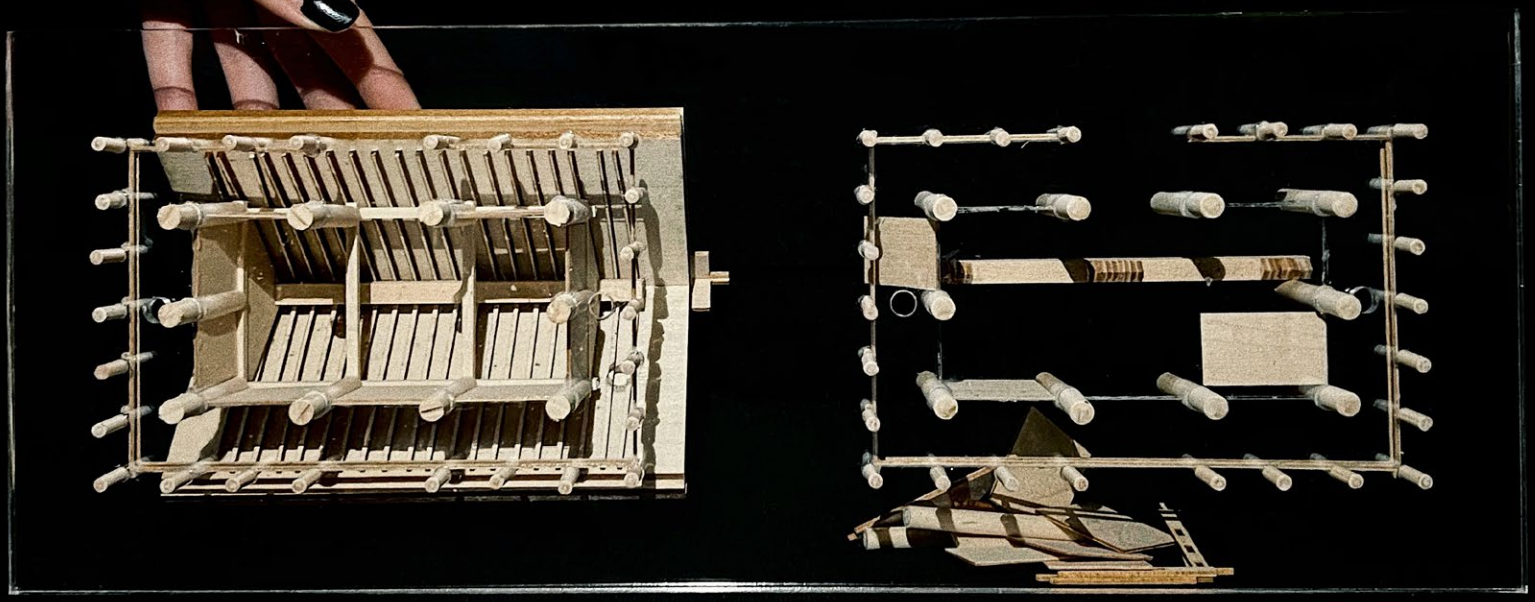


SHIYU LYU

Selected Works 2021-2024
Master of Architecture 2024
Columbia University GSAPP

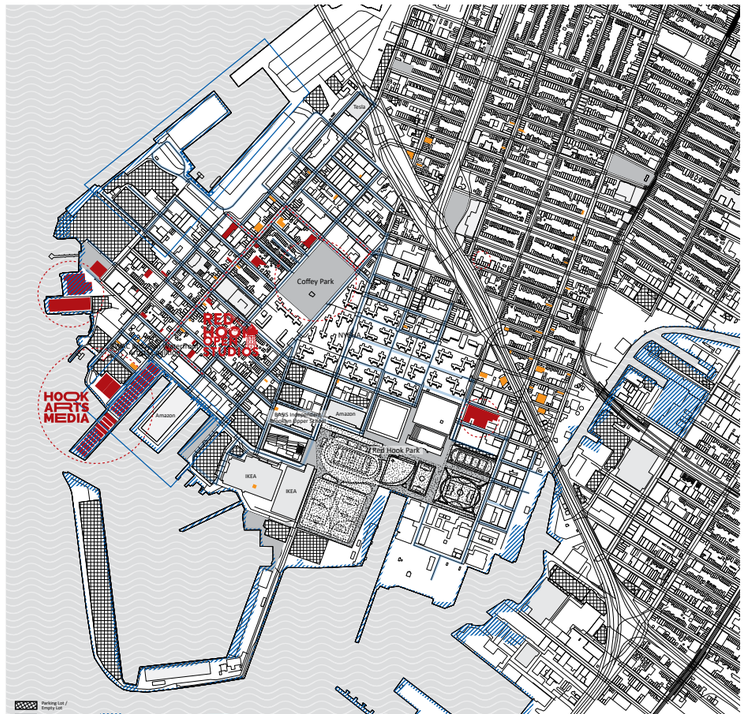
CONTENTS

Density and Weaving

Theme: Constructive Entropy
Year: Fall 2023
Site: Red Hook, New York
Instructor: Mark Tsurumaki
Collaborator: Caining Gu

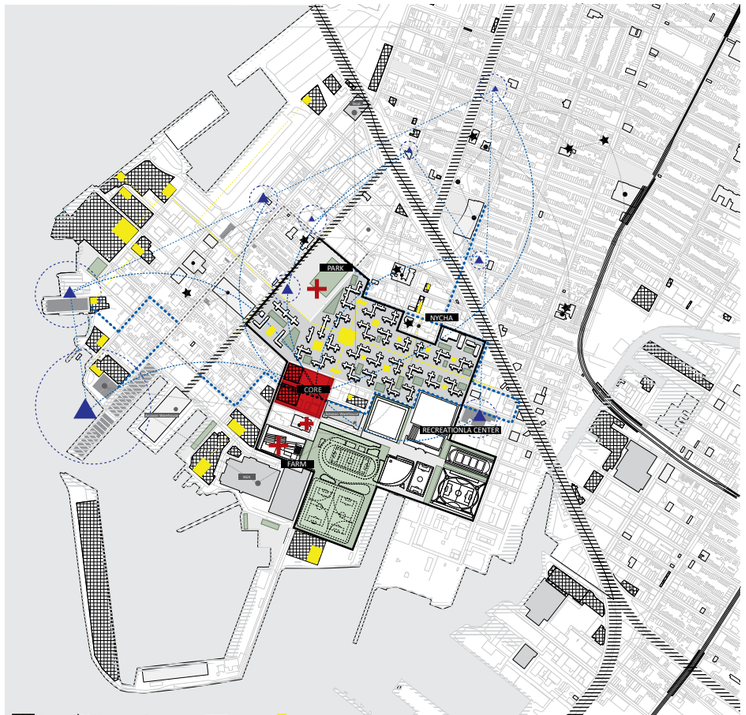
Our project introduces bamboo as an affordable, easy-to-grow, and sustainable building material to achieve constructing various scales of bamboo structures from large clusters to very fine and porous systems to remediate current issues and future concerns.

Our strategy involves constructing a community center atop the existing structures, repurposing them to reduce expenses and environmental impact. Additionally, we are contemplating an expansion that would extend the building's reach into both the public housing area and the upscale art neighborhood on the opposite side, potentially serving as an urban link to revitalize the entire area.



Red Hook Map
Existing Conditions and Concerns

- Urban segregation
- Food desert
- Soil contamination
- Flooding



Analytical Map
Design Plan

- Building Extension and urban connection
- Farm-to-table
- Bamboo phytoremediation
- Evacuation platform and shelter

1636

The Dutch established the village of Red Hook (Roode Hoek). It was one of the earliest areas in Brooklyn to be settled. The area was named for its red clay soil and the hook shape of its peninsular corner of Brooklyn that projects into the East River.

1600s

The history of Red Hook, Brooklyn, dates back to the 1600s when it was an important shipping and transportation center. During the 19th century, Red Hook was a major port and was known for its thriving commercial and industrial activity. It was a center of shipbuilding, and was also an important hub for trade, including the export of goods like coffee, sugar, and molasses.

1936

The Red Hook Houses, built in 1938, were originally built for families of dock workers and are one of the first and largest Federal Housing projects in the country. The 1990 Census estimated the population at just fewer than 11,000 with more than a third under age 18. That same year the average income per household was under $10,000. Unemployment in Red Hook was estimated at 30 percent among men and 25 percent among women.

1850s

In the 1850s the Atlantic Basin opened and Red Hook became one of the busiest ports in the country. Dockworkers of various ethnicities began settling in Red Hook. African-American dock workers began to move to Red Hook in the 1890s, while Italians had settled around Columbia Street.

1990

Life magazine named Red Hook as one of the "worst" neighborhoods in the United States and as "the crack capital of America"

1960s

Red Hook experienced a period of decline, the shipping and tons of other businesses had moved to New Jersey and the neighborhood suffered from economic hardship and crime.
Red Hook's isolated geography, compounded by the Gowanus Expressway to the north and low access to public transit, has meant limited economic opportunity for the lowest-income Red Hookers.

1946

Robert Moses's most decisive blow to Red Hook was further marginalizing the neighborhood by cutting it in half with the Gowanus Expressway in 1946. The 1950 opening of the Brooklyn Battery Tunnel cut the neighborhood off from the rest of the City.

2004

Red Hook has a large IKEA store (346,000 square feet (32,100 m2)) , near the Gowanus Expressway.

1990s

Communities on the margins do often draw artists, musicians, actors, and people in search of affordable rents and larger spaces.

In the 80s and 90s, folks from the Lower East Side's arts community began turning up in Red Hook.

2012

During Hurricane Sandy, Red Hook experienced significant flooding, with many homes and businesses being inundated with water. The neighborhood was without power for several days, and many residents were forced to evacuate. The flooding caused significant damage to the infrastructure, including roads, bridges, and the electrical grid.

2014

The community has been working to improve its resilience to future storms, with measures like flood walls, elevated parkland, and improved drainage systems.

2000s

Hurricane Sandy had a significant impact on Red Hook, Brooklyn. The neighborhood is located on a low-lying peninsula and is surrounded by water on three sides, making it vulnerable to flooding and storm surges.
In the aftermath of Hurricane Sandy, Red Hook has been working to recover and rebuild. Red Hook has also been the recipient of significant funding from the government and non-profit organizations to help support its recovery efforts.

2016

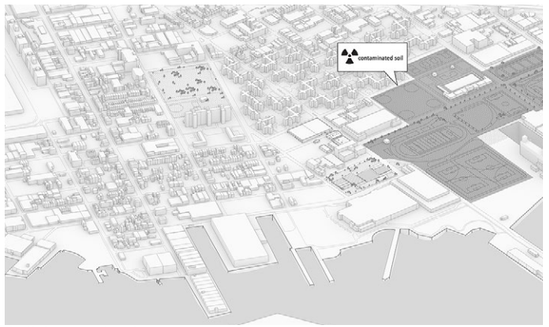
The Puerto Rican family that owned the Bait & Tackle building sold it to an investment company in 2016, and O'Meara's rent shot up by 30%. Rising rents pushed more than a dozen of O'Meara's friends out of the neighborhood and, in many cases, out of the city entirely.

2010s

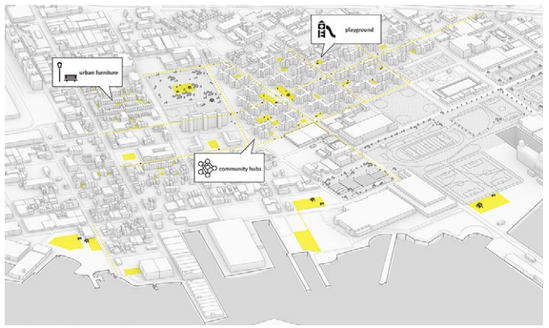
Yet five years after Sandy later, virtually all visible signs of Sandy have vanished from Red Hook, and indeed much of New York. Homes and businesses have largely been repaired, a
nd new residents, far from being scared off by the storm, are flooding in. New Red Hook buildings like the Basis Independent School have gone up in the years since Sandy, and pricey new condos are emerging on the neighborhood's waterfront.

TODAY

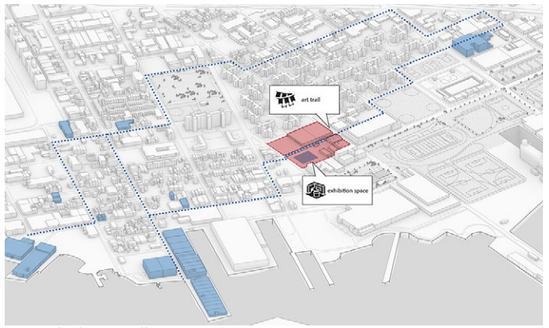
Envisioned Future



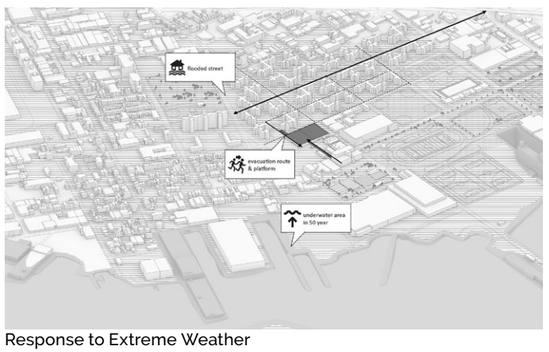
Soil Contamination



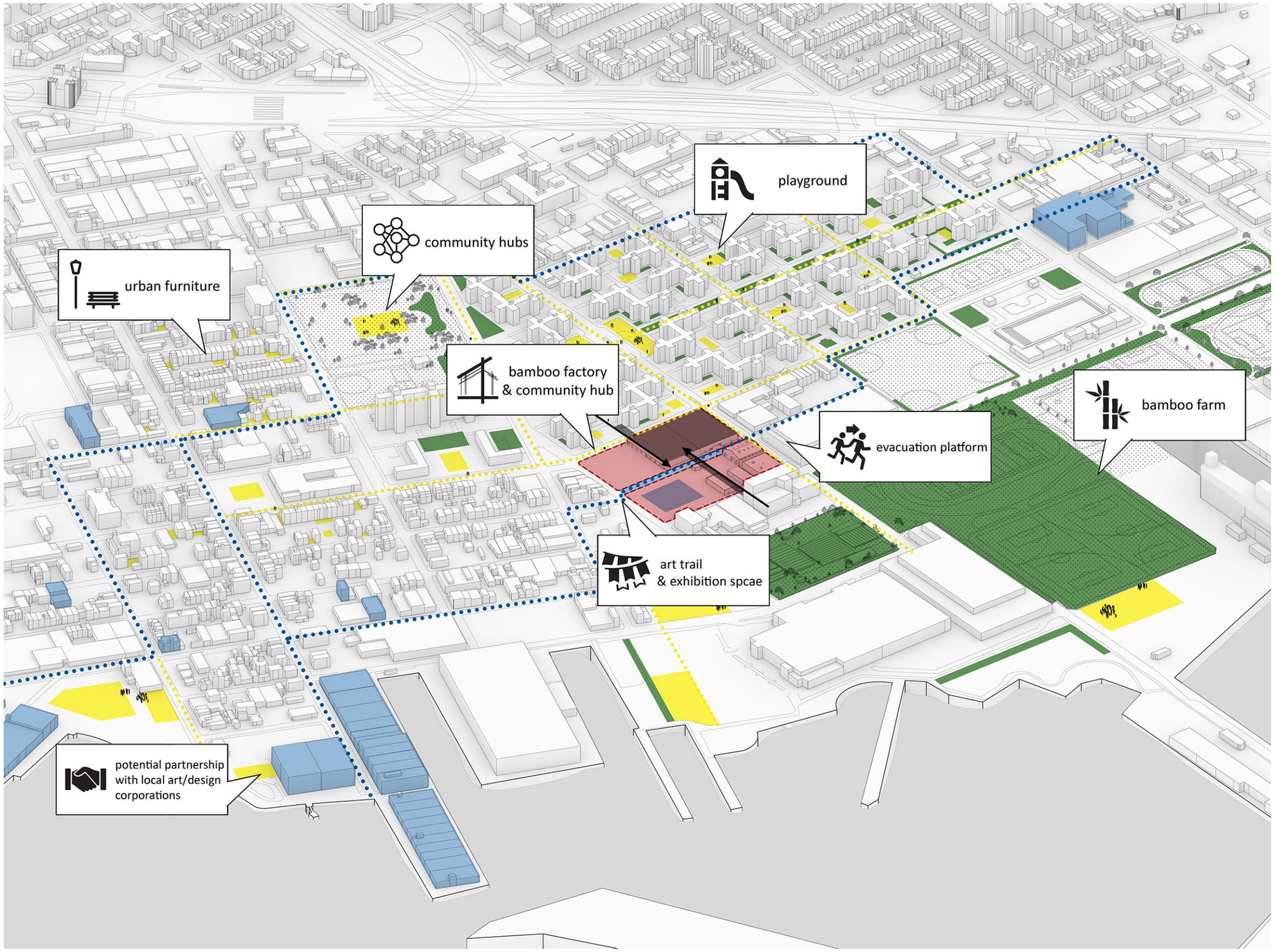
Urban Intervention



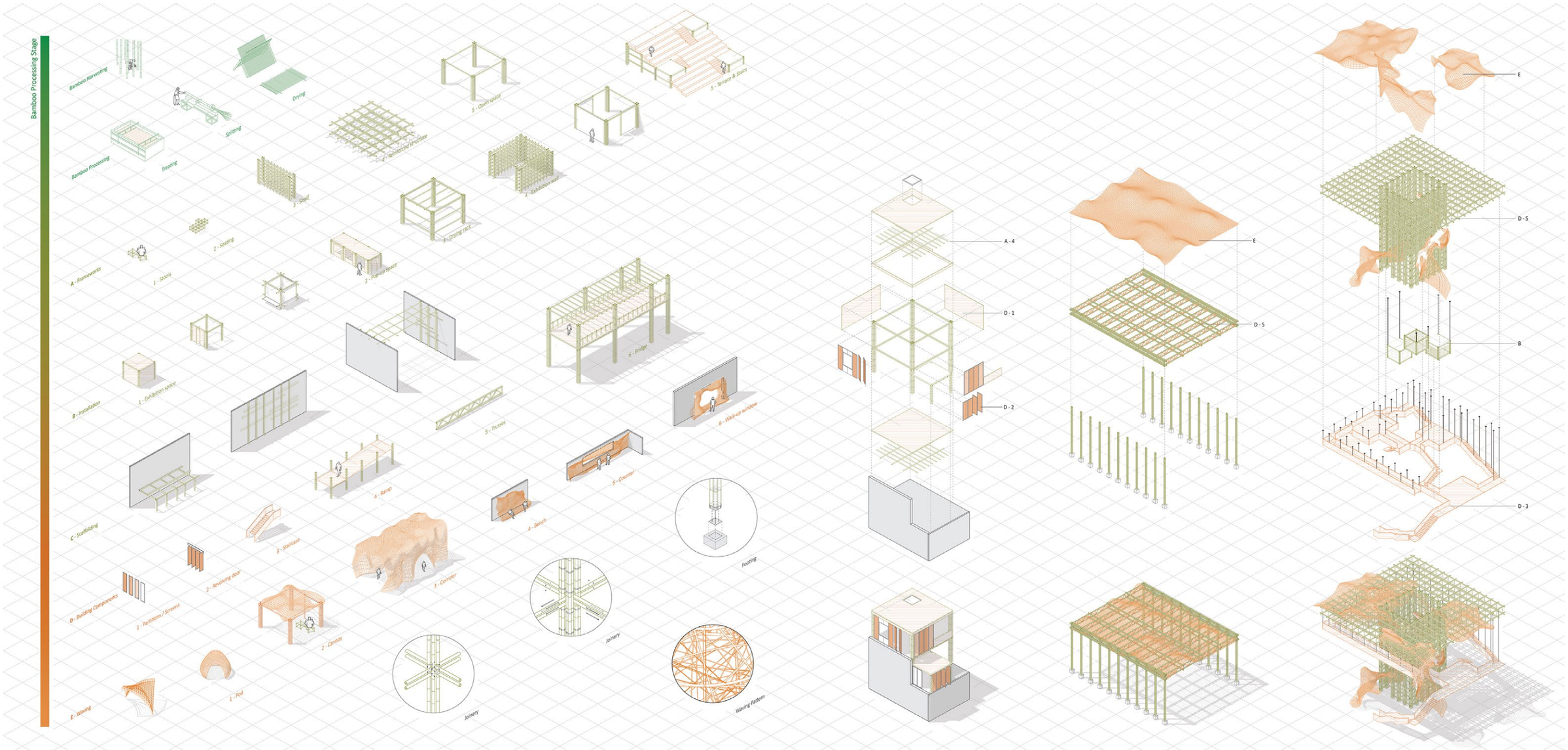
Extended Art Trail



Response to Extreme Weather



Urban Strategy I Evolvement through Time



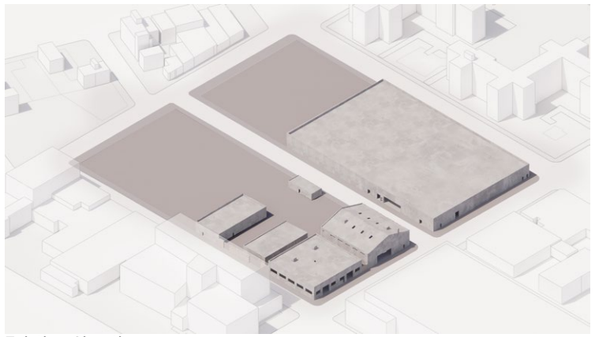
Kits-of-Parts

Bamboo applications in various scales and in different bamboo processing stages

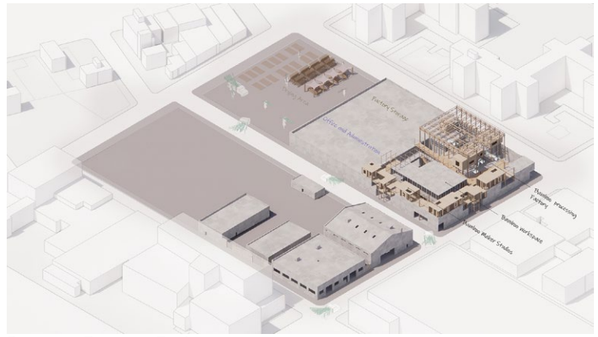
The Core Community Center - Summer
Showcase of bamboo construction; activation of various types of space

