The background of the entire page is a complex, repeating geometric pattern. It consists of a grid of thin, light gray lines that intersect to form a series of overlapping triangles and star-like shapes. The pattern is highly symmetrical and creates a sense of depth and complexity. The lines are arranged in a way that they form a grid of squares, but each square is further subdivided into smaller triangles and stars, creating a multi-scale geometric structure.

[Field Theory]

*the study of lattice systems created through
modular paneling transcending multiple scales*

Kelly Drewry

[Field Theory]

the study of lattice systems created through modular paneling transcending multiple scales

Kelly Drewry

Thesis submitted to the faculty of
the Virginia Polytechnic Institute
and State University in partial
fulfillment of the requirements for
the degree of Master in Architecture

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William Galloway

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[Field Theory]

the study of lattice systems created through modular paneling transcending multiple scales

-kelly drewry

the abstract

This is a study of patterning and the connection between the proportions created and destroyed through this process. The analytical study of a pure geometry creates spaces and forms at every scale and in every orientation. These patterns can be laid out in modular panels, whether rotated, overlaid, skewed, or mirrored, in order to create architectural design decisions in plan, section, or elevation. Since the proportions of the module grow exponentially, possibilities are endless in terms of project type and scale. Decisions are made at multiple scales, starting with the human and working up to the building scale, as well as the realm of possibilities that fall in between. The module is acting as a matrix which regulates the articulation every architectural element. It creates order and reason for decision making, whether it be the layout for a city's master plan or a small home. Furthermore, it establishes regularity and control for the organization of spaces. The language of the modular system guides the design development through the grammar established in the particular modular panels. For example, human interactions, seating areas, pathways, and transition spaces naturally belong to certain areas based on the module. This way of working allows for simultaneous planning of the entire site while also organizing the practical and material complexities of the space.

[Outdoor Walking Promenade]

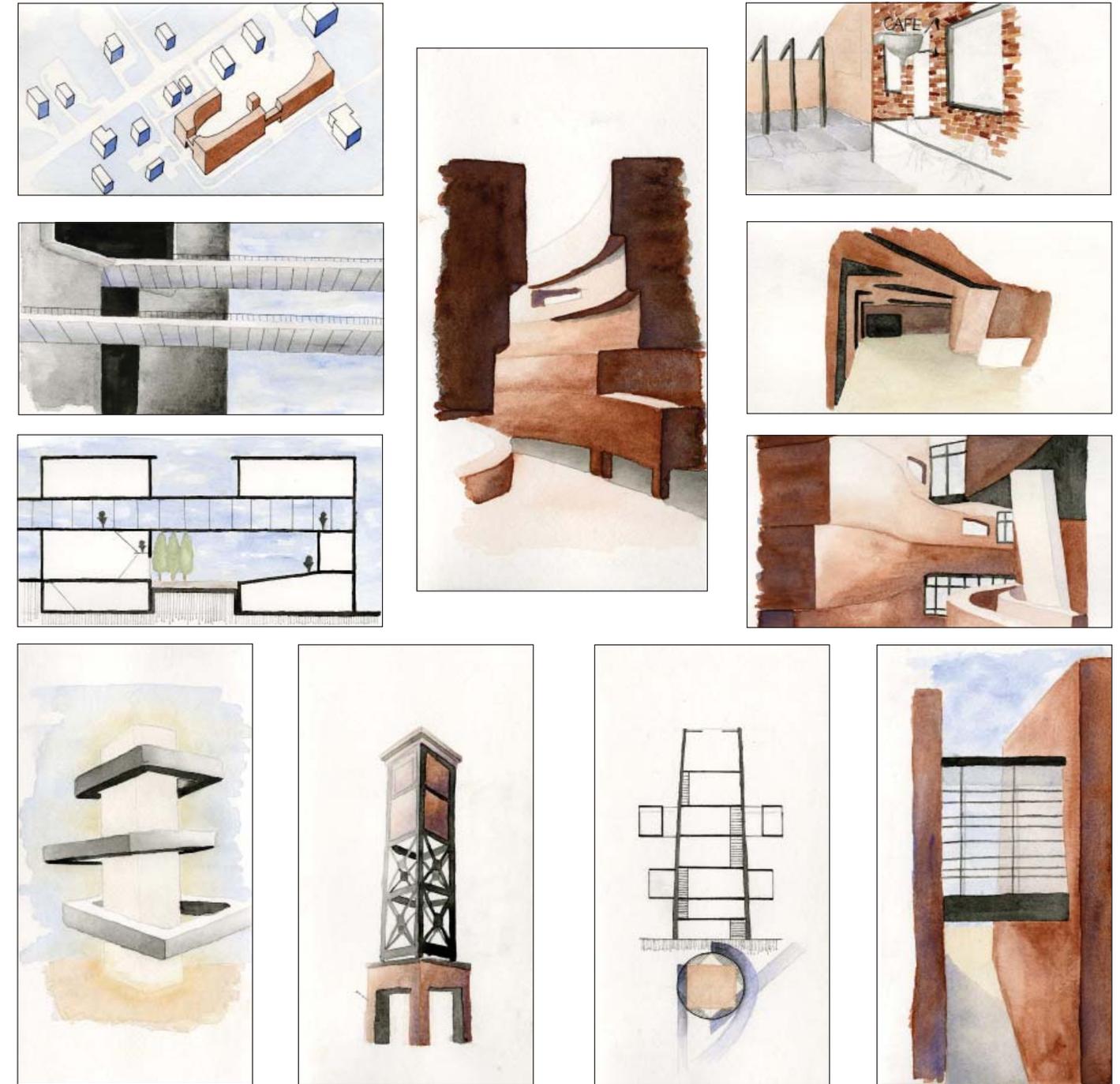
the project

I am applying these strategies to a walking promenade consisting of a complex lattice system. The lattice system itself is composed of six modular panels varying at scales starting at six feet (equating the human scale) and ending at forty-eight feet (serving as the building scale in this particular project). The lattice system's density happens toward the base of the structure, coordinating with the human, structural needs, and overall aesthetics of the project. The density exponentially decreases as the structure reaches its maximum height emphasizing the vastness of the structure compared to the human. These six modular panels were developed by overlaying squares at varying scales and visually choosing which lines would remain a part of the panel. These panels then become arrayed at different scales and orientations in order to establish a pattern that seems arbitrary to the naked eye, but in fact is consistent across the entire system. A section cut through the space shows an arched column structure. This basic shape was also created the square--the inscribed circle is truncated at the two outer legs of the square creating a simple arched steel structure. The two basic design decisions--the lattice system and the structure--become one as the structure takes on the shape and appearance of the lattice work.

[Dual Methodology]

the process

The study began with the generation of a series of overlaying patterns and grids, all created based on the square. This grid pattern established module components that could be manipulated at varying scales through sketches, transparency overlays, and computer simulation. The methodology of the project has been a constant switch back and forth between system-based and qualitative thinking. The systematic taking place in the grid system, pattern, and modular panels. This objective and systematic thinking establishes the building blocks for the thesis--the limits and rules that begin to form the language for the project. The subjective thinking--decisions on which lines in the grid become the modules, material thicknesses, and spatial features--takes place through qualitative decision making. These decisions are based on tangible and perceptible massings and drawings of the spatial qualities of the walking promenade. This dual production contributes the back and forth means of thinking present throughout the project and thesis. Production and study take place in computer modeling and drawings, as well as physical drawings, watercolors, and screenprints. The exploration of the space in multiple media at several scales is used to make all architectural decisions.

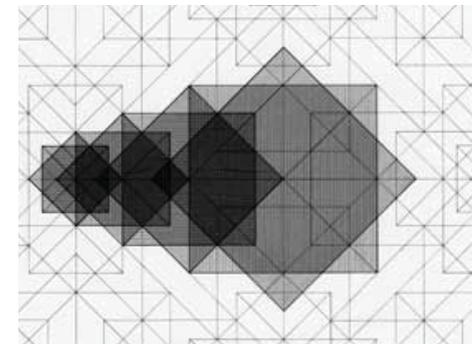


Above: Preliminary watercolor sketches showing initial design ideas

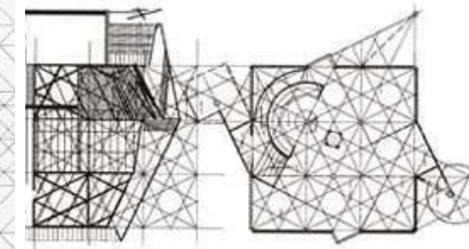
_Walter Netsch

The Chicago architect is most recognizable for his use of field theory--rotating squares into complex shapes. The practice of breaking down geometries into figures and rotating them to develop different spaces served as Netsch's way of breaking the typical architectural box. He worked through scheme after scheme for each project design by overlaying transparencies filled with square patterns, picking and choosing which lines would become walls, rooms, floor patterns, and so forth. I began my thesis study in a similar fashion--overlying squares at different scales and studying the patterns possible within each shape.

"...I mean, you keep asking these questions. You have no idea what decision making involves. It's just hard work. I would sit there and do hundreds and hundreds of little patterns..."
-Walter Netsch



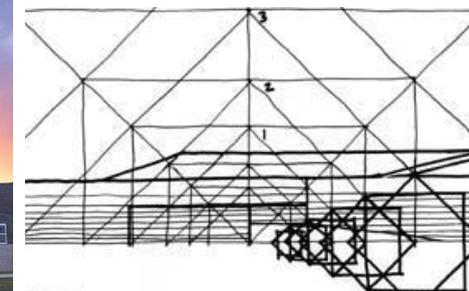
1 [sketch by Walter Netsch, www.som.com, 2010]



2 [sketch by Walter Netsch, www.som.com, 2010]



3 [photo by John de Nugent, www.johndenugent.net, 2010]



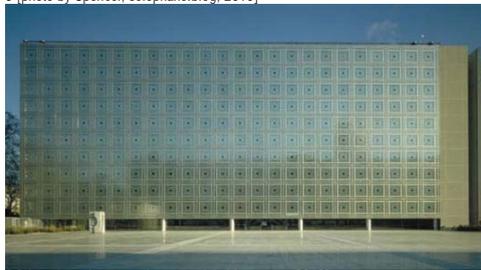
4 [sketch by Walter Netsch, www.som.com, 2010]

_Jean Nouvel

The French architect has a number of his works showcased throughout museums and architectural centers. His intricate patterns of latticework on building facades captured my attention, particularly the Institut du Monde Arabe (IMA) or Arab World Institute (AWI). Nouvel's facade composition is often tied into the interior lighting of the building program. I took particular interest in the repetition of modular panelling.



5 [photo by Spencer, selophane.blog, 2010]



6 [photo by unknown author, www.inhabitant.com, 2010]



7 [photo by Ateliers Jean Nouvel, www.desmena.com, 2010]



8 [photo by Darrell Godliman, www.flickr.com, 2011]



9 [photo by Barbara Burg and Oliver Schuh, www.smu.edu, 2011]



10 [photo by Pedro, www.panoramio.com, 2011]

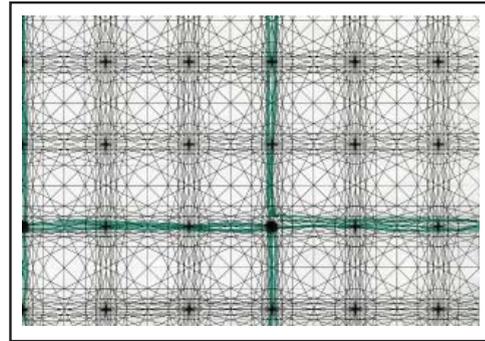
_Santiago Calatrava

Known for his distinct style of work on bridges and train stations, Calatrava has brought the status of civil engineering projects to new heights. His combination of engineering and sculpture has established a unique style of architecture. The Agora, an outdoor walking promenade, was built as part of the Athens Olympic Sports Complex. The projects' ideas of repetition and structure were very influential in my thesis.

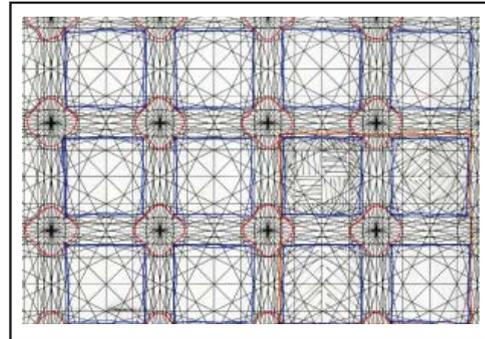
[diagrammatic grid studies]

Overlays of flooring/tiling systems, structural bays, column grids, and pedestrian traffic patterns. All studies look at the design in plan.

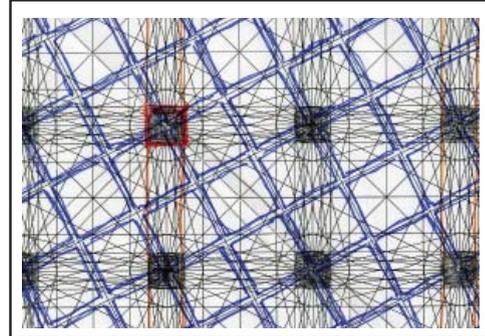
sharp x,y axis--large bays



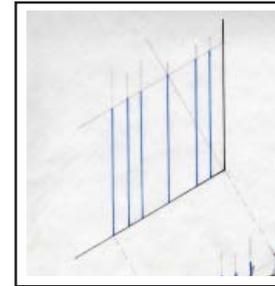
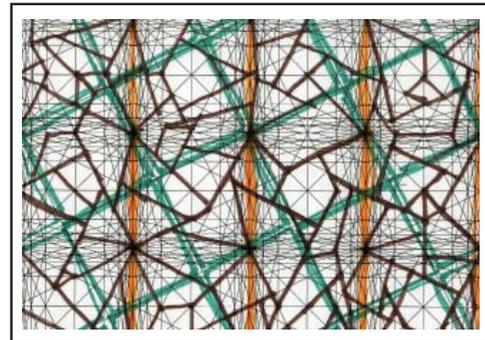
pedestrian transition spaces with structural columns marking bays



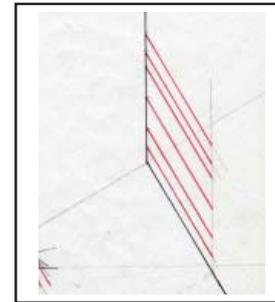
column grid system happening on diagonal axis



