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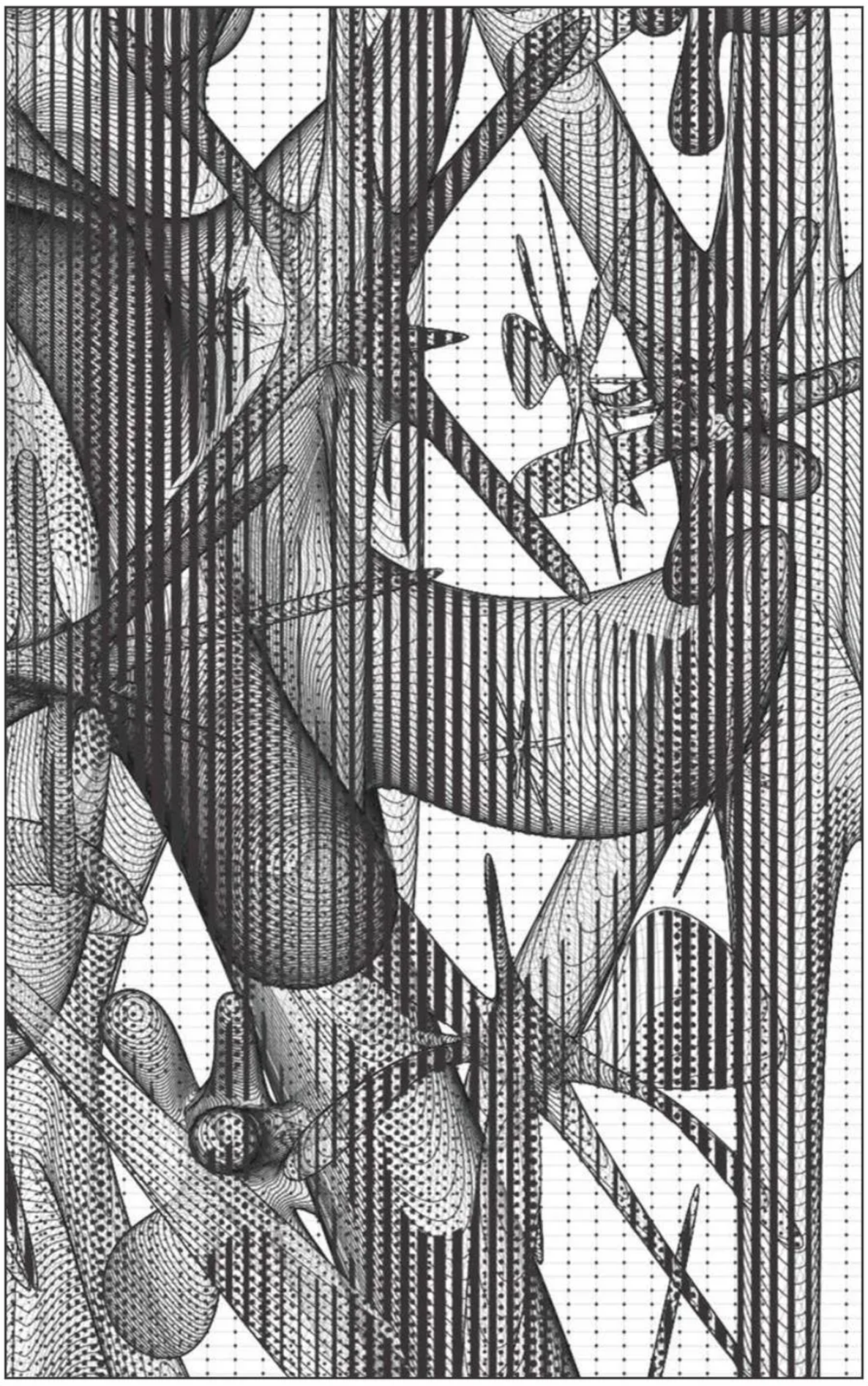

KIRAH CAHILL

University of Pennsylvania
Master of Architecture
Selected Works

Master of Architecture Candidate | **kirahcahill@gmail.com**

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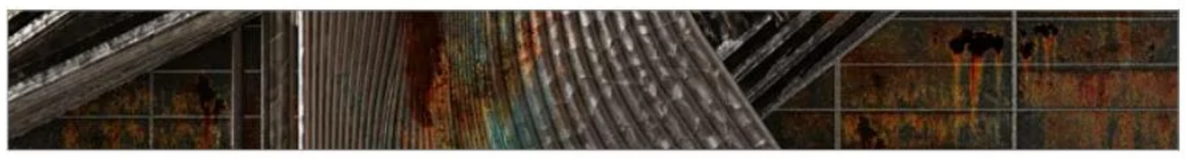

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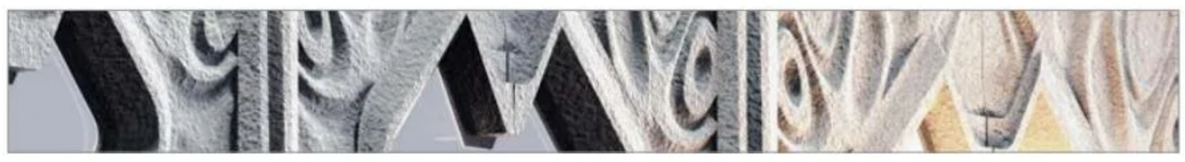

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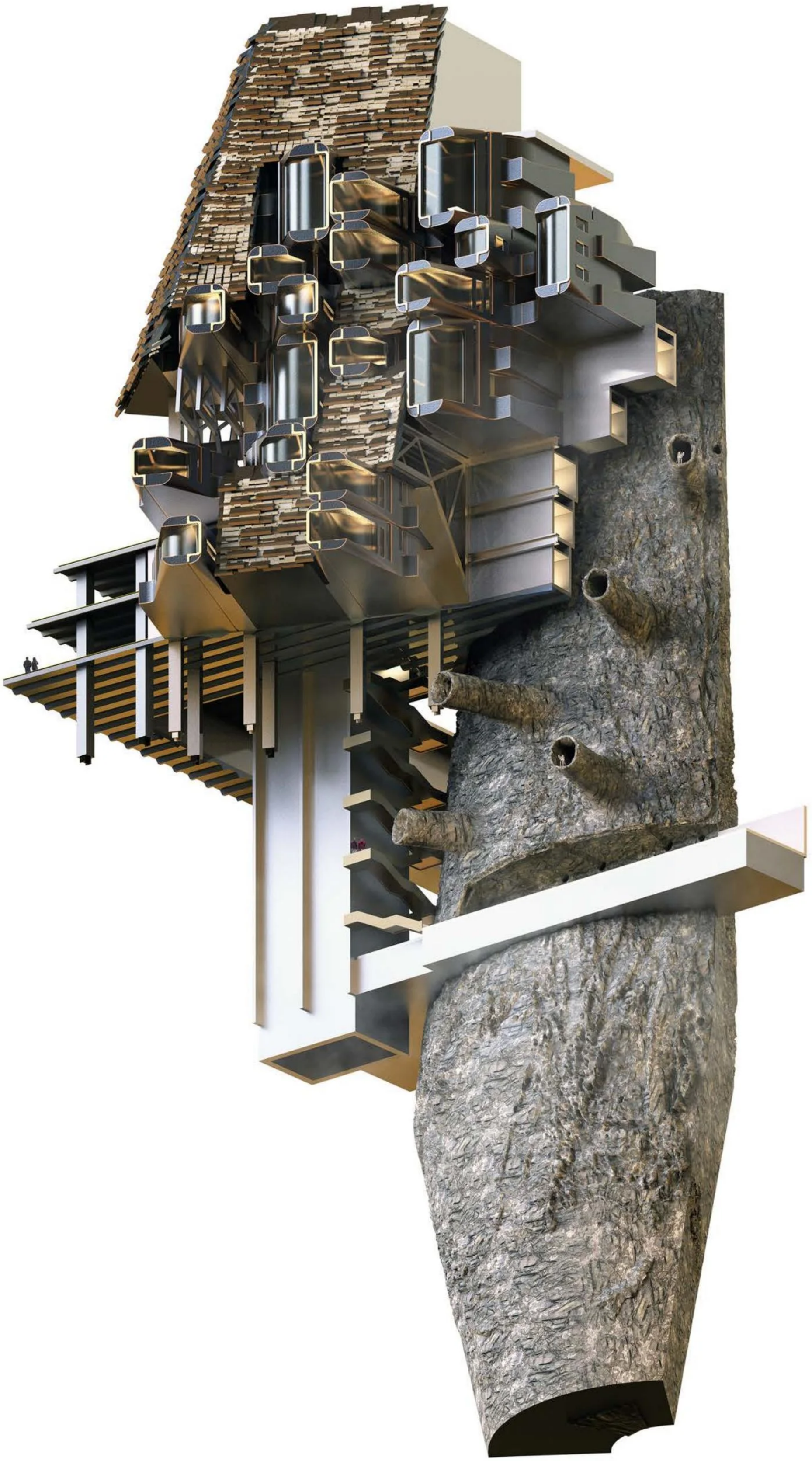

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1

LATRANS COHABITATOR

ARCH 6010 Design Studio III
Gisela Baurmann
Fall 2022

Left:
unit cluster render highlighting connection between units, vertical & horizontal circulation, and coyote lookouts in atrium space

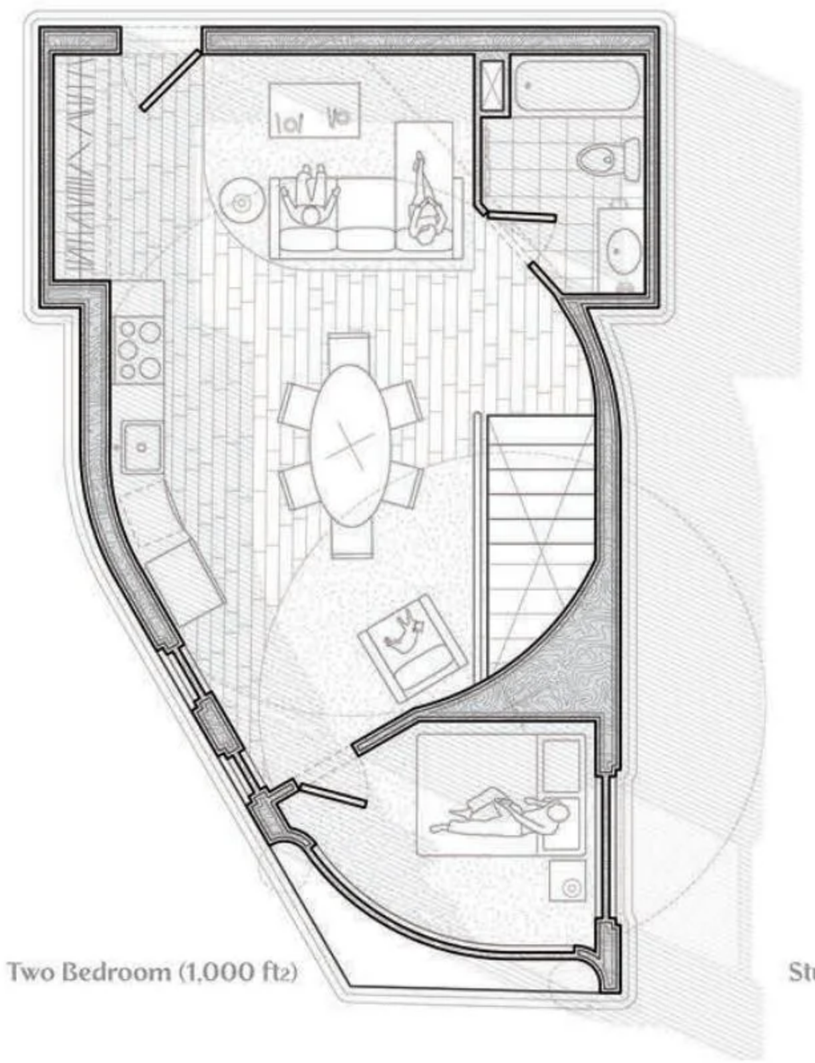
In modern society, the flora and fauna which compose the natural environment are rarely given full consideration and are frequently undervalued. The built environment is no exception to this trend and is usually designed with exclusively human use and social impact in mind. Even the best examples of "environmentally-friendly" architecture focus primarily on reducing harm to the natural environment or creating the illusion of cohabitation through questionable practices of "green washing," or simply covering a building in various types of plants and fungi.

As a result, humans consistently create environments which are inhospitable at best, or deadly at the worst, to all other species with which we share this planet. This passive aggression does not have to continue, however. Humans have progressed exponentially over the past few centuries, especially through industrialization and technological innovation, making us much more capable at preventing harm caused by even the most dangerous of animals. We should no longer fear the creatures who live in the shadows and the outskirts of our cities. Instead, we should explore what can be gained through radical inter-species relations.

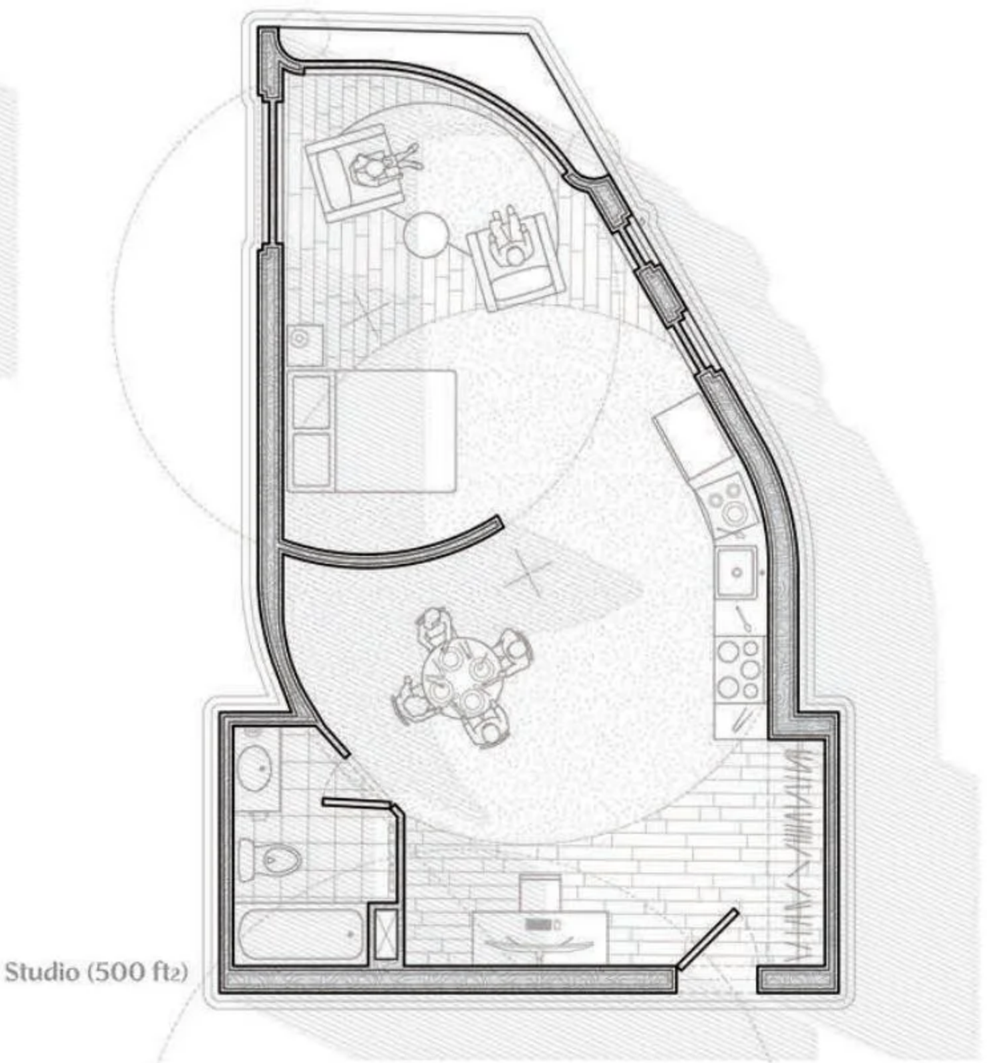
How might the human experience be different if, instead of consistently fighting to resist and control the natural environment, we decided to share our cities, homes, and daily lives with the wilderness? How might the environment respond when provided with space to expand and grow?

The Latrans Cohabitator is a housing project which imagines a world in which non-domesticated animals are provided with built spaces alongside those created for human habitation. In this particular case, *Canis Latrans*, known colloquially as the "coyote," is cohabitating with humans in an apartment complex. Coyote dens and tunnels weave above and between human occupied apartment units and also take advantage of special areas, such as the multi-story atrium space, where they dead end at lookouts where coyotes and people can have more direct interactions.

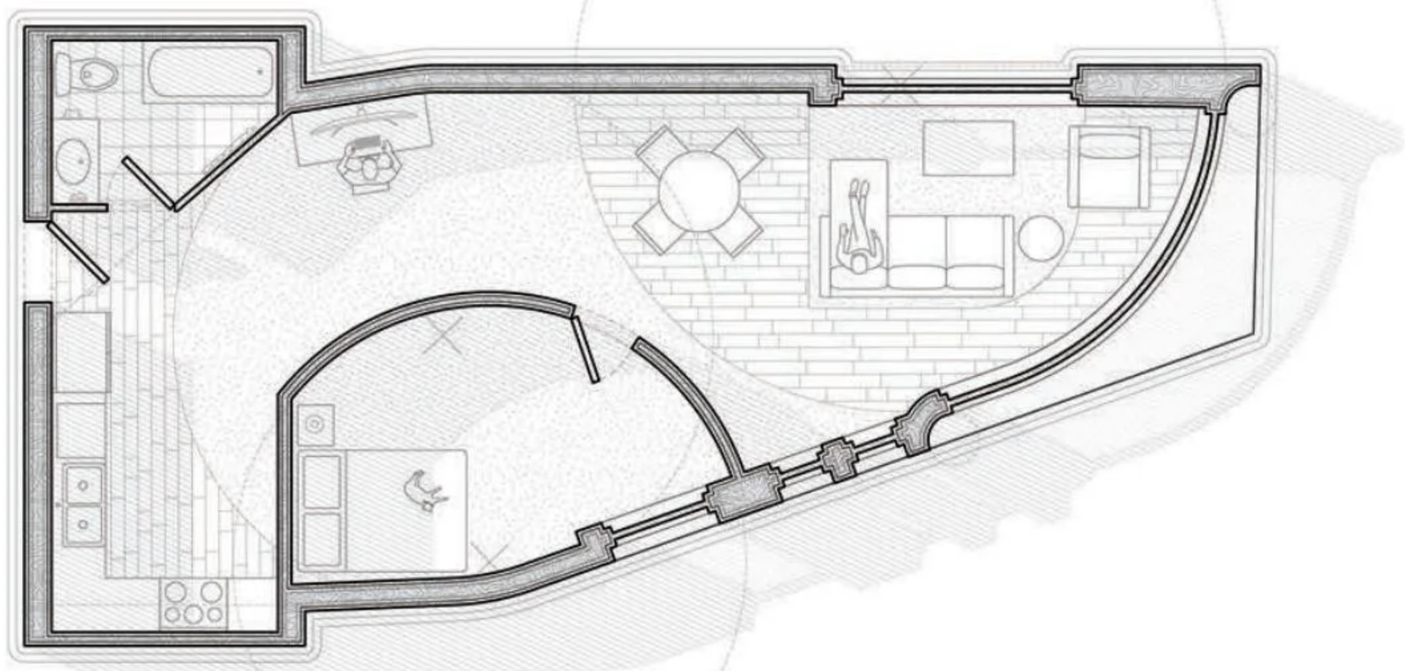
Take care not mistake cohabitation to mean domestication - the primary goals of this housing project are to fully consider the needs of both humans and coyotes as independent occupants, as well as to carefully choreograph interactions that will work to expand minds and enhance the daily lives of both species.



Two Bedroom (1,000 ft2)



Studio (500 ft2)



One Bedroom (750 ft2)

Top:
unit plans showing studio, one bedroom, and two bedroom layouts

Bottom:
site plan showing context of building by Anabelle Basin and adjacent warehouses and apartment buildings

Right:
detailed plan showing single-loaded corridor on northwest side of the building, interior atrium space with coyote lookouts, vertical & horizontal circulation routes, and courtyard space



For humans, there are three apartment unit types offered in the Latrans Cohabitator.

The Studio style is perfect for a single adult. The 500 square foot unit is complete with a kitchen, full bath, dining or living space, and semi-partitioned bedroom space.

The One Bedroom style is also suitable for a single adult, but at 750 square feet would be the perfect size for a couple living in New York City. This unit style offers a larger kitchen and living space than the studio, as well as a fully partitioned bedroom and the standard full bathroom.

Lastly, there is a two-bedroom unit which is an excellent fit for roommates or a small family unit. This two-level apartment unit has all the features of the one bedroom, as well as an additional bedroom.

The apartment complex is located on the edge of Anabelle Basin in the Queens neighborhood of New York City, NY.

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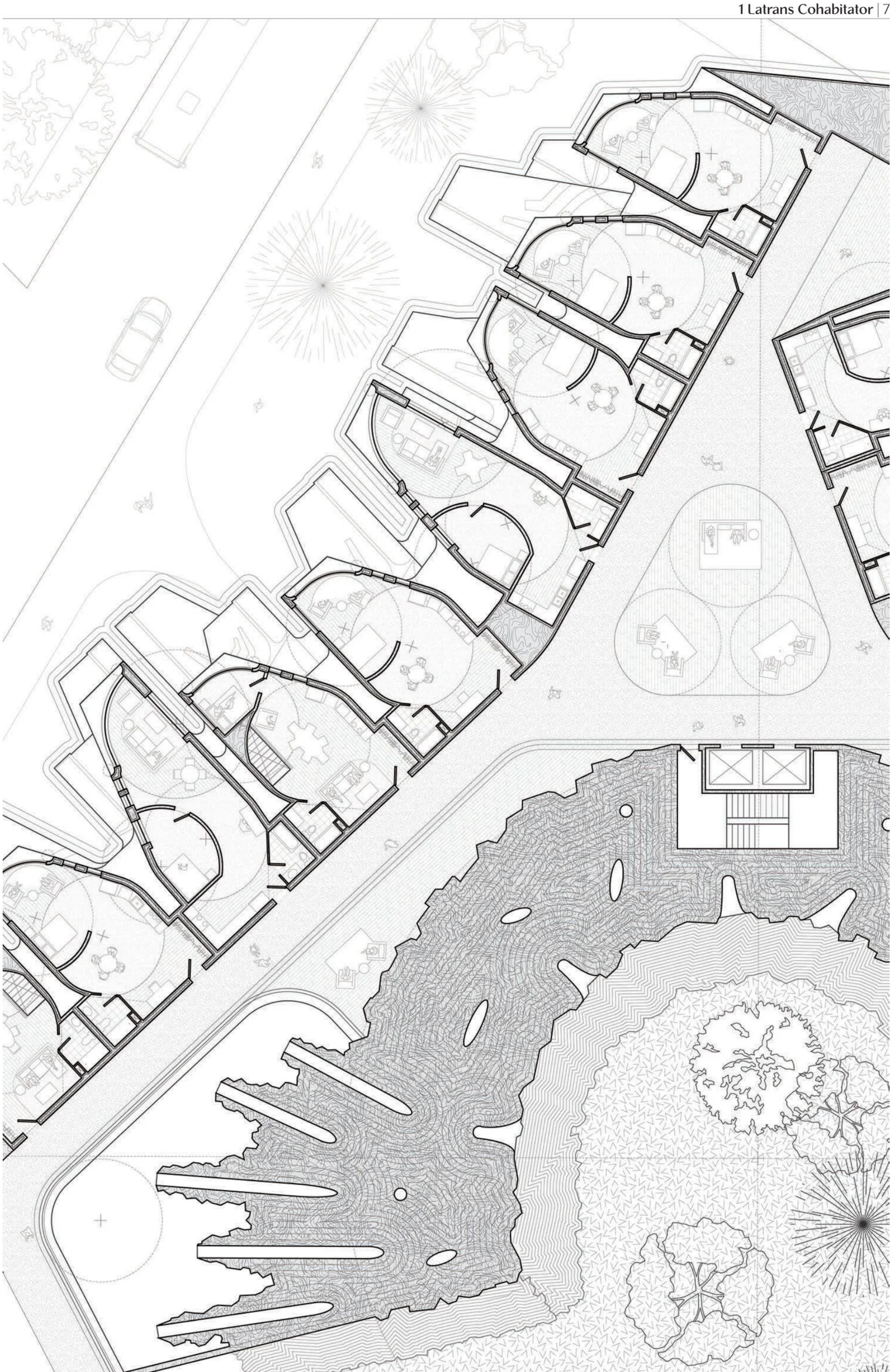
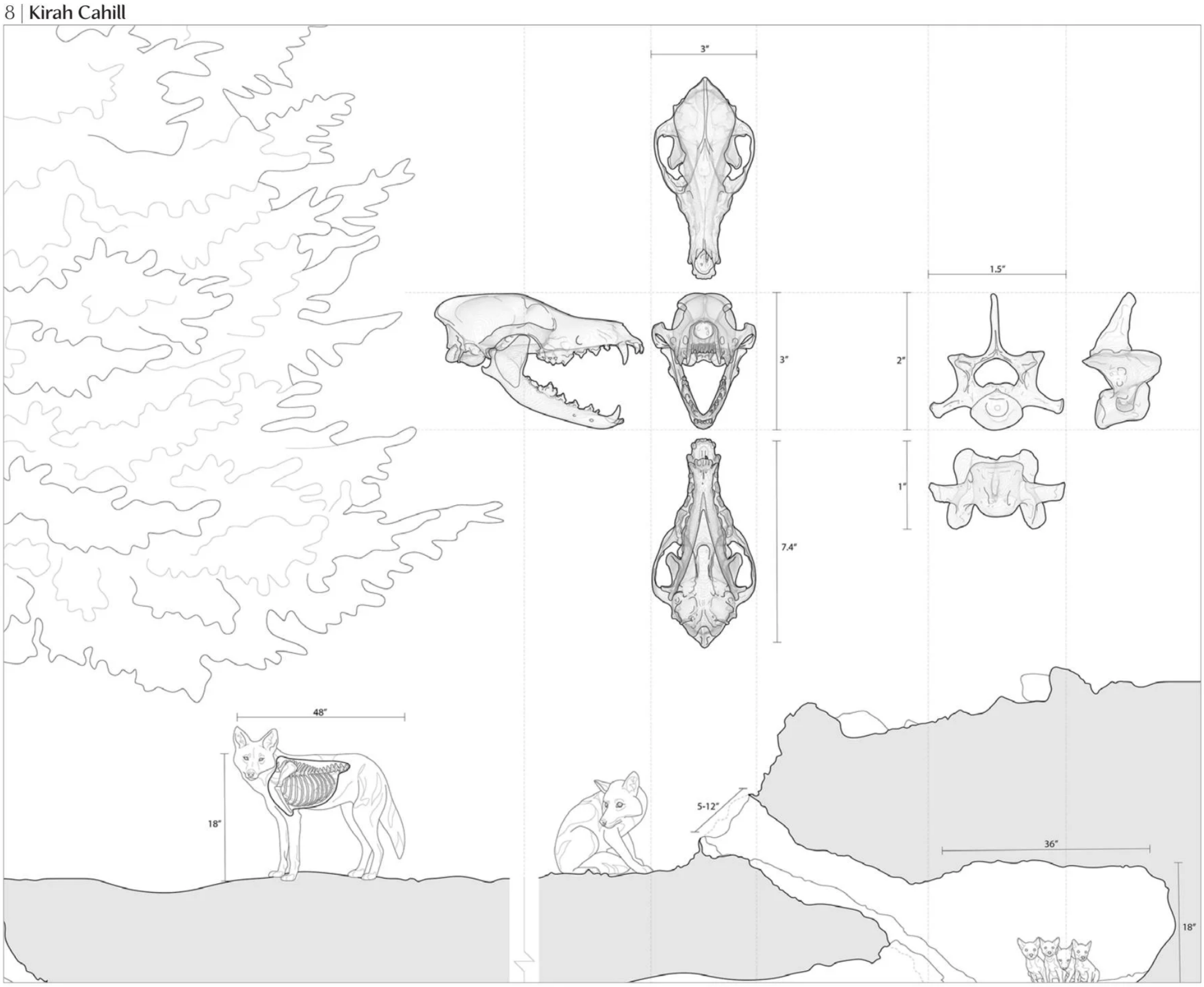
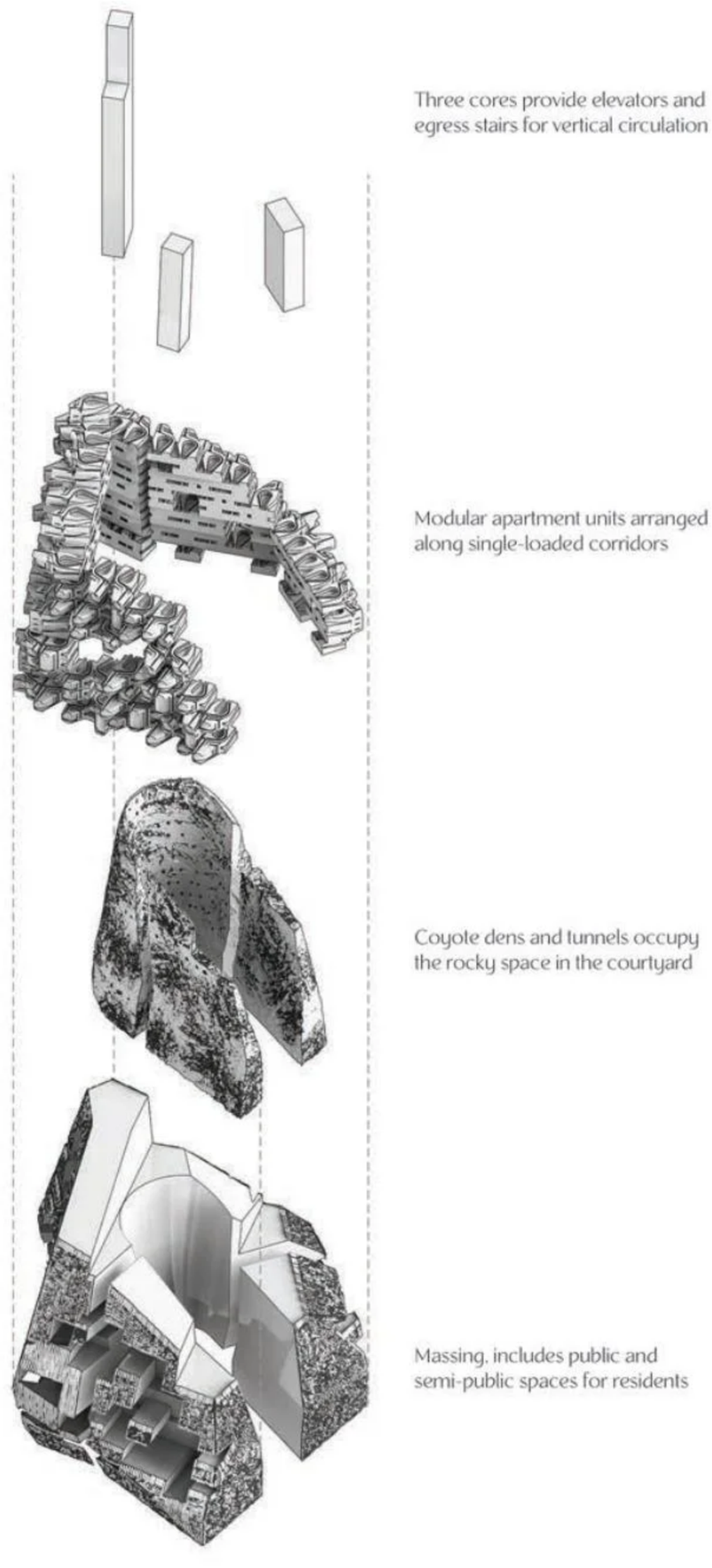