Construction Process of The Core

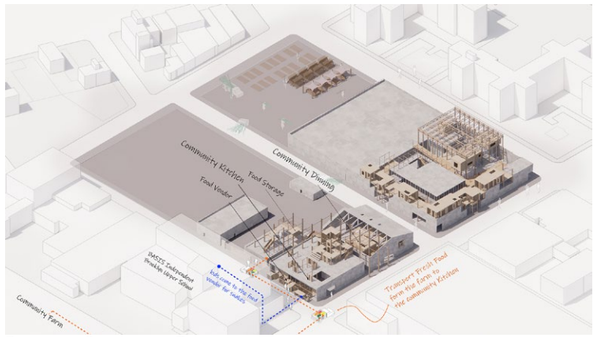
Existing structures vs. New bamboo structures



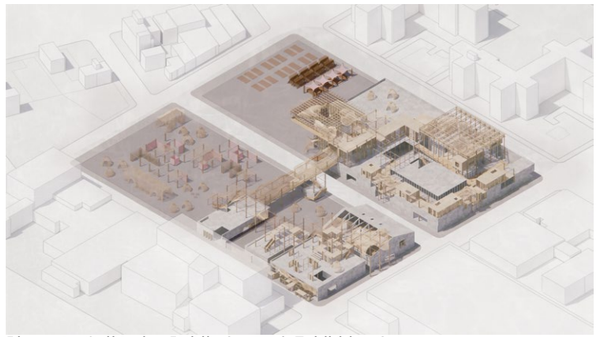
Existing Situation



Phase 1 - Bamboo Factory



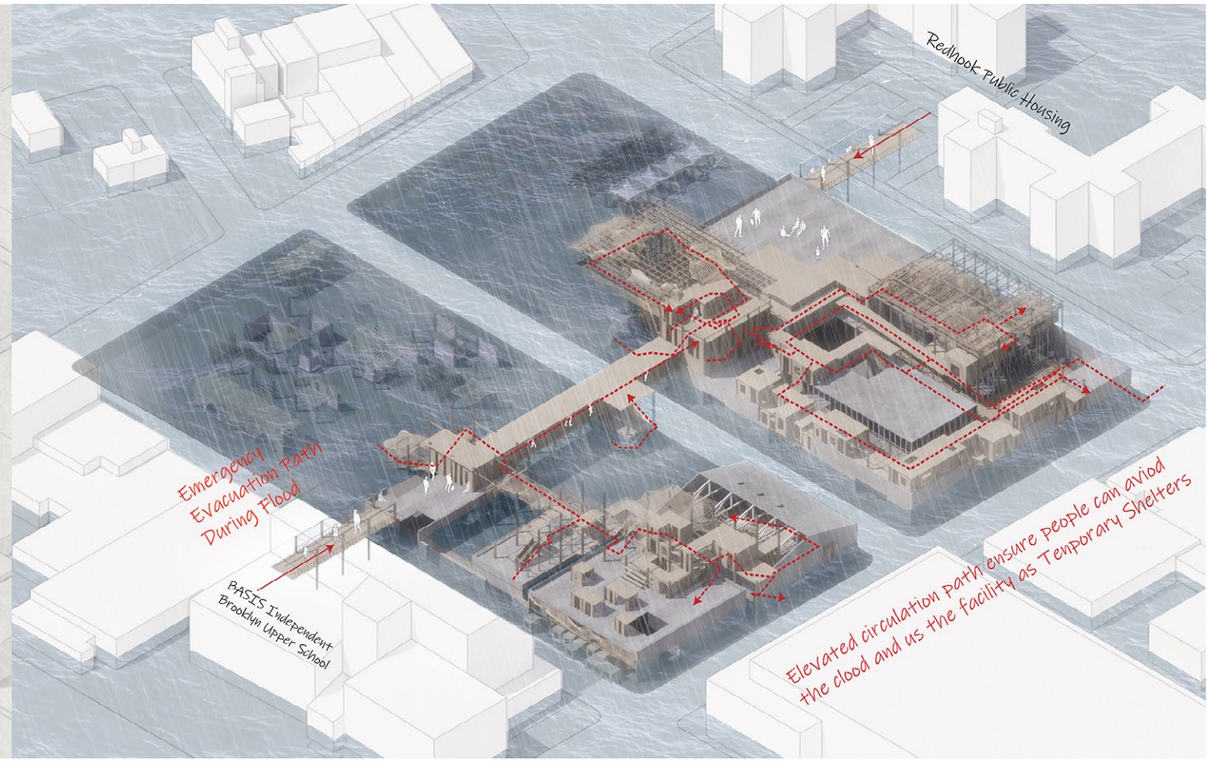
Phase 2 - Communal Dinner



Phase 3 - Collective Public Space & Exhibition Space

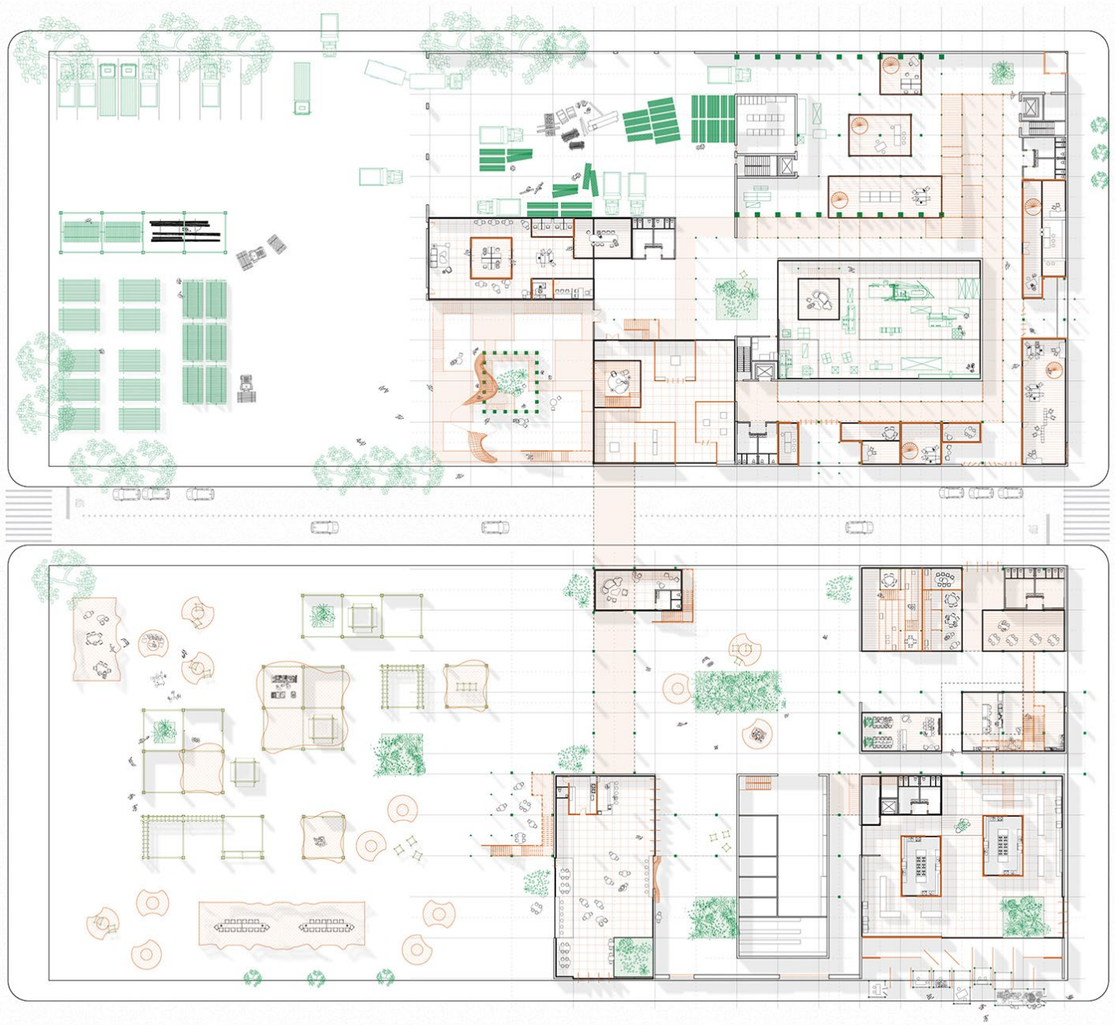
Winter

Elevated circulation & increased openings on ground level

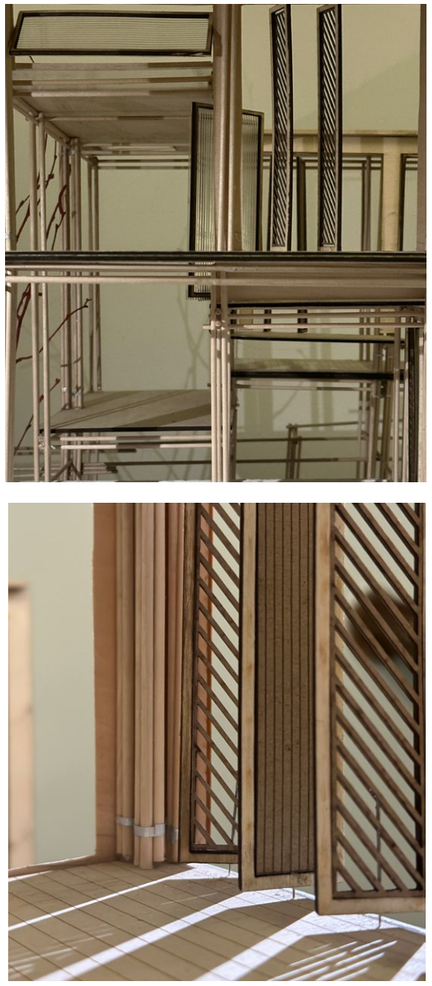


Flood Control

Elevated circulation & increased openings on ground level



Grid within Grid
Different scales of grid system waved together by using bamboo connection



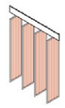
Porous Structures & Replaceable Partitions

