



Yake Wang
Columbia University GSAPP

Work Sample
2023-2026

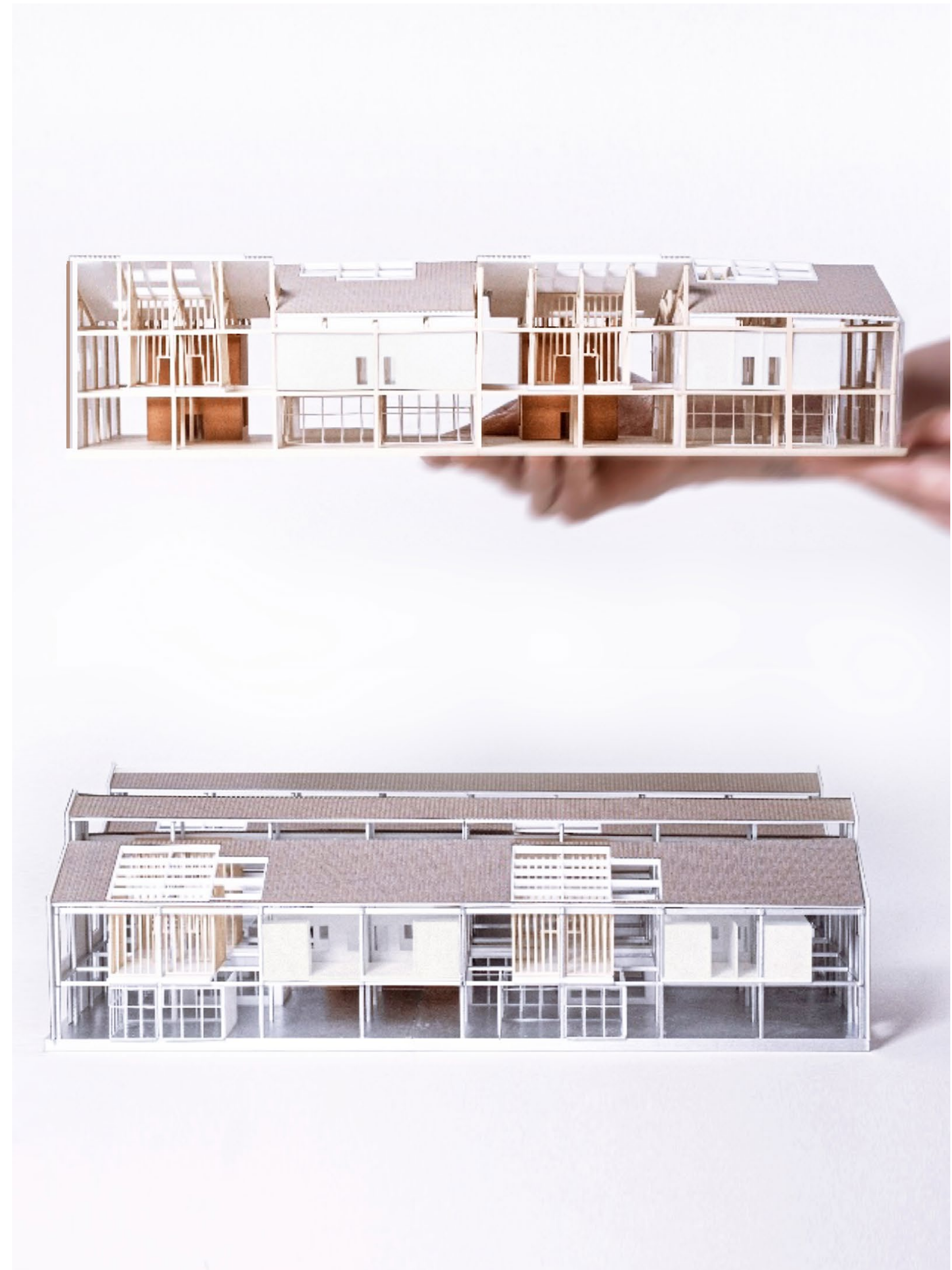
INTERWOVEN

A Renovation of Existing Factory

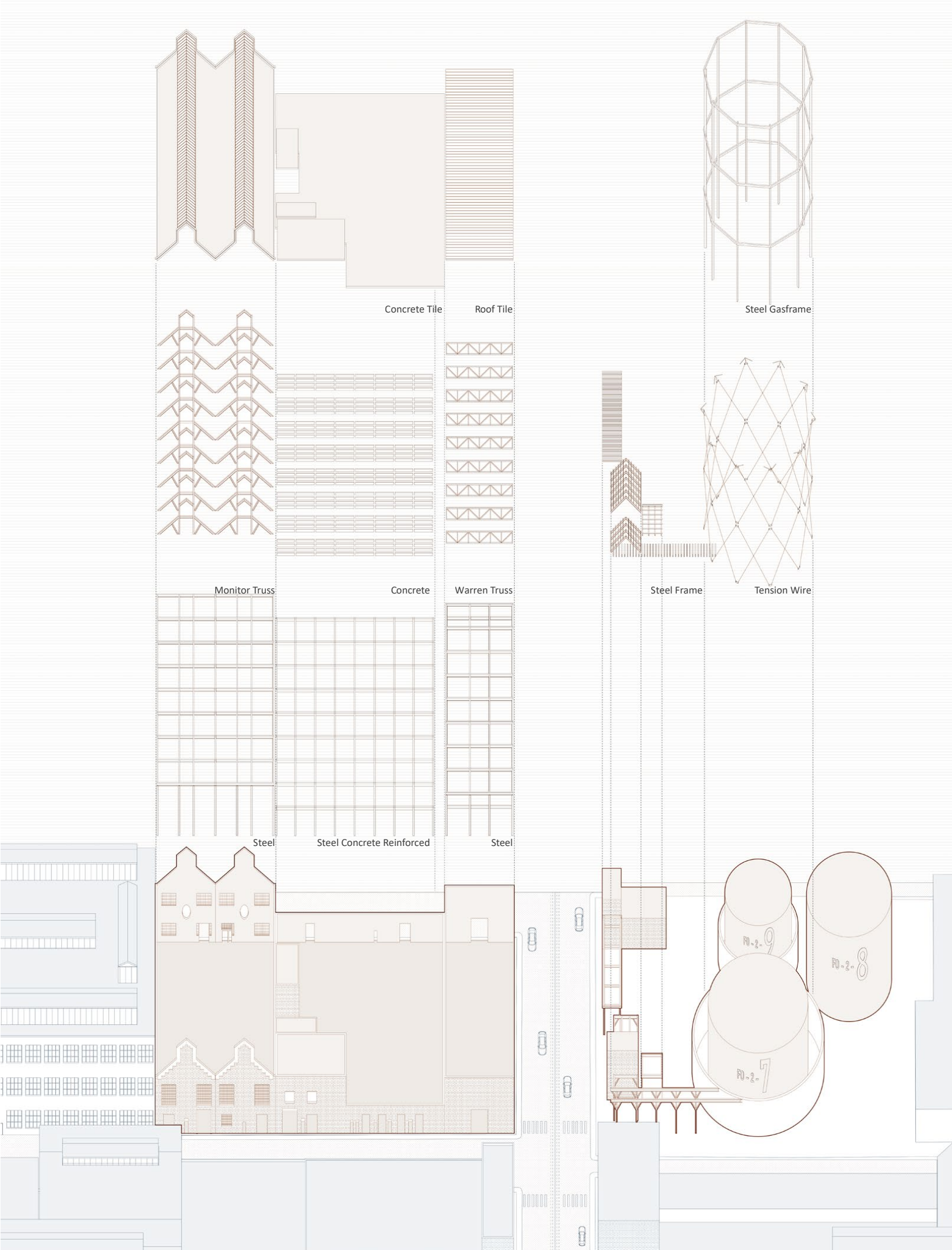
Term	ADV V Fall 2025
Type	Team of Two (Hongan Nan)
Location	Sunset Park, Brooklyn
Instructor	Phu Hoang

Our project establishes a framework for rethinking how architecture can support community health through culturally grounded, bottom-up practices. The proposal introduces a renovation that positions the building as a flexible armature rather than a fixed typology—an infrastructure that spatializes grassroots knowledge and allows healing, learning, and daily rituals to take form through use.

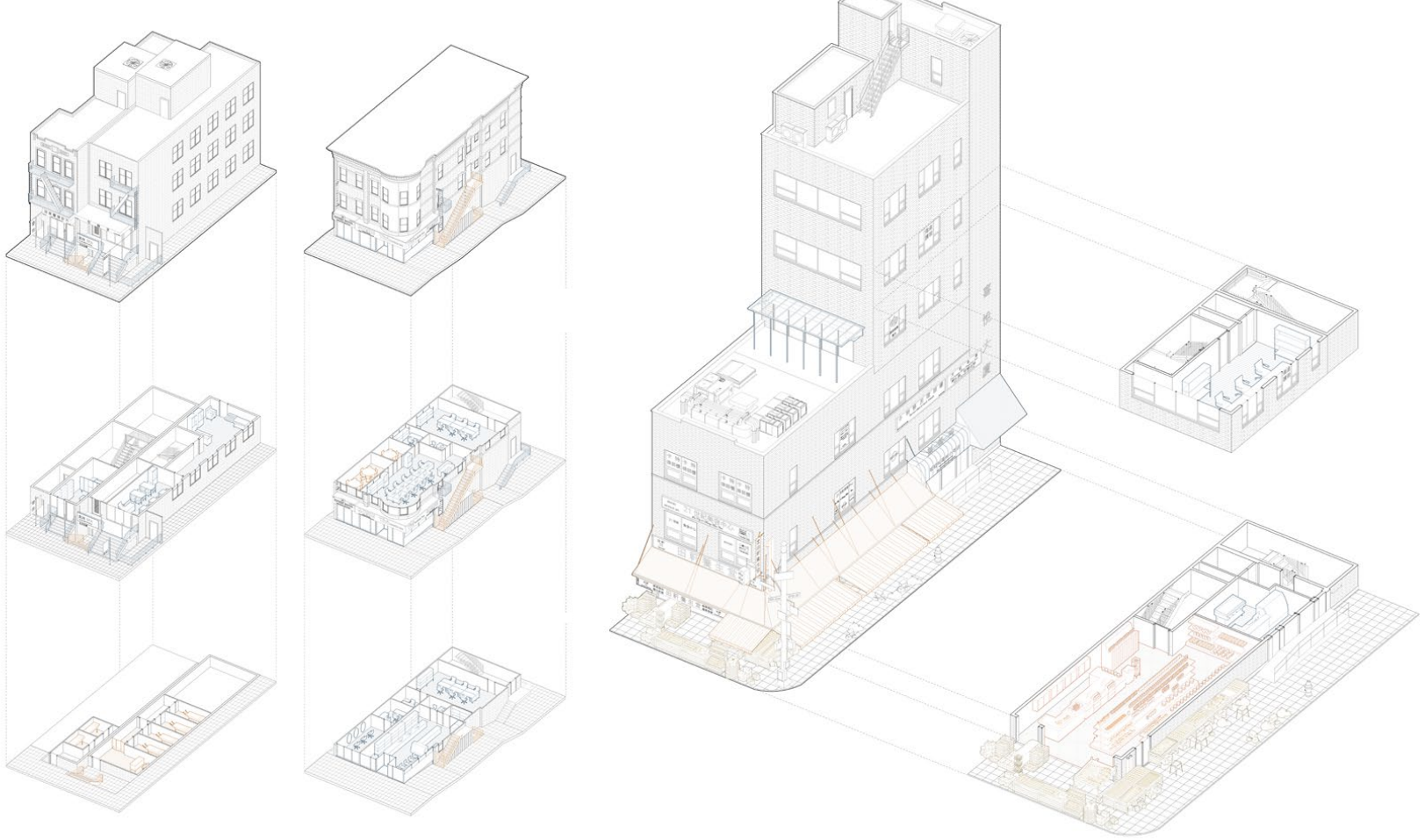
By bridging immigrant herbal traditions, communal care, and institutional healthcare, the project aims to cultivate an environment where culture and wellness co-evolve and where the building acts as an operational mediator rather than a prescriptive container. The interlace layout becomes the architectural driver: it generates a series of in-between spaces where programs overlap, transition, and coexist. These interweaving conditions allow activities to expand and contract over time, providing a structural flexibility that reflects how community practices unfold. The armature therefore operates not as a rigid hierarchy but as a spatial gradient that supports multiple forms of learning, production, and wellness simultaneously.



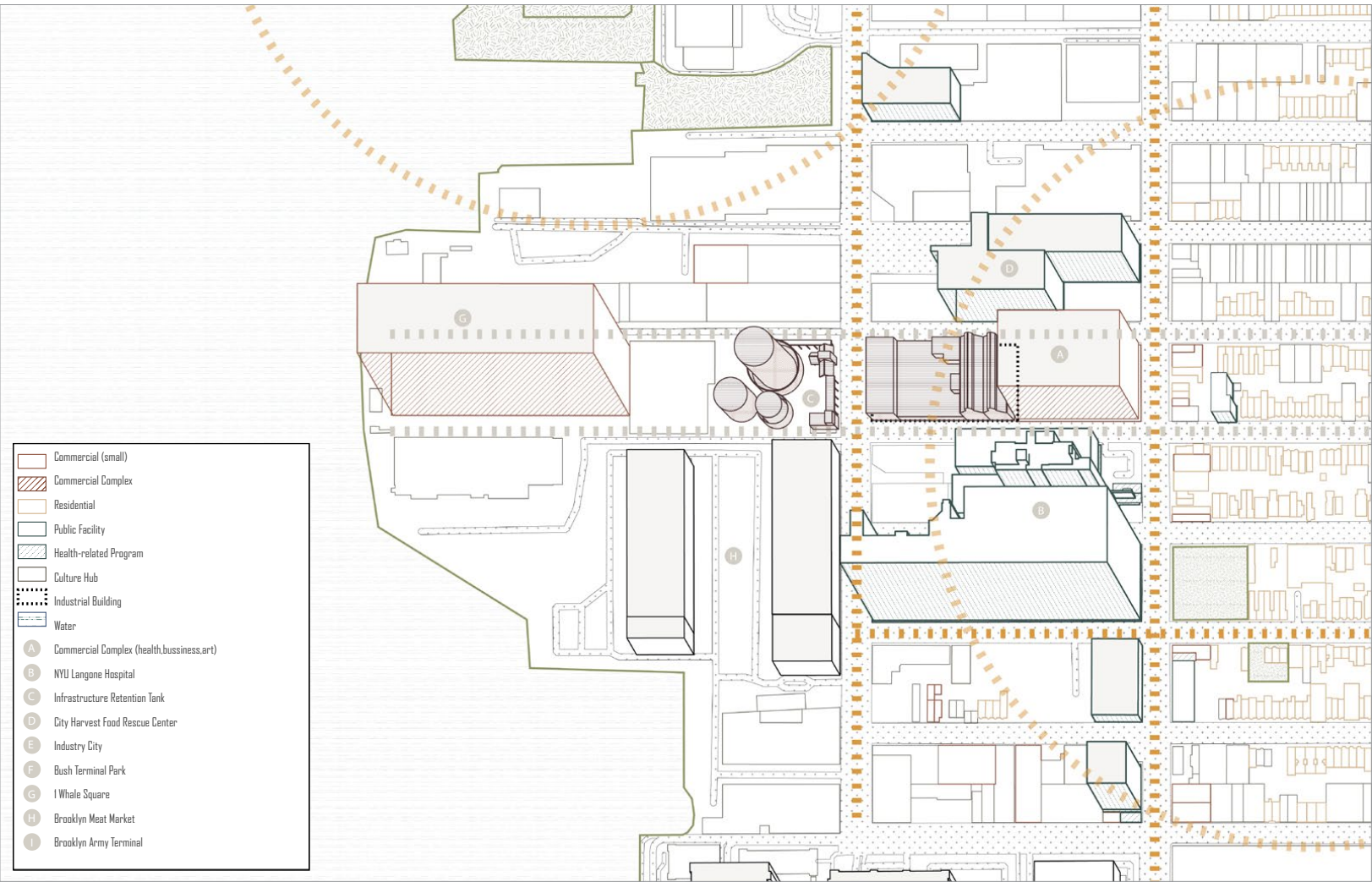
Existing Structure Analysis



Anti-Typology Study in Chinatown



Unregulated Zoning in Sunset Park



The “Waterfall””

The “Hearth”

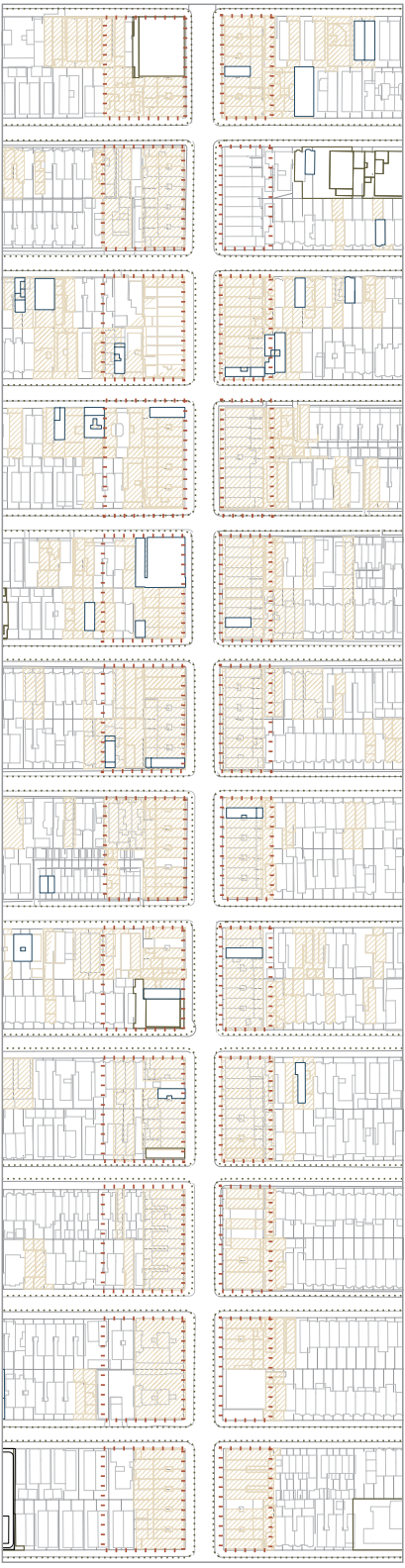
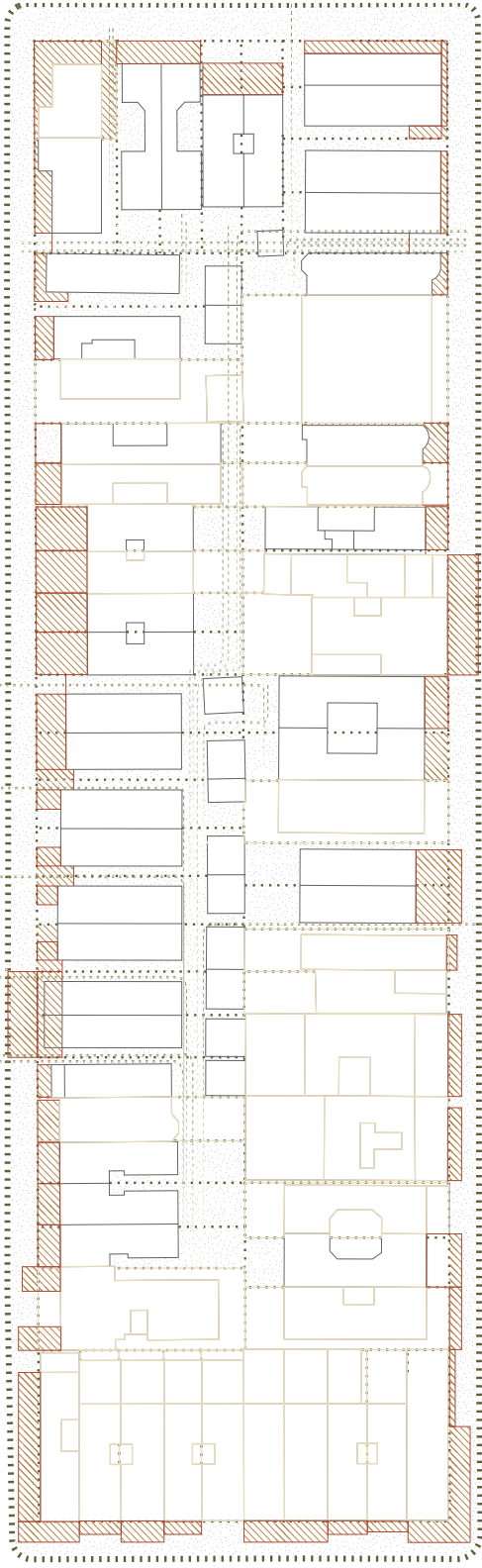
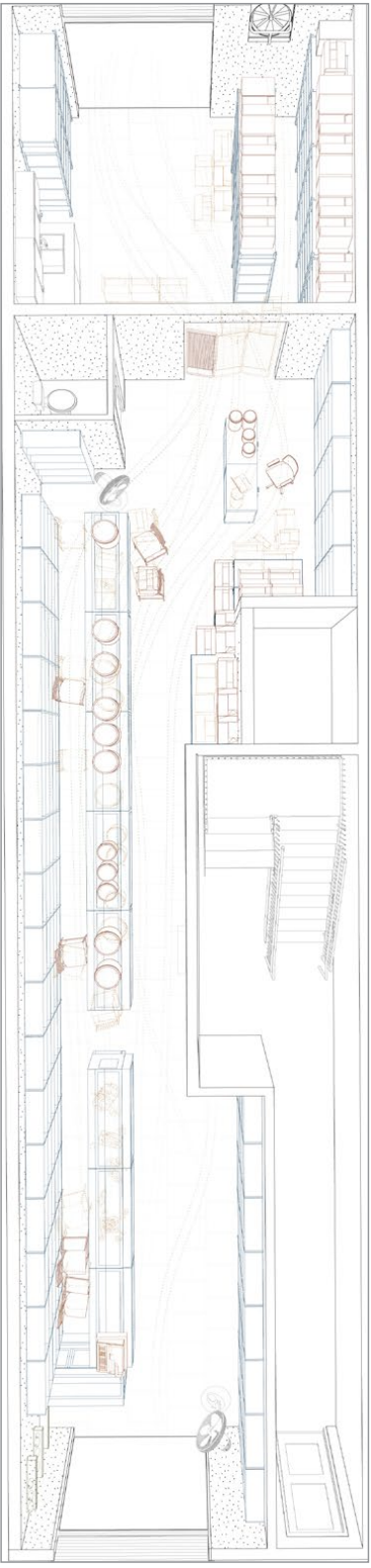
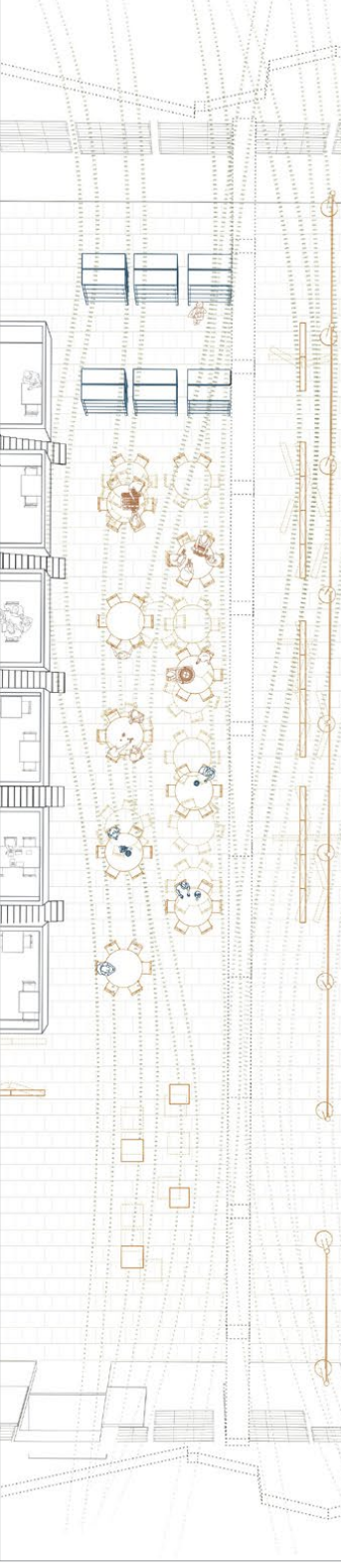
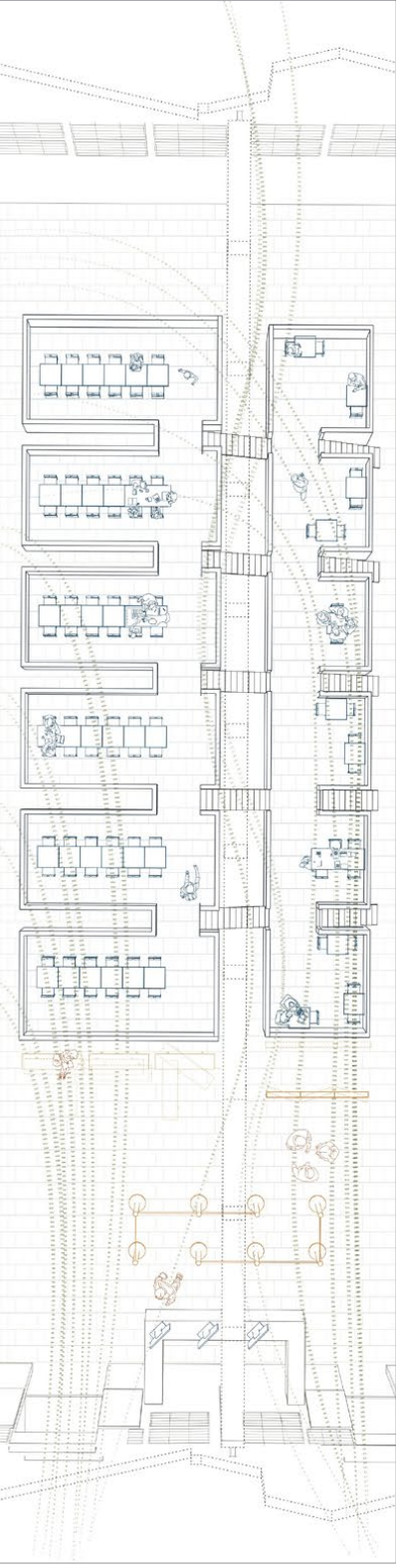
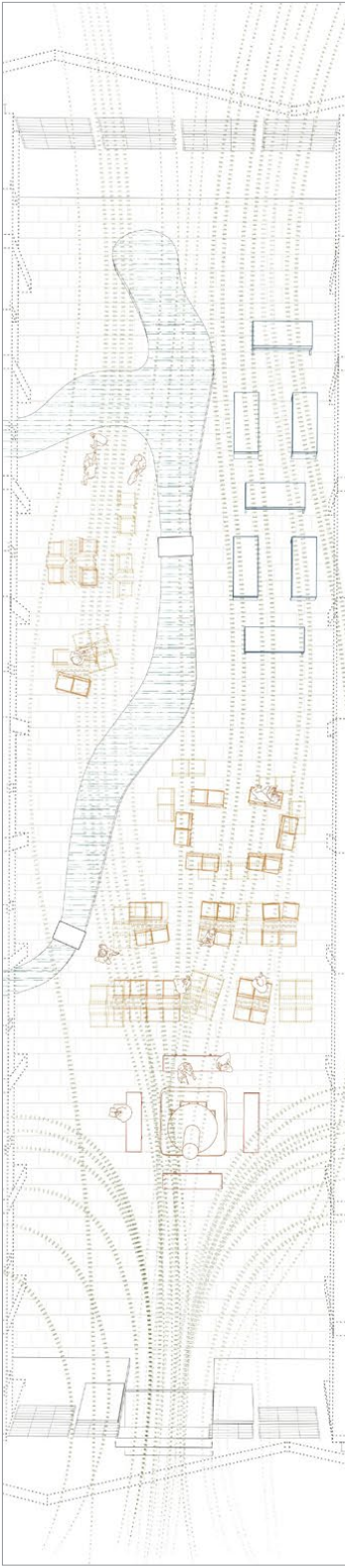
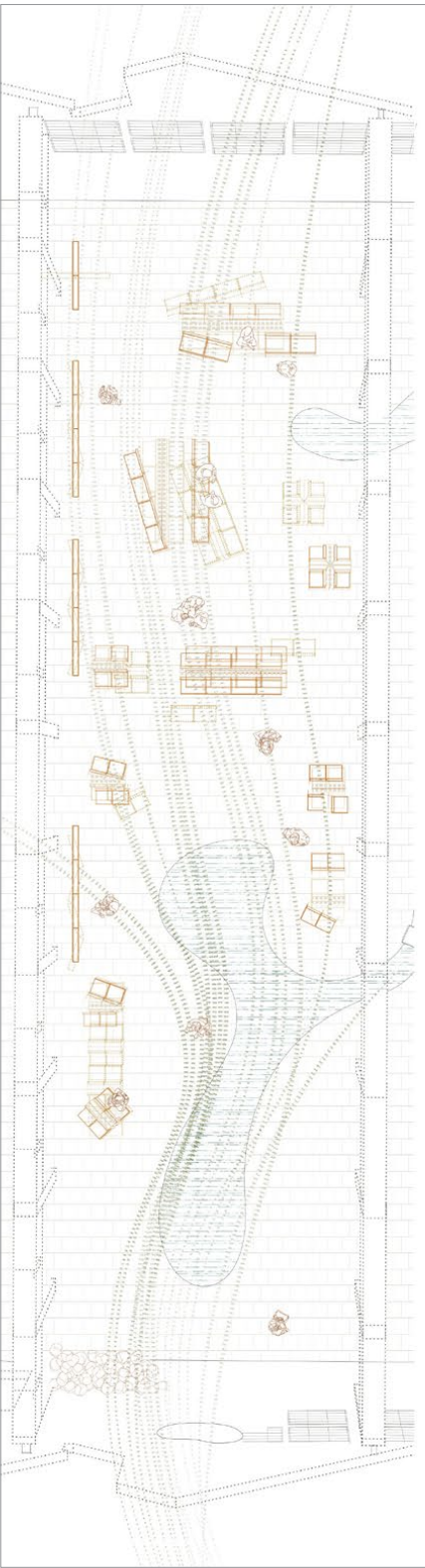
The “Air”