Top:
coyote anatomy & den studies

Bottom:
exploded axonometric showing semi public spaces, coyote spaces, units, and vertical circulation

Right:
section drawing showing lobby, apartment units connected to single-loaded corridors, semi-public amenity spaces for residents, intermediary floors for coyote dens & circulation, coyote tunnel circulation in rock, and coyote lookouts in atrium



Coyotes, or *Canis Latrans,* live in small packs usually consisting of an adult pair and their pups, although sometimes there can be three or four adult family members that live together. As adults, coyotes will sleep in found shelters like fallen logs, shrubs, or under various types of overhanging rocks and foliage. However, when coyotes have pups they prefer to give birth and raise their pups in dens. These dens are sometimes found in caves or hallowed out trees, or dug into hills. Dens that are dug into the Earth can be either fairly shallow (just a few feet below the surface) or exceedingly deep (up to 60 feet below the surface) and often have multiple entrances.

The Latrans Cohabitator provides coyotes with found dens and tunnels, similar to those coyotes use in the natural environment. The rocky courtyard space is a very similar experience to the dens coyotes dig for their young, while the intermediate coyote levels and corresponding dens above and between human apartment units are more refined spaces created out of typical building materials. All spaces offer coyotes quiet, safe spaces for sleeping, resting, and raising their young. Coyotes are able to come and go as they please,

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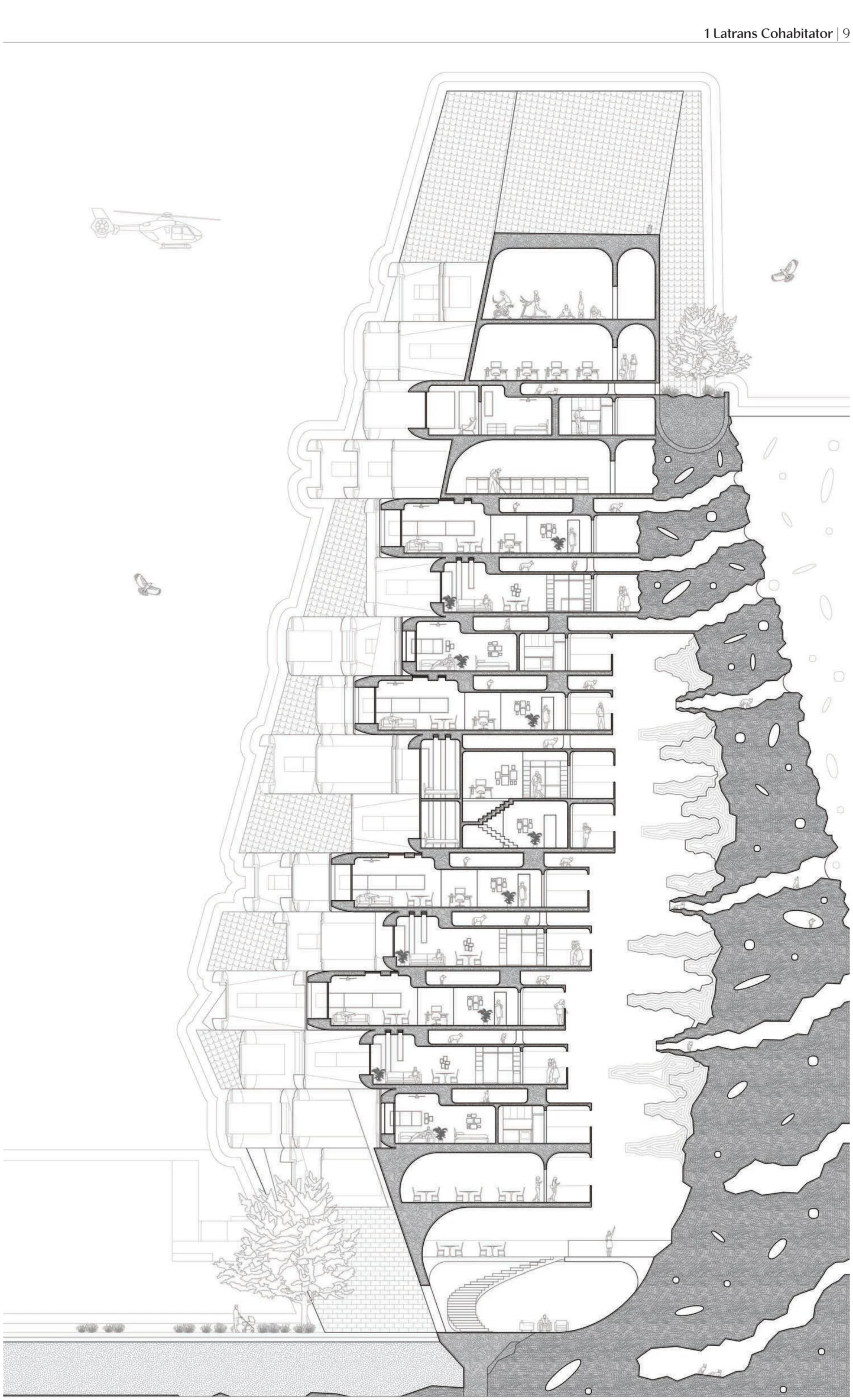



Top:
photograph of 3D printed model, PLA, approx. 12" tall and 8" long

Bottom:
detail photograph of 3D printed model showing shingles & modules

Right:
oblique section & plan, created for ARCH 621 Visual Studies III taught by Brian De Luna



One major concern of the Latrans Cohabitator is determining the appropriate amount and place of interaction between people and coyotes. People occupy apartment units (shown in cream in the image immediately to the right), semi-public amenity spaces (behind the shingled facade), and a double-level lobby with commercial space, which provides transition between the private apartments and public street.

The coyotes, by contrast, are provided with a rock structure and den spaces nestled among the modular human apartments. The rock, located at the central courtyard, contains a network of tunnels for circulation while the dens are located between and above apartments.

Atrium spaces, such as the one featured in the chunk model above and rendered unit cluster to the far right, offer unique experiential spaces where people and coyotes can interact more directly through the coyote lookouts which provide both people and coyotes the opportunity to directly see and hear each other (if desired by both).

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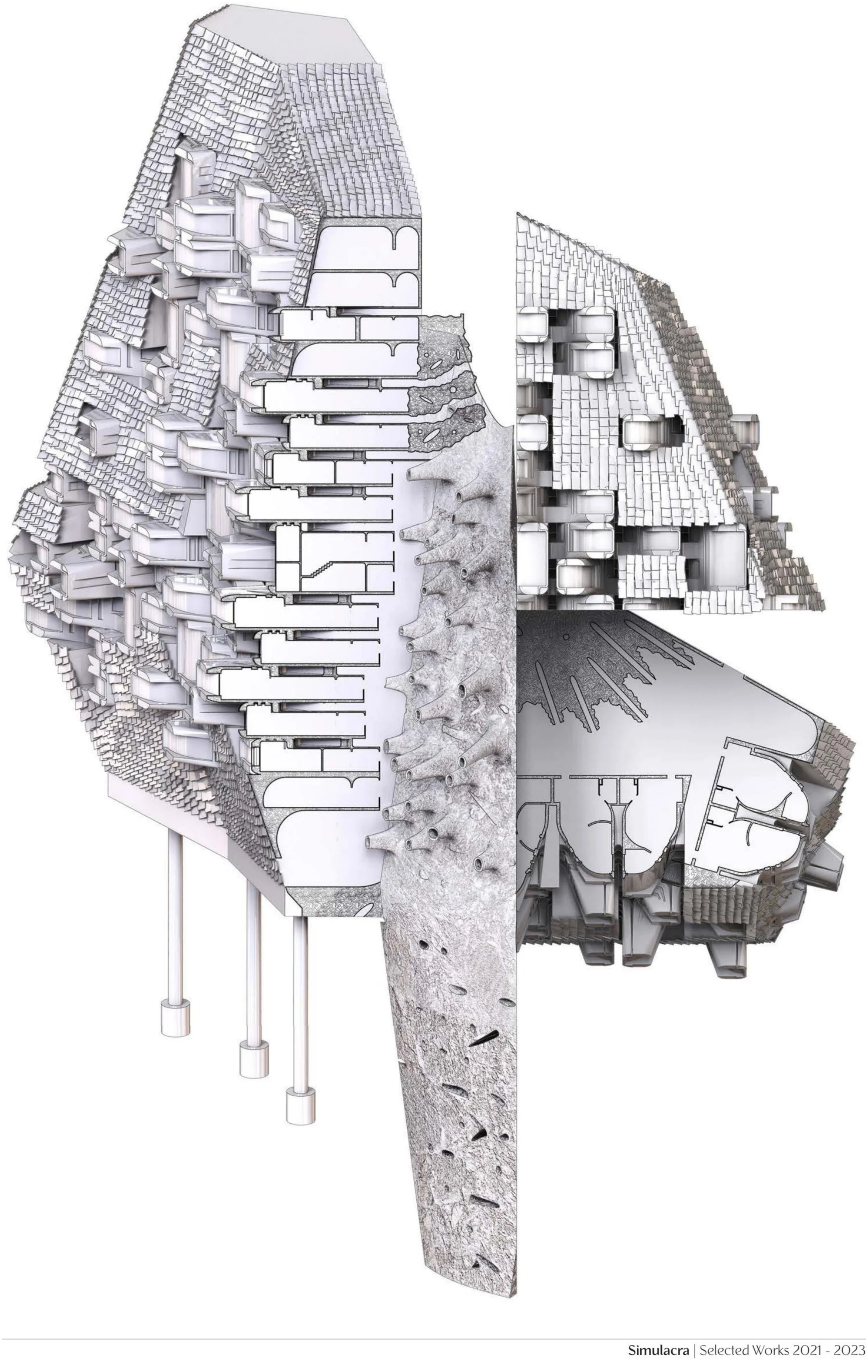



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2

VIBRANT ARTIFACTS

ARCH 7220 Vibrant Artifacts
Barry Wark
Fall 2023

Collaborators:
Francisco Anaya
& Grace Infante

Left:
early elevation render, studying controlled weathering effects and their potential as design

Excerpt from course syllabus:

> "As we move into an age of environmental consciousness and the nature-architecture dichotomy dissolves in favor of emerging ideologies of interconnectedness, it may no longer be appropriate to perpetuate the notion that our buildings are impervious and separate to the environments in which they are sited. This has given rise to an emerging field of architectural design that experiments with new ecological aesthetics and a desire for an architecture of enmeshment. The seminar will explore these ideas through the design and representation of spatial objects that speculate on conditions of permissible weathering, degradation and inhabitation of our artifacts by non-human entities. In support of this task, students will learn the surrounding theoretical context by studying key texts from Bennet , Kallipoliti, Morton and Mostafavi and Leatherbarrow that focus on the topics of weathering, ruination and contemporary ecological ideas. Through case studies, students will gain understanding of where and why these various effects occur in the built environment at present and how they might be controlled and designed in their proposal. The seminar will create these artifacts using procedural design and modelling workflows in Houdini FX, allowing students to integrate computational intelligence through weather simulation and geometric analysis."
>
> - Barry Wark. 2023 ARCH 7220 Vibrant Artifacts

Based on the case study, Willow Street Steam Plant in Philadelphia, PA, this project is interested in the relationship between bricks, stone, and metal, and the effect that these materials begin to have on each other. In the case study, the steam plant's rusty metal and eroded brick show as contrasts or two distinct elements. However, the project investigates the intersection of their deterioration, like when the rusted metal begins to affect the color, vibrancy and quality of solid material through its leakage.

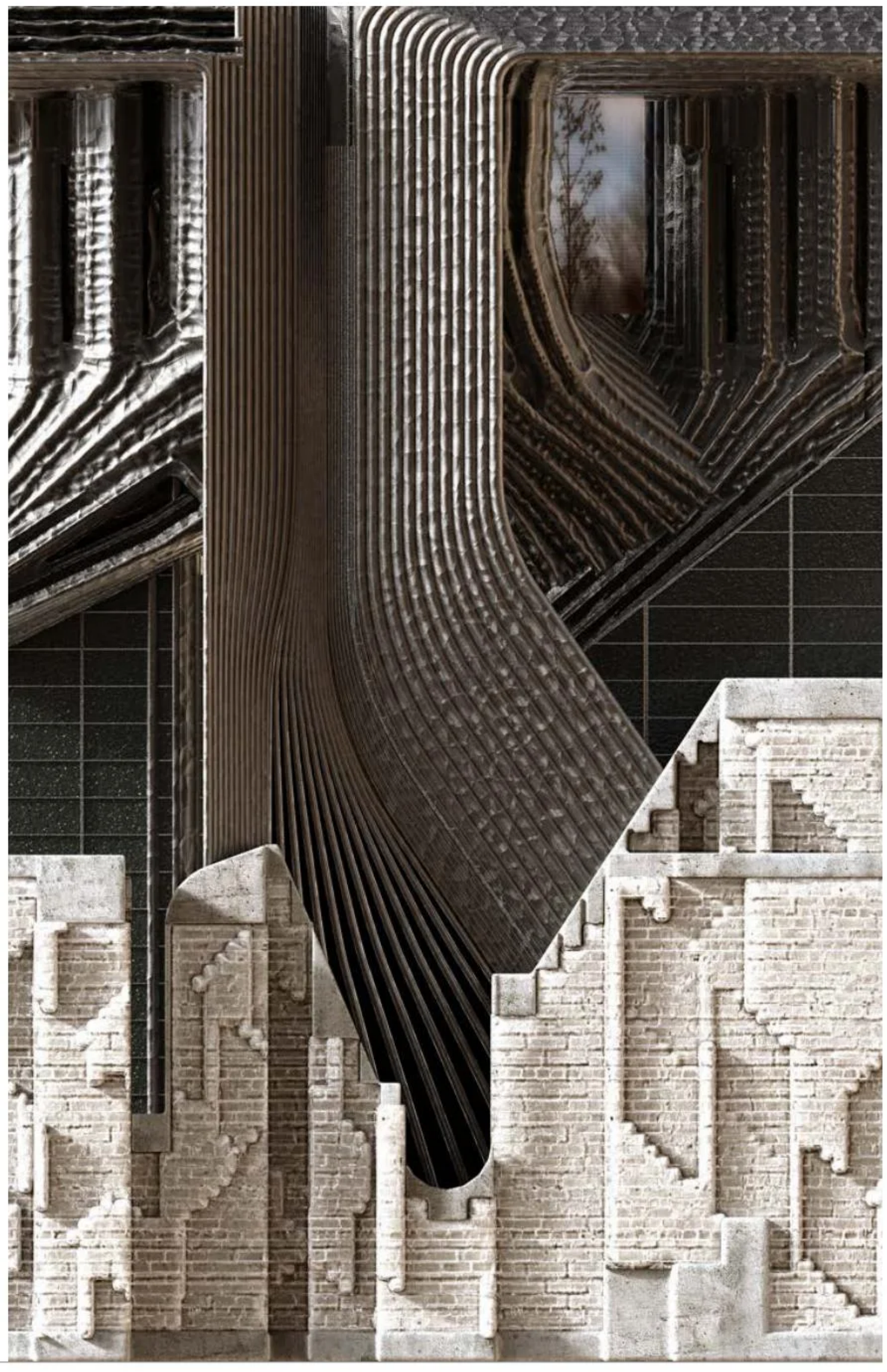
To manipulate how these materials interact and to design towards an anticipated effect, water is funneled using a corrugated metal that becomes a metal framing, among other facade conditions. This allows the rust and leakage to go mainly through the center and dispersing in



Top:
case study diagram, elucidating patterns of weathering on metal and brick at the Willow Street Steam Plant, Philadelphia, PA

Bottom:
rendered facade elevation showing design on the day of construction completion, prior to any weathering effects taking place

Right:
rendered facade elevation showing how the design is aesthetically enhanced by weathering conditions such as rust, erosion, and staining



some areas through the side due to the directionalities of this metal. The metal canvassing in the back with its evenly divided seams results in a more even and widespread coloration versus the concentrated coloration of the corrugated metal. In order to further manipulate the staining colorations, we cap parts of the painted brick with stone.

Jane Bennett's theory of vibrant matter explores the idea that matter, including non-human entities like metals, has its own vitality. Rusted metal facades can be seen as a manifestation of this theory, as they depict the dynamic processes of decay and transformation in the material world, suggesting a lively interaction between human-made structures and the forces of nature. The rusting process highlights the agency of materials and their capacity to undergo changes, aligning with Bennett's perspective on the vitality inherent in all matter.

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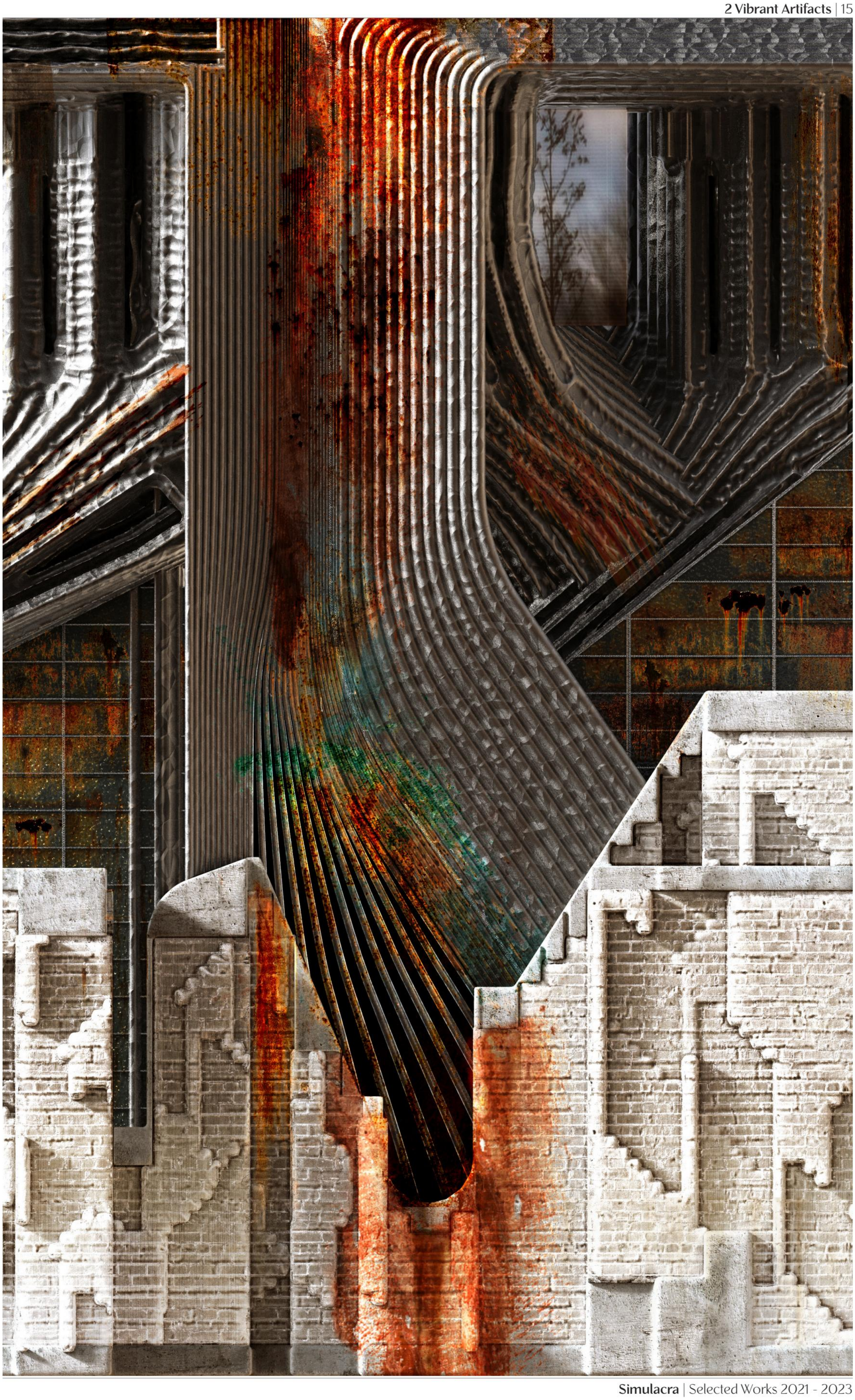




3

PERLICRETE

ARCH 7323 Matter, Making, & Testing
Richard Garber
Fall 2023

Collaborators:
Grace Infante,
Sophie Wojtalewicz
& Penghui Zhang

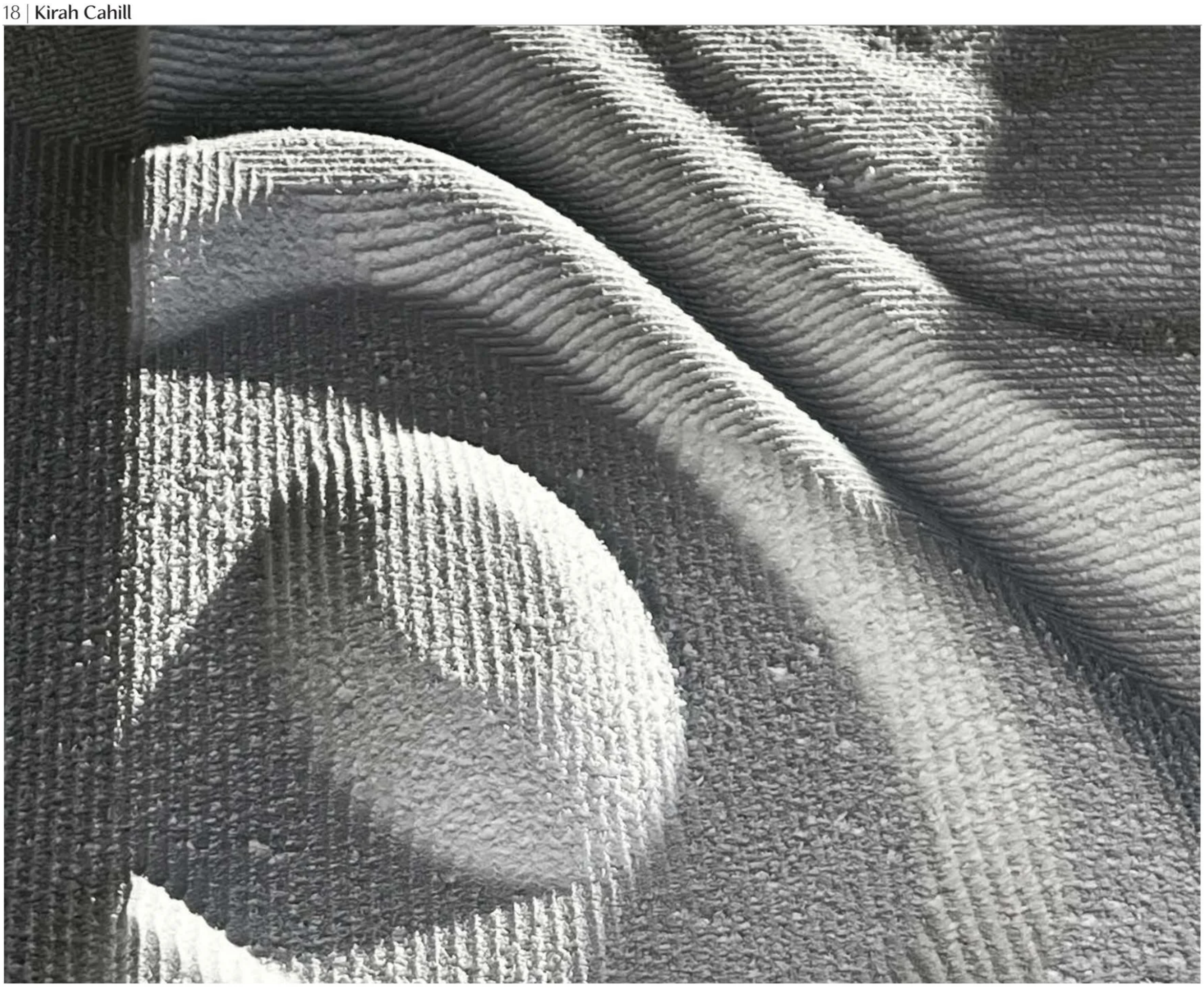
Left:
elevational photograph of completed and cured insulated concrete sandwich panel

Perlicrete is an insulated, precast architectural concrete panel design exhibiting a complementary combination of manual modeling techniques and algorithmic- or procedurally-based modeling techniques. Specifically, this project's smoothly curved ridges were modeled utilizing NURBs (Non-Uniform Rational B-Splines), where each edge and surface was thoughtfully shaped and positioned by the designer, while the topography-like valley in the middle was created using mathematical functions such as perlin noise, where the overall pattern was crafted by a designer by changing certain input parameters but the specific shapes are determined algorithmically. Working procedurally like this will be the future of design, since it offers many benefits from increased speed and workflow efficiency to highly-detailed bespoke products. Perlicrete gives visual expression to these two design processes, fostering discussion of when and how these methods can be utilized.