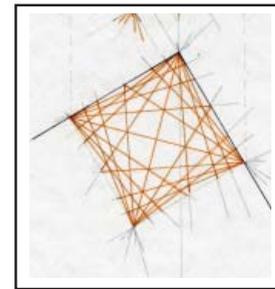
tiling system with multiple layers



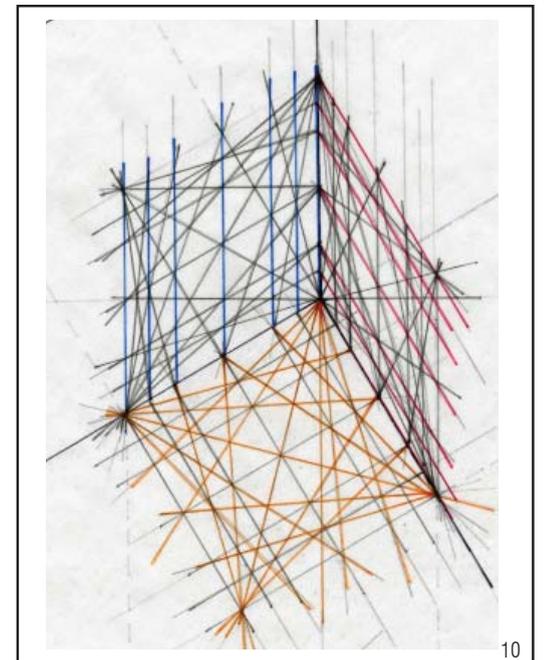
sky



walls



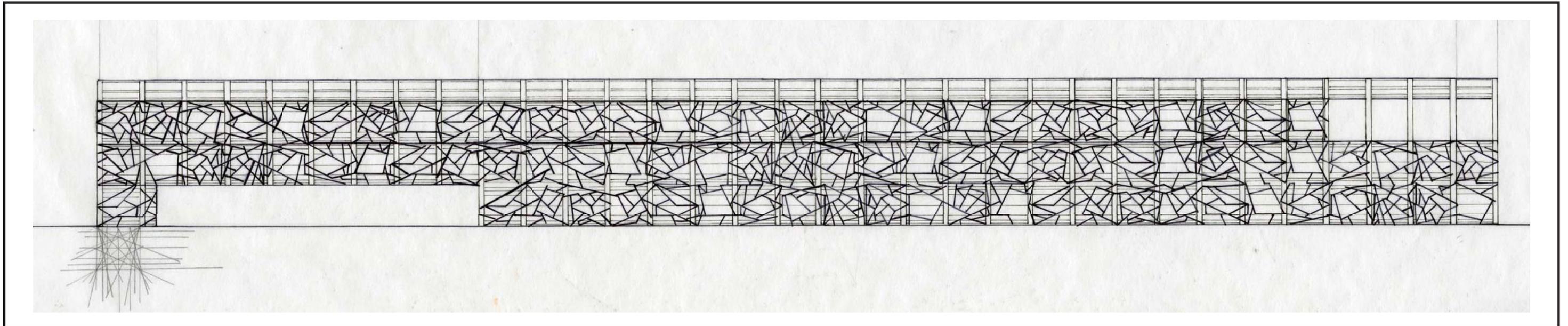
ground

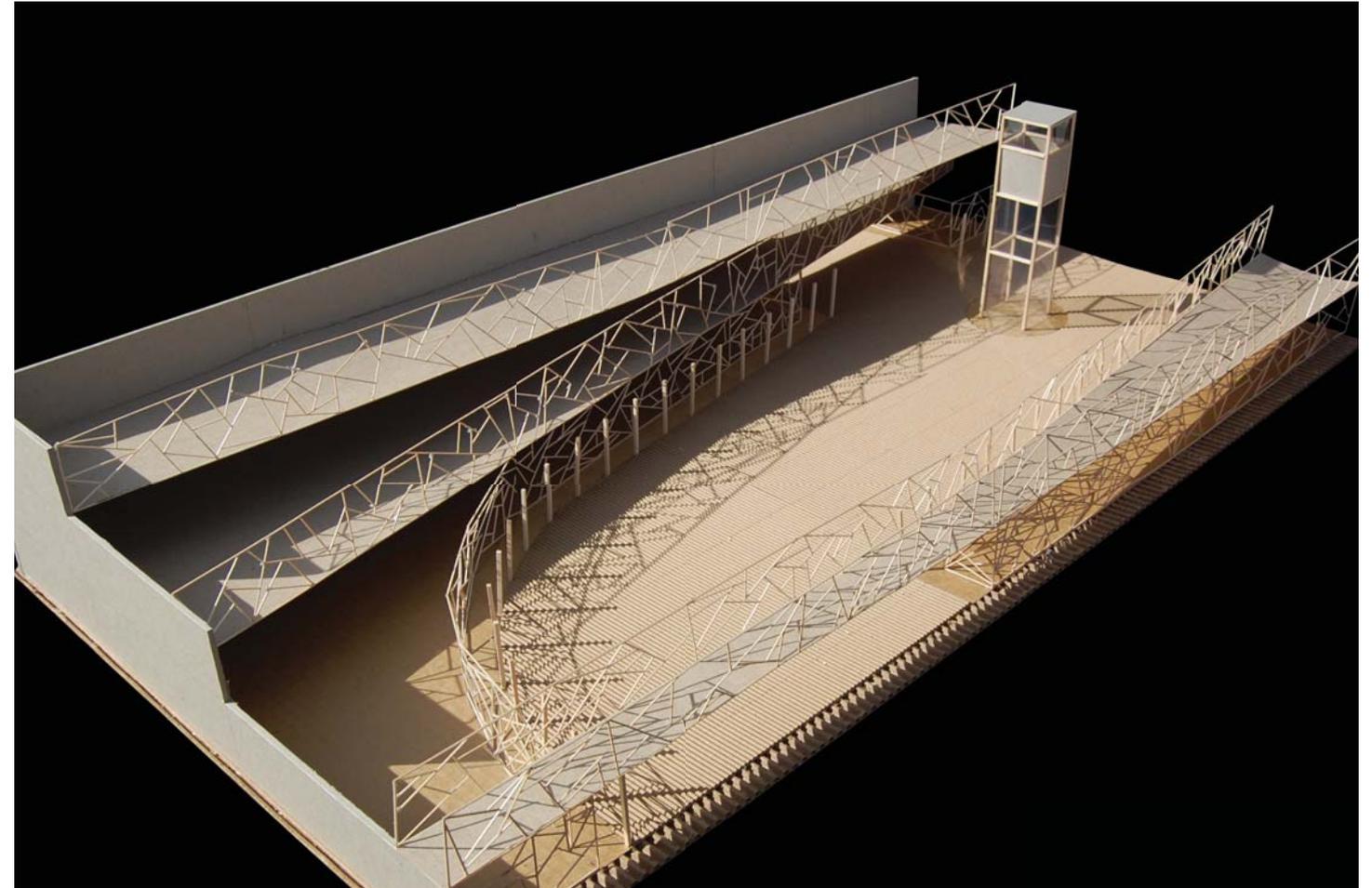


This study shows the literal separation of construction lines--vertical, horizontal, and diagonal. Assigning an axis to each construction type allows each direction to take on its own quality. These qualities become present in the ground, walls, and sky connection of the architecture.

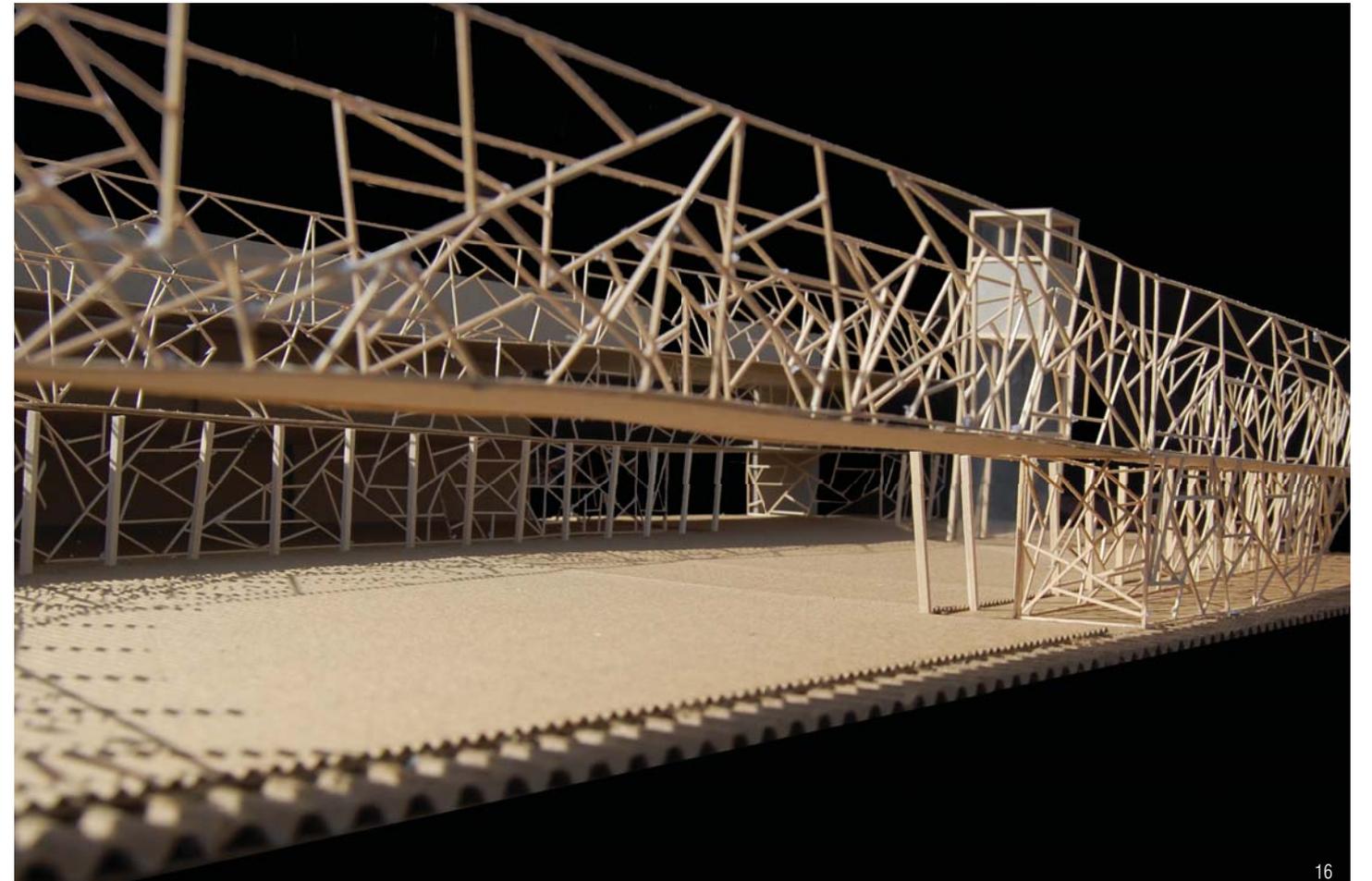
[initial designs]

The first design is an attempt at a lattice system that acts as the facade a building. All of the components take place at the same scale. Arbitrary decisions are made about which lines become facade members. There is little study of repetition or module fabrication at this point. The main conceptual idea here is to be to apply the lattice system to any two dimensional surface, with the designer choosing how dense the elevation would appear based on qualitative and programmatic reasoning.



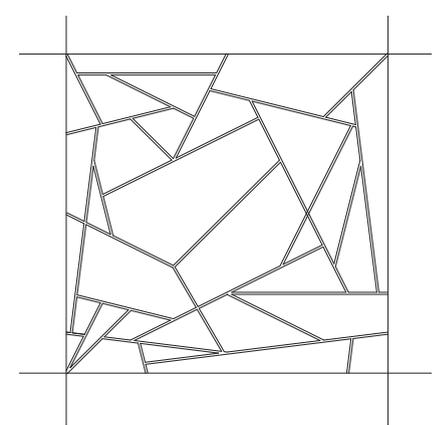
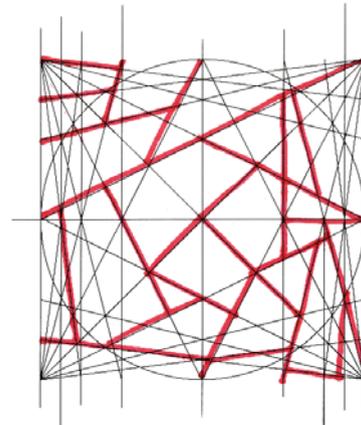
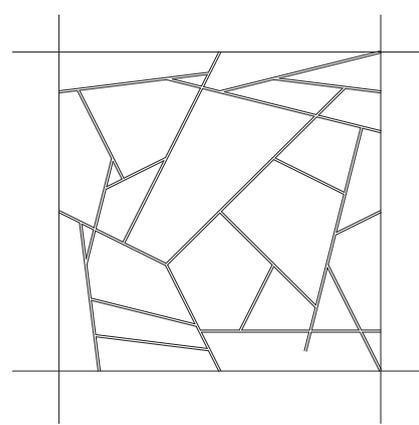
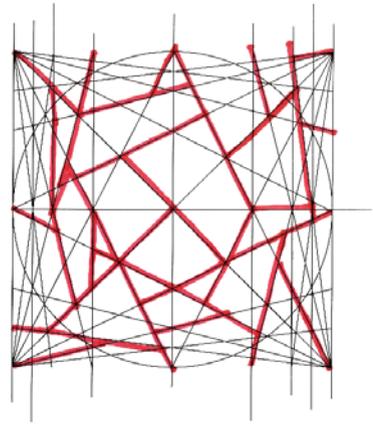
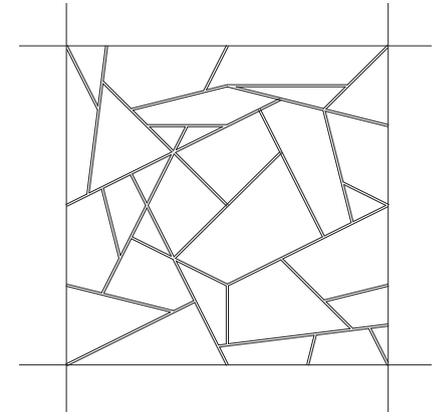
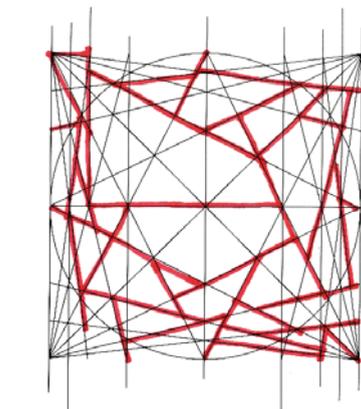
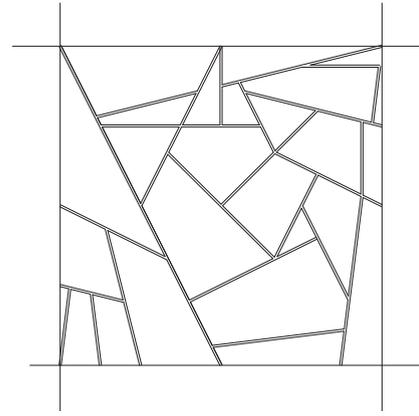
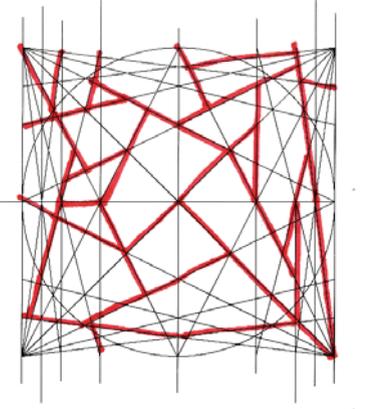
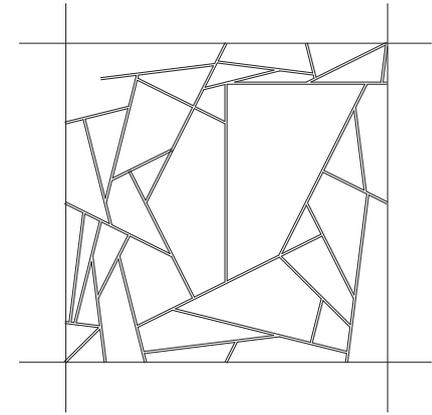
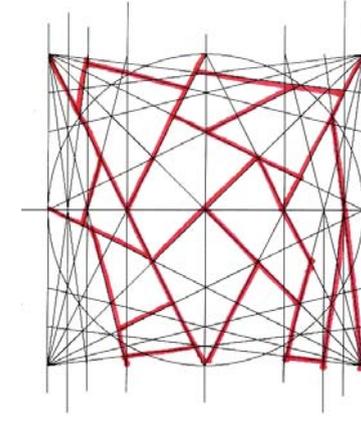
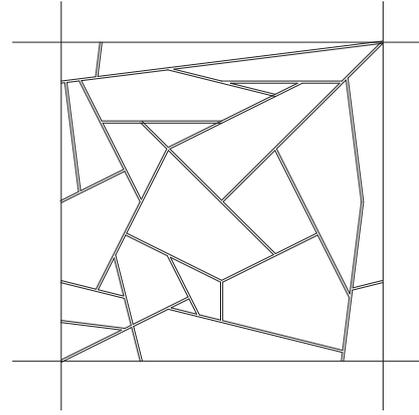
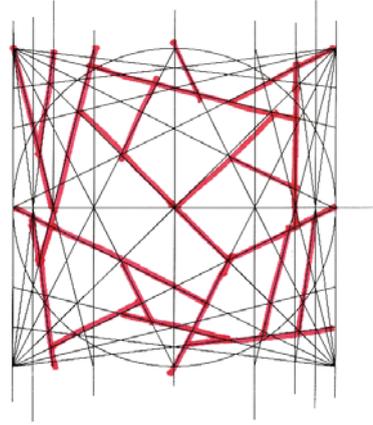


Right: Early model of showing lattice system with the program of an outdoor urban plaza.

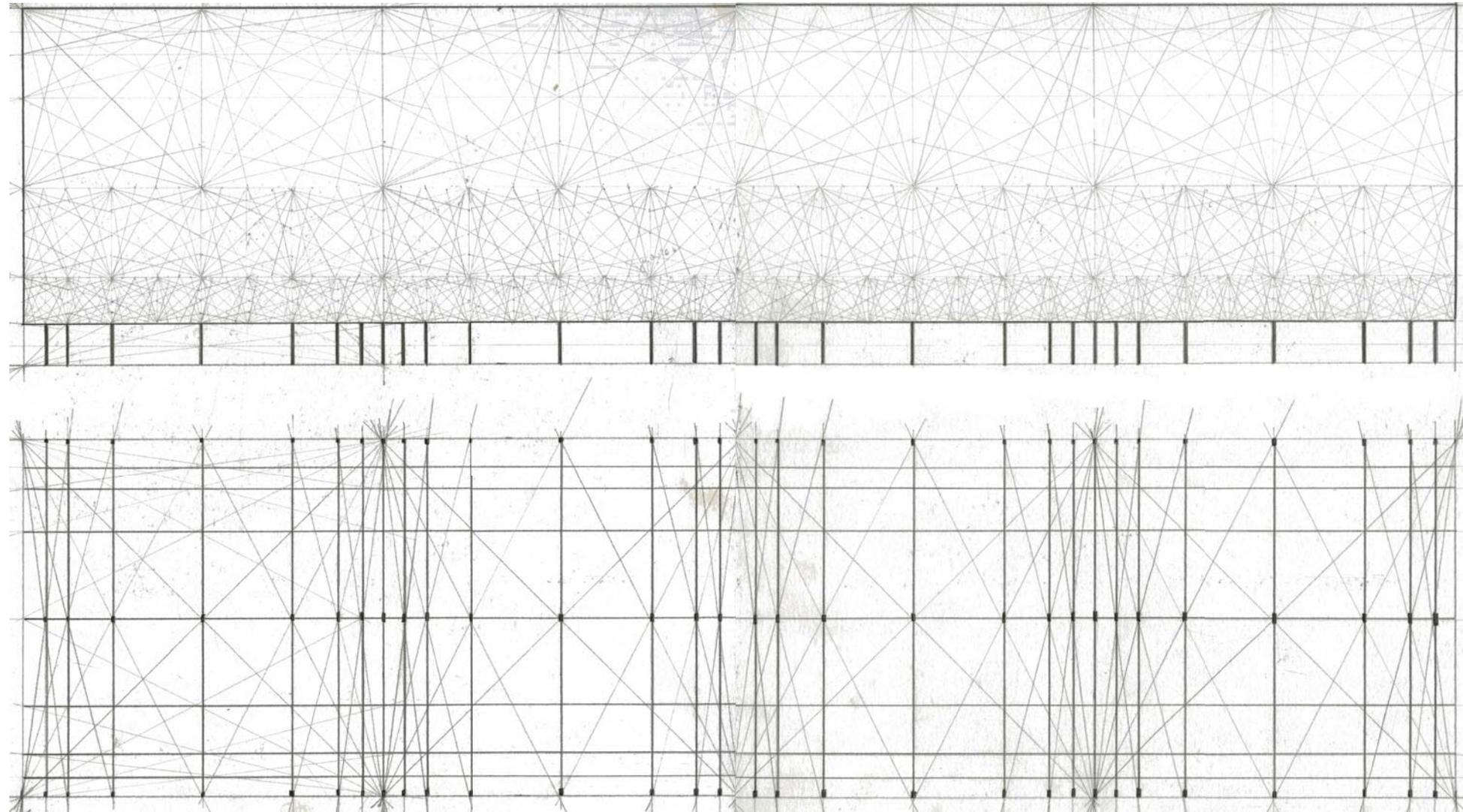


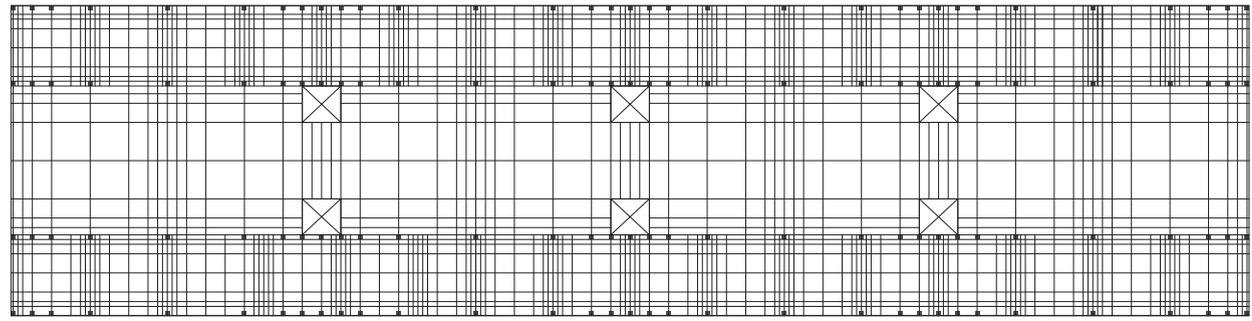
[module panels]

These six panels make up the entire facade. All of the square modules can be applied at numerous scales—starting at the human (six feet), and ending with the building (in this particular project, forty eight feet). The application and size of these panels can easily be adjusted based on the site and the programmatic needs.