The “Ground”

The Eastern Herb Store

The Block Between 56th and 57th St

The City Grid on 8th Ave



SESC Pompéia Factory

Building

Block

Street

In SESC Pompeia, Lina Bo Bardi reimagined the industrial site as a civic landscape rooted in *bioclimatic design* and *community well-being*. The removal of interior walls established four major collective zones—the “Waterfall,” the “Hearth,” the children’s play area, and the library—each encouraging gathering and layered use. The project’s environmental strategies demonstrate a sensitivity to climate and resource efficiency. These *passive systems* transform the building into an adaptable climatic container. Equally important is the programmatic logic: fixed cores coexist with flexible areas that welcome “messy” occupations—*informal uses, seasonal activities, and community improvisation*.

The Eastern Herb Store exemplifies an *anti-typological* approach, rejecting the rigid Western pharmacy model. The elongated ground floor is divided by shelves and curtains rather than walls, and dietary therapy.

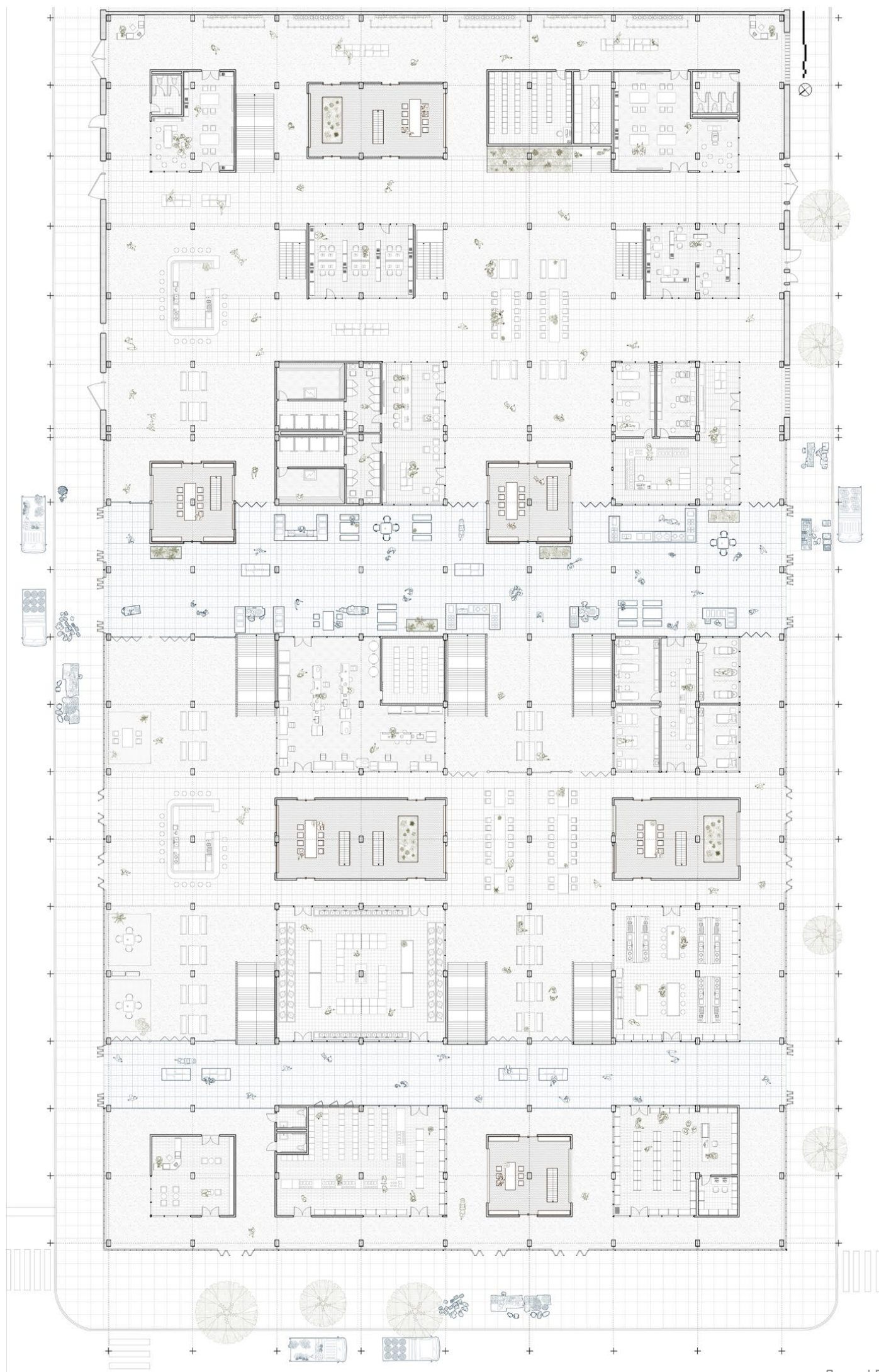
The mixed-use block demonstrates diasporic urbanism’s *resistance* to fixed categories, where commerce and residence intertwine. Ground-floor businesses extend into domestic life, while residents overlook and engage street economies.

Health-related spaces in diasporic enclaves rarely conform to singular functions. Pharmacies transform into hybrids of commerce, healthcare, and domesticity, *dissolving the rigid typologies* of Western medical space.



Oblique Collage Drawing

The design investigates natural (unregulated) and artificial (regulated) ventilation as dual systems—one spatial, the other climatic. This calibrated relationship between openness and enclosure, between facade rhythm and roof profile, defines a new atmospheric equilibrium. The Health Commons becomes both a co-adaptation and a climatic instrument—where structure, air, and care coalesce into a coherent spatial and environmental strategy.

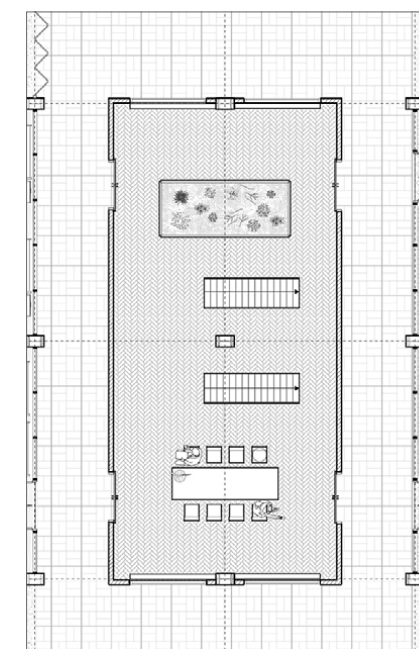
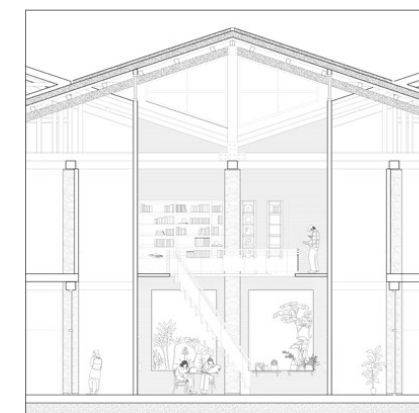
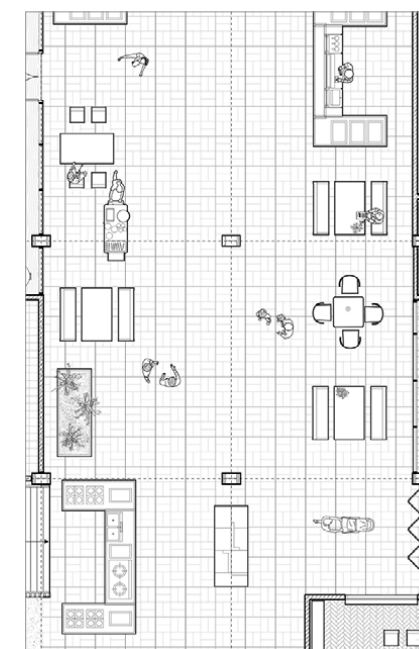
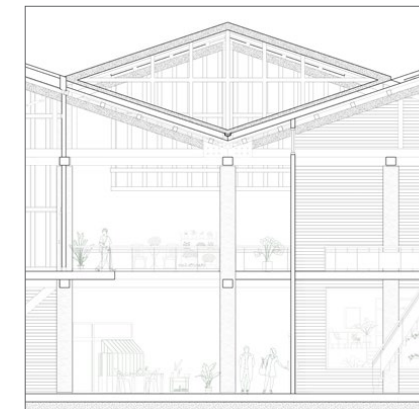


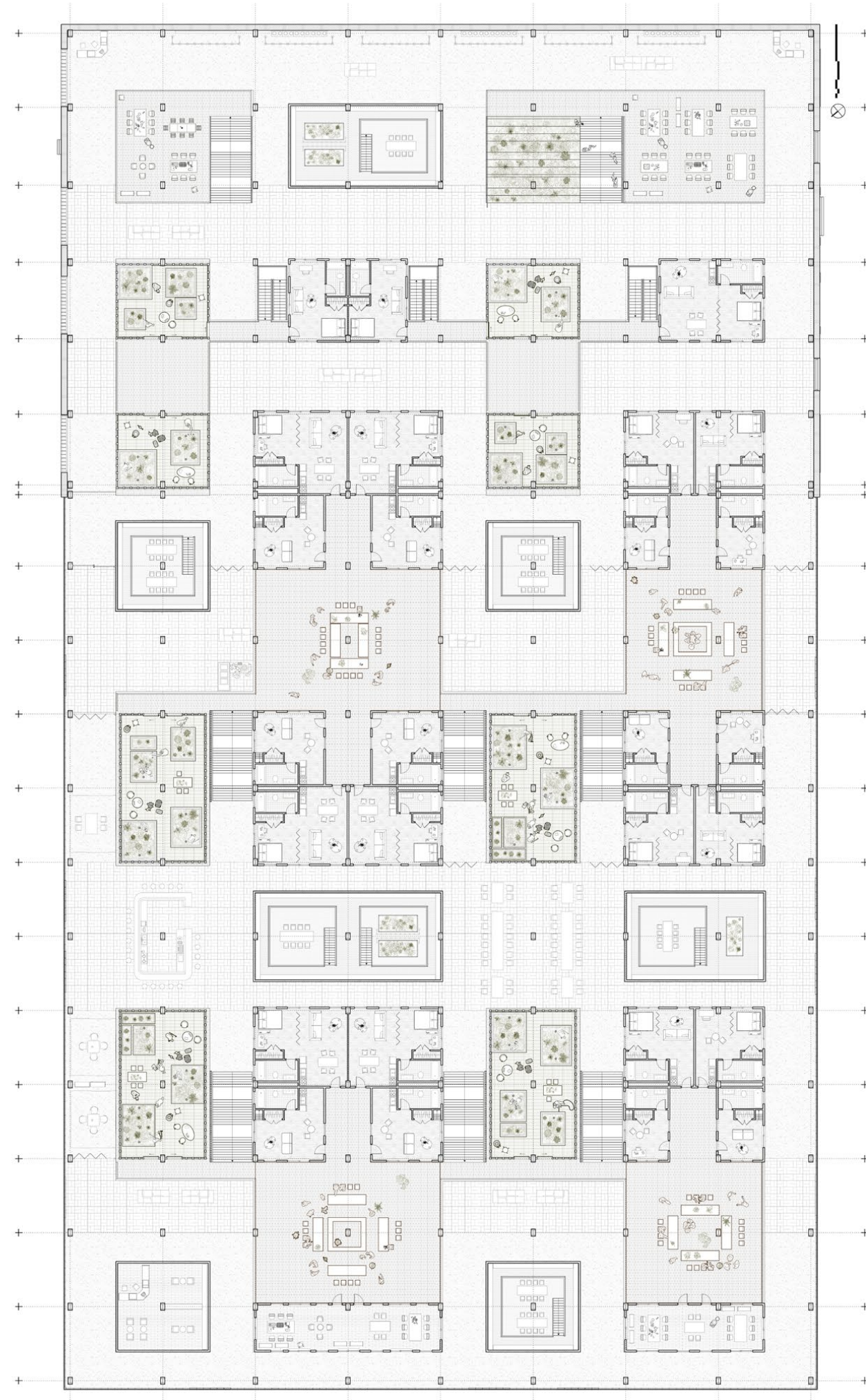
Ground Plan Drawing



The design framework is organized through an interlaced system of herb planting cores, community cores, and knowledge cores. These *cores* are distributed across the existing steel and brick structures to produce a continuous spatial network rather than isolated programmatic zones.

Herb drying overlaps with communal cooking; circulation merges with small learning pockets; climatic *gradients* generate sensory shifts from warm to cool. Immigrant knowledge grows in this way—through experience, adaptation, and seasonal practice. Architecture here becomes a medium through which sensory knowledge is observed, shared, and practiced.





2nd Floor Plan Drawing



Model Photo- Unregulated Layout



Model Photo- New VS. Old



Model Photo- Old Renovation



3D Projection - Outside Inside

Project reframes architectures as a flexible Infrastructure for community health rooted in cultural practice, which adapts existing block factory buildings by preserving their facades, structuresm and reusing the materials



Orthographic - Sectional Perspective

These environmental systems allow scent, temperature, and air movement to become experiential layers that guide occupants through the building

HOUSING FOR PLANT LOVER

A Future Work-Living Garden Housing Prototype

Term	Core III Fall 2024
Type	Team of Two (Hongan Nan)
Location	127th St West Harlem, New York
Instructor	Hilary Sample

The researcher examines the perspective of housing in New York City, the historical context of small units, and the impact of legislation on living standards in megacities. Examines the *interplay* between humans and *plants*, emphasizing the need of a healthy lifestyle and the urban *housing crisis*. The pricing, maintenance, and design must be integrated not just as a solution to the housing crisis but also to foster a community for the future.

The objective is to develop an economical housing initiative that includes communal vertical gardening areas, appealing to horticulture enthusiasts and families in search of *cost-effective* living arrangements. This method encourages community engagement, advocates for a healthy lifestyle, and improves community welfare. The concept seeks to provide an engaging atmosphere that fosters a healthy lifestyle.