Today, architectural modeling is typically done utilizing NURBs or mesh geometries that are modeled in a very specific and controlled way using programs like Rhino, Revit, Sketchup, Maya, or 3DS Max. While this workflow allows designers maximum influence over their designs, it can also be limiting in some key ways:

- Working with NURBs surfaces can be complex, and mastering their manipulation requires a steep learning curve. Users often need significant training to efficiently create and edit NURBs surfaces.
- NURBs are excellent for creating precise, controlled geometric shapes, but they can be less intuitive for modeling organic or freeform shapes.
- Fine-tuning complex mesh structures can be time-consuming, and achieving specific geometric details may be challenging.
- Achieving intricate details, especially in architectural models, may require a considerable amount of time. This can be a drawback in scenarios where rapid prototyping or quick design iterations are essential.
- Performing complex operations on large NURBs models or dense mesh geometries can be resource-intensive. This might lead to slow processing times, especially on less powerful computers.

Employing a procedural workflow in the design of precast concrete wall panels presents a myriad of advantages and cutting-edge capabilities. By integrating mathematical functions such as Perlin Noise or Modulo operations, designers can achieve bespoke mass standardization, marrying the benefits of customization with efficiency. The procedural approach



Top:
close-up photograph of CNC-milled EPS foam formwork, expressing a ribbed texture resulting from the machining process.

Bottom:
a process photograph taken during fabrication of the concrete panel at Northeast Precast in Vineland, NJ.

Right:
select shop drawings showing expected components of assembly;

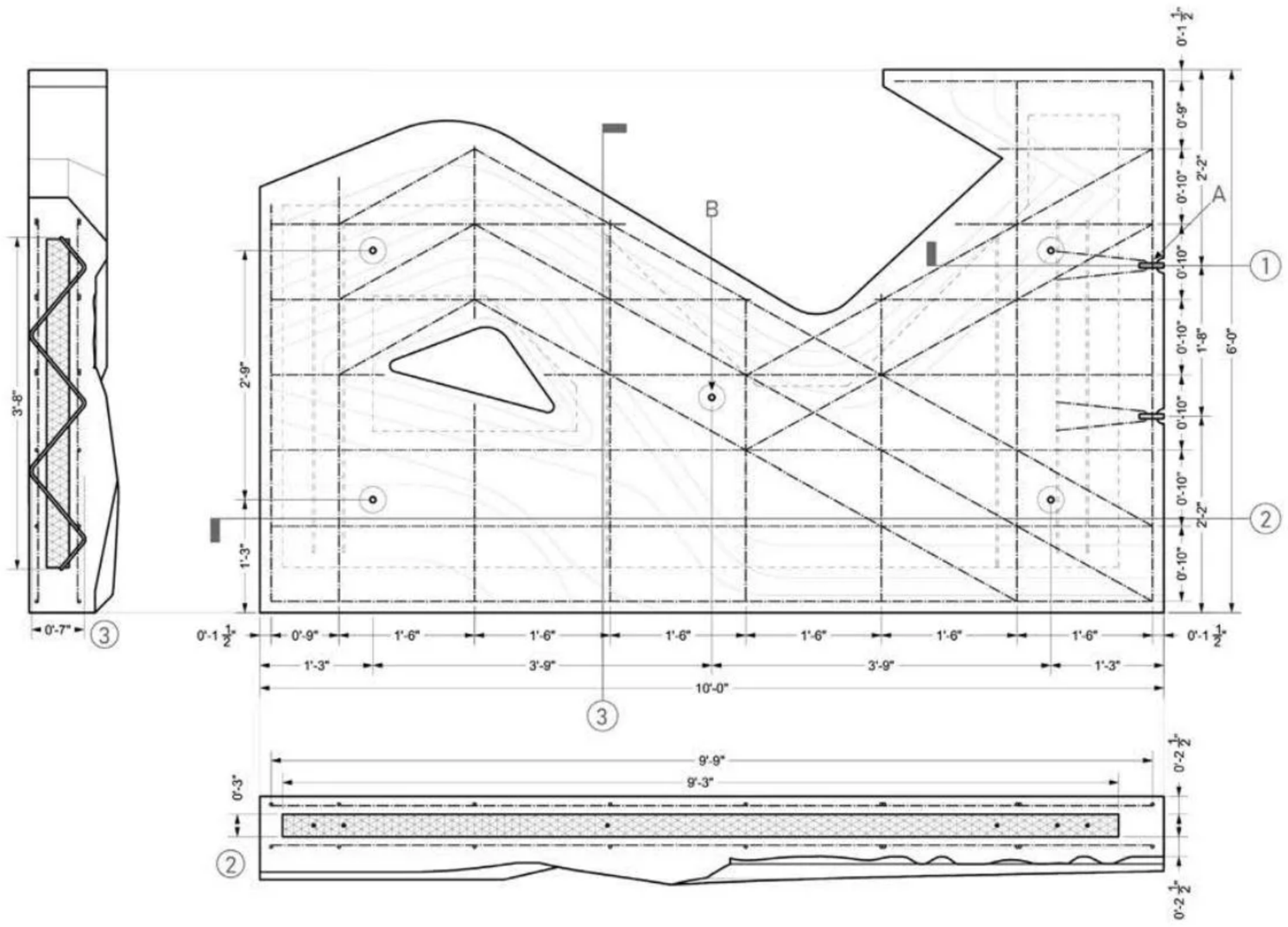


enables parametric control, facilitating rapid iteration and adaptation to diverse design requirements. This not only streamlines the design process but also ensures a level of consistency in the final product. The use of mathematical functions adds a layer of complexity and detail, allowing for the creation of visually compelling and structurally optimized patterns. Moreover, it opens avenues for the exploration of innovative and intricate designs that may be challenging to conceive through traditional methods. The result is a fusion of precision, customization, and aesthetic sophistication in precast concrete wall panel design.

The ARCH 7323 Matter, Making & Testing course presented a unique opportunity to fabricate Perlicrete as a 10' tall, 6' wide, and 1' deep insulated panel. Students were able to partner with Project Managers at Northeast Precast in Vineland, NJ, to bring their designs to life. Students also partnered with CNC Philly to create EPS foam formwork for Perlicrete's complex geometry. Ultimately, students generated 3D models, fabrication drawings, and CNC files before working with Northeast Precast and CNC Philly to fabricate the final concrete panel.

Master of Architecture Candidate | **kirahcahill@gmail.com**

SHOP TICKET

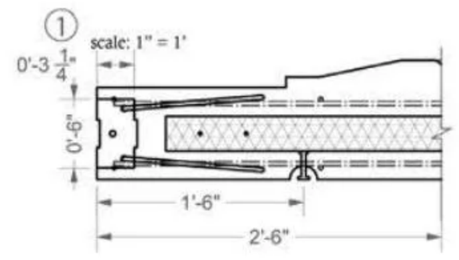


TOTAL CONCRETE: 1.16 cubic yards
WEIGHT: 1.16 x 27 x 150 = 4,698 lbs.

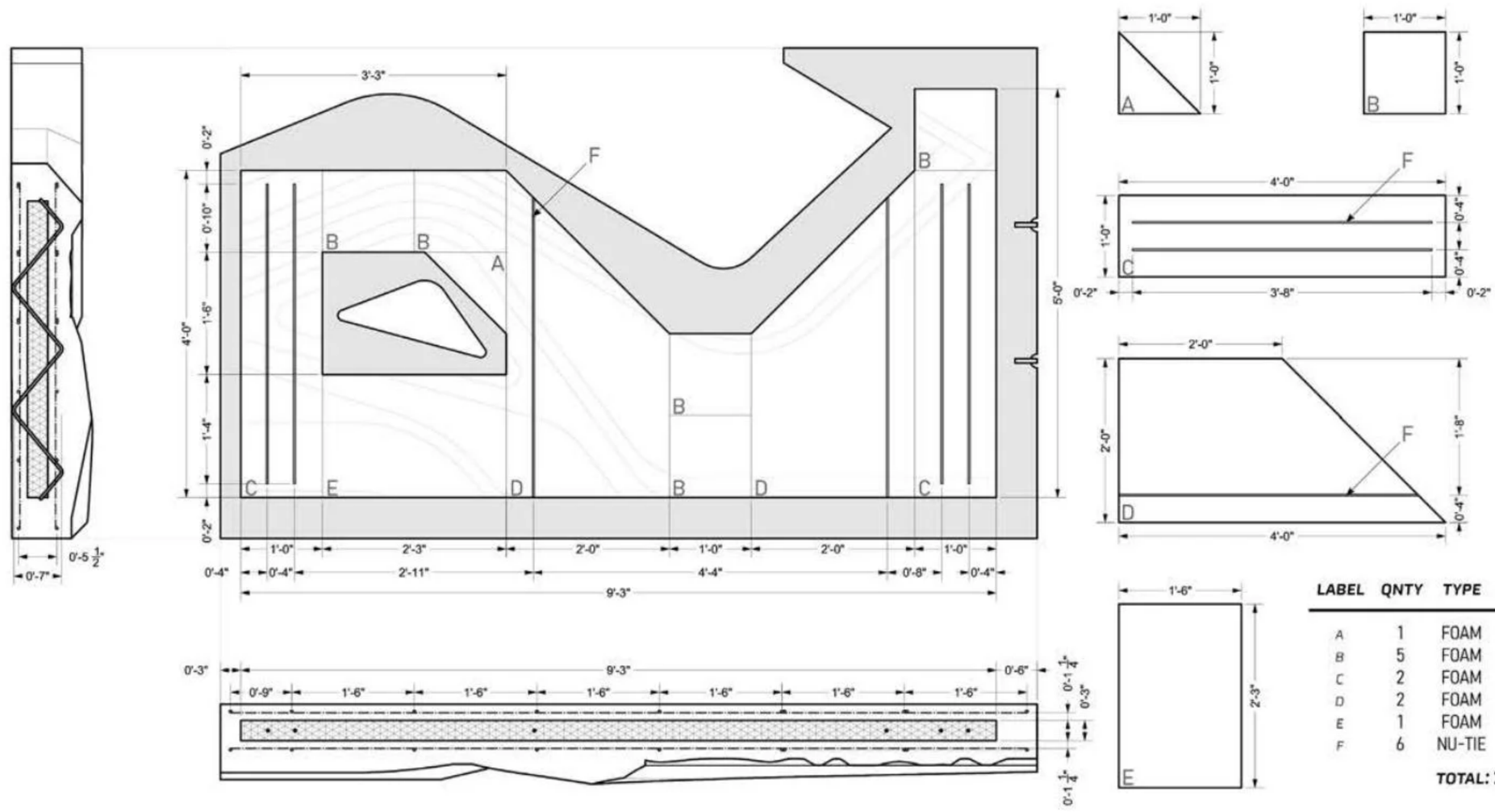
FIRST POUR:
0.93 cubic yards
3,767 lbs.

SECOND POUR:
0.23 cubic yards
932 lbs.

LABEL	QNTY	TYPE
A	2	4T AR Sandwich Panel Erection Anchor
B	5	1T ALP Lifting Pin System (anchors & rubber recess system)



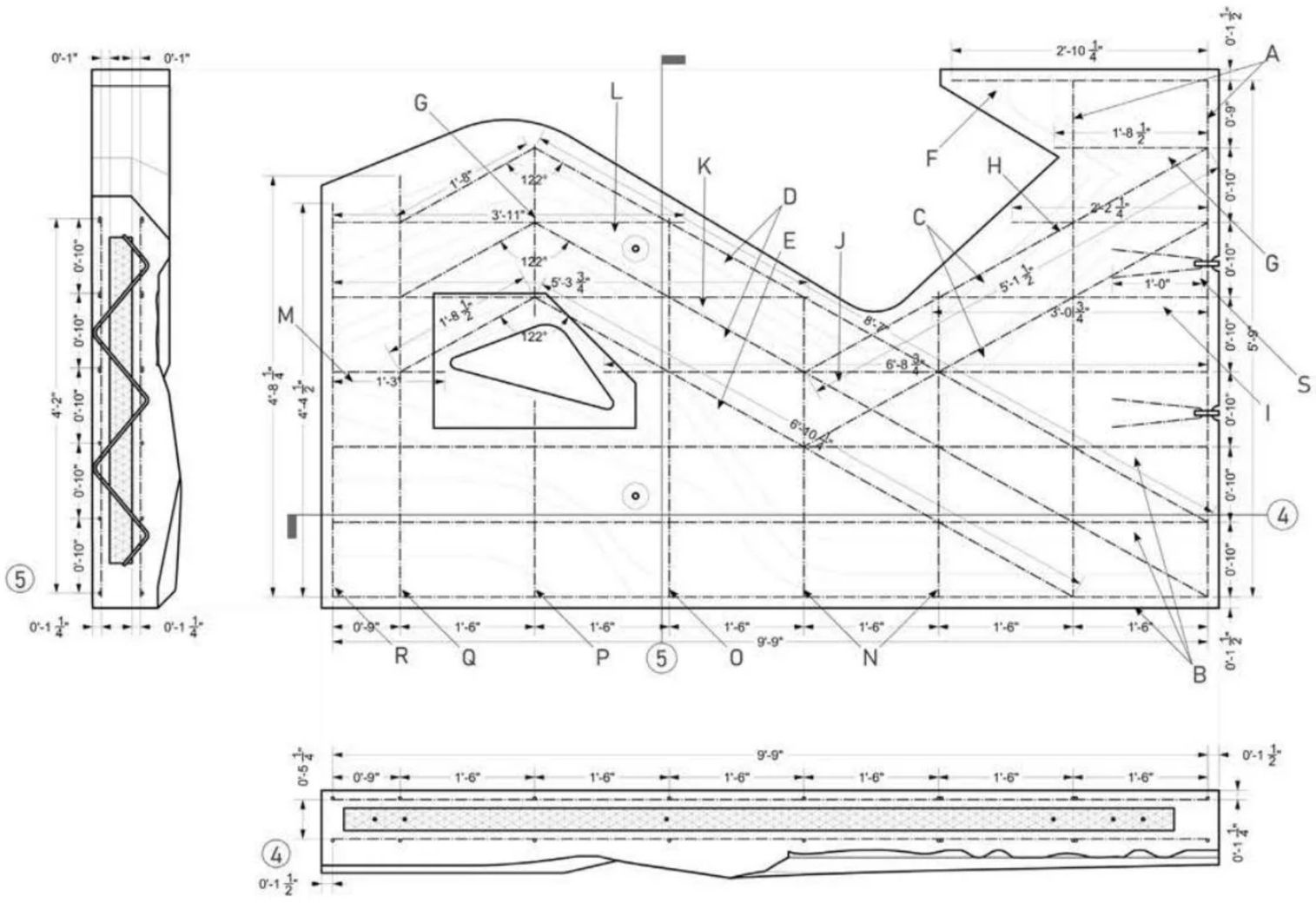
FOAM TICKET



LABEL	QNTY	TYPE	LENGTH	HEIGHT	45 DEG CUT
A	1	FOAM	1'	1'	YES
B	5	FOAM	1'	1'	NO
C	2	FOAM	4'	1'	NO
D	2	FOAM	4', 2'	2'	YES
E	1	FOAM	1' 6"	2' 3"	NO
F	6	NU-TIE	3' 8"	0' 7"	N/A

TOTAL: 28 SQFT FOAM

REBAR TICKET



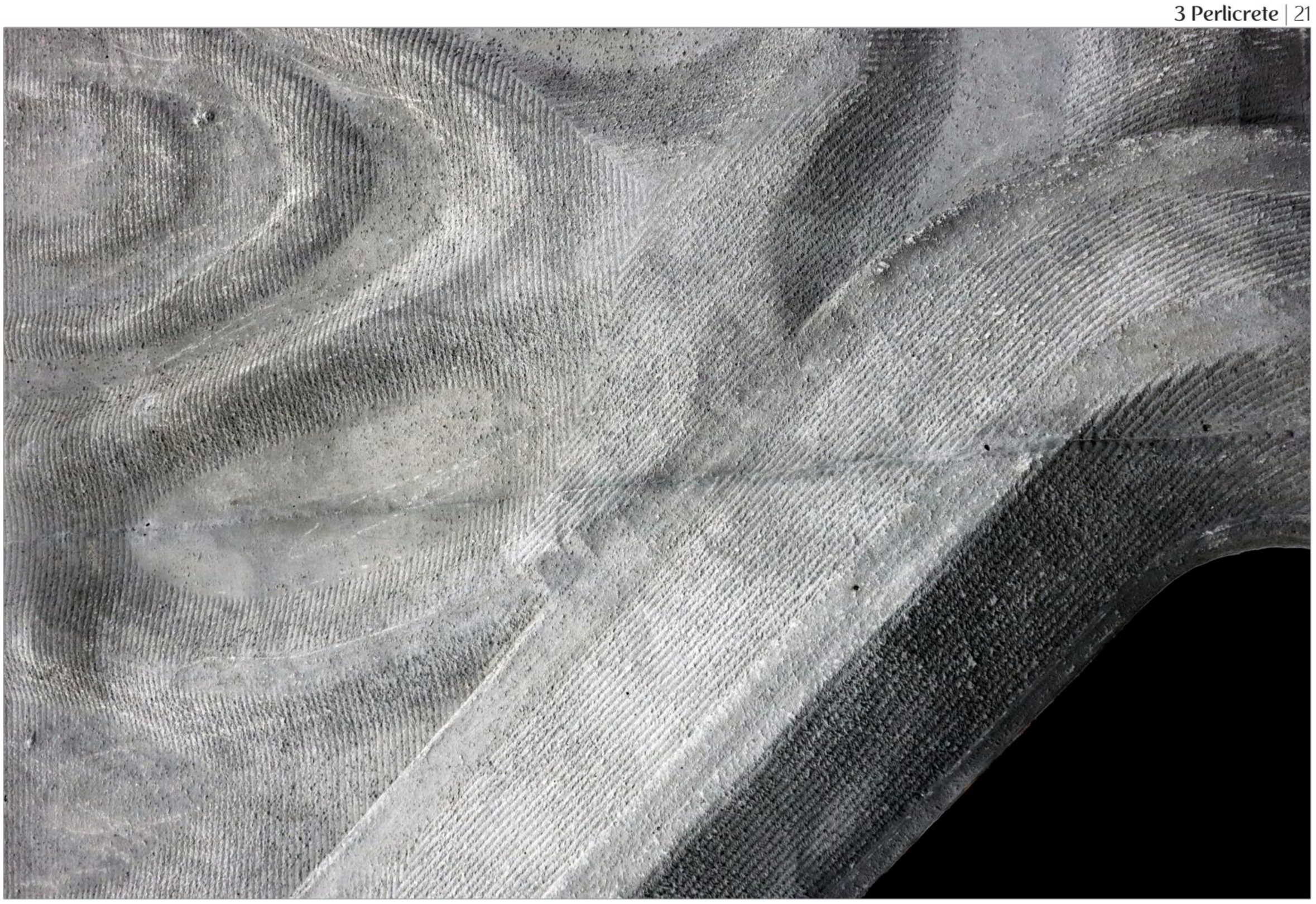
LABEL	QNTY	TYPE	LENGTH	BEND
A	2	#3	5' 9.00"	N/A
B	3	#3	9' 9.00"	N/A
C	2	#3	5' 1.50"	N/A
D	2	#3	10' 3.00"	122
E	1	#3	8' 6.75"	122
F	1	#3	2' 10.25"	N/A
G	2	#3	1' 8.50"	N/A
H	1	#3	2' 2.25"	N/A
I	1	#3	3' 0.75"	N/A
J	1	#3	6' 8.75"	N/A
K	1	#3	5' 3.75"	N/A
L	1	#3	3' 11.00"	N/A
M	1	#3	1' 3.00"	N/A
N	2	#3	3' 4.00"	N/A
O	1	#3	4' 2.00"	N/A
P	1	#3	2' 1.00"	N/A
Q	1	#3	4' 8.25"	N/A
R	1	#3	4' 4.50"	N/A
S	4	#3	2' 0.00"	20

TOTAL: 93' 1.25"

This Page:
detail photographs of completed and cured insulated concrete sandwich panel

Next:
rendering of concrete panels assembled into a potential facade condition, with focus on the unique corner condition created



















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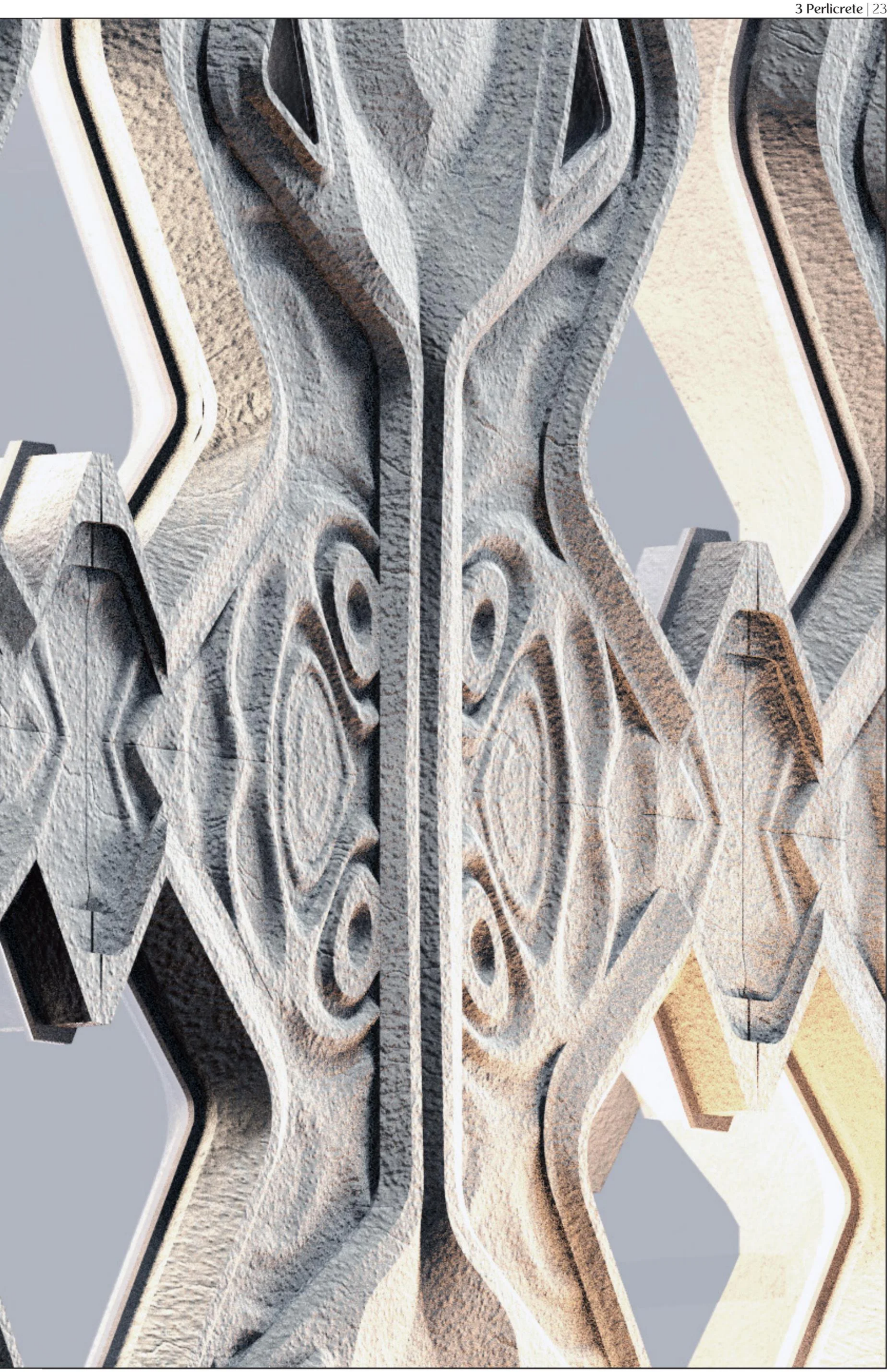