E-1

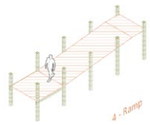
E-2

E-3

D-2

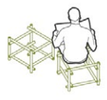


D-4

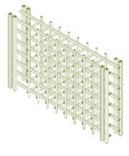


D-5

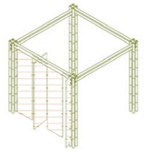
A-1

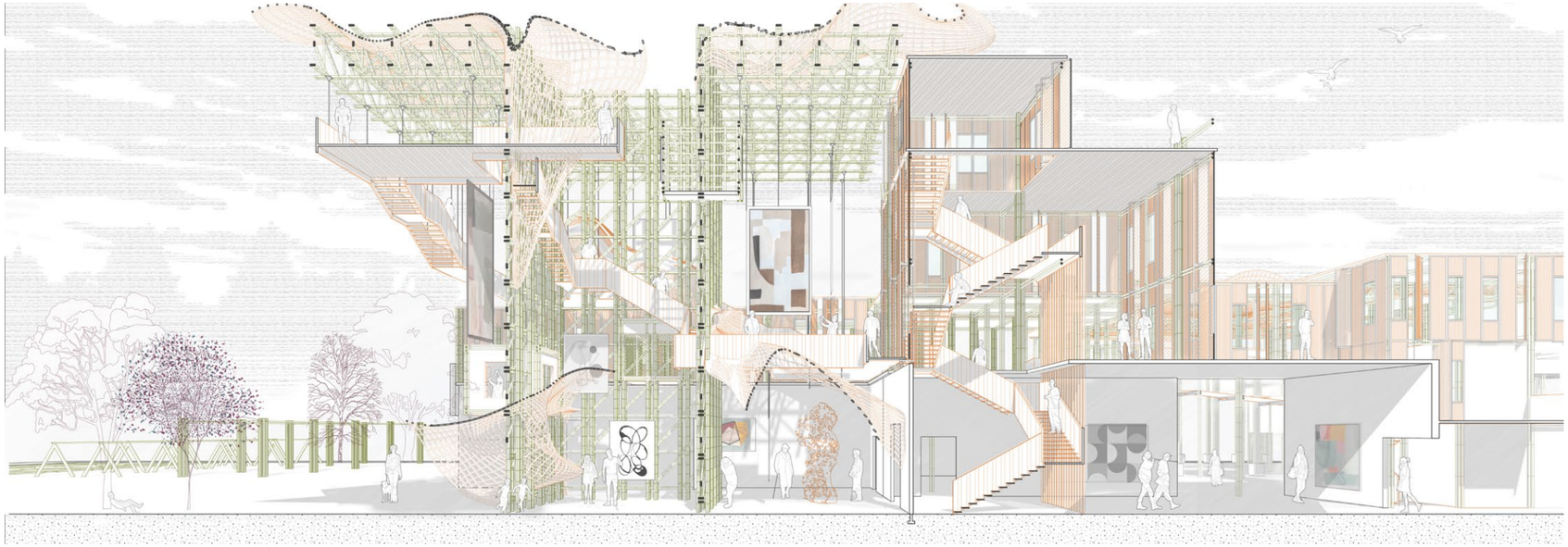


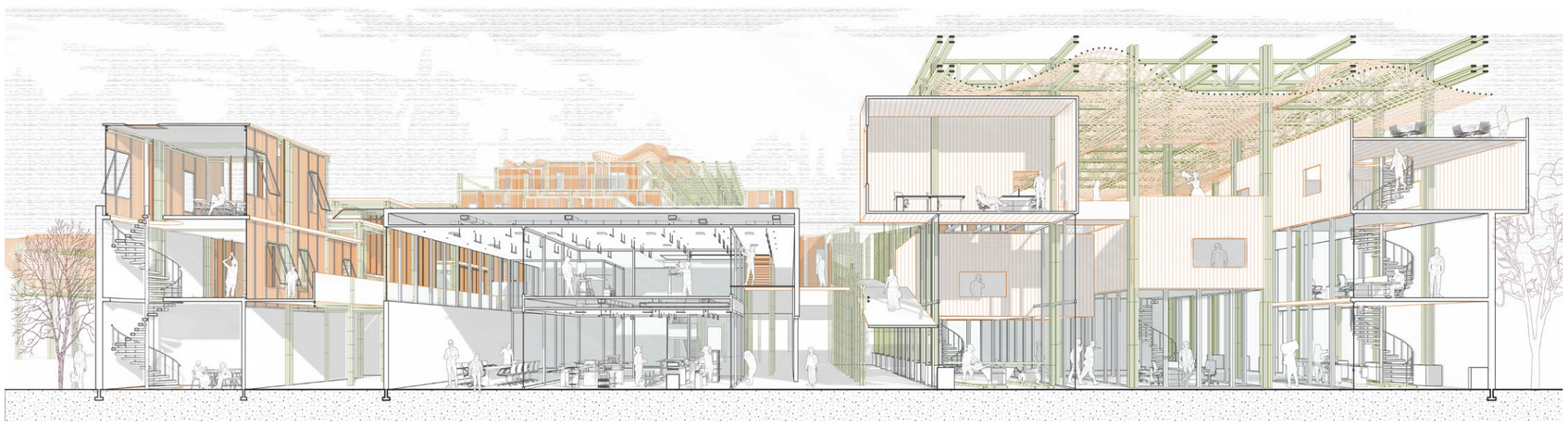
A-3

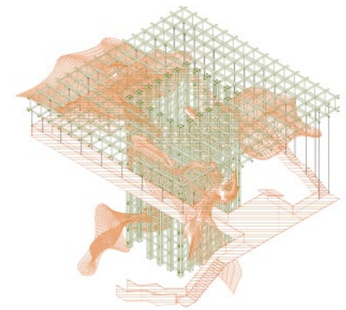


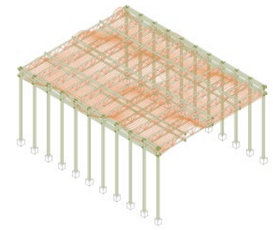
B-1

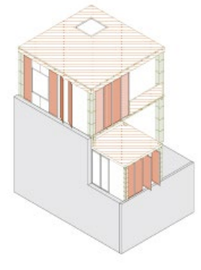


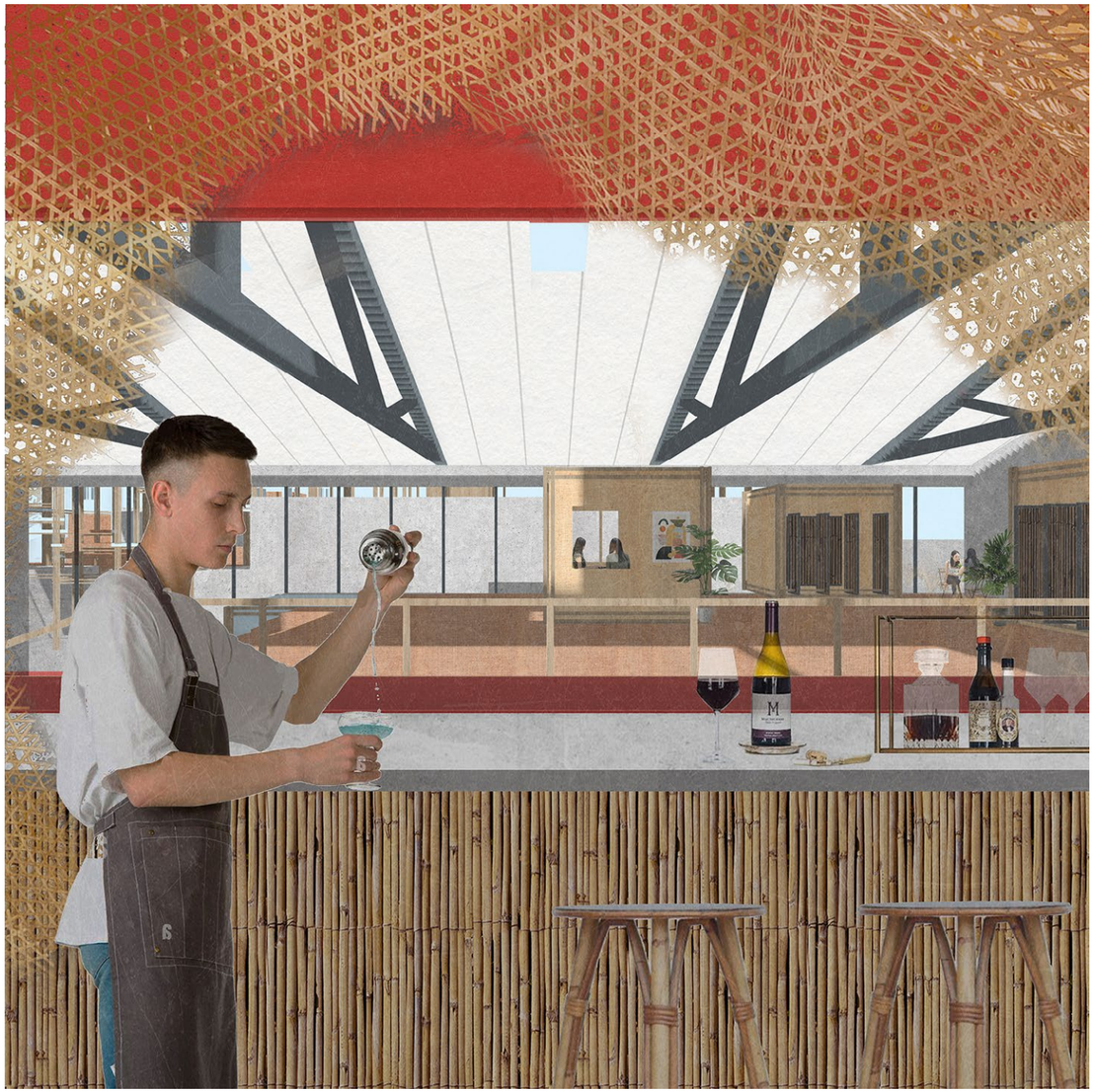












Hanging Enclosed Units & Opening Dining Area

Bamboo Processing & Makerspace

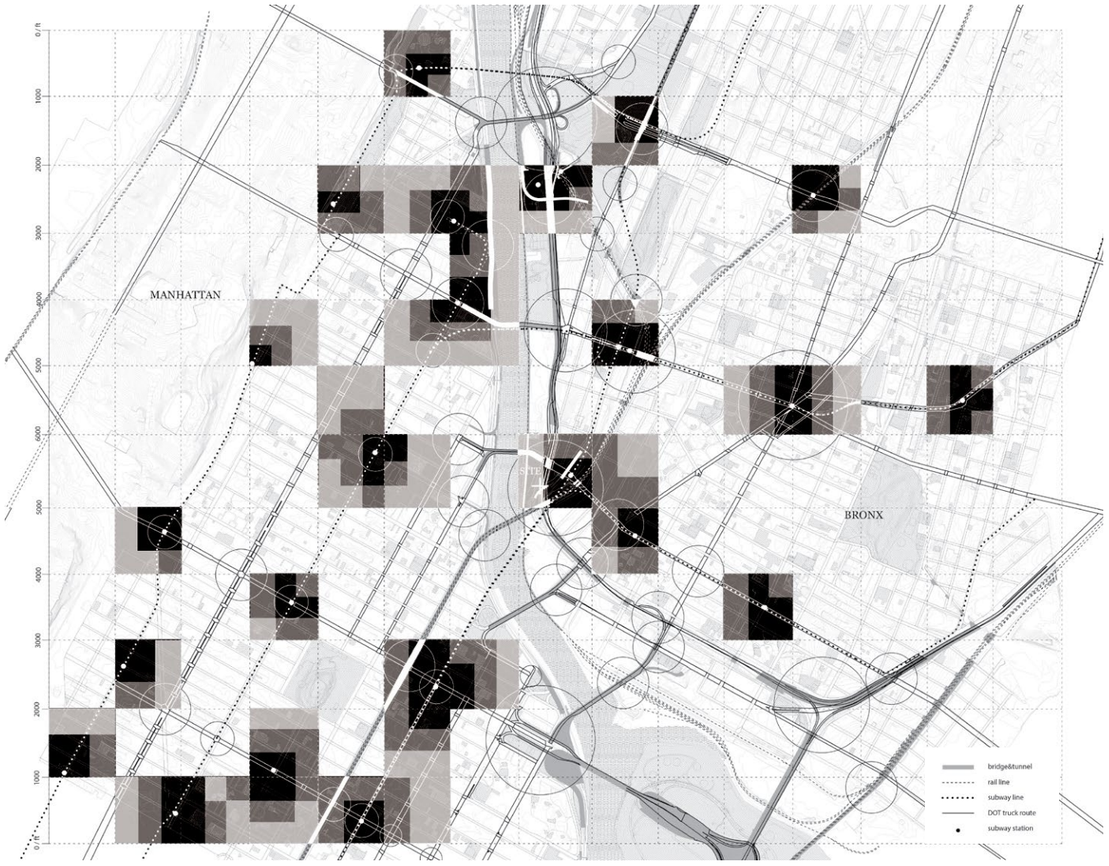
Organic Living in Machine

Theme: New Standards
Year: Fall 2022
Site: Bronx, New York
Instructor: Esteban de Backer
Collaborator: Lula Chou

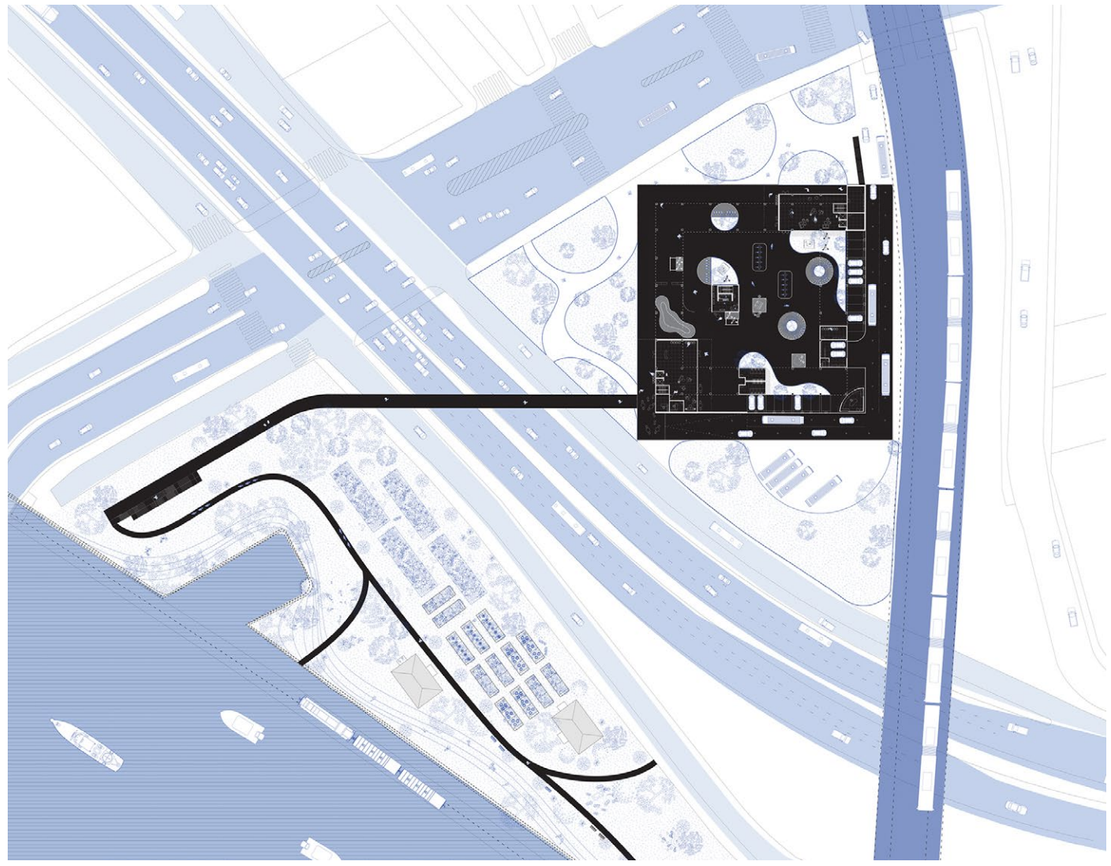
The project addressed critical issues at the site by seamlessly integrating housing with a public infrastructure facility in a densely populated area, fostering accessibility for both people and vehicles while reclaiming natural waterfront access for the community.

Central to our design philosophy is the concept of circulation as the pivotal intermediate space. Through the implementation of two circulation types, each tailored to distinct privacy levels, our innovative approach, featuring externalized circulation and a tripartite system, extends living spaces, unlocking a realm of possibilities and flexibility for the inhabitants.

Urban Remedy for Humans and Vehicles
Trade between waterfront life and the enclosed lot

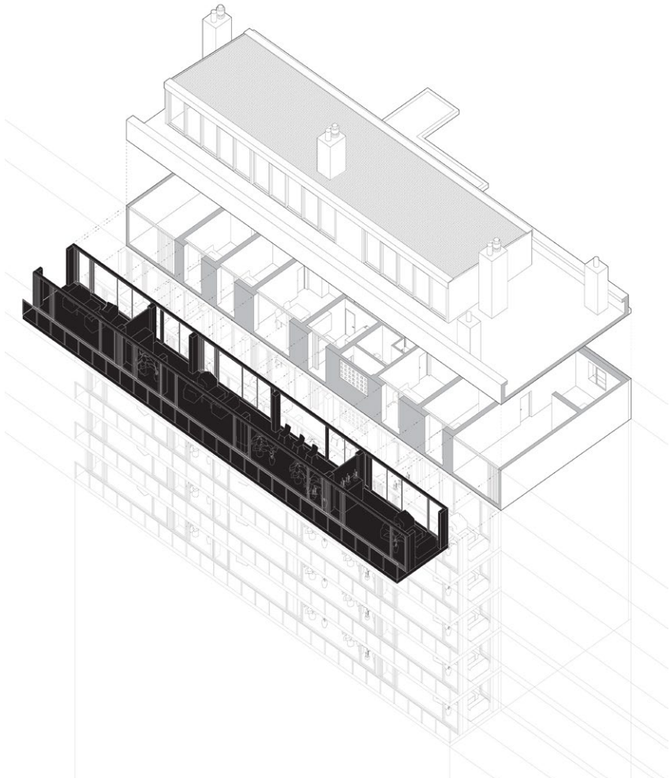


City Accessibility
Congestion Zones

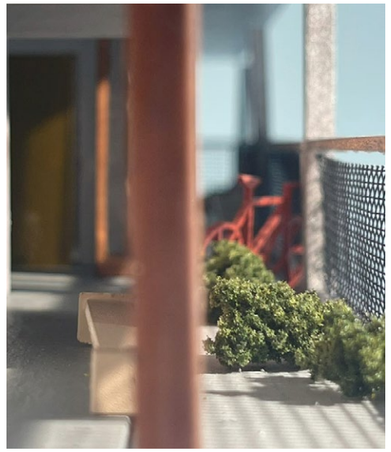


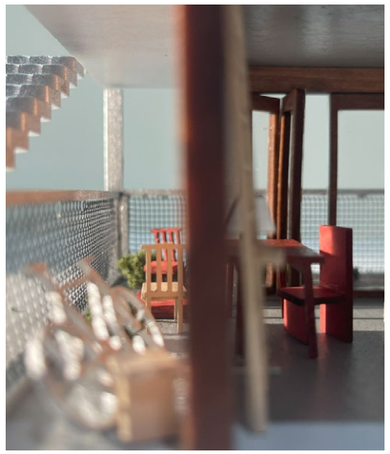
Swap of Housing and Community Garden
Trade between waterfront life and the enclosed lot

Precedent Study



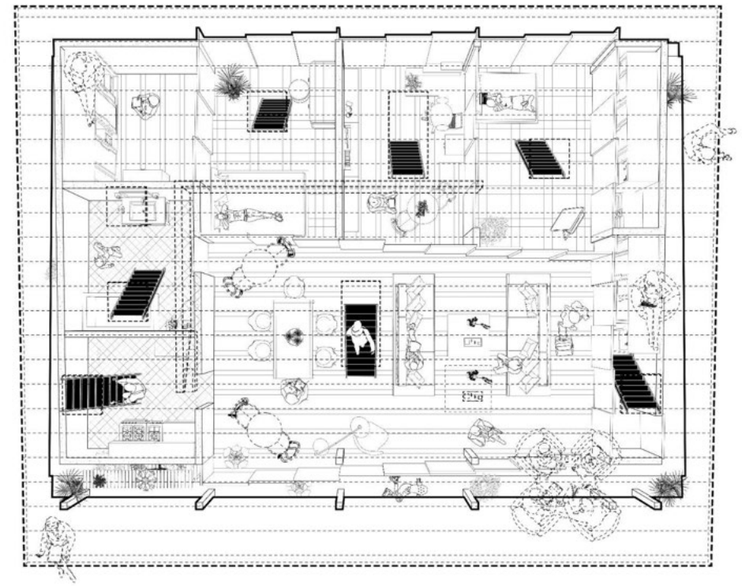
Transformation of 530 Dwellings, Lacaton & Vassal
Winter garden- an intermediate space, buffer zone offers soft transition between inside and outside



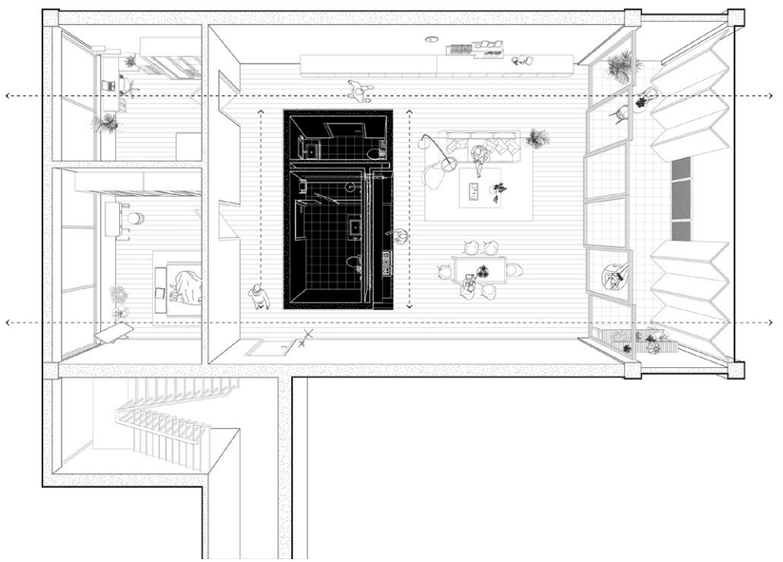


Physical Model I Intermediate Space

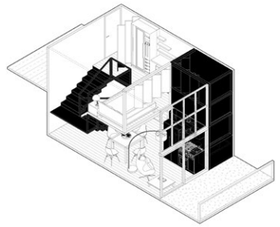
Unit Precedent Study



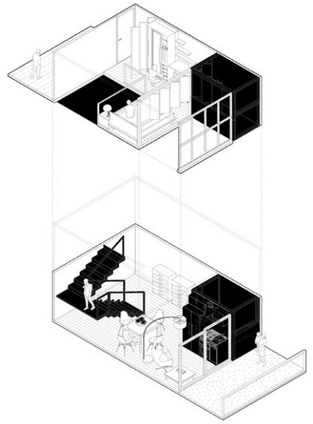
Roof House I Tezuka Architects
Accessible roof - extended living space



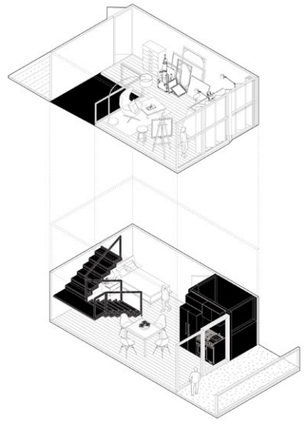
Brunstorp I Arrhov Frick Arkitektkontor
Wet core in the center - continuous circulation around