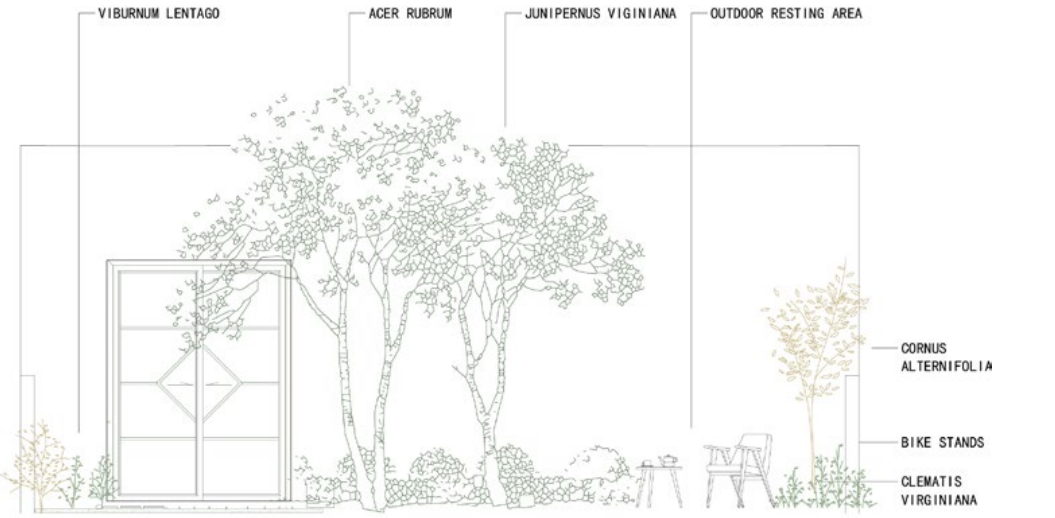




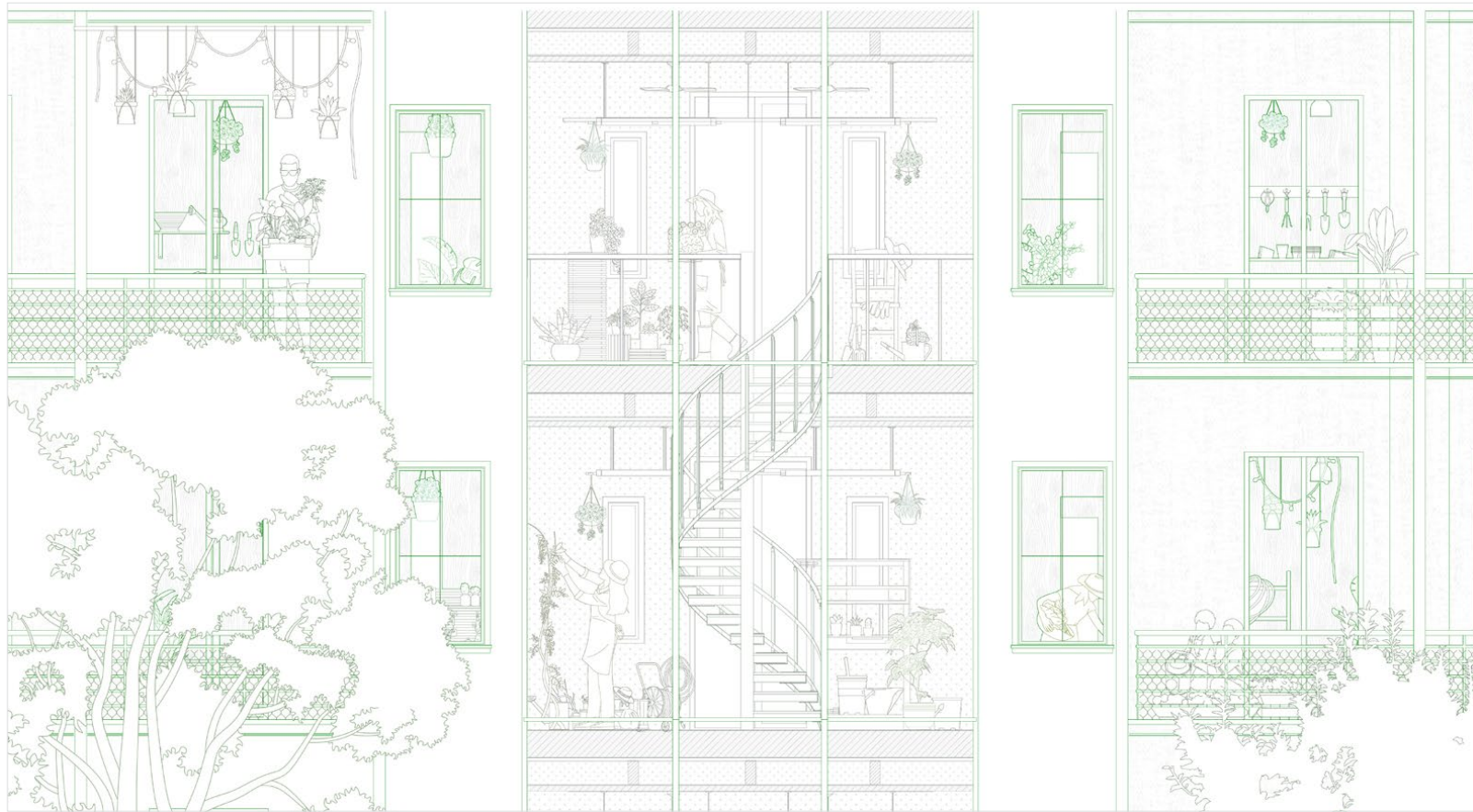
Ground Floor Plan Drawing



Residential Lobby- Indoor



Residential Lobby- Outdoor

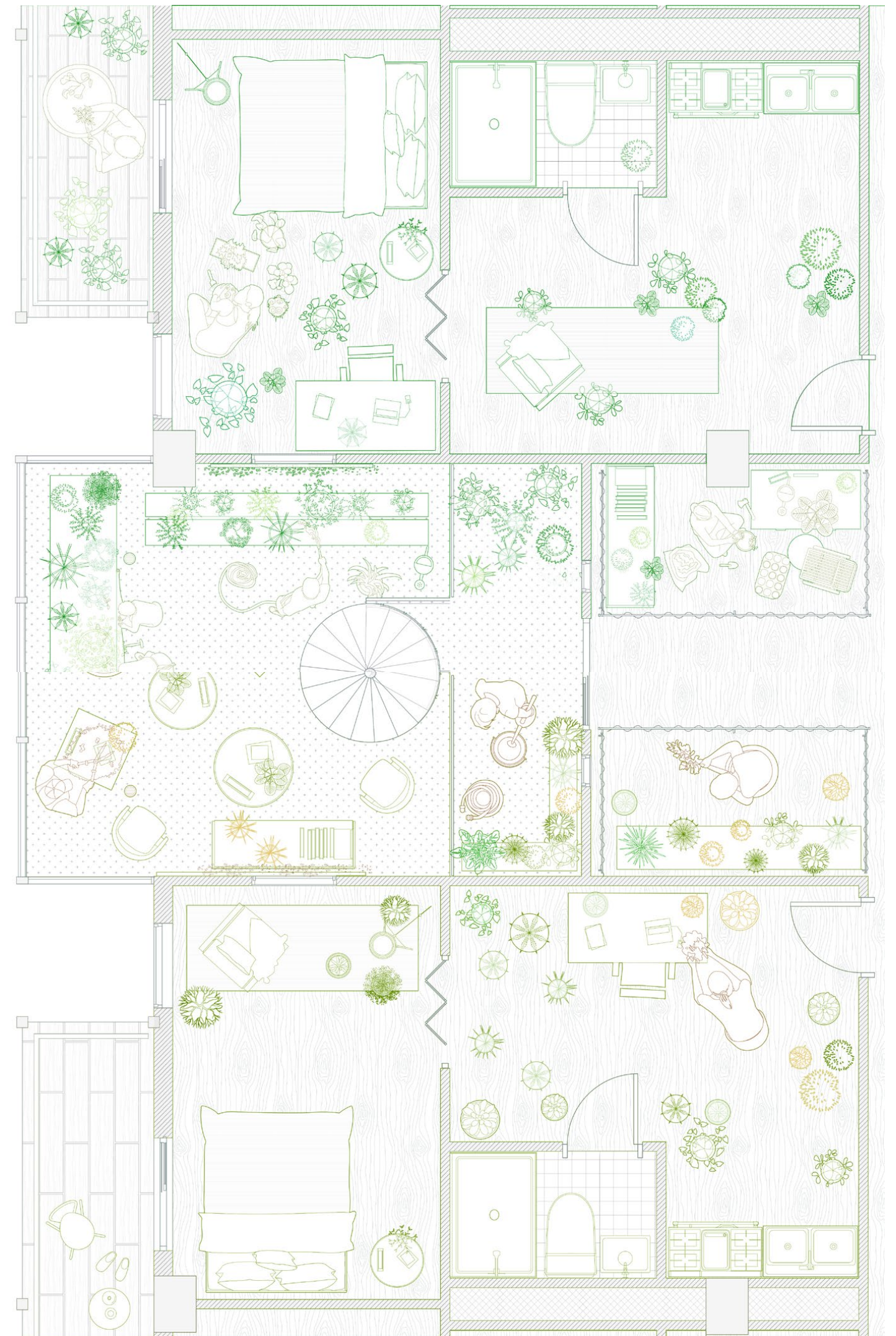


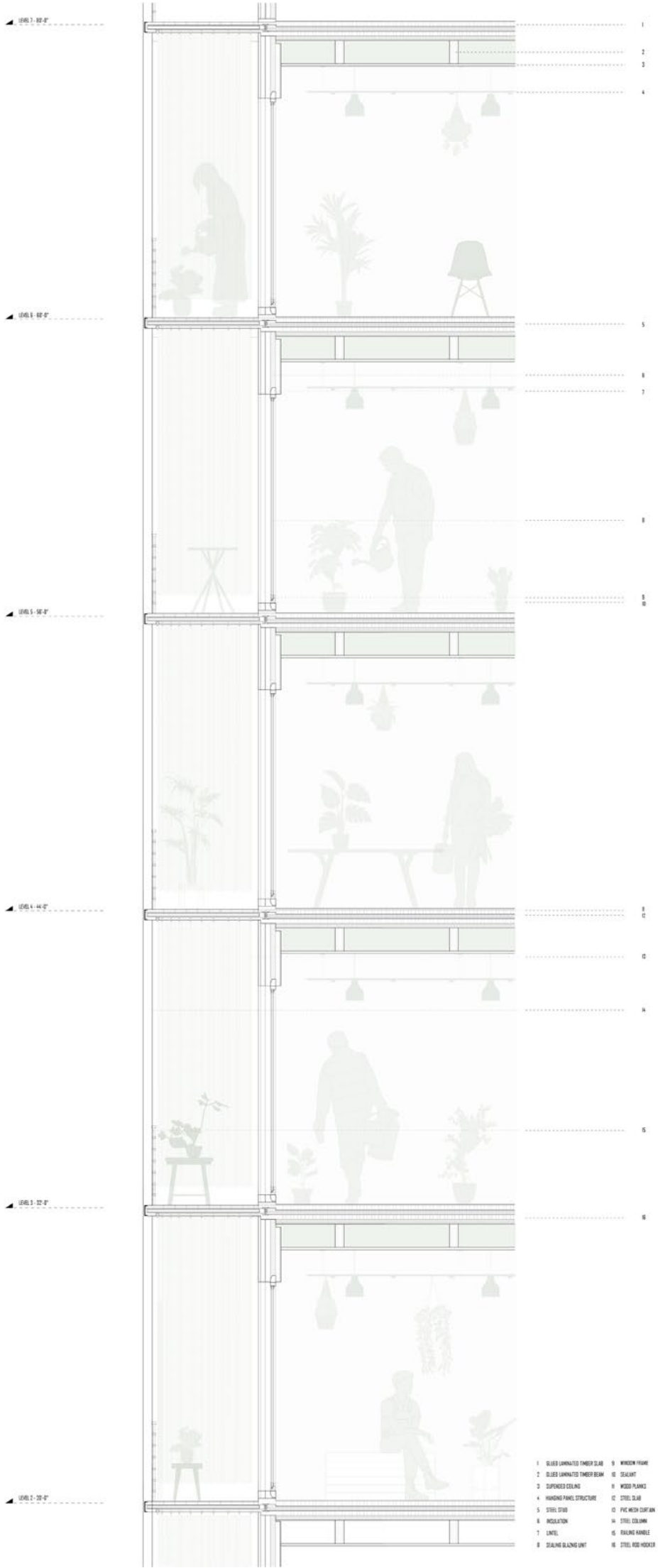
Elevation Outside - In Drawing

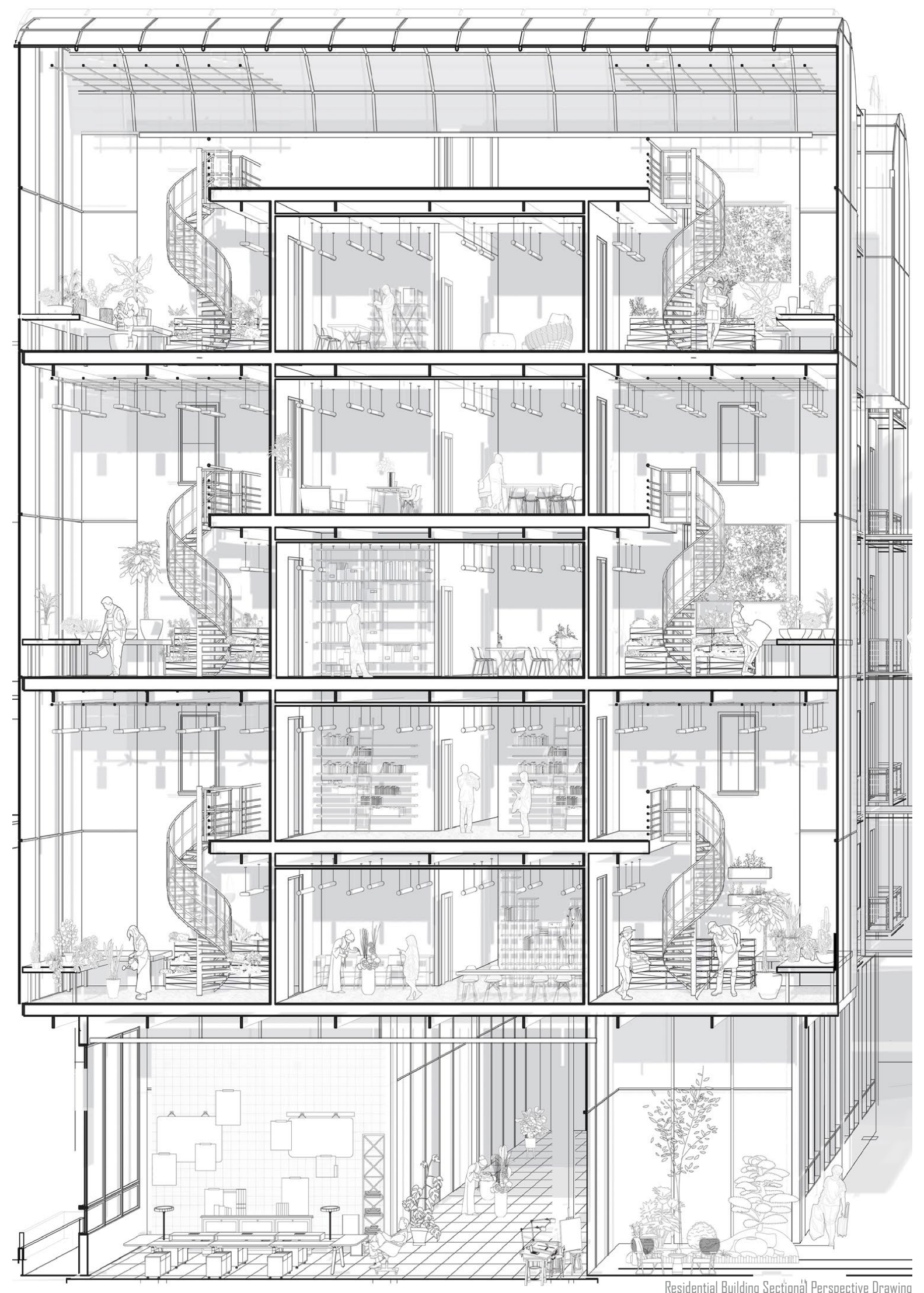
Garden has been created by human actions, nevertheless the life of plants have a far deeper history than human existence. First the plants grow on the earth, then the human start to interact with them for food, and the technology starts allowing the us to grow plants we want around the housing, garden has been introduced as a private land identification, then the city grow, the urban structure starts to forming public gardening and the towers drag people away from the greens. In this project, we attempted to reestablish the interaction between plant and human existence, presenting a dwelling design based on seasonal shifting and climate.



Section Inside - Out Drawing







Residential Building Sectional Perspective Drawing



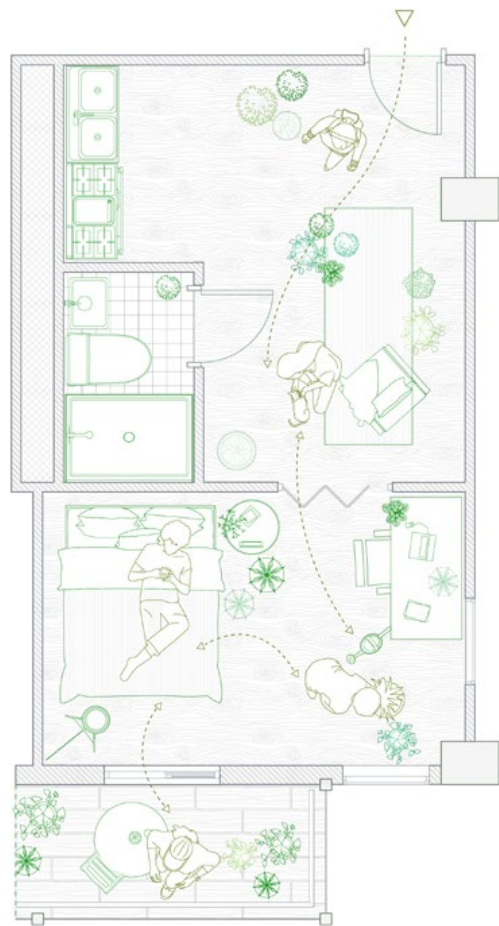
Model Photo- Residential Unit



Model Photo- Residential Unit



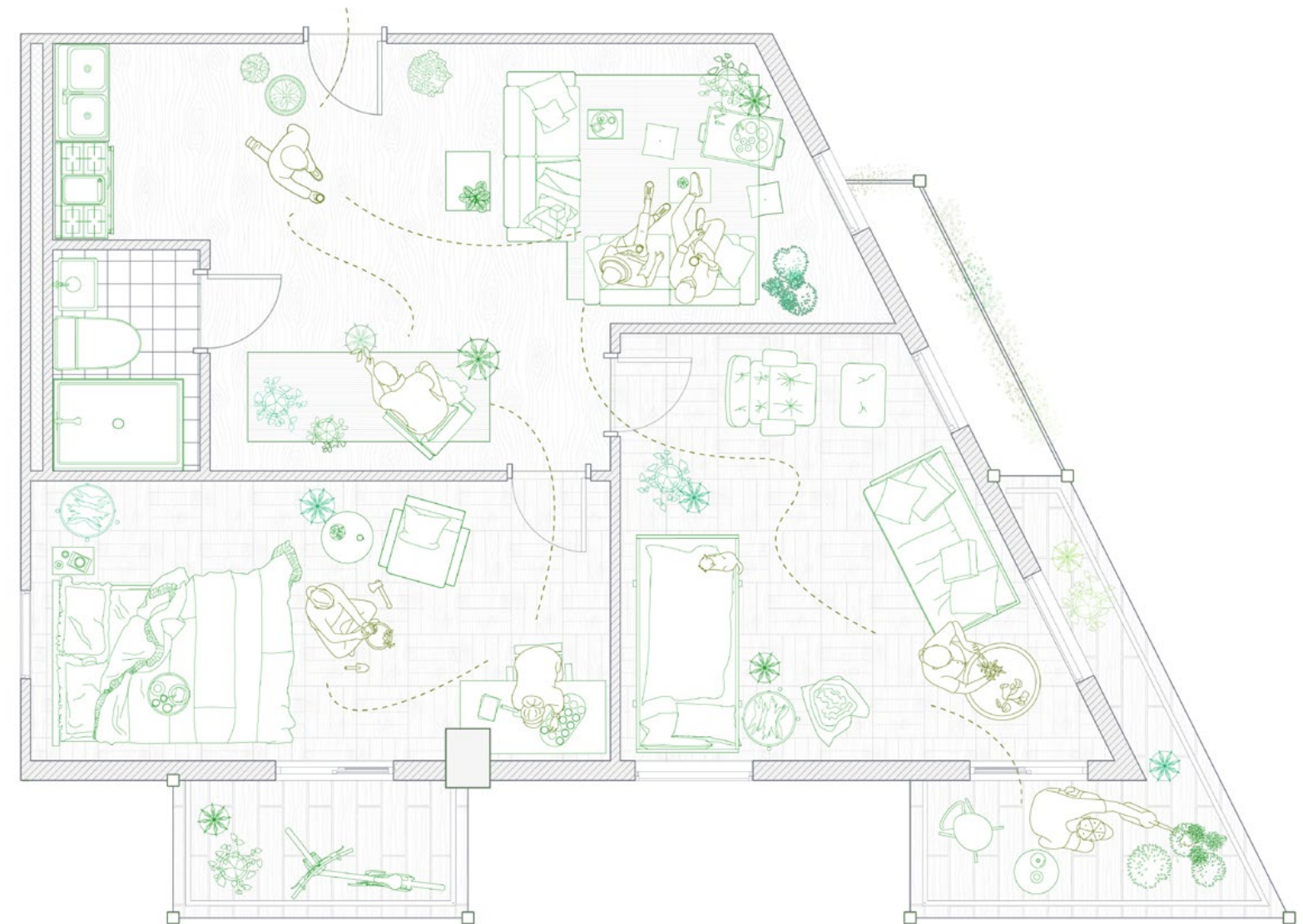
Model Photo -Residential Lobby



Residential Unit Plan- 1b1b



Residential Unit Plan- 2b1b A



Residential Unit Plan- 2b1b B

THE KNOWLEDGE VESSEL

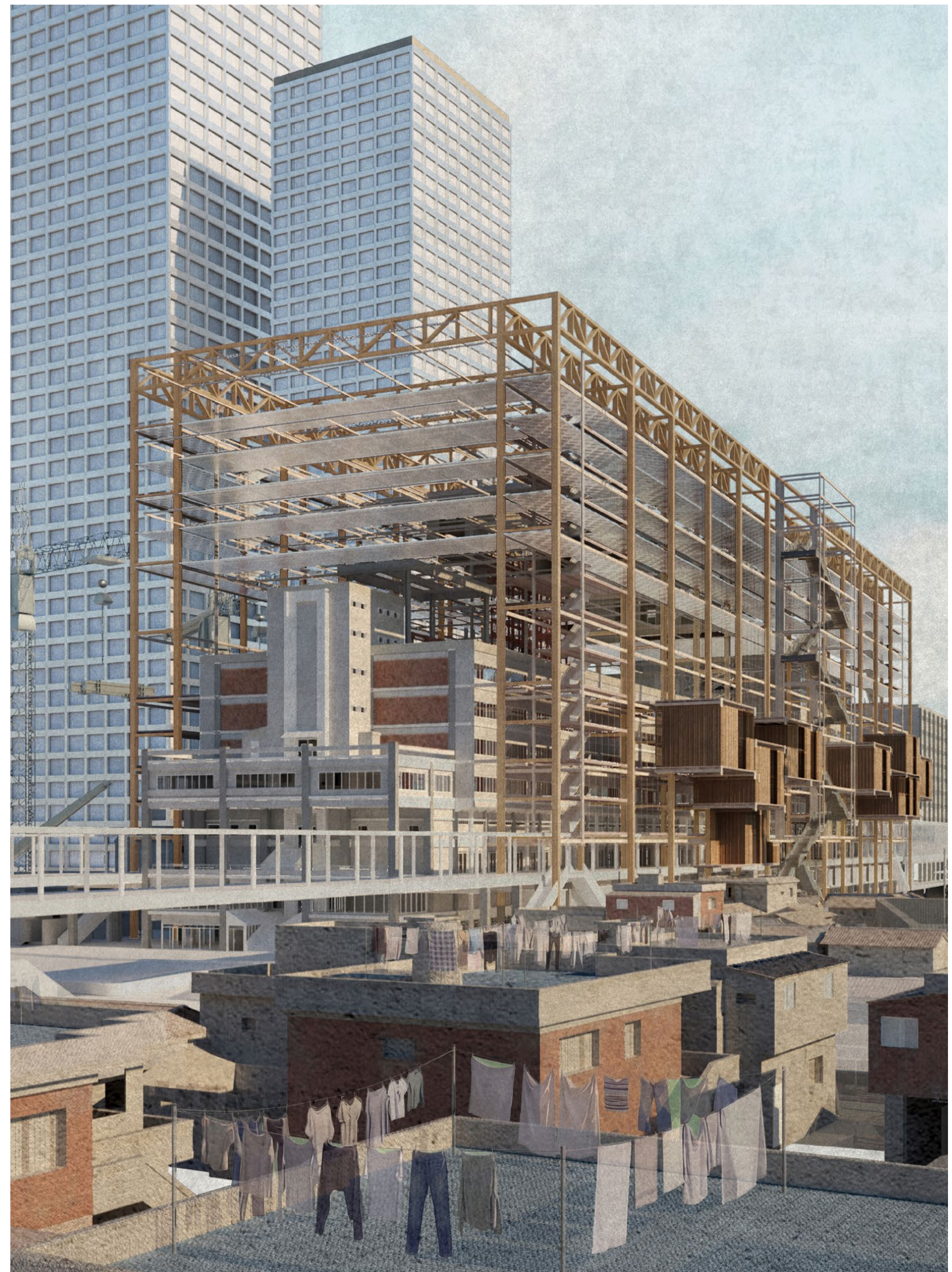
Reframing Sewoon Sangga as a Living Production Network

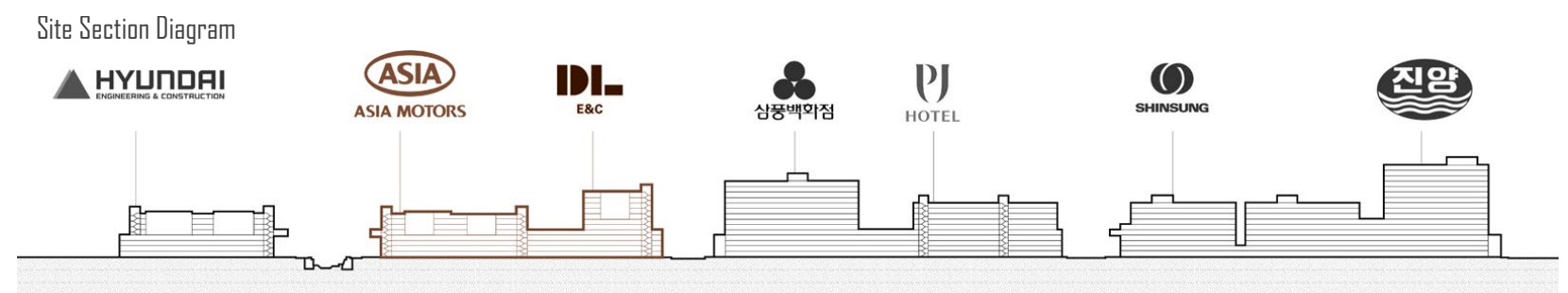
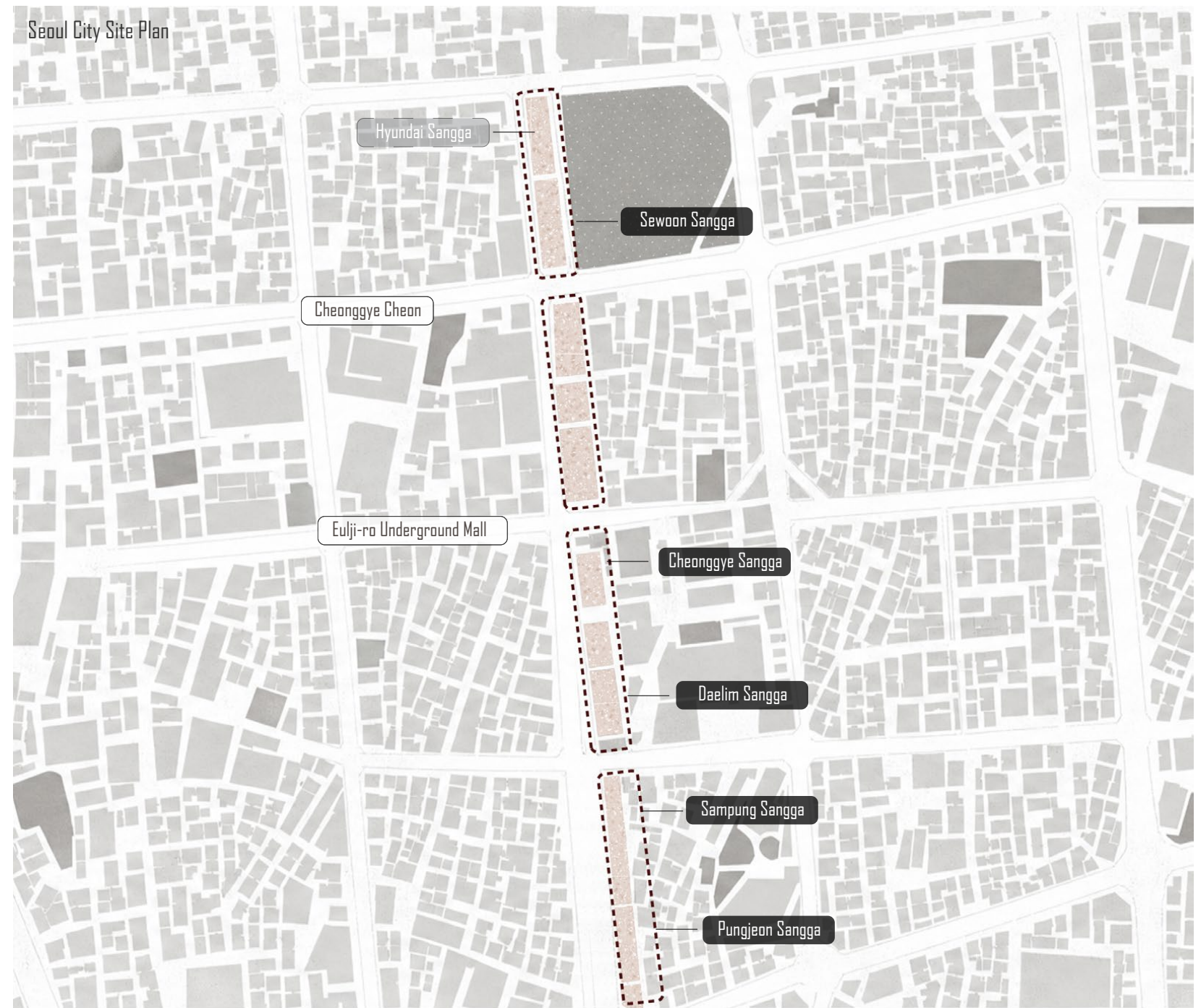
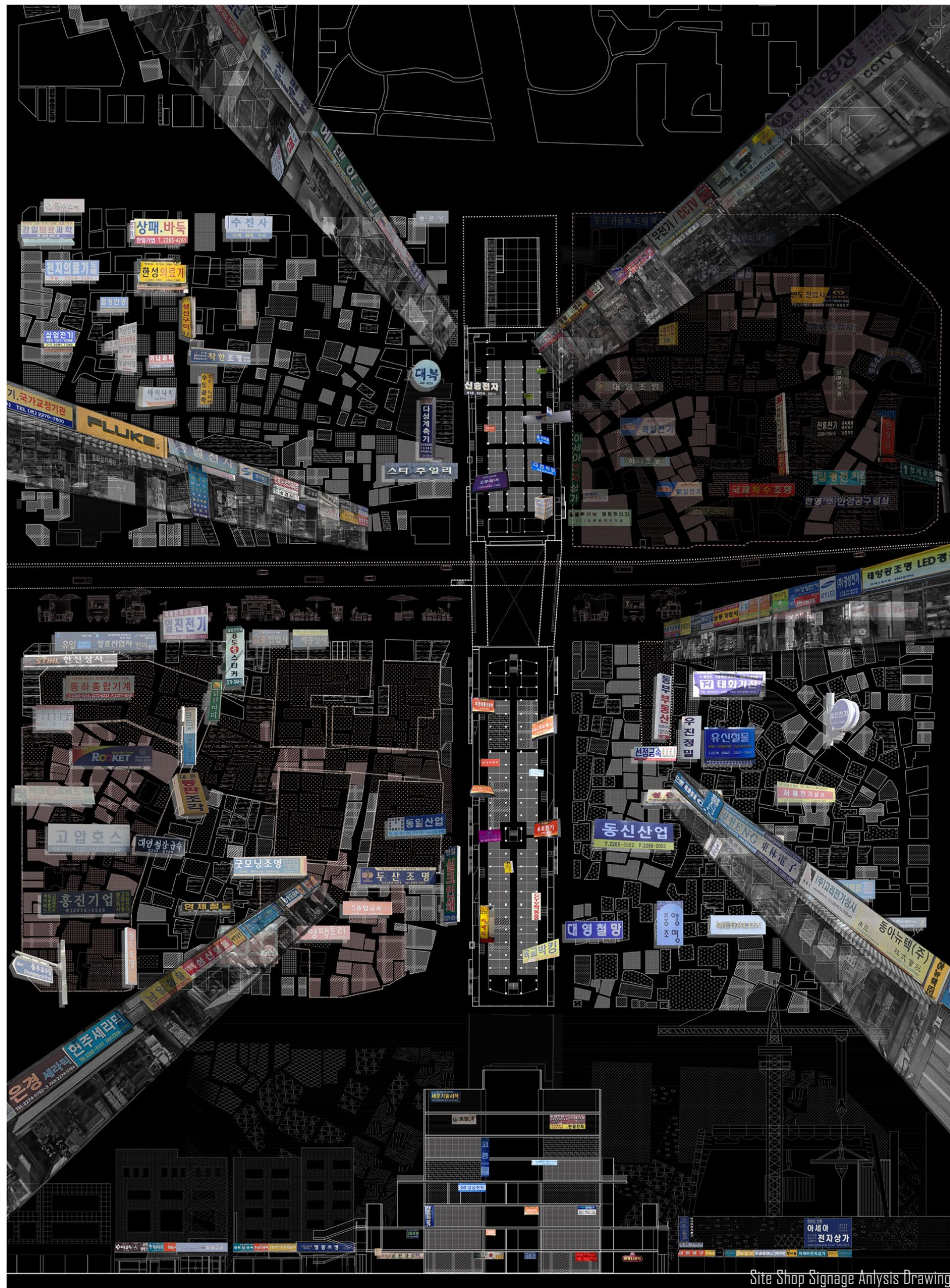
Term	ADV VI Spring 2026
Type	Team of Two (Hongan Nan)
Location	Seoul, South Korea
Instructor	Nahyun Hwang

This project reconsiders Sewoon Sangga not as an isolated megastructure, but as part of a larger network of small-scale production and exchange embedded within its surrounding urban fabric. As redevelopment erodes these interconnected systems, the project identifies the loss of tacit knowledge—informal, experience-based knowledge transmitted through making—as the critical issue.