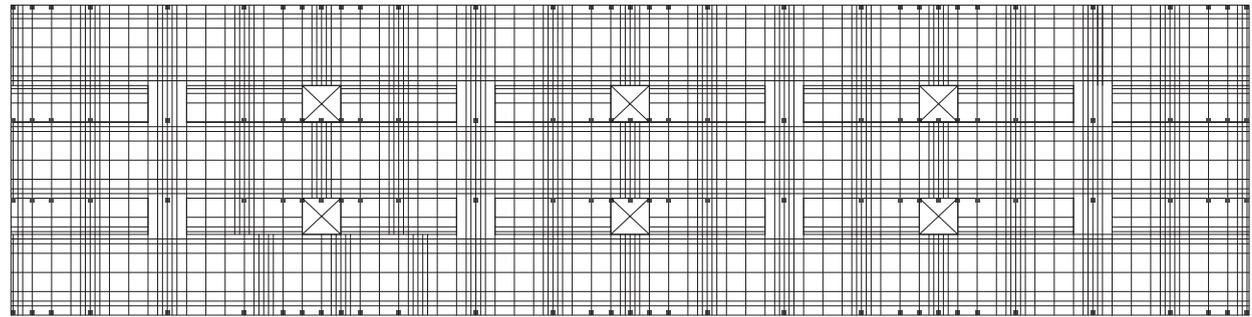


The modular paneling system can be applied in elevation and plan. The grid underlay in the elevation shows how the scale breakdown is created and affects the density of the lattice system. The highest density happens at the human scale, as the architectural elements touch the ground, while the least density occurs as the structure meets the sky. This simple gesture allows the architecture to address the ground and sky simultaneously.

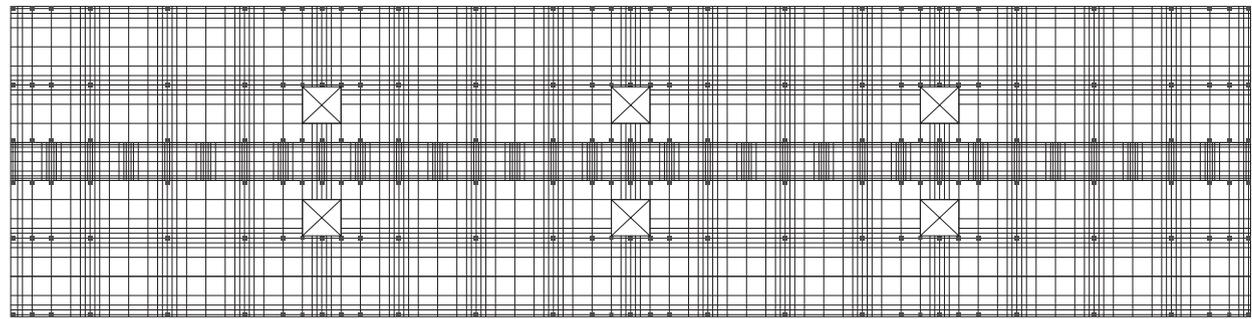




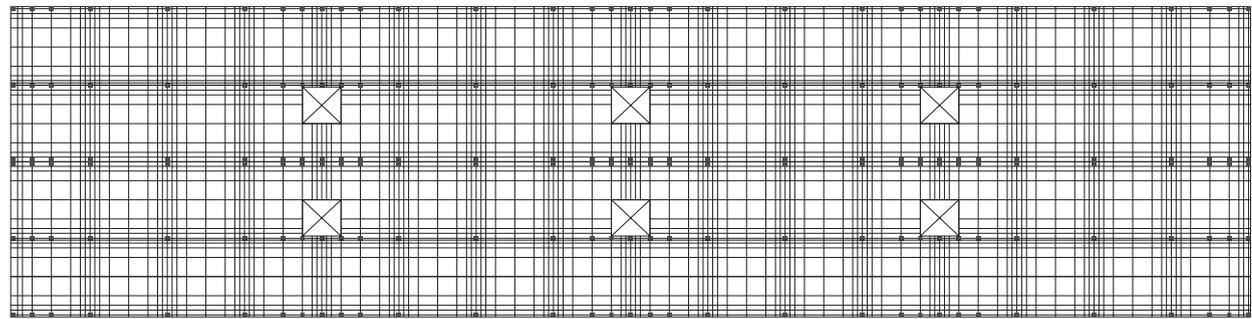
4th floor



3rd floor

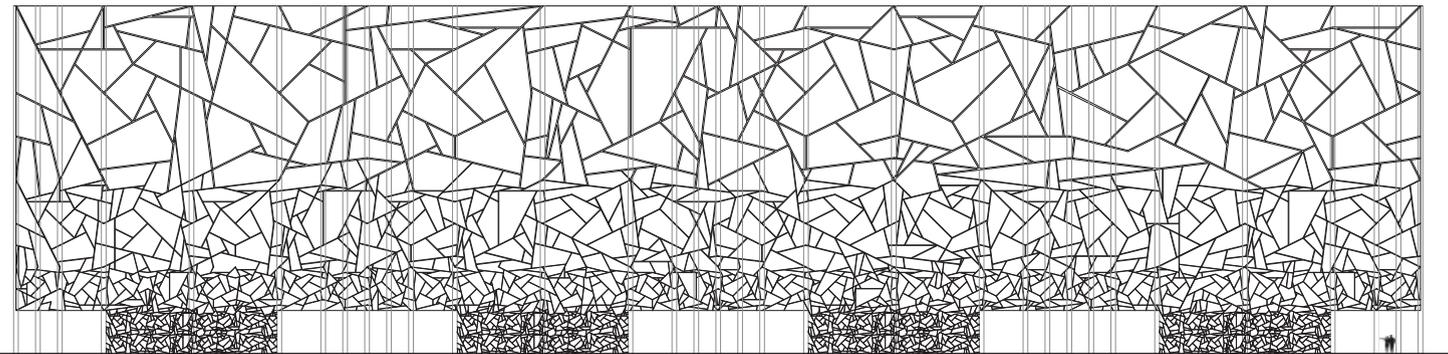
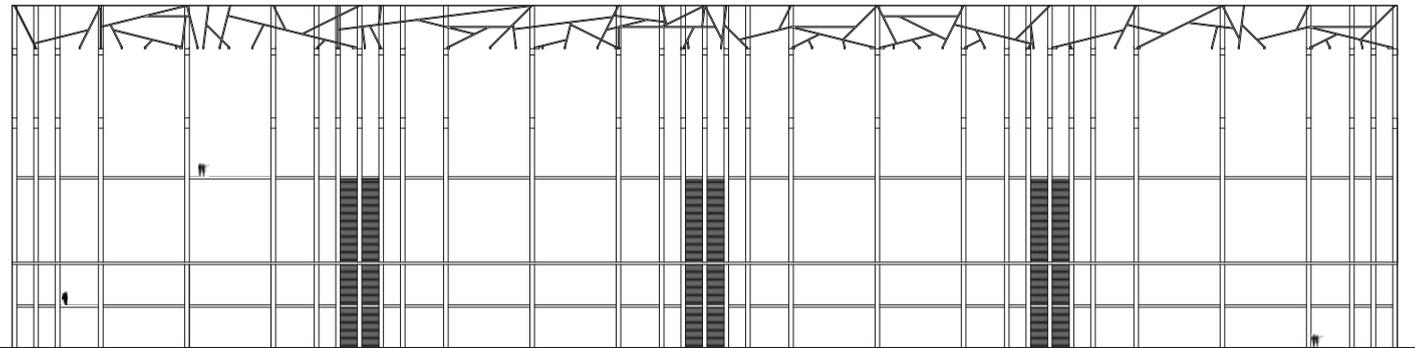
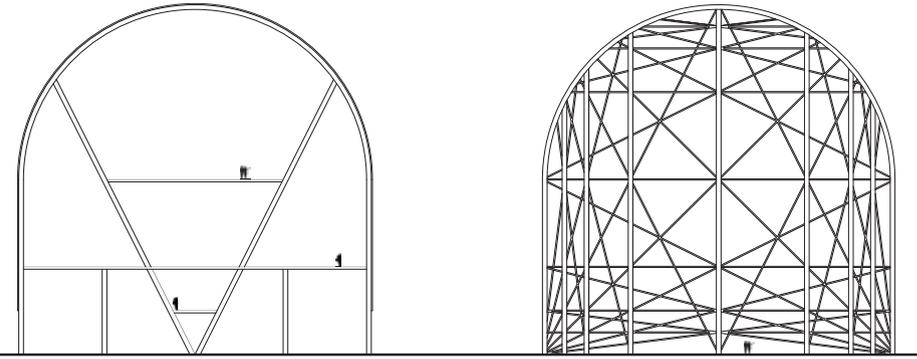


2nd floor



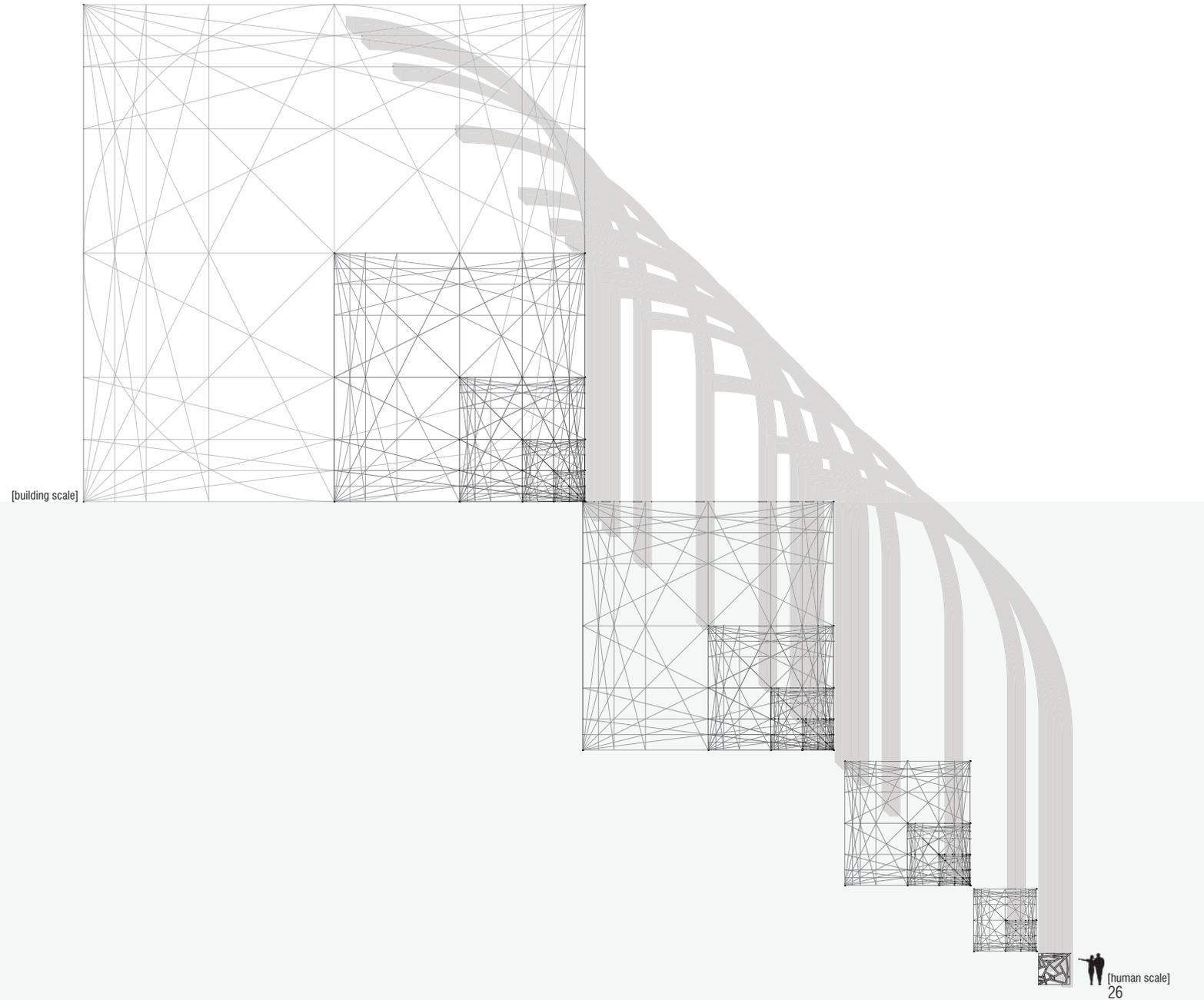
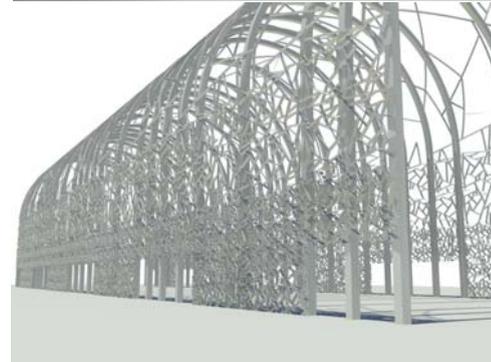
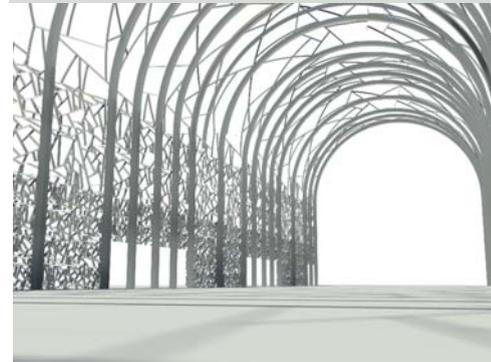
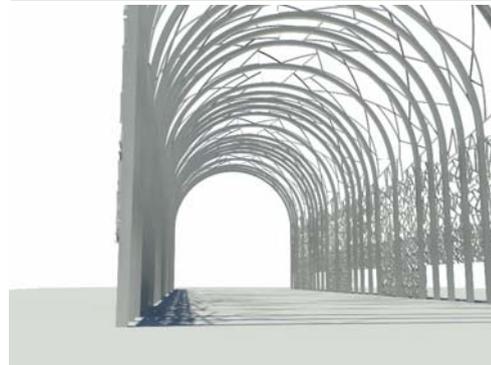
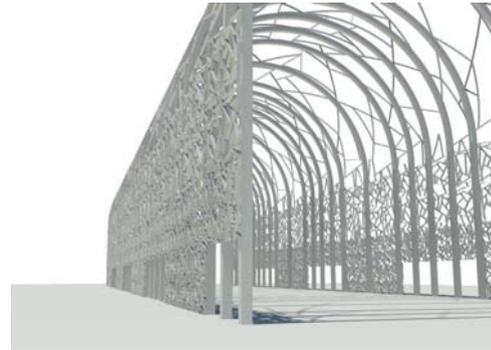
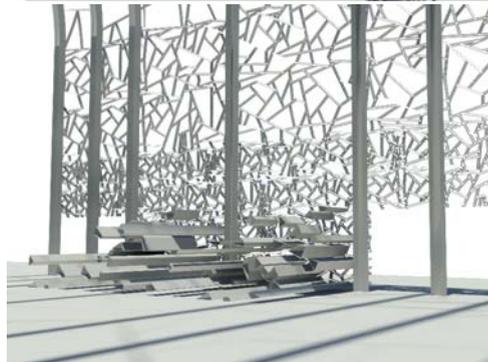
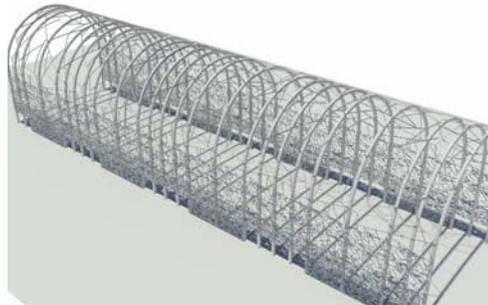
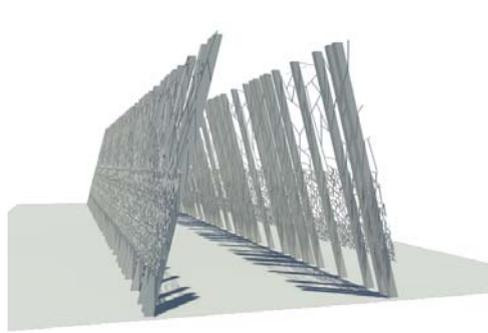
1st floor

Several studies applied the lattice system to varying programs. This enclosed urban plaza proved that structure, program, and aesthetics can all be based on a grid system—more particularly, the grid created in the articulation of the square.