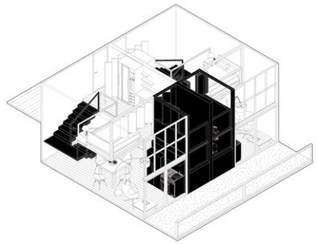
Studio

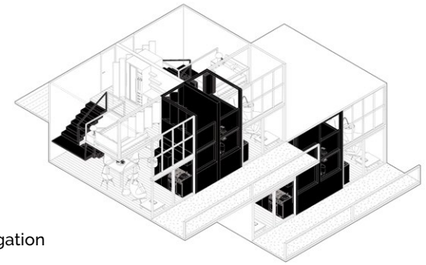


Studio with atrium

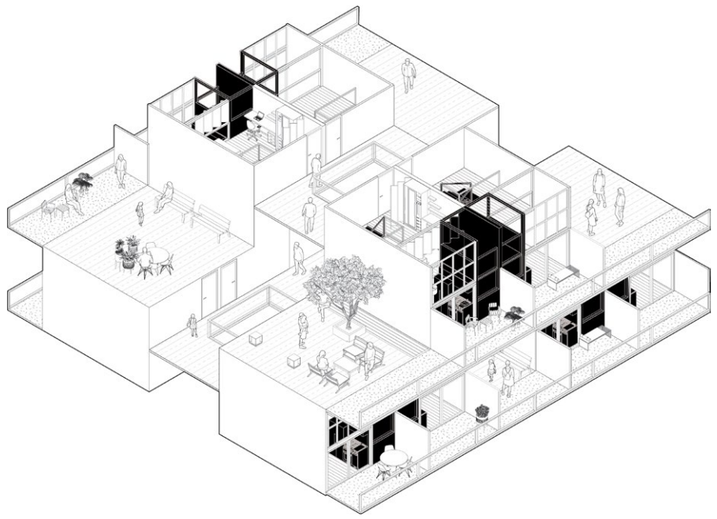


Studio with extended floor area



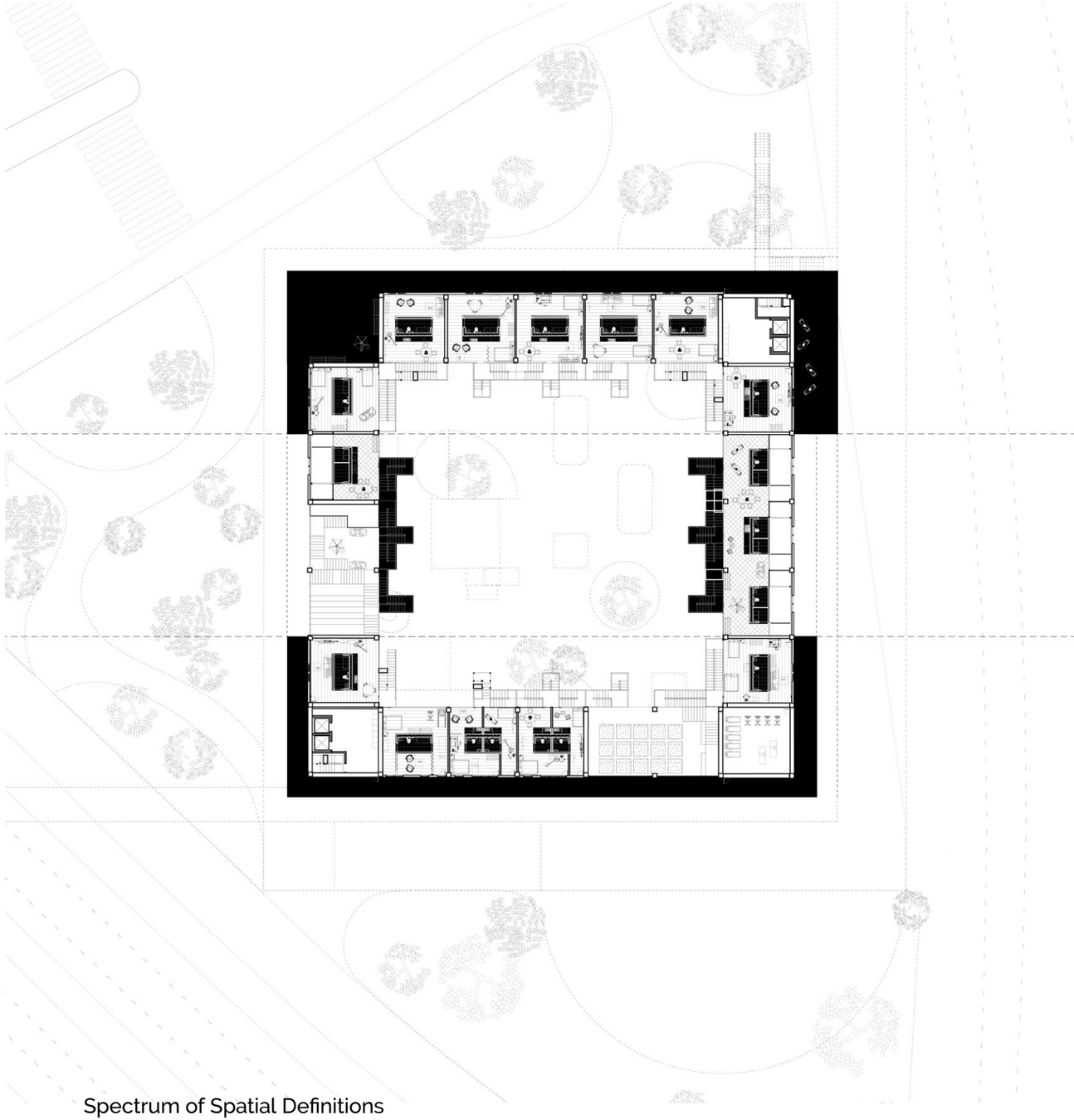


Aggeragation



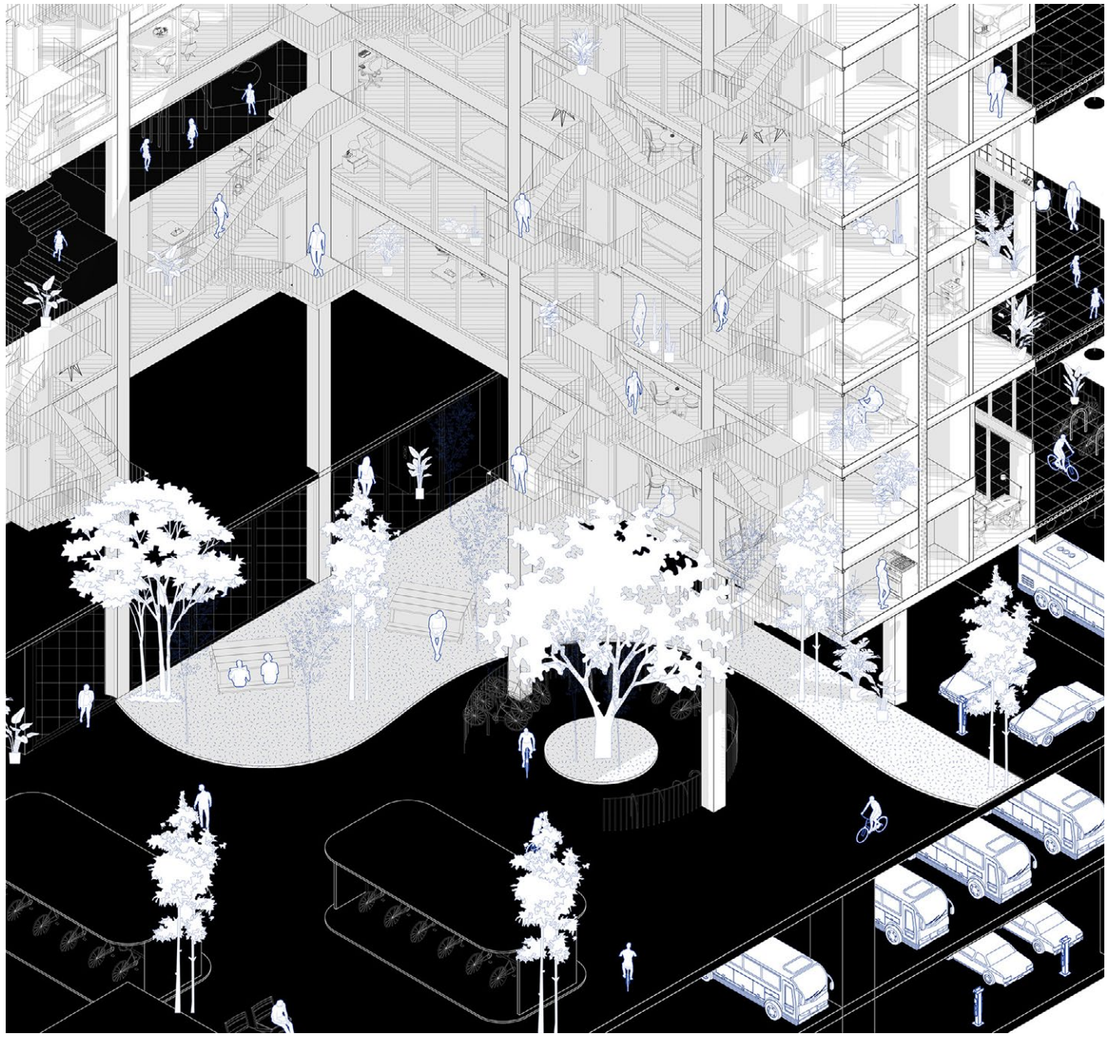
Unit Study

Interior layout build around wet core and vertical circulation



Spectrum of Spatial Definitions

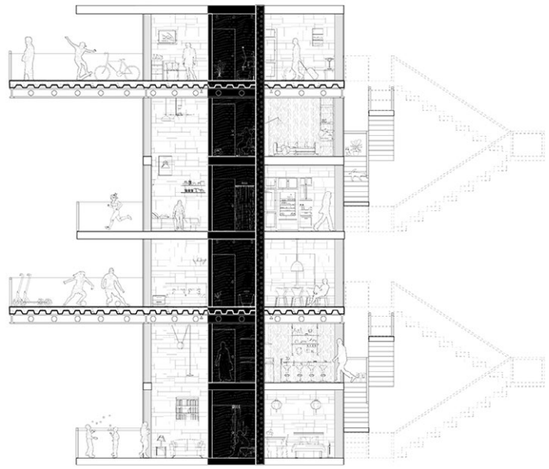
Private cores-intermediate terraces-shared perimeters



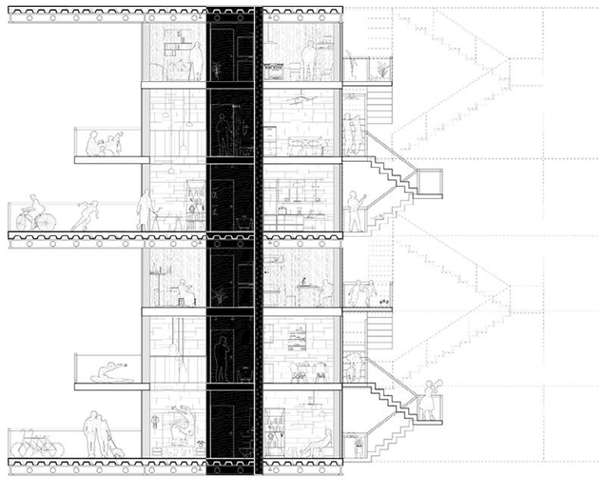
Urban Intersection of the Environment and Infrastructure
Open ground floor to allow access for people and automobiles

Gradient of Movement
Home access to street

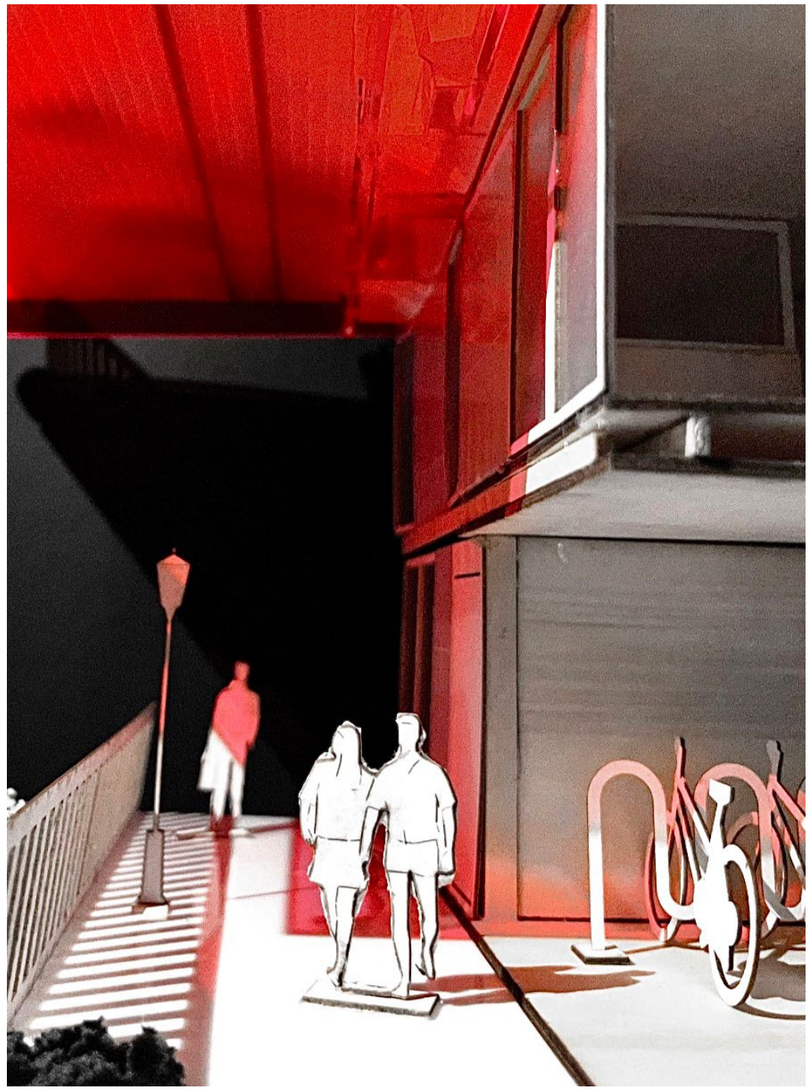
Spacial Negotiations
Maximized interior living through externalized circulations



Single-Story Units
Tripartite System with Continuous Wet Cores



Double-Story Units
Panoramically Interconnected



Public Shared Corridor

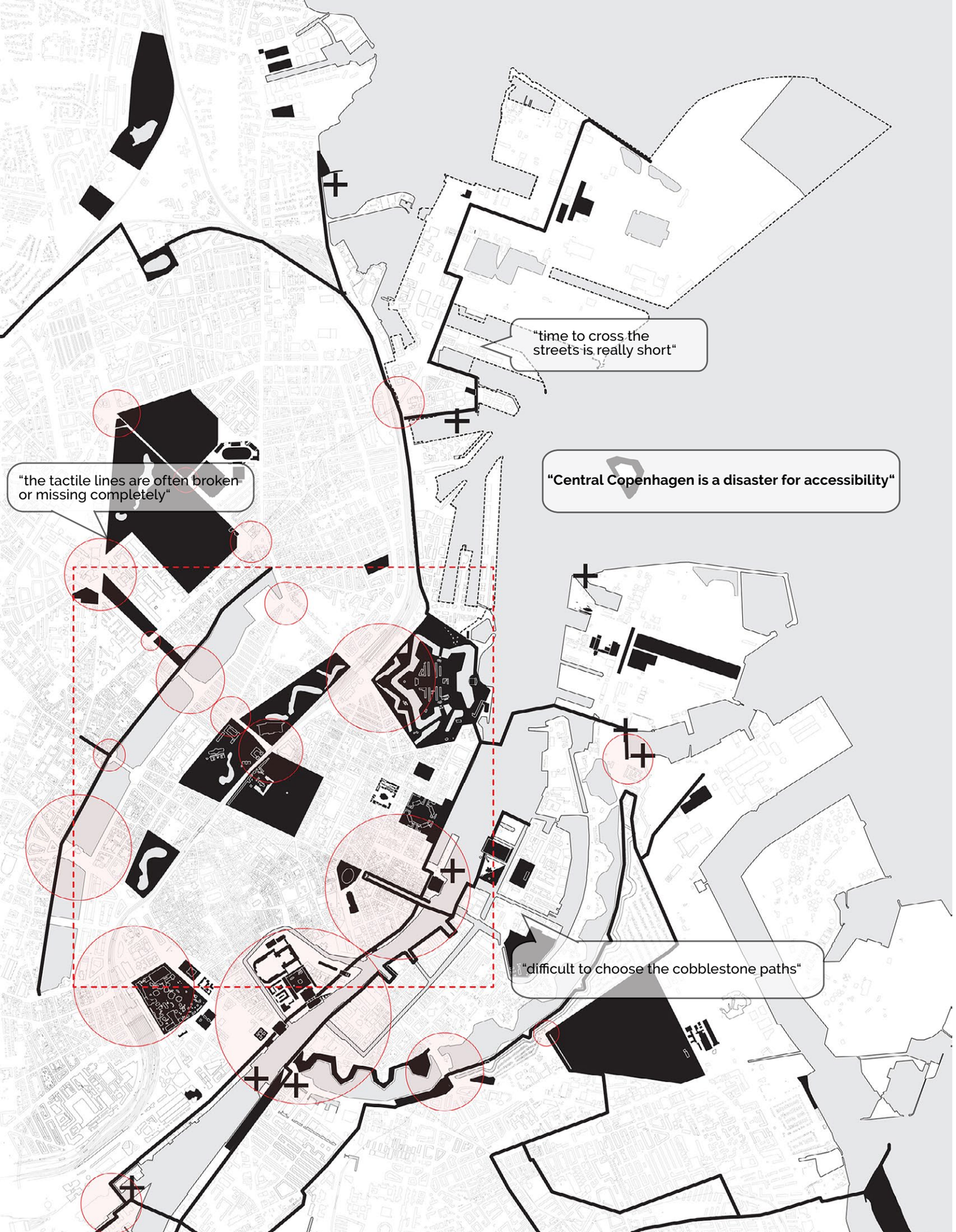
Private Externalized circulation

Friction

Theme: Dis/Abling Architecture: States of Play
Year: Spring 2024
Site: Nordhavn, Copenhagen
Instructor: Irina Verona, Jennifer Carpenter, Jerron Herman

This project is designed to create an inclusive and multifunctional space for artists, integrating areas for living, practicing, and performing, along with a publicly accessible green space. The main objective is to facilitate slow movement and enhance accessibility through the strategic use of material friction and deceleration techniques.

In a detailed exploration of material properties and their impact on mobility, the project emphasizes the modulation of movement through the application of varying friction levels achieved by different material textures. These materials not only adjust the speed and sound of movement, offering a richer sensory experience but also blur traditional spatial boundaries to create a unified, open layout that offers multiple navigational options



Surface Material Research

Friction as a key factor influencing mobility

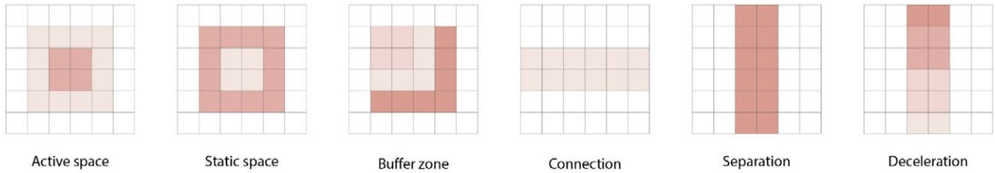




Street Surface	Asphalt	Cobblestones	Paving stones / Tiles	Concrete	Green surface
Application	Used for roads and bike lines	historical area, city center	visual appeal of public spaces, pedestrian zones and low-speed vehicle areas	sidewalks, residential streets	parks
Material Behavior	smooth, durable, suitable for traffic	historical area, city center	Require high level of maintenance, Smooth tiles can be slippery when wet	sidewalks, residential streets	Natural surfaces, not conducive to high-speed transportation

Friction high — low

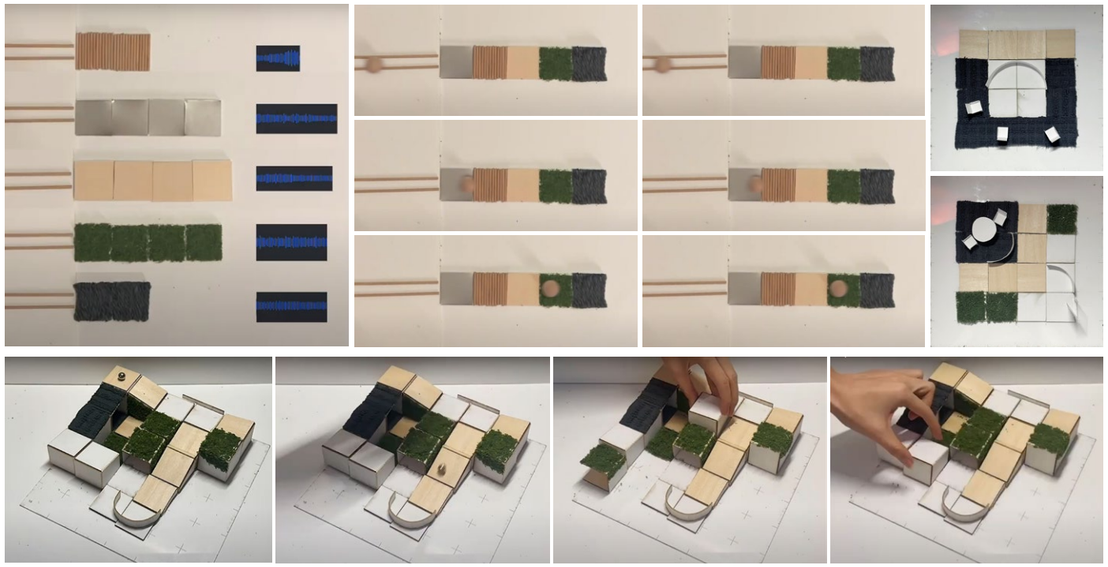
Velocity slow — fast



Active space · Static space · Buffer zone · Connection · Separation · Deceleration

Sensory Model

Adjust material friction to regulate movement velocity

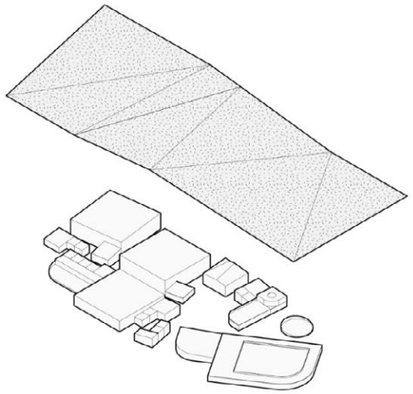


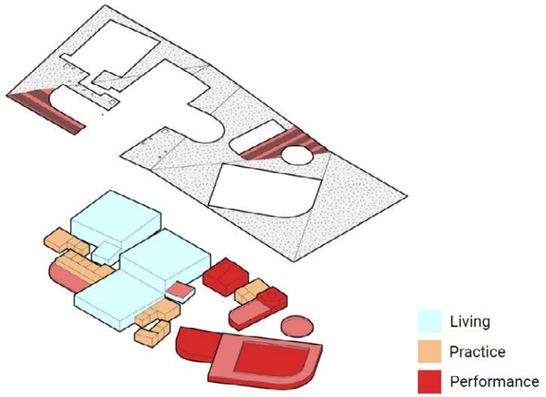
Disabled Space

A multisensory environment that harmonizes materiality with the diverse needs of its users. It serves as a meditative buffer, decelerating the high pace of urban life to a more contemplative pace, fostering an inclusive zone that tempers the sensory overload of the external world. The deceleration is achieved through the application of materials with different frictional properties.

Incorporating Slopes

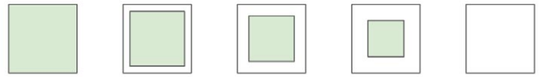
The walkable green roof introduces a gentle undulation in the landscape, increasing surface friction and naturally reduce the pace of pedestrian flow

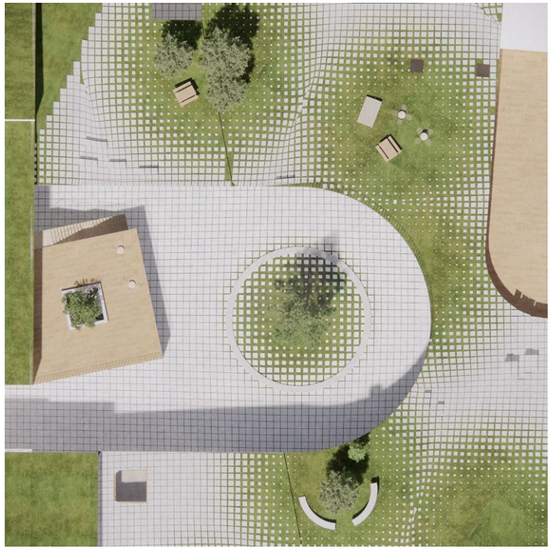


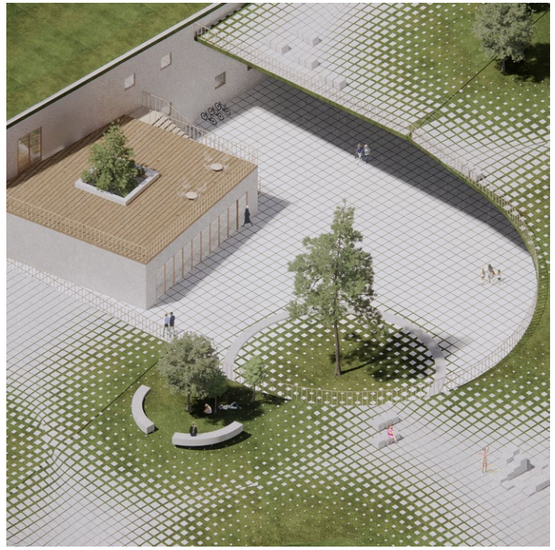


Green vs. Paver Ratio

Use a green-to-paver ratio to control friction levels and to creates a visually smooth transition between materials Pavers offers smooth pathways, while green areas encourage users to pause and interact







Deceleration through detour

Connects various communal spaces to encourages users to engage more deeply with their environment

Intermediate space

Serving as a buffer zone to create a transition between the public and private

Park-ticipation

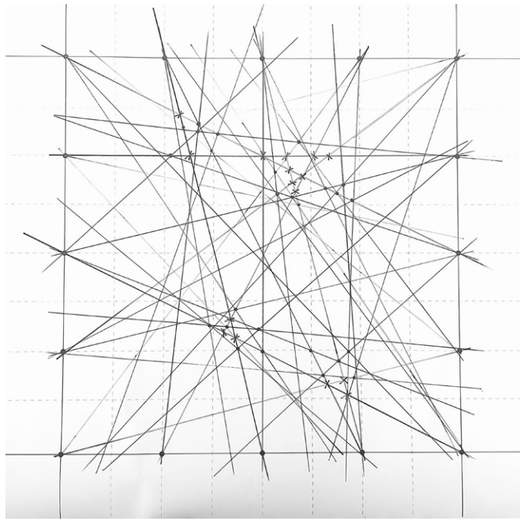
Theme: Designing with/for Uncertainty
Year: Spring 2023
Site: Bridgeport, Connecticut
Instructor: Rachely Rotem
Collaborator: Jason Zeyang Li

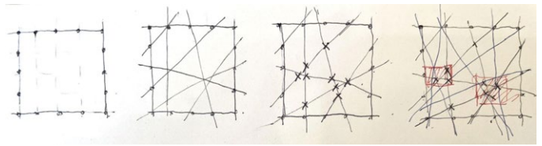
Our architectural design statement is rooted in the legacy and history of Bridgeport, a city that once thrived as a hub of heavy industry and manufacturing. Despite the aftermath of post-deindustrialization, we are committed to exploring the potential for reconnection and revitalization, particularly in the fragmented southend of Bridgeport.