Rather than proposing a fixed architectural solution, the design introduces an open spatial framework that supports adaptability and user participation. Inspired by the spatial logic of Sokgolmok alley networks, existing horizontal relationships are translated into a vertical system of circulation and interaction. Minimal spatial units, defined by human-tool relationships, enable flexible occupation and continuous reconfiguration.

The project positions architecture as an enabling condition, allowing existing social, spatial, and productive networks to persist and evolve within a changing urban context.



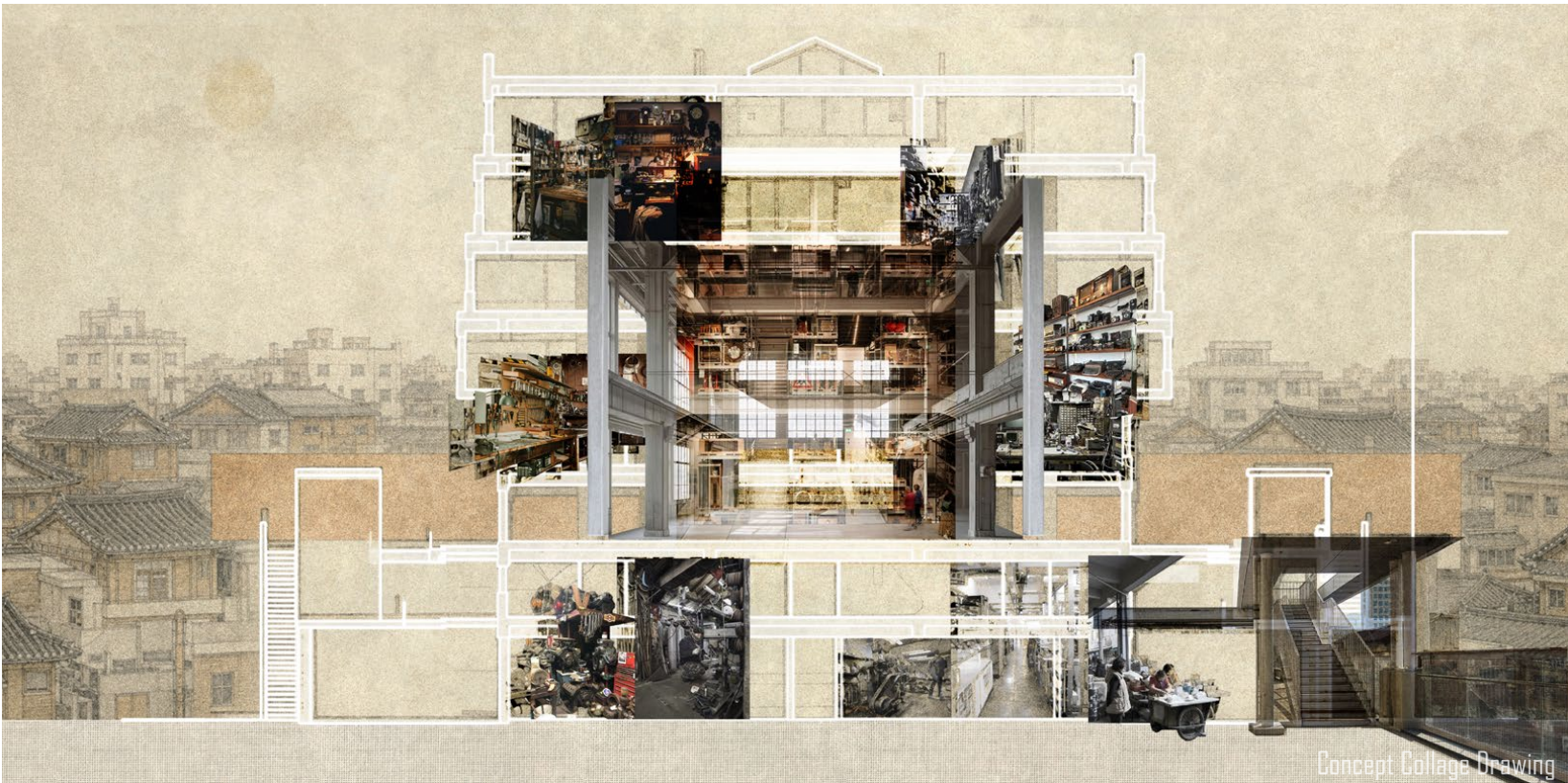


Located in the center of Seoul, Sewoon Sangga emerged during South Korea's rapid postwar industrialization as a mixed-use megastructure intended to modernize the city and support urban manufacturing. Beyond its architectural form, the district developed into a dense production ecosystem composed of electronics repair shops, watchmakers, jewelers, metal workers, tailors, and small-scale manufacturers. These workshops formed a highly interdependent network supported by surrounding streets, suppliers, and informal collaborations.

The significance of Sewoon Sangga lies not only in its physical structure, but in the tacit knowledge embedded within everyday spatial practices. Compact workshops where skills are transmitted through direct practice and long-term relationships between craftspeople. However, contemporary urban redevelopment and shifting economic conditions have displaced surrounding workshops, gradually weakening this collective production network and transforming Sewoon Sangga into one of its last remaining spatial vessels.



Concept Collage Drawing



Concept Collage Drawing



Industrial Ecosystem Disrupted

The industrial ecosystem in the area has been disrupted by the demolition of the old factory building. The new building is a modern, multi-story structure that has replaced the old one. The old building was a large, single-story structure that housed the factory. The new building is a modern, multi-story structure that has replaced the old one. The old building was a large, single-story structure that housed the factory. The new building is a modern, multi-story structure that has replaced the old one.



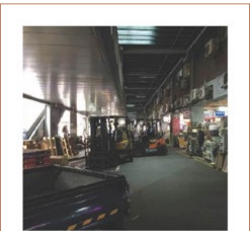
(De) Gentrification

The area has been gentrified, but the old factory building has been preserved. The new building is a modern, multi-story structure that has replaced the old one. The old building was a large, single-story structure that housed the factory. The new building is a modern, multi-story structure that has replaced the old one.



Circulation & Planning Tension

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Look of Management

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Closure of Technical Bookstore

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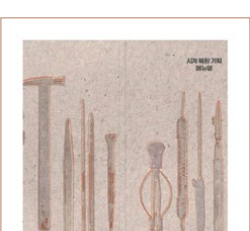
The Time of Tacit Knowledge

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Traditional Repair Stone Needs

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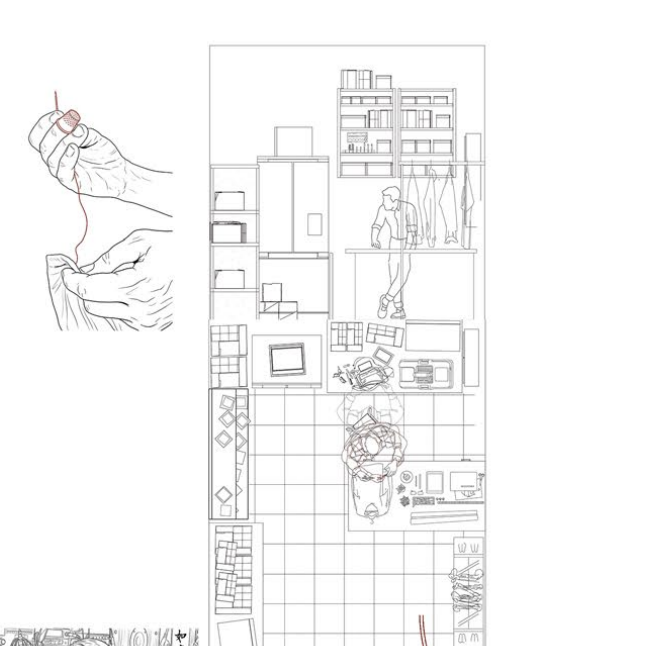
Tools and Hands

The area has been gentrified, but the old factory building has been preserved. The new building is a modern, multi-story structure that has replaced the old one. The old building was a large, single-story structure that housed the factory. The new building is a modern, multi-story structure that has replaced the old one.

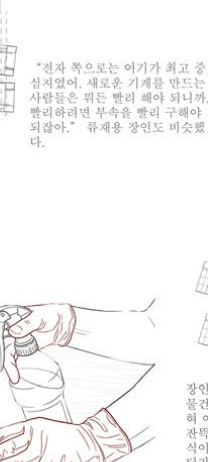








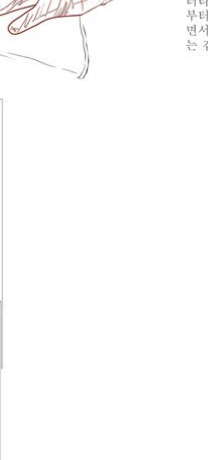




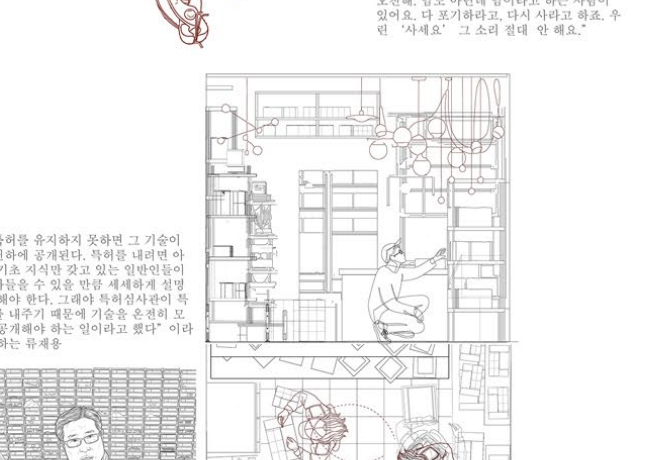






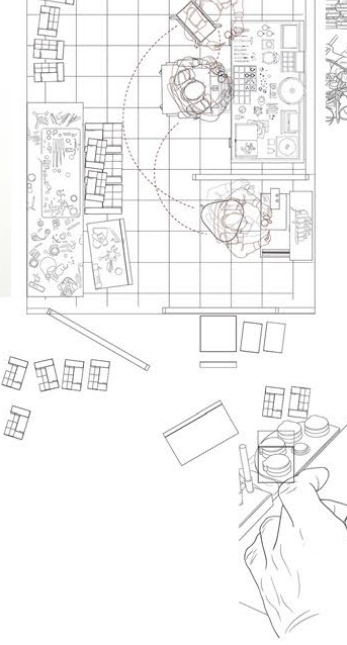






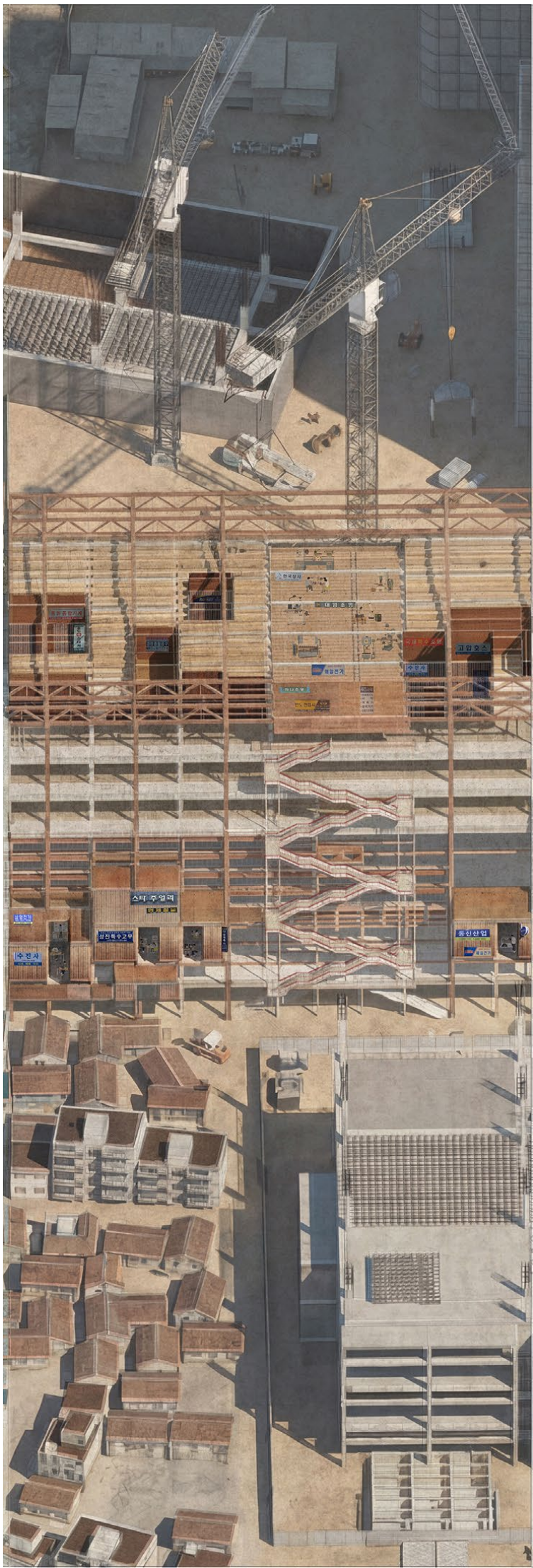




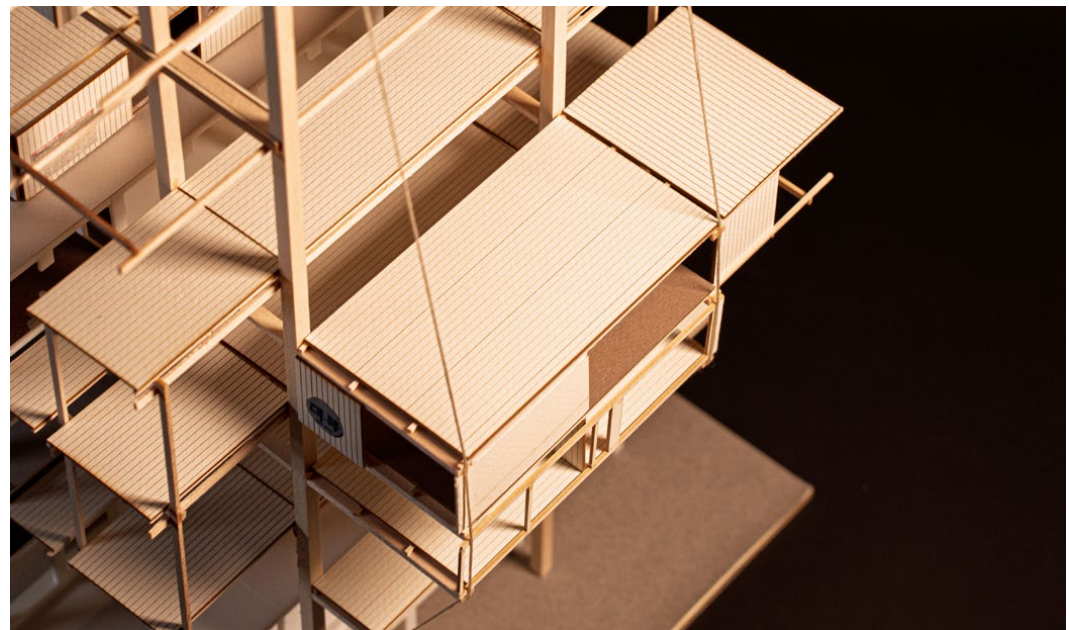




Tacit Knowledge Shop Diagrams



Time Changing Oblique Collage Drawing



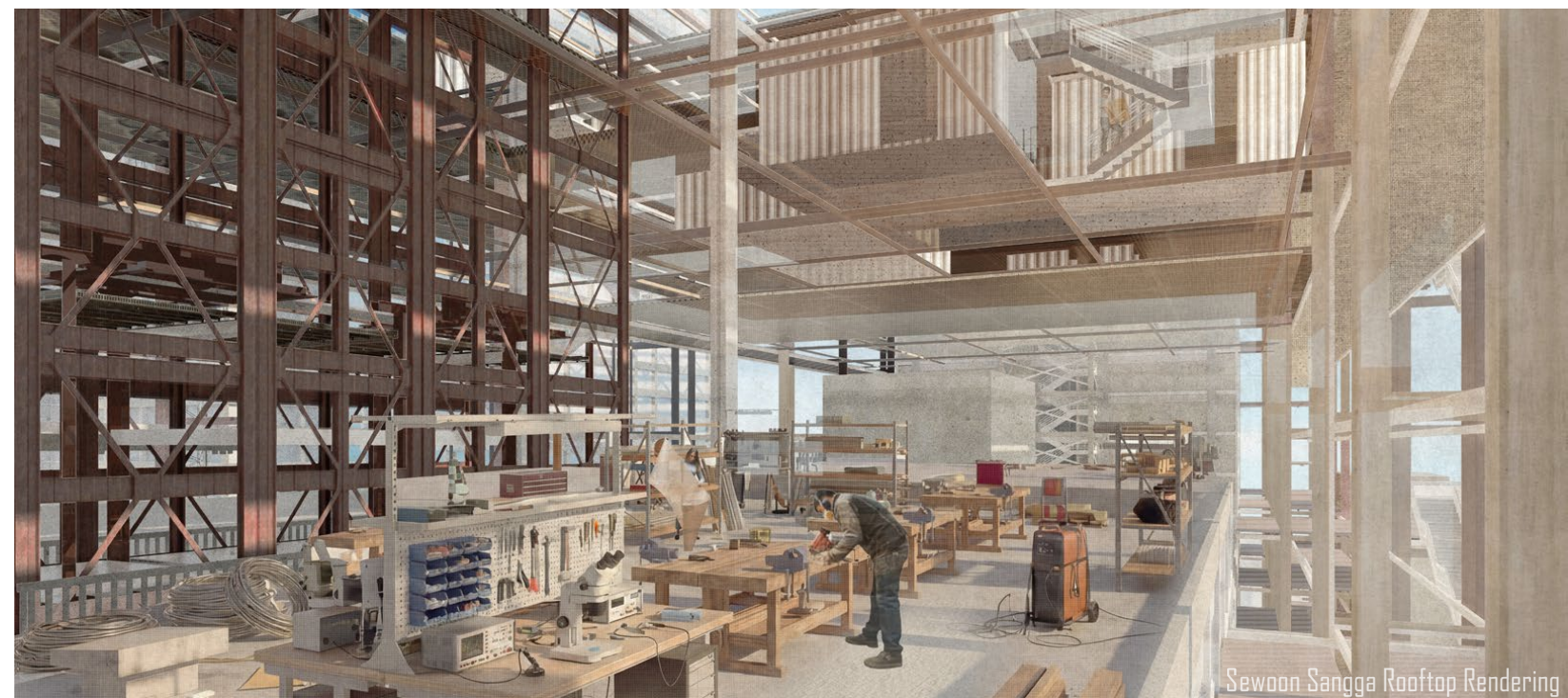
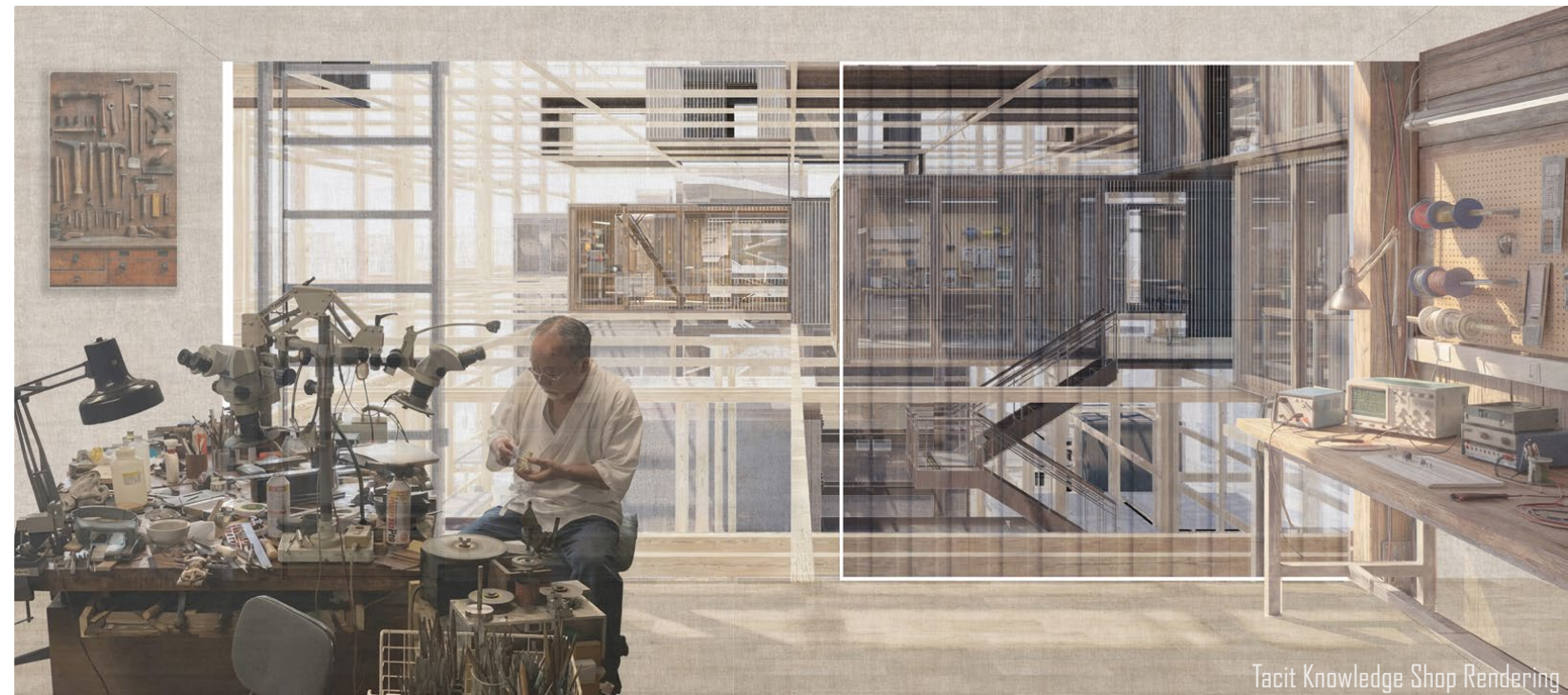
Replaces fixed programs with modular, spatial units based on body movement, allowing flexibly assemble and continuously adapt spaces through practice.



Inspired by Spatial City, the project introduces an open framework system, enabling flexible user participation, spatial adaptation, and evolving community relationships.



Preserves existing shop signage to maintain individuality, spatial memory, and social diversity rather than imposing standardized architectural uniformity.



THE WILD AND WILLED

A Pre-k daycare advocates for learning through risk-oriented play and wild nature

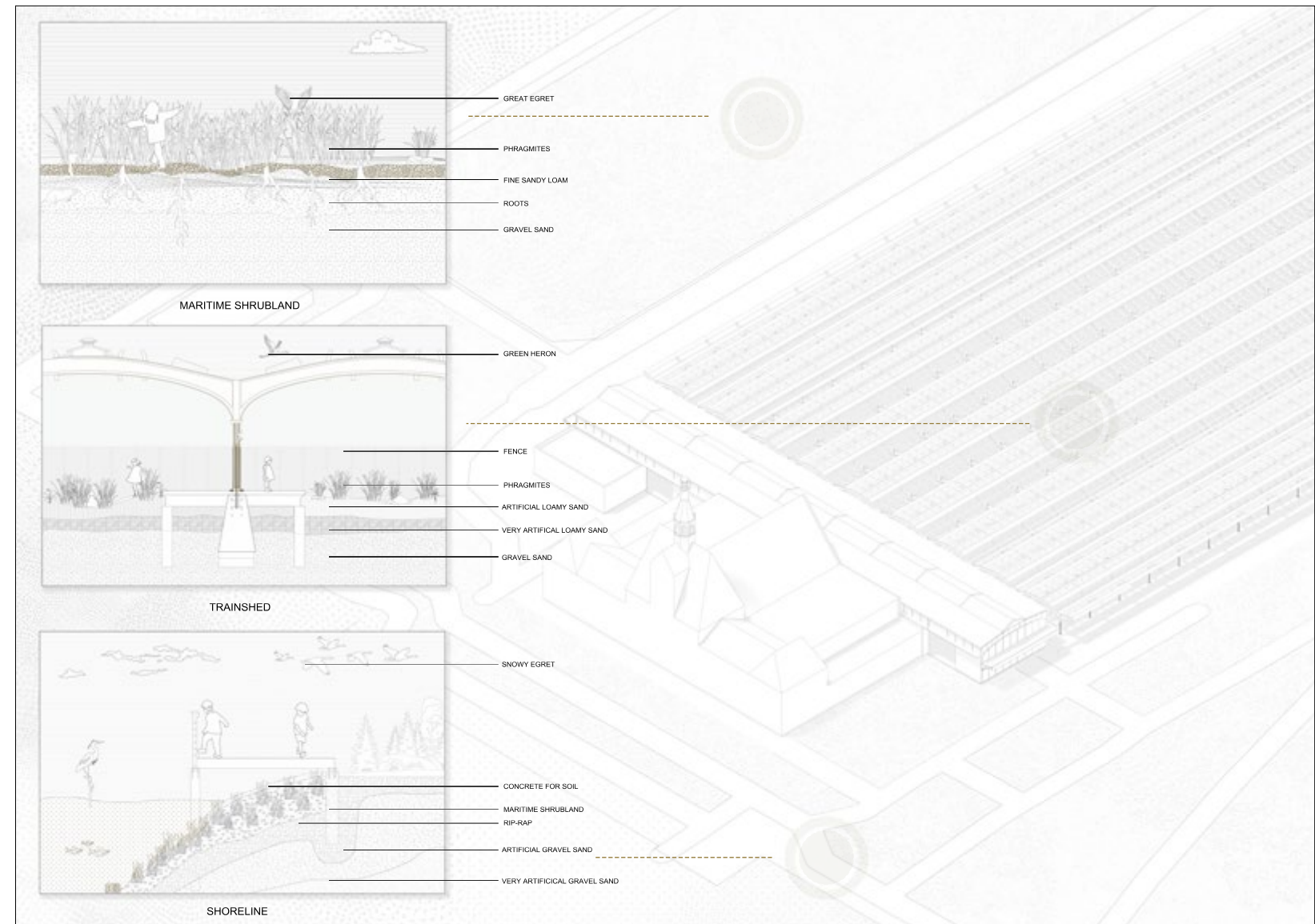
Term	Core IV Spring 2025
Type	Group Work (Hongan Nan)
Location	Liberty State Park Train Shield, New Jersey
Instructor	Mini Hoang

Our first study began with Friedrich Froebel's play theory and his idea of "gifts," since the architectural environment is seen as a sequence of carefully crafted spaces that move children from the security of confined, ordered interiors to the exciting unpredictability of the outdoors. This flexible and non-linear process helps children to move between sensations of safety and curiosity at their own speed.