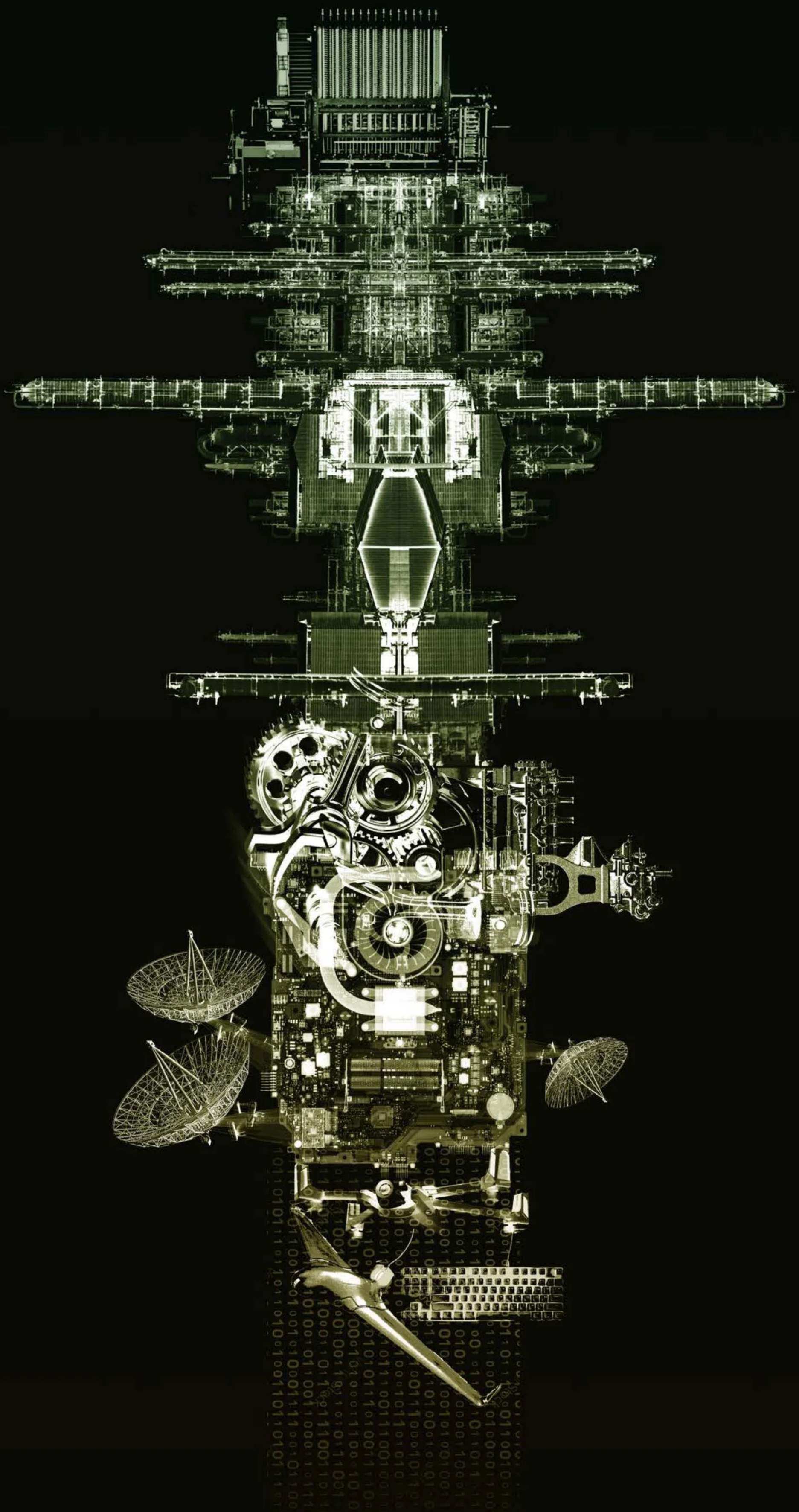

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4

AUTOMATA BAZAAR

ARCH 5020 Design Studio II
Jacqueline Martinez
Spring 2022

Left:
conceptual collage showing progression of technological innovation from the 20th to 21st century (timeline ascends from bottom to top)

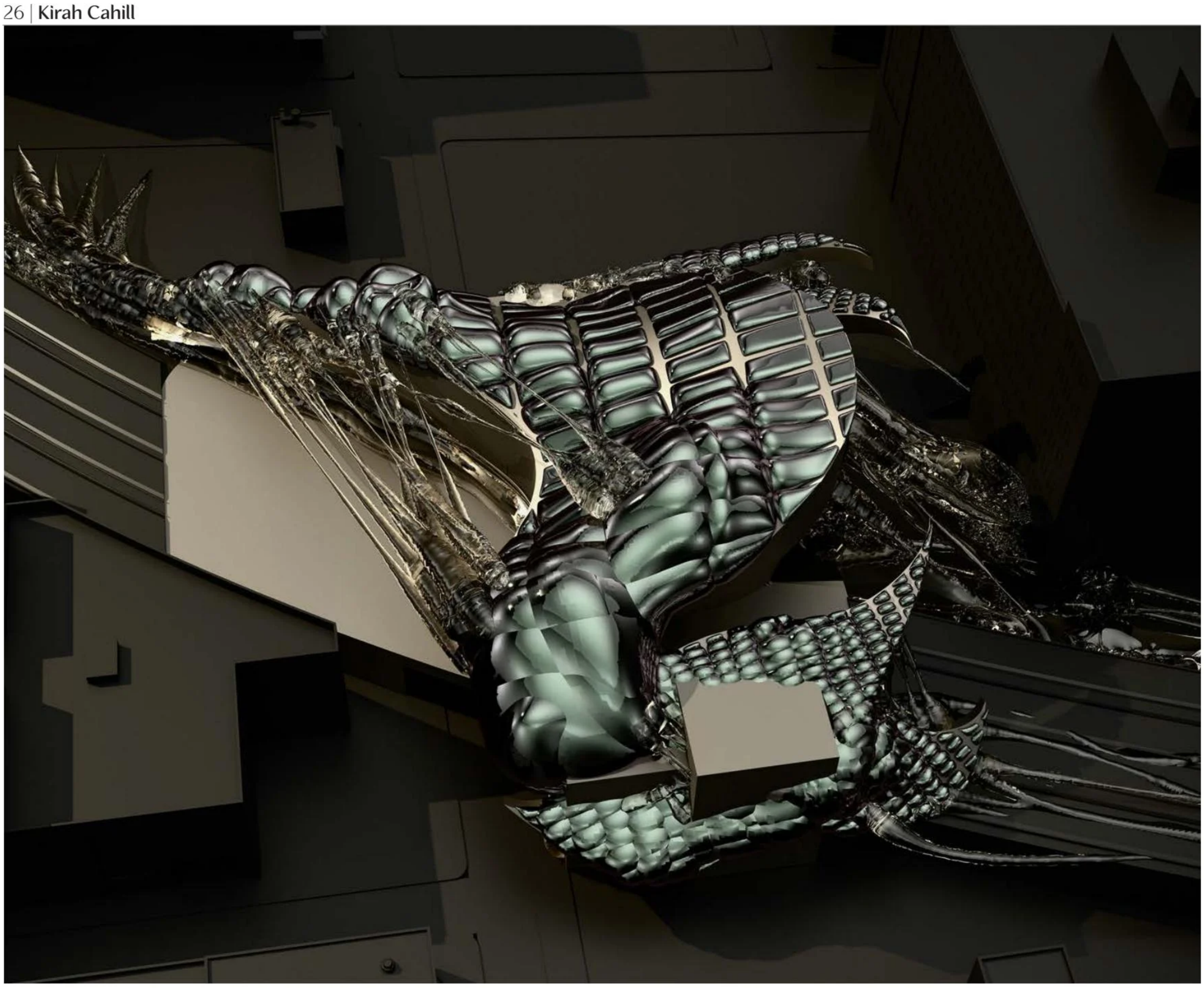
In its earliest days, the neighborhood of Callowhill was more of a suburb than part of the city proper and was home to the Norwich Market. As Philadelphia's population grew and the boundary of the city expanded and Callowhill became the city's first red light district. This time period greatly increased the diversity of the area, as its convenient location near both the Schuylkill and Delaware rivers and multiple commercial railway hubs caused the streets to fill with more markets, various shops, vendors of exotic goods, sailors and other laborers. Also during this time, the area was known for its bars, nightlife, crime and suspect inhabitants since for many years it did not have a designated police force.

As industrialization took hold of the city around the turn of the 20th century, Callowhill saw an increase in factories, warehouses, and hostels for laborers and foremen. The area saw an increase in poverty and alcoholism, which was further exacerbated by the Great Depression when economic hardship hit Callowhill especially hard.

Callowhill, once vibrant, slipped into decline as factories closed and people abandoned its impoverished streets. Although the City's urban renewal plans focused on revitalizing Callowhill, many of the initiatives were created with misjudgment and failed to bring economic opportunity or positive change to the neighborhood.

Today Callowhill is finally seeing some investment as gentrification brings new businesses and refurbishment projects aimed at creating loft-style apartments for young professionals in the abandoned factories. Despite this gleam of hope on the horizon, the area is still dependent upon its remaining factories and warehouses. What will happen to this neighborhood as digitalization replaces the remnants of its industrial backbone? What goods or services can it offer as no-contact exchanges, online commerce, artificial intelligence, and virtual reality consume more and more of peoples' lives?

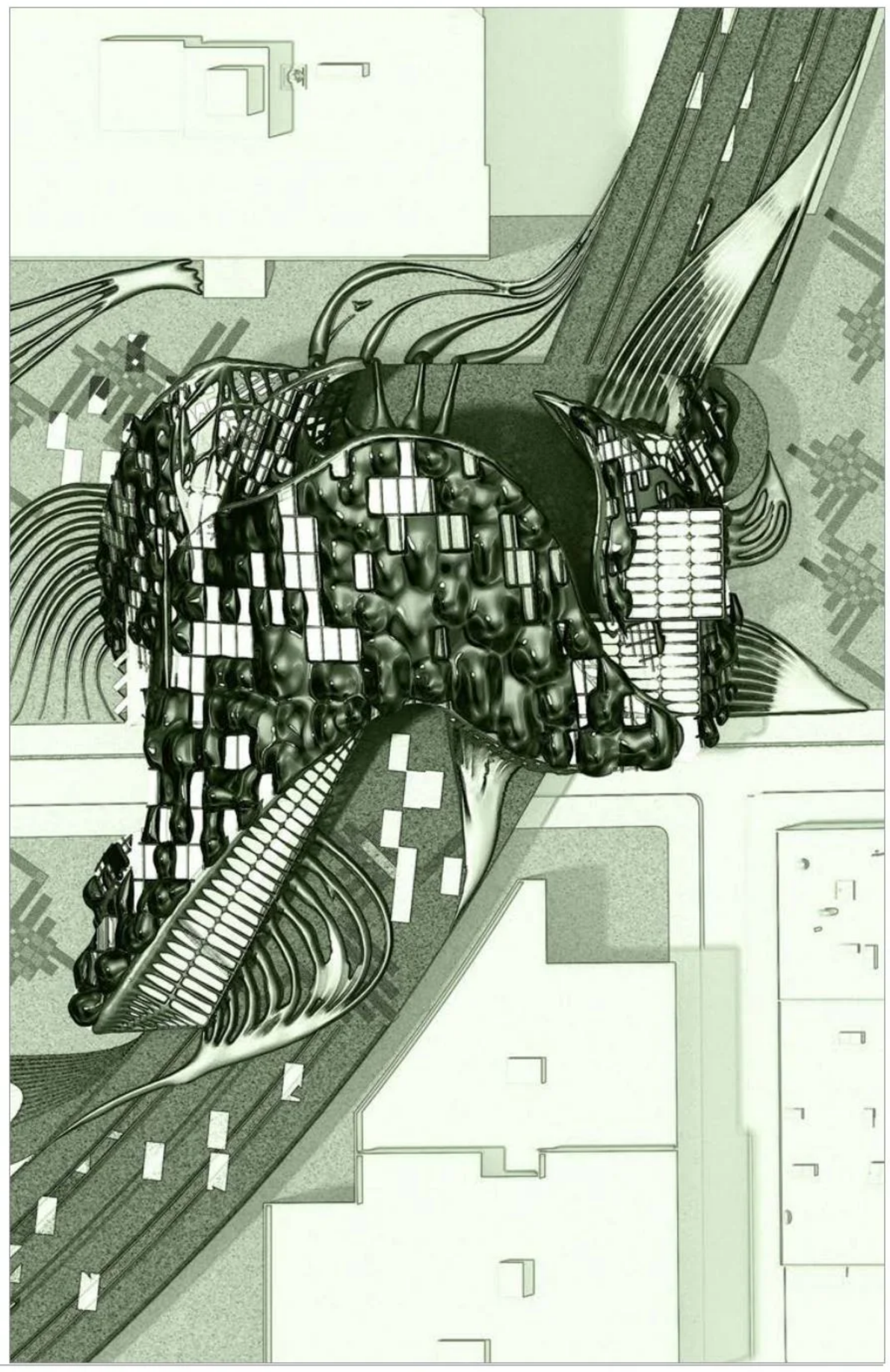
Automata Bazaar connects with Callowhill's rich history and diversity to transition it into the 21st-century and foster higher quality consumer-to-consumer online exchanges and more immersive digital experiences than what can be found at home on a personal computer. Autonomous drones and virtual reality portals offer users a unique physical interface where users can connect with an increasingly digital reality.



Top:
early axonometric rendering, showing experimentation with tectonics and distortions performed in ZBrush

Bottom:
site plan showing context of surrounding warehouse buildings in the Callowhill neighborhood of Philadelphia, PA and integration of the structure with the viaduct

Right:
interior rendering of a person walking into the digital side of the marketplace, followed by a drone

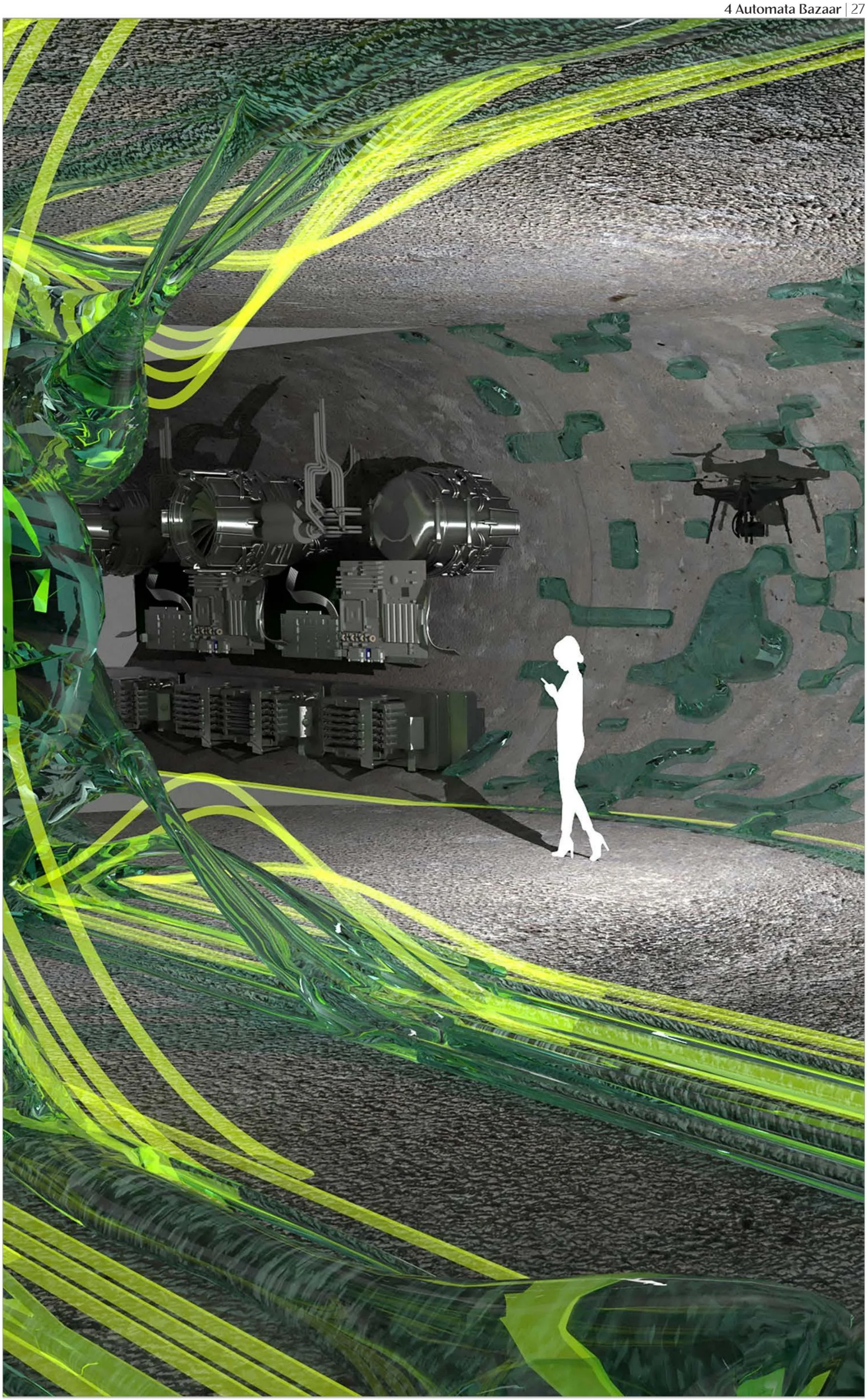


Automata Bazaar is so named because it uses artificial intelligence and an army of various types of drones to self-operate. Therefore, the marketplace is, in some sense, alive.

These drones, or automata, are programmed to perform many tasks such as packaging and shipping items bought and sold within the market, maintaining the immense network of computers and electrical systems that allow the virtual reality portals to work, maintaining the building structure itself, and even gardening the surrounding public green spaces on both the street and viaduct levels. It is even believed that some drones were created solely for the purpose of surveilling the human users of the market and its surroundings...

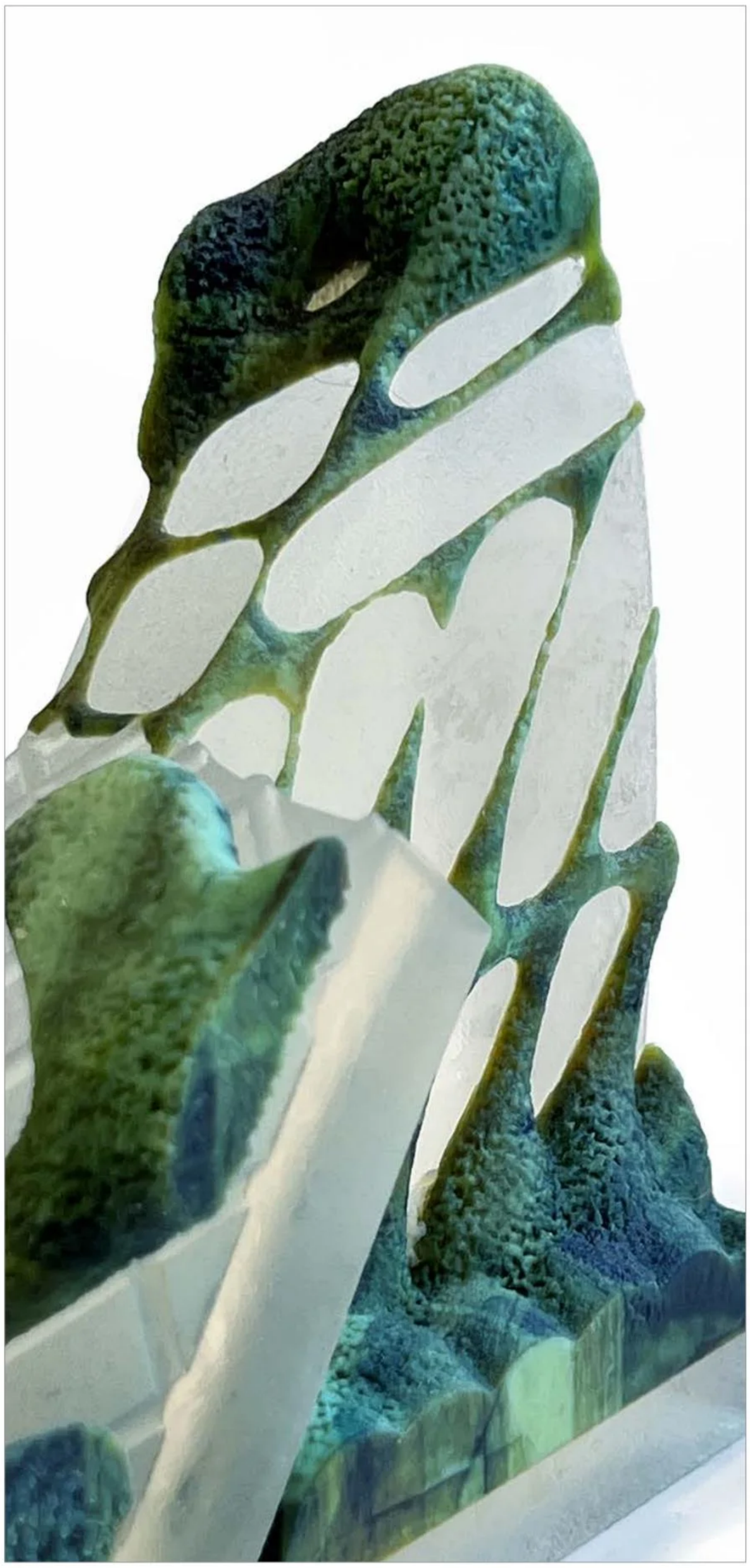
The overall design of the structure intends to highlight its animate, otherworldly, and sometimes sinister presence. The envelop is porous like skin in places, allowing drones to pass through. Large cables grasp at the surrounds, siphoning off electricity from Callowhill's infrastructure. The building even moves and "talks" as the drones fly about, generating a vibrating growl heard throughout the neighborhood.

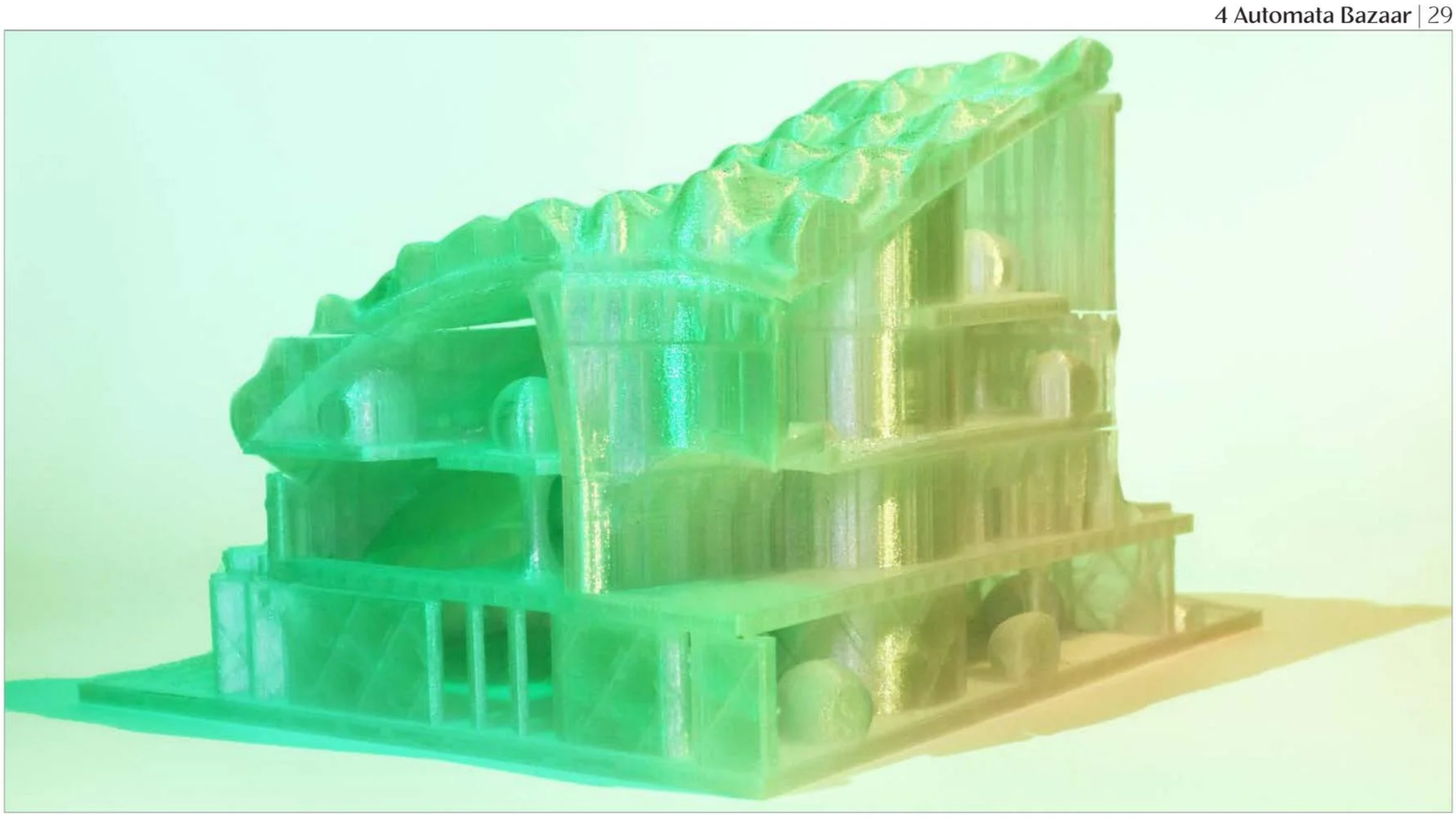
Master of Architecture Candidate | **kirahcahill@gmail.com**

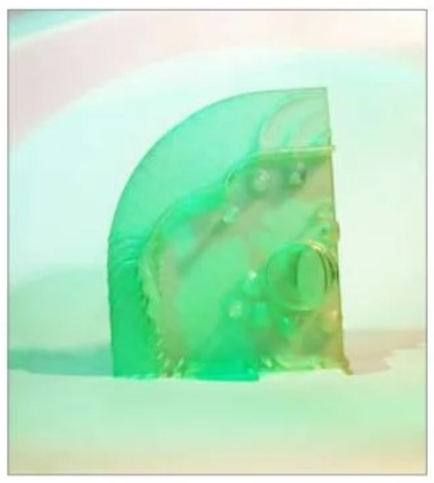


Left:
photograph of detail model, 3D printed with resin powder in transparent and opaque colors.
~4" x 4" x 1"

Right:
photographs of chunk model 3D printed in transparent PETG filament which can be disassembled to view the plan of each floor.
~12" x 12" x 12"