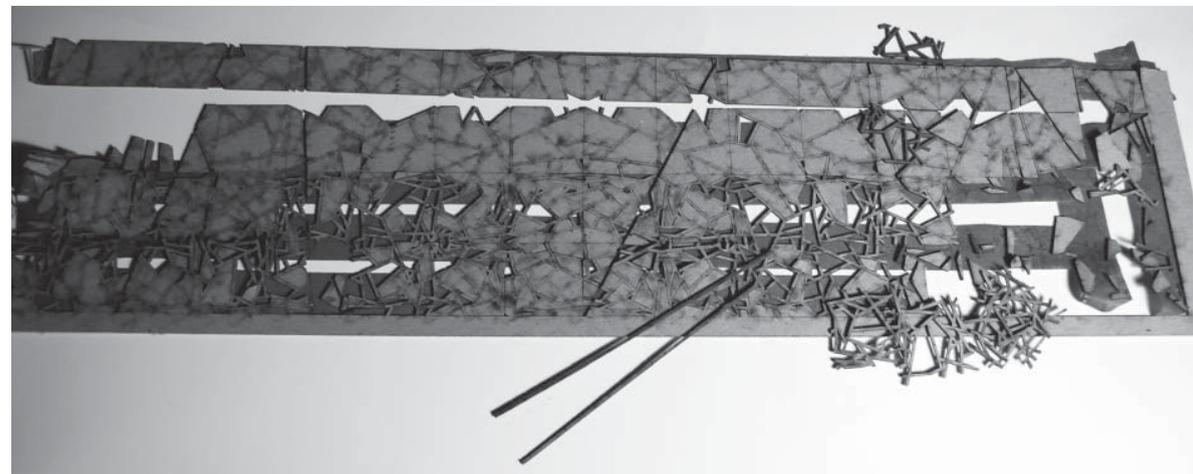


[simplifying the design]

The three variables of the design include the module lattice system, the structure, and the connection between the structure to the ground. Trial and error iterations, via computer model and physical model test the qualitative application of the system.



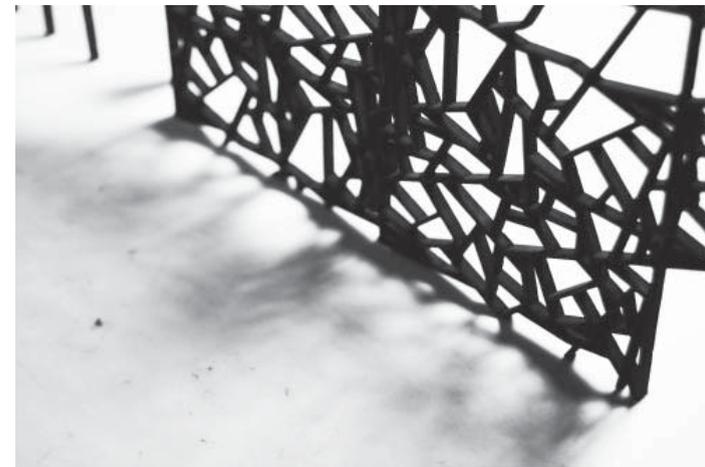
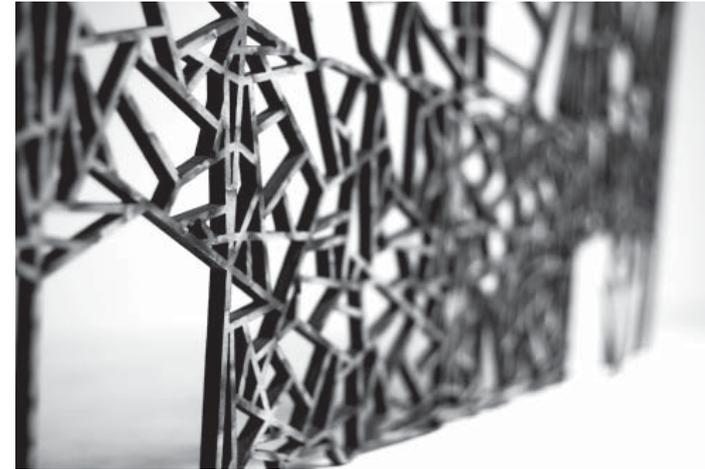
Left: Photo of chipboard model--modular panels.

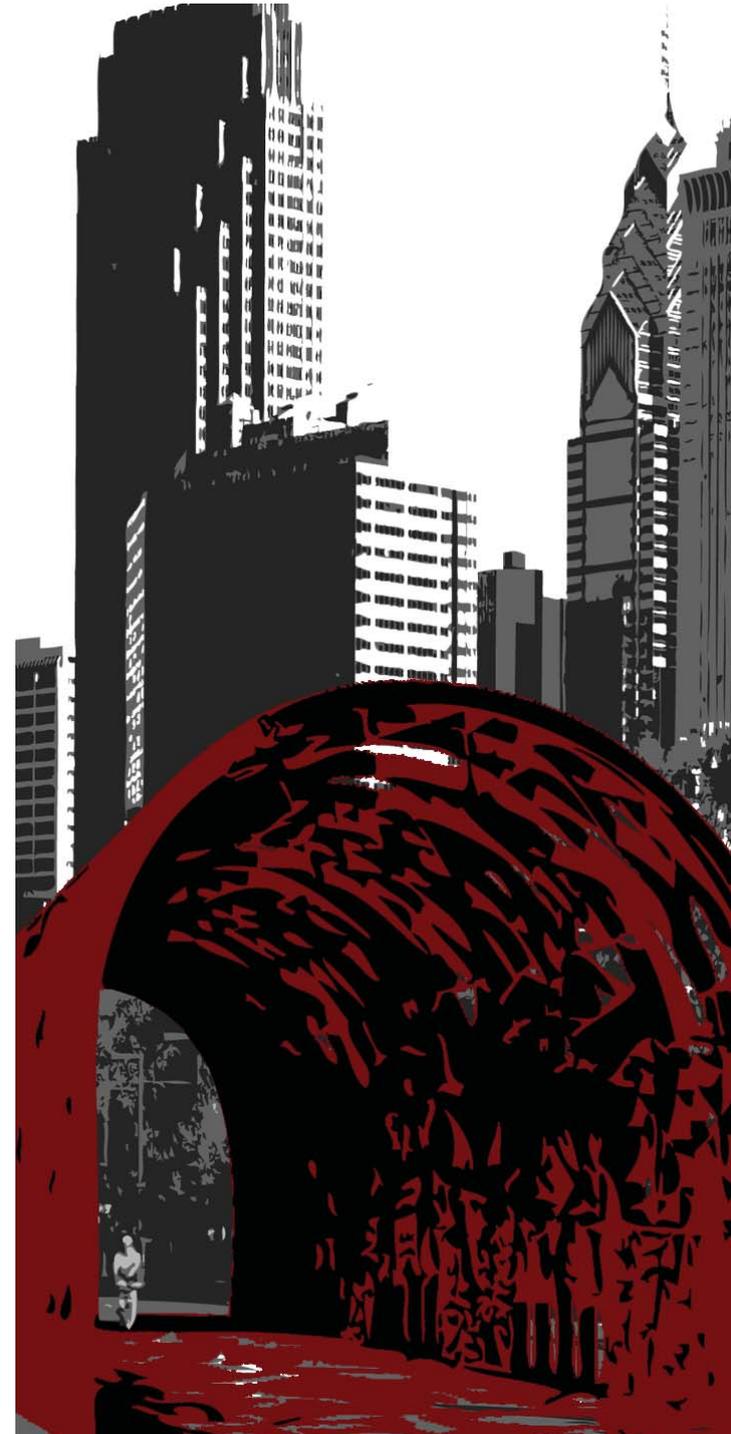


Right: Several photos of various study models showing qualitative studies of shadow, material, and proportions.



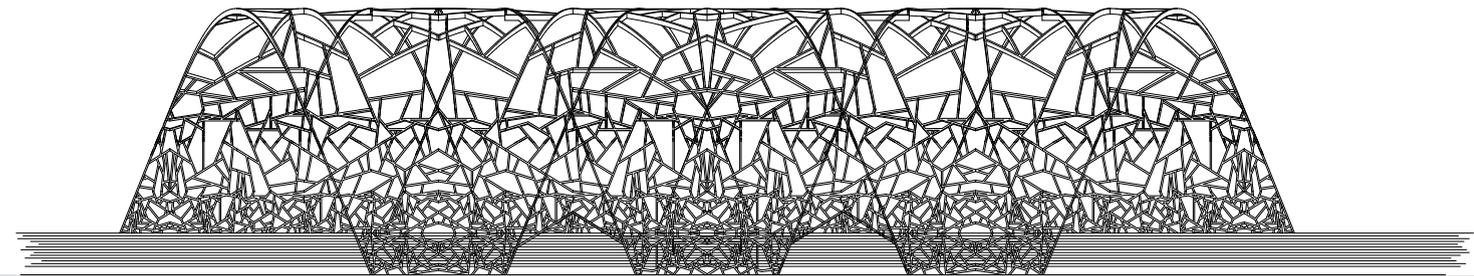
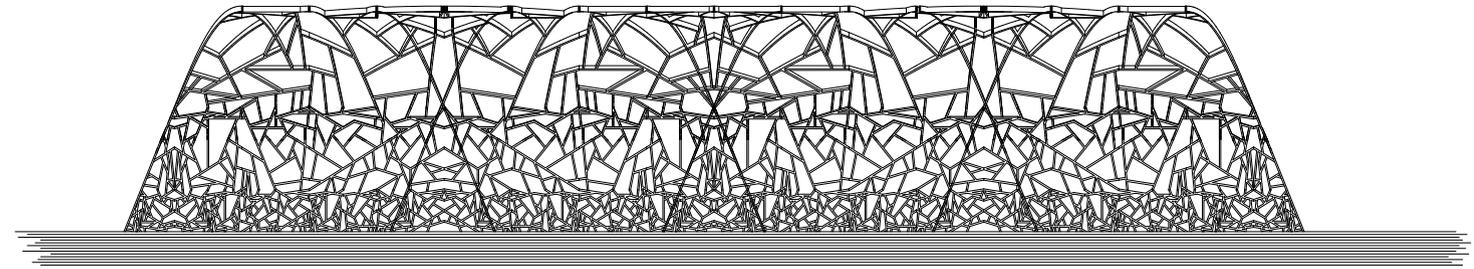
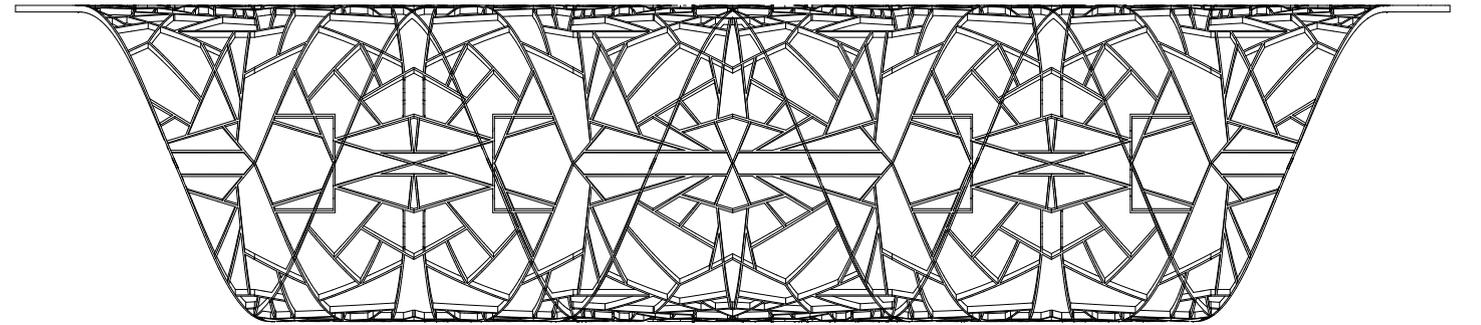
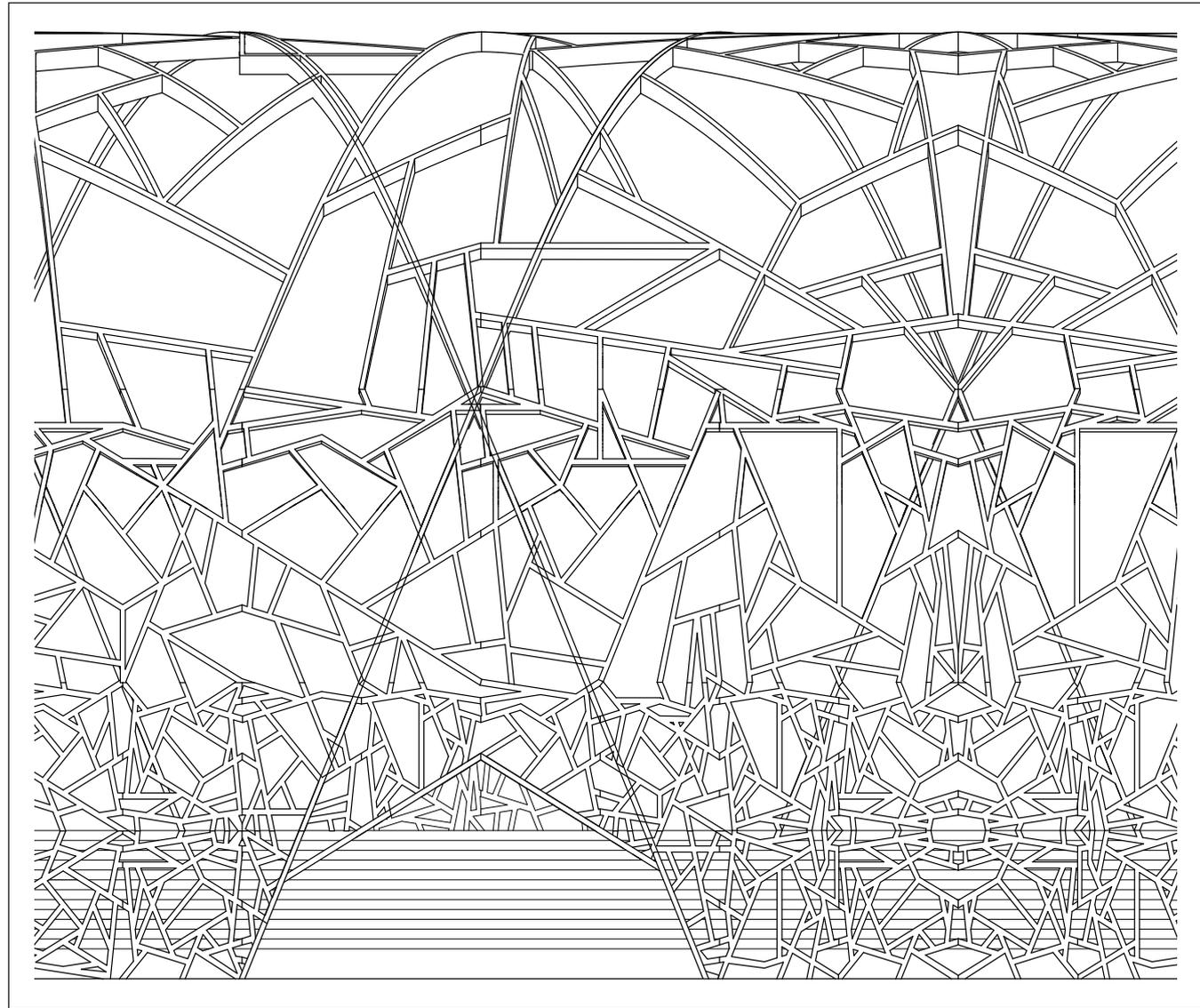
Right: Photos of study models used to investigate which material depth would create the best shadows.