Our architectural philosophy is grounded in a profound conviction regarding the transformative influence of nature and the essential role of danger in human growth. The landscape, characterized by its unforeseen wetlands and diverse ecological strata, actively engages in the educational process rather than only functioning as a background.

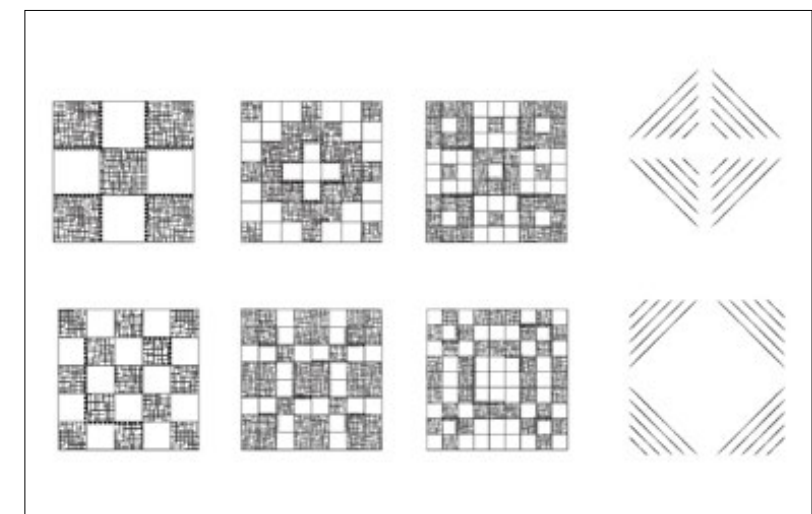
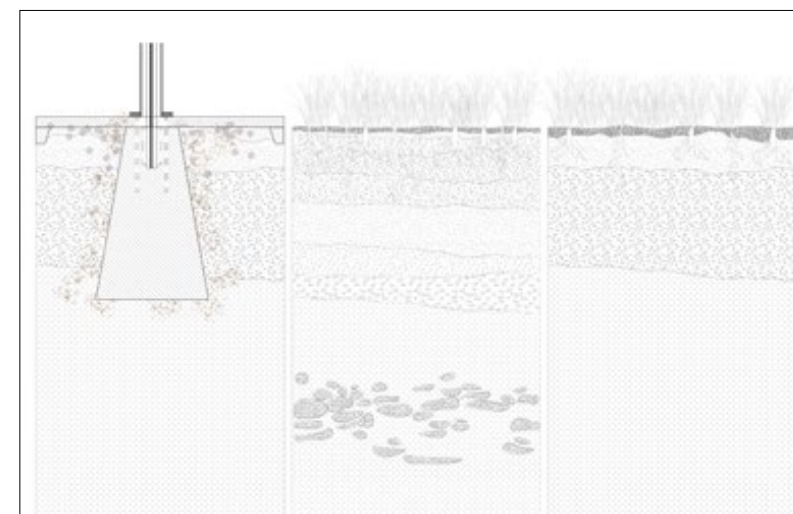
This location is unique as it contains the unforeseen, security with adventure, and limitation with freedom to cultivate resilience, curiosity, and a profound connection to the natural environment. So we propose a child care center, programmed with liberty science center and the neod, inviting kids 2-4 come to the site as part of their curriculum.





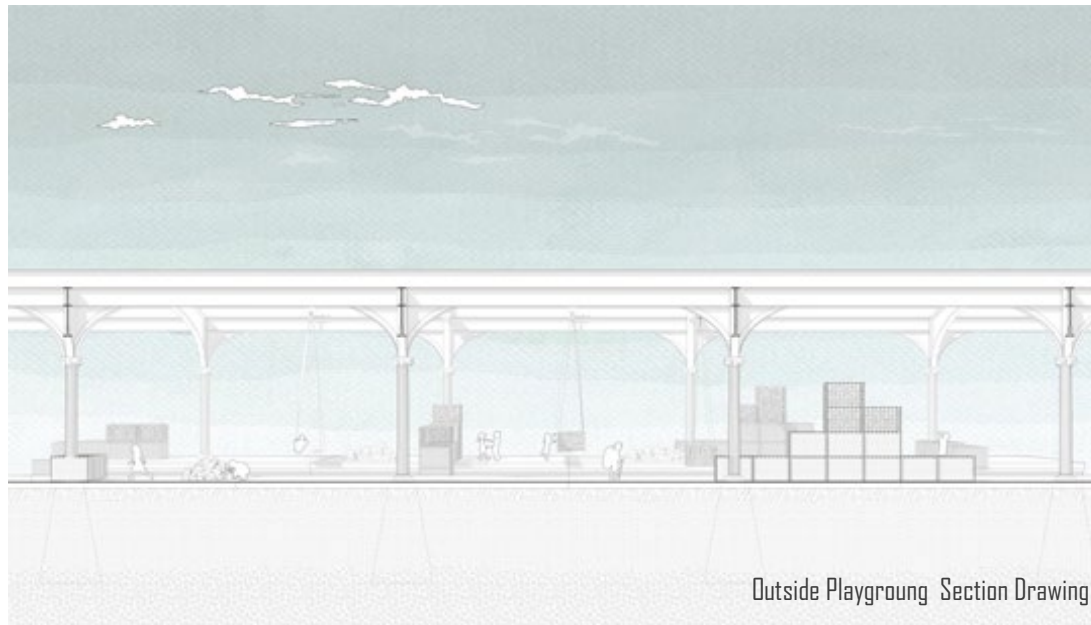
Microclimate has also been examined in addition to the broader scale. The soil composition of Liberty State Park is characterized by nutrient-rich, disturbed, and predominantly hydric conditions, creating an environment conducive to the proliferation of non-native species such as the invasive *Phragmites australis*. Frequently saturated, these soils facilitate the formation of artificial wetlands where resilient, invasive plants thrive. The alteration of natural environments, coupled with an abundance of nutrients and water, enables invasive species to outcompete indigenous flora, so transforming the ecosystem and facilitating the domination of non-native plants in the park's wetland areas.

We decided to introduce a gabion wall system to the site, as it contains the same energy as mentioned by Froebel. We present a gabion wall system configured in a module of 3x3x2. The height is ideal for children to engage in activities that promote understanding of scientific concepts via play, such as the principles of gravity and various elements of the Earth, including sand, rock, and concrete. The design features a gabion wall system to delineate functional spaces, including family rooms, classrooms, a research center, and animal encounter zones

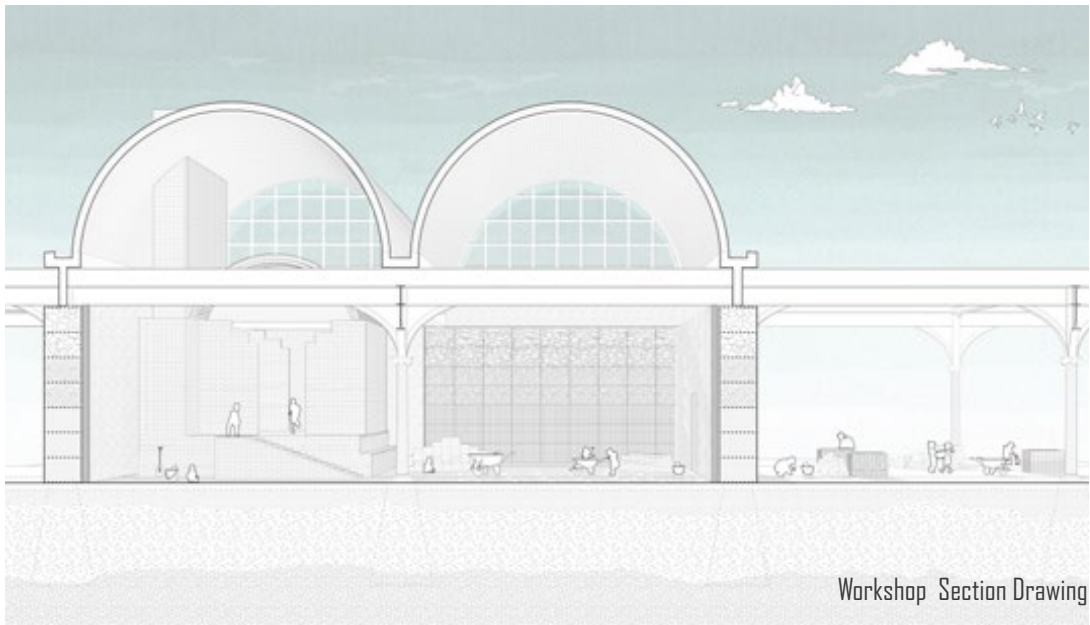




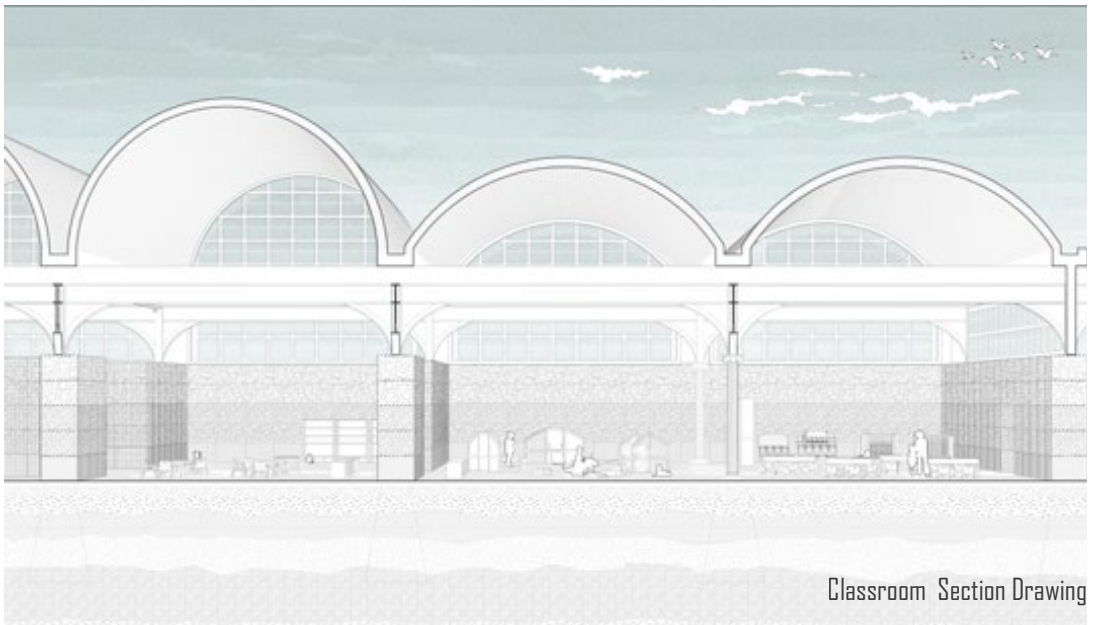
Section Perspective Drawing



Outside Playground Section Drawing



Workshop Section Drawing



Classroom Section Drawing



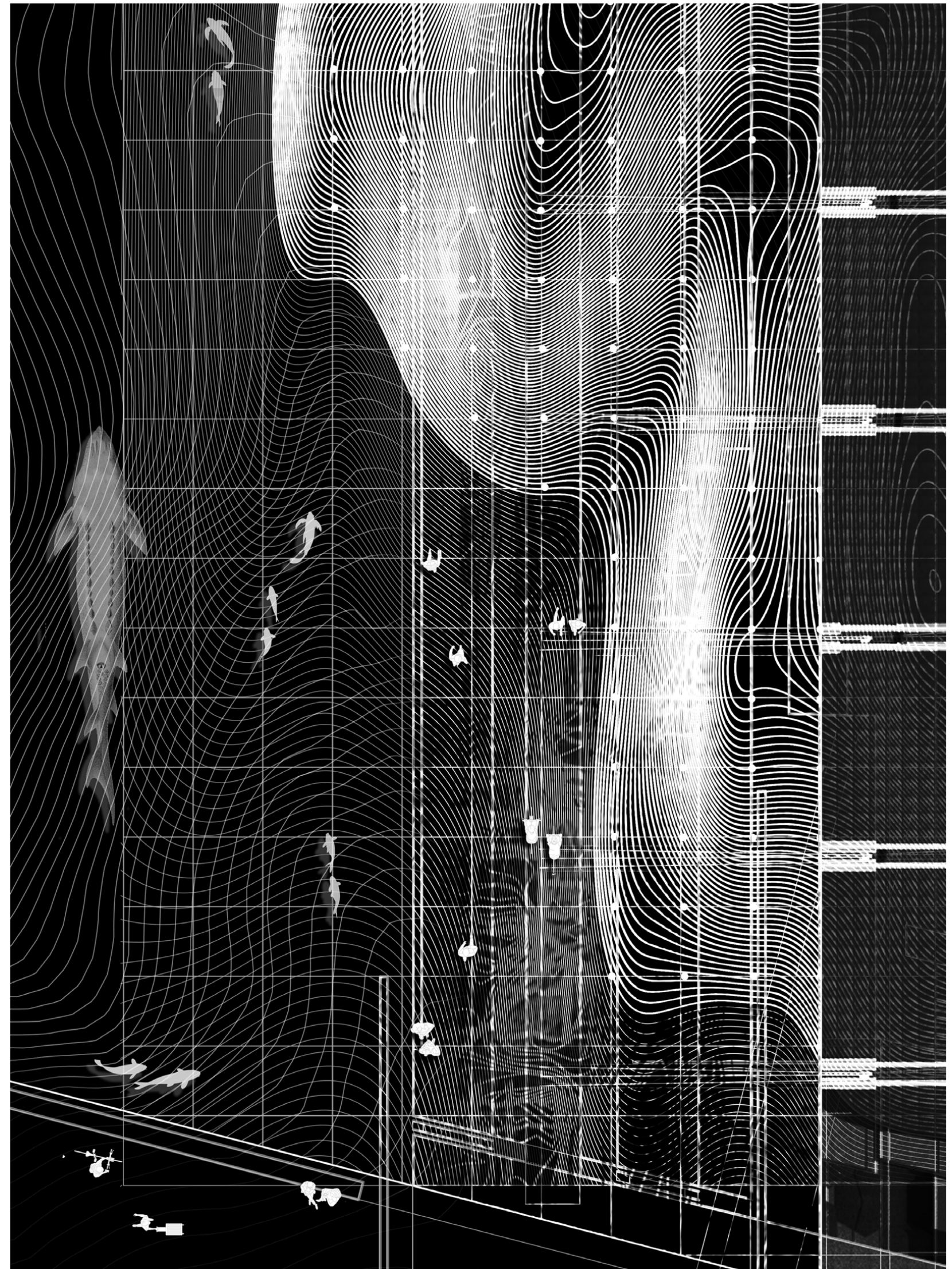
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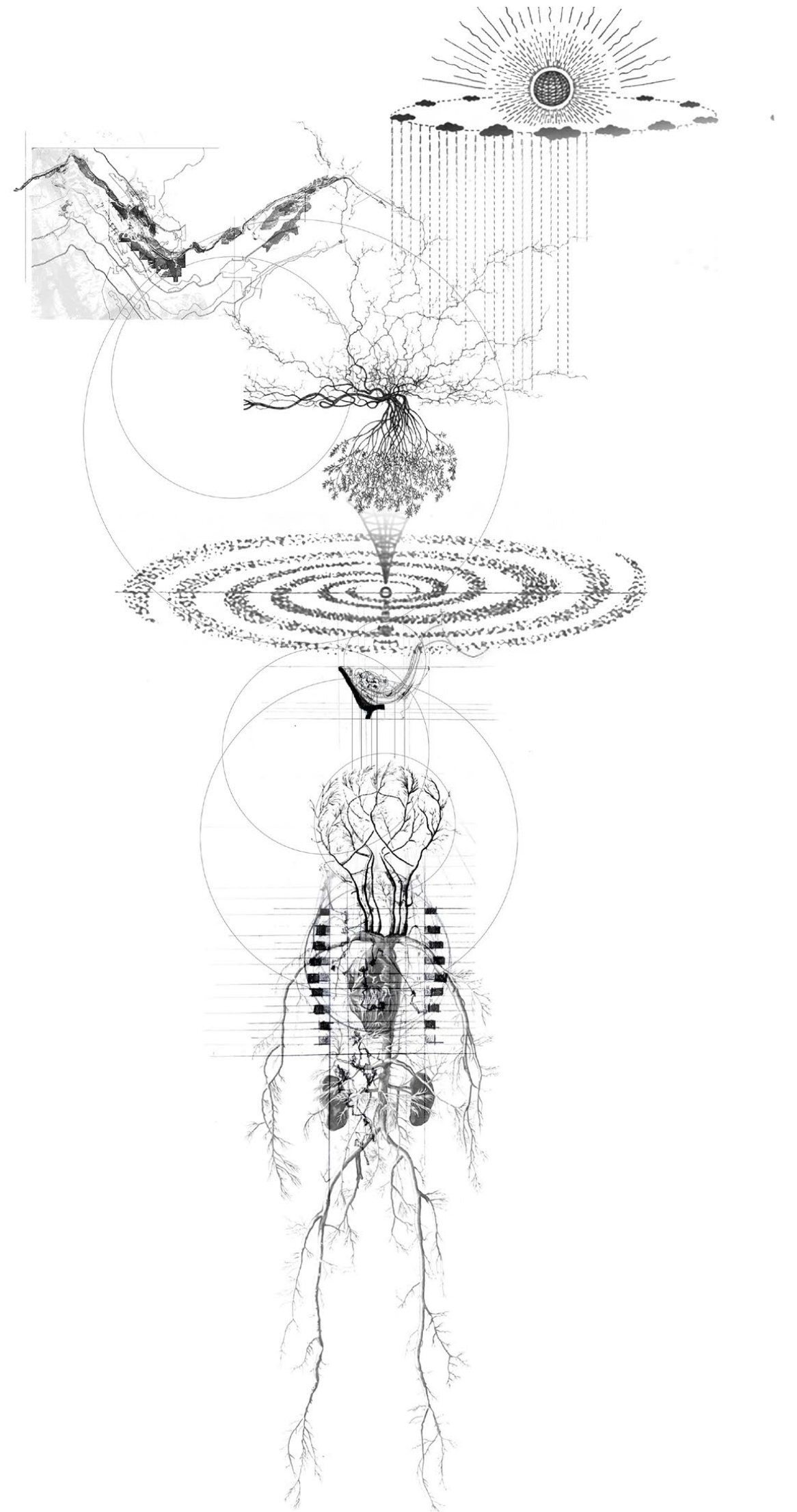
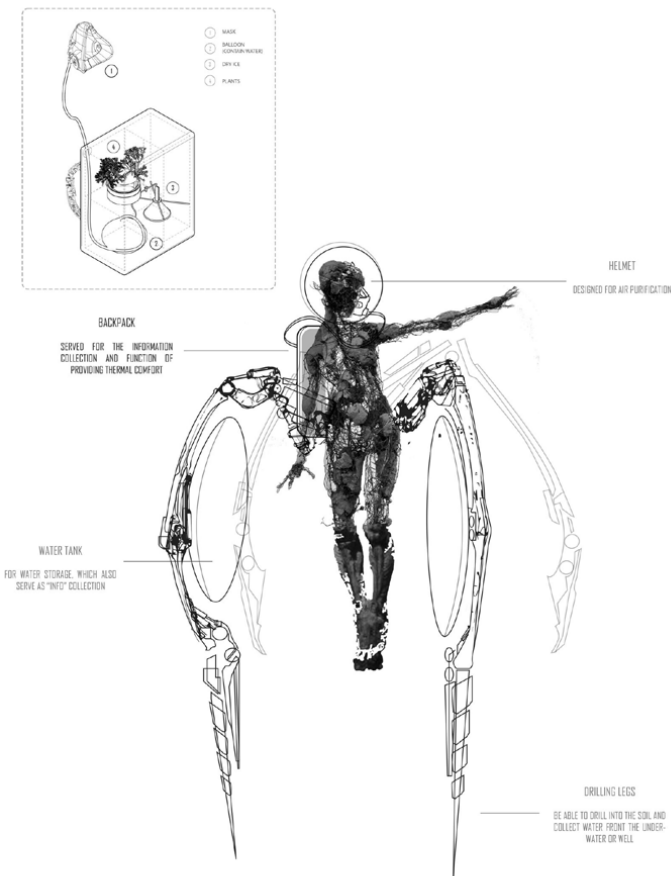
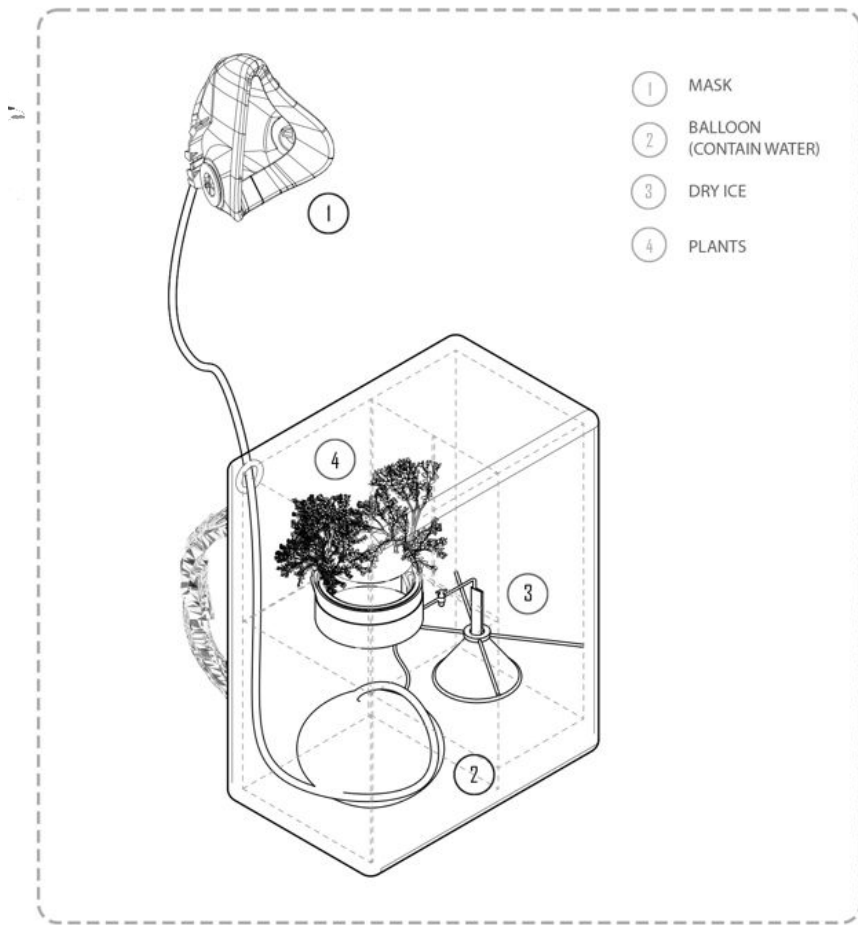
Study of the Edge of Manhattan based on different kinds of ways and in different spaces and times

Term	Core I Fall 2023
Type	Individual Work
Location	New York
Instructor	Lindy Roy

The Acies, instead of a steady line, might be a Hetetrapias that is limited to slices in time, which is constantly moving and changing.

The research towards Hudson River suggested that the space between water and pier 45 could be viewed as a living edge, which in other word, a Acies. It is a batterfield between human activity and natural reclamation. The design relates to a sense of connection between people and nature, a shared sense of purpose and meaning that flows from that, and which translates to the ways of how to coexist. The project is designed to receive an authority vested in the past, preserve it in the present while coping with new circumstanceds, and to transmit it to this space.





Modern cognitive psychology sees humans as information processing systems, viewing cognition as the processing of information with the human brain serving as the central processing unit. The entire cognitive system of an individual consists of four parts: receptors, effectors, memory, and a processor (or control system). The human body is likened to a carbon-based, pre-programmed, highly sophisticated, and intelligent computer system.