Our proposed project are pocket parks consisting of customizable modular units that aggregate to challenge the traditional ideas of what a park can be, focusing on the reclamation of underutilized urban spaces for different species through the idea of "intuitive collaboration" threaded through the elements of "Biodiversity", "Social gathering", and "Outdoor recreation".

Urban Fragmentation

Borders in-between parcels due to the industrial history





Collaboration Experiment

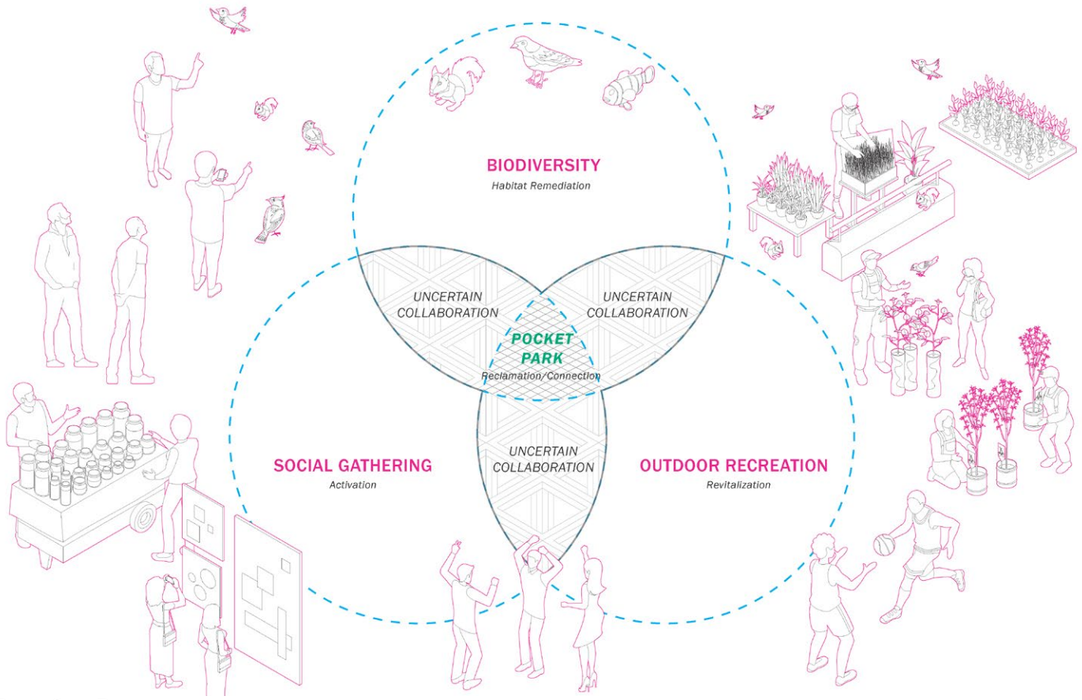
Instruction

1. Connect two points on the outside frame to form a line. Use each point on the frame only once before moving to the next step.

2. Mark all the intersection formed from Step 1 with a cross "x" sign.

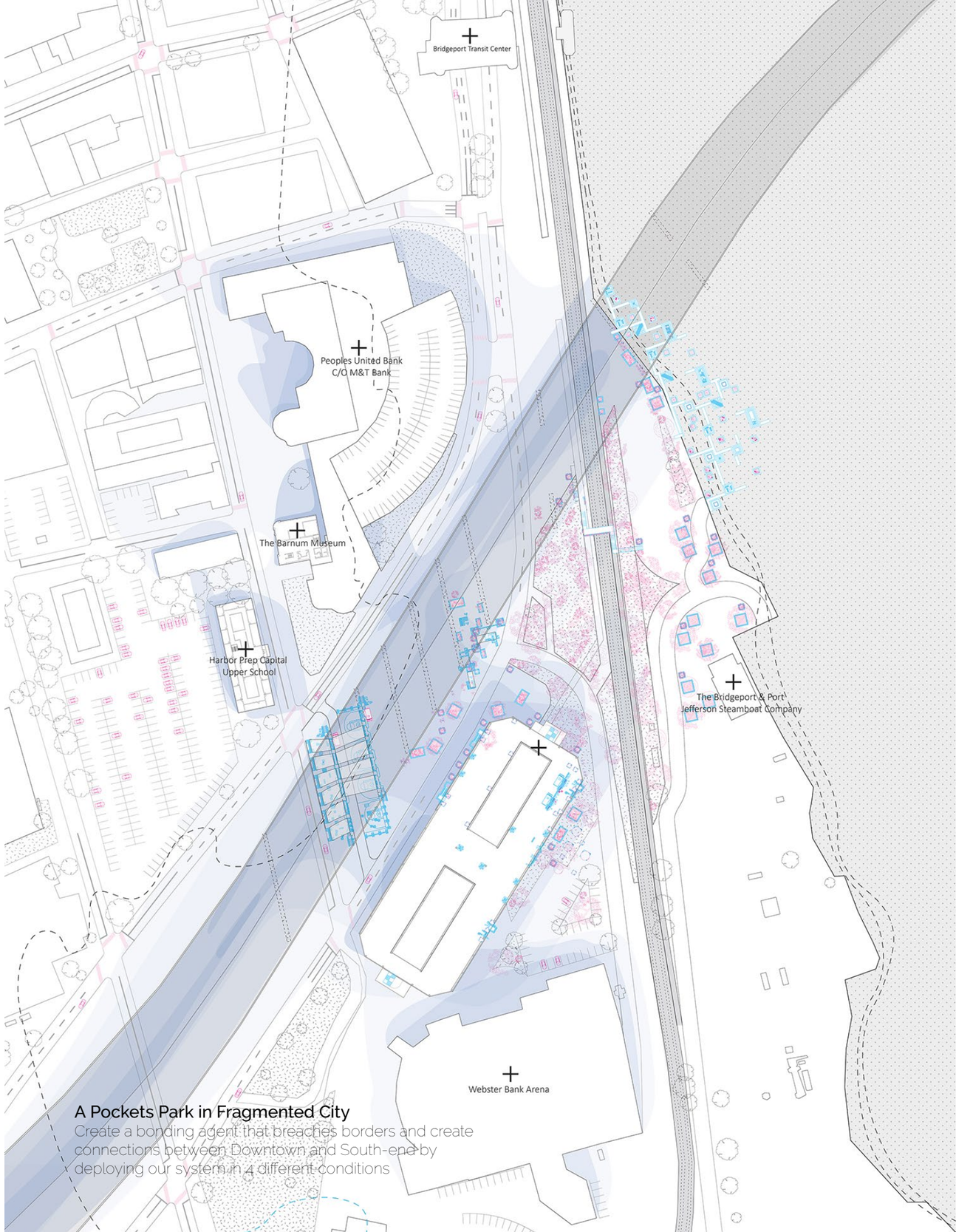
3. Choose one point on the outside frame and connect it to an intersection that is within one grid unit from an "x" inside the frame.

4. Mark the chosen intersecting point with a dot.



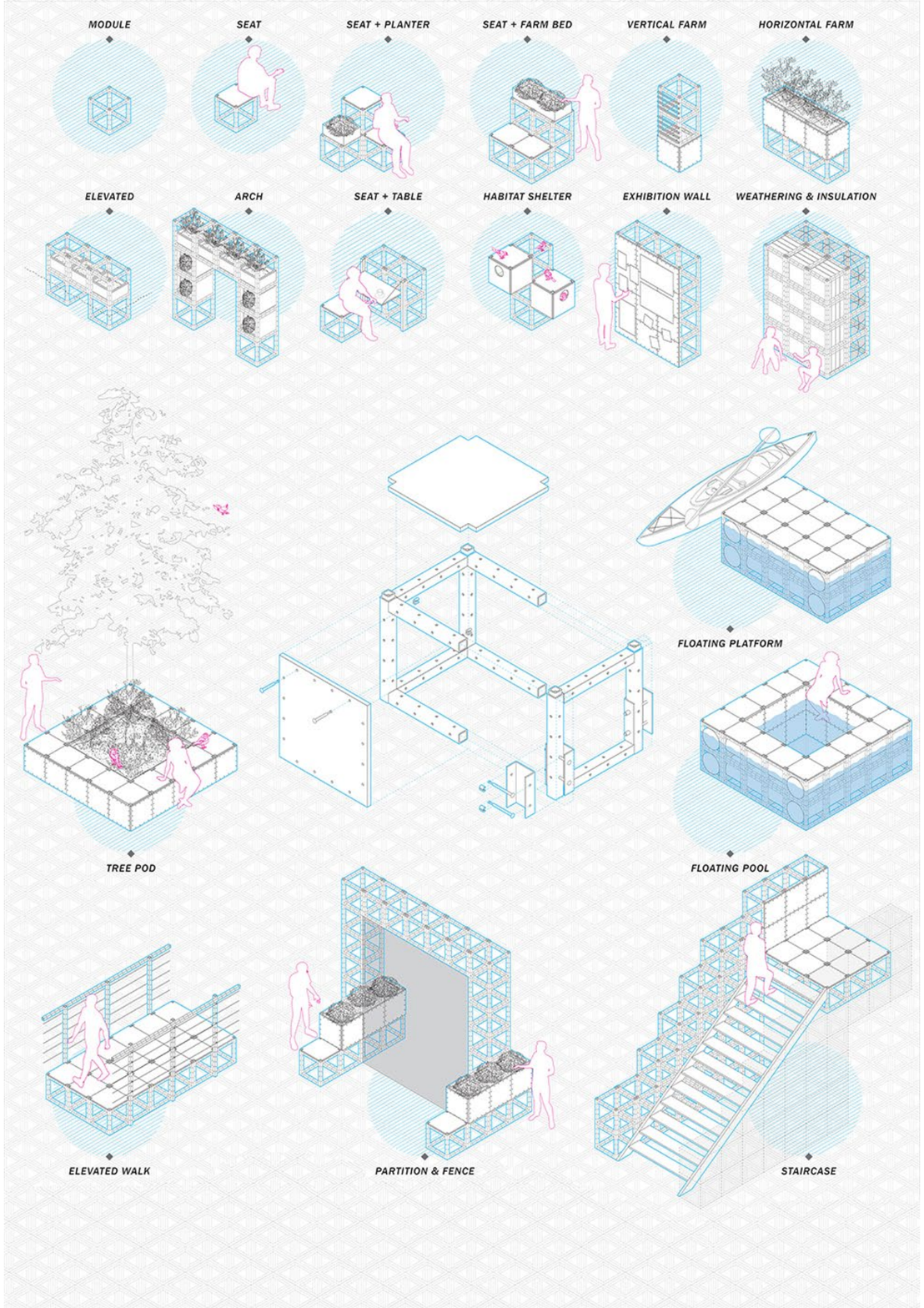
Redefine Park

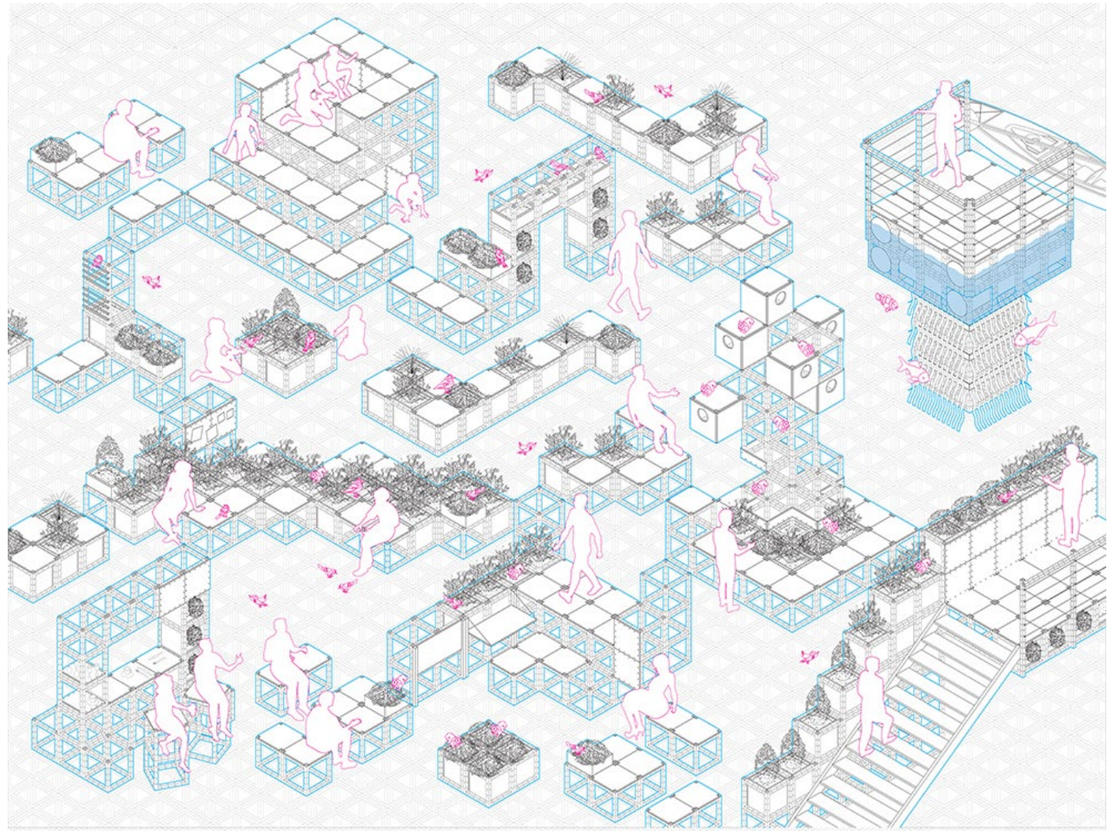
Borders in-between parcels due to the industrial history



A Pockets Park in Fragmented City

Create a bonding agent that breaches borders and create connections between Downtown and South-end by deploying our system in 4 different conditions





Kit-of-Parts

Customized through intuition and collaboration to form functions

Habitat for Nature Species
The media for people to collaborate with natural elements

Habitat for Nature Species
The media for people to collaborate with natural elements

Direct Sunlight Hour >6 hr 6 - 8 hr <8 hr Bridgeport Harbor

20 m
15 m
10 m
5 m
0 m

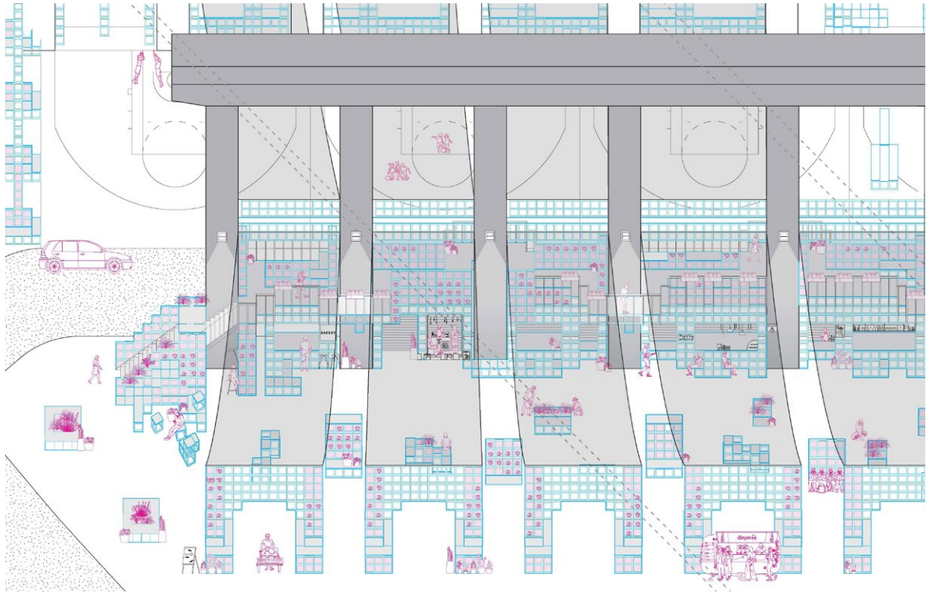
Base Flood Elevation

Sea Level

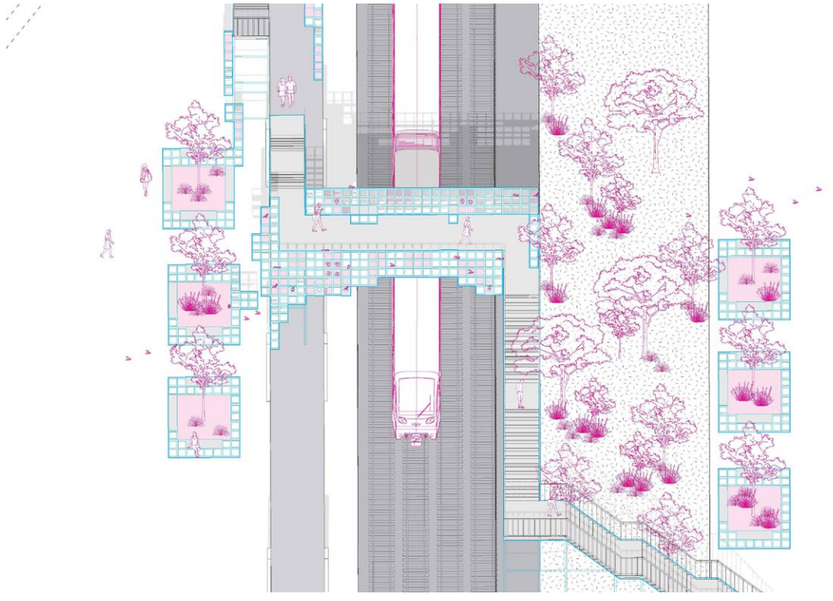
Cotoneaster
Inkberry
Winterberry
Young Oak Tree
Pin Oak
White Oak
East Red Cedar
Beech Tree
Phytoplankton
Duckweed
Wild Celery
Macroalgae
Water Milfoil
Water Lettuce