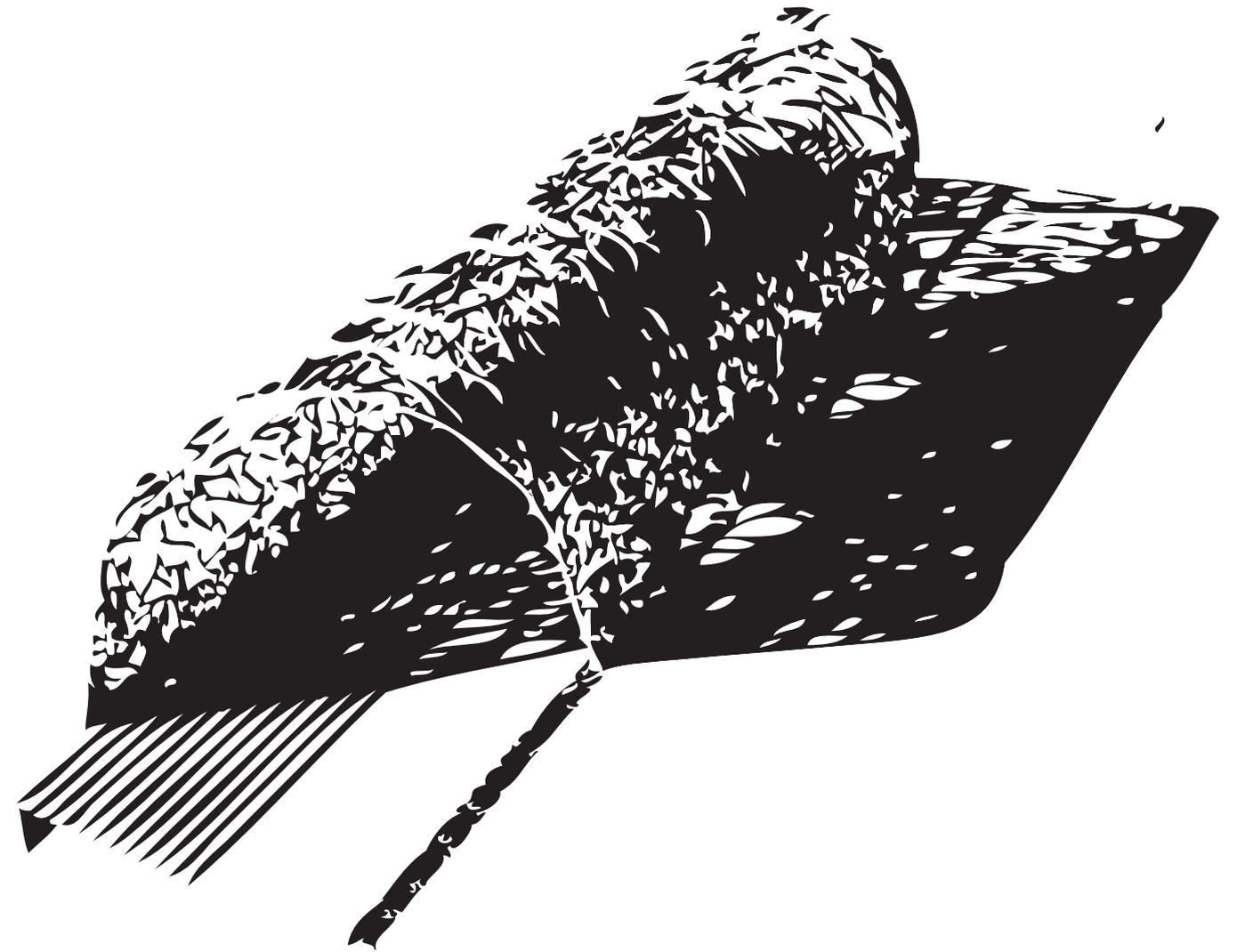


[urban setting]

Applying the walking promenade to various cityscapes at multiple scales creates an opportunity for the walkway to become a gathering or meeting location. The structure becomes a transition space, as well as a piazza for busy city workers and residents to enjoy the outdoors.

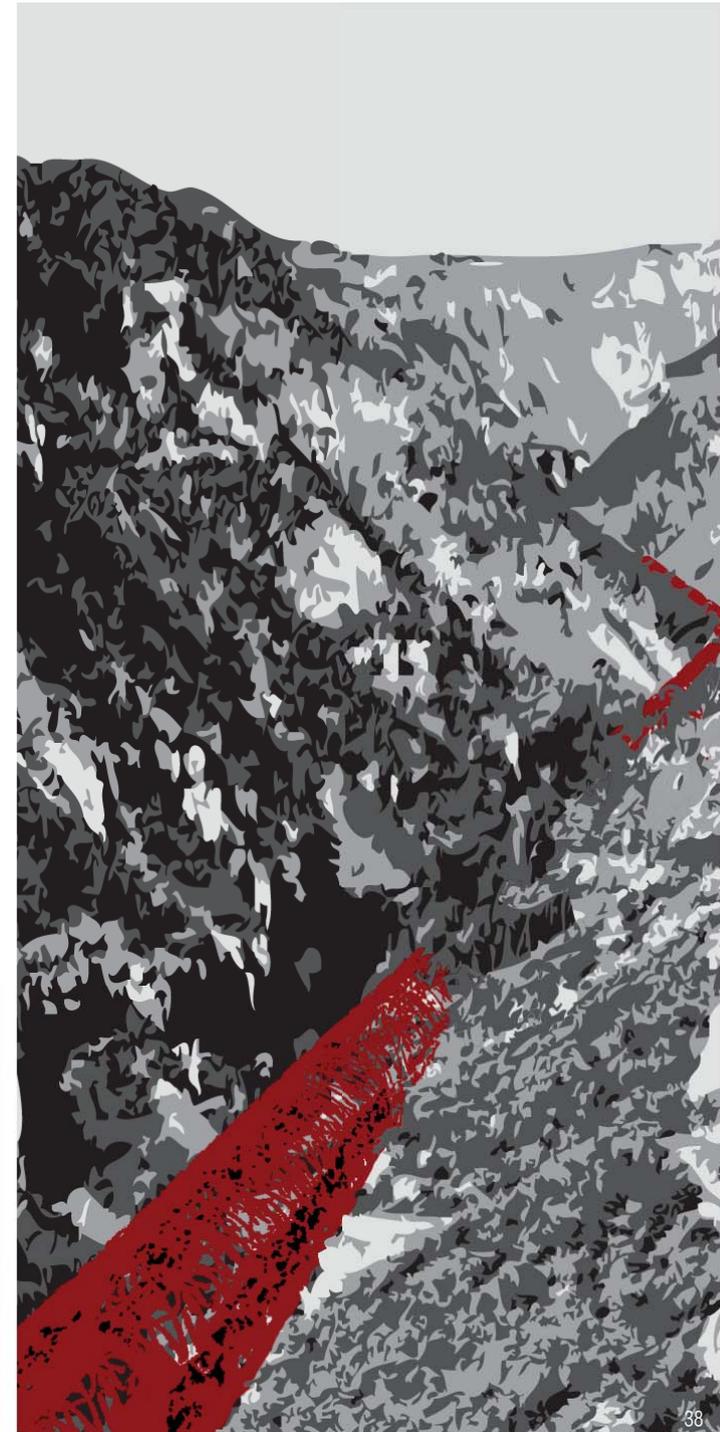
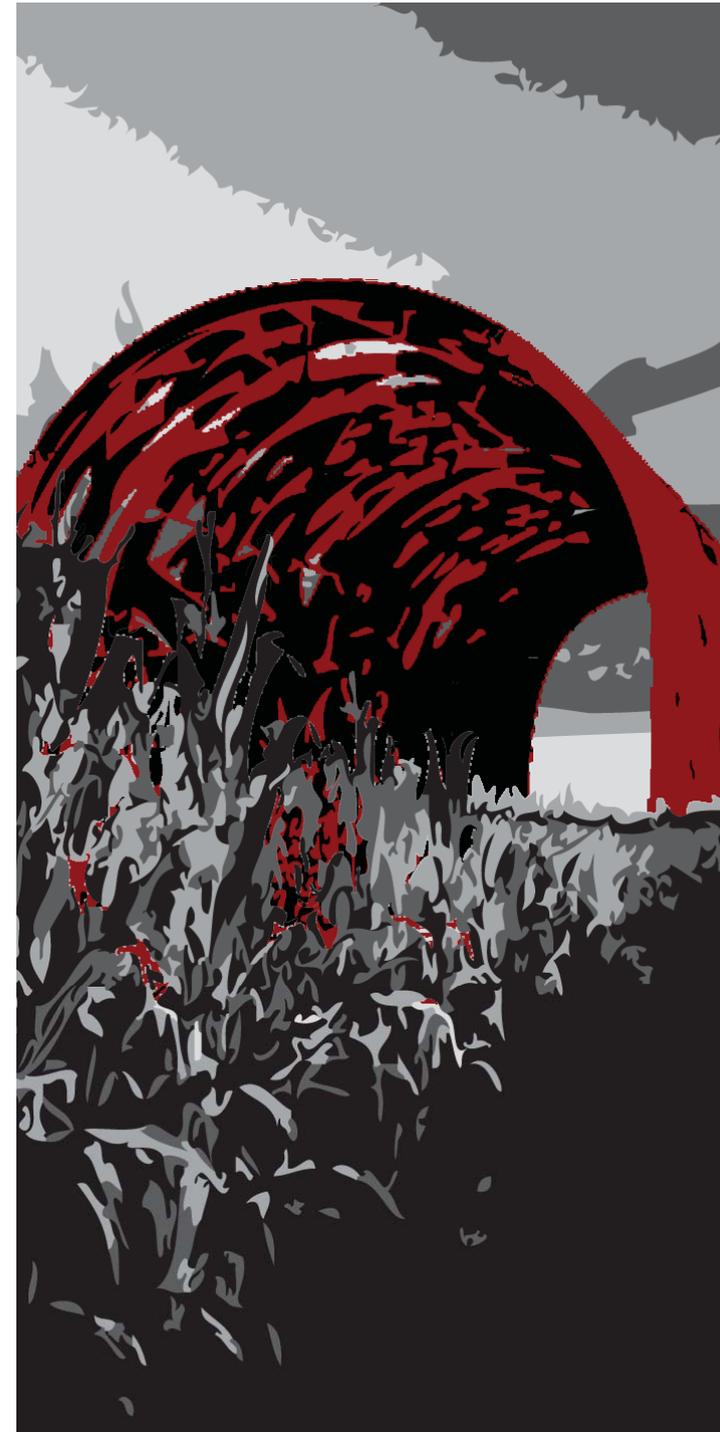


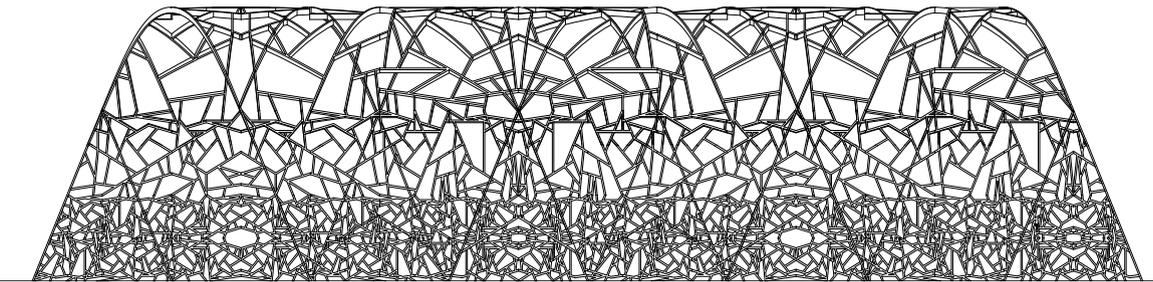
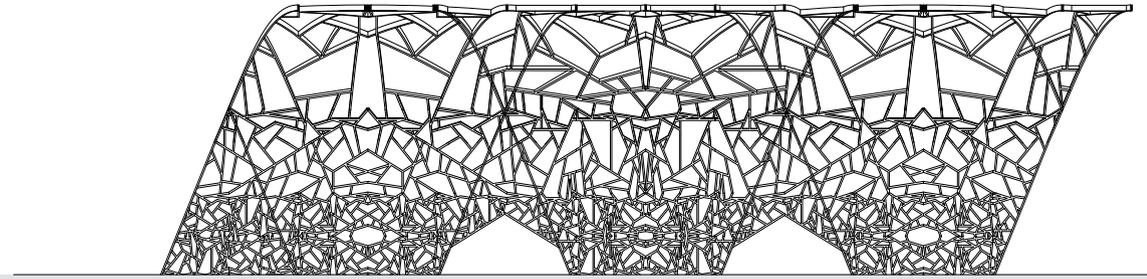
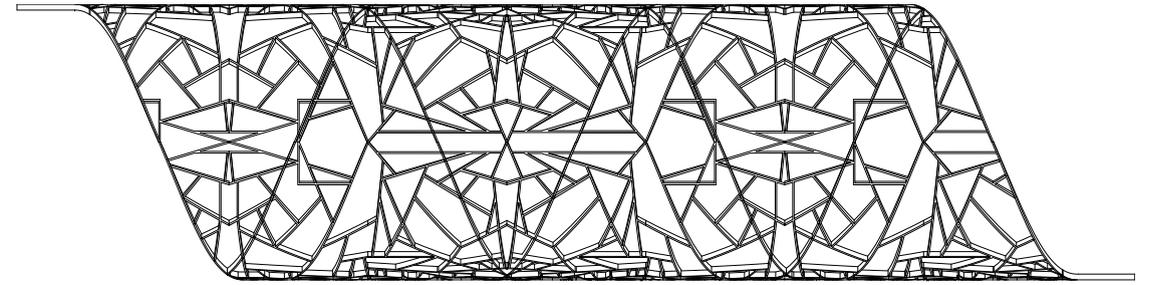
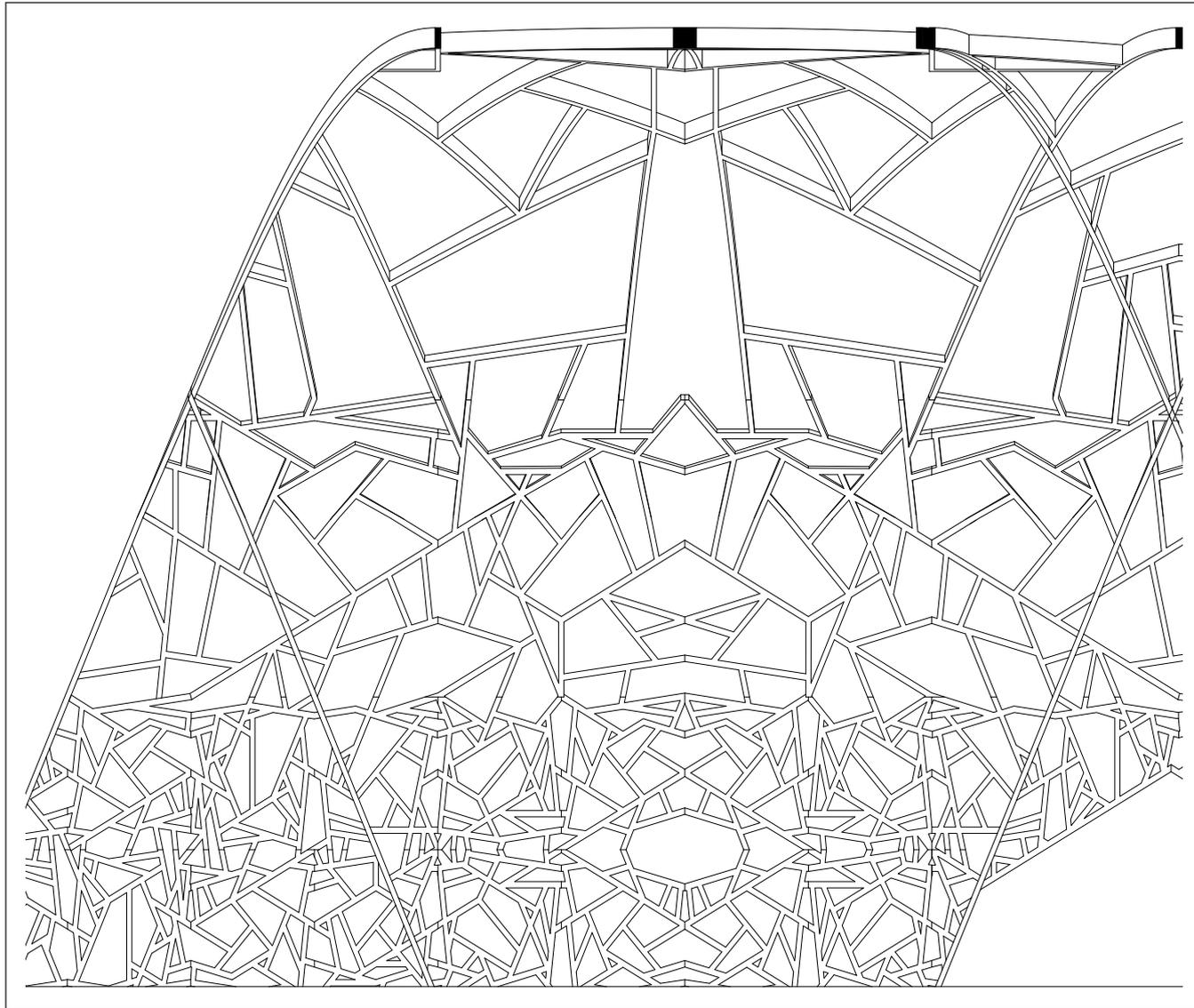
Right: Screenprint showing urban location's shadows.