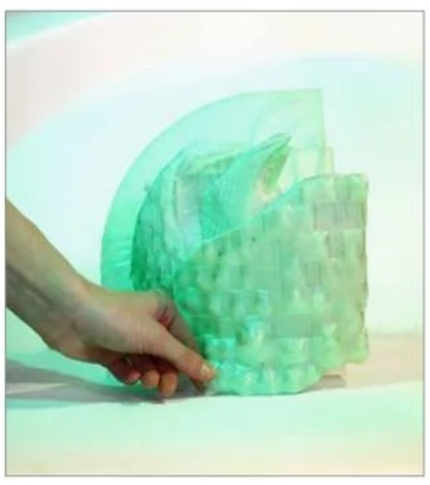




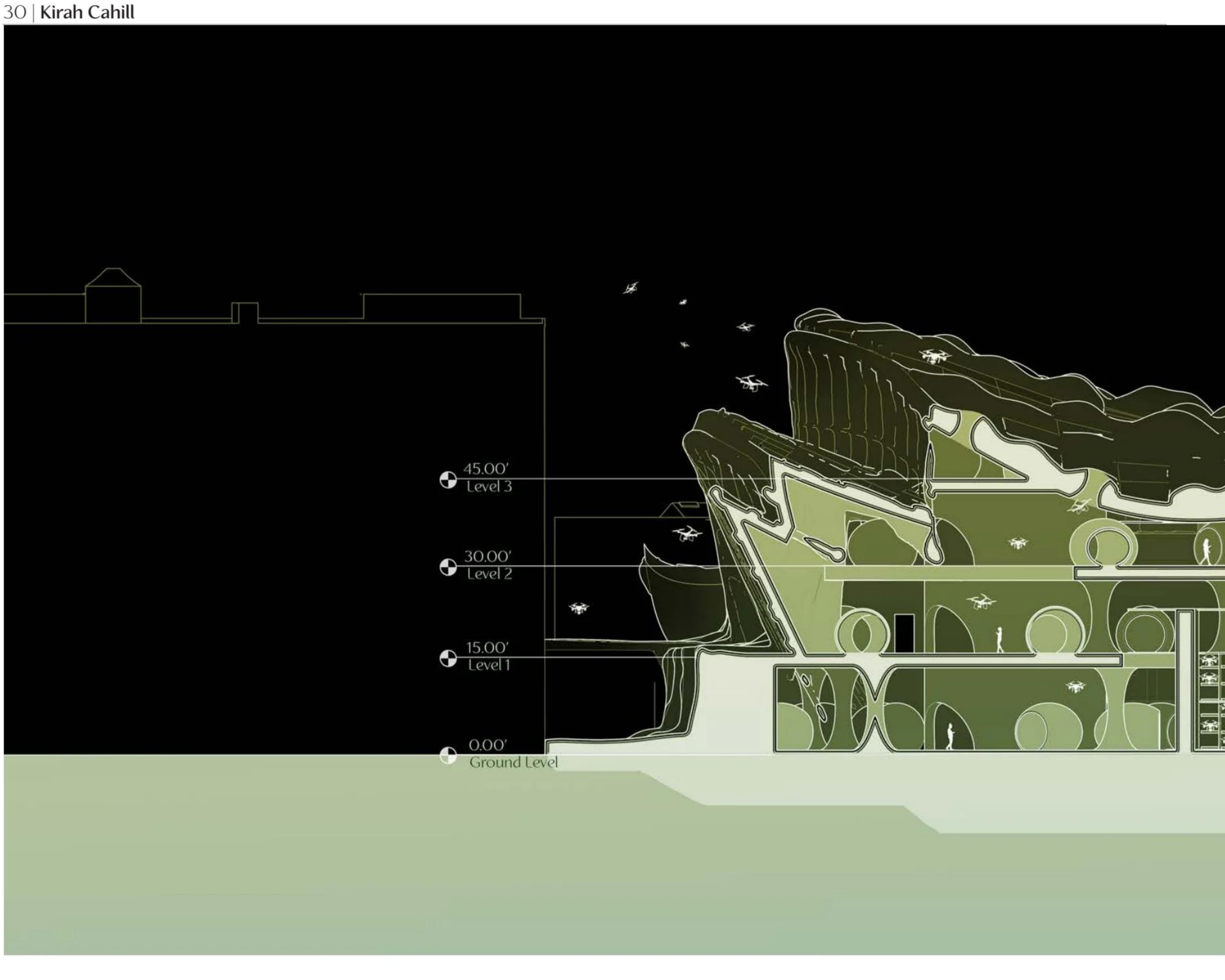








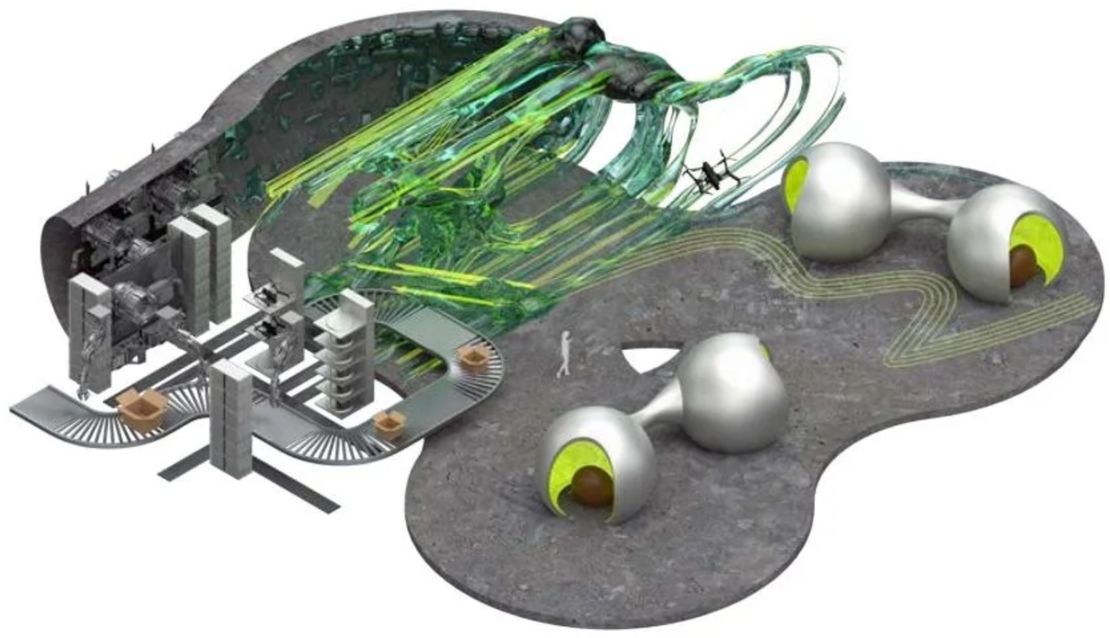




Top:
section drawing showing consumer-oriented area and drone-oriented area of the marketplace

Bottom Left:
photograph of 3D printed physical chunk model showing the area of the market designated for human interactions, complete with virtual reality shopping pods

Bottom Right:
second level plan showing the building's relationship to the historic viaduct which is unique to the Callowhill area of Philadelphia



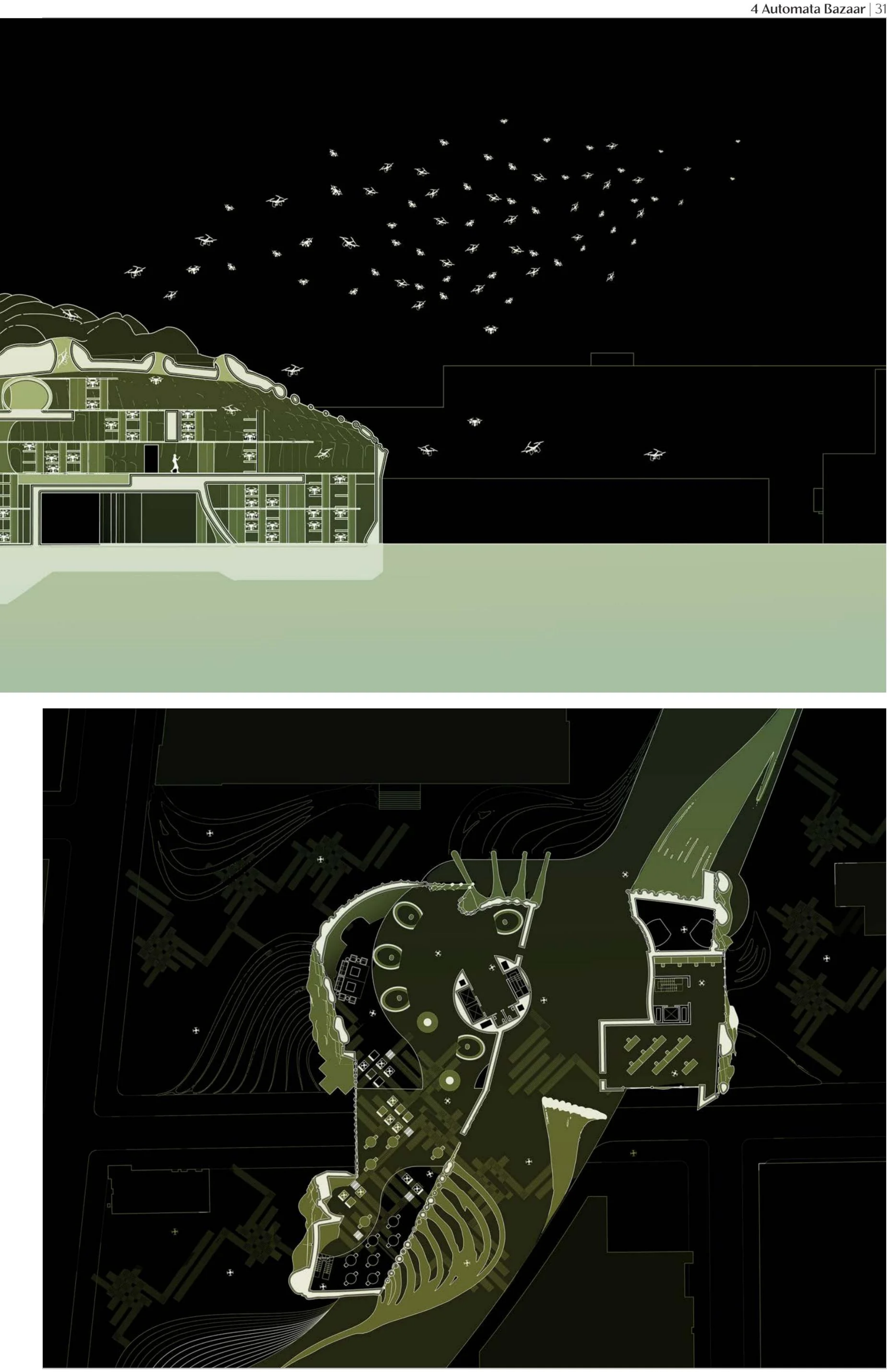
Inside the market users will find immersive, interactive virtual reality portals. These portals feature convex screens which reach around a lounge chair to embrace the user, physically separating them from their reality and encompassing their entire field of vision so as to generate the most captivating digital experience possible. Within these portals, users can create digital products and buy or sell digital goods and services.

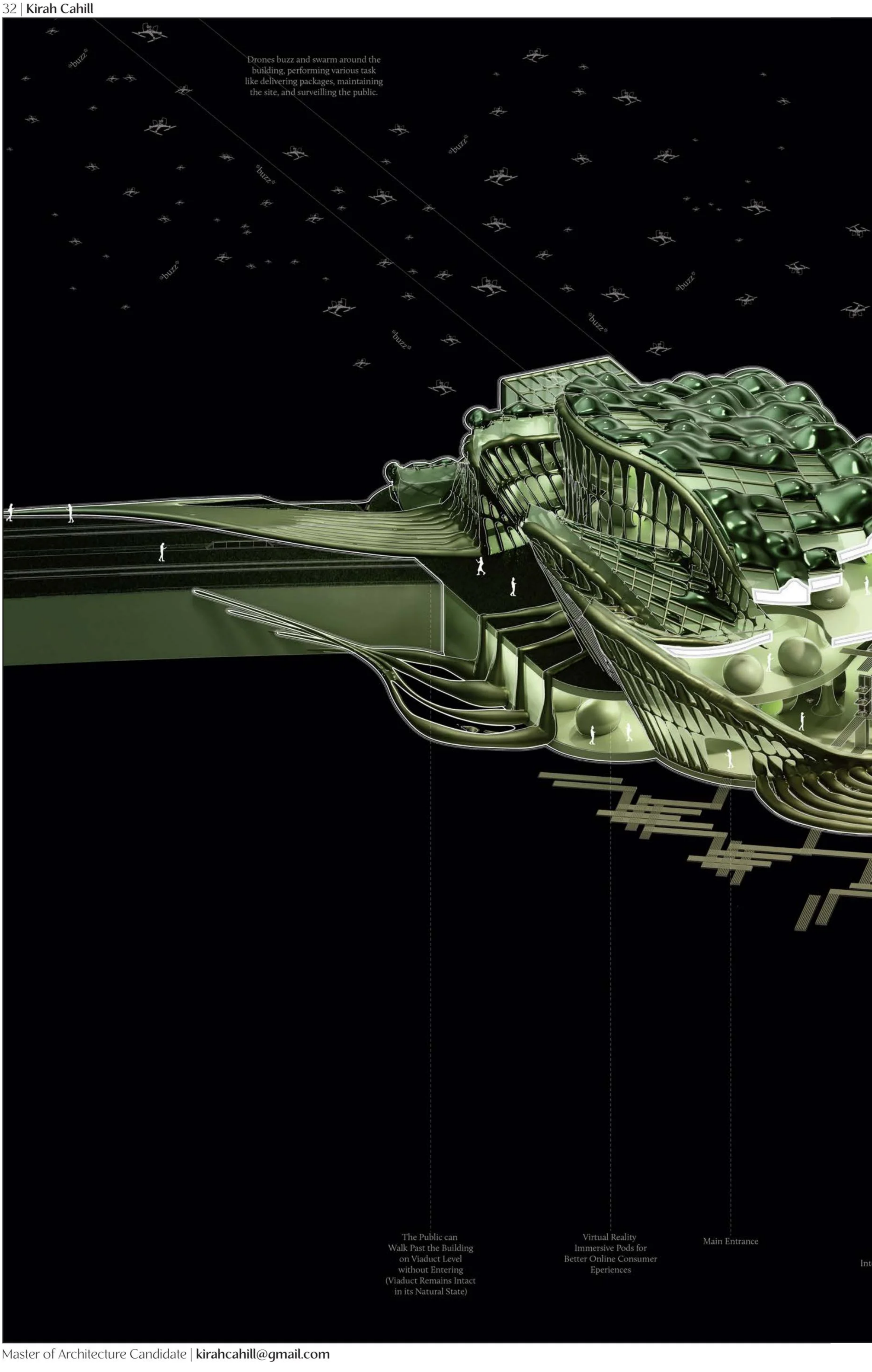
Drones allow the exchange of physical goods through online networks. When a physical good is bought or sold through the market's virtual reality portals, the drones will take care of all sorting, packaging, and shipping fulfillments. The drones can even leave the market to deliver goods straight to consumers homes in the greater Philadelphia area.

Neon cables and wires create communications networks between the virtual reality portals and the drone's computer interface and docking system which add to the overall user experience, visually illustrating the complexities of the Automata Bazaar's operations.



Master of Architecture Candidate | **kirahcahill@gmail.com**





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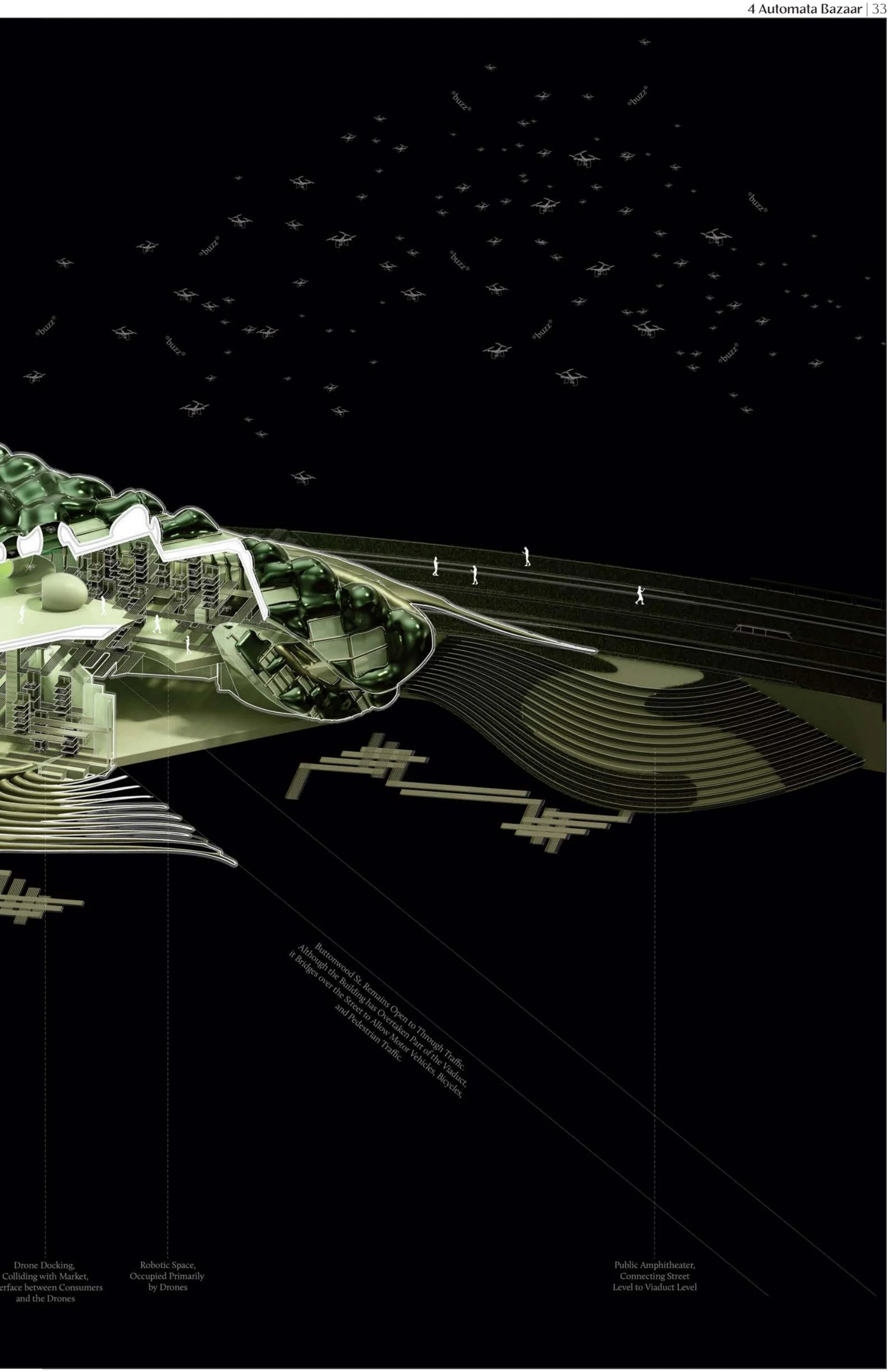
buzz
buzz
buzz
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buzz
Buttonwood St. Remains Open to Through Traffic.
Although the Building has Overtaken Part of the Viaduct,
it Bridges over the Street to Allow Motor Vehicles, Bicycles,
and Pedestrian Traffic.
Drone Docking,
Colliding with Market,
erface between Consumers
and the Drones
Robotic Space,
Occupied Primarily
by Drones
Public Amphitheater,
Connecting Street
Level to Viaduct Level

Master of Architecture Candidate | **kirahcahill@gmail.com**

5

ERSATZ AVIARY

Disrupt the Reflection Competition
University of Pennsylvania
November 2022

Left:
North Elevation Render

Excerpt from competition brief:

"Philadelphia is located along the Atlantic Americas Flyway, which extends from the tip of South America to the Canadian Arctic. Food sources and nesting areas—from backyards to parks and street trees—support the many billions of migrating birds that make this route annually. The Penn campus also plays a vital role, providing seasonal or year-round habitat to some 80 species of birds, but it also presents the risk of collision with glass windows.

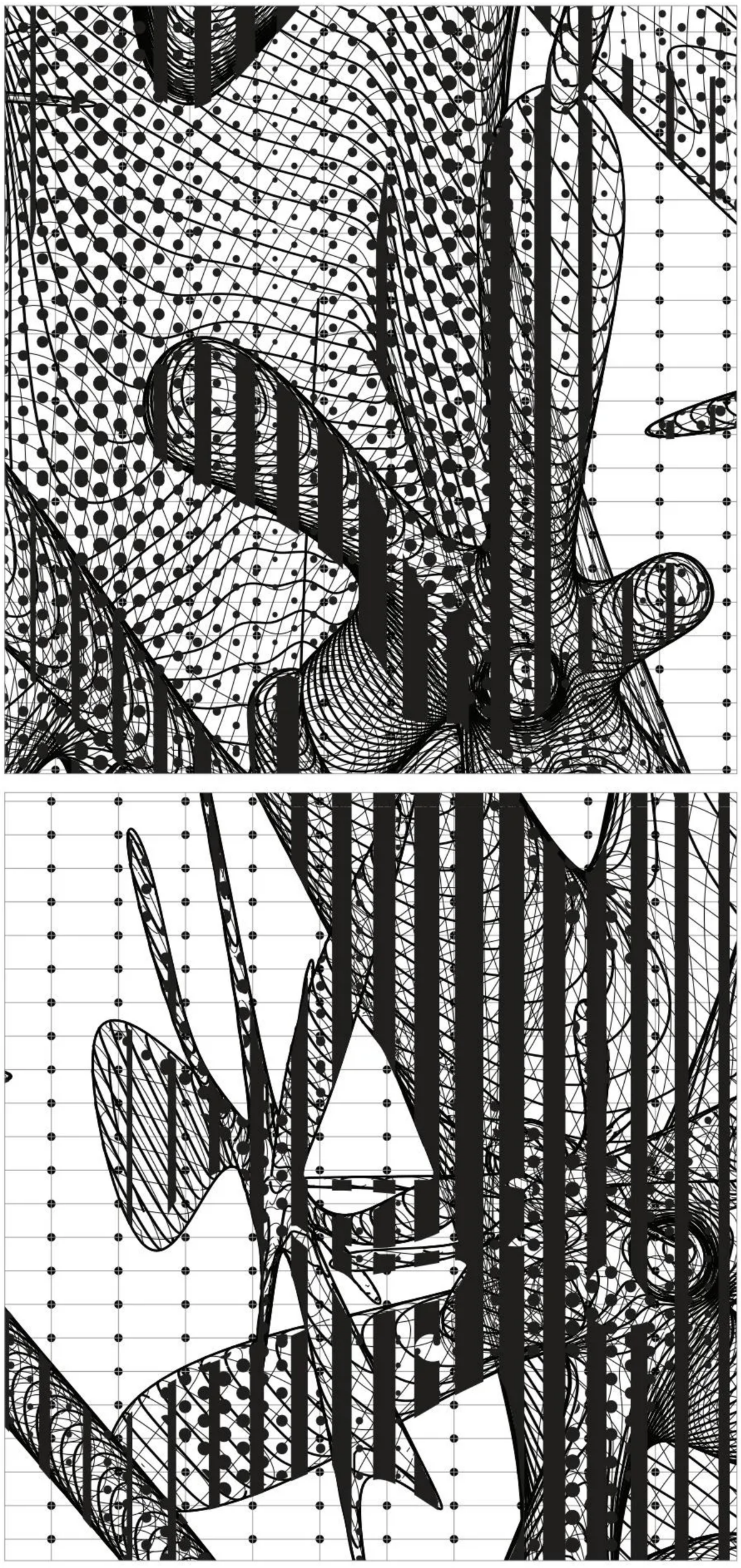
The Disrupt the Reflection competition was announced in September and open to all Weitzman students. The jury included Jeff Goldstein, FAIA, principal and co-founding partner at DIGSAU; Eva Lew, AIA, director of architecture and planning in Penn's Office of the University Architect; Kate Orff, founding principal of SCAPE and director of the Urban Design Program and Center for Resilient Cities and Landscapes at Columbia University's Graduate School of Architecture, Planning and Preservation; Keith Russell, program manager for urban conservation for Audubon Mid-Atlantic; and Lucinda Sanders, adjunct professor of landscape architecture and design partner and president and CEO of OLIN.

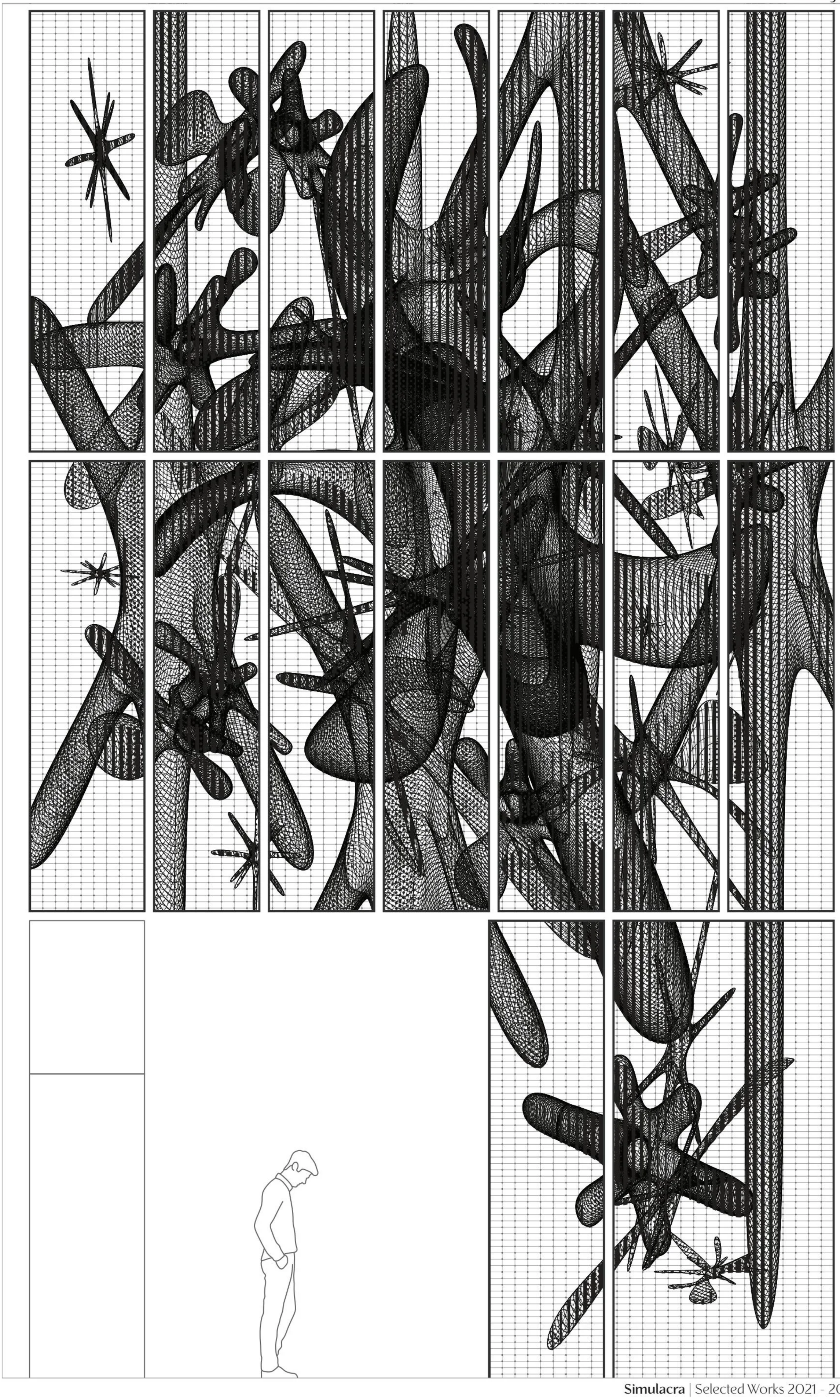
The competition was organized by Karen M'Closkey, associate professor of landscape architecture, in consultation with Bird-Friendly Penn, which is led by the Penn Facilities & Real Estate Services Landscape Architecture Group in partnership with Penn Sustainability."