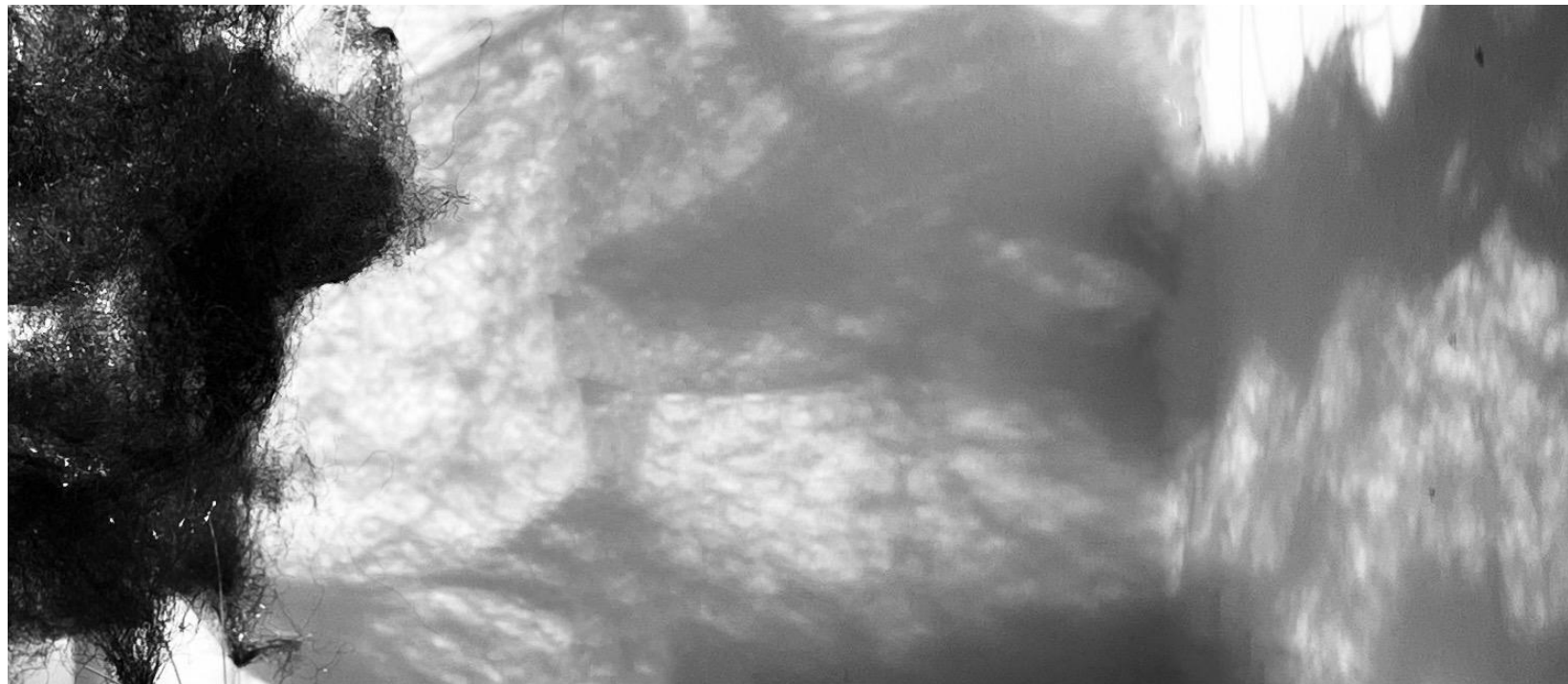
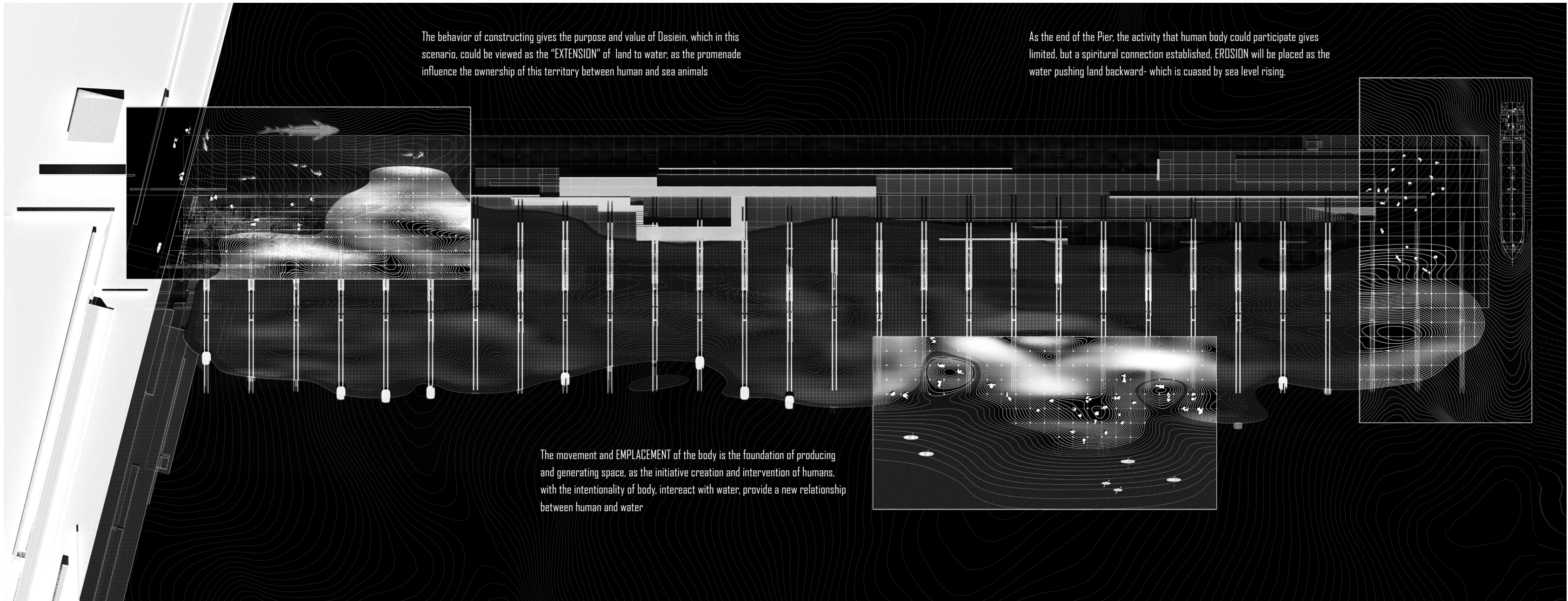
Among the research, Human cognition is the result of the combined interaction of the mind and body with the external environment. The phenomenal world is merely a partial macrocosmic reflection and mapping of information relative to humans, as forming a dynamic accumulation of various stimuli, experiential models, and abstract information models within the entire system.

The first phrase experiment is designed to test out the process of the human being's physical body sensing the world and how this random movement has been processed to a certain type of information.

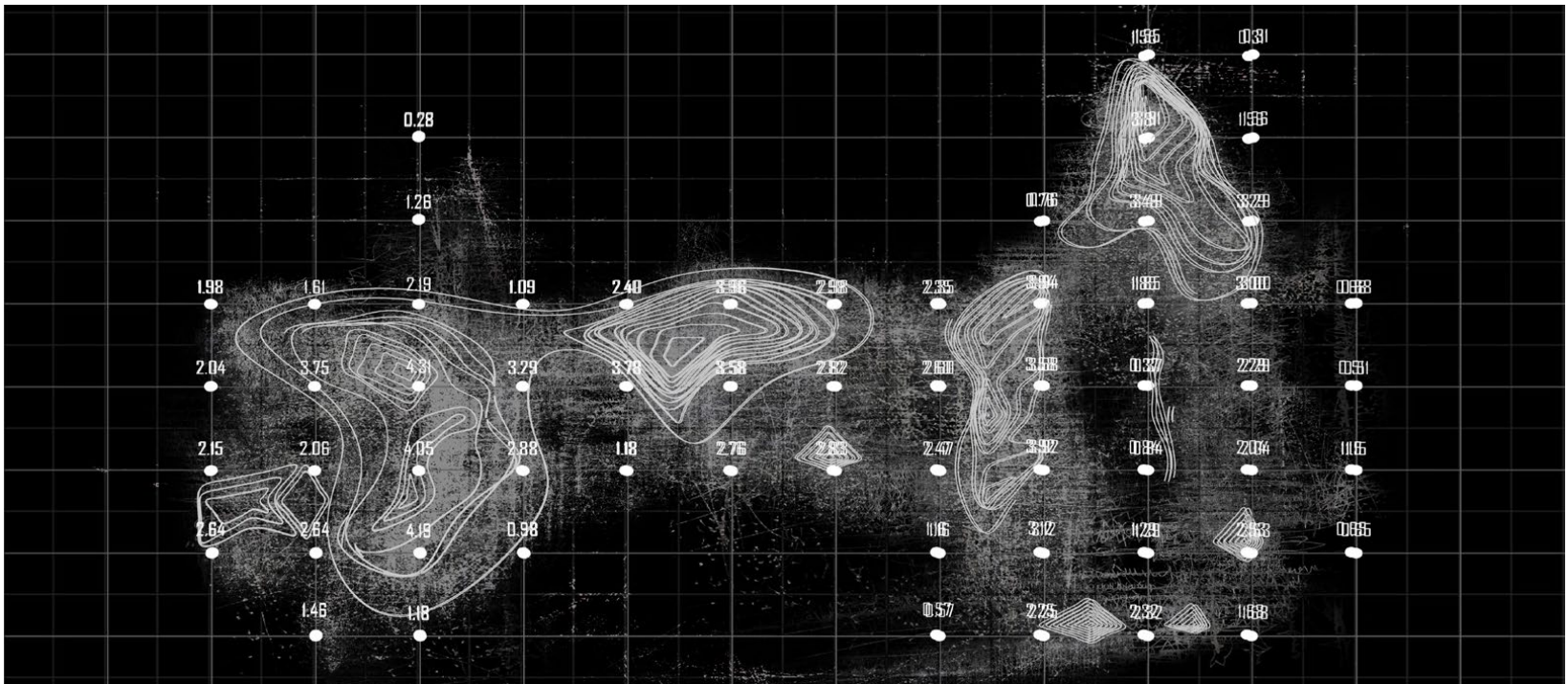
Section drawings are developed. During the mediation, the smoke has been captured by eyes as the original spiral shape has been changed because of the interaction of human breath, as the temperature and energy field of the environment. The energy waved together which somehow softened the boundaries of the physical body.

In this case the physical world is just the mirror reaction and mapping of part of the macroscopic universe information relative to humans. It is a combination of different stimulation experience models and abstract information models that are dynamically accumulated by the entire system.





A zoom-in version has been developed to study this relationship between the human body and the environment. By graphing the interweaving structure between the smoke and the energy field, a Heteropias has been found. As the boundary between the physical model and its shadow keeps changing and forming a space that is also counted by time. The space is not only identified by the present, but also the activities used to happen at the site. The ghosting effect affects the meaning of space and the motion of human beings.



The design offers an opportunity to register the interaction between water and the human-beings. The installation allows the water to affect the land, changing the landscape, forcing people to move in a certain path and gesture. The scale of the new part of the pier is the same dimension as the Pier, offset from the existing landfill constructio which allows the tension to happen. The space is created to allow social cohesion to happen in this "unstable" landscape terrain. It receives an authority vested in the past, to present while coping with new circumstances. n

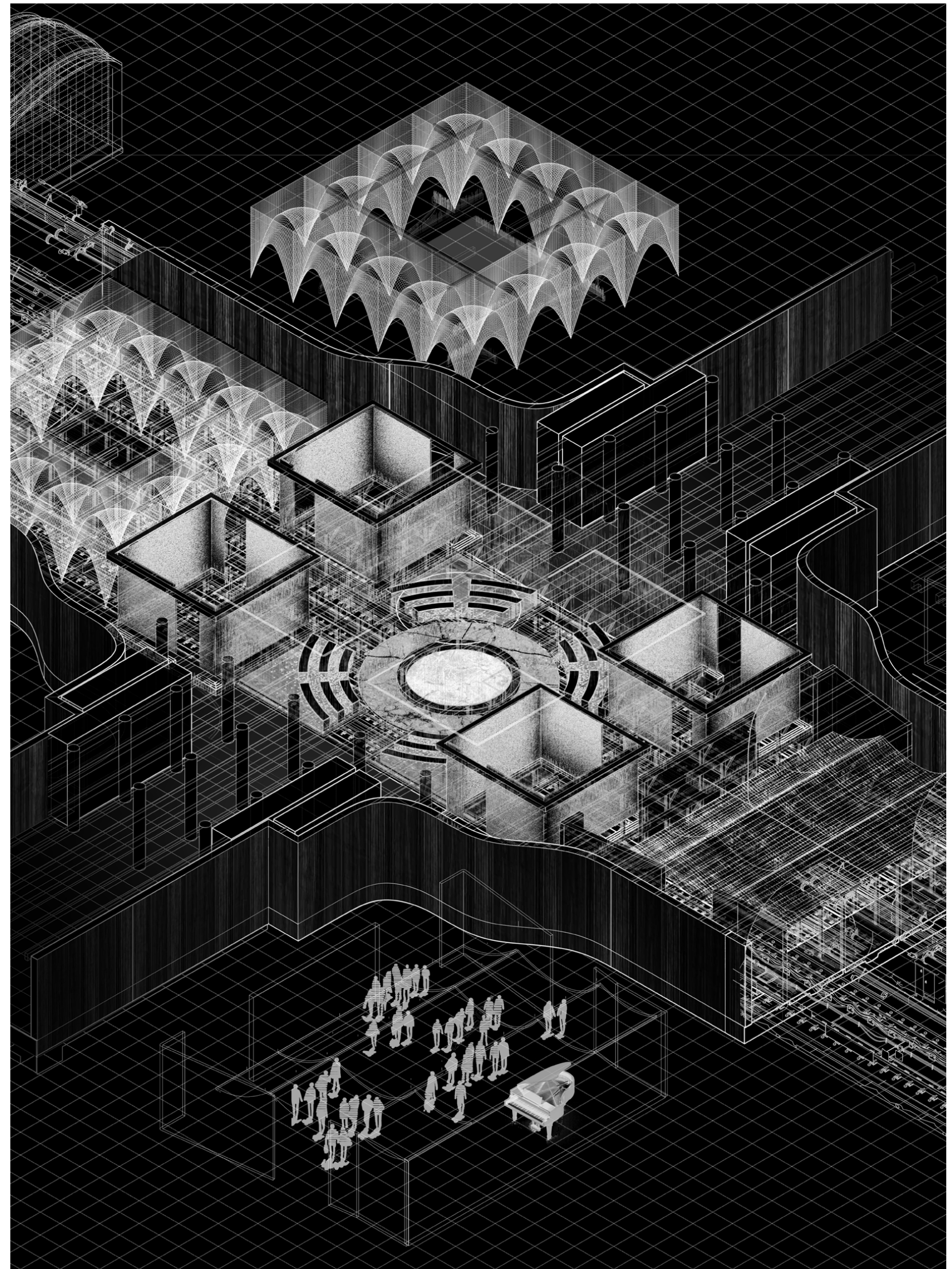
GHOSTED INFRASTRUCTURE

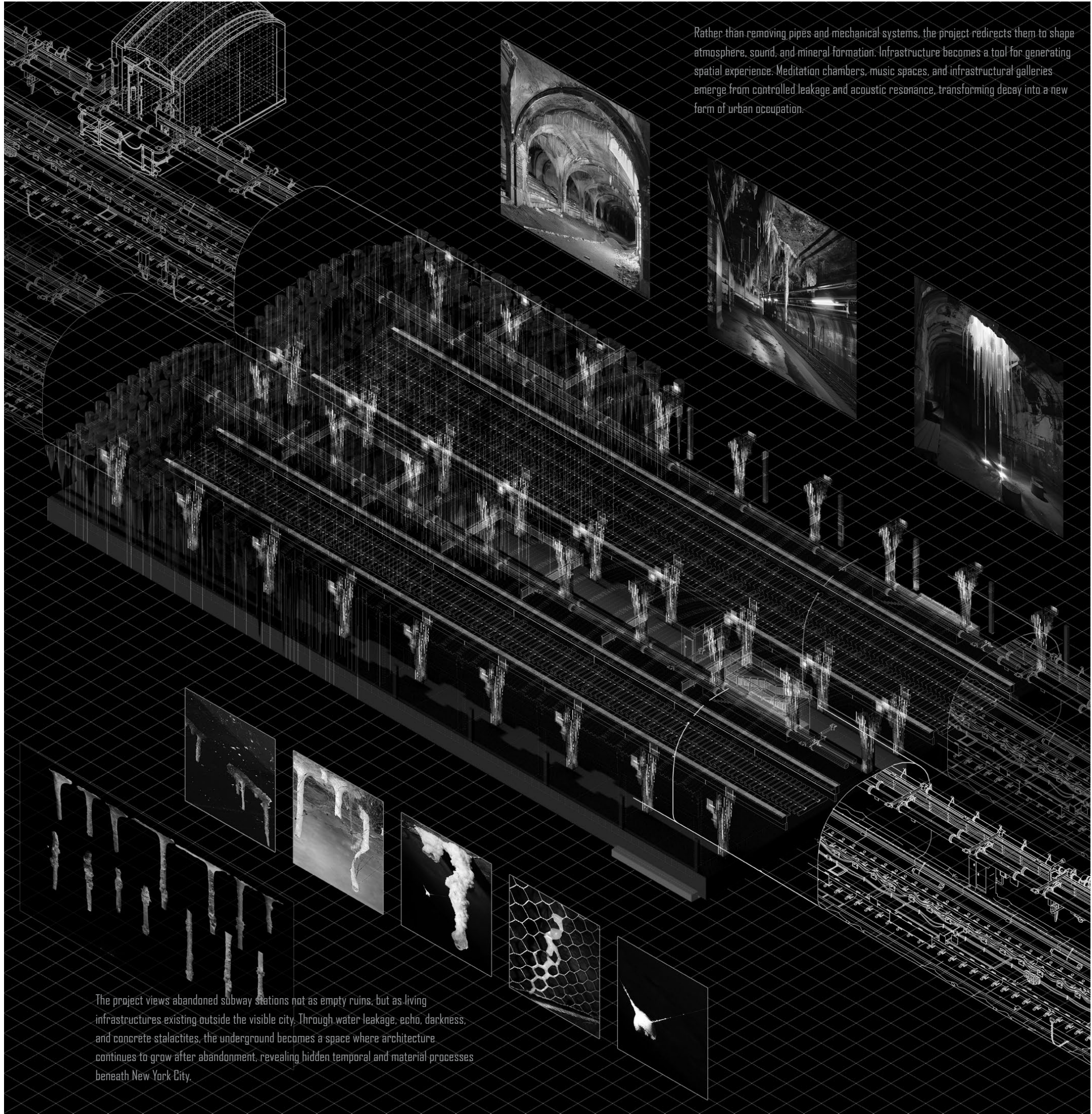
spatial orchestration of abandonment in NYC City

Term	Core II Spring 2024
Type	Individual Work
Location	New York
Instructor	Regina Teng

Located within the abandoned underground subway infrastructure of Lower Manhattan, this project investigates spaces hidden beneath the contemporary city yet never fully erased from it. Built during the early twentieth century, many of these stations were left unused due to changing transit systems, technological limitations, and urban redevelopment. Over time, water infiltration through aging concrete structures produced mineral formations similar to stalactites, transforming the underground into an environment shaped by leakage, darkness, echo, and gradual material growth.

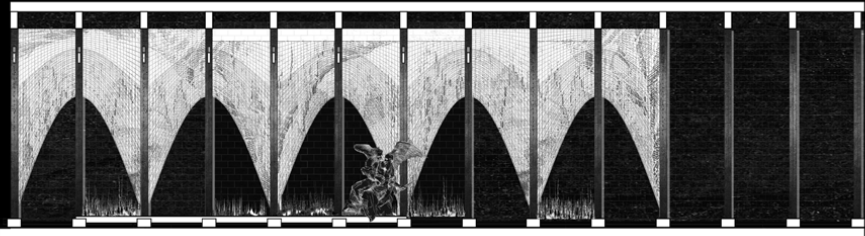
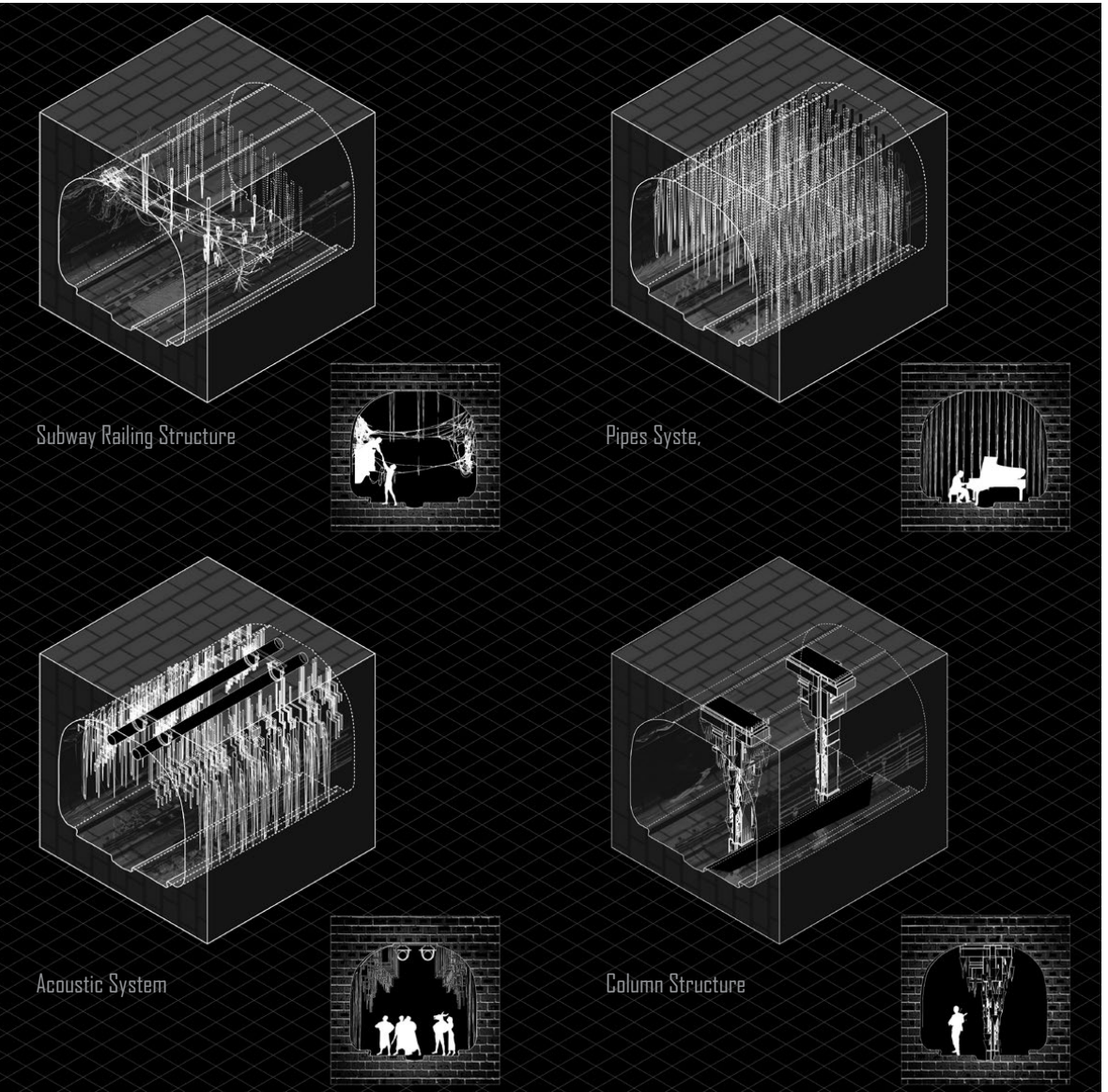
The project understands these abandoned stations as “ghosted spaces” — infrastructures that no longer function within the visible city but continue to exist materially and atmospherically beneath it. Rather than treating abandonment as the end of architecture, the proposal explores a lingering condition in which space continues to evolve after its original use disappears. Existing pipes, drainage, and MEP systems are redirected to guide sound, humidity, and mineral accumulation, transforming infrastructure into a generator of meditation spaces, gathering chambers, and infrastructural galleries.





Rather than removing pipes and mechanical systems, the project redirects them to shape atmosphere, sound, and mineral formation. Infrastructure becomes a tool for generating spatial experience. Meditation chambers, music spaces, and infrastructural galleries emerge from controlled leakage and acoustic resonance, transforming decay into a new form of urban occupation.

The project views abandoned subway stations not as empty ruins, but as living infrastructures existing outside the visible city. Through water leakage, echo, darkness, and concrete stalactites, the underground becomes a space where architecture continues to grow after abandonment, revealing hidden temporal and material processes beneath New York City.



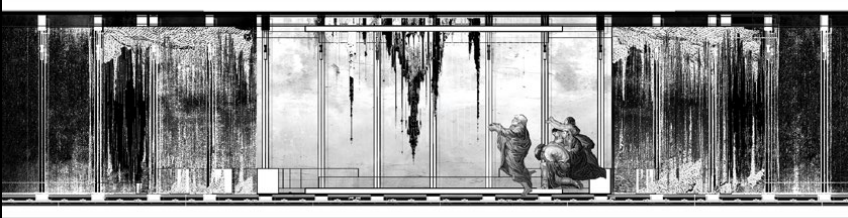
Chamber of Resonance

A subterranean gathering space where dripping water, concrete surfaces, and infrastructural echoes transform abandoned transit infrastructure into an immersive environment for experimental sound and collective occupation.



Cathedral of Silence

A meditative chamber shaped by darkness, humidity, and mineral growth, where concrete stalactites and reverberation create a spatial experience of stillness, slowness, and suspended time.



Archive of Residue

An infrastructural gallery preserving obsolete mechanical systems, fragments, and urban artifacts, revealing the hidden material memory embedded within the abandoned subway network.

THE CANOPY

Collactive Assembly Combination with Grasshopper

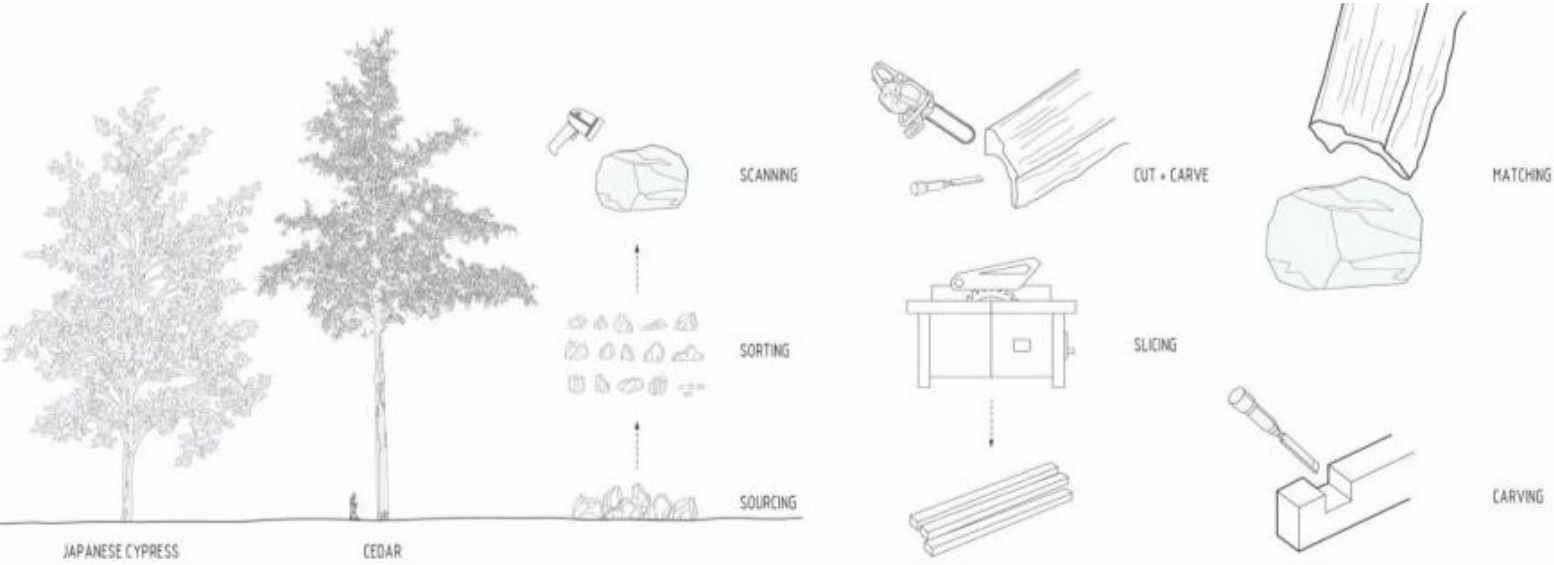
Term	Elective Spring 2024
Type	Group Work
Location	Lower East Side, New York
Instructor	Danniely Staback Rodríguez

The Canopy is a project that explores the potential of wood and masonry joinery. By designing a distinctive wall assembly, the wall aspires to evolve into a canopy that responds to local conditions while reexamining the relationship between manmade structures and natural components.