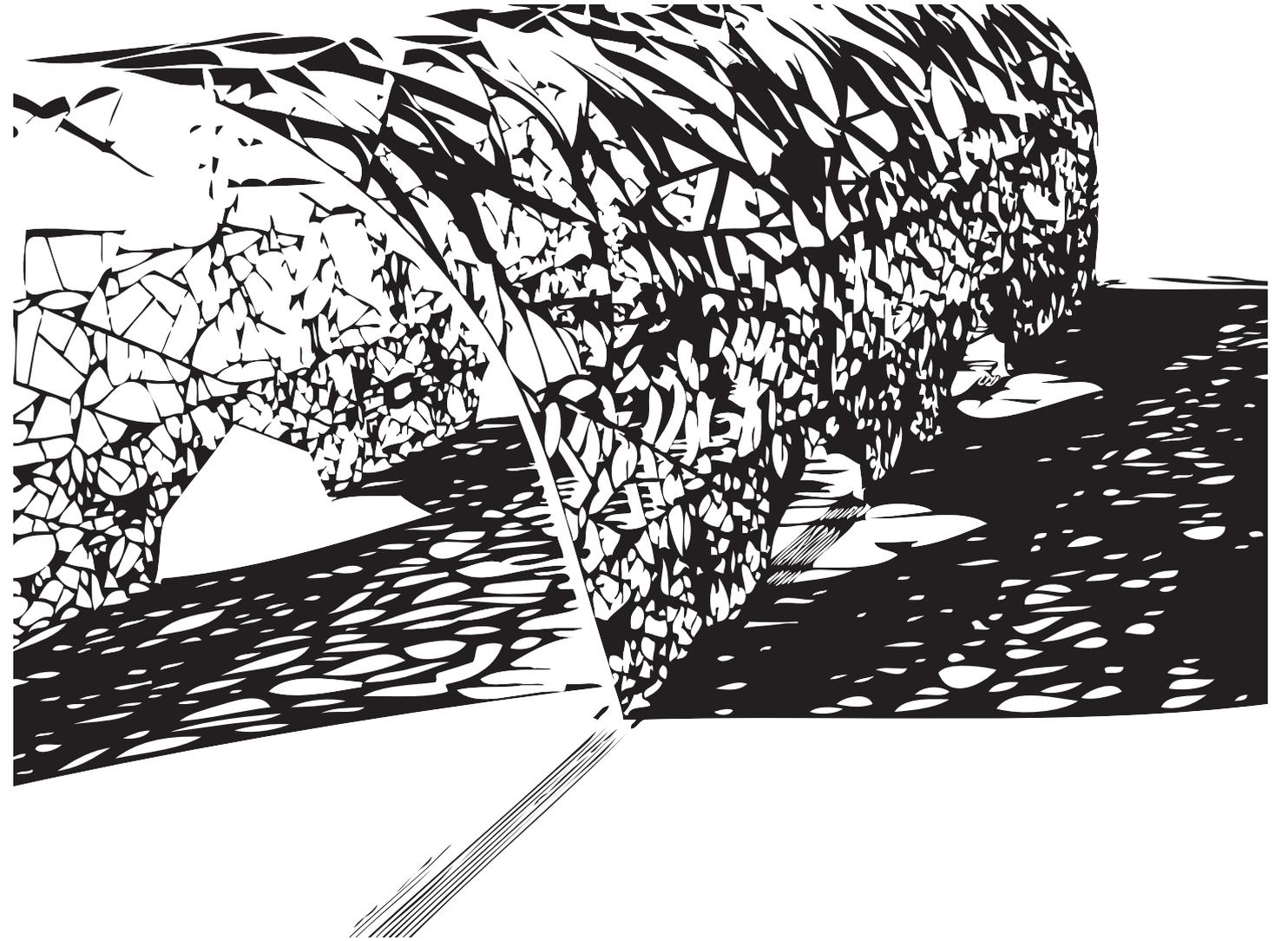
[rural setting]

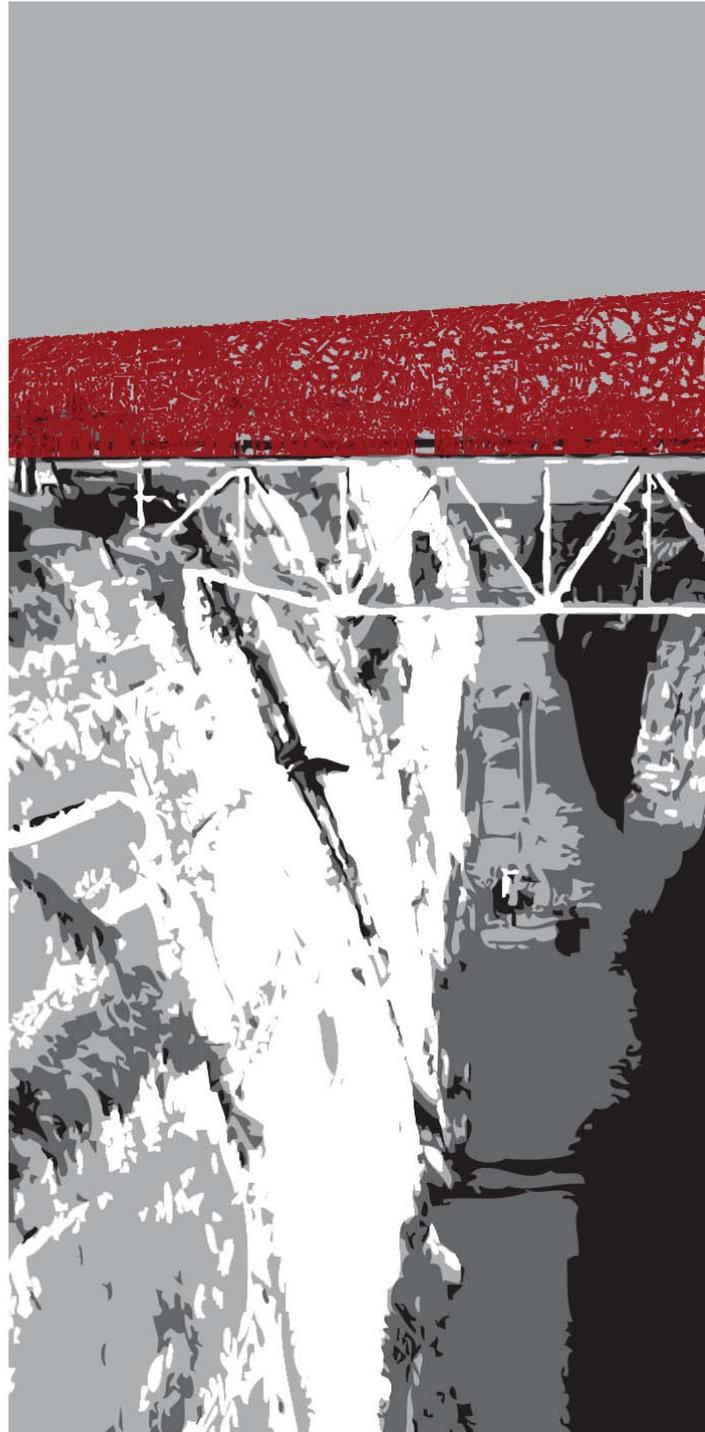
The application of this structure to the middle landscape makes a more pronounced and bold statement towards architecture and its environment. The promenade would claim its role as a place of movement and passage.





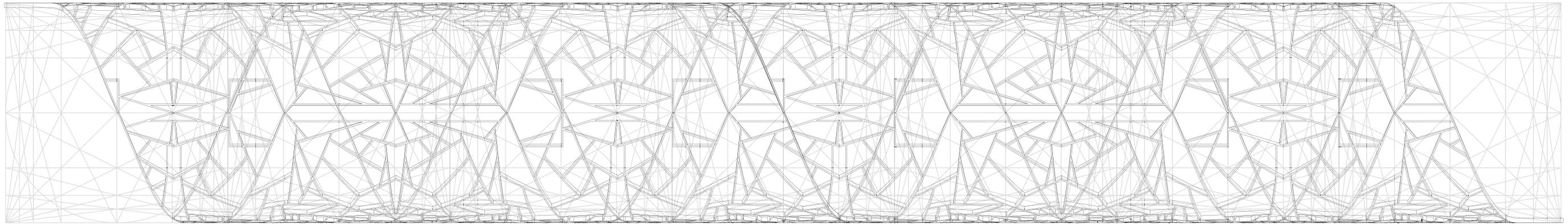
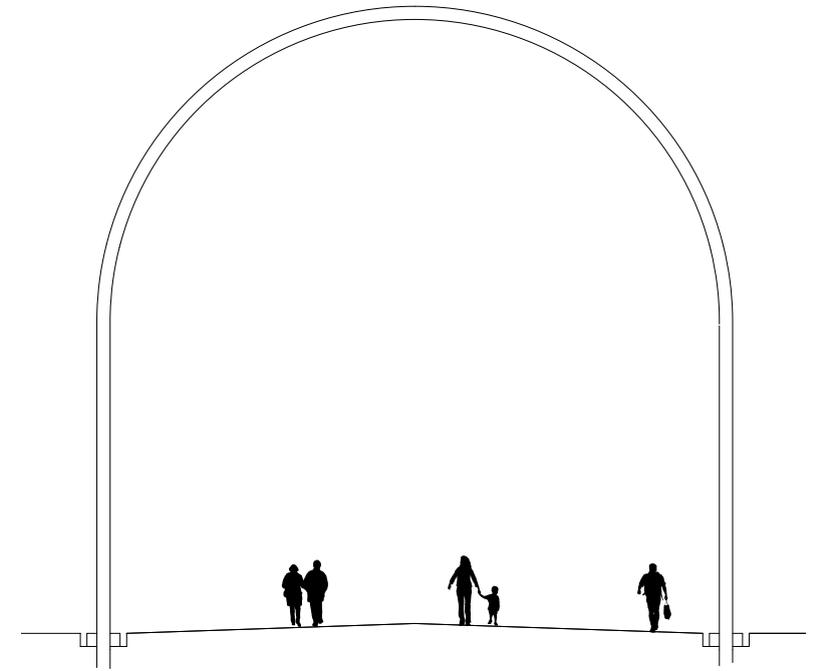
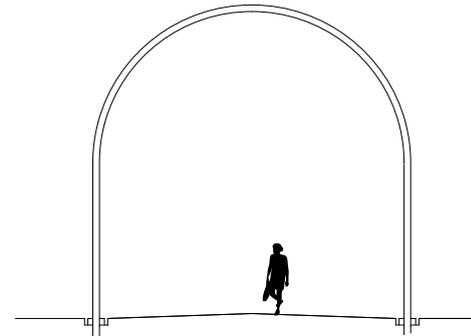
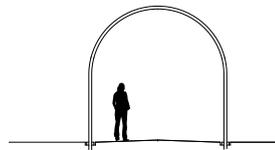
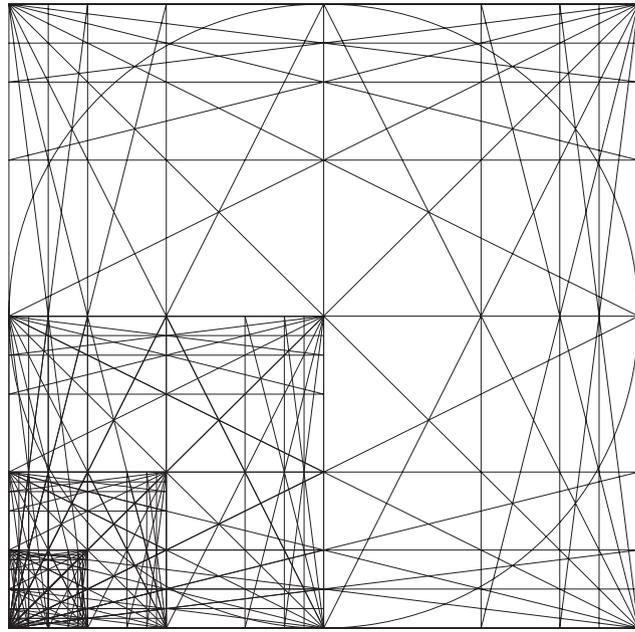
Right: Screenprint showing rural location's shadows.





[scaling possibilities]

The modular system can be applied at any scale starting with the human and ending with the building scale. This building scale may vary based on program and site needs. All design decisions are made within these scales, allowing the design to become applicable for multiple instances.



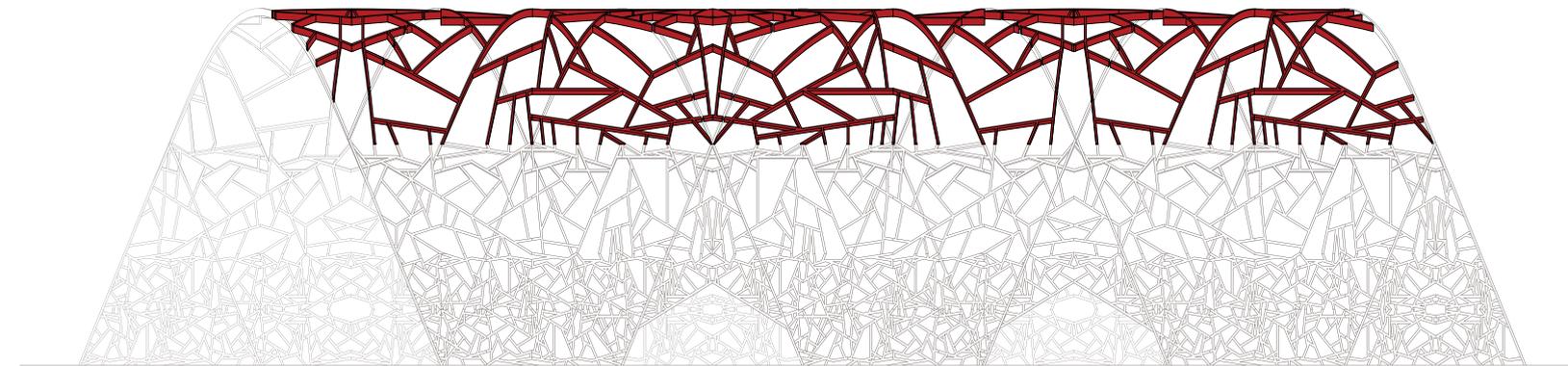
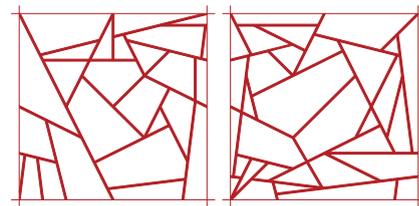
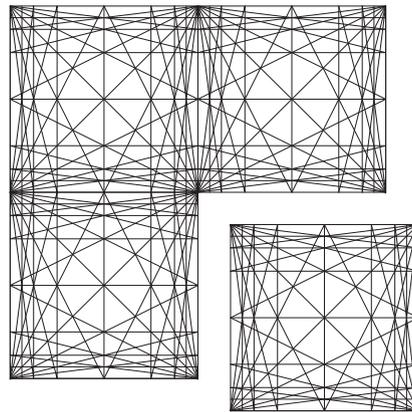
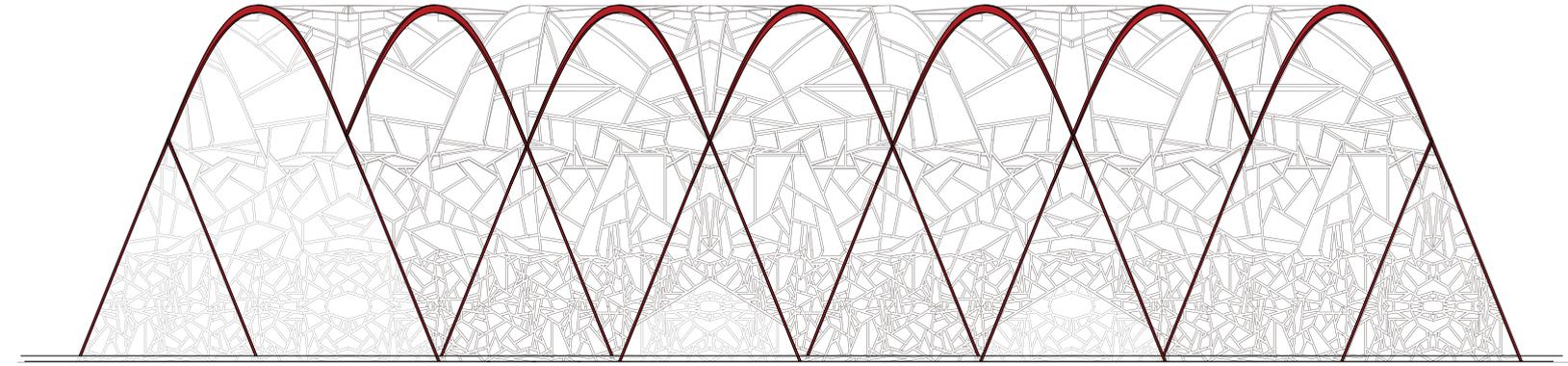
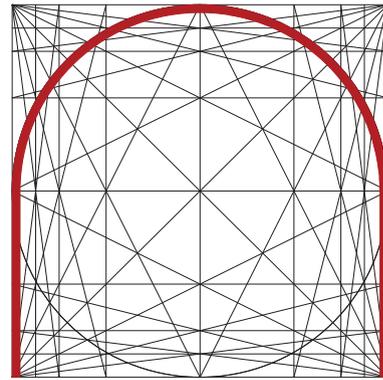
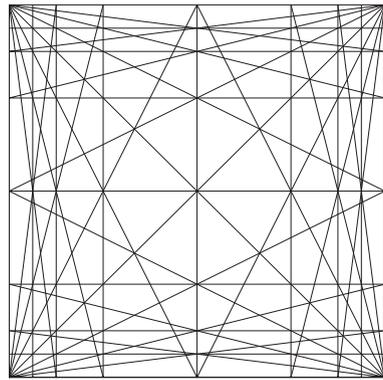
1 + 2 + 3 + 4 + 5 + 6 + 7 + ...