Habitat Catalog

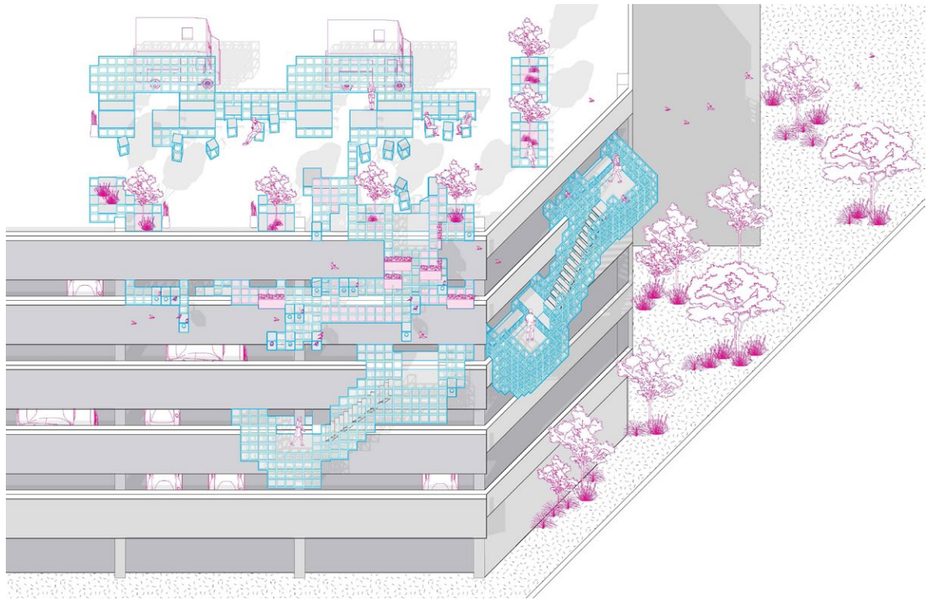
Provide habitat for natural species



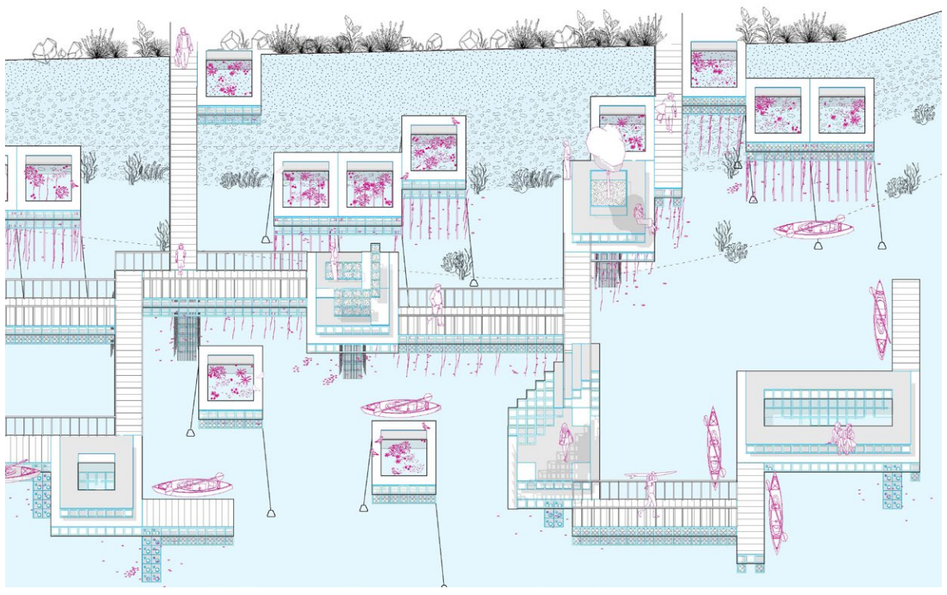
Under Fly-over Highway
Moss Nursery / Playground / Exhibition / Market



Crossing Railroad
Squirrel Habitat & Bridge

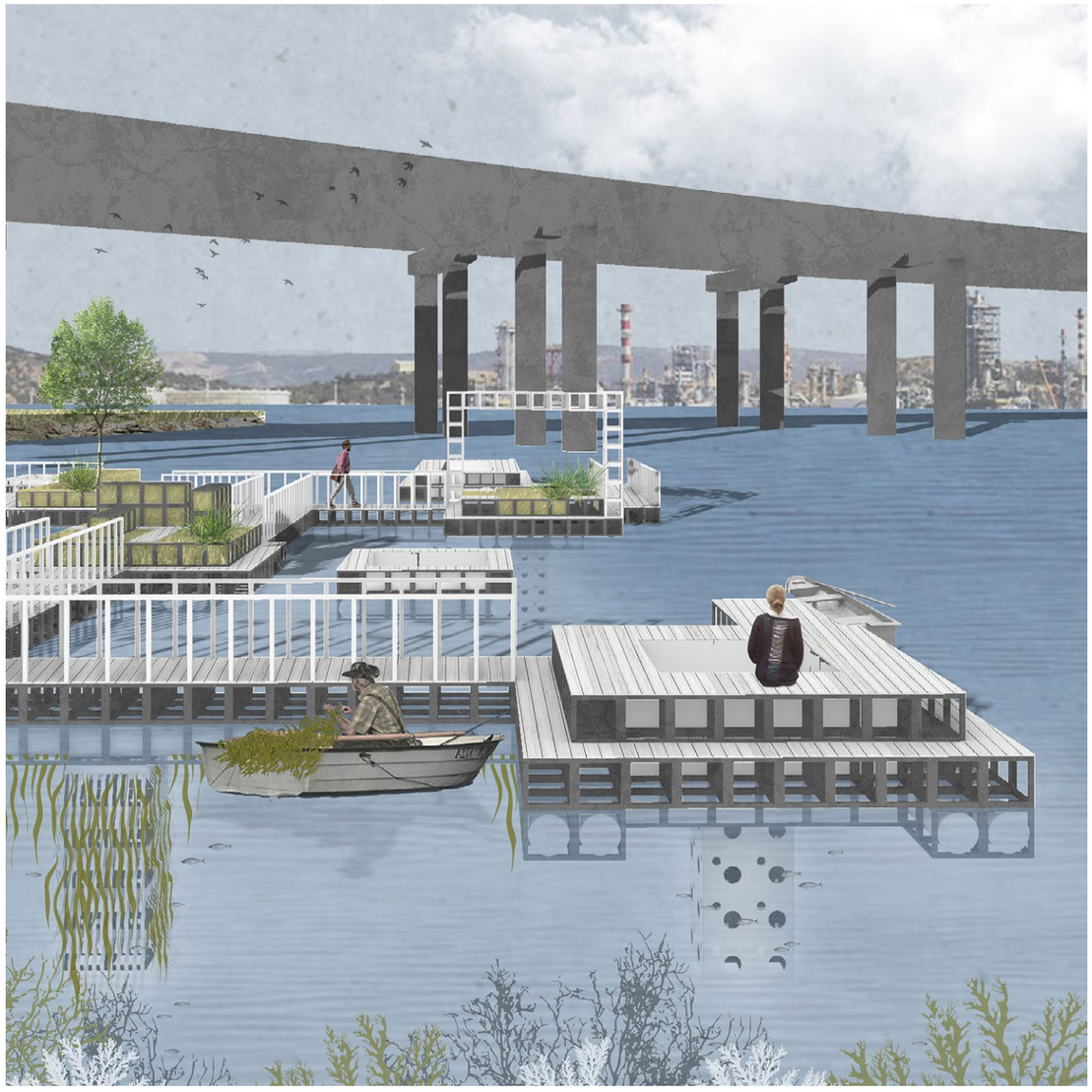


Multi-level Carpark
Birdhouses



Waterfront
Aquatic Habitat

Under Fly-over Highway
Activation of underutilized gray space



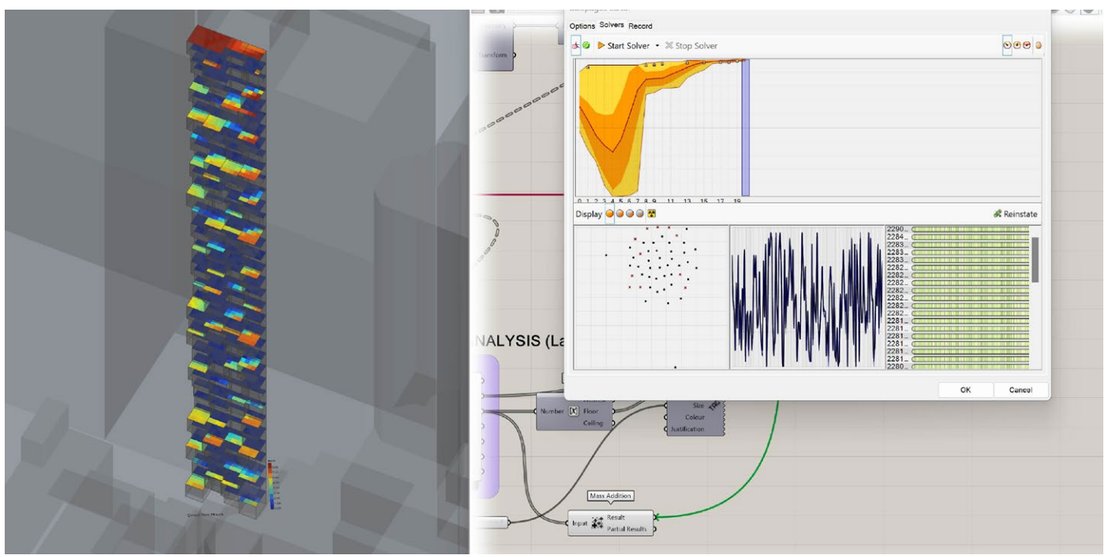
Floating Platforms I Water Garden
Habitat for aquatic species

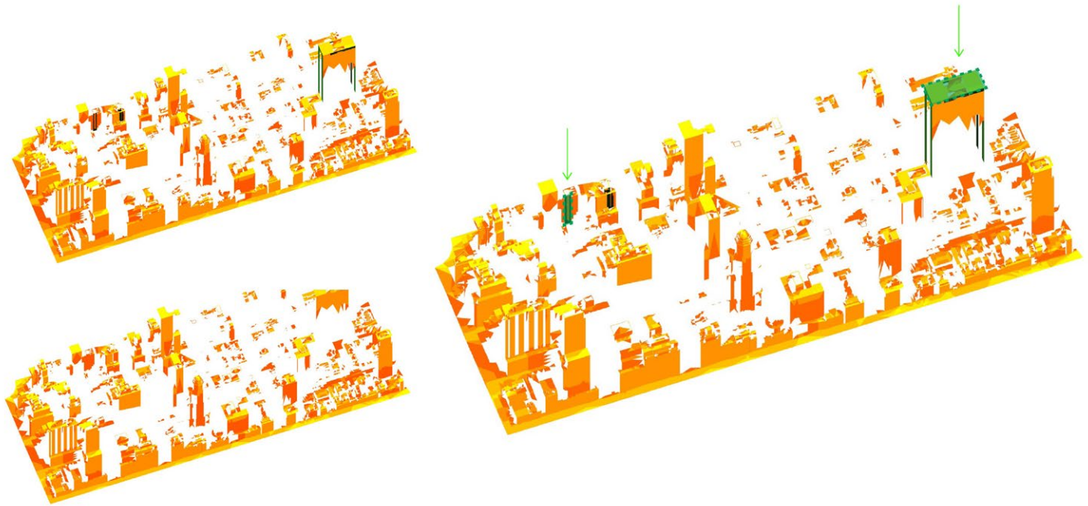
Green I Manhattan

Theme: Generative Design
Year: 2023 Spring
Instructor: Danil Nagy
Collaborators: Anna Kim, Han Qin, Jason Li, Xavier Zhapan

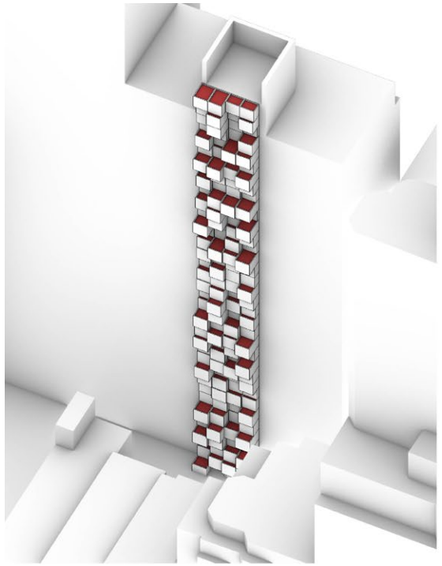
Our project – "Green Manhattan" – is interested in analyzing and locating optimal areas for green infrastructure in the city of Manhattan (Midtown, where the grounds are overcrowded and overshadowed by super-skyscrapers), whether it be curbside, rooftops, or facades, according to sun exposure. Then, designing these infrastructures to allow plants to gain maximum/sufficient direct sunlight, purify the cityscape and allow human interaction, and reduce urban heat island effect.

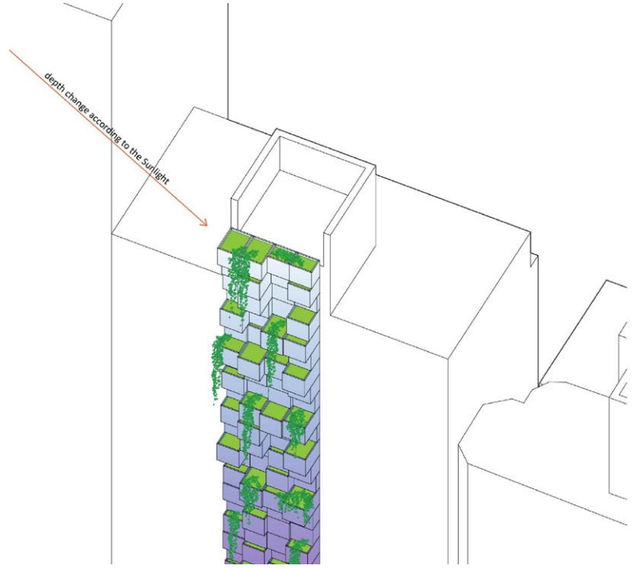
The project is envisioned to be a workflow or tool that is repeatable at different city blocks or even different urban contexts in different parts of the world.





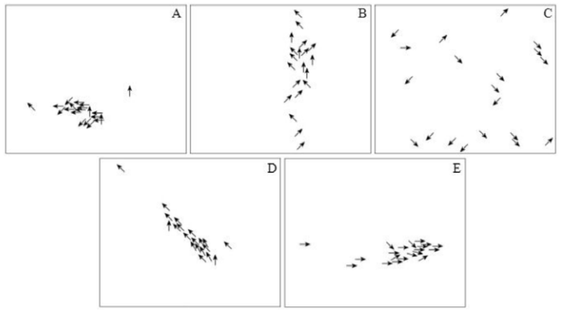
Urban Analysis
Model - Building blocks in Midtown, New York
Input - Connect geometry and surfaces in Ladybug setup
Output - Surfaces with 7 hour or more sun exposure a day

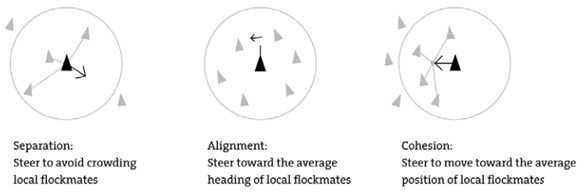




Condition A - Facade
Input - Subdivide facade into a rectangular grid
Output - Extruded box with the maximum amount of sun exposure duration possible
Tools - Galapagos for optimization

Inspiration - Birds Flocking Algorithm





Separation:
Steer to avoid crowding local flockmates

Alignment:
Steer toward the average heading of local flockmates

Cohesion:
Steer to move toward the average position of local flockmates

Object-oriented programming (OOP) & agent-based system

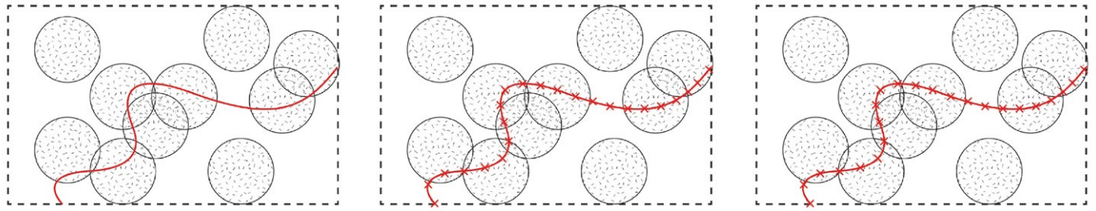
In the context of Generative Design, we can use such agent-based systems to define solutions within a design space by parameterizing the behaviors of a set of agents, allowing the behaviors to play out over a series of time steps, and then taking the final state of the agents as the design solution.

```python
import Rhino.Geometry as rh

class Room:
    
    # intialize room instance
    def __init__(self, point, rad):
        self.cp = point
        self.r = rad
        self.avoid_vec = rh.Vector3d(0,0,0)

    # method for checking distance to other room object and movig apart if t
    def avoid(self, other_rooms):
        self.avoid_vec = rh.Vector3d(0,0,0)
        for room in other_rooms:
            if room != self:
                d = self.cp.DistanceTo(room.cp)
                if d < self.r + distance:
                    vec = rh.Vector3d(self.cp) - rh.Vector3d(room.cp)
                    overlap = (self.r + distance) - d
                    vec.Unitize()
                    vec = vec * overlap * alpha
                    self.avoid_vec += vec
        self.cp.Transform(rh.Transform.Translation(self.avoid_vec))
        
    # method for checking distance to the point in path and movig apart if t
    def avoid_path(self, path):
        self.avoid_vec = rh.Vector3d(0,0,0)
        for point in path:
            d = self.cp.DistanceTo(point)
            if d < self.r + distance:
                vec = rh.Vector3d(self.cp) - rh.Vector3d(point)
                overlap = (self.r + distance) - d
                vec.Unitize()
                vec = vec * overlap * alpha
                self.avoid_vec += vec
        self.cp.Transform(rh.Transform.Translation(self.avoid_vec))

# create empty list to store room objects
rooms = []

# loop over all center points, create new room object, and add to list of r
for point in points:
    room = Room(point, radius)
    rooms.append(room)

distance = 5

# LOCAL OPTIMIZATION LOOP
for i in range(max_iter):
    for room_1 in rooms:
        other_rooms = [room for room in rooms if room != room_1]
        room_1.avoid(other_rooms)
        room_1.avoid_path(path)

# export list of moved object center points from script
cps = [room.cp for room in rooms]
```

Script Stages 1

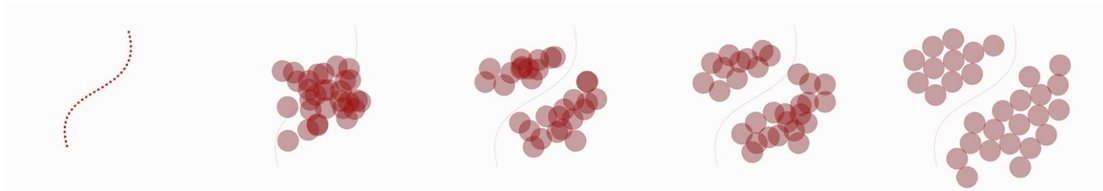
- Define the Room Class
- Create Room Objects
- Avoid Overlapping with Other Circles

Defined *avoid* method, use agent-based modeling to simulate the behavior of the circles as they move to avoid collision and find a stable packing arrangement.