This design for the Larry Robbins House at the University of Pennsylvania creates the illusion of a dense thicket of foliage-esque figures. Designed to mimic plants and tree branches, this abstract application design will help birds see the glazing on the Robbins House at the University of Pennsylvania, thereby limiting bird collisions and deaths. The pattern is drawn with lines spaced between 2" and 4" apart, which is the height and width of an average flying bird. This spacing signals to birds that they cannot fit to pass through.

Left:
close-up images of screen design, showing various line weights and hatch patterns which together create a visible barrier that birds will know to avoid during flight.

Right:
drawing of screen design as it would appear over the entire building facade, with a figure for scale reference.





Master of Architecture Candidate | **kirahcahill@gmail.com**

6

GROTTESCA DOMINA

ARCH 7010 Design Studio V
Barry Wark
Fall 2023

Collaborator:
Sophie Wojtalewicz

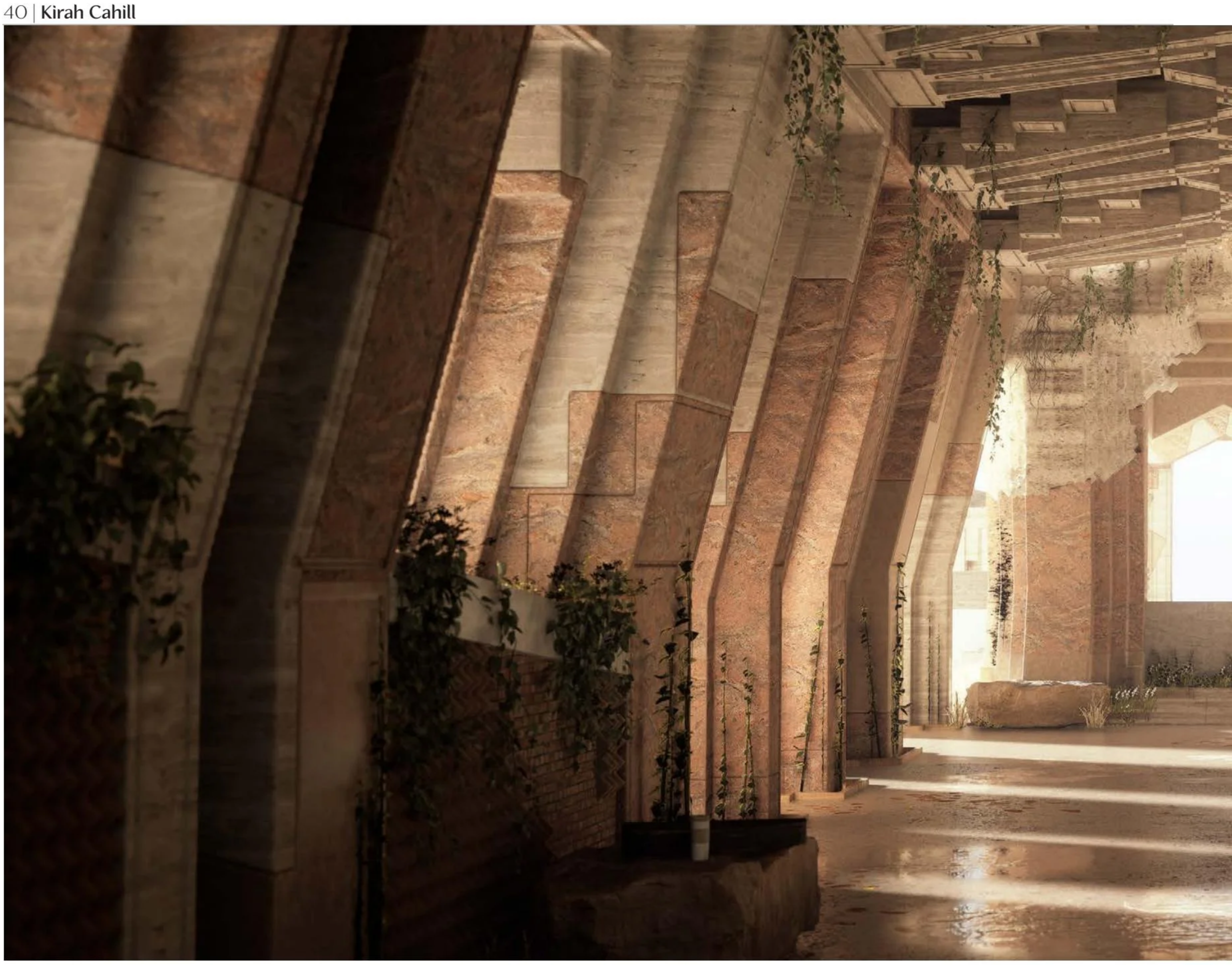
Left:
exterior rendering showing potential weathering effects interacting with the building structure and envelope

Located on the northern side of Bologna, Italy, Grottesca Domina is a civic structure designed based on ideas of temporality and environmental enmeshment. Connected to a canal with a vibrant ecosystem, the project aims to foster critical discussion and analysis of the integration between man-made urban fabric and "nature" - which man often views as separate from himself despite being inextricably linked.

Grottesca Domina is a structure composed of two parts - a permanent structure constructed from Italian travertine marble that is designed to last for centuries or longer and a, relatively, temporary structure constructed primarily from brick which will last for some decades while allowing for more flexibility and change than the permanent structure. As seen in project images, the marble primary structure of Grottesca Domina reinterprets Bologna's traditional grotto and porticoes in contemporary, semi-enclosed spaces which allow for flexible, multipurpose spatial programming. Meanwhile, the temporary structure is added in addition to the primary structure, creating thermally enclosed mixed-use spaces that can be more easily modified over time.

These two systems are based loosely on the concepts introduced by Le Corbusier's Maison Dom-Ino, which redefined the approach to building design by separating the structure from the envelope and prompting a distinction between the primary load-bearing elements and the secondary, often more decorative, aspects of a building like facades and envelopes. This design not only provided a flexible and efficient structural system but also marked a shift towards a more rational and industrialized approach to construction. While this separation allowed for greater flexibility in design, enabling architects to explore diverse materials for facades without compromising the structural integrity of the building, it also initiated a shift in architectural thinking from creating long-lasting expressive structures and spaces to focusing primarily on more ephemeral building components such as envelopes and facades and using those elements to hide the perhaps overly efficient and unsightly structure. Grottesca Domina wishes to find a middle-ground between these traditional and modern design ideologies by creating an expressive and lasting structure that has the qualities of flexibility and modularity that the Maison Dom-Ino exhibited, but without relying on the building envelope as the primary design element.

Furthermore, Grottesca Domina highlights the often forgotten or mis-



Top:
rendering of semi-enclosed portico interior space

Left:
exterior rendering showing rustication of the lower levels near the canal, with textured quoining that allows for thicker vegetation growth on the side of the building and distributes weathering across each surface to enhance its aesthetic appeal

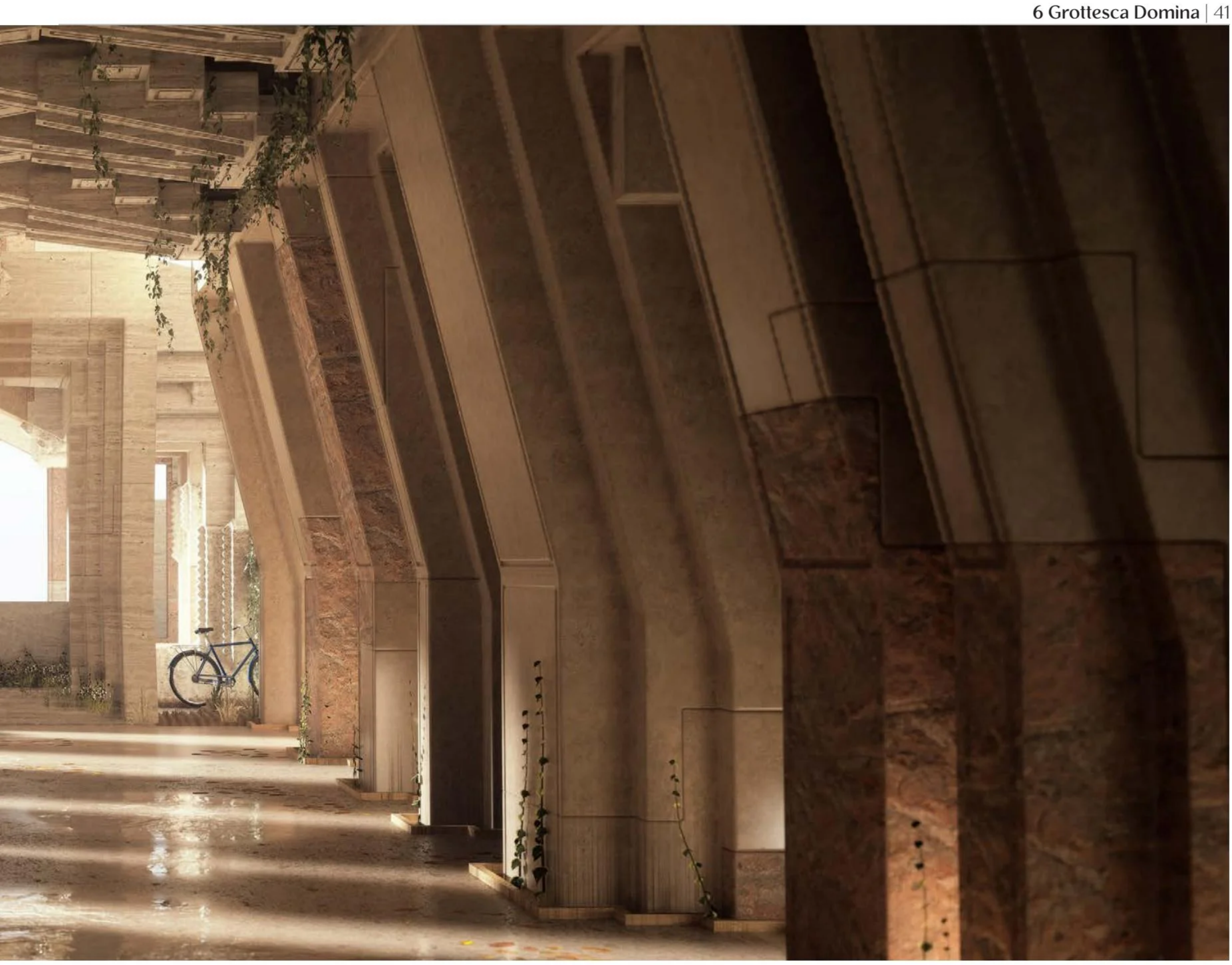
Right:
exterior rendering from the canal level, showing the facade is perforated with various entrances and tunnels for people and water



interpreted relationship between humans and the environment. Ideas of environmental enmeshment relate back to essays by Timothy Morton, who theorized that the idea of a pristine, harmonious nature is a misleading construct that hinders our understanding of ecological issues. He advocates for an ecological approach that embraces the interconnectedness of all entities, including human and non-human elements, in a complex and dynamic mesh. Morton introduces the term "mesh" to describe this entanglement, emphasizing the interdependence and coexistence of various beings. The book encourages a shift in perspective from viewing nature as an external, untouched entity to recognizing ecological relationships as inherently intertwined and inseparable from human existence.

The primary structure interacts directly with the canal by pumping water through the unique grotto-like moments and channeling rain water from the structure into the canal below. This interaction offers a peaceful and therapeutic environment for users, who would be surrounded by the calming sound of trickling water and colorful sights of lush vegetation.

Master of Architecture Candidate | **kirahcahill@gmail.com**

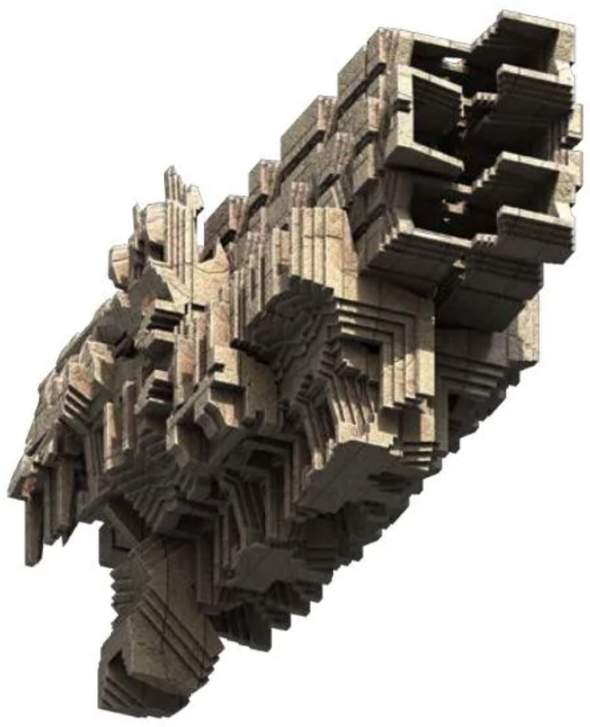




Top:
interior image showing the view from below the grotto space, as light filters through and water trickles down the wall in a small stream

Bottom:
early study objects exploring the tectonic relationships between individual stone pieces and their assembly to form the grotto, portico, temporary structure

Right:
interior rendering from inside the grotto space, looking toward the portico spaces



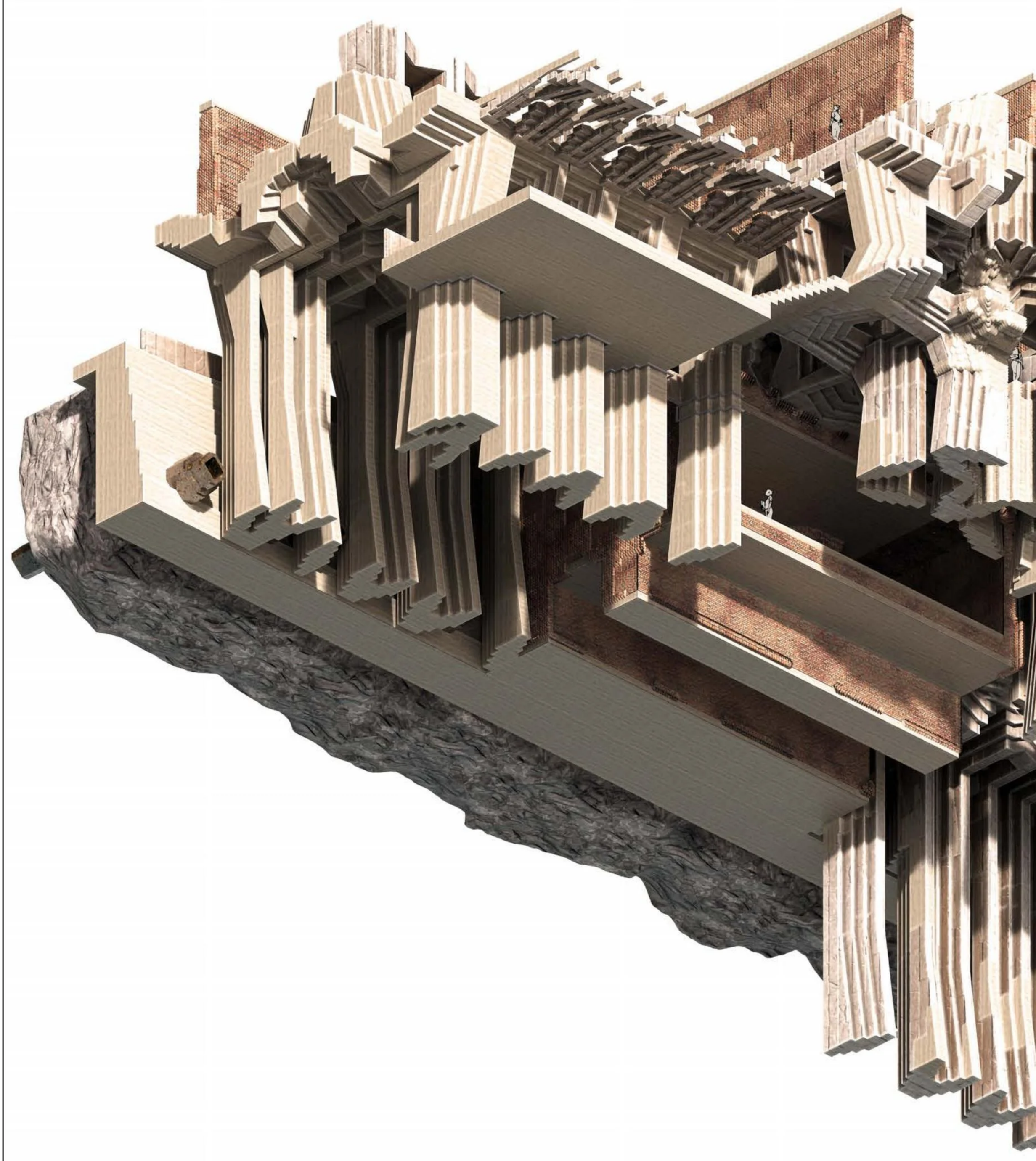
Moreover, however, the constant flow of water through the structure and the unique formal language with repeated rhythmic edge conditions and slanted surfaces will result in aesthetic weathering conditions, such as the accumulation of staining and microbial life. These weathering effects will highlight the structure's enmeshment with the environment as well as convey an even greater sense of temporality which is closer to a human sense of time.

Beyond the connection to water, Grottesca Domina also considers solar design as key way in which the building emphasizes the passage of time and intensifies its overall atmospheric and aesthetic conditions. Strong contrasts are created between the multiplicitous edges and slanted surfaces, practically changing the building's form right before the viewer's eyes as the sun passes across the warm travertine and brick. Each time a person visits the building will appear different, as the lighting conditions change from morning to evening and summer to winter.



Master of Architecture Candidate | **kirahcahill@gmail.com**





Master of Architecture Candidate | **kirahcahill@gmail.com**





7

JACKED K'NEX

ARCH 5010 Design Studio I
Kyriaki Goti
Fall 2021

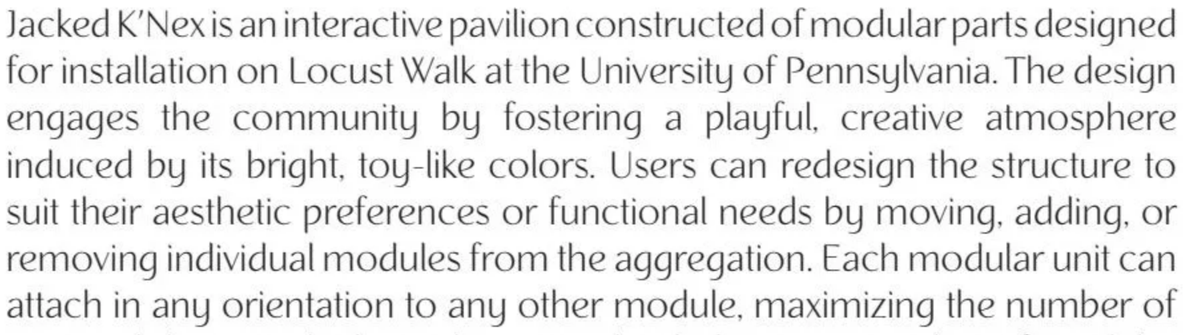
Collaborators:
Ying Chen,
Diego Martin,
Yanjie Zhang

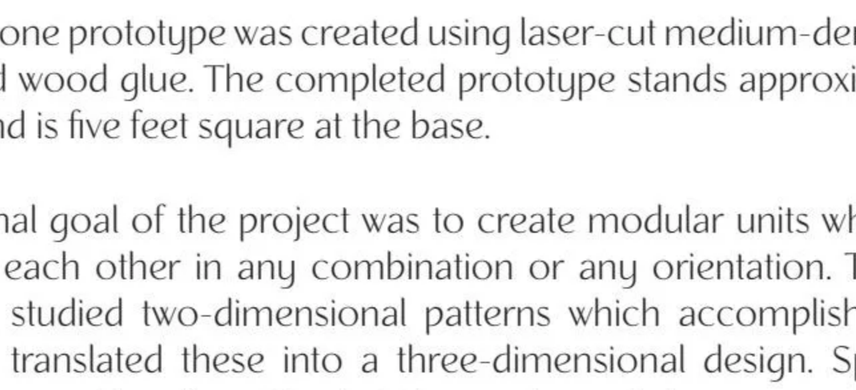
Left:
photograph showing 6' tall physical model, constructed with laser-cut MDF and wood glue.

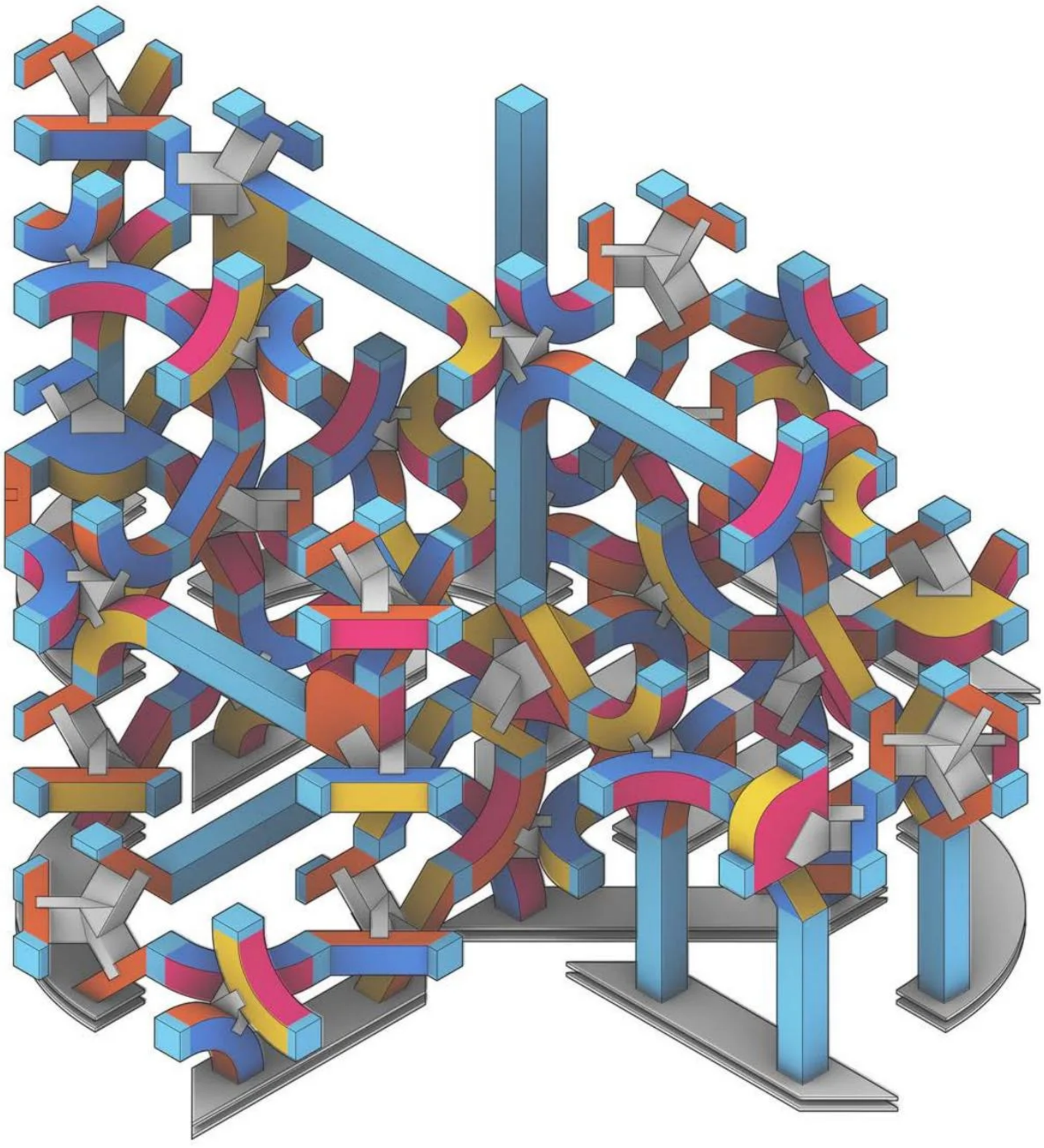
Jacked K'Nex is an interactive pavilion constructed of modular parts designed for installation on Locust Walk at the University of Pennsylvania. The design engages the community by fostering a playful, creative atmosphere induced by its bright, toy-like colors. Users can redesign the structure to suit their aesthetic preferences or functional needs by moving, adding, or removing individual modules from the aggregation. Each modular unit can attach in any orientation to any other module, maximizing the number of potential designs which can be created with the given number of modular pieces.

A one-to-one prototype was created using laser-cut medium-density fiber-wood and wood glue. The completed prototype stands approximately six feet tall and is five feet square at the base.

The original goal of the project was to create modular units which could attach to each other in any combination or any orientation. To do this, the team studied two-dimensional patterns which accomplish this idea and then translated these into a three-dimensional design. Specifically, inspiration was taken from Truchet tiles, as shown below.