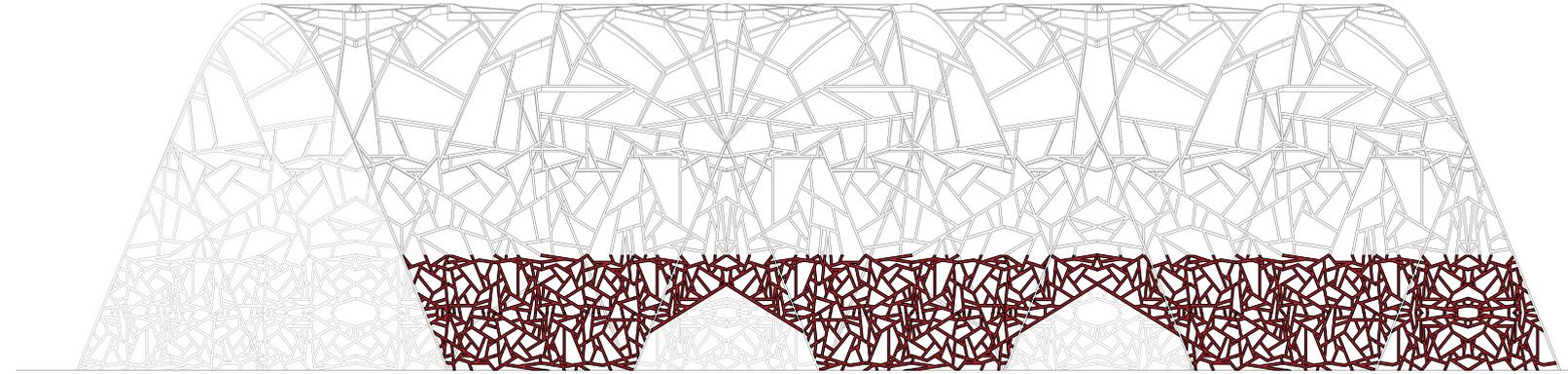
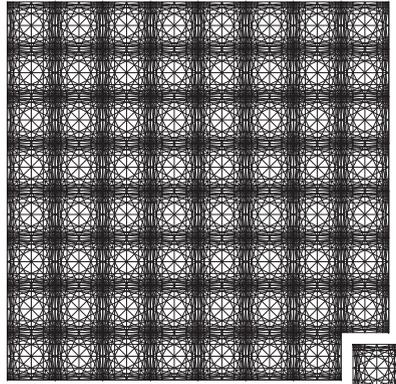
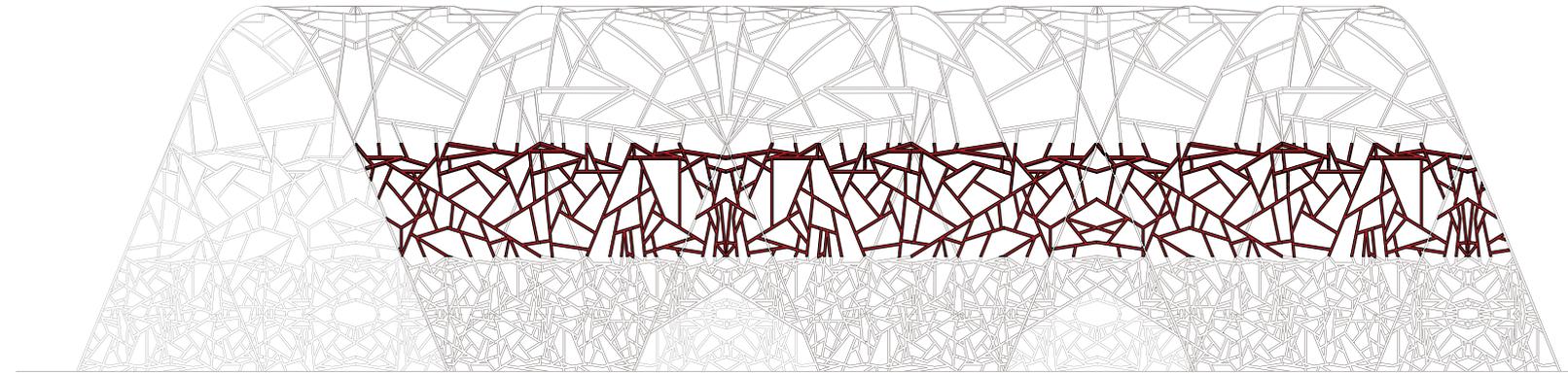
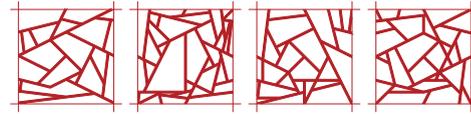
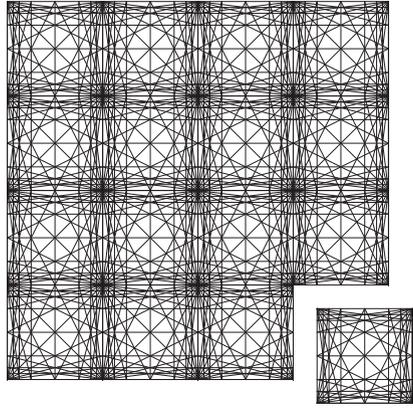
Right: Screenprint showing promenade's shadows.



[system breakdown]

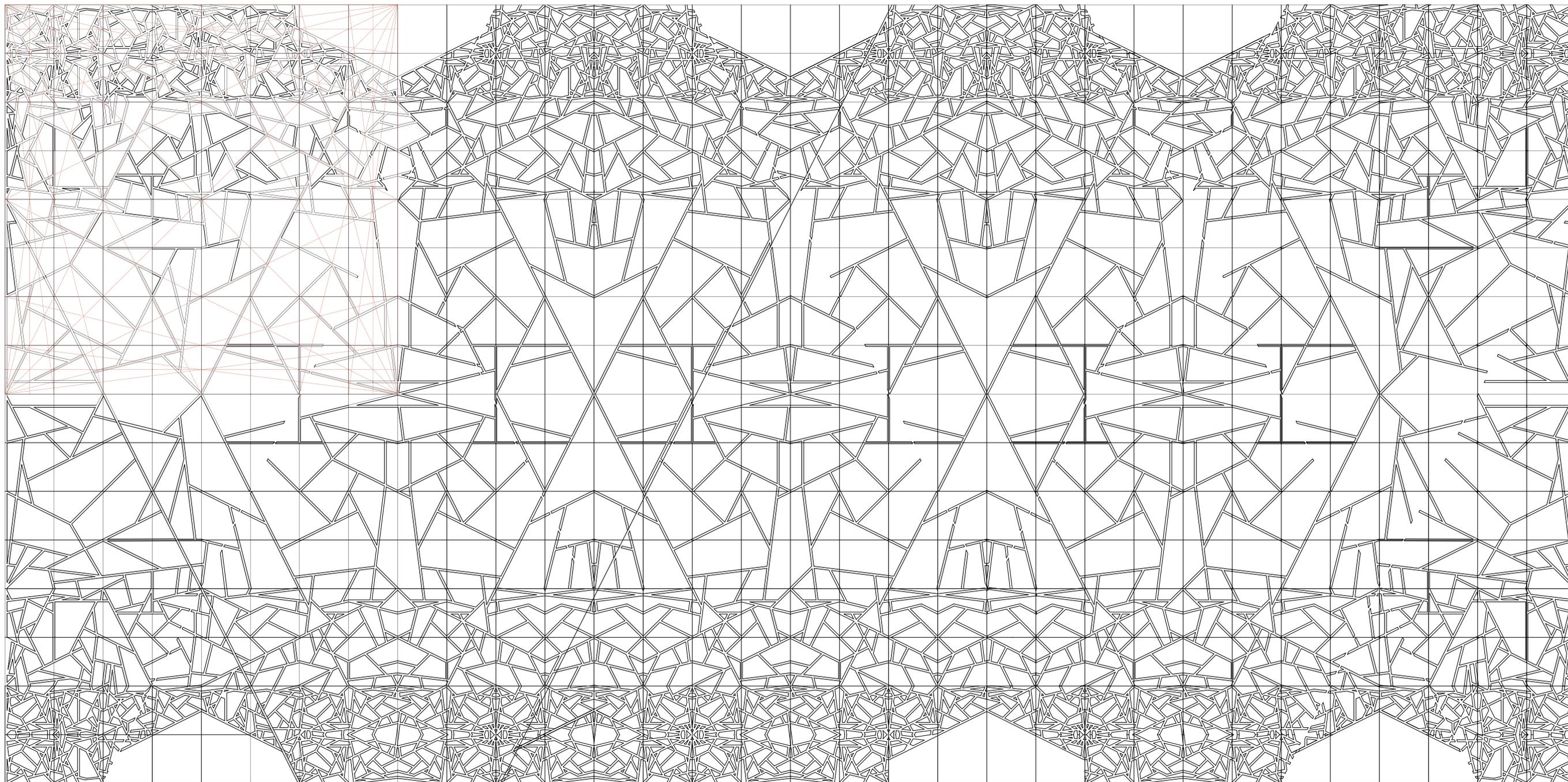
The modular panels range from building scale to human scale. Each module is repeated at these various scales throughout the project.



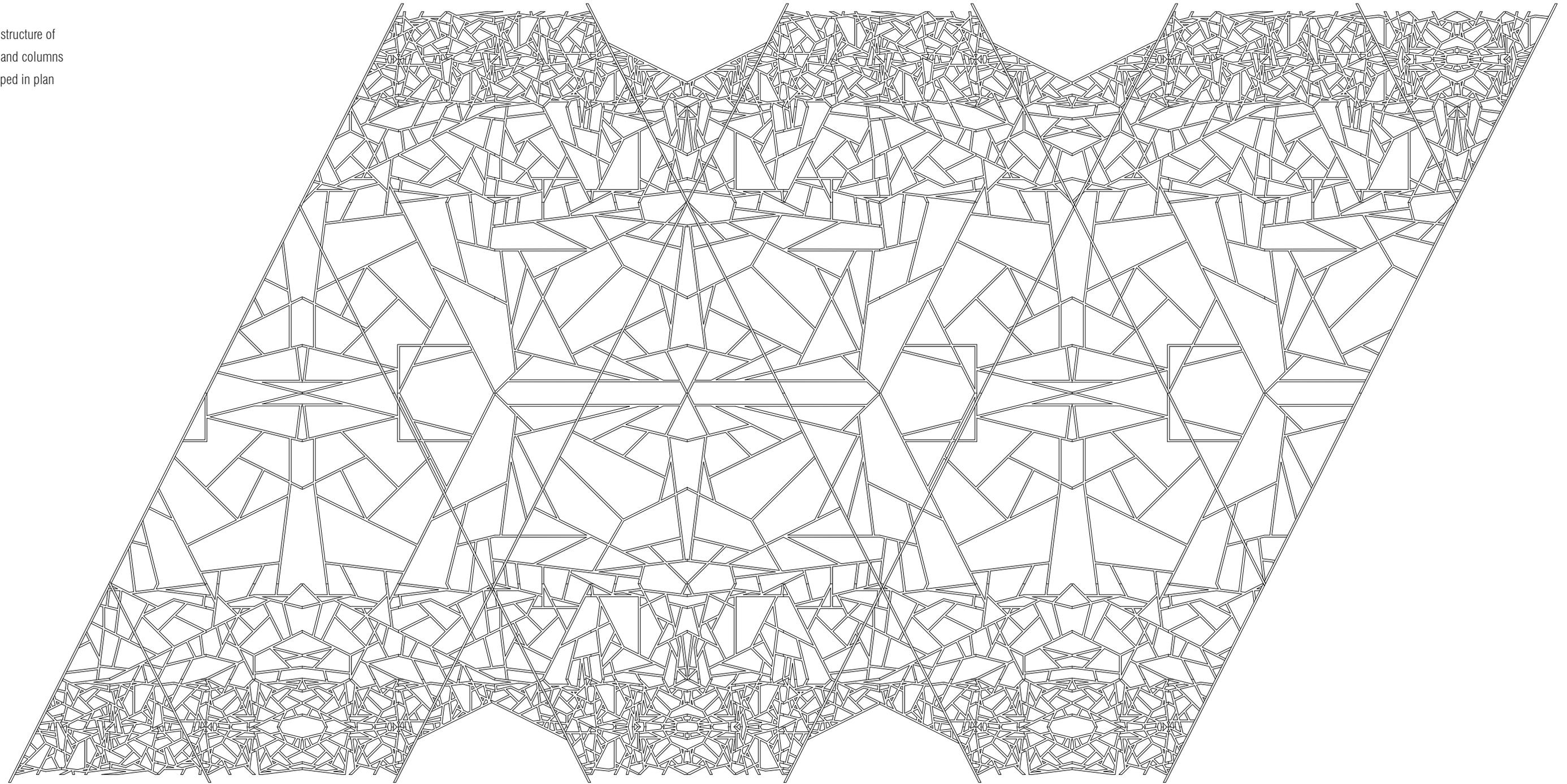


[understanding the design]

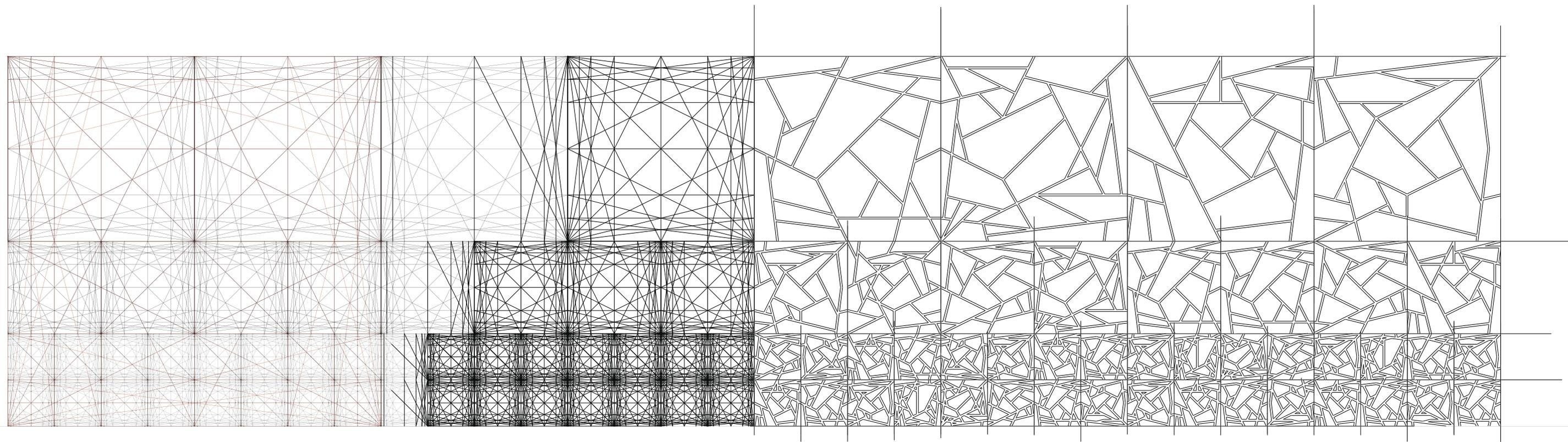
Final modular system used to develop the lattice system and columns, shown unwrapped in plan view.



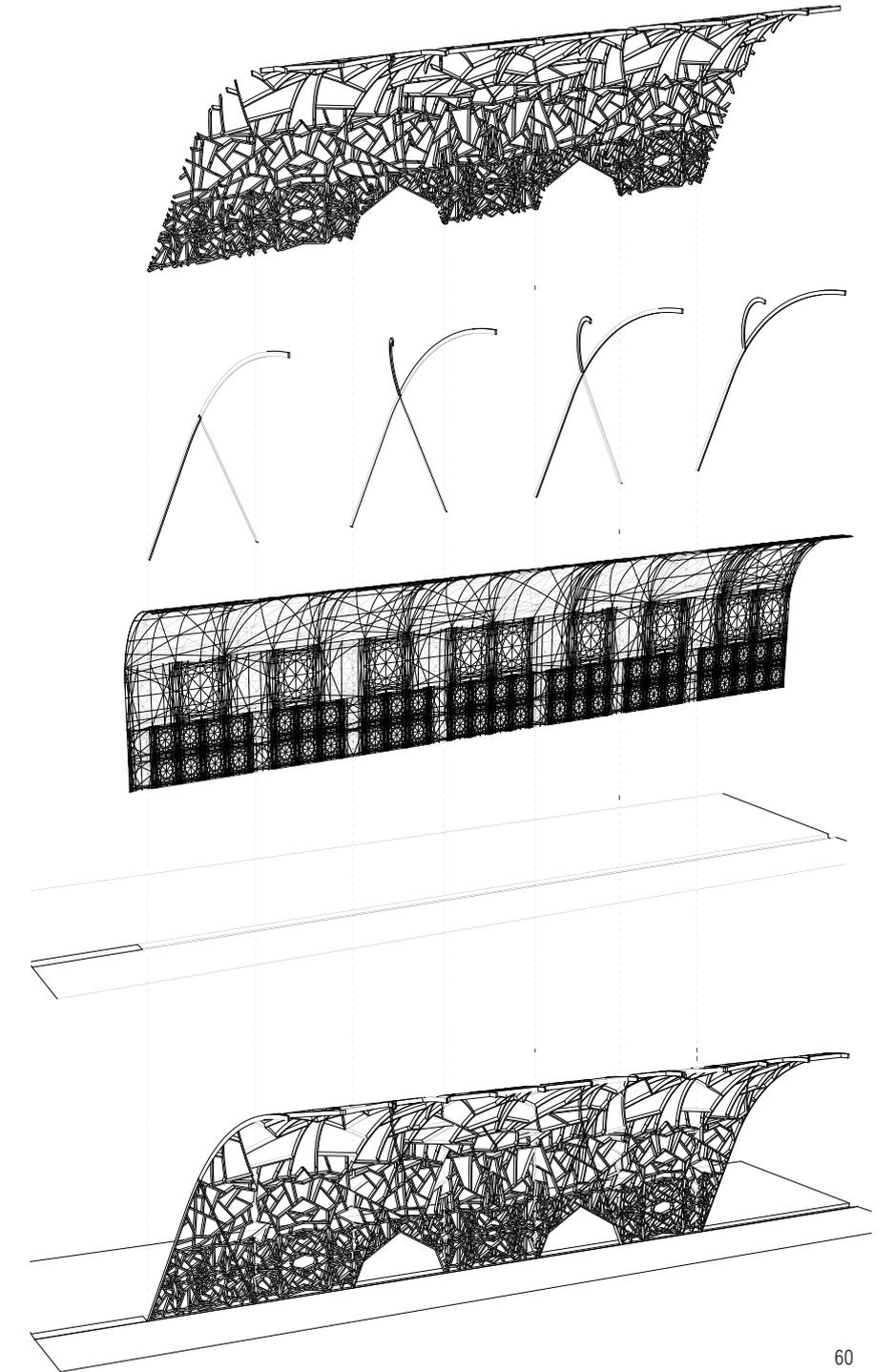
Final modular structure of
lattice system and columns
shown unwrapped in plan
view.



Elevation transforming
from diagrammatic study of
lattice formation to panelling
system of modules.