Design - Finding the Pathway

Input - Move objects away from other objects and certain input points in a local optimization loop
Output - Crcle acts as an agent and interacts with other circles and points in the environment



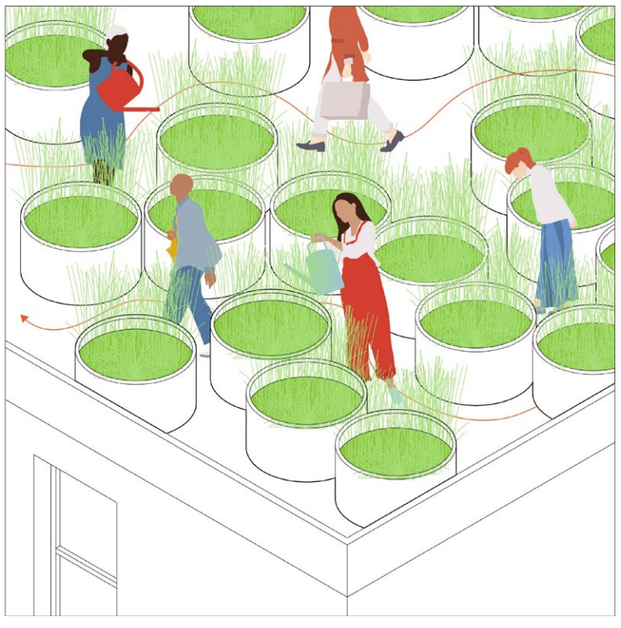
Optimization

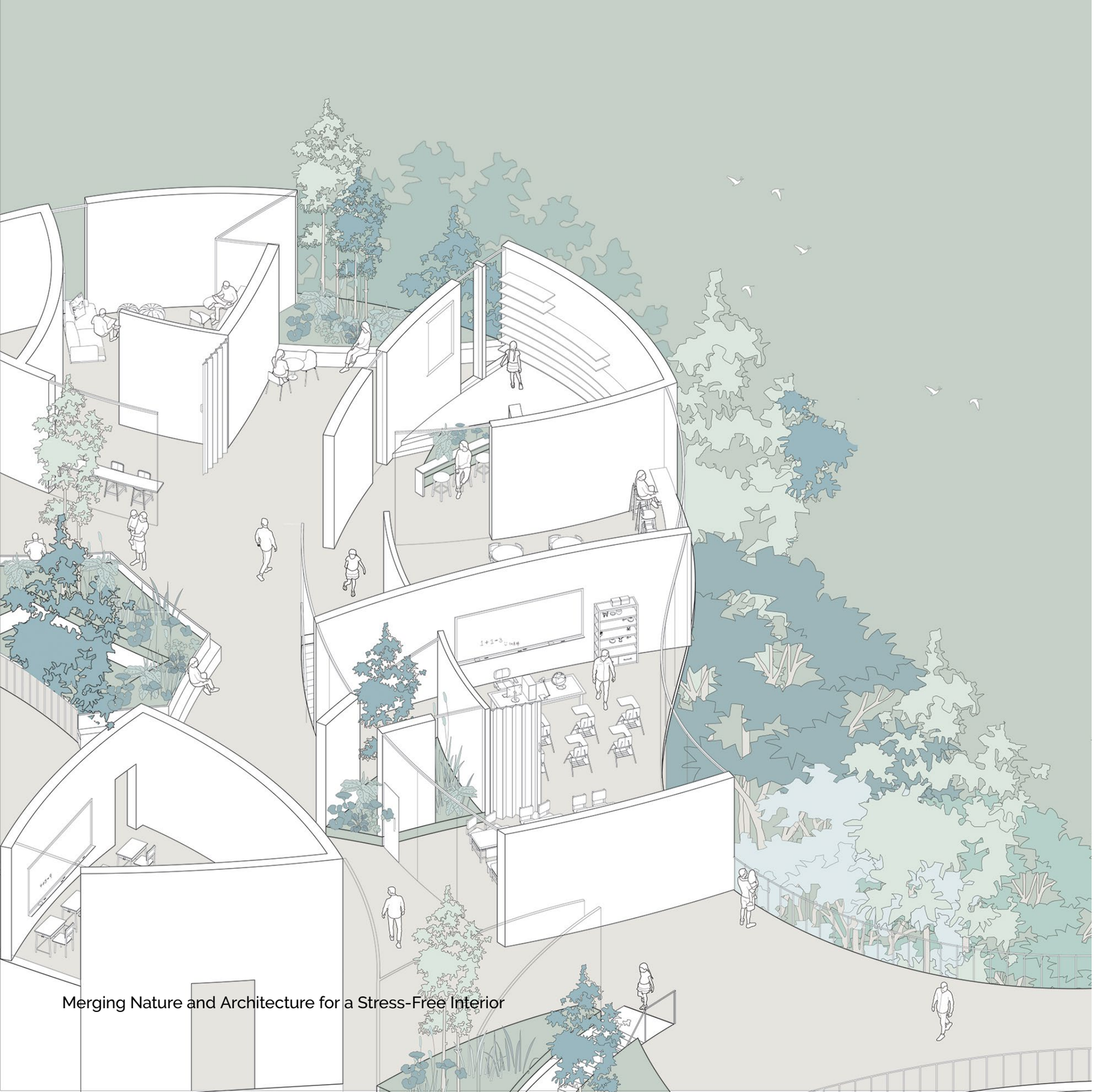
```python
    # method for checking distance to other room object and movig apart if t
    def avoid(self, other_rooms):
        self.avoid_vec = rh.Vector3d(0,0,0)
        for room in other_rooms:
            if room != self:
                d = self.cp.DistanceTo(room.cp)
                if d < self.r + distance:
                    vec = rh.Vector3d(self.cp) - rh.Vector3d(room.cp)
                    overlap = (self.r + distance) - d
                    vec.Unitize()
                    vec = vec * overlap * alpha
                    self.avoid_vec += vec
        
        self.cp.Transform(rh.Transform.Translation(self.avoid_vec))
        
    # method for checking distance to the point in path and movig apart if t
    def avoid_path(self, path):
        self.avoid_vec = rh.Vector3d(0,0,0)
        for point in path:
            d = self.cp.DistanceTo(point)
            if d < self.r + distance:
                vec = rh.Vector3d(self.cp) - rh.Vector3d(point)
                overlap = (self.r + distance) - d
                vec.Unitize()
                vec = vec * overlap * alpha
                self.avoid_vec += vec
        self.cp.Transform(rh.Transform.Translation(self.avoid_vec))
```

Script Stages 2

- Avoid Overlapping with Input Points From the Curve
- Local Optimization Loop
- Export List of Moved Object Center Points

Defined *avoid_path* method to avoid overlapping with points from the curve.



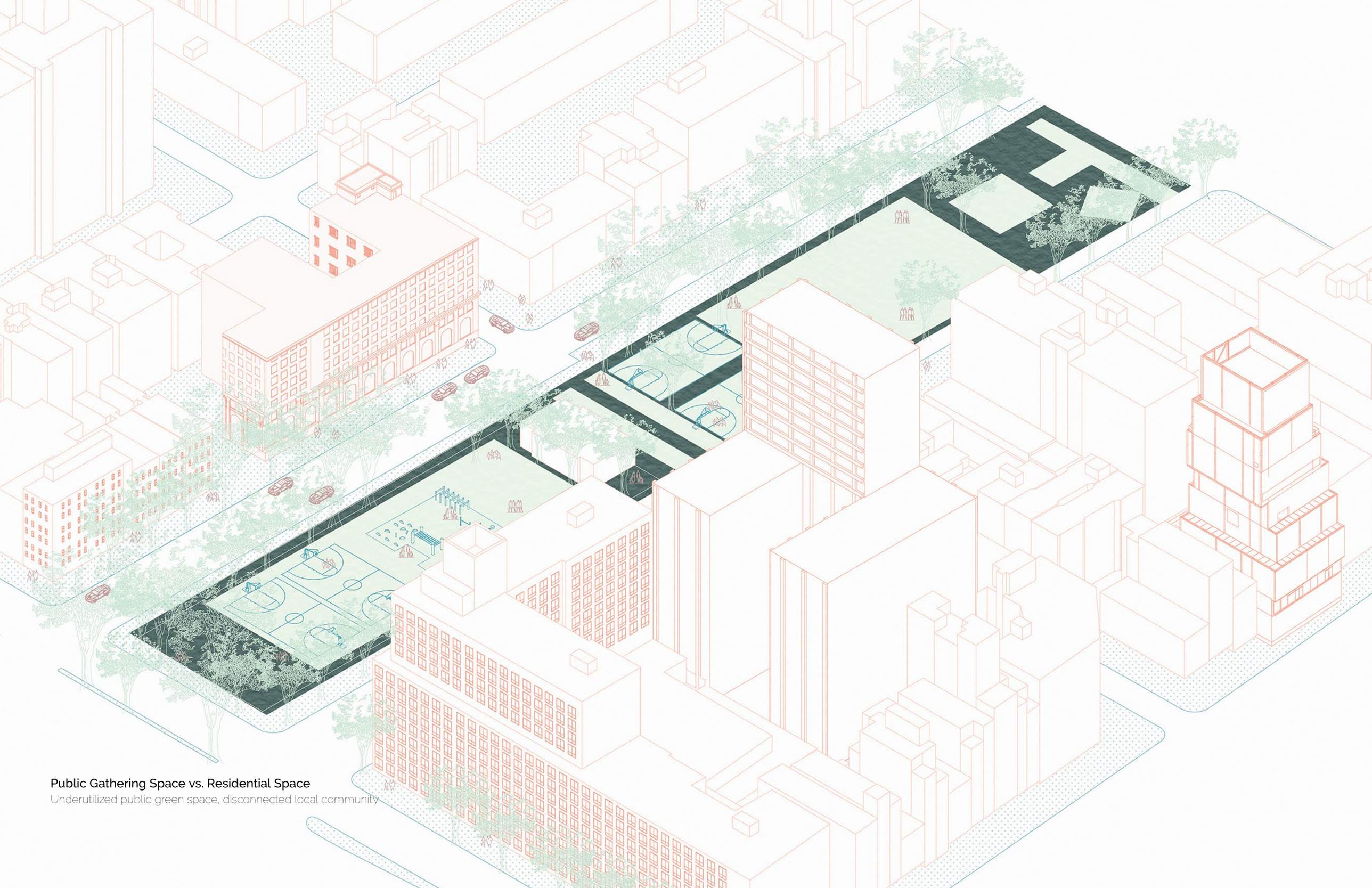


Inside Out

Theme: All Is School
Year: Spring 2022
Site: 198 Forsyth St, New York
Instructor: Benjamin Cadena
Individual Work

Sara D. Roosevelt Park is a significant public space, rich with lush vegetation and a vibrant history of immigration from diverse communities. Despite its potential as a gathering place, limited accessibility and safety concerns have hindered its use by local residents. The design objective is to create a more accessible and welcoming environment for students and visitors by seamlessly integrating indoor and outdoor spaces.

The organic form and high degree of transparency of the design serve to merge boundaries and foster a strong connection between the interior and exterior environments. The spaces within the building are divided by concrete walls and glass partitions that intersect in a way that allows for varying levels of visibility. The use of lush vegetation as a prominent interior element is a deliberate choice, as it brings the natural beauty of the park into the building, creating a safe and calming atmosphere for reading and socializing.



Public Gathering Space vs. Residential Space

Underutilized public green space, disconnected local community

Atrium and Interior Garden

A Safe Green Space for People to Connect Outside

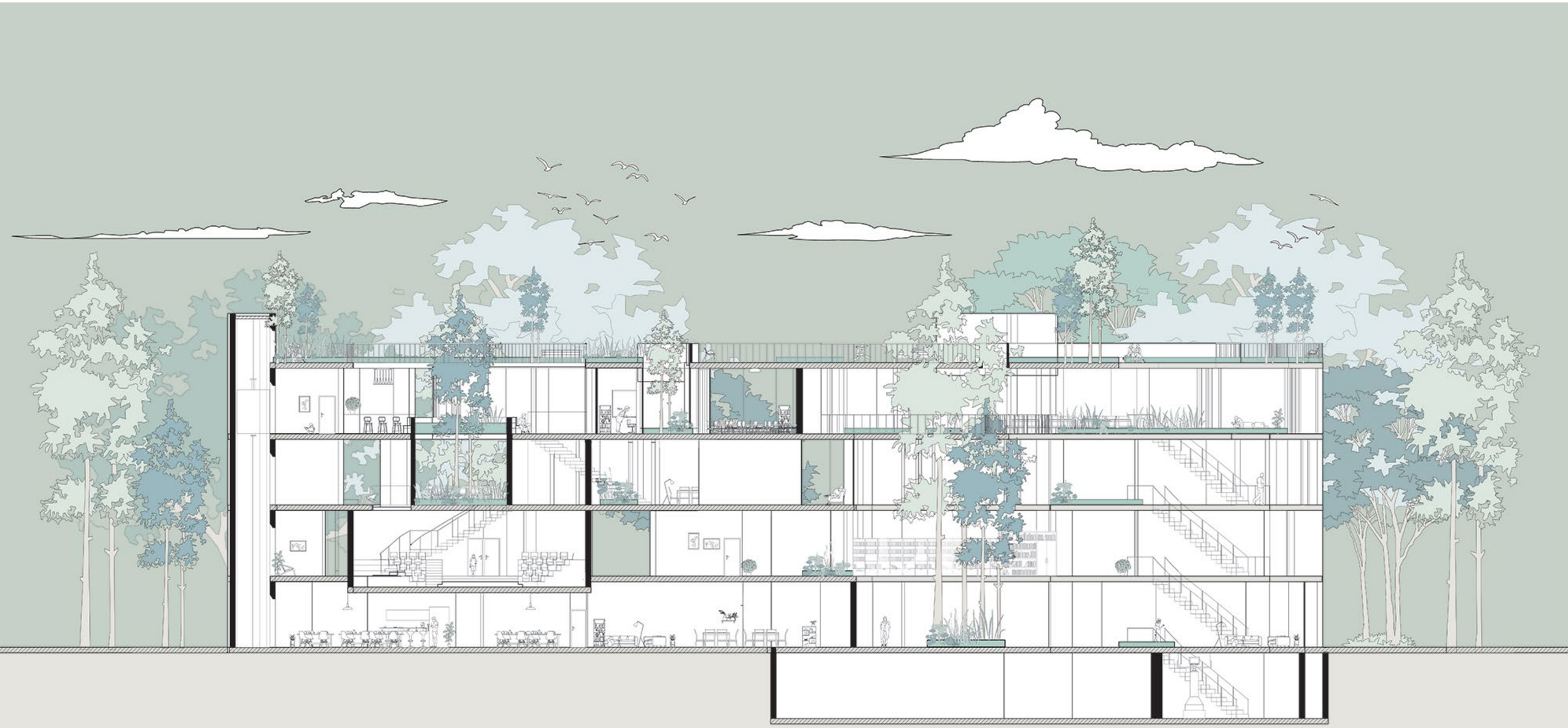
Conceptual Model

Porous Facade with Greens

Green Connection between Inside and Outside

Intersecting Curves Walls and Organic Building Form

Break the rigid building blocks and blur the boundary between inside and outside



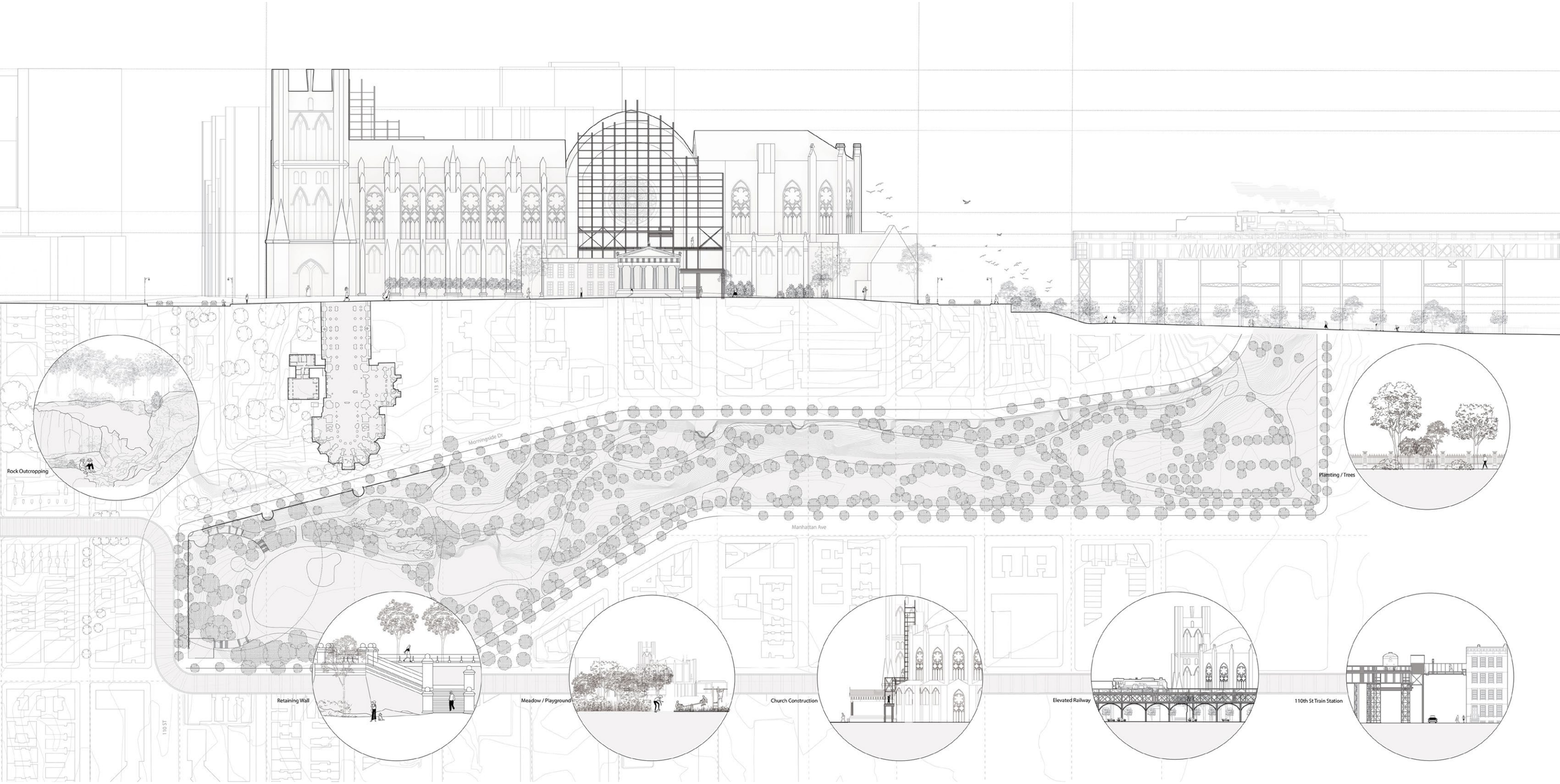
Porous Structures with Indoor Gardens

Stacking floors to create skylights and atrium for bringing plants in

Cliff Clinic

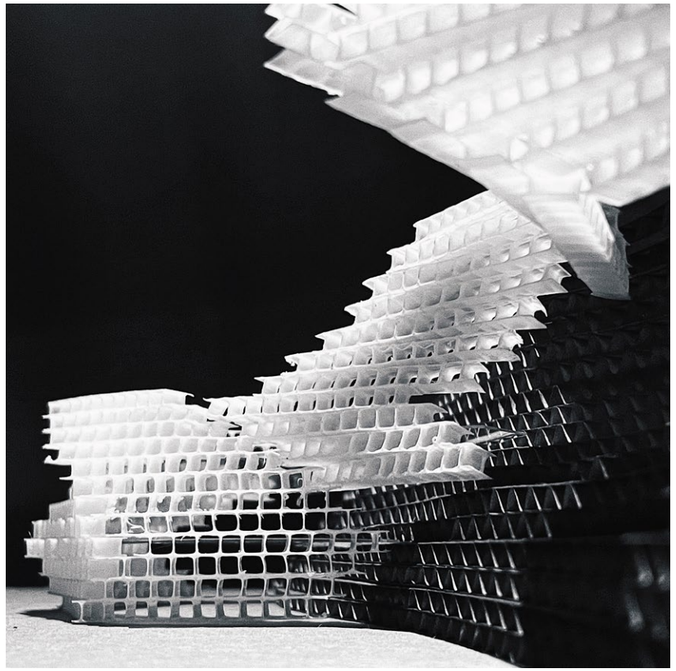
Theme: City Intervention
Year: Fall 2021
Site: Morningside Park, New York
Instructor: Lindy Roy
Individual Work

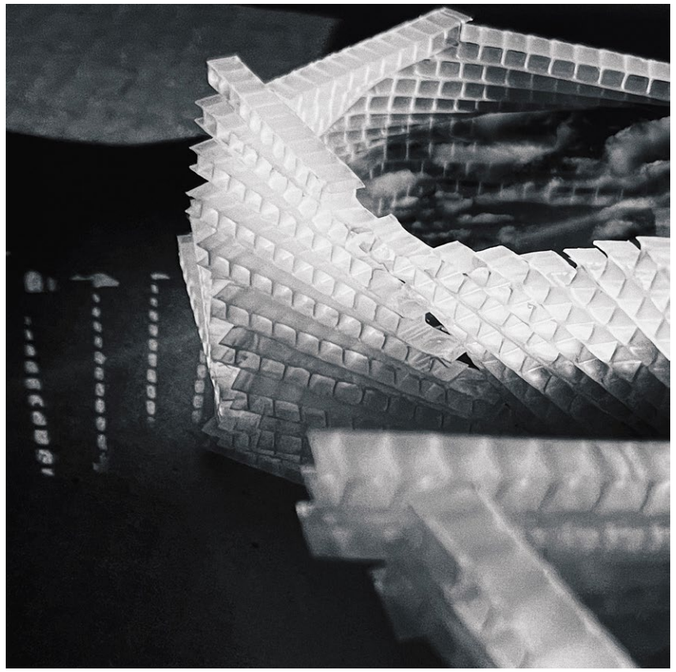
This design project aims to address the historical racial injustices inherent in the site and their impact on public spaces through a critical and thought-provoking approach. By examining the unique characteristics of Morningside Park, the project seeks to create a new network of inclusive and innovative spaces that address these challenges. The local community's rich history serves as a backdrop for exploring new possibilities for inclusive and empowering public spaces.



