Portfolio.

ARCHITECTURE

Rachel Ran Yan

SELECTED WORKS
2016 - 2025

CONTENTS

The Yellow Invitation is a comprehensive design for a circular library and community hub along the Gowanus Canal, conceived as a social condenser to foster exploration and community engagement. At its core is a vibrant yellow staircase system, a dynamic spatial invitation that encourages spontaneous movement and discovery through layered mass timber volumes. Transitional spaces and an adaptable perforated zinc facade further enhance spatial connectivity, daylighting, and environmental performance. Driven by a commitment to sustainability, the project integrates passive conditioning strategies, low-carbon materials, and life-cycle considerations, aspiring to serve the evolving needs of its community over a century-long lifespan.

01

The Yellow Invitation

Project Type: Circular Library | Mixed-use Community Hub

Focus: Mass Timber Construction | Sustainable Design | Facade Syatem Design

Tool: Rhino | Grasshopper | Ladybug | Climate Studio | Life Cycle Assessment | Revit | Lumion | Enscape

Project Context: Academic Project | Comprehensive M.Arch Studio | University of Toronto

The project is located along the eastern edge of the Gowanus Canal in Brooklyn, New York, at the intersection of light industrial zones to the south and dense residential neighborhoods to the north and west.

Affected Buildings

- 2 ft
- 4 ft
- 6 ft

Sea Level Rises

- 6 ft
- 4 ft
- 2 ft

Industrial Area factories, warehouses, and big box stores along the Gowanus Canal

Townhouse feature brick or brownstone exteriors and industrial-inspired details

Public Housing consists of large brick mid-rise buildings with courtyards, built in the 1930s-40s

Recreational Centre historic brick facility serving as a community hub within Red Hook Park

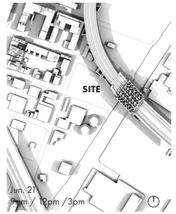
Sponge Park long Gowanus Canal designed to manage excessie surface water runoff

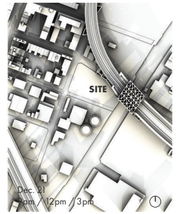
300 Huntington St. commercial building featuring a brick and glass facade, industrial-style windows

Powerhouse Arts contemporary arts centre renovation of existing building/ expansion

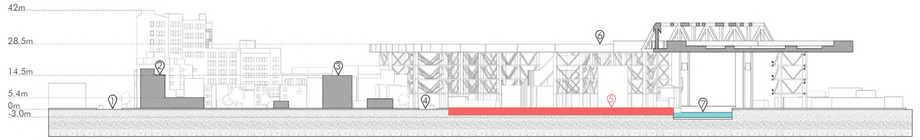
Old American Can Factory historic industrial complex with a brick facade, and repurposed factory space

Artists Coalition nonprofit arts group in a former warehouse with expansive exhibition spaces

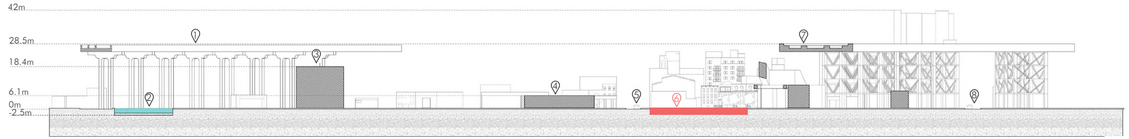




The surrounding area is marked by diverse building typologies including low-rise townhouses, public housing, industrial warehouses, and emerging green infrastructure. This urban mix results in a highly dynamic social environment, drawing a wide range of users including residents, workers, and visitors. Sea level rise maps indicate that the site and adjacent areas are at significant risk of flooding, especially under 4–6 ft scenarios. Solar studies and sectional diagrams further reveal complex topography and layered urban infrastructure, including elevated highways and railways. In response to these conditions, the project integrates passive strategies and porous ground-level design to address flood resilience. It also accommodates the circulation and spatial needs of a wide range of users, reflecting both the complexity of the site and a commitment to sustainable, inclusive architecture.

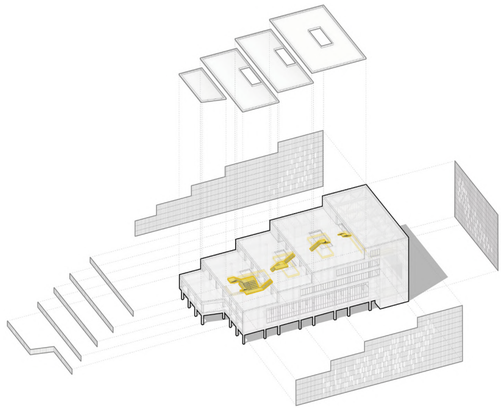


1.Court St 2.Apartment 3.Office Building 4.Smith St 5.Proposed Site 6.Railway 7.Gowanus Canal



1.Gowanus Expy 2.Gowanus Canal 3.Concrete Industry 4.Fuel Oil Depot 5.Proposed Road 6.Proposed Site 7.Railway 8.Huntington St

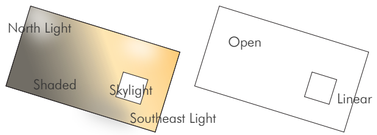
Concept and Strategy



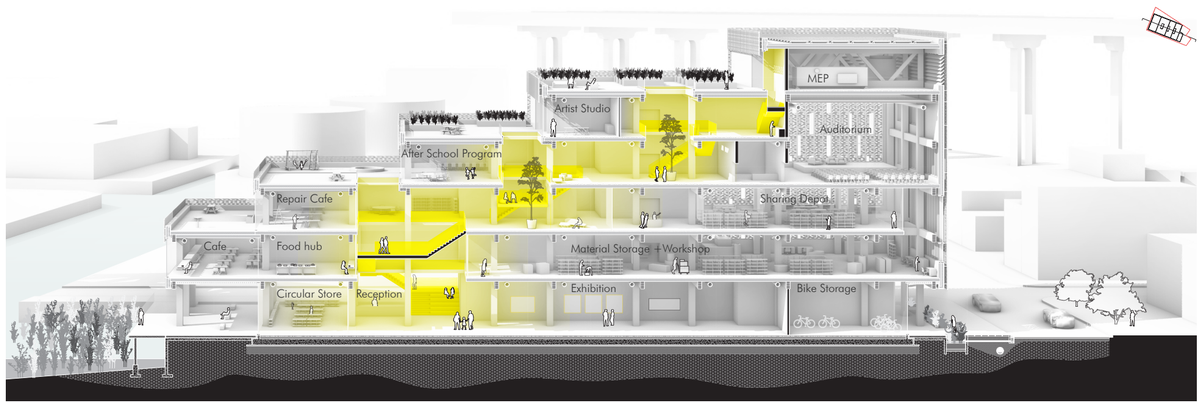
This project is envisioned not only as a flexible container for an unconventional mix of programs, but more importantly, as a social condenser that fosters spontaneous exploration and unexpected encounters.
The exploded axonometric diagram highlights the key components: a very regular mass timber structural frame, an lively yellow circulation system embedded within, and a muted perforated zinc façade that wraps around the whole. The main architectural concept reads the best in the long section below. The series of interior atriums connected along a tilted axis. All programs are places around this public axis, inviting visitors to come up from the ground level and explore the building. Externally, the stepped massing generates terraces facing the Gowanus Canal, designed for leisure, food growing, and outdoor learning.
The building features a rich gradient of daylighting conditions and spatial qualities, all organized within a simple structural frame. Through the integration of passive design strategies and flexible spatial organization, the project responds to its hybrid context and remains adaptable to a wide range of future uses over its envisioned hundred-year lifespan.

Massing Model

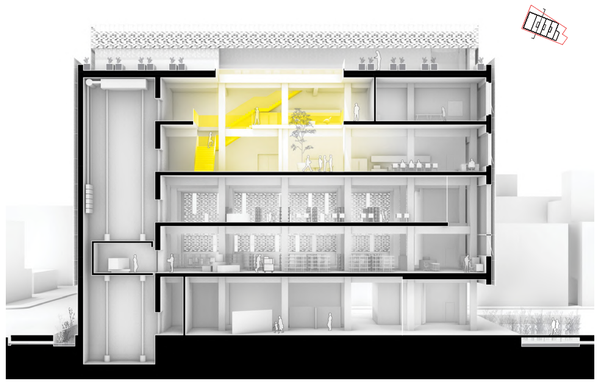
Life Cycle Approach

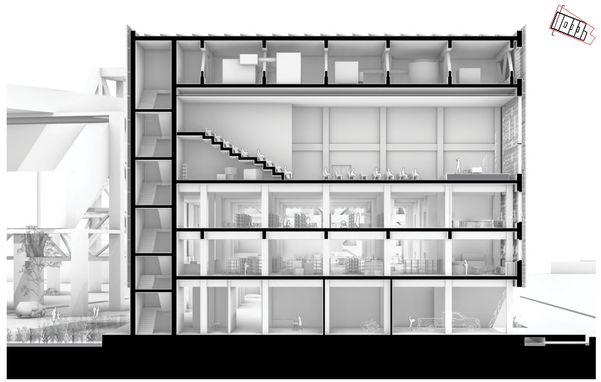


Program Distribution

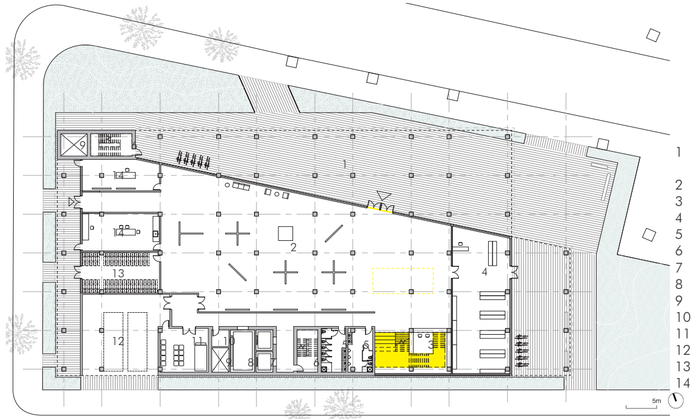


Sections Highlighting Circulation and Program





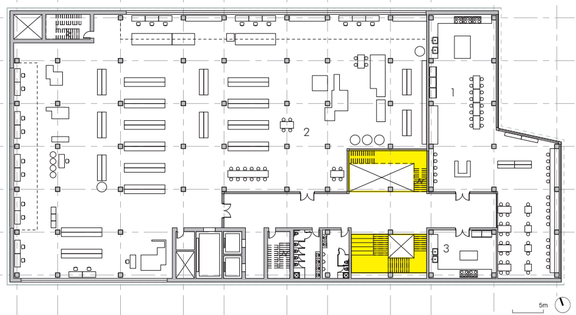
Floor Plan - Level 1



1 Outdoor Exhibition/ Marketplace
2 Exhibition | Event Space
3 Reception
4 Circular Store
5 Public Washroom
6 Egress Stair
7 Elevator
8 Freight
9 HVAC Shaft
10 Janitor's Closet
11 Garbage Room
12 Class B Loading
13 Bike Storage
14 Artist Studio

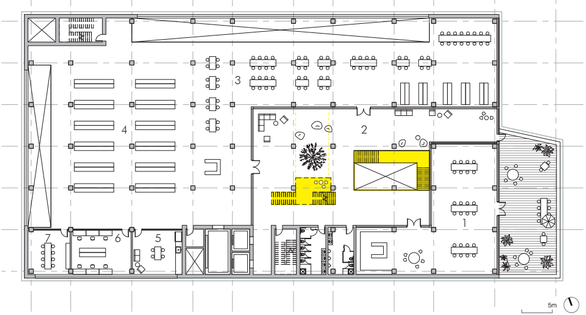
The site is located at the intersection of a light industrial zone to the south and a residential area to the north and west, making it a transitional threshold between contrasting urban fabrics. On the ground level, circulation access from the subway station, the residential neighborhood, and the future greenway is prioritized by placing servant spaces, such as vertical shafts, mechanical rooms, and loading bays on the south side of the lot. This allows the north edge to remain open and porous, enhancing access and visual connection from the street to the canal. The ground-level landscape, designed as a filtering system for urban runoff, reinforces this circulation path and guides pedestrians into the building. The internal layout places public and semi-public programs like exhibitions, circular store, cafe, and workshops on lower levels, while more private or secure functions such as offices, artist studios and after-school programs are located on upper floors. Atriums and yellow public staircases interweave through all levels, activating vertical circulation and enhancing spatial connectivity and social encounter. The rooftop levels accommodate solar panels, food gardens, and shared patios, offering daylight and outdoor space for people of all ages to gather and connect.

Floor Plan - Level 2



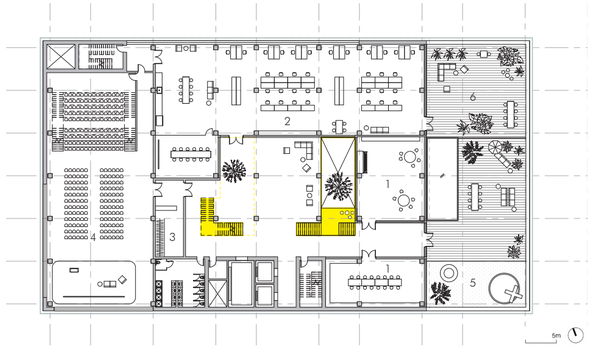
1 Cafe | Community Kitchen | Food Hub
2 Workshop | Material Storage
3 Events Catering

Floor Plan - Level 3



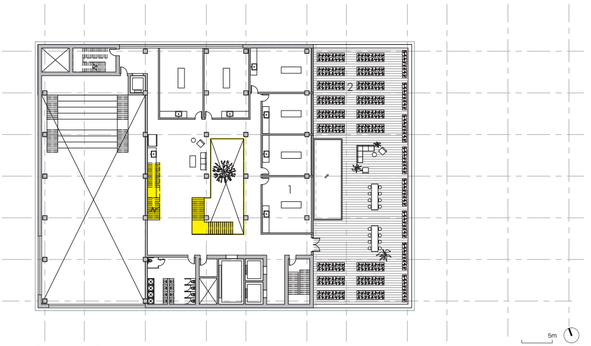
1 Repair Cafe
2 Open Lounge
3 Workshop (Repair, Training, Making)
4 Sharing Depot
5 Staff Room
6 Librarian's Office
7 Staff Refurbishing Shop

Floor Plan - Level 4



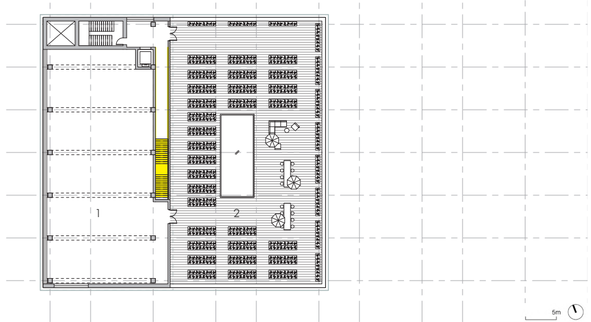
1 After School Program
2 Office for Start-up Companies
3 Coat Check
4 Auditorium
5 Kids Play Area
6 Office Patio

Floor Plan - Level 5



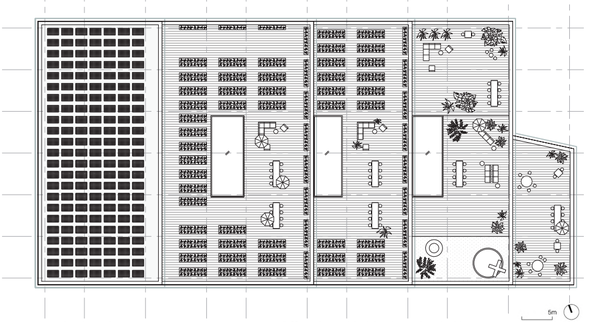
1 Artist Studio
2 Food Growing

Floor Plan - Level 6



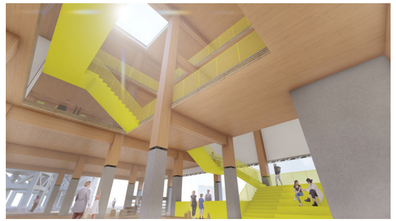
1 MEP
2 Food Growing

Roof



1 PV Panels
2 Food Growing
3 Food Growing | Public Patio
4 Office Patio | Public Patio | Kids Play Area
5 Public Patio

Atrium Moments and Program Views



Level 1 - First Atrium | Reception

Level 2 - First Atrium | Cafe/Workshop

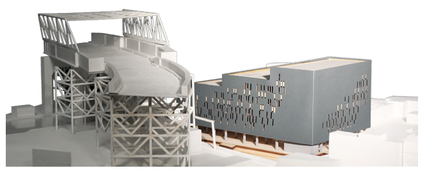
Level 3 - Second Atrium | Library of Things

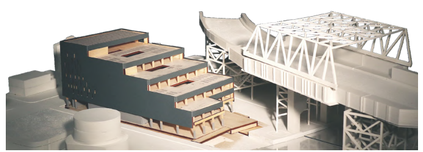
Level 4 - Second Atrium | After-School Program

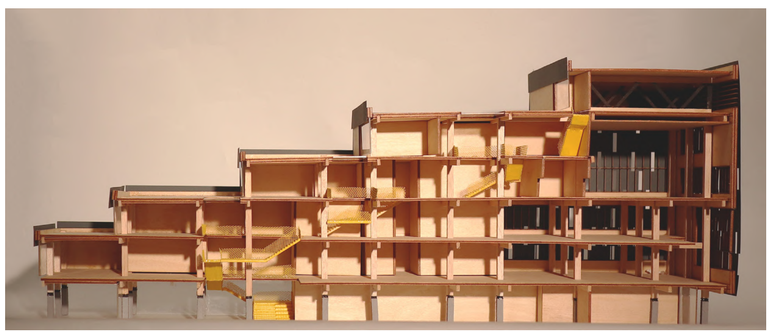
Level 4 - Third Atrium | Office/Auditorium Entrance

Each atrium anchors a different spatial moment and reflects its surrounding program. The first atrium, located near the entrance, spans two stories and is enclosed by three sides of glass walls. It creates a strong sense of openness, directly connecting the building interior with the street and canal. As the circulation moves upward to Level 2, the atrium continues, separating the café and workshop zones through a more transparent and soft-edged boundary. By Level 4, the third atrium is defined by increased enclosure as surrounding programs require more privacy and controlled access. The sectional model at 1:100 captures the tectonic logic of structural layering, material thresholds, and spatial hierarchy. The site model at 1:200 communicates the massing and facade strategies in its urban context. Both models are carefully crafted to express construction clarity and spatial intent.

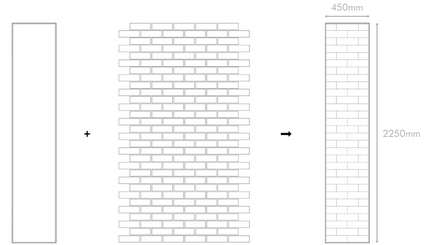
1:200 Site Model and 1:100 Sectional Model





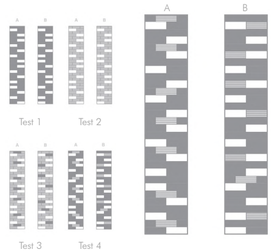


Facade Studies - Panel Pattern



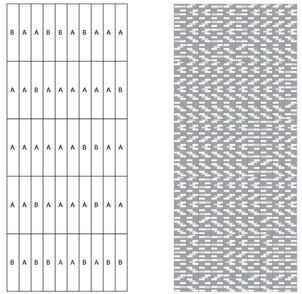
Zinc Panel | Brick Common in the Area | Patterned Zinc Panel

Facade Studies - Perforation

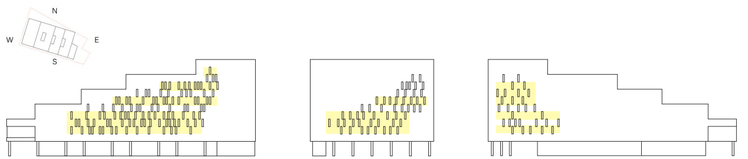


Selected Pair

Facade Studies - A/B Panel Distribution



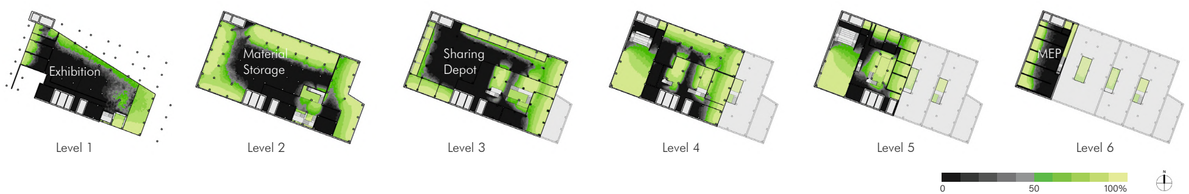
Facade Studies - Panel Removal and Glazing Behind the Shroud



North Elevation | West Elevation | South Elevation

The zinc facade system is developed as both cladding and secondary screen, selected for its durability and recyclability. The perforation module adopts the size of a standard local brick, referencing the masonry context while maintaining a monolithic surface expression.
A series of panel prototypes were tested to balance opacity and daylight permeability. The selected version incorporates staggered brick-like perforations that soften the surface and add depth without fully revealing the floor slabs behind. To break repetition across the elevations, two different panel types were developed and distributed in an irregular sequence. In certain areas, panels are strategically removed to introduce larger openings. These removals respond to program needs and building orientation offering more transparency where daylight is needed, and maintaining shade and privacy elsewhere.

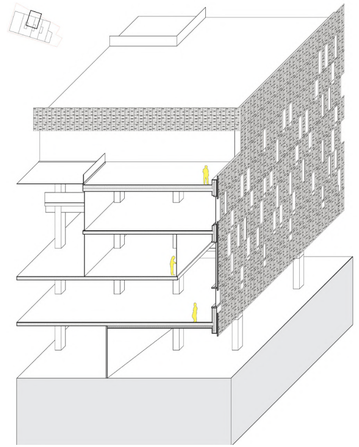
Facade Studies - Daylight Simulation

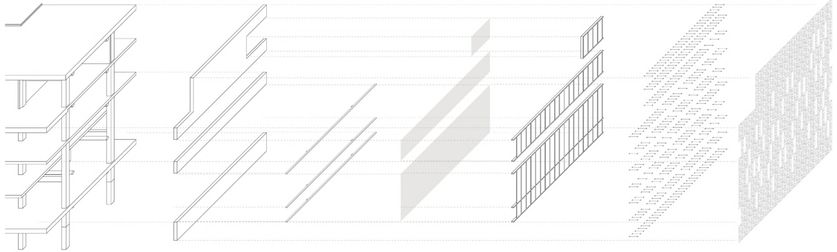


Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6

Daylight simulations helped shape the spatial organization of programs throughout the building. Areas that receive limited or no natural light, such as the interior zones on lower floors, are used for functions less dependent on daylight, including material storage, sharing depots, MEP, and exhibition spaces that rely more on artificial lighting. In contrast, naturally lit areas near the façade or under skylights are allocated to programs that benefit from daylight, such as children's after-school program, artist studios, and office spaces. This alignment of daylight access with program needs supports both user comfort and energy efficiency. Daylight analysis was integrated early in the design process to guide program placement and ensure spatial quality.

Facade Studies - Assembly

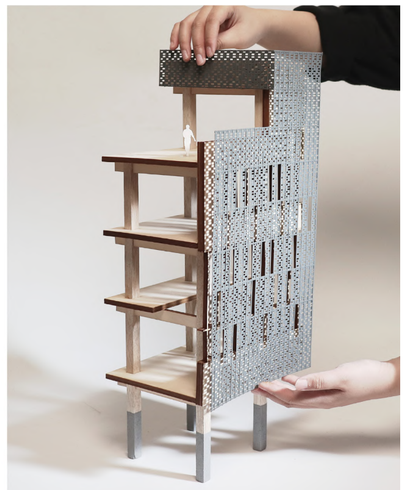




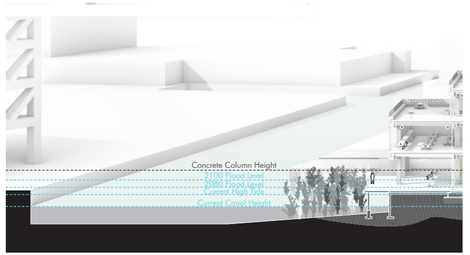
Main Building Structure | CLT Wall Assembly with Metal Cladding | Additional Beam for Double-Height Window | Glazing | Metal Mullion | Non-Conductive Connections | Perforated Zinc Screen

The facade system is composed of multiple layers: a structural CLT wall with metal cladding, glazing with supporting metal mullions, and an outer perforated zinc screen. The physical model demonstrates the relationship between structure and enclosure, emphasizing how light, material, and ventilation interact across the facade. Carefully crafted at scale, the model also serves as a study of assembly logic and spatial layering.

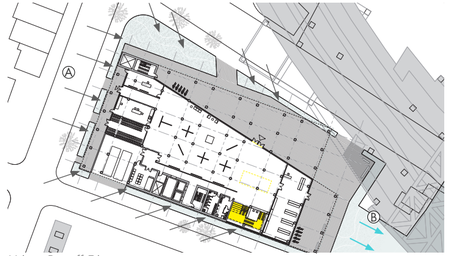
Facade Studies - 1:50 Physical Model



Landscape Strategy



Flooding Prevention



Urban Runoff Filter

A. Connection to Street Catch Basin

B. Water Level Height Difference

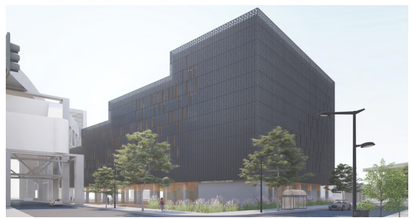
To address the site's vulnerability to flooding, the ground level is elevated above the projected high water mark. Structural columns at this level are constructed with a hybrid system: concrete forms the base segment exposed to flood risk, while mass timber continues above, connected by a custom steel joint that prevents water ingress and ensures structural continuity.
In response to the site's severe urban runoff challenges, the landscape is designed as a multi-functional water filtration system. A recessed urban runoff filter collects surface water from surrounding streets and roofs, channels it through planted bio-retention zones for sediment and pollutant removal, and gradually releases the treated water into the Gowanus Canal.

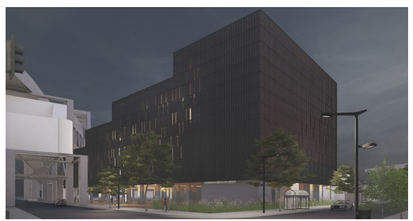
Event-Based Space

Exhibition

Lecture

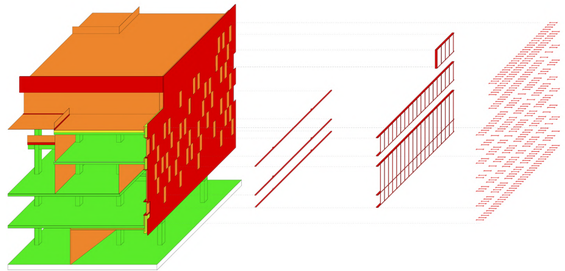
NW Corner - Daytime & Nighttime





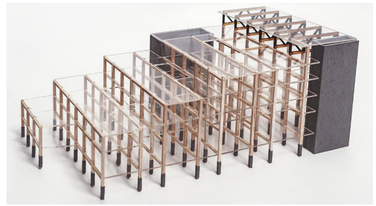
Two event-based spatial conditions highlight the building's ability to transform in response to different programmatic needs. On the ground floor, the exhibition zone opens into a large public venue, closely connected to the street and neighborhood. On Level 4, lectures in the auditorium activate the yellow stair and atrium platforms, turning circulation into shared social space. Indoor and outdoor areas around the auditorium create a layered, communal event setting.
By day, the perforated shroud reads as a mute, monolithic surface. A soft light strip at the base, along with landscape, gently guides visitors toward the canal and building entrance. By night, interior light glows through the perforations, turning the volume into a warm, luminous lantern.

Embodied Carbon Analysis



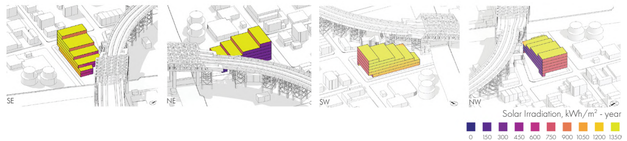
Metal Frames	1200kg CO_2/m^2
Tiles	1001kg CO_2/m^2
Double Glazing	266kg CO_2/m^2
Stone Wool Insulation	75kg CO_2/m^2
Mass Timber	-665kg CO_2/m^2

1:200 Structural Model



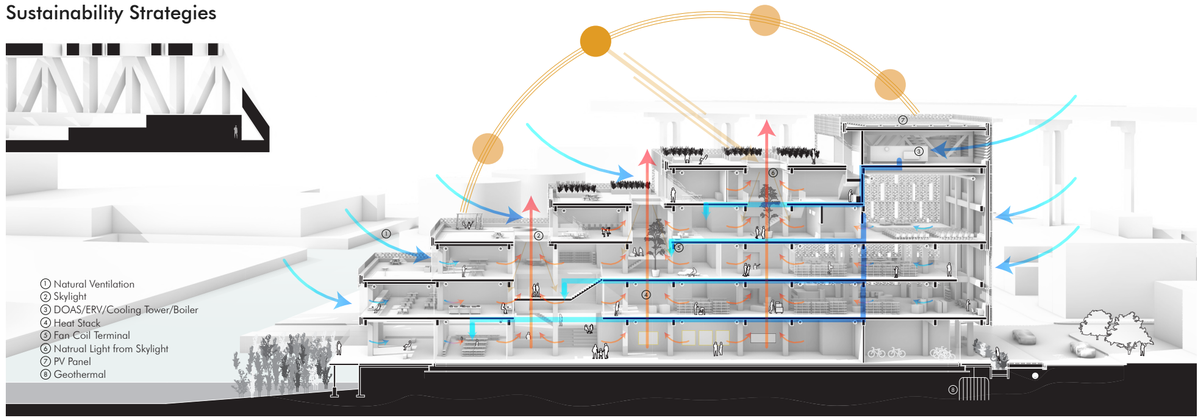
The structure adopts a regular grid of columns with beams running in a single direction. This layout was developed after calculating optimal beam spans and cross-sections, ensuring structural integrity while minimizing depth. This system preserves generous floor heights and provides sufficient clearance for mechanical systems. It also supports skylight integration at each floor, allowing natural light to reach deep into the interior.

Solar Condition Analysis

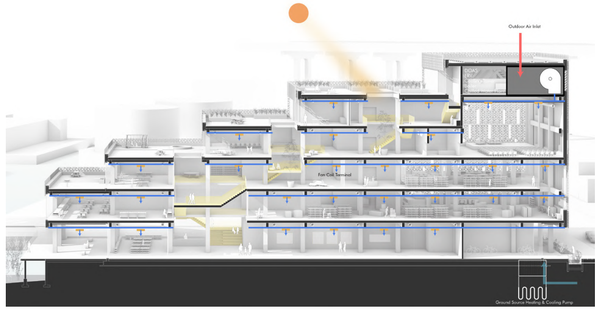


The embodied carbon diagram reveals that the façade contributes significantly to the building's overall carbon footprint. However, zinc was selected for its high durability, resistance to corrosion in the canal's humid environment, and minimal long-term maintenance needs. Many of the materials used, including zinc, mass timber, and stone wool insulation, are recyclable or renewable, reducing the building's lifecycle impact. The solar condition analysis informs the placement and orientation of rooftop solar panels. By mapping annual solar irradiation, the design maximizes energy capture on the most exposed roof surfaces, enhancing overall building performance.

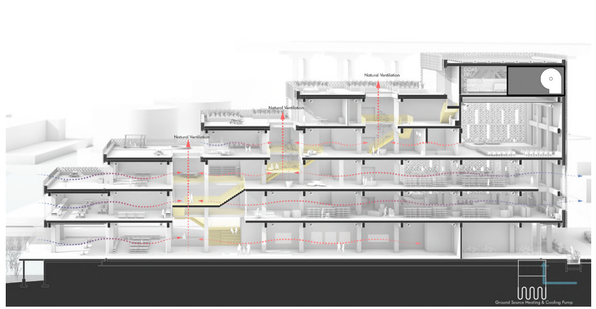
Sustainability Strategies



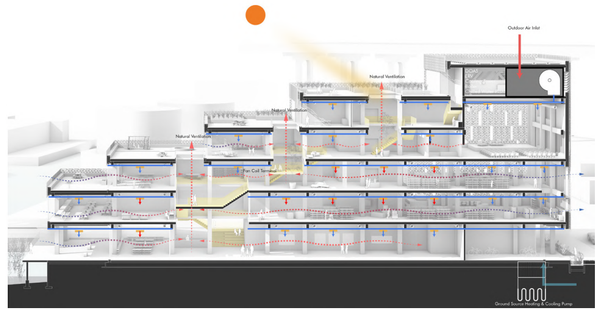
Seasonal Thermal and Ventilation Strategies



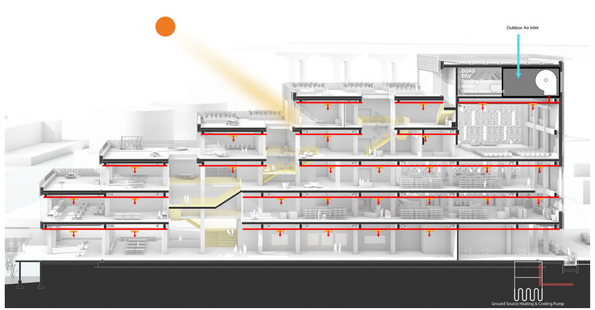
Summer Daytime



Summer Nighttime

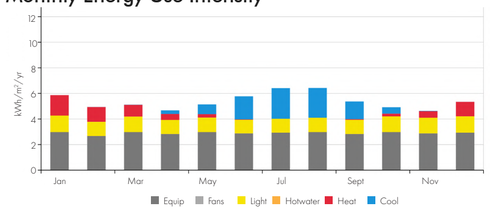


Spring/Fall Daytime

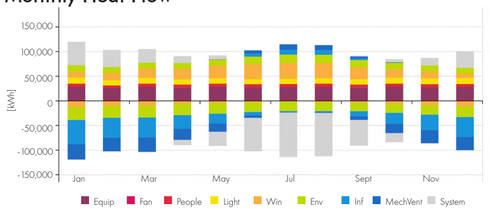


Winter Daytime

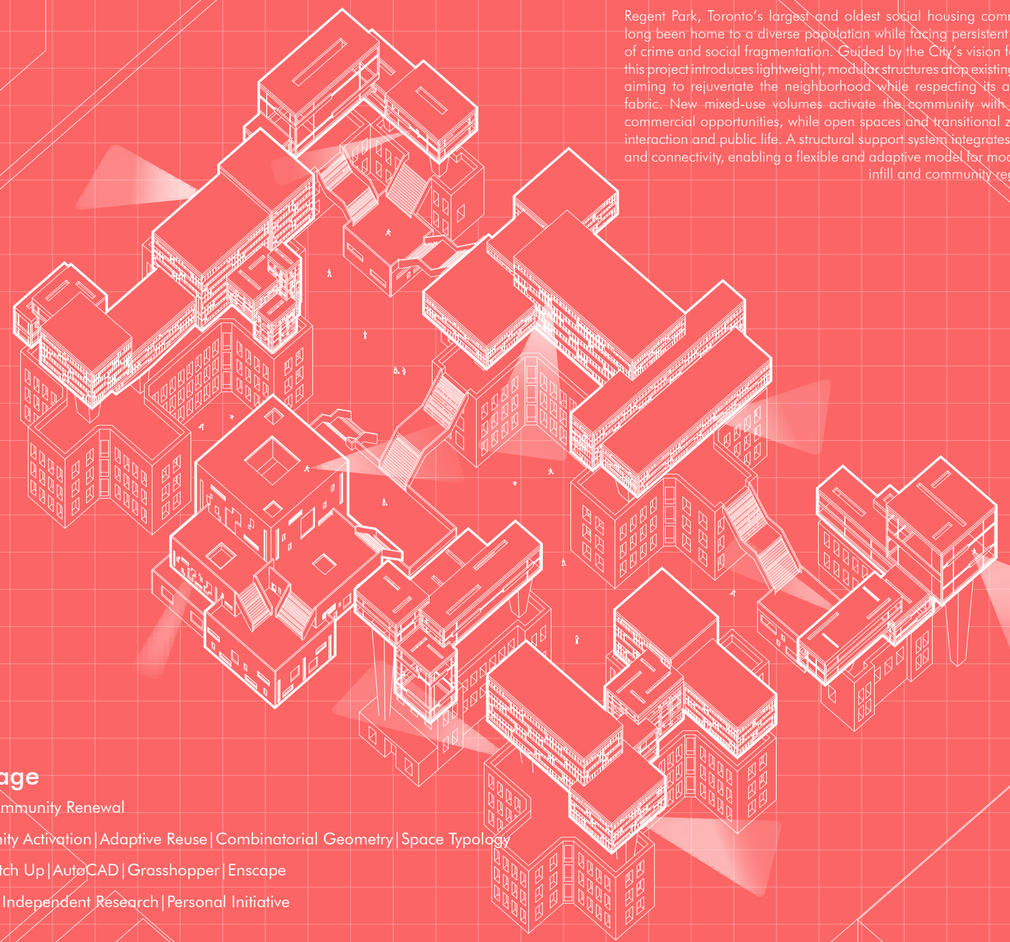
Monthly Energy Use Intensity



Monthly Heat Flow



Cooling peaks in summer and heating in winter, but overall demand stays steady. Internal heat gains offset winter heating needs, while passive strategies like spring/fall ventilation and skylight daylighting reduce cooling and lighting demands, leading to lower overall system loads.



Regent Park, Toronto's largest and oldest social housing community, has long been home to a diverse population while facing persistent challenges of crime and social fragmentation. Guided by the City's vision for renewal, this project introduces lightweight, modular structures atop existing buildings, aiming to rejuvenate the neighborhood while respecting its architectural fabric. New mixed-use volumes activate the community with social and commercial opportunities, while open spaces and transitional zones foster interaction and public life. A structural support system integrates circulation and connectivity, enabling a flexible and adaptive model for modular urban infill and community regeneration.

02

Cube Village

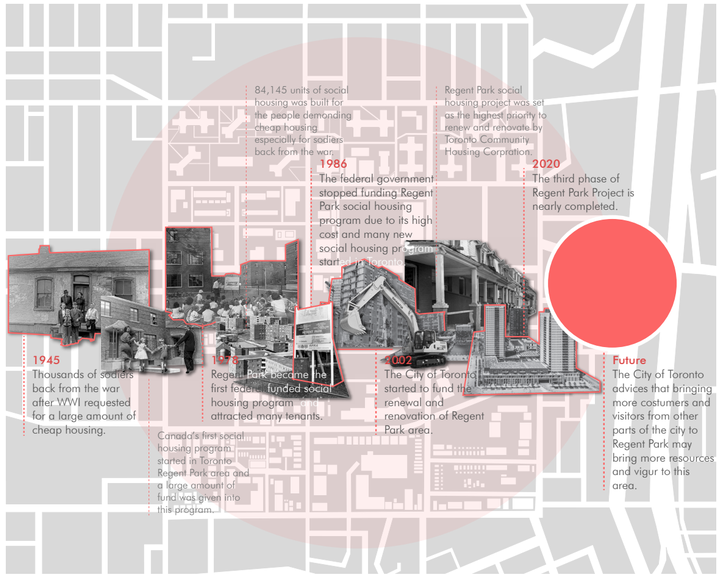
Project Type: Community Renewal

Focus: Community Activation | Adaptive Reuse | Combinatorial Geometry | Space Typology

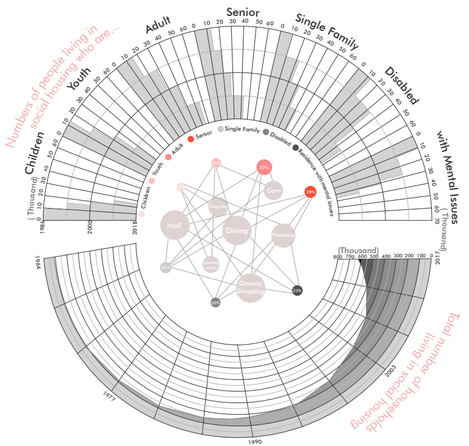
Tool: Rhino | Sketch Up | AutoCAD | Grasshopper | Enscape

Project Context: Independent Research | Personal Initiative

History of Social Housing in Regent Park, Toronto



People living in Social Housing

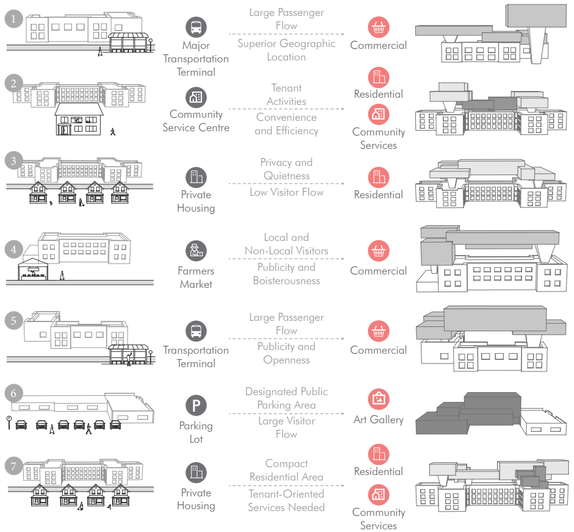


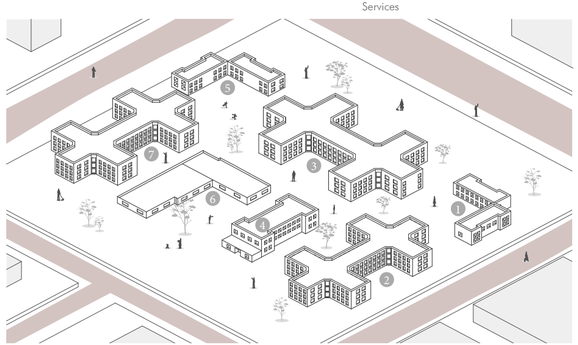
Located in downtown Toronto, Regent Park is the city's oldest social housing community, undergoing decades of redevelopment aimed at reversing its historical isolation and socio-economic challenges. The area is home to many children, seniors, and individuals living alone, with high rates of disability and social disconnection. These demographic conditions highlight the need for flexible housing and shared spaces, guiding the project's focus on inclusion, connectivity, and community-oriented design.

Site Analysis

Site analysis reveals an uneven distribution of service-oriented programs across Regent Park. Restaurants are the most common commercial type, while pharmacies and clinics are the least represented. Population data shows that 20% of residents live with disabilities and 23% face mental health challenges, highlighting a critical lack of healthcare services. Gyms and daycare facilities are also absent, despite the fact that 38% of residents are children or youth and 37% are adults. Moreover, places such as restaurants, grocery stores and pharmacies are concentrated along the south edge of this area which makes people who live near the north edge harder to reach. This imbalance informed the project's decision to focus on the under-served northern portion of Regent Park. All newly introduced programs are derived from and respond to the logic of existing functions, for instance, commercial spaces are added near transit hubs, while large community center and art gallery is positioned near the parking facility. By mapping existing functions and identifying service gaps, the design proposes targeted interventions to improve equity, accessibility, and community well-being.

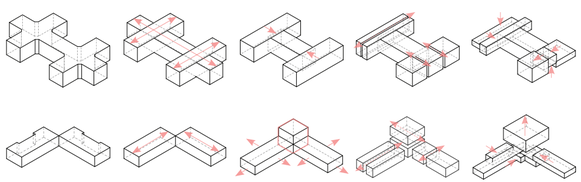
Strategy and Concept





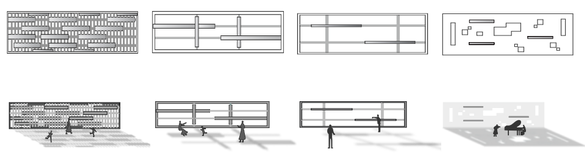
Form Finding

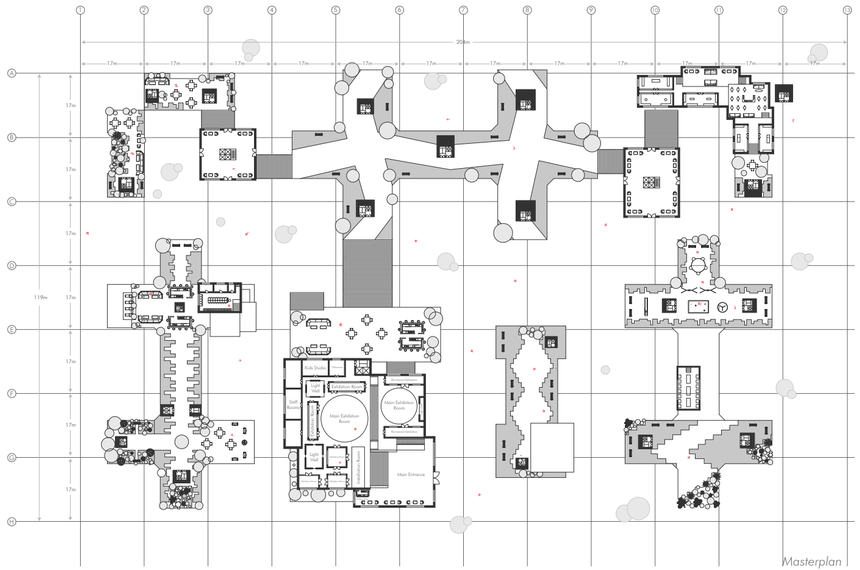
The existing buildings form a grid that defines the base geometry for further development. Original forms are simplified and transformed, then shattered into smaller modules. These modules are rearranged, resized, and intersected to generate new volumes, enabling flexibility and integration with the existing urban fabric.



Facade Forming

Four façade types respond to the needs of different user groups and programs. Residential façades maximize shading to ensure privacy and security, while commercial and community façades use higher transparency to enhance openness and access to views. The gallery façade is visually distinct; its openness and clean structural expression clearly signal its public and cultural significance.

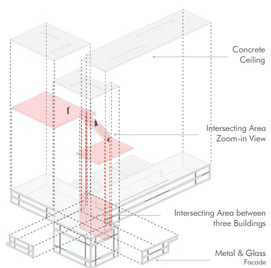




Masterplan

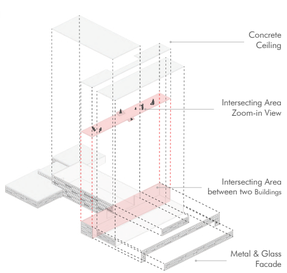
A central void emerges between the new volumes and existing structures, forming a shared open space that fosters interaction among diverse user groups. Vertical transport modules not only enable movement between ground and upper levels but also function as supportive structures.

A system of cores anchors the elevated volumes while linking them structurally and circulationally to the base buildings. Acting as vertical circulation shafts, these elements provide access to upper modules and the open spaces. The new additions feature façades of metal and glass, clearly distinguishing them in texture and language from the existing brick buildings.



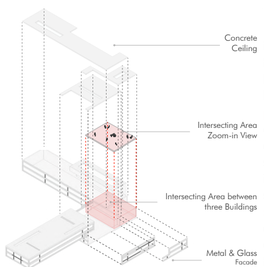
Type 1 Intersecting

This intersection occurs at the confluence of three buildings and functions primarily as a vertical and horizontal transfer hub, equipped with escalators and staircases. It supports seamless transitions between programs, optimizing circulation and spatial fluidity across the site.



Type 2 Intersecting

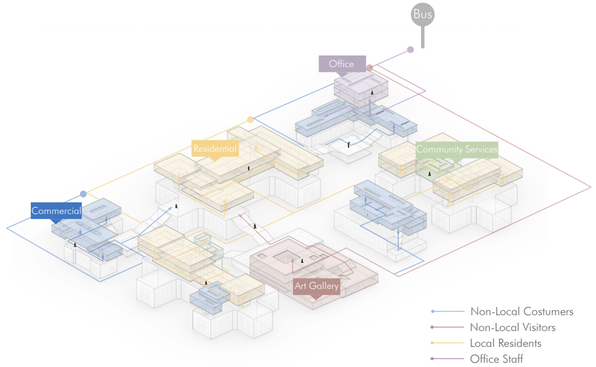
Located between two major volumes, this narrow linear intersection acts as a connective corridor. While programmatically neutral, it plays a critical role in spatial transition serving as a quiet, flexible buffer that enables continuity between distinct functional zones.



Type 3 Intersecting

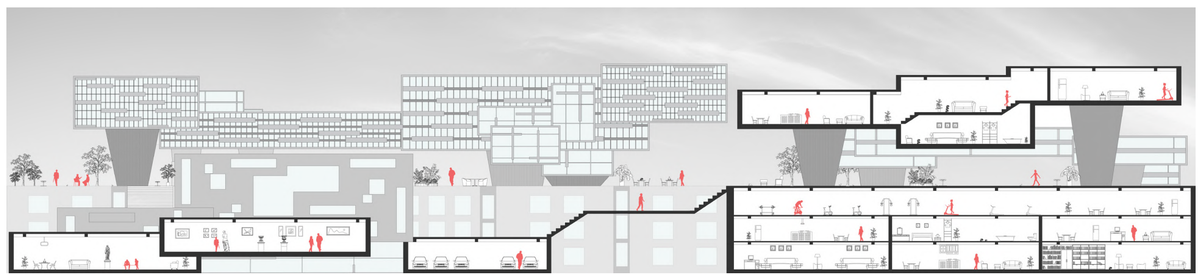
This expansive intersection joins three adjacent buildings and hosts communal programs such as cafés and gathering areas. Designed to support cross-group interaction, this shared node fosters social exchange and provides essential services at the intersection of circulation flows.

Circulations and User Groups

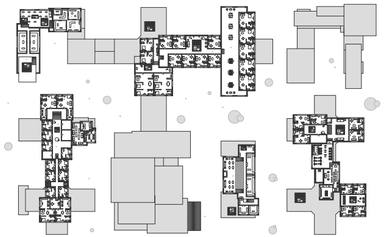


Circulation is strategically organized to accommodate four primary user groups: local residents, non-local customers, non-local visitors, and office staff. Each group follows a distinct path to minimize conflict and enhance spatial efficiency. Non-local customers and visitors coming for leisure or shopping, remain at the site's perimeter, where commercial programs are located near major bus stops, avoiding intrusion into residential zones.
Local residents enjoy the highest degree of accessibility, with direct connections to both private gardens and shared amenities. Office functions are placed in the upper-right corner, closest to the transport hub, allowing office staff to access their workspaces quickly without disrupting other user groups.

Section

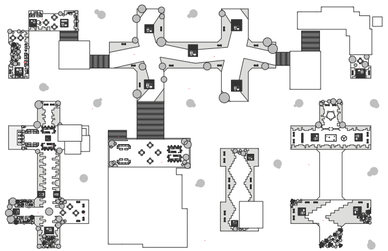


Detailed Plans



Interior

Interior programs include restaurants, bars, libraries, reading rooms, gyms, laundry rooms, conference spaces, shops, and public learning centers. Residential units vary in size and layout to support a range of household types and lifestyles. The overall spatial organization considers user flow, privacy gradients, and contextual integration. Each modular cube is both autonomous and interlinked, enabling flexible expansion while maintaining clear program identity.



Open Space

The rooftop open space is organized into three distinct zones, each tailored to a particular user group and characterized by unique spatial qualities. For residents, amenities include barbecues, children's play areas, and outdoor lounges, supporting daily recreation and family use. For external visitors, the space offers long walking trails, wide lawns, and shaded areas to support public engagement. For workers on-site, smaller pockets with seating and shade provide spaces for relaxation and informal meetings.

The Civic Sail is a high-rise design for Qingdao's waterfront, conceived as a new civic landmark that reclaims the city's skyline from colonial architectural symbols. Historically, the city's most prominent landmark was St. Michael's Cathedral, a relic of German colonial occupation. This project proposes a contemporary counterpoint, a dynamic tower shaped like a sail, celebrating Qingdao's maritime culture while adding a new civic identity. The design compresses diverse urban functions within a single vertical structure, challenging traditional skyscraper hierarchies. Instead of vertically segregated programs, the tower distributes functions horizontally and spatially across its structure, promoting accessibility and public engagement throughout. This strategy transforms the high-rise into a truly democratic space where citizens can engage with the building at every level.

03

The Civic Sail

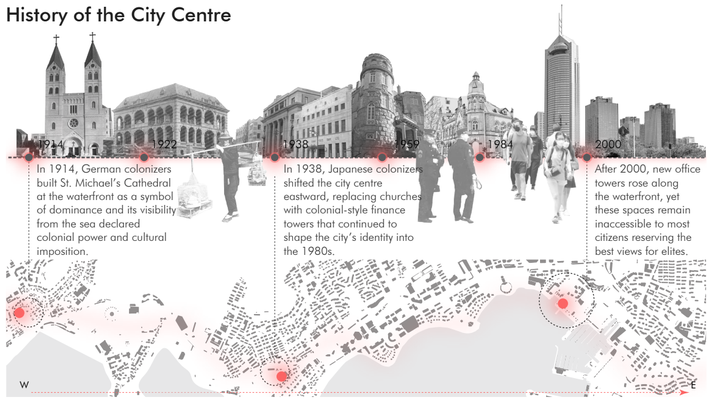
Project Type: High-Rise Architecture | Civic Landmark

Focus: Mixed-Use Vertical Community | Programmatic Integration | Democratic Space | Cultrual Narrative

Tool: Rhino | AutoCAD | Grasshopper | Enscape | Twinmotion

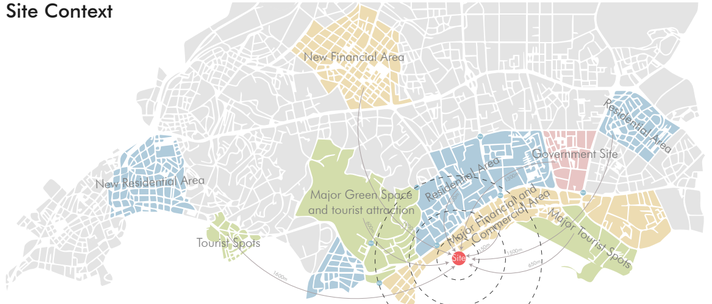
Project Context: Independent Research | Personal Initiative

History of the City Centre



Qingdao is now a major tourist destination in China. Yet when people speak of its most iconic landmark, many still point to the German-built cathedral. This enduring association reveals a troubling imbalance: a postcolonial city still visually defined by its colonial past. In response, this project proposes a new civic landmark, an architecture of democracy, not exclusion, and a statement of anti-colonial resistance. It challenges the legacy of spatial dominance and privatization by offering a public symbol that belongs to all citizens. The design envisions a modern civic symbol free from the legacy of imperialism, where spatial access and civic identity are no longer reserved for the few.

Site Context



Shopping Centre
Groups: Shoppers
Missing Function: Green Space
Flow of People: Medium

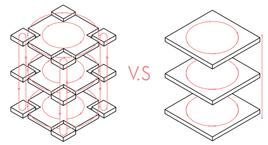
Compact Residencial Area
Groups: Residence
Missing Function: Dining, Activity Space
Flow of People: Medium

Tourist Sports
Groups: Visitors
Missing Function: Green Space
Flow of People: High

Waterfront
Groups: All Citizens
Missing Function: Shading
Flow of People: High

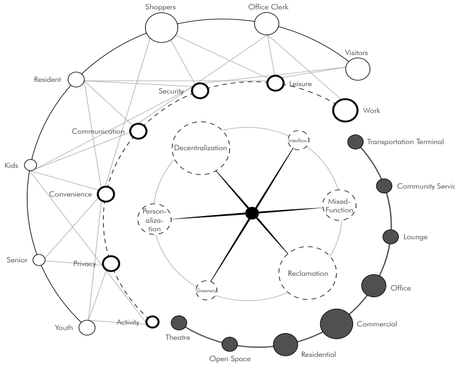
Financial Centre
Groups: Office Clerk
Missing Function: Interaction with Other parts of the City
Flow of People: High

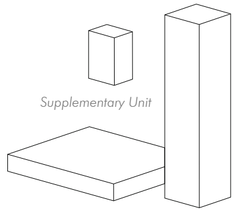
Concept and Strategy



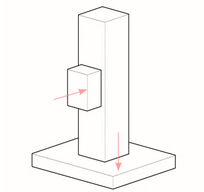
Comparison with Conventional High-Rise

In most conventional high-rise buildings, space follows a vertical hierarchy: commercial at the base, offices in the middle, and luxury residences on top. Prime views and amenities are often reserved for the few, leaving the general public excluded. Built on the city's best land, these towers reinforce exclusivity and spatial inequality.
In response, this project proposes a new model that democratizes access to both space and experience. Instead of layering functions by floor, programs are broken down and evenly distributed across levels. Residential units, offices, public lounges, and commercial spaces coexist on each floor, allowing all citizens to share the same views, amenities, and public life.

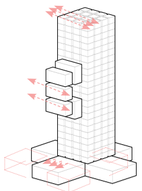




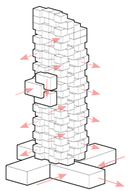
The site is located on Qingdao's eastern waterfront, in line with the city's long-term eastward coastal development. The tower derives from three basic volumes that are broken apart and recombined, echoing the project's strategy of redistributing programs across all levels. Shaped like a sailboat, it contains commercial space and a ferry terminal at the base, while diverse programs fill the vertical tower. At its midpoint, a sea-facing sky theatre offers views and shared cultural use.
The façade employs high-performance terracotta cladding, a material known for its resistance to salt, moisture, and UV exposure which are crucial qualities for Qingdao's coastal climate. Terracotta offers greater durability, lower maintenance cost, and a naturally textured, warm finish.
The façade design intensifies from bottom to top, responding to the site's atmospheric gradient, from fog-heavy lower levels to sunlit high altitudes. It also expresses a sense of vertical growth, like coastal sediment layers forming over time.



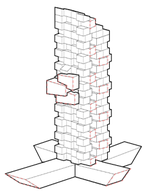
Basic function boxes are combined in a proper way. The supplementary unit works as a special area for large-scale performances with the best view in the building.



The boxes are shattered to be smaller units. Volums are subtracted from the ground level commercial area to increase the spacial diversity.



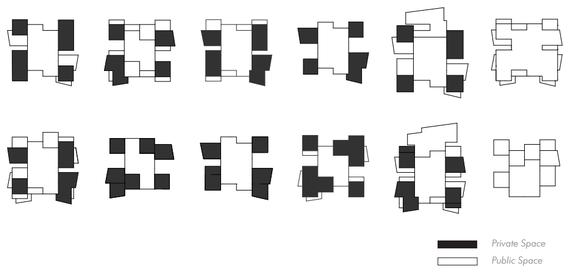
Units are moved towards different directions and some units are removed to create open terraces and sky gardens. Ground units are resized to balance the volumn on top of them.



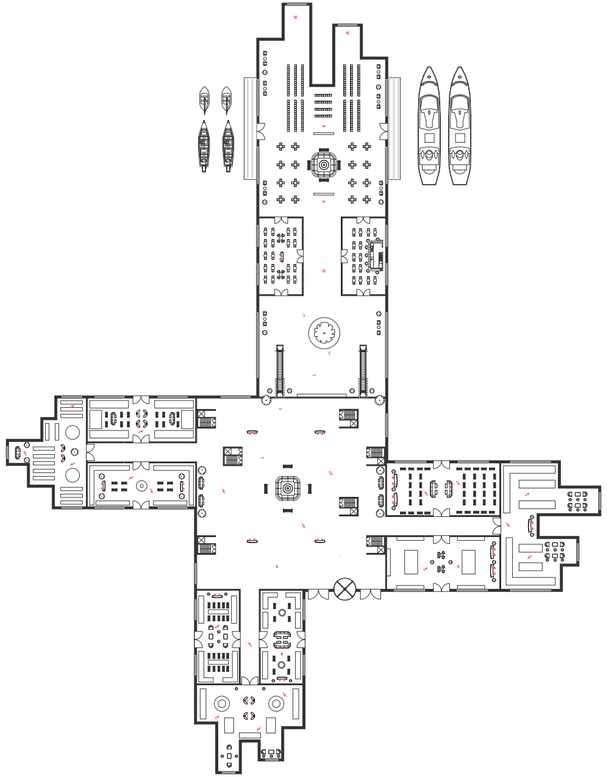
Units are transformed and sheared to create better view. The base units are transformed into the shape of a sailboat to emphasize its connection with the sea.

Floor Plans

Typical Floor Plan

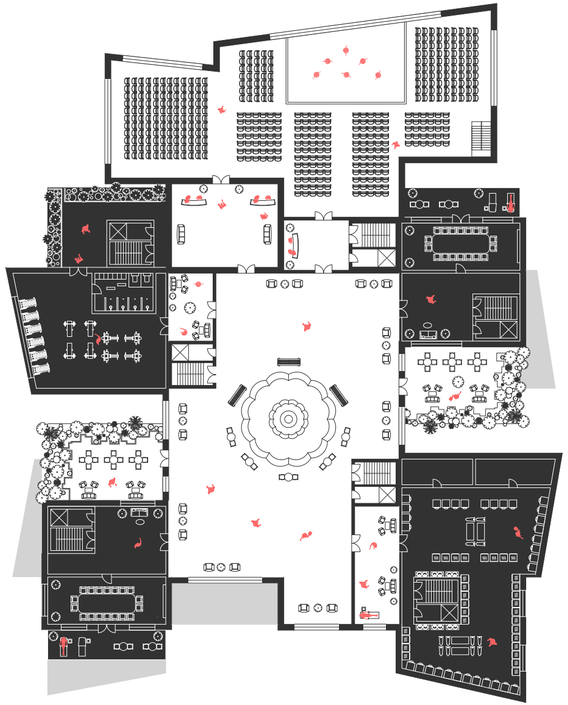


Plan Diversity



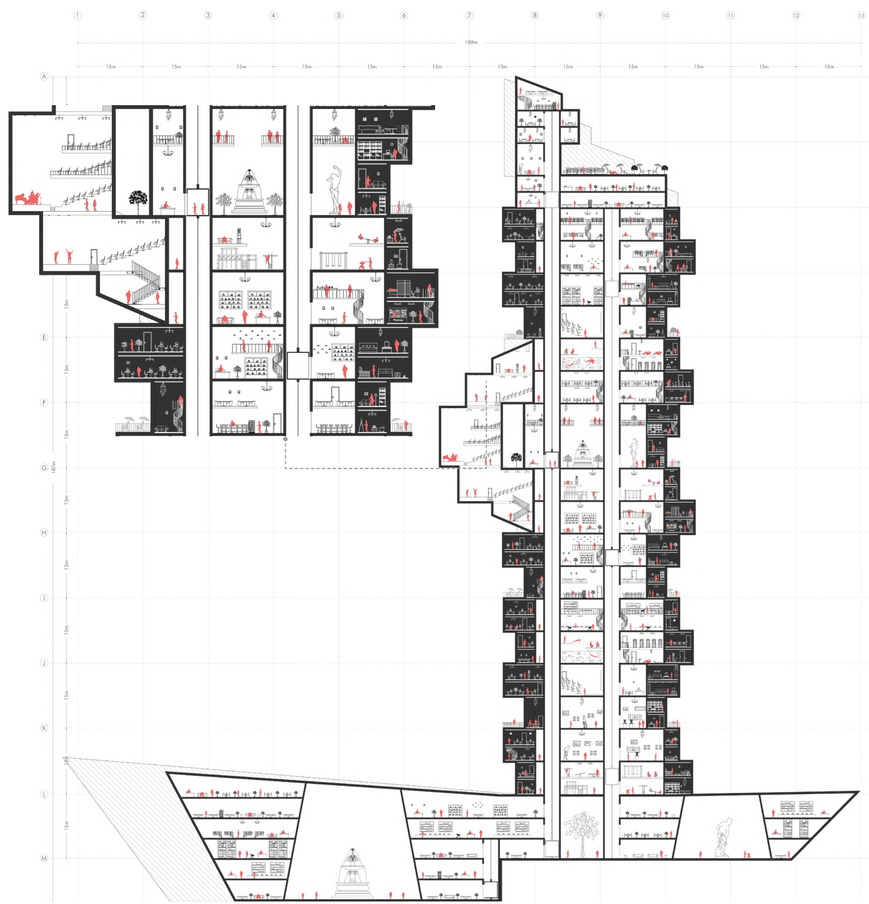
Ground Level

Rooftop



Sky Theatre

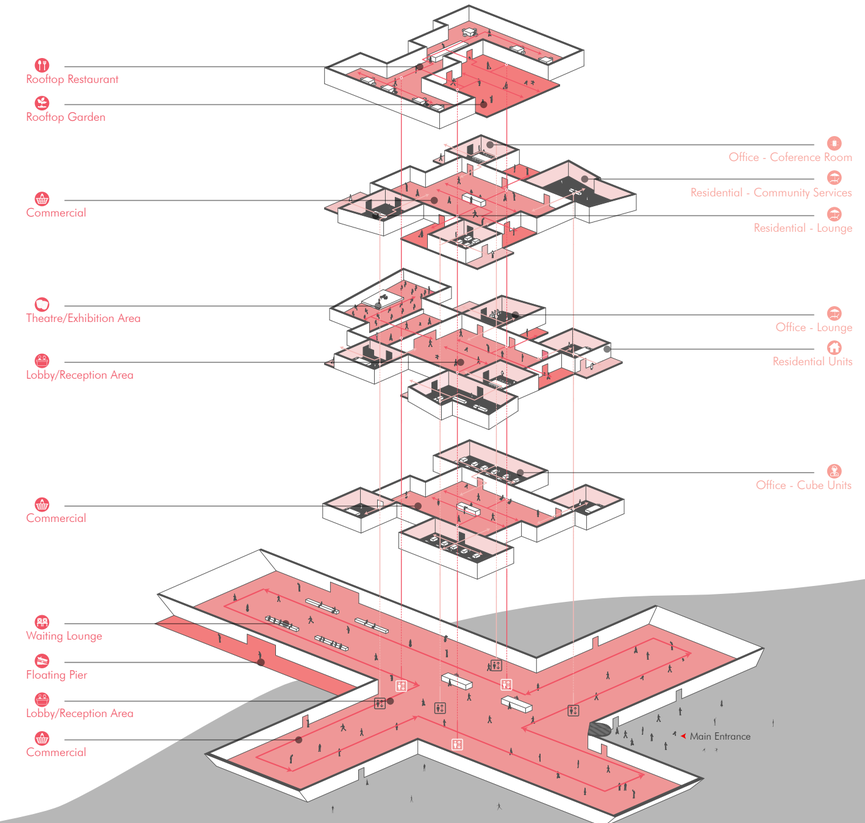
The ground floor functions as a civic gateway, integrating a ferry terminal, retail spaces, and gathering zones into one active public platform. Its cross-shaped layout enables fluid circulation and multi-directional access, inviting both local residents and waterfront visitors. The open design reflects the project's broader goal of inclusivity and public accessibility from the ground up.
Each typical floor mixes private and public programs, placing residential and office units in the corners while positioning commercial zones and shared lounges at the centre. This layout ensures that every user can access every level of the building. By dissolving vertical boundaries, the design not only fosters interaction but also advances spatial democracy through equal access and shared experience.
The sky theatre floor, located mid-tower, offers a shared cultural space with sea views. Surrounded by exhibition and event areas, it forms a central highlight in the building's vertical core. Its placement ensures equal access to the most scenic elevations, reinforcing the architectural vision of spatial equity.
The rooftop serves as a public open space, combining green terraces, dining zones, and leisure spaces atop the tower. Open to all users, the sky garden radiates from the core and connects to the skyline, offering both visual relief and social engagement. It completes the vertical sequence of public amenities.
The tower features two parallel circulation systems: one for public zones and one for private access. Public elevators link the ground floor, sky theatre, and rooftop, while private users access residences and offices separately. Though distinct, the systems intersect at shared spaces, allowing optional interaction while maintaining privacy.



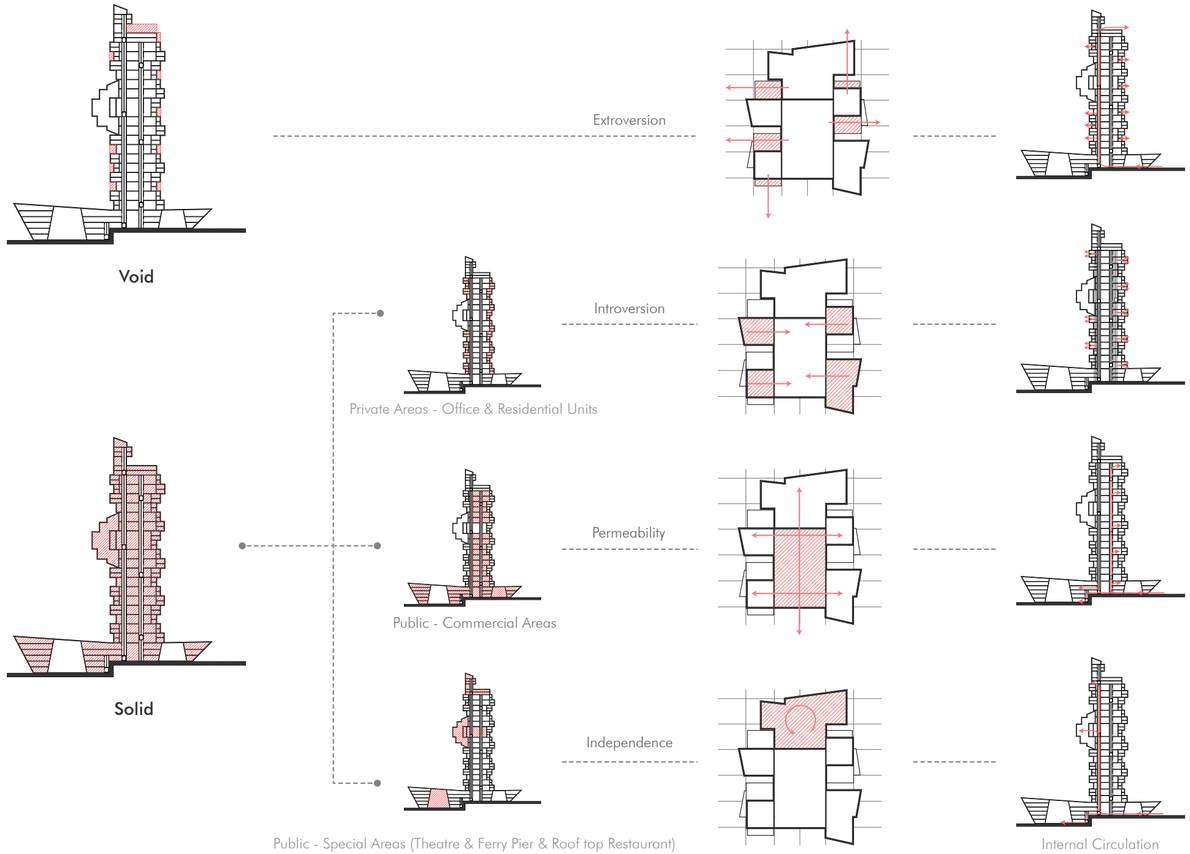
The facade does not fully cover the building. The place where the facade does not cover determines the boundary between the inside and outside of the building. On the inside, the privacy of the units is emphasized and on the outside, the openness and view is more significant.

A combination of different materials is used on the bulding including concrete supporting columns, terra-cotta and metal facade, and glass windows. Glass balconies facing each other brings less privacy comparing with those ones facing away which often works as relatively more private spaces.

Circulation and Program



Spatial Logic and Behavior



Toronto's growing vacancy crisis and housing shortage inspired this adaptive modular parasitic system. The project explores a system that grows across and around existing urban structures, transforming them into dynamic, inclusive habitats. Initiated from vacant office spaces, the system progressively expands along building exteriors, forming a responsive new urban layer. A catalog of modular components including housing, public space, commerce, and infrastructure, provides the building blocks for aggregation. Growth paths are informed by bio-inspired algorithms, while rule-driven parametric logic generates the spatial deployment of modules across varying architectural contexts. Through this approach, the project envisions a scalable strategy for bringing new life and social value to underused parts of the city and fostering inclusive urban ecosystems.

04

Adaptive Urban Parasitic System

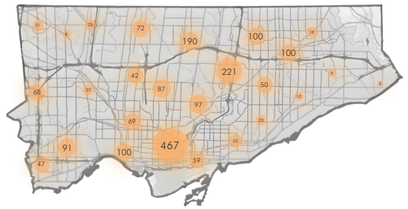
Project Type: Adaptive Modular Urban System | Housing Crisis Response

Focus: Parasitic Growth | Modular Architecture | Generative Design | Parametric Workflow

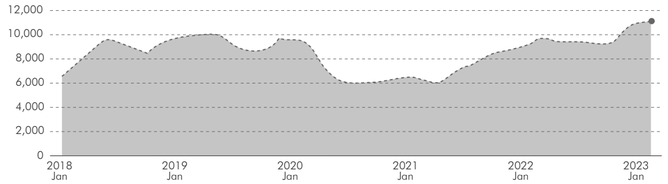
Tool: Rhino | Grasshopper | Enscape | Twinmotion | 3D Printing

Project Context: Academic Project | M.Arch Studio | University of Toronto

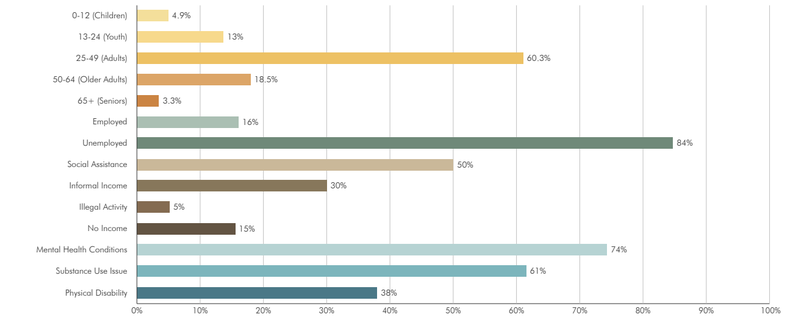
Background and Current Issue



The Number and Distribution of Vacant Offices in Toronto



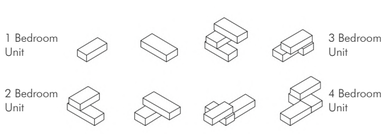
The Number of People Experiencing Homelessness in Toronto



Toronto Homeless Population Breakdown

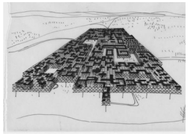
Toronto is facing a dual crisis of housing shortage and growing vacancy in office buildings. As of recent data, over 3,000 vacant office units are concentrated in the downtown core. At the same time, homelessness in the city has steadily increased since 2018, with over 10,000 individuals experiencing homelessness in 2023 alone. Demographic data reveals that the majority of Toronto's homeless population are adults aged 25–64. Many are unemployed (54%), and a significant portion (50%) rely on social assistance. In addition, 61% report substance use issues, and 38% experience physical disability. These statistics highlight the need for not just more housing, but adaptable, supportive environments that respond to complex social and health-related challenges.This project takes these realities as a starting point, exploring how existing vacant infrastructure can be reimagined through modular, parasitic systems to deliver affordable, flexible housing rooted in social care.

Case Study



Habitat 67, Moshe Safdie, 1967

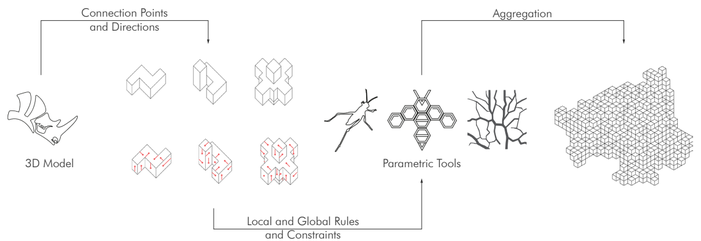
Habitat 67 is a seminal example of modular housing that rethinks the relationship between density, livability, and urban form. Using a single prefabricated concrete module, the project stacks and offsets units to create diverse housing typologies while maintaining structural simplicity. By aggregating modules in varied configurations, Habitat 67 achieves a wide range of unit sizes, addressing the needs of different household types. This modular flexibility allows for scalability and adaptability, offering a valuable precedent for designing inclusive and efficient housing systems.

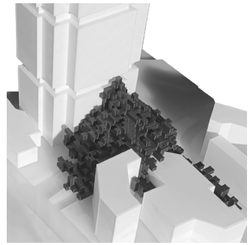


Spatial City, Yona Friedman, 1958

Unlike Habitat 67's grounded, stacked aggregation, Spatial City imagines a lightweight, elevated urban framework built above existing structures. This vision emphasizes mobility and minimal impact. Modules are suspended within a structural frame and can be freely inserted, removed, or rearranged. This modular and elevated approach allows for organic urban growth, making it adaptable to changing needs and contexts. Spatial City shifts the focus from permanence to flexibility, offering an open-ended system responsive to shifting urban needs.

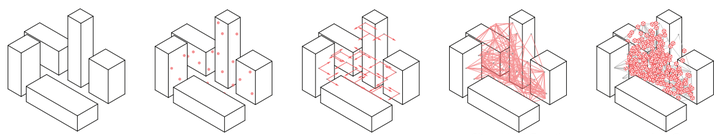
Concept Development



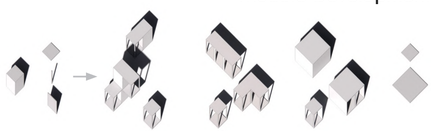


Building on the insights from the two case studies, this design integrates modular thinking with parametric design strategies to form a generative system tailored to contemporary urban challenges. This design explores a rule-based generative strategy that begins with defining potential connection points and directions on each module and starting points on existing buildings. Using parametric tools, such as Grasshopper, Wasp and Physarealm, local and global rules are applied to control the growth direction, aggregation logic, and spatial constraints. Inspired by biological growth, the parasitic system is driven by defined rules and environmental constraints, enabling it to self-propagate. Once initiated, the system can continue expanding organically adapting to context and spreading across the city like a living organism.The images on the right show a 3D-printed model of one iteration, where modules grow out of vacant building surfaces and gradually form a parasitic urban system. This physical prototype demonstrates how the system adapts to irregular geometries and builds a layered, responsive urban structure.

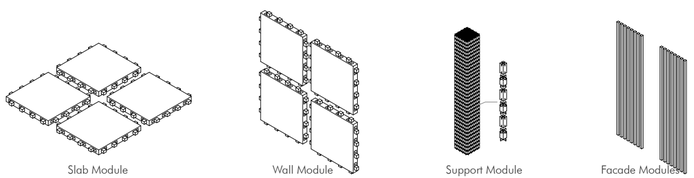
Growth Process



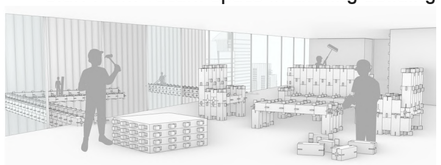
Module Development



Submodules



Start From Vacant Space in Existing Building



The system begins by identifying vacant spaces across existing buildings as anchor points for growth. Guided by local and global rules, modules aggregate outward along available paths, simulating slime mold behavior to explore optimal paths and connections. Submodules such as slabs, walls, and facades define the structural logic and allow efficient stacking and expansion. A set of programmatic modules including housing, public, commercial, are developed from these elements to adapt to diverse spatial and social needs. This layered growth strategy ensures adaptability across different site conditions while keeping a clear architectural identity.

The system begins within vacant office interiors, using small multifunctional submodules to form walls, furniture, and infrastructure. Their compact scale allows gradual deployment in constrained spaces. By starting from within existing buildings, the design takes advantage of available structure and utilities minimizing waste and cost. As modules accumulate, the system grows outward and integrates with the host, transforming underused space into vibrant, inhabitable environments.

Module Types and Target User Groups

Loner Living Module

Designed for the largest demographic group, this module offers low-cost, single-occupant housing with privacy and flexibility.

Couple Living Module

Supports paired individuals who seek shared housing with basic amenities, enhancing emotional support and space efficiency.

Group Living Module

Provides multi-room units to accommodate extended families or multigenerational households, respecting cultural and social needs.

Small Commercial Module

Offers a compact unit for small-scale businesses such as food stands, repair shops, or resale activities, fostering economic participation.

Large Commercial Module

Enables broader community programs—training, resource centers, or cooperative enterprises—facilitating re-integration through employment.

Woekshop Module

A space for material recycling and skill development, counseling, and job-readiness programs; supports youth engagement.

Single Public Module

A flexible, accessible, small-format unit for basic services: health-care, intake, outreach, or legal aid.

L-Shape Public Module

Its enclosed shape offers more privacy, suited for group therapy, mental health support, or safe community gatherings.

I-Shape Public Module

Optimized for linear sites and accessible move-ment, ideal for mobility programs or quiet public use.

Public Garden Module

Designed as a small and flexible public healing landscape, supporting safe outdoor engagement and therapeutic programming.

Private Garden Module

Offers safe, enclosed open space for vulnerable individuals, especially useful for trauma recovery or parenting environments.

Public Park Module

Provides communal green space to reduce stress and support informal in-teraction among resi-dents.This module is de-signed for all groups.

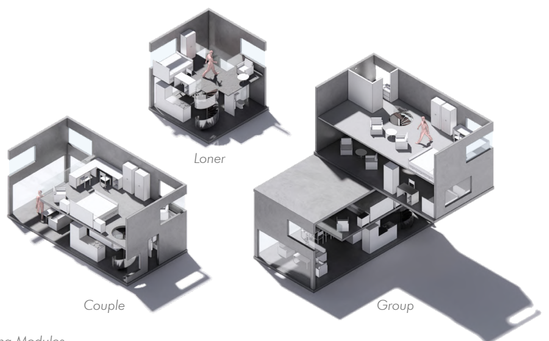
Farm Module

Enables hands-on agricultural work, offering food production, community meals, and therapeutic gardening.

Power Generation Module

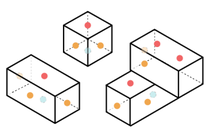
Supports energy self-sufficiency for off-grid conditions, especially useful in transitional or low-infrastructure zones.

Designed Modules and Local Connection Rules

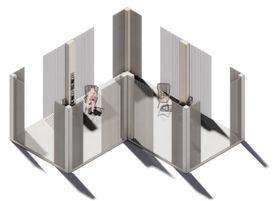


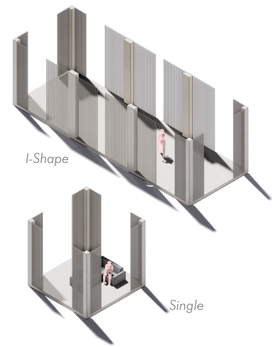
Living Modules

Connection Types:
Sides: Living, Public, Commercial, Open, Farm
Top: Power Generation, Farm, Living, Commercial, Open
Bottom: Living, Public, Commercial
Connection Point Location:



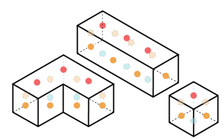
Top Connection Point Side Connection Point Bottom Connection Point



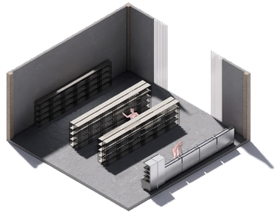


Public Space Modules

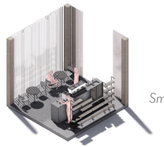
Connection Types:
Sides: All Types of Modules
Top: All Types of Modules
Bottom: Living, Public, Commercial, Workshop
Connection Point Location:



Top Connection Point Side Connection Point Bottom Connection Point



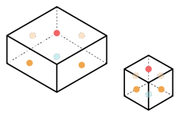
Large



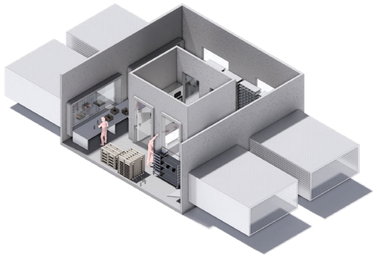
Small

Commercial Modules

Connection Types:
Sides: All Types of Modules
Top: All Types of Modules
Bottom: Living, Public, Commercial, Workshop
Connection Point Location:



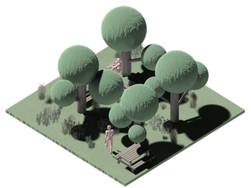
● Top Connection Point ● Side Connection Point ❄ Bottom Connection Point



Workshop Module

Connection Types:
Sides: Workshop, Public, Commercial, Open, Power Generation
Top: Workshop, Power Generation, Commercial, Open
Bottom: Workshop, Public, Commercial
Connection Point Location:

● Top Connection Point ● Side Connection Point ❄ Bottom Connection Point

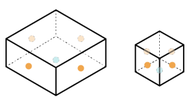


Park

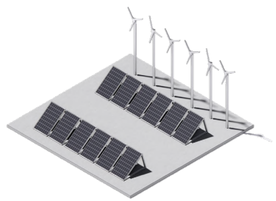
Garden

Public Open Space Modules

Connection Types:
Sides: All Types of Modules
Top: None
Bottom: All Types of Modules
Connection Point Location:

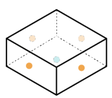


● Side Connection Point ❄ Bottom Connection Point

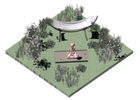


Power Generation Module

Connection Types:
Sides: Power Generation, Public, Commercial, Open, Farm, Workshop
Top: None
Bottom: Living, Public, Commercial, Workshop
Connection Point Location:



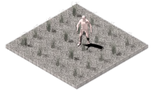
● Side Connection Point ❄ Bottom Connection Point



Private Garden Module

Connection Types:
Sides: Living, Open, Farm
Top: None
Bottom: Living, Public, Commercial
Connection Point Location:

● Side Connection Point ❄ Bottom Connection Point



Farm Module

Connection Types:
Sides: Power Generation, Public, Commercial, Open, Farm
Top: None
Bottom: Living, Public, Commercial
Connection Point Location:

● Side Connection Point ❄ Bottom Connection Point

I-Shape Transportation Module

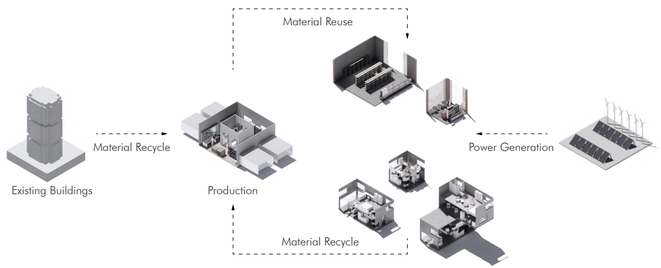
L-Shape Transportation Module

Support Module

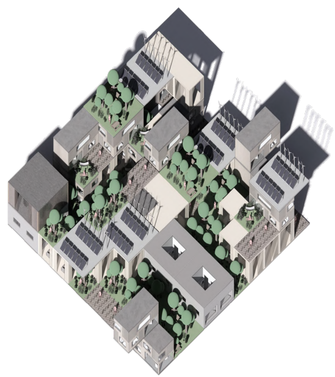
Stair Module

Each primary module is designed with distinct functions and corresponding connection logic. Variations in connection point location and local rules reflect spatial needs and usage considerations. For example, workshop modules are restricted from connecting directly to residential modules within a certain range to preserve living quality. Power generation and workshop modules are required to connect to two or more open space modules, ensuring adequate environmental buffering. Some modules, such as open space units, only connect at the base with no top connection points, preserving their accessibility and openness. In addition to primary units, supportive modules like transportation links, stairs, provide structural continuity and enable smooth circulation. These smaller-scale units allow flexible insertion, bridging spatial gaps and supporting both vertical and horizontal expansion across varying site conditions.

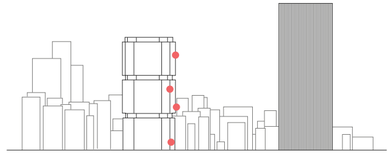
Lifecycle of Modular Expansion



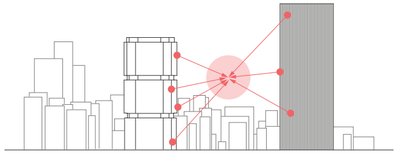
Modular expansion begins with material recycle from vacant offices, where reusable components are sorted and redirected to nearby workshop sites. These components are fabricated into modules, which are then deployed across the system. Solar panels embedded within modules provide decentralized energy, supporting self-sufficient growth and reducing reliance on external infrastructure. On the right, the aggregated cluster is formed entirely through local rules. Each module connects based on function, orientation, and connection logic, adapting organically to spatial conditions.



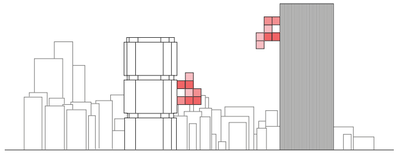
Global Aggregation Rules and Constraints



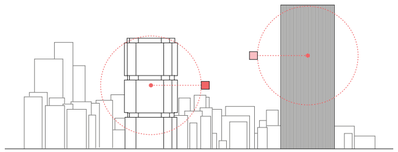
Starting Points on Buildings
Initial aggregation begins at strategic points on existing buildings, identified through a combination of vacancy data, population density, and infrastructural resource availability. These starting nodes are prioritized based on their capacity to host new programs, proximity to social demand, and structural adaptability.



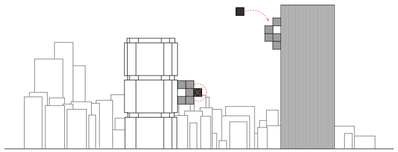
Growth Path
Growth follows a slime mold-inspired simulation, responding to environmental conditions such as resource access, sunlight, and connectivity. Like a living organism seeking food, the system expands toward favorable zones and merges at key intersections to form larger communal spaces.



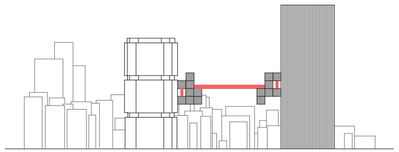
Proportion of module and their locations
Module types and their distribution respond to surrounding building uses. For Example, in residential zones, the system increases living and public modules to support daily life and foster community. Office-dense areas prioritize open spaces and workshops to balance activity types and enhance material reuse.



Part-Specific Rules
Part-specific constraints ensure functional and livable growth. When modules extend beyond a certain distance from the host building, a workshop module is required to support material processing. Open space and public modules also appear at regular intervals to maintain quality of life and communal access.

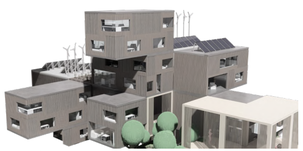


Adjacency/Exclusion Constraints
Adjacency and exclusion constraints regulate how modules connect, maintaining spatial clarity and functional separation. For instance, noisy units avoid proximity to living modules, while public and open spaces are encouraged to cluster. Incompatible placements are filtered out during this stage.

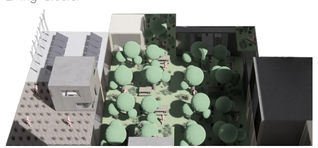


Access Radius Enforcement
To ensure accessibility and circulation efficiency, each residential module must connect to at least one transportation or public space module within a defined radius. This rule guarantees that all living units remain reachable and well-integrated into the larger system, even as the aggregation expands.

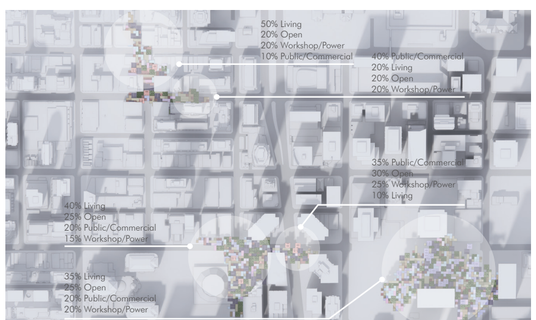
Controlling Aggregation through Parameters



Living Cluster

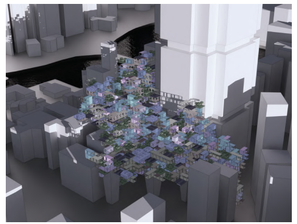


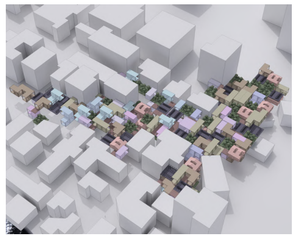
Open Space Cluster

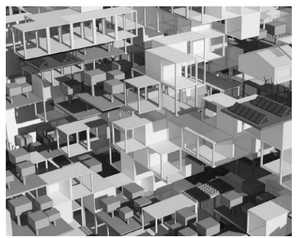


By adjusting parameters, module distribution within each macro-cluster, or urban parasitic entity, is tailored to local context and adjacent programs. High-rise zones maintain a balanced mix of modules, while low-rise neighborhoods emphasize living units to sustain community continuity. At convergence points between macro-clusters, open space and public modules become more prevalent, creating shared spaces that foster civic interaction.
Through parametric control, the system operates across two nested scales of organization. At the macro level, modules form large parasitic structures responding to city-scale conditions. At the micro level, they self-organize into spatial clusters, such as residential pockets or public courtyards, shaped by local needs. These micro-clusters emerge not only as functional typologies, but as strategies for concentrating activity. By regulating parameters, originally dispersed modules are reorganized into intentional formations transforming spatial discreteness into social collectivity.

System Behavior

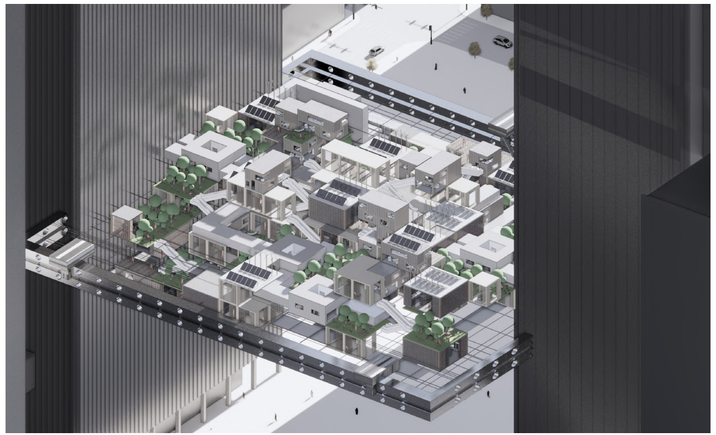




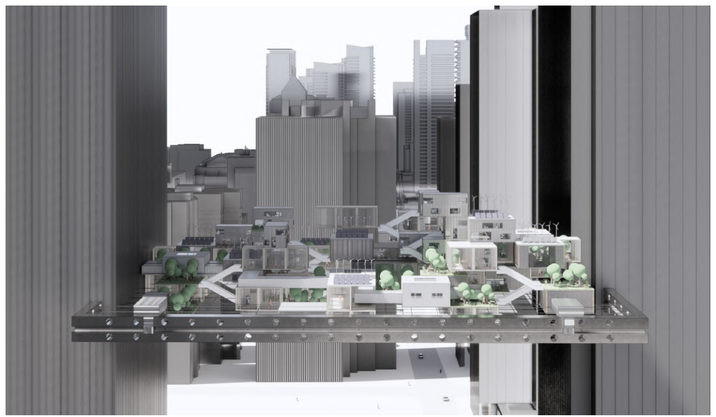


To better analyze the system's overall behavior at an urban scale, these simulations employ simplified modules that abstract spatial types while preserving programmatic logic. The images illustrate how the aggregation system adapts to varied urban conditions: expanding vertically when space is limited, extending horizontally along street corridors, and reconfiguring to form porous interfaces between buildings.

Full Module Aggregation Outcomes



This visualization captures an early-stage growth of the adaptive parasitic system, where modular clusters begin to aggregate within an aerial space between two high-rise buildings. Housing, public space, green infrastructure, and energy modules are flexibly combined, forming a vibrant and multifunctional environment.
A spanning structural frame and fine-grained hanging system support the suspended modules, enabling expansion without ground-based infrastructure. While speculative, this strategy highlights the system's adaptability to diverse urban contexts and its potential to activate underutilized spaces through modular growth.



This perspective highlights the layered spatial organization and inhabitable depth of the adaptive parasitic system. Modular units are aggregated along a multi-level structural framework, creating a vibrant elevated streetscape suspended within the urban skyline.
A variety of spatial typologies including private living spaces, public terraces, communal gardens, and infrastructure modules, are strategically interwoven, fostering rich social and functional interactions across the vertical plane. The system's dynamic circulation pathways connect different levels and modules, promoting accessibility.

This project explores a multi-objective optimization (MOO) workflow to inform the early-stage design of a community hub. Guided by diverse stakeholder needs, the process defined three primary goals: maximizing usable floor area, enhancing building sunlight exposure, and increasing spatial diversity. Parametric modeling and performance-based simulations guided the generation and evaluation of over 200 design iterations. Six optimal solutions were identified through quantitative analysis, with final selections refined through an iterative visualization process to explore spatial qualities and design expression. The project demonstrates how optimization and data-informed methods can enrich design exploration and support adaptive, responsive architectural outcomes.

05

Performance-Driven Community Hub

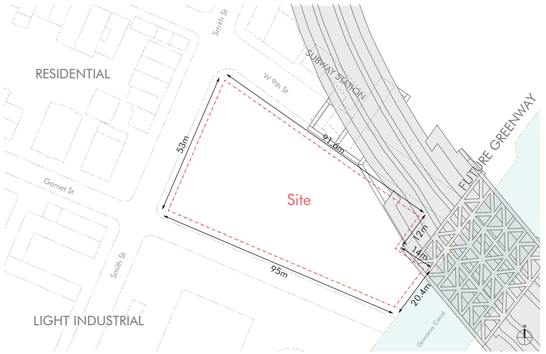
Project Type: Data-Informed Generative Architecture

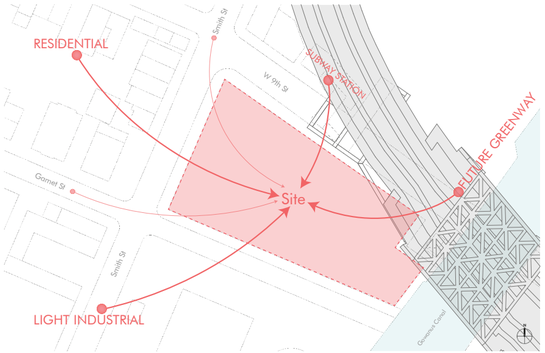
Focus: Multi-Objective Optimization | Parametric Design | Computational Design

Tool: Rhino | Grasshopper | Ladybug | Discover | Midjourney | Stable Diffusion | ControlNet

Project Context: Academic Project | M.Arch Studio | University of Toronto