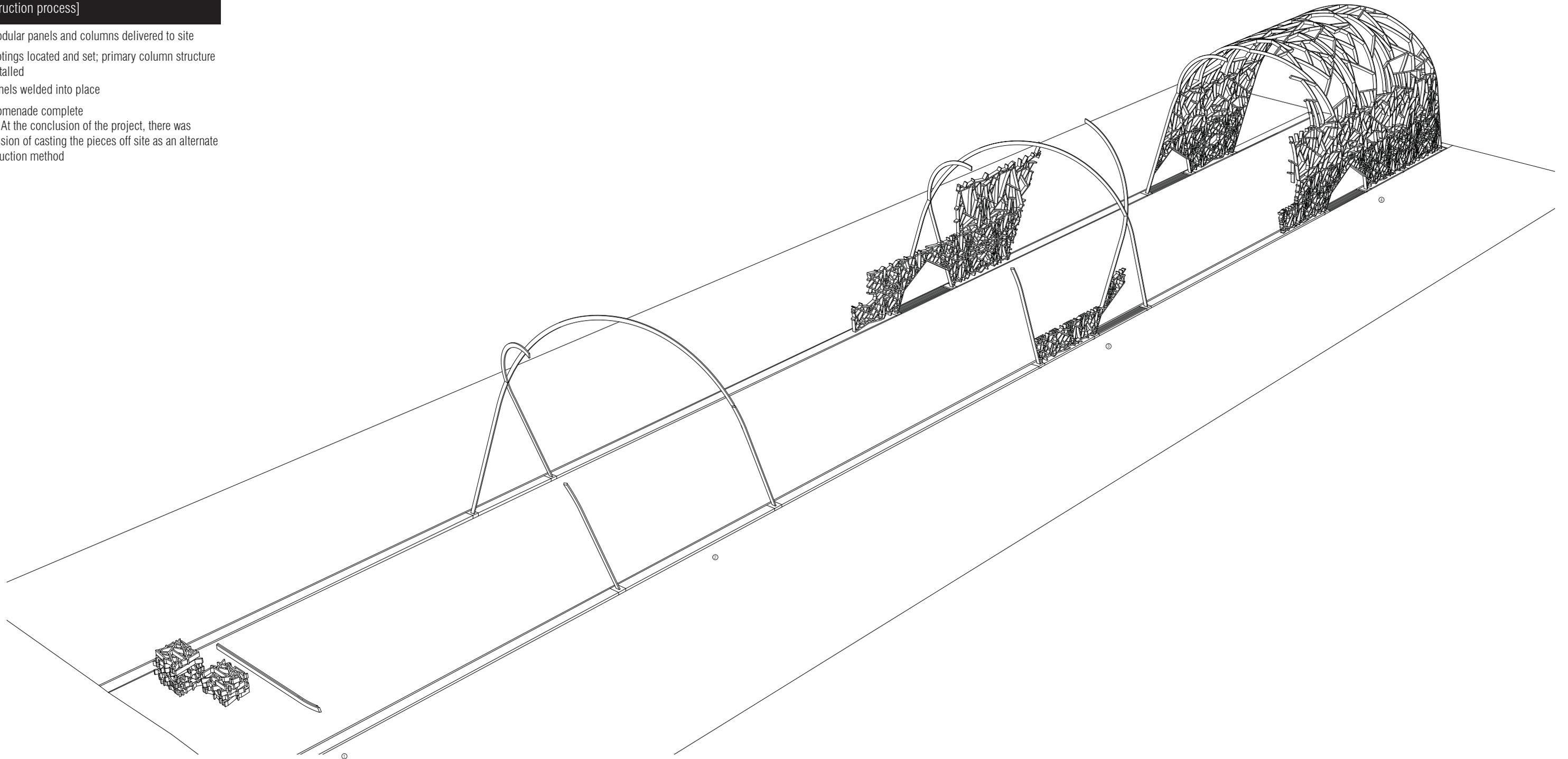
Right: Sectional perspective showing individual elements of the project--ground, panelling method, columns, and lattice system.



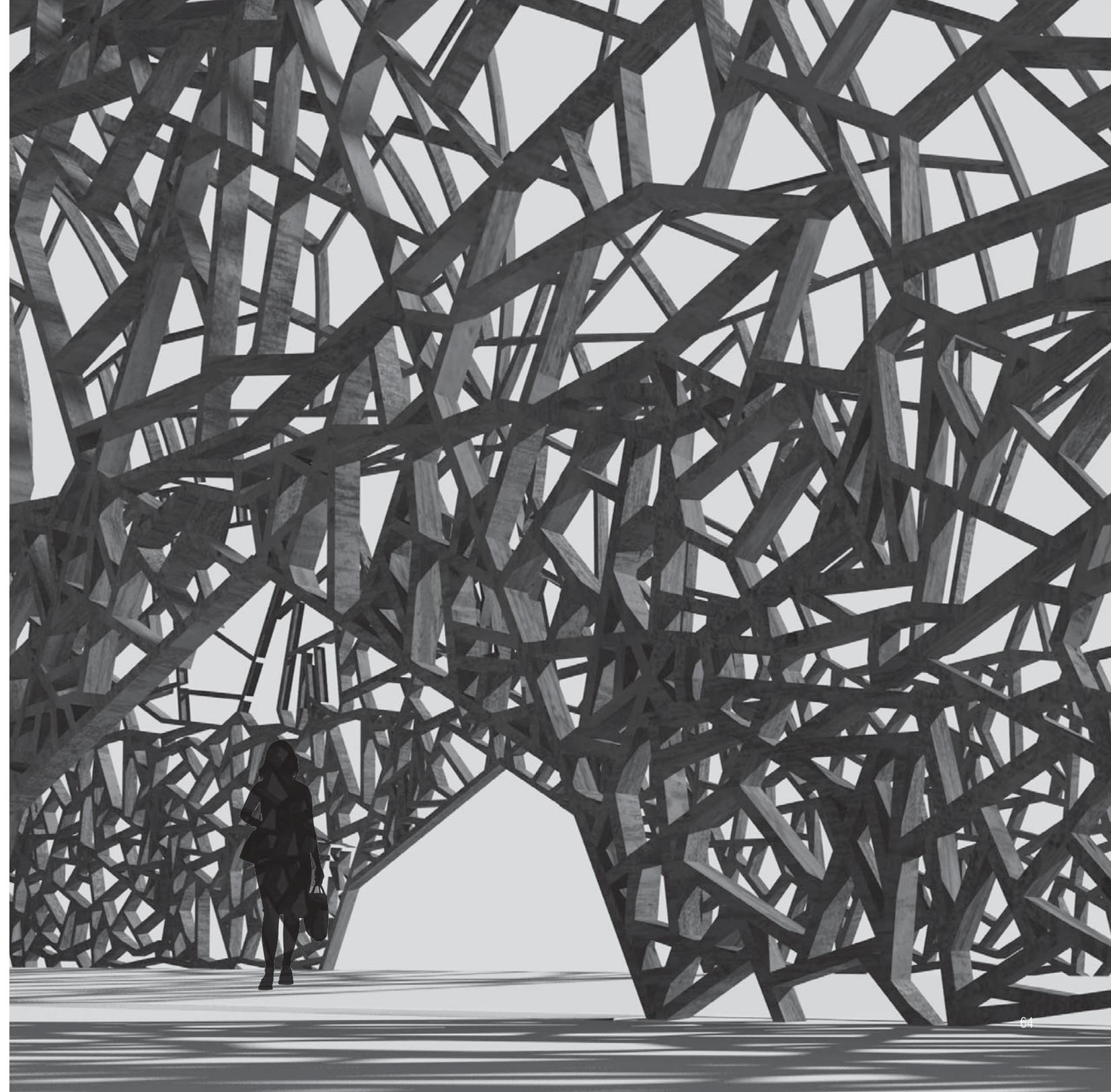
[construction process]

- ① modular panels and columns delivered to site
- ② footings located and set; primary column structure installed
- ③ panels welded into place
- ④ promenade complete

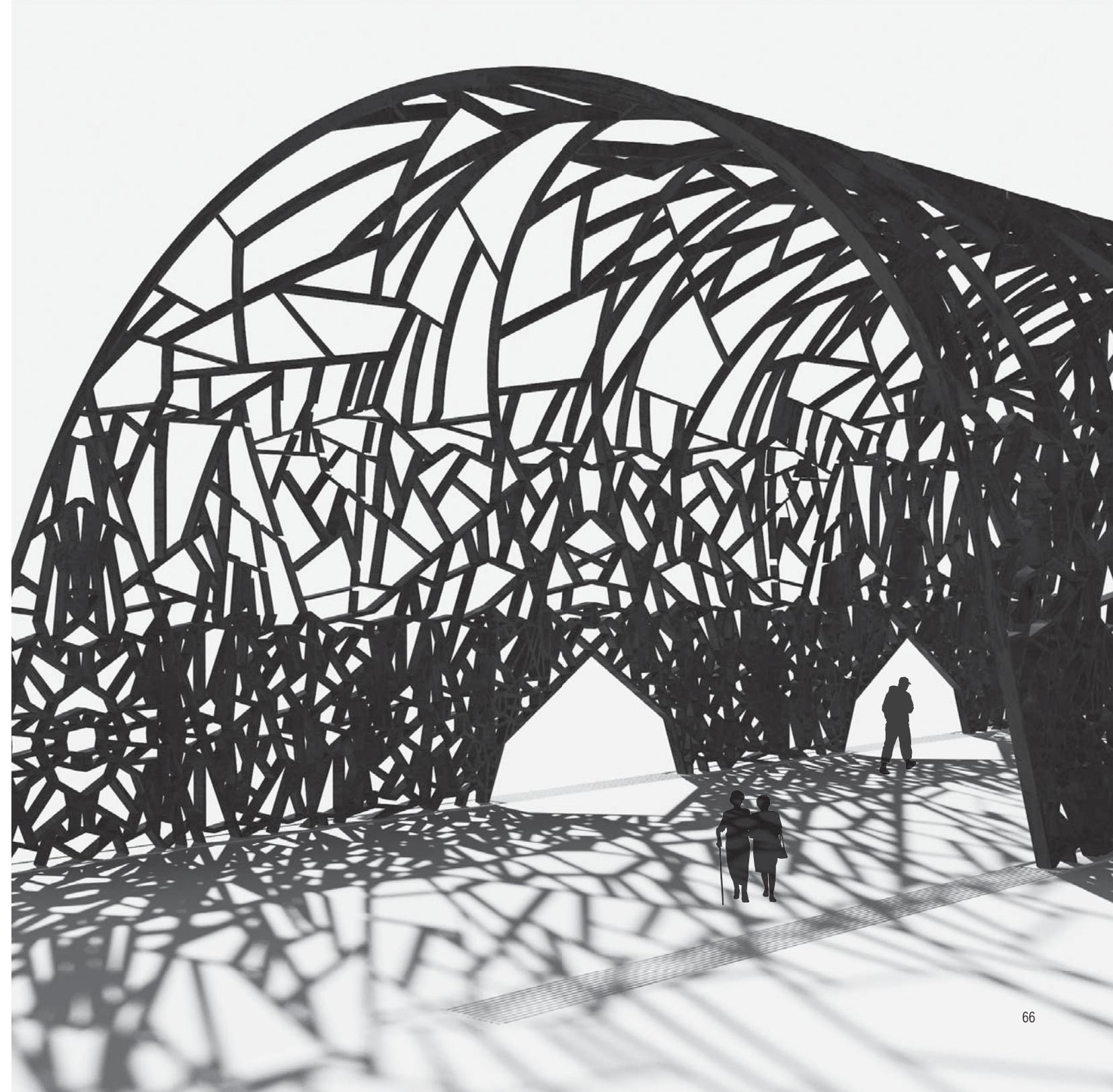
Note: At the conclusion of the project, there was discussion of casting the pieces off site as an alternate construction method



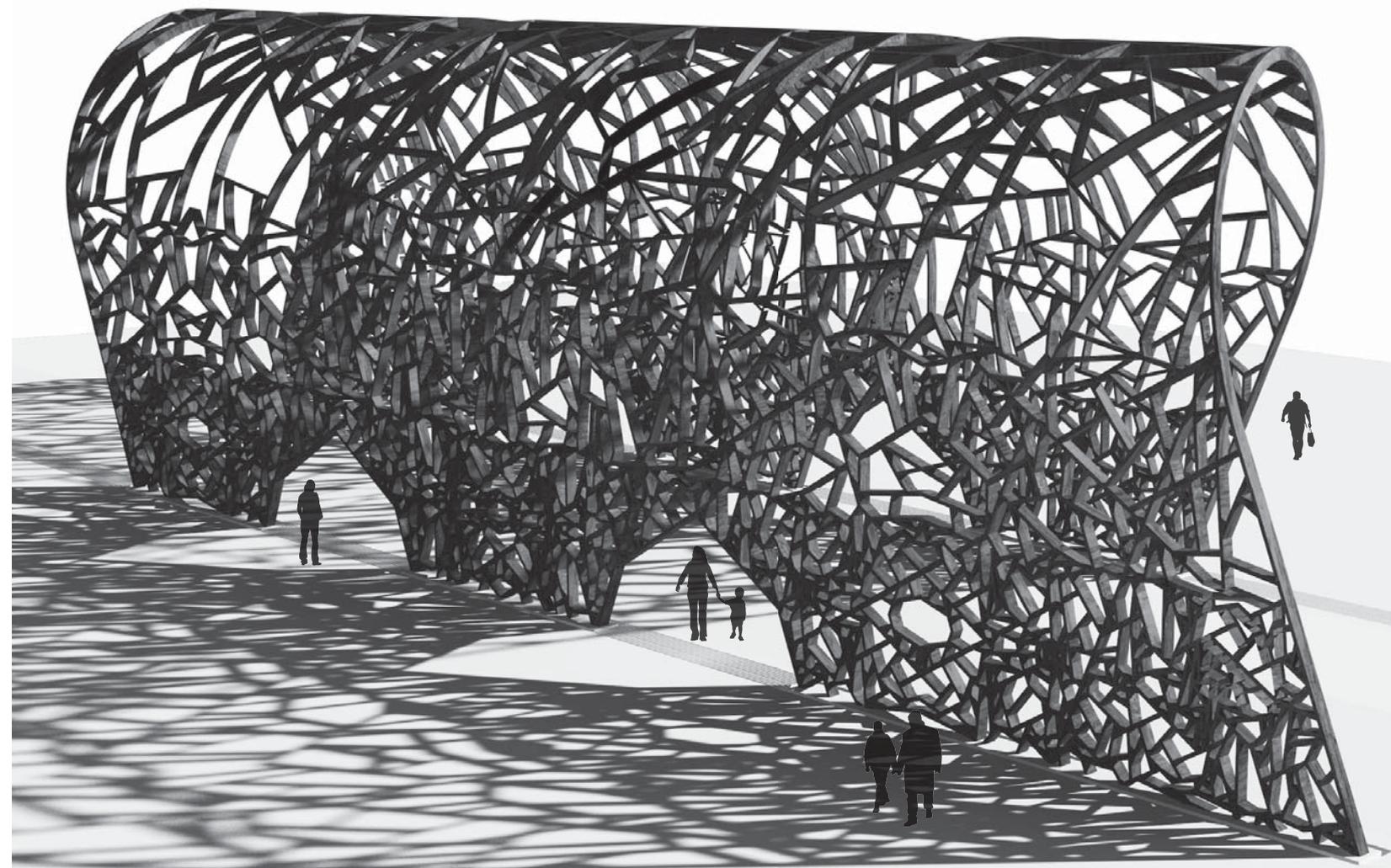
Right: Final rendering showing facade and passageways.



Right: Final rendering showing main entrance into walking promenade.

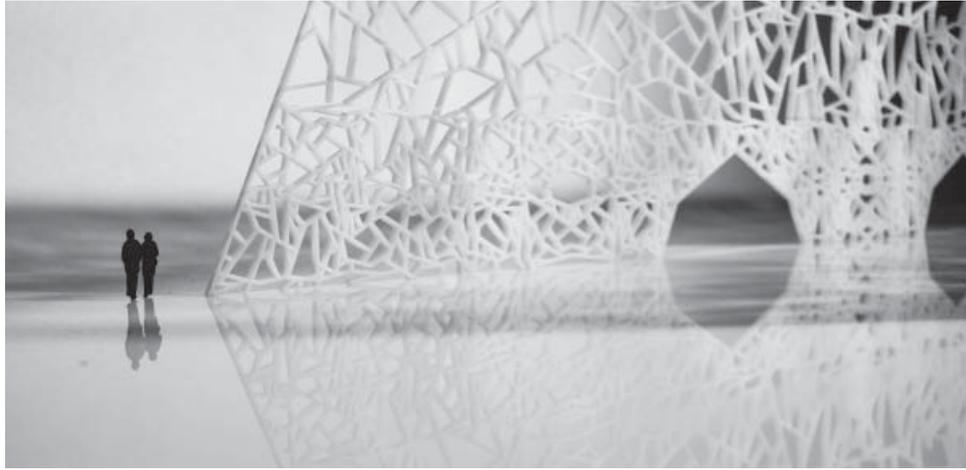


Right: Final rendering showing entire promenade.



[final model]

The lattice facade was created and modeled in Rhinoceros, and then 3d printed in the same modular panels it would be constructed and fabricated in. The base of the model is reflective plexiglass to represent the project's polished concrete flooring surface.



Right: Photograph showing perspective of final model.



Right: Photograph showing front view of final model.



My work this year has been a study of field theory as it can be applied to the square at multiple scales. Investigations have been made via overlaying, rotating, and skewing squares in a series of patterns. This method creates unlimited architectural possibilities that can be applied to almost any building, at any scale, and within any context. These modular patterns come together to form fields of space that become the underlying driver for the architectural components that go into the project. These modular panels become the building blocks of the particular project type studied over the course of the year. The outdoor walking promenade consists of six basic panels (all derived from the square) that are scaled starting with the human and ending with the building. These panels also take place at incremental scales in between, creating a density highest at the ground level-human scale and lowest as the project soars towards the sky-building scale. The conclusions about the thesis have taken place through the study of the lattice work in a facade form as part of an outdoor walking promenade.

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[image credits]

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