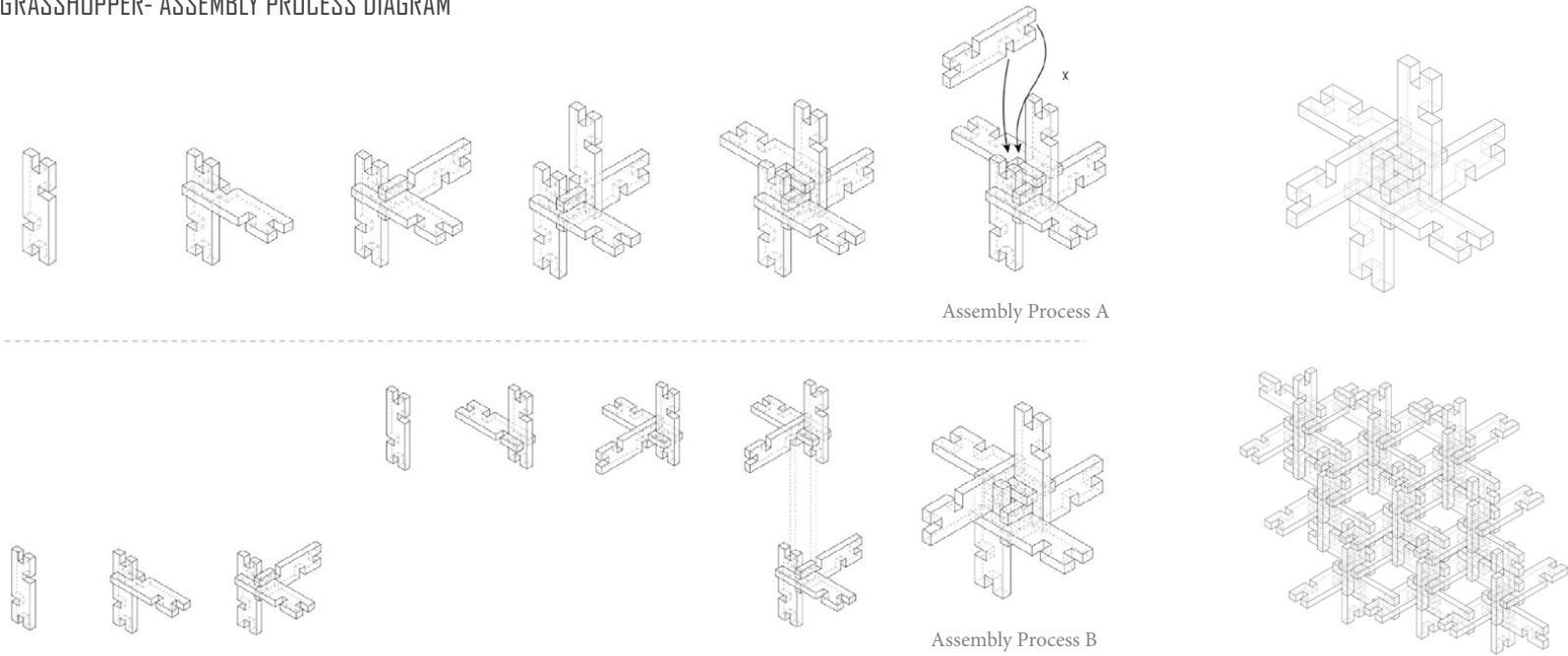
The proposition Attempts to integrate ancient construction practices with contemporary technology focus on minimizing material waste via reuse, while also considering the mechanization of lock production. The Grasshopper script may now control the creation of the blocks, as well as the dimensions and angles of the interlocking components. It might also regulate the area required for this construction, so facilitating room for human activities. Connections with alternative materials would be significant. The concept might provide a temporary space in the neglected urban region. The masonry and wood team might also investigate methods for controlling them under gravitational conditions. Additional materials may be included to realize this concept.



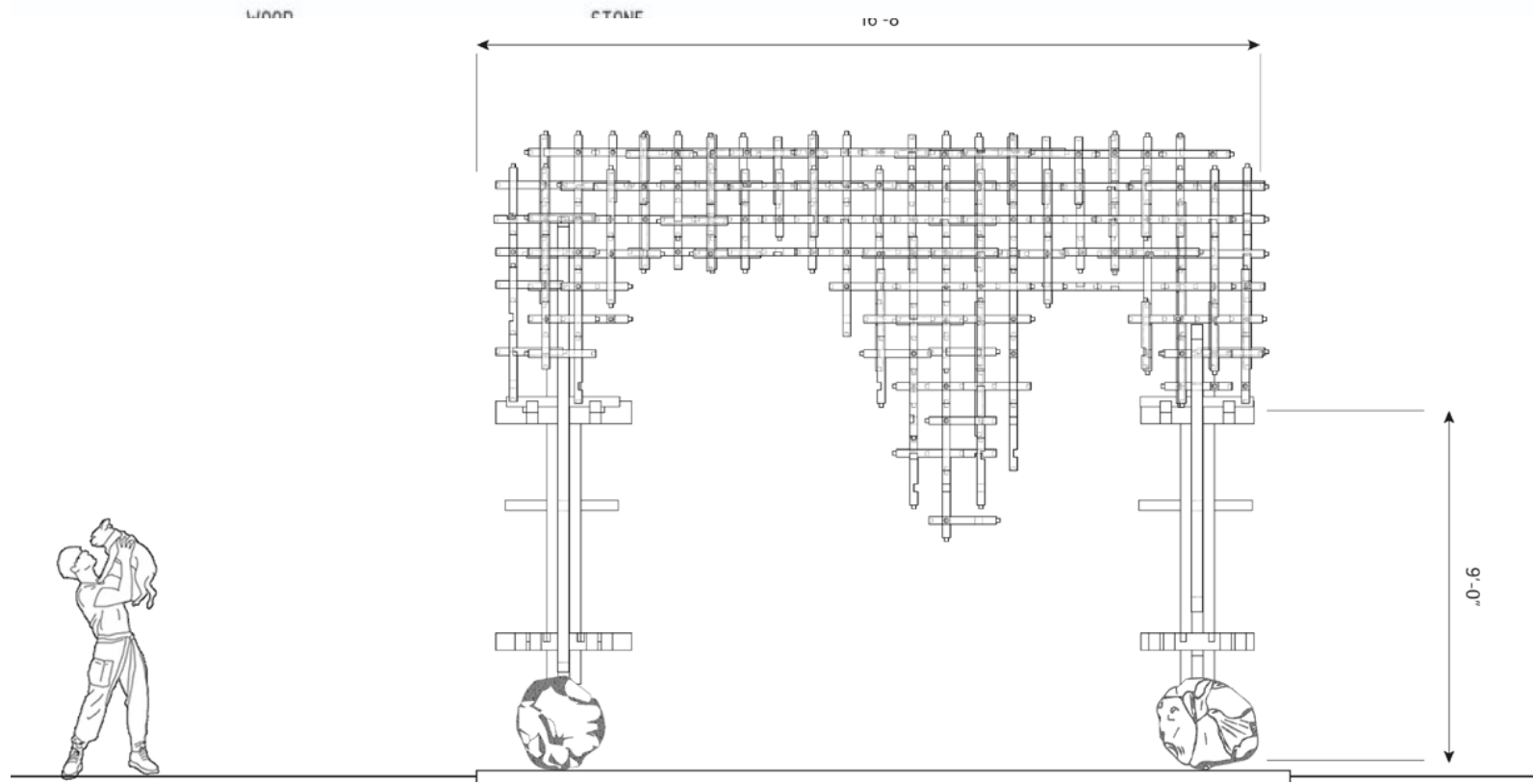
MATERIAL LIFE-CYCLE DIAGRAM



GRASSHOPPER- ASSEMBLY PROCESS DIAGRAM



SECTION DRAWING



Urban Strata at 1227

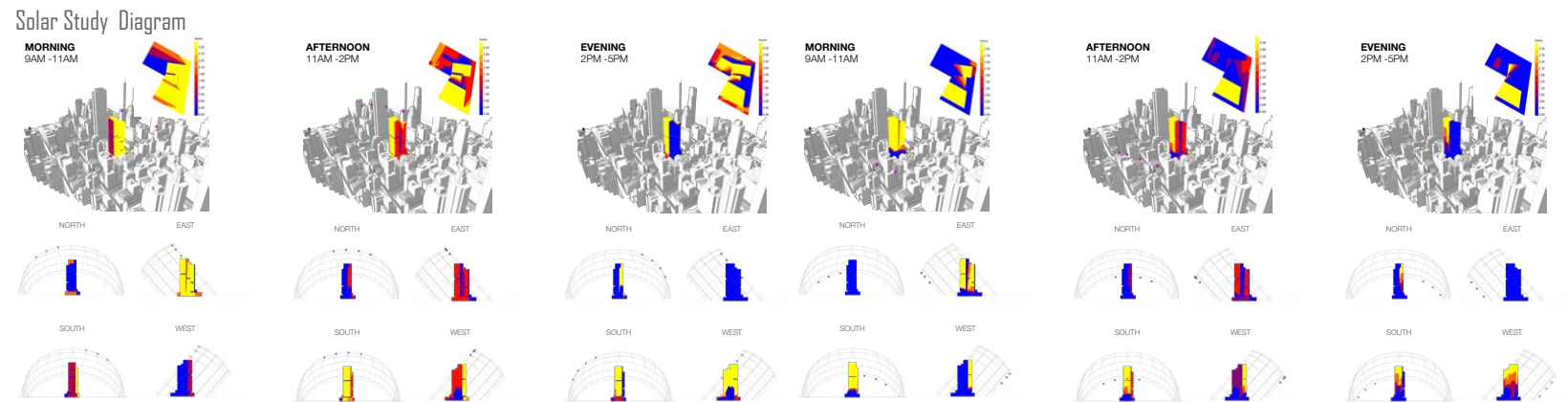
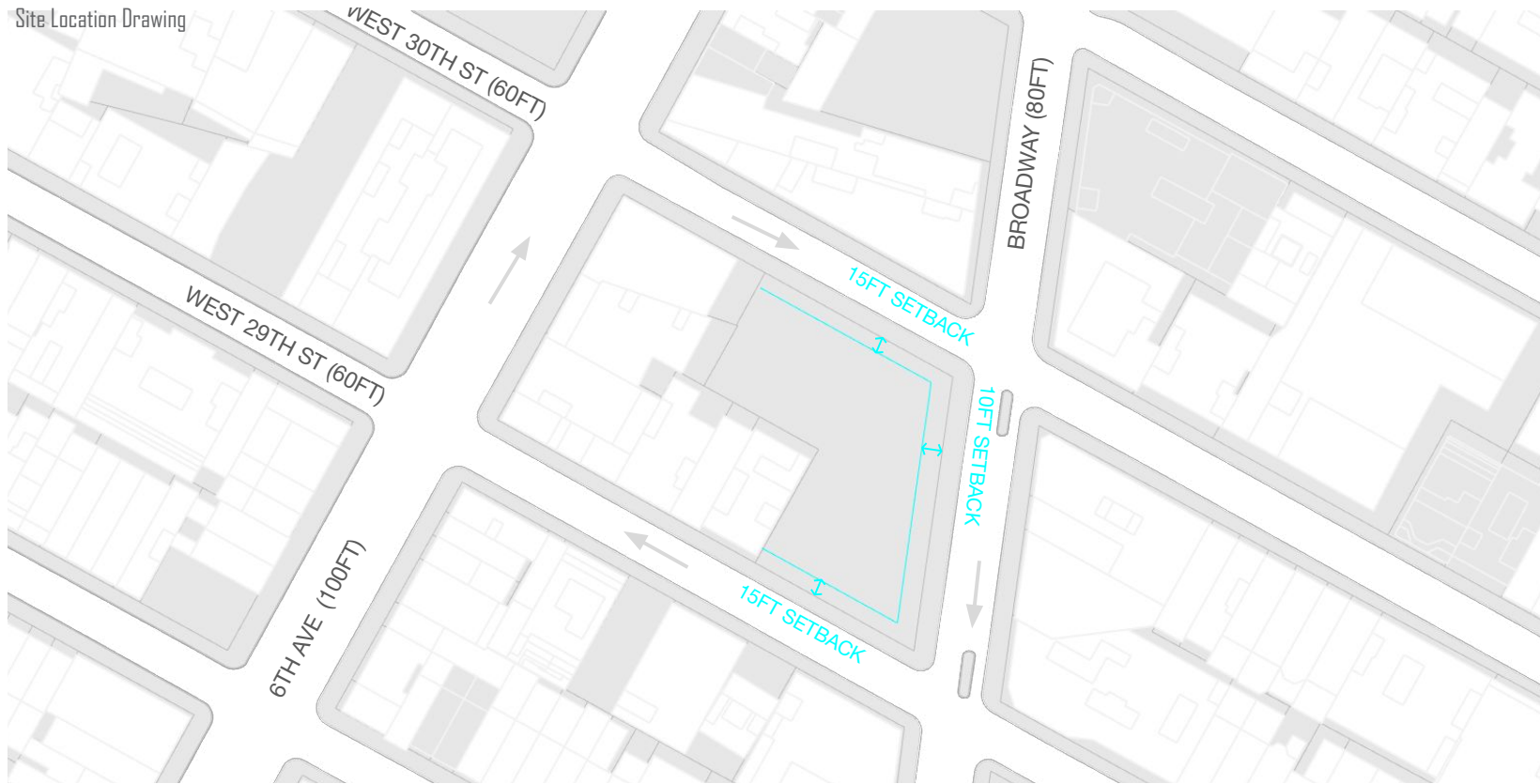
Co-living Working Space in Mahanttan

Term	Elective Spring 2026
Type	Group Work
Location	1227 Broadway, New York
Instructor	Joseph A. Brennan

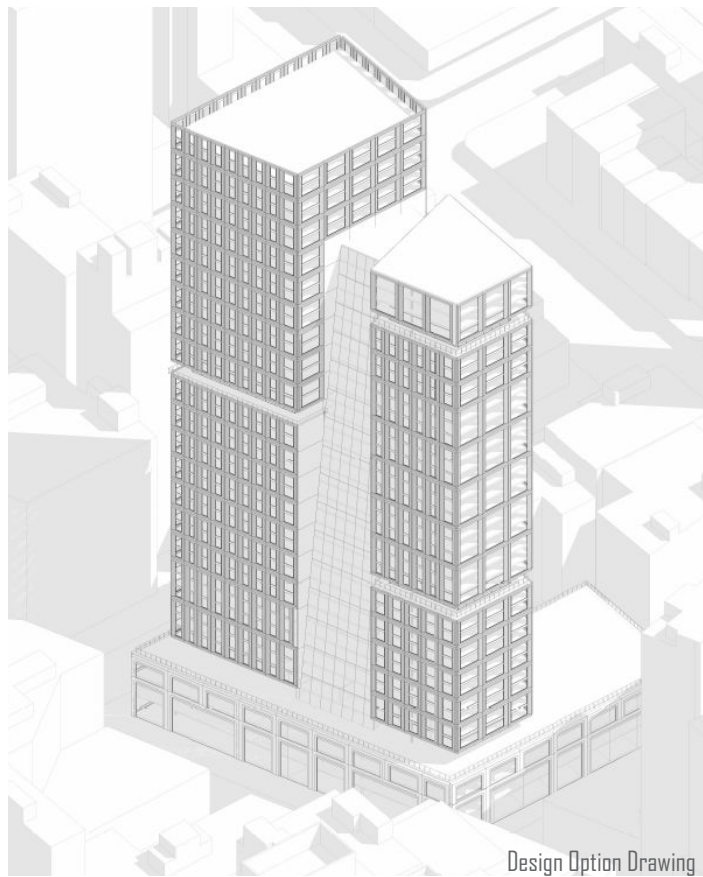
Located at 1227 Broadway in Manhattan, this project explores the design of a mixed-use co-living and working tower within a dense urban context. The proposal focuses on the relationship between environmental analysis, facade performance, and realistic structural development under New York City zoning and building constraints. Through detailed studies of solar exposure, shadow impact, and surrounding urban conditions, the facade system was developed as both an environmental and architectural response.

The building combines retail and office programs on the lower floors with residential units above, creating a vertical integration of public and private spaces. The final facade design utilizes terracotta panels and vertical extrusions that respond directly to solar orientation, improving shading performance while establishing a layered exterior identity. The project emphasizes practical building systems, structural logic, and constructability, bridging environmental performance with contemporary urban housing design.

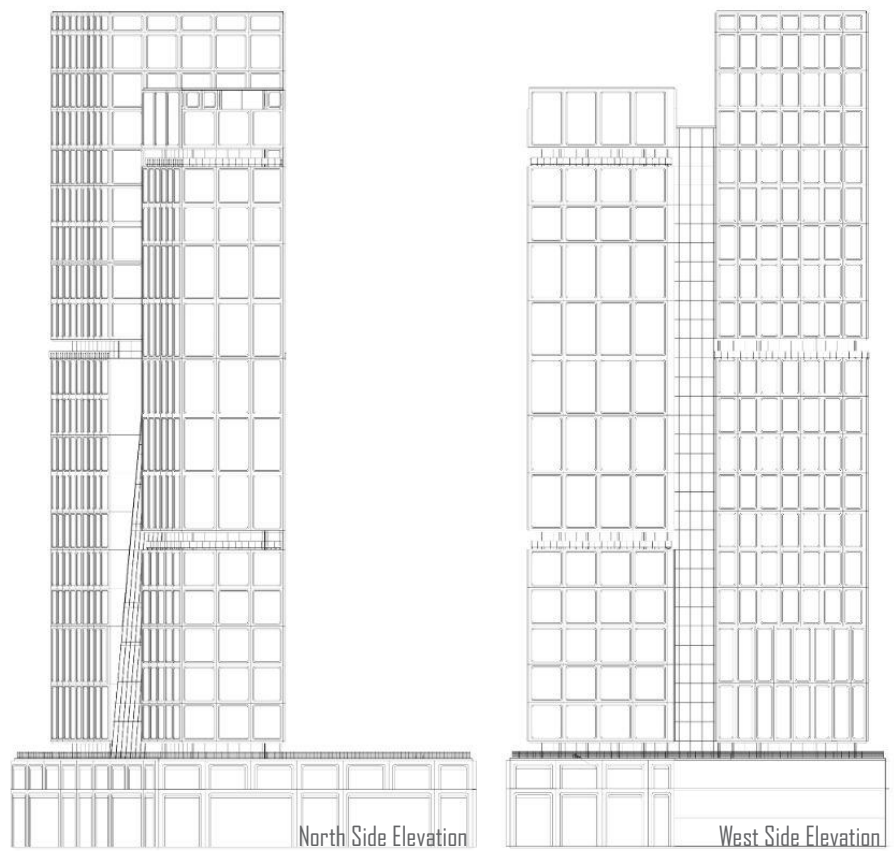




STREET VIEW RENDERING



Design Option Drawing



North Side Elevation

West Side Elevation



GROUND FLOOR RENDERING



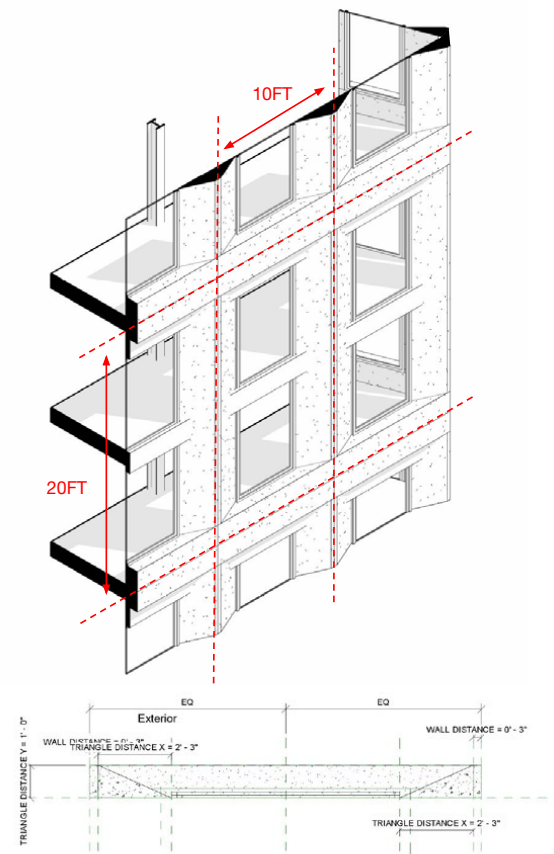
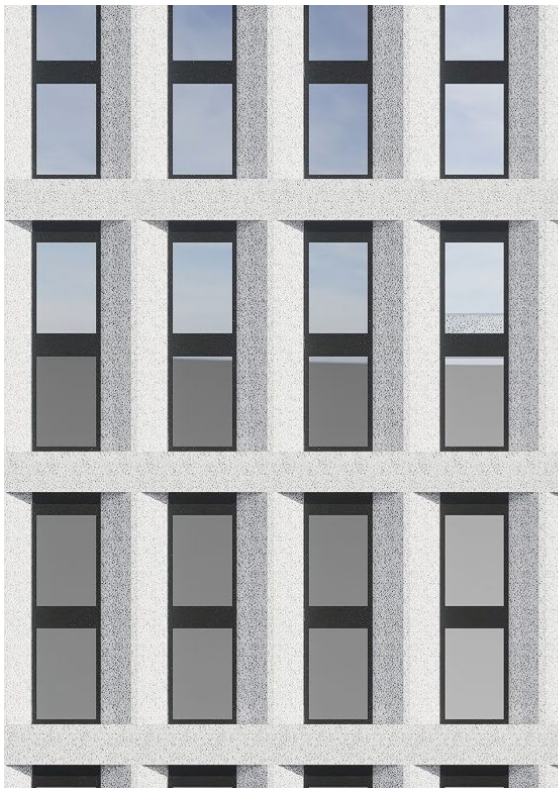
SHARED WORKZONE RENDERING



OFFICE SPACE RENDERING

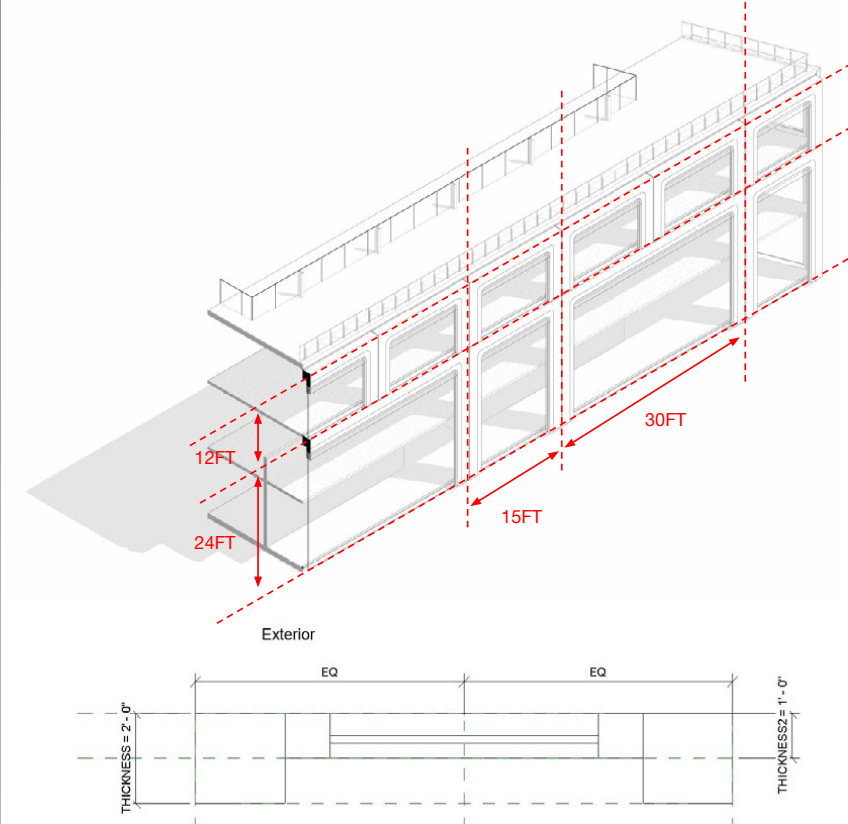


APT GYM RENDERING



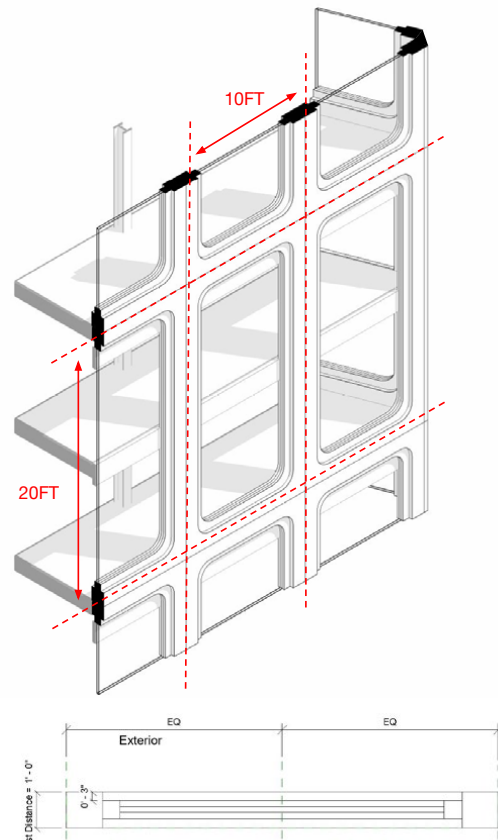
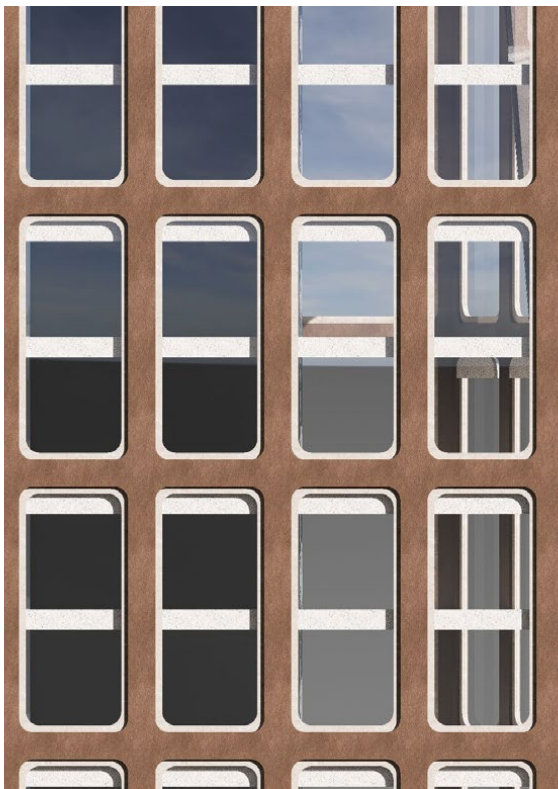
Option One | Vertical Terracotta Paneling

A solar-responsive terracotta facade with strong vertical depth, offering shading and rhythm but requiring more precise detailing and panel coordination.