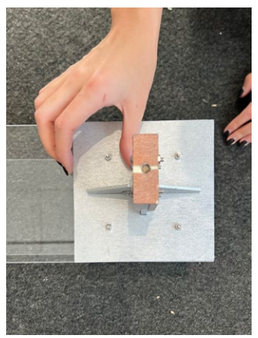
Site Section/Site Analysis

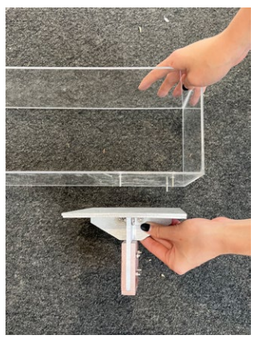
Public infrastructures and Morningside park

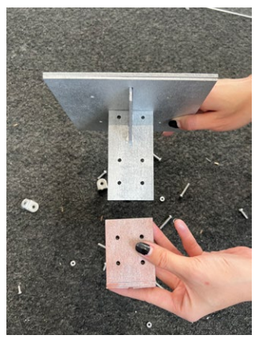




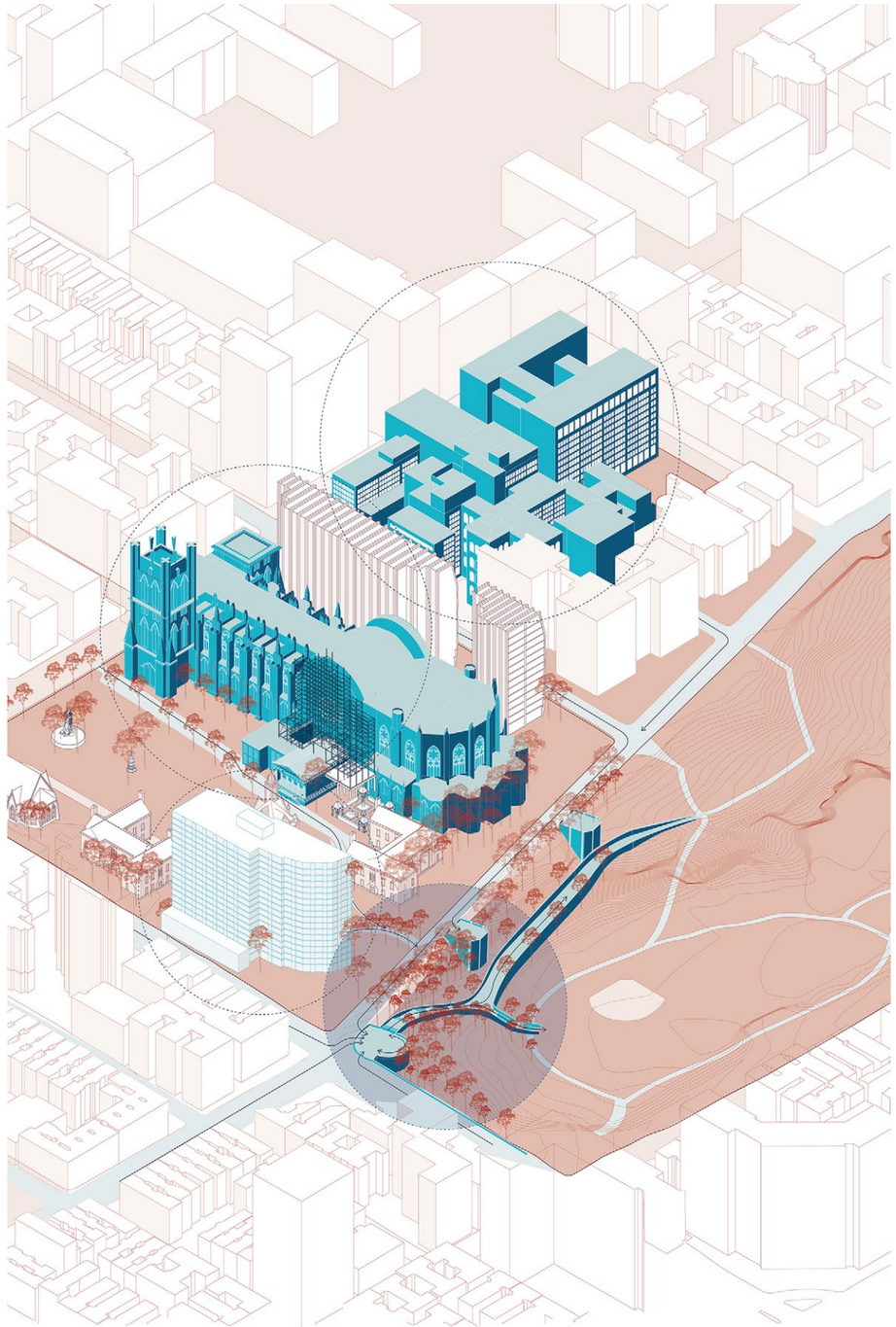
Form Study



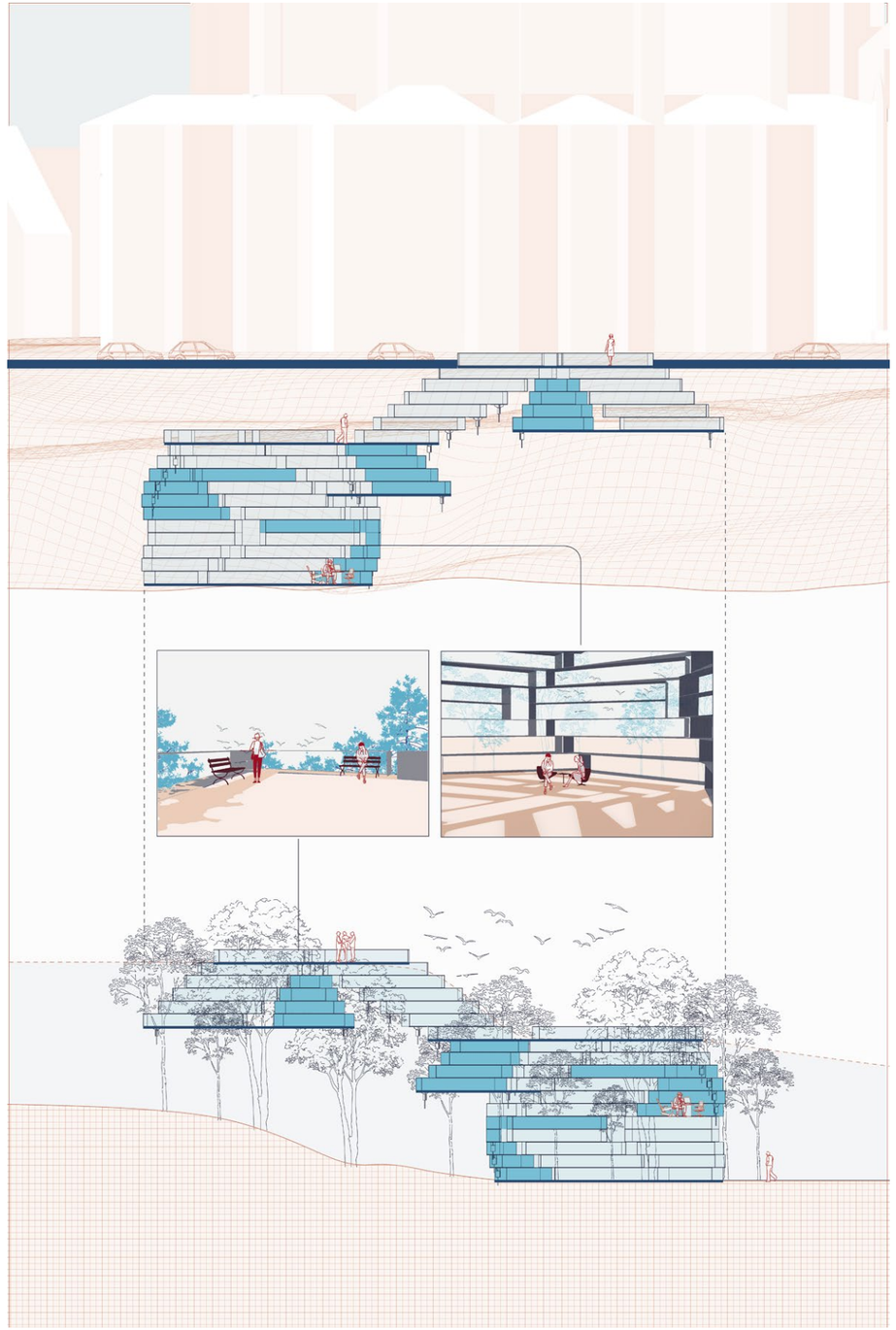




Assembly Structure



Resources from Public Infrastructures
Build a connection along Moriningside park

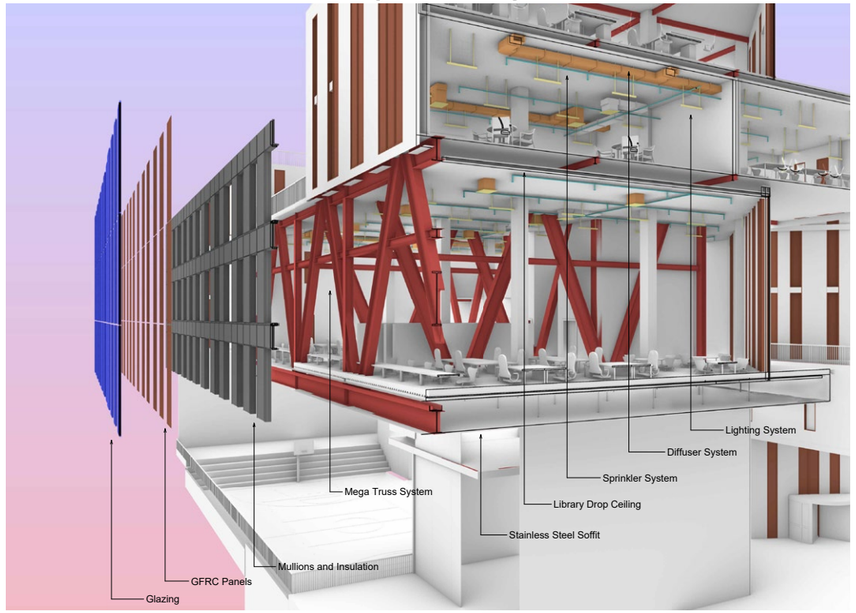


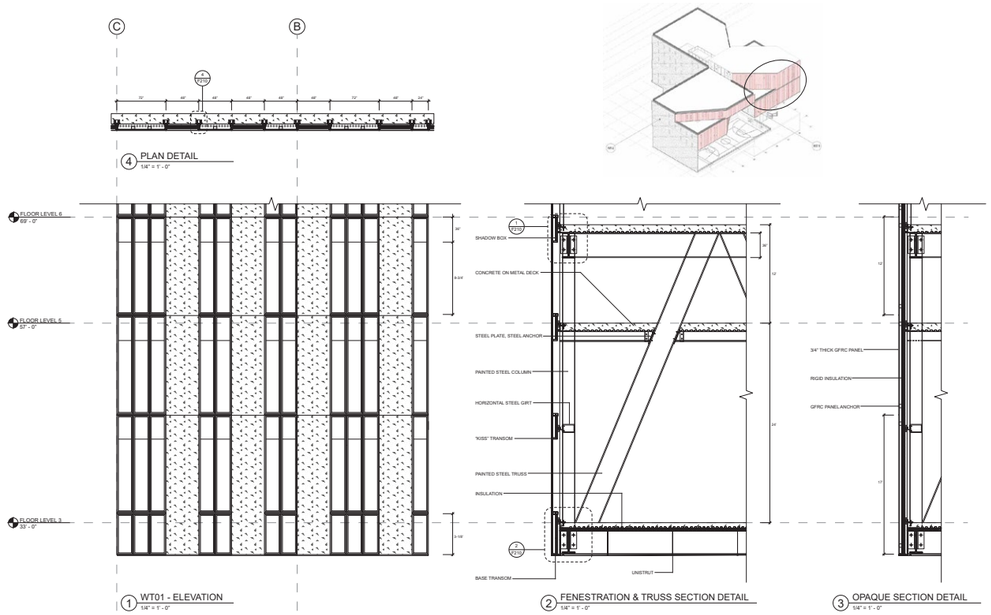
Vertical Connection
Provide access to the park

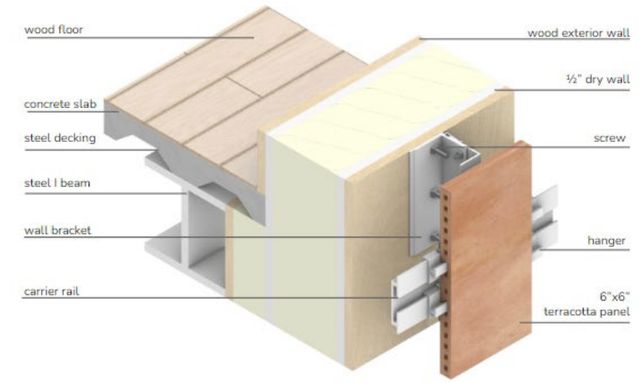
Theme: Building Systems Integration

Year: Fall 2022

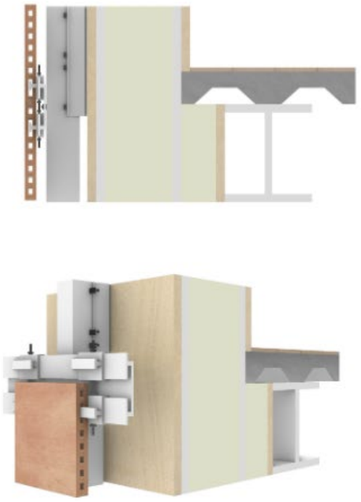
Collaborators: Lula Chou, Jason Li, Haoge Gan, Caining Gu

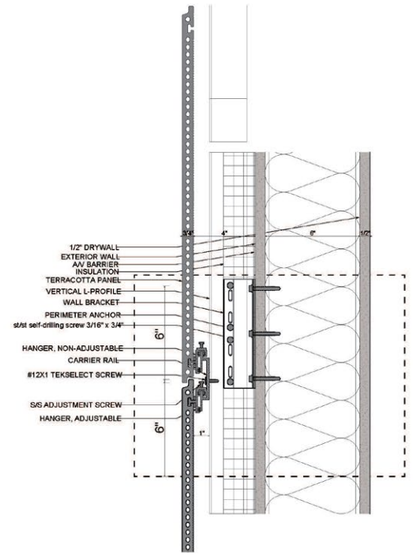




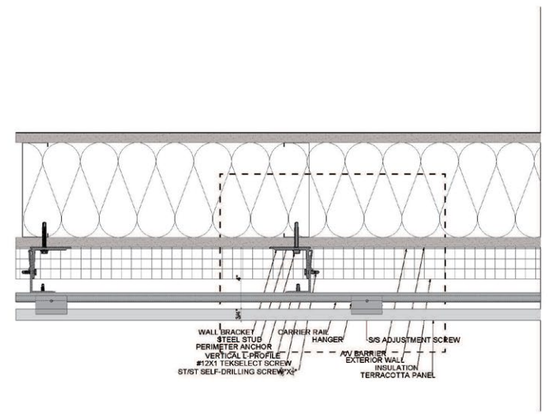


Fabrication Model View

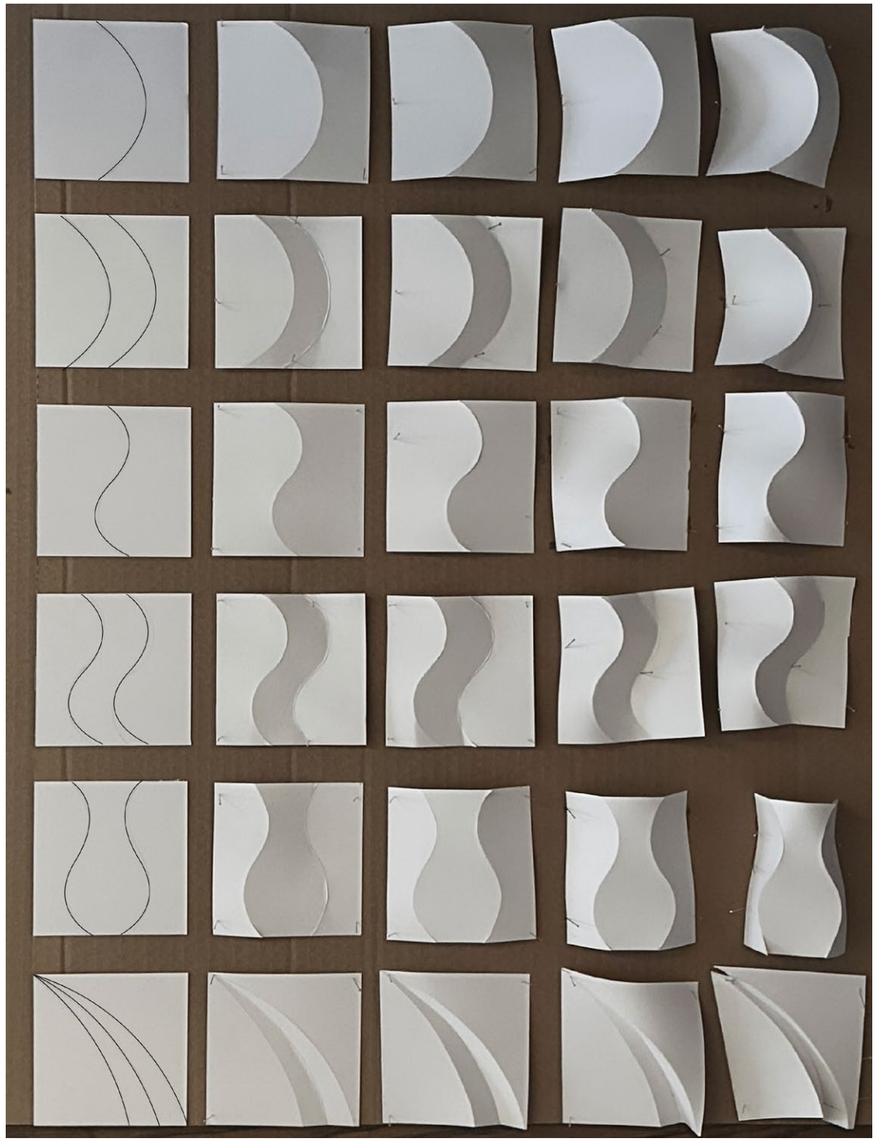




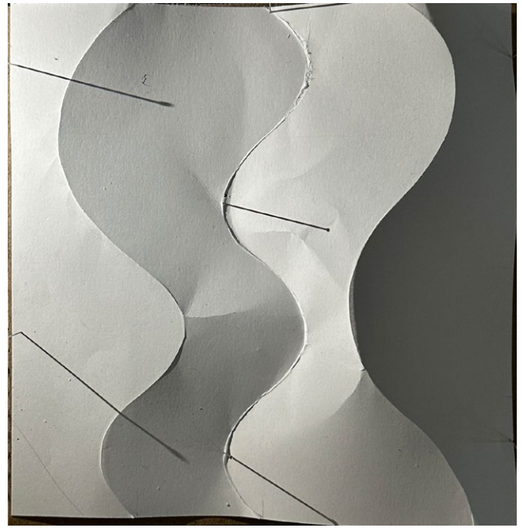
Shop Drawings

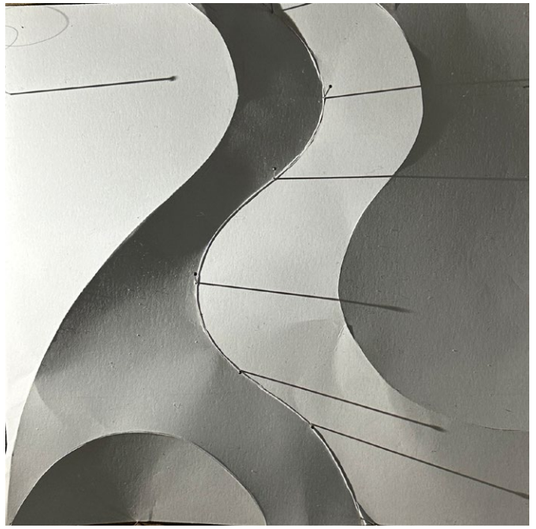


Theme: Architecture Apropos Art
Year: Fall 2023
Instructor: Steven Holl & Dimitra Tsachrelia



Folding of Curve in Different Degrees
Explore the interplay of light and shadow on different planes





Multiple Curves Folding on A Single Continues Surface
Formation of different types of undulation