanical fastening that would allow the sheets to be connected into one large network. We tested this system in paper models and believed it would allow the project to maintain characteristics of expansion and even fluffiness without becoming totally floppy. Masonic Zoom didn't go beyond proposal form, but I am now working with many of the same issues in a project that will be fabricated and tested full scale in the field.

MATERIALIZED LINE

My current project, Wavelength, has a simple organization that describes shifts in form and color over a series of curved sections. What is (purposefully) less straightforward is the development of each of the curved sections, and the process by which I have been moving between part and whole. My interest here is the balance between the implied envelope—the project's figure—and the internal dynamics among the serial sections. I am using constellations as a way to visualize possible alternative shapes at the local level even as I am moving toward a particular global figural ambition (fig. 6).

In this project, there are constraints and controls, but unlike previous drawing projects where physics was a graphic representation, this project will be fabricated and installed in a real site, so it is important that it is accountable to real physics. I am using constraints and controls to develop the shape, and I am also ascribing certain physical characteristics to them, like span and bending radii. The project will be fabricated in 0.1-in thick aluminum. I am working with a structural engineer to define a set of properties that act as constraints, like ranges of possible bending given the material thickness and possible lengths of unsupported spans.

When described in terms of digital modeling, these constraints are approximations of material and structural performance, or parameters, that are represented by nodes in a grasshopper definition. The controls, by contrast, are the modifications to these initial conditions. They can by manipulated either by number sliders, in the case of increasing the length of an arc, or just by altering the shape of a curve or moving a point in space. Because constraints are fixed and controls are dynamic, there are areas within the project which are non-negotiable, and other areas that are in nearly perpetual formal flux.

Figure 7 shows one of the profiles in the series represented as a constellation (at the top, the points that constitute its control polygon) and various profiles drawn among the points of the constellation that allow me to imagine alternative shapes. In this project, I have been working with the control points (constellations) visible in digital space as I develop the model. In past projects, I have usually left control polygons and control points as background information that I only make visible when adjusting the shape of a curve or drawing an interpolated curve using edit points.

On one hand, this makes for some clutter on the screen. On the other hand, it allows me to imagine deviations form, and disruptions to, the overall figure caused by formal negotiations at the local level, among a small group of consecutive profiles, for example. In the case of a serial section project such as this one, these local level dynamics are essential; a project comprised simply from a contoured object—no matter how intricate the object—is totally monotonous. There is potential for a more nuanced relationship between section and envelope when the sections are allowed to exert some influence on the overall form by way of local level interactions. There ought to be some turbulence in the waveform, in other words.

The project can be read at various levels of resolution. It can be described in narrative or metaphoric form (i.e. turbulence in the wave), as constellations that suggest shapes, as point clouds before they are organized into constellations, and, simply, as lists of numbers that represent these points as Cartesian coordinates. It is the oscillation amongst these representations that allows me to manage the relationship between the envelope and the section, or the field (of profiles) and the figure (their implied envelope.)

Oscillation among representational means has another benefit to the work that concerns time. It makes the work go more slowly, and therefore more deliberately. Especially when working with digital tools that enable designers to turn out many quick iterations, it is important to make time to reflect. One way of reflecting is to see and un-see the project. Frameworks that allow partial control privilege the design decisions that occur in translation. This depends on setting up processes that are non-linear and in which the same information can be seen in many different ways.

ENDNOTES

1. A very tiny spectrum of attitudes toward shape could be constructed from two poles of twentieth century architectural discourse. It would include, on one end, Louis Sullivan's position in his 1896 article "The Tall Office Building Aesthetically Reconsidered" that "whether it be the sweeping eagle in his flight, or the open apple-blossom…form ever follows function," and at the other end, Robert Venturi, Denise Scott Brown and Steven Izenour's description in *Learning From Las Vegas* (Cambridge: MIT Press, 1977) of the concept of a "duck" in opposition to a "decorated shed."

2. See Stan Allen, "From Object to Field," in AD Profile 127 (Architecture After Geometry), *Architectural Design,* vol. 67, no. 5/6 (1997): 24–31.

3. The Traer physics engine for processing was developed by Jeffrey Traer Bernstein. His code and a more detailed description of its functions can be found at Bernstein's website, http://murderandcreate.com/physics/. Processing is an open source software and "software sketchbook" for designing with code. It is most commonly used by visual artists. More information and code can be found at the Processing website, http://processing.org.

4. The proposal for Masonic Zoom was a collaboration with Jenna Didier and structural engineer Roel Schierbeek.