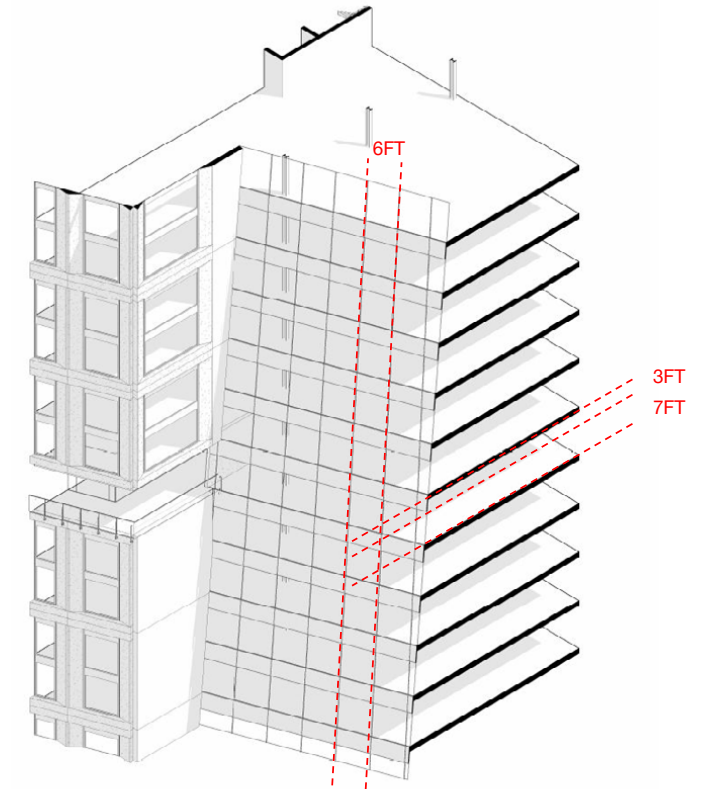
Podium Facade | Rounded Brick Paneling

A grounded brick podium facade that relates well to the street scale and surrounding context, but may feel visually heavier at the base.



Option Two | Rounded Brick Paneling

A softer brick facade that creates a warmer and more tactile urban expression, though it may reduce the sharper vertical definition of the tower.



Curtain Wall Facade

A lighter glass facade that maximizes daylight and views, but requires stronger solar control and may feel less materially grounded

The Case for Structural Redundancy:

Intervening in the Pantheon as a case study of structural adaptation

Tamzid Jaigirdar & Yake Wang
Long History of Architectural Technology
Dec 16th, 2024

We live in the shadows of those who came before us. Whether it be the ruthless but efficient turn-of-the-century New Yorkers who’ve blessed us with our subway or the medieval merchants who have provided us with Arabic numerals, we are indebted to those who came before us for the social, cultural, and physical structures. On the topic of structures, our approach to structure as designers has followed a straight trajectory. The visual and quantitative thinning of buildings has been one of the most dominant features of the modern project. Taking advantage of the advances in production afforded by the Industrial Revolution, architects and engineers consistently brought materials to their limits. This approach allowed for the thin image that modern architects desired, albeit limiting the future adaptability of structures. However, as we face an ever-increasing climate crisis and the dream of infinite capital seems dead, we must challenge ourselves as designers to design sustainably. We must question, as a profession, if designing around reduction of structural material as a given is helpful for our continued future.

It could be argued that structural lightness in its minimization of material would be the most sustainable path forward. Buckminster Fuller’s geodesics¹, like the Expo 67 biosphere pictured in Fig 1², explore the possibilities of thinness as a sustainability solution. Behind the filigree veil of Fuller’s dome, the carbon debt left by aluminum scaffolding weighs down the effectiveness of the structure, preventing it from becoming a real solution.



Fig 1: Expo '67, Montreal, Quebec, Canada. Library of Congress

Notions of structural efficiency and reproduction first appear in western tradition in the renaissance with Leon Battista Alberti. As Carpo writes in “*The Alphabet and the Algorithm*”

¹ Conrads, Ulrich. “Programs and manifestoes on 20th-century architecture”. MIT Press. 1971

² Expo '67, Montreal, Quebec, Canada. Library of Congress

*“Alberti’s notion that the perpetuity of a monument would be guaranteed by a sequence of numbers better than by the original monument itself may sound odd. Daily experience suggests that stone and marble are stronger and more resistant to time than parchment or paper. And the idea that a statue can be made through the assembly of prefabricated parts does not fail to evoke for us an uneasy feeling of technological déjà vu.”*³

In Alberti’s methods, we start to see the inklings of the digitization of architecture as well, alluding to an architecture of ever-increasing efficiency in material. While digitization does not necessarily lead to structural efficiency, the ability to quantify the weight and capacity of a structure implies an ability for designers to design around minimization. On the other hand, structural thinness still existed within a trial-and-error approach to architecture, arguably perfected by the modern work of Felix Candela. Candela’s work also serves as a perfect example of why a trial-and-error approach to structural design fell out of favor due to the need to charge for two thin shell vaults in the event of failure and being heavily reliant on the cost of labor⁴.

In contrast, the architects of antiquity, due to an inability to calculate loads to the same degree we’re able to today, designed with a large degree of structural redundancy. Structures such as the Pantheon, the great Gothic Cathedrals, and many other classical structures have a structural capacity that far exceeds that of its dead load. Modern examples of structural redundancy also exist in the form of large industrial buildings. The great power stations and factories of the Industrial Revolution have become the most redefinable buildings across multiple cities. The capacity of these structures to exhibit a multitude of design futures has led to them becoming the commissions architects most aggressively compete over. From Tate Modern and Domino Sugar, the additional structural capacity of these projects has helped them to be completely reimaged⁵. It must be noted though that if all structures were designed with structural redundancy, the carbon cost of projects would also rise, similarly to the geodesics of Fuller.

While interventions like Tate Modern were not intentional by the original architects, could it not be argued that designers could craft structures with a similar level of adaptability? In addition, if we take structural lightness to its extreme, could temporary programs ebb and flow through time built upon more solid programming? In essence, if the deployment of structural

³ Carpo, Mario. “The Alphabet and the Algorithm”. Massachusetts Institute of Technology. 2012

⁴ Pendas, Maria. “Fifty Cents a Foot, 14,500 Buckets: Concrete Numbers and the Illusory Shells of Mexican Economy. Massachusetts Institute of Technology. 2018.

⁵ The changing nature of technology and uncertainty of production led many 19th-20th architects to overdesign structures. This in turn has led to the surviving industrial buildings from this period being highly adaptable as seen from the examples explored above.

redundancy and structural efficiency separately don’t provide a solution to our climate crisis the strategic application of both mindsets in tandem provides new potentials for architectural space.

Using the Pantheon, we will demonstrate how its ability to support a large amount of additional load provides the potential to address future concerns. Quantitatively, we would like to investigate the potential of temporary additions to the Pantheon. Utilizing light CLT decks paired with minimal structural connections we aim to take advantage of the vertical space of the Pantheon. Alongside proposing an intervention on the Pantheon, we will calculate the existing buildings capacity to support it. Through this approach, we hope to unlock new spatial possibilities in the classical structure.

The Pantheon was built during the reign of Marcus Agrippa in 27 BCE. The original purpose of the building was to serve as a temple for all gods. After the fall of Rome, the structure saw continued use in the form of a church. The structure is composed of a rectangular portico supported by solid granite columns that greet visitors into a large hemispherical dome made of concrete. Which is 43.3 meters in diameter. The dome is built over a cylindrical structure of the same diameter and height, with the rotunda’s internal geometry approaching a perfect sphere. The height of the rotunda to the top of the dome matches its diameter.⁶

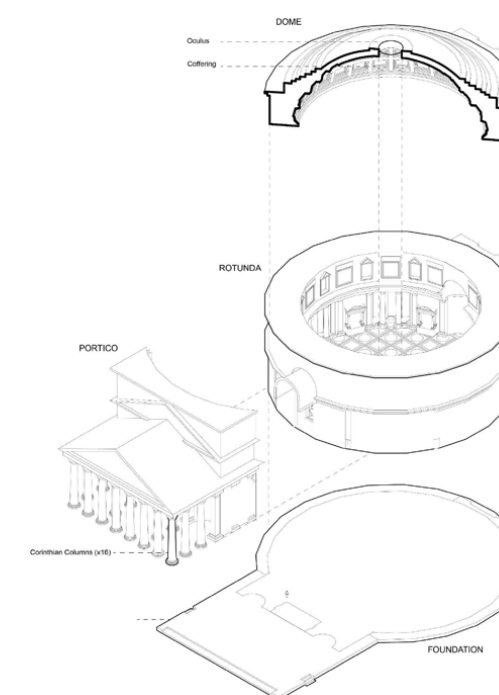


Fig 2: Exploded Axonometric of the Pantheon, Nashia Olise⁷

⁶ Waddell, Gene. Creating the Pantheon: Design, Materials and Construction. Roma: “L’Erma” di Bretschneider, 2008. 16

⁷ Exploded Axonometric of the Pantheon, Nashia Olise

The origins of the use of the Pantheon for this project and the very notion of the investigation of the essay arise from Workset II's prompt.

“Using the same building parts, and adding as necessary, design a structural frame for a building on the same site that would be appropriate to provide housing for 100 persons today. Provide a plan, a section, a rendering or model of the structure, and one drawing of the structural parts you are adding, if any. Be prepared to discuss how the structure stands.”

Our group's original proposal poached the portico's columns and paired them with a CLT deck to create a satirical play on Corbusier's Maison Dominio⁸. to define space for housing.

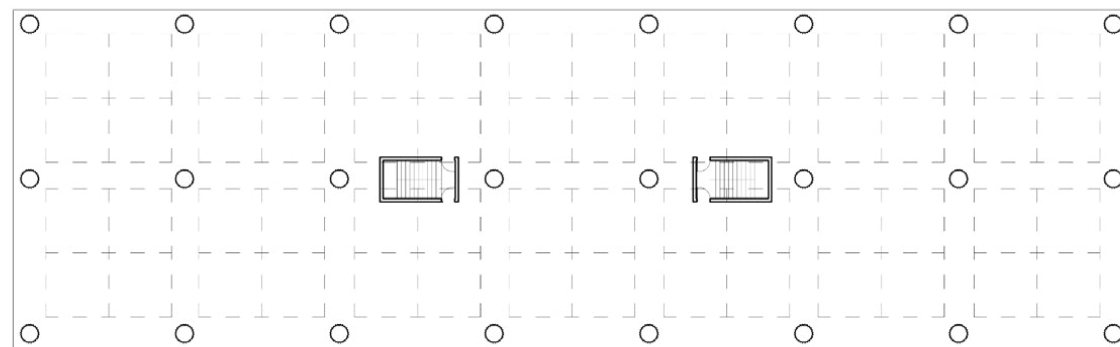


Fig 3: Original response to workset II

While there was an image value, there's little more to add from this proposal. In addition, the proposal failed to utilize the most interesting aspect of the Pantheon, the dome. To the excitement of everyone, the response for this investigation rectifies the missed potential of the dome. Where the initial proposal shines is its demonstration of how structural redundancy and efficiency could work together. The absolute solidity of the column provides a greater spatial future than Corbusier's original Maison Domino.

⁸ Corbusier. "Five Points on Architecture". Architectural Press. 1959.

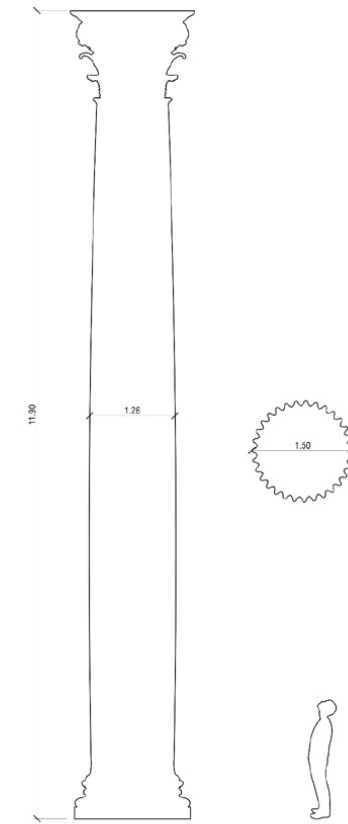


Fig 4: Analysis of the Pantheon portico columns

Applying the lessons learned in the Workset II proposal we began to imagine how a similar approach could be applied. Analyzing the ceiling of the structure, we decided to offset a series of planes supported between the coffers of the dome. Through this move, we aimed to give access to a space that since construction, no one has been able to access. To achieve this we've collected relevant structural data to inform our design proposal and subsequent intervention.

Geometrically, the dome of the Pantheon is generated by rotating a semi-circular arch 360 degrees around its central axis. Domes are inherently rigid and stable. Domes can withstand applied loads and their own weight without significant deflection or instability in displacements. The dome of the pantheon, shaped by a rotational arch, generates internal meridional forces that transfer loads to the supporting drum of the structure. The measured forces are compressive and escalate in size from the crown to the base of any dome subjected to symmetrical loading along the axis by its self-weight⁹.

⁹ "Dome Structural Analysis Basics." Dome Structural Analysis Basics, 2017.

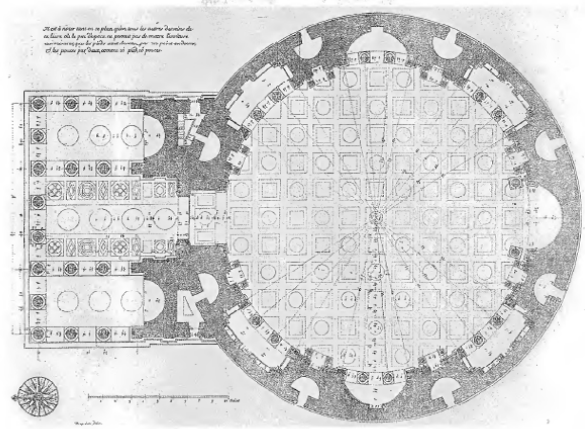


Figure 5: Plan of Pantheon, Antoine Degodetz, 1682

Focusing specifically on the coffers of the Pantheon, we collected a collection of findings regarding the structure. Discrepancies in the plan between the bisectors of the coffer sectors and the axes that theoretically partition the circle into 28 equal segments, the mean reported divergence is a mere $0^{\circ} 36'$. The angles between the vertical axes of the coffer sectors are about $12^{\circ} 50'$, corresponding to the partition of the 360° ideal model into 28 equal segments.

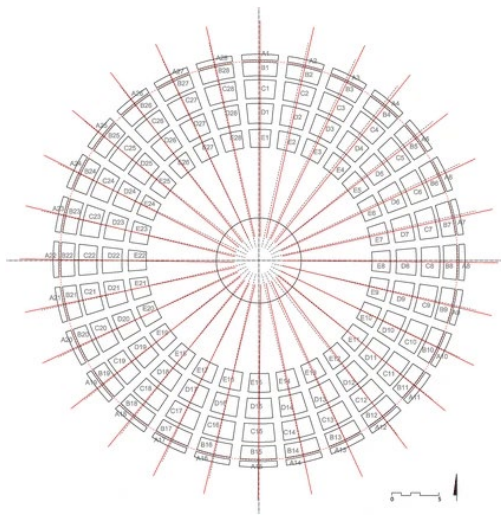


Figure 6: General arrangement: analysis of the accuracy of the main axes and of the distribution of bisectors of the sectors. Rachel Fletcher, 2019¹⁰

¹⁰ General arrangement: analysis of the accuracy of the main axes and of the distribution of bisectors of the sectors. Rachel Fletcher, 2019

Furthermore, The coffers' width decreased as they moved towards upper levels, with the difference between the upper and lower edges increasing at higher levels due to the need to adapt to spherical curvature. The last coffer's upper width was half of the lower length of the first level's coffers. The coffer sector opposite the entrance portal had a significant width difference, impacting the radial arrangement of the coffers and generating a divergence of the bisector. This difference was registered by comparing the survey model and the ideal model, and the bisector showed a gap with the North-South axis. The analysis shows that the coffer sector of the North-South axis opposite the entrance portal has a major difference in width (the coffer of the first level of this sector, named A1, measures 4.00 m in its lower part, whereas the rest of the coffers measure as follows: A2, 3.90 m; A3, 3.94 m; A4, 3.86 m; A5, 3.83 m; A6, 3.86 m; A7, 3.85 m; A8, 3.92 m)¹¹.

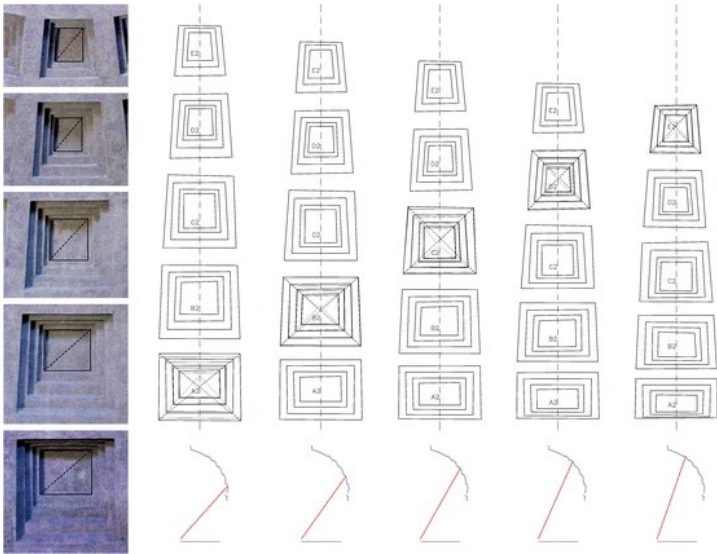


Figure 5: Study of the proportions of the inner levels applied on the survey model orthogonal views and perspective projection from the centre of the room of the coffers of the North-East quadrant. Rachel Fletcher, 2019¹²

¹¹ Fletcher, Rachel. Geometric proportions in measured plans of the Pantheon of Rome by Rachel Fletcher, 2019.

¹² Study of the proportions of the inner levels applied on the survey model orthogonal views and perspective projection from the centre of the room of the coffers of the North-East quadrant. Rachel Fletcher, 2019

According to the chart, our selected beams self-weight could be calculated using,
Weight per meter (kg/m) x Spanning distance (m)

$18.4kg/m \times 4m = 73.6 \text{ kg}$

As the span is 4 m and the distance between each beam is 1 m, the overall weight of the beam structure would be

$73.6kg \times 4 = 294.4 \text{ kg}$

Adding the live load, which is identified as 200 kg, and the necessary hardware, which has been identified to be around 5 kg, each structural section of the intervention corresponding to it’s may weigh

$819.2kg + 294.4kg + 200kg + 5kg = 1318.6 \text{ kg}$
 $1318.6kg \times 40 = 52764 \text{ kg}$

And to calculate the maximum load of the column in Pantheon, the equation is given as

$P_{max} = \sigma \text{ (Pascals)} \times A(m^2)$
 $r=1.52=0.75 \text{ meters}$
 $r=21.5=0.75 \text{ meters}$
 $A=\pi \times (0.75)^2 \approx 1.77 \text{ m}^2$
 $A=\pi \times (0.75)^2 \approx 1.77 \text{ m}^2$
 $\sigma=15 \text{ MPa}=15 \times 10^6 \text{ Pa (Pascals)}$

So the maximum axial load PmaxPmax that the column can bear is given by:

$P_{max}=\sigma \times A$
 $P_{max}=\sigma \times A$
 $P_{max}=15 \times 10^6 \text{ Pa} \times 1.77 \text{ m}^2$
 $P_{max}=15 \times 10^6 \text{ Pa} \times 1.77 \text{ m}^2$
 $P_{max} \approx 26.55 \times 10^6 \text{ N (Newtons)}$
 $P_{max} \approx 26.55 \times 10^6 \text{ N}$
 $26.55 \times 10^6 \text{ N} \times 16 = 41.056 \times 10^7 \text{ N}$

And the weight of the dome could be calculated using the equation

$W=V \times \rho$
 $V=2/3 \pi r^3$
 $r=43.32=21.65 \text{ m}$
 $r=243.3=21.65 \text{ m}$
 $V=2/3 \pi (21.65)^3 \approx 33,436 \text{ m}^3$
 $W=V \times \rho=33,436 \text{ m}^3 \times 2,100 \text{ kg/m}^3$
 $W \approx 70,213,600 \text{ kg} \approx 70,214 \text{ metric tons}$

From the insights gained we deployed a series of CLT floor plates 10 meters in width offset from their position in the dome. These floor plates are tied back to the Pantheon on the axis that separates the coffers from each other. From this initial layout, we began to calculate our structural loads. The weight of the intervention is divided into two major parts: the live load and the dead load. The dead load contains structural elements such as the CLT floor plates, steel beams, steel rods or cables, and the necessary hardware, while the live load includes human weight and optional furniture.

Starting with dead loads, The exact weight of CLT is dependent on the density of the species used and the thickness of the panel alongside the toppers used. For our proposal, we selected from the Wood Works chart and used SLT3, which would be 51.2kg/m2.

Limit States Design (LSD) Bending Resistances^(a) for Structurlam CrossLam

CLT Grade ^(b)	Name	Layers	Depth (mm)	Weight (lbs) per sq. ft	Weight (kg) per sq. metre	Major Strength Direction				Minor Strength Direction			
						F _b S _{ed} (10 ³ N-mm/m)	EI _{ed} (10 ⁹ N-mm ² /m)	GA _{ed} (10 ⁶ N/m)	V _{ed} (kN/m)	F _b S _{ed} (10 ³ N-mm/m)	EI _{ed} (10 ⁹ N-mm ² /m)	GA _{ed} (10 ⁶ N/m)	V _{ed} (kN/m)
V2M1	SLT3	3 layers	99	10.5	51.2	16	735	7.0	32	2.40	34	7.5	12
	SLT5	5 layers	169	17.0	83.0	37	2,968	15	44	21	883	15	34
	SLT7	7 layers	239	25.0	122.0	67	7,559	22	56	48	3,360	23	46
	SLT9	9 layers	309	32.0	156.2	105	15,351	30	68	84	8,282	30	58

(a) Tabulated values are Limit States design values and not permitted to be increased for the lumber size adjustment factor in accordance with CSA O86.
(b) The CLT grades are developed based on ANSI/APA PRG 320, as permitted by the standard using all visually graded No. 2 SPF lumber in both major and minor strength directions.

Fig 7: CLT floor plate chart, Wood Works¹³

To calculate the load of the floorplate we used the formula below.

Weight per sq. meter(kg/m2) x Area(m2)

$51.2kg/m^2 \times 4 \times 4m^2 = 819.2kg$

B. Weight of the Steel Beam Structure Support

The supporting structure utilizes an I-shaped steel beam spanning 4 meters each. The distance between each would be 1 meter from the center, which requires 4 beams per structural bay.

Fig 8: Steel weight chart, Hitesh Steel¹⁴
Source: <https://www.hiteshsteel.com/i-beam-weight-calculator.html>

¹³ CLT floor plate chart, Wood Works

¹⁴ Steel weight chart, Hitesh Steel

From our calculations, we were able to determine that the dome of the Pantheon possessed the structural capacity to support our designed intervention. We were successful in our assumption that the Pantheon would be able to support the load of our intervention. The next question that follows immediately is why does that matter? It's hard to imagine this proposal being something the Italian government would build. We would argue that thought experiments in paper architecture can awaken discussions that can lead to real spatial and tectonic properties. From this project, we hope that viewers take away the potential and validity of mass in contemporary practice. While this intervention may seem rash, one could imagine the same philosophy used on the Pantheon being applied to disused parking structures, stadia, infrastructure, and similar high-load structures. When viewed from that lens, the approach no longer seems that radical. Strategically deploying lightweight structures that take advantage of existing buildings should be an approach that architects take seriously when appropriate. Beyond the aesthetics of parasitic architecture, in the vein of Lebbeus Woods, if we can build in ways that take advantage of existing infrastructure to reduce overall material in a more adaptable way, why would we not pursue these scenarios? By managing our structures accordingly, we can arrive at new spatial forms that hopefully lead to a more sustainable future.

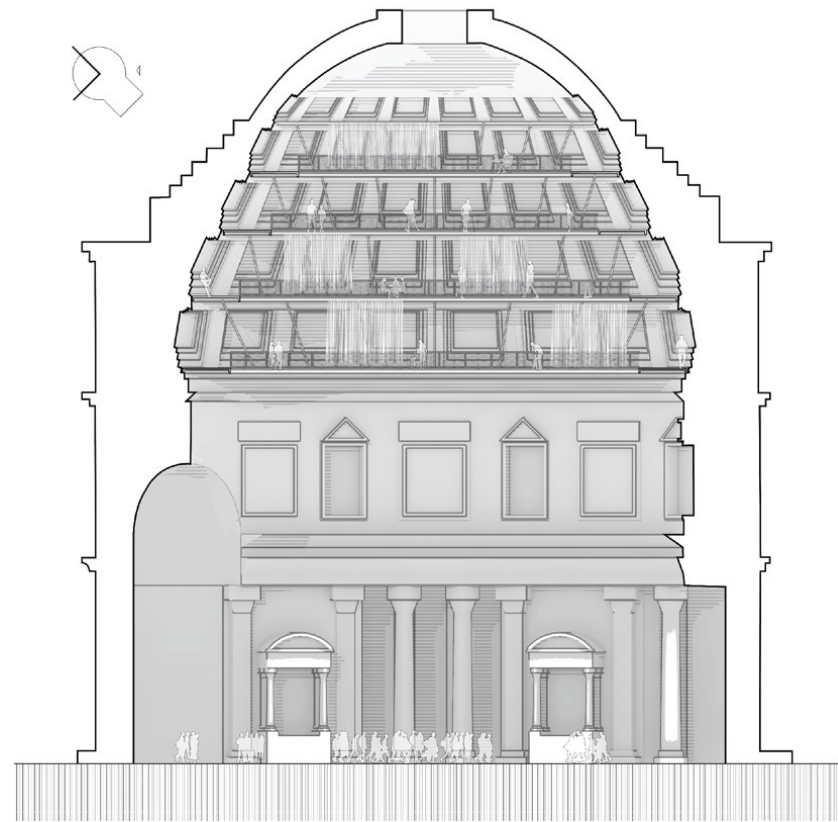


Fig 9: Partial Section

Fig 10: View looking down intervention



Fig 11: View looking across volume