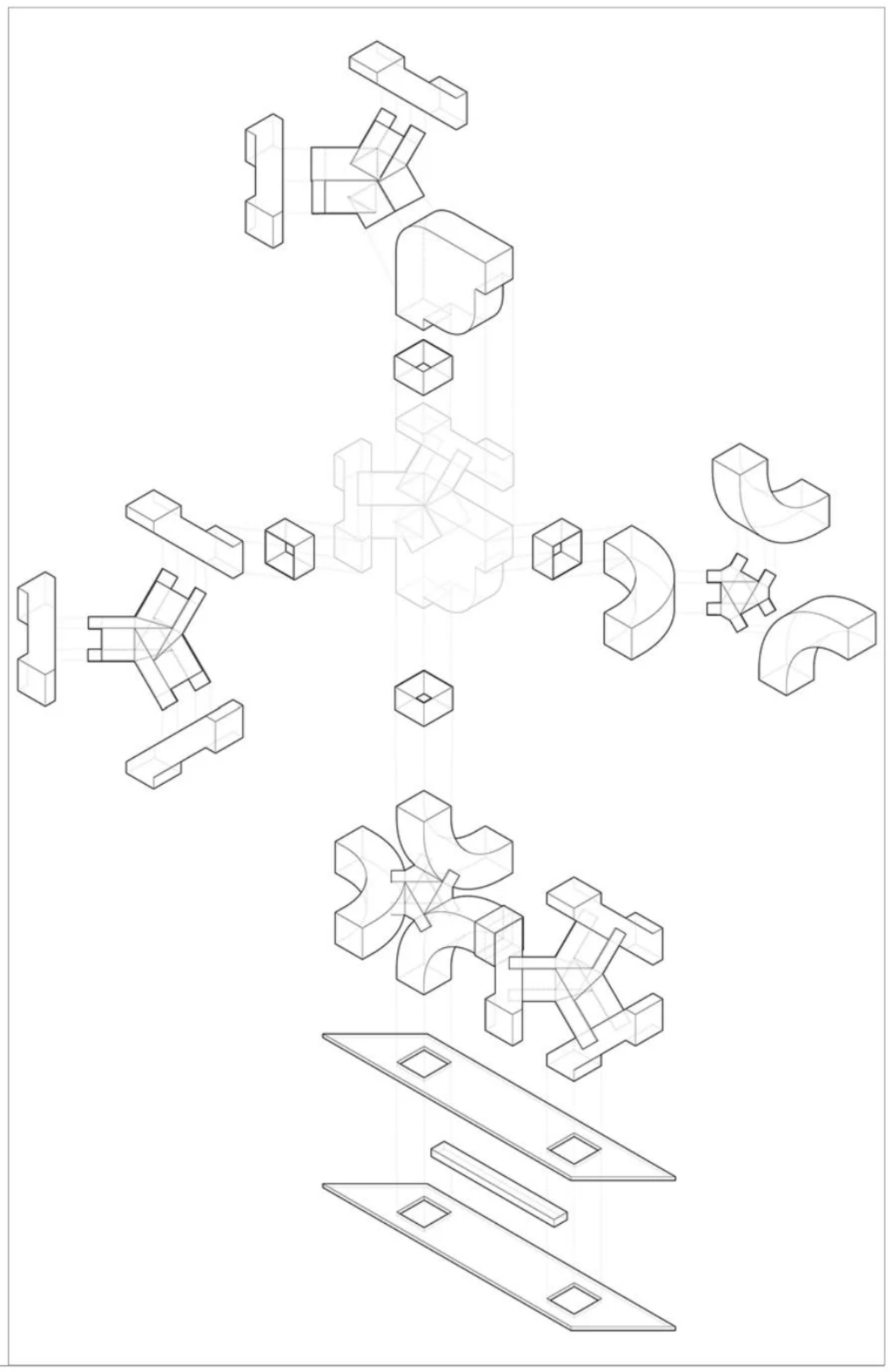




Top:
axonometric view of sample aggregation of modules

Bottom:
exploded axonometric illustrating assembly and component logic of an individual modular unit

Right:
orthographic views demonstrating organizational logic of the modules



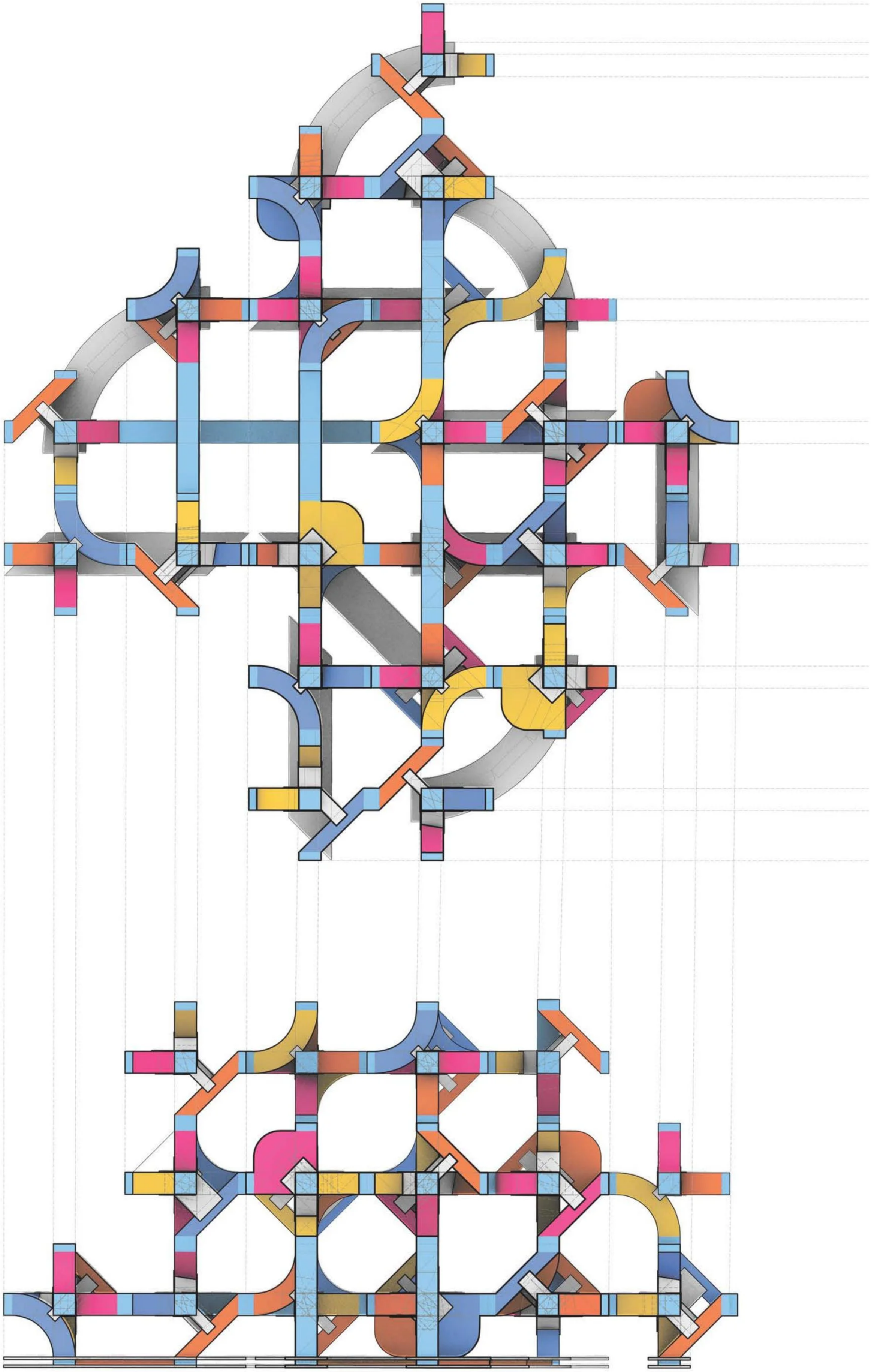
Once the overall tectonic was decided on, the main focus of the team was designing a central connecting node which would hold the three arms of each module together. This was the most important factor in the fabrication process because each module had a unique composition of arm styles and therefore required its own unique connection node.

For example, the exploded axonometric immediately to the right shows one of each module type. It is clear that the connecting elements for the module on the right, composed of curved arms, is different from the module on the left, composed of straight arms.

These central connecting pieces were also required to hold each of the three arms at a precise angle which would allow all module types to connect with each other, as facilitated by wooden sleeves which bound the arms of multiple modules together.

Furthermore, these nodes had to be laser-cut and assembled by hand within the tolerance, due to limited fabrication time available which made 3D printing these connections impossible.

Master of Architecture Candidate | **kirahcahill@gmail.com**



Master of Architecture Candidate | **kirahcahill@gmail.com**

8

CIRROSTRATUS

ARCH 6020 Design Studio IV
Danielle Willems
Spring 2023

Collaborators:
Haoxing Chen
& Ruiqi Han

Left:
early design development tectonic
and material studies

Cirrostratus hybridizes two infrastructures - the data center and water filtration plant - into one cohesive and aesthetically exuberant pier structure located on the Hudson River in New York City. This project is further differentiated from other infrastructural projects because it is open to the public, providing an educational experience to spread awareness of pollution in the Hudson River, and it utilizes multiple modes of passive climate control.

The project challenges the traditional architectural typology of the data center with its unique server cooling methods, adaptable server organization that allows for growth over time, and experiential programming designed to allow further interface with the public while still maintaining data security. Typically, data centers are designed with closed, windowless rooms and boring rows of servers. These facilities are usually closed to the public, with high levels of security throughout. A prime example of a standard data center building typology is the AT&T Long Lines building in New York City. This structure has a rigid, brutalist design with no windows and relies completely on unsustainable mechanical air conditioning for climate control and cooling its servers. Cirrostratus challenges this typology by using a renewable source for its cooling - the Hudson River. Water is pumped from the river into the building on the west end, where it then passes through water-chilled precast concrete slabs and a series of tanks located adjacent to the data servers. At this point, the water acts as a heat sink; the chilly water absorbs heat from the servers through both radiation and convection. By the time the water reaches the east end of the project, it has warmed and is released back into the Hudson River. Beyond this new cooling method, Cirrostratus challenges the typical data center typology by opening itself to the public. Data is still secure in locations unreachable to guests, but offers a unique experience where New Yorkers can observe the beautiful light show of the data servers as their lights filter through transparent rods and the water tanks, flickering and reflecting the motion of the waves onto the ceiling and walls. Users will feel like they are underwater, in a quiet and meditative retreat from the loud and busy streets of New York City.

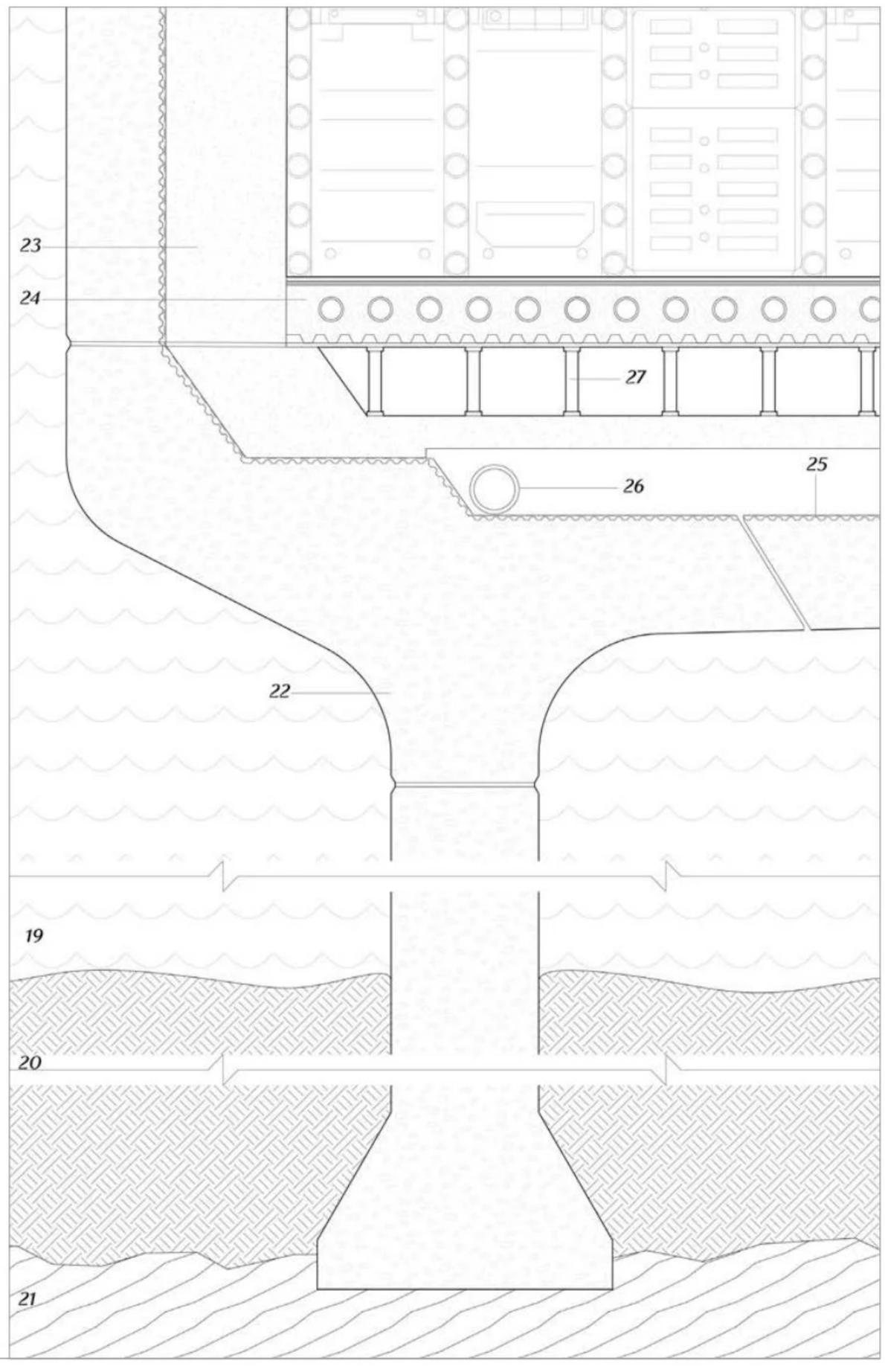
When designing the water-based cooling method for Cirrostratus, the designers believed the project offered a unique opportunity to support the ecosystem of the Hudson River. This way, the project doesn't merely use the river for its resources, but also gives back to the environment to create a symbiotic relationship with the site.



Top:
night time plan view rendering

Bottom Left:
detail drawing showing foundation condition

Bottom Right:
day time site plan showing site relationship to Hudson River Park and apartments



A mix of precast and in situ concrete is used to create the lower half of the building which comes into contact with the water. The outermost layer of concrete acts as a waterproof barrier, the next inner layer is part of the main structural system, and the floor are made of precast concrete units which include water circulation of cool water which draws heat from the servers out of the building.

Detail Key:
19 - Hudson River
20 - loose soil / sand
21 - bedrock
22 - protective, reinforced concrete
23 - structural reinforced concrete
24 - water-chilled precast concrete flooring
25 - drainage mat
26 - drain
27 - steel substructure elevates floor for server maintenance & cooling

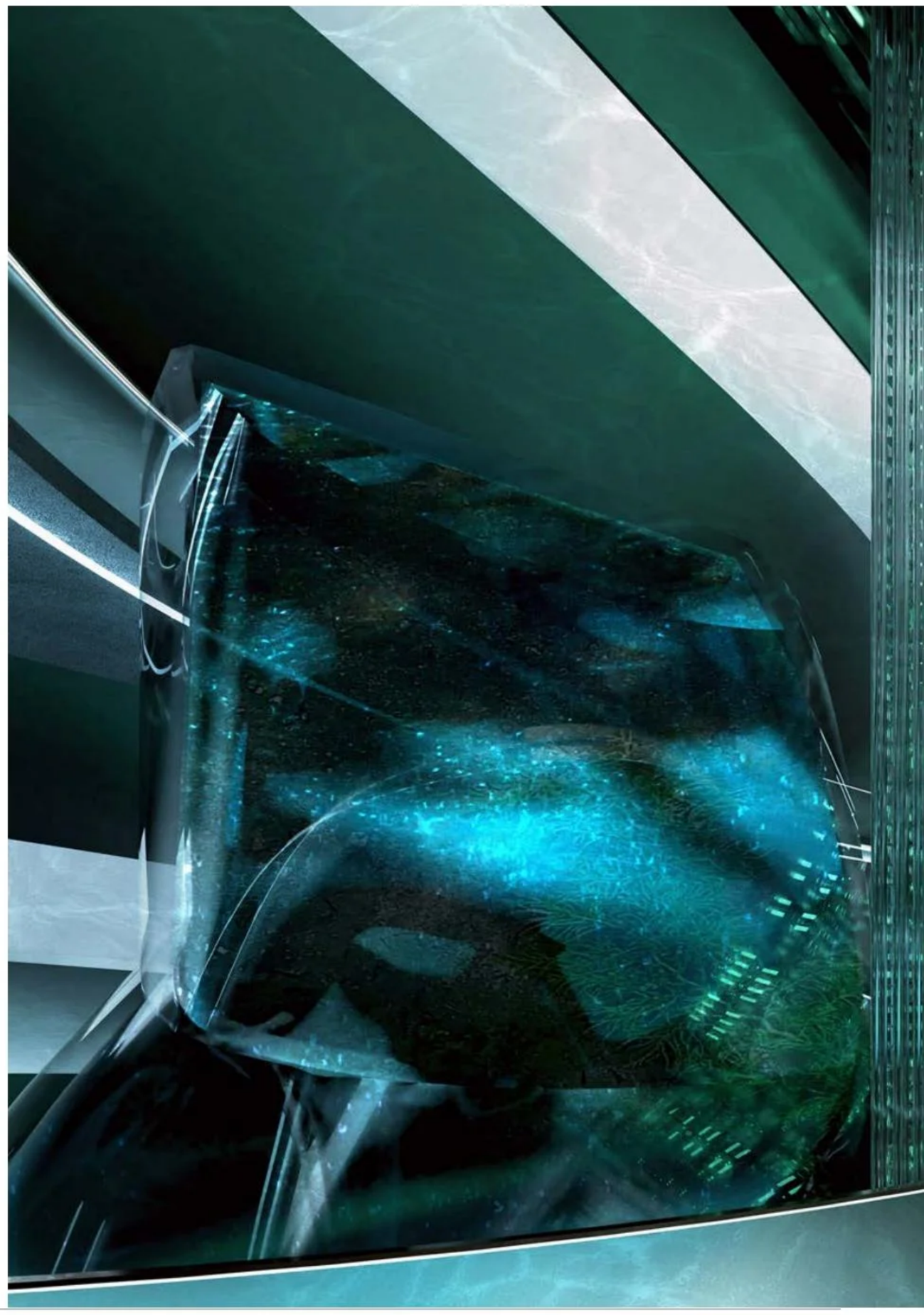
Master of Architecture Candidate | **kirahcahill@gmail.com**




Pier 97 Hudson River Park
Pier 99 NYC Sanitation
Pier 97 Hudson River Park
VIA 57 West Apartments
Pier 97 Hudson River Park

Top:
night time top view render

Bottom:
night time interior render, showing light from the data servers reflecting through the chilled water filtration tanks and transparent glass curtains

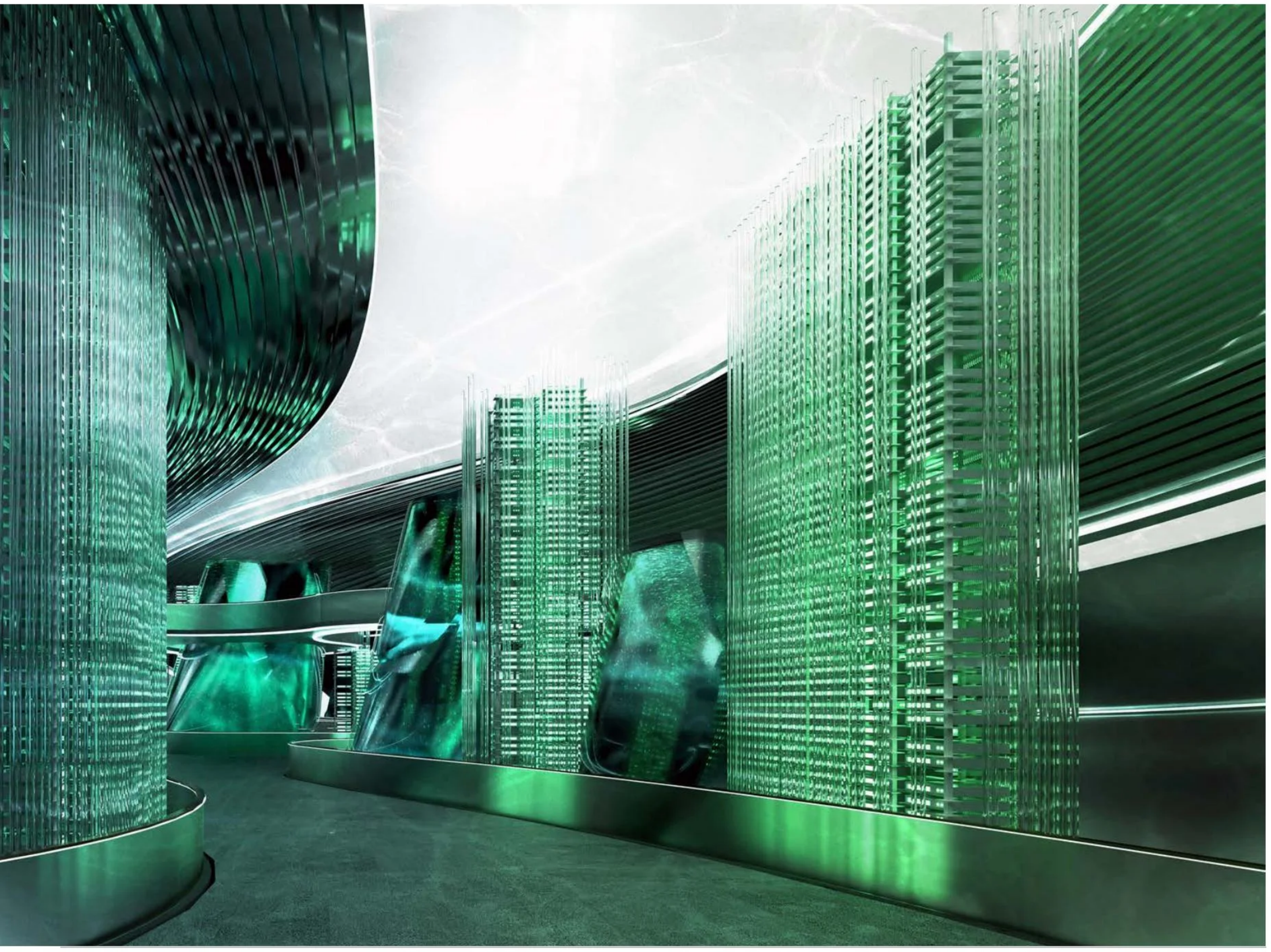


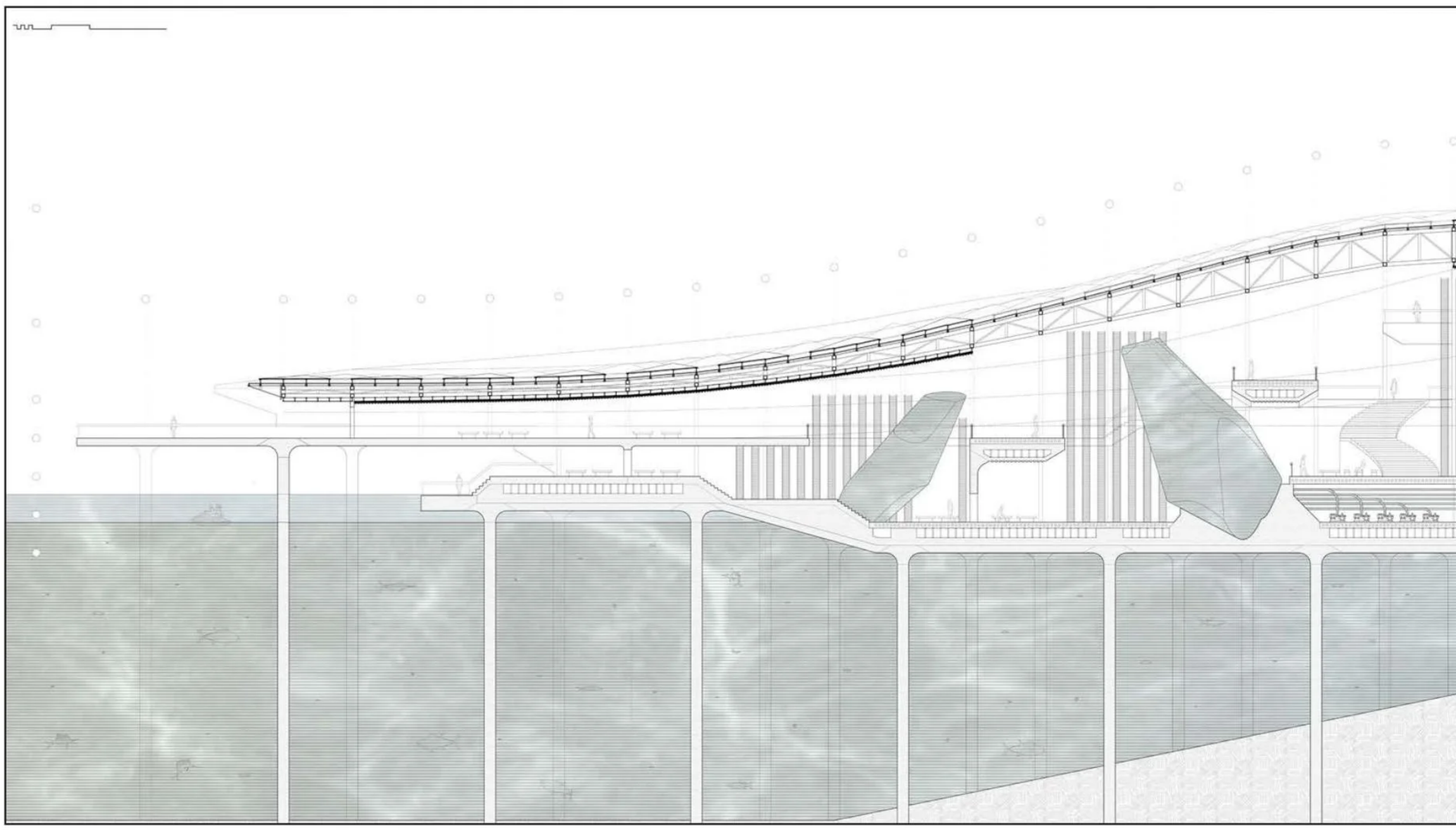
Cirrostratus, therefore, will filter and clean the Hudson River water as it passes through the building and cools the servers. A combination of chemical and natural processes will be used to rid the water of its pollutants. For example, some tanks will contain high concentrations of oyster species that are native to the Hudson River and which naturally filter the water. The public will be able to observe the purification of the river water as they progress through the project. The tanks closest to the west side of the building will display water just pulled from the Hudson and still polluted to a high degree. As users travel closer to the east side of the project, they will observe the water in the tanks becoming progressively more clear and clean. In this way, Cirrostratus will offer a new type of educational experience for citizens of New York, explaining the dangers of water pollution and offering examples of how to take care of the environment.

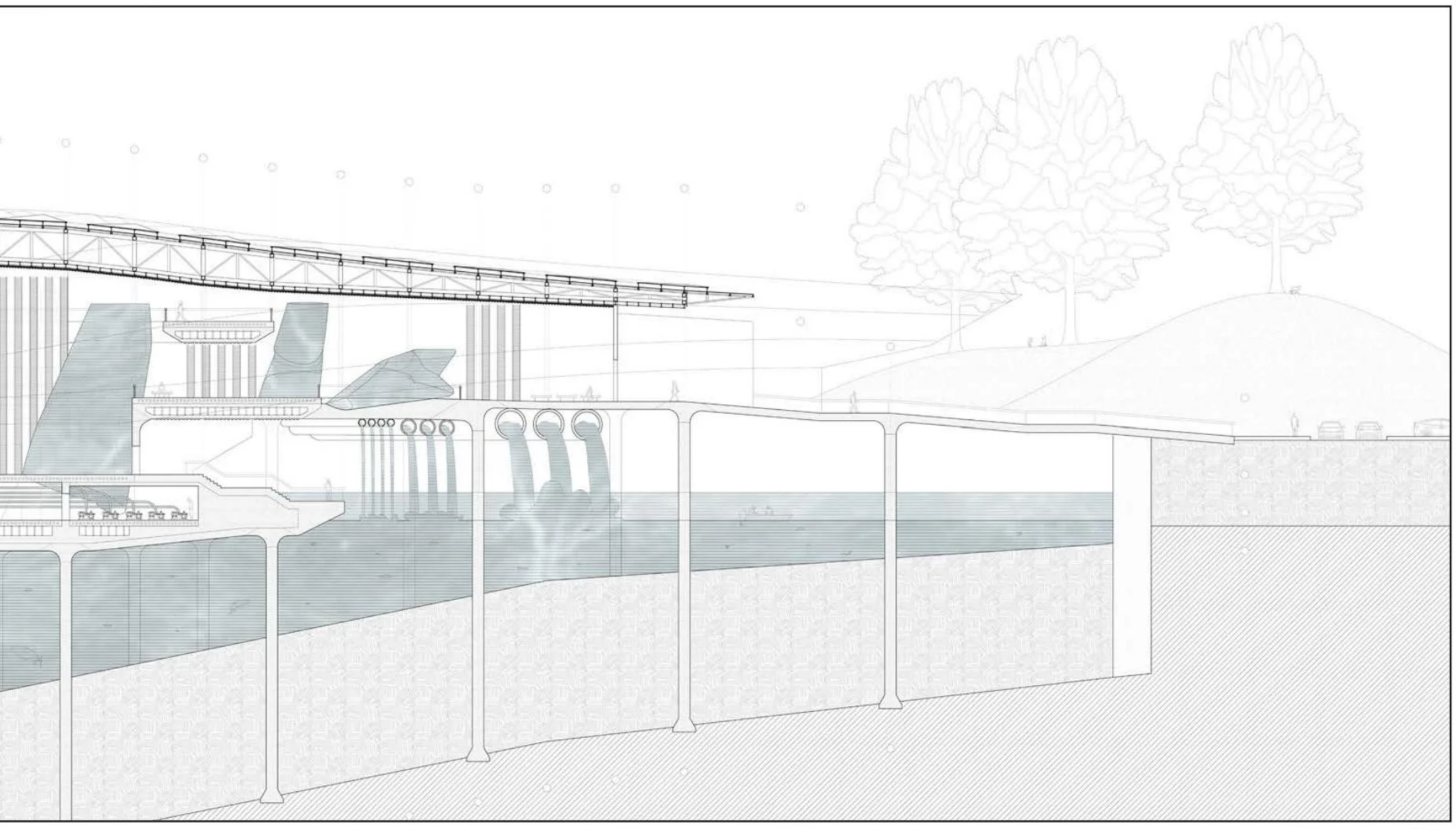
Cirrostratus is a new type of infrastructure project, combining both data center, leisure, and educational programs for users in an exuberant and resilient design.

Master of Architecture Candidate | **kirahcahill@gmail.com**

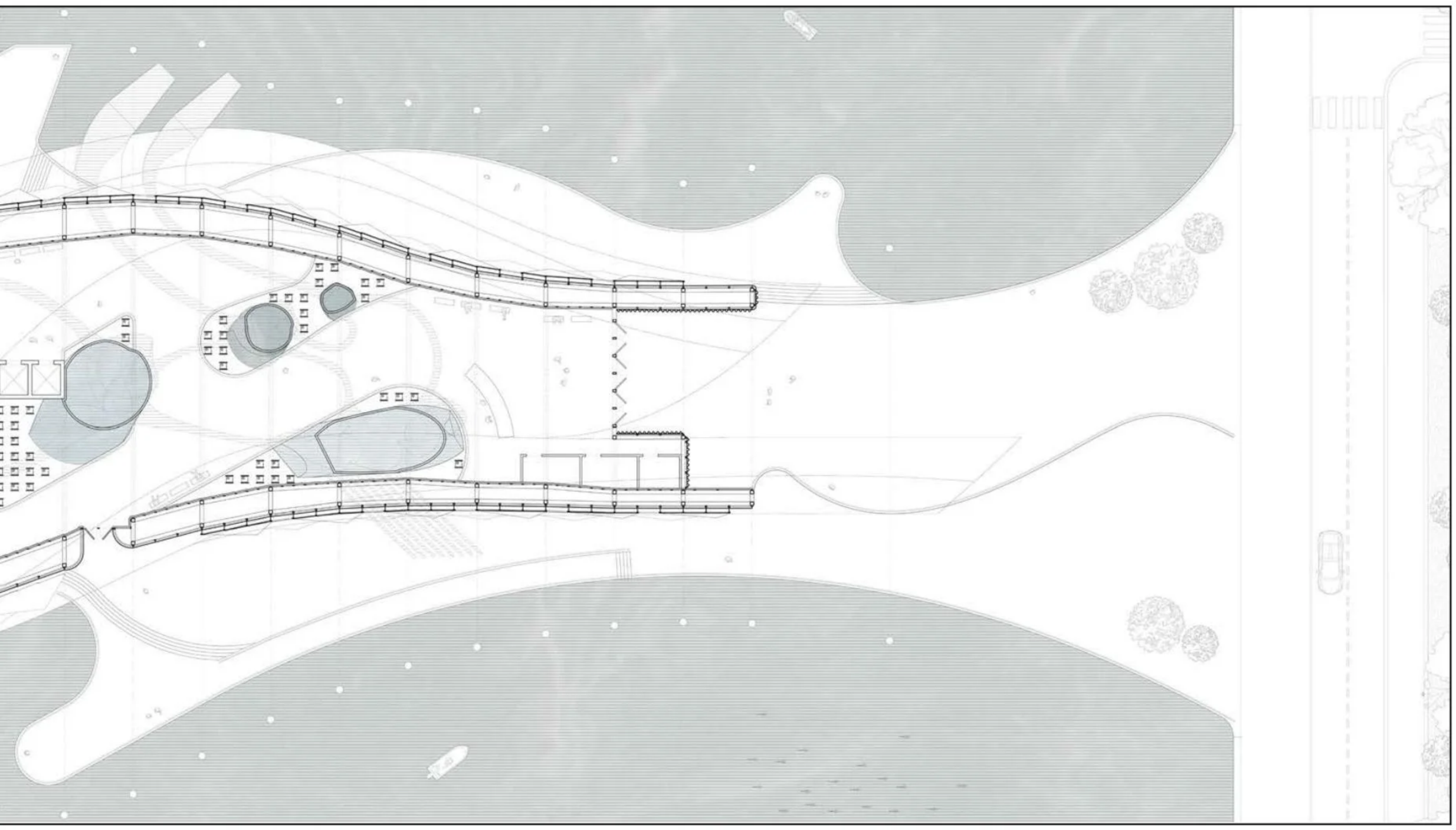




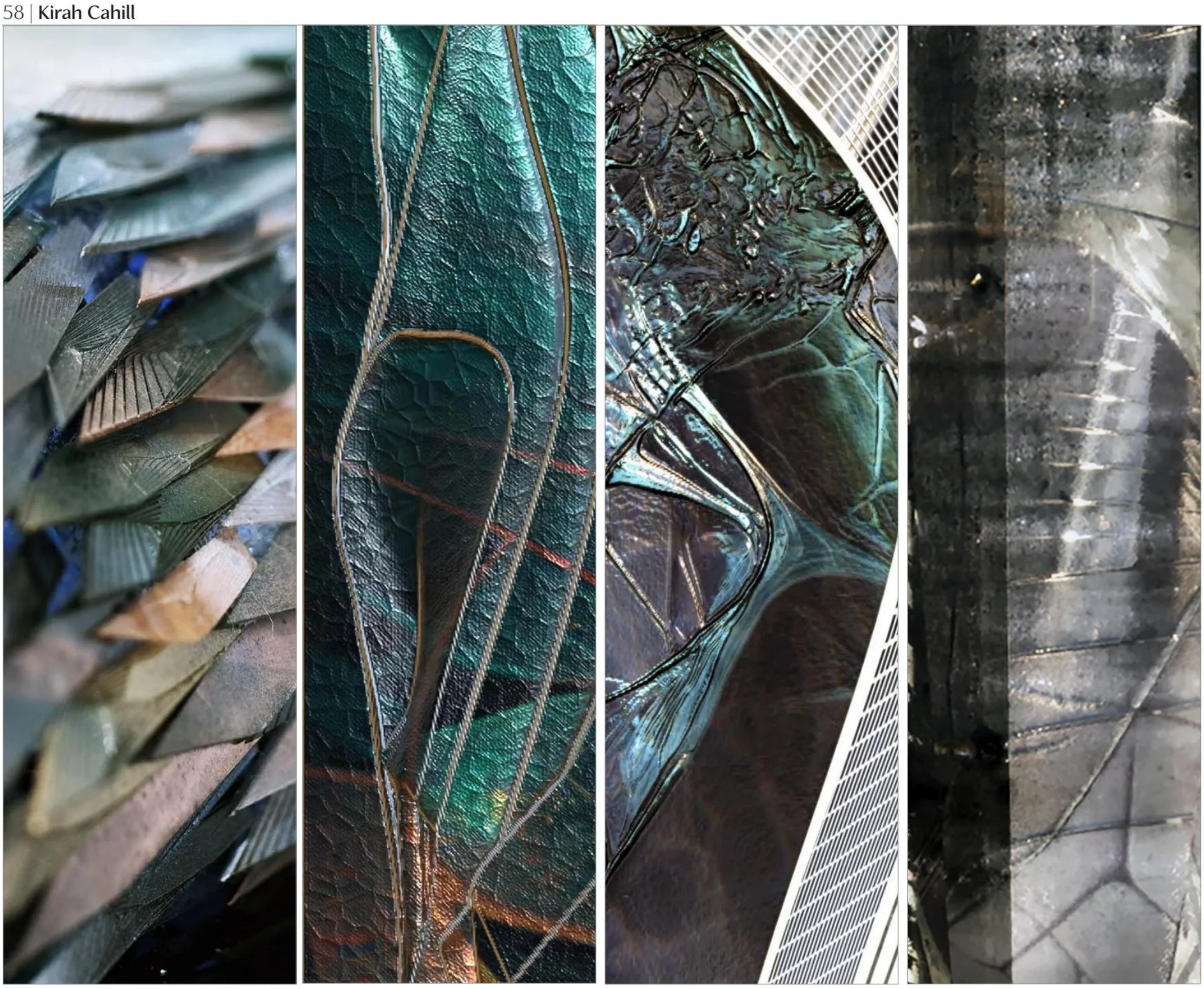




Top:
section drawing highlighting the flow of chilled water from the Hudson river, through a series of pipes and tanks where the water is filtered inside the building, before being returned back into the Hudson



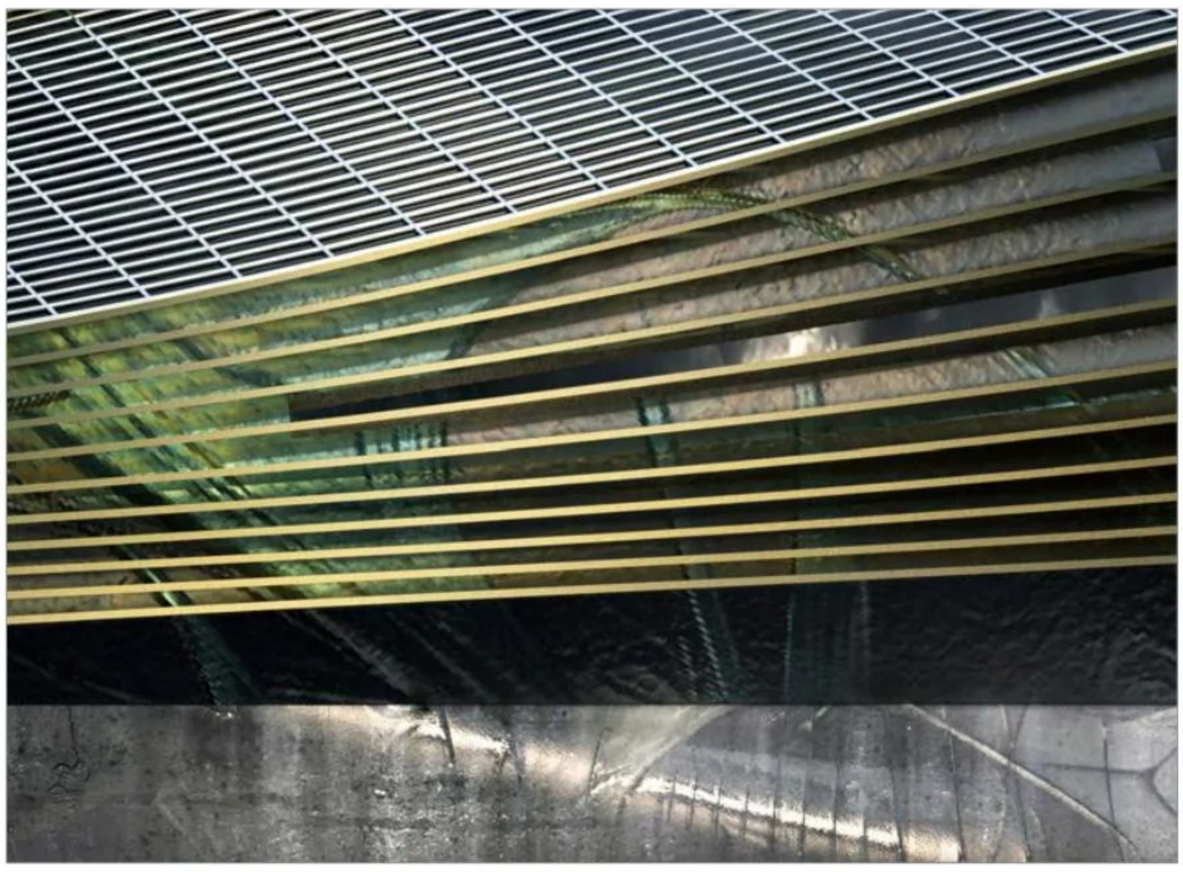
Bottom:
plan drawing highlighting the relationship between the flow of water and flexible arrangement of data server towers inside the building

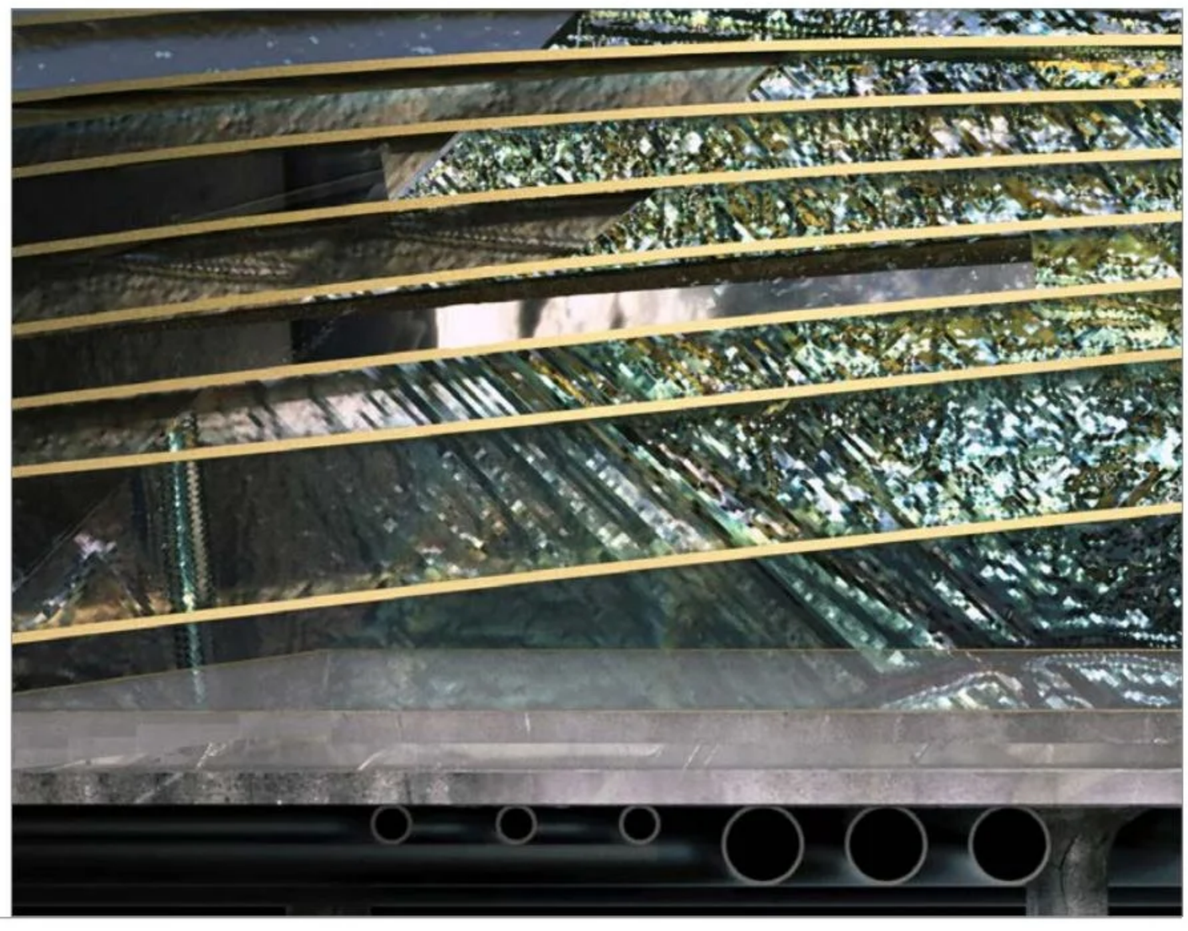


Top:
material studies

Middle & Bottom:
close-up renderings of building envelope in elevation

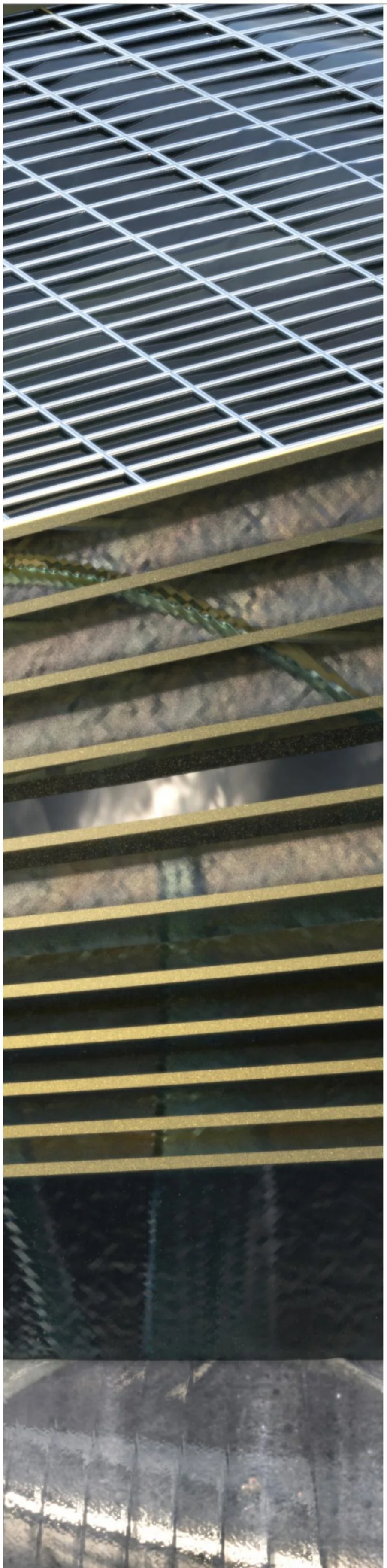
Right:
detail of cladding system, paired with a corresponding elevation

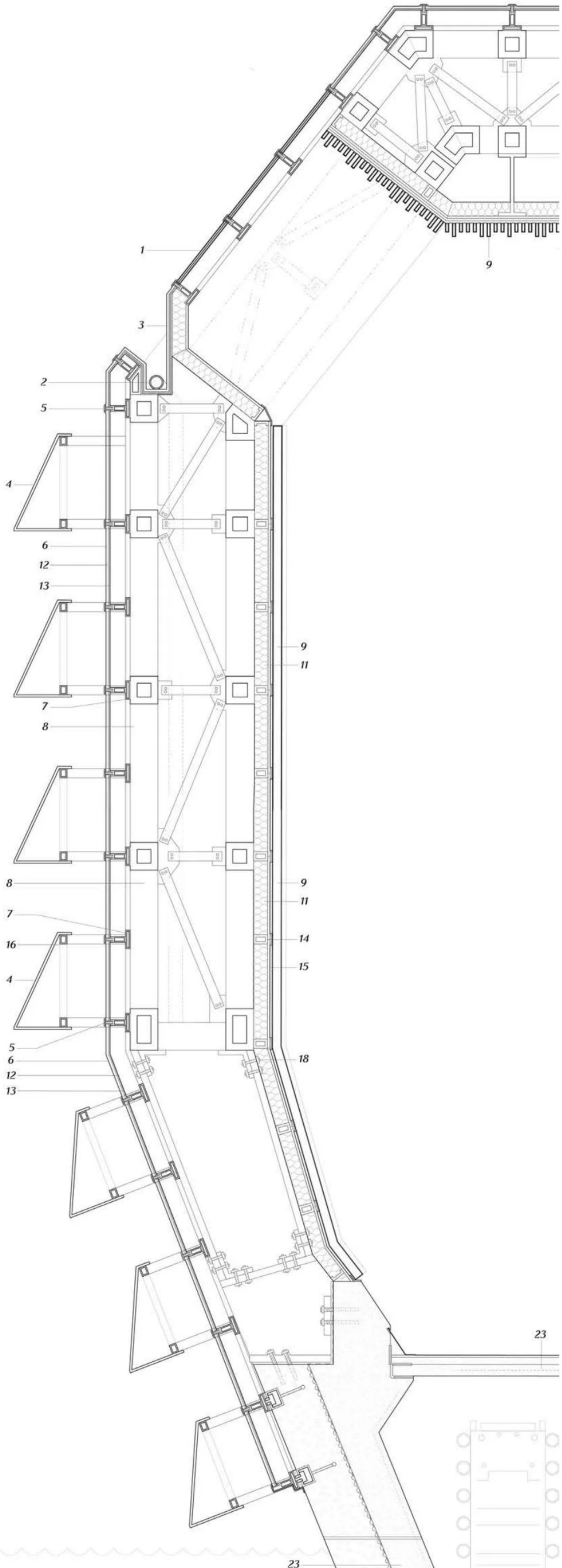




Detail Key:
1 - triple pane glazing
2 - drain
3 - insulated metal & plywood gutter
4 - perforated aluminum solar shades
5 - horizontal mullion
6 - ceramic waterproof & insulated panel
7 - steel substructure to support cladding
8 - structural steel truss
9 - USG Paraline Baffles Linear Ceiling
10 - vertical mullion
11 - batt insulation
12 - rigid insulation
13 - water-vapor barrier
14 - steel stud to support interior partitions
15 - gypsum board
16 - aluminum frame for solar shades
17 - aluminum support for solar shades
18 - bolt

Master of Architecture Candidate | **kirahcahill@gmail.com**

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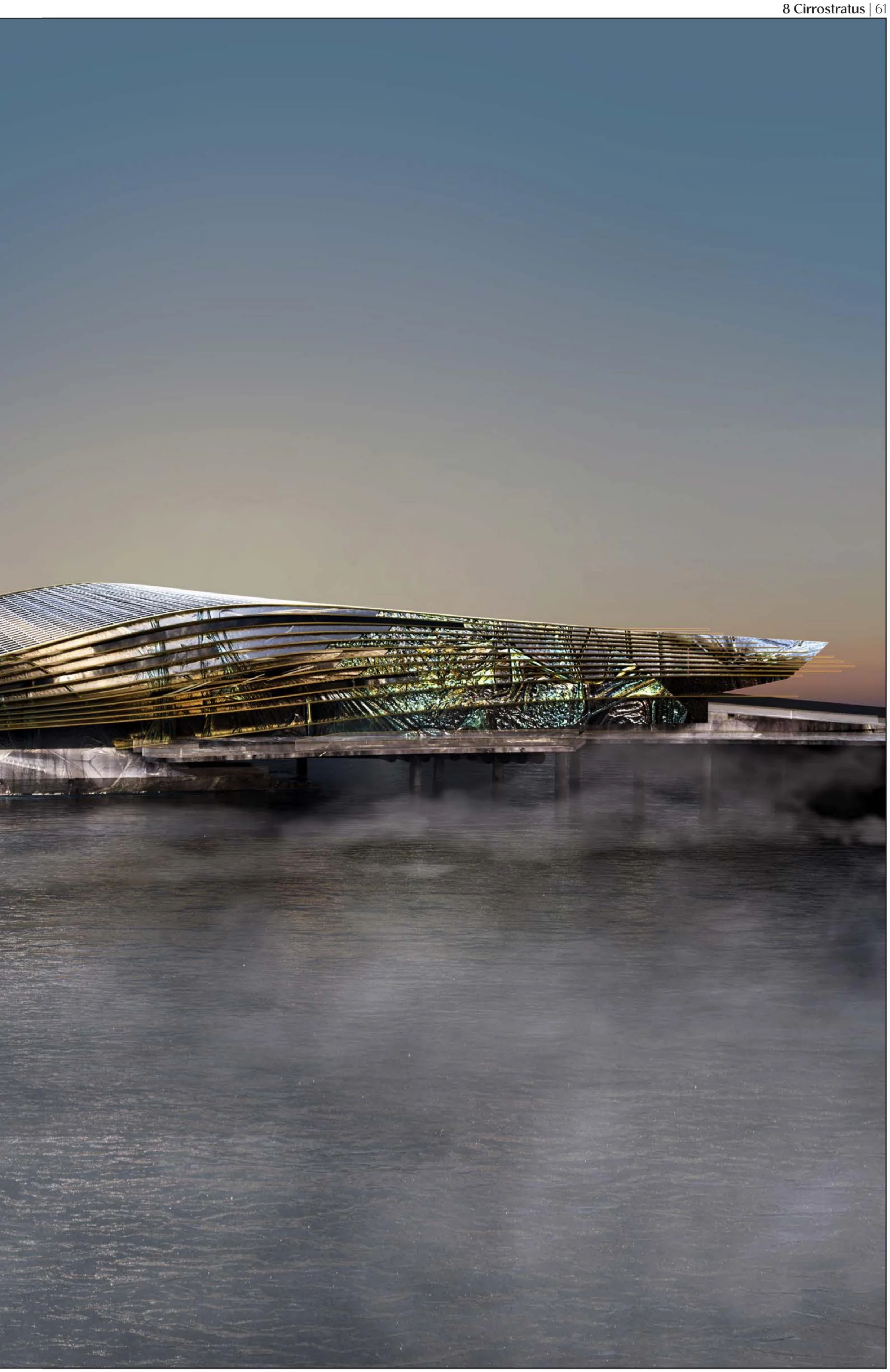

KIRAH SHANNON CAHILL

CONTACT
(610) 551-5431
kirahcahill@gmail.com
linkedin.com/kirah-cahill
instagram.com/ksc.dsn

RECENT EXPERIENCE
Guest Tutor - CDNext (Design Morphine & PA Academy 2023)
Architectural Summer Intern (Skidmore, Owings, & Merrill 2023)
Introduction to Architecture (Columbia University 2020)

MASTER OF ARCHITECTURE CANDIDATE
University of Pennsylvania
Stuart Weitzman School of Design
Expected Graduation May 18th, 2024
GPA 3.95

BACHELOR OF SCIENCE IN BUSINESS, ECONOMICS
Summa Cum Laude
Indiana University in Bloomington
Kelley School of Business
Graduated December 19th, 2020
GPA 3.92

AWARDS
Will M. Mehlhorn Scholarship (University of Pennsylvania 2023)
E. Lewis Dales Travel Fellowship (University of Pennsylvania 2023)
Honorable Mention (Starchitect Chair, the Charette 2022)
Merit Scholarship (University of Pennsylvania 2021 - 2023)
Summa Cum Laude Graduation Honors (Indiana University 2020)
Founder's Scholar (Indiana University 2019 & 2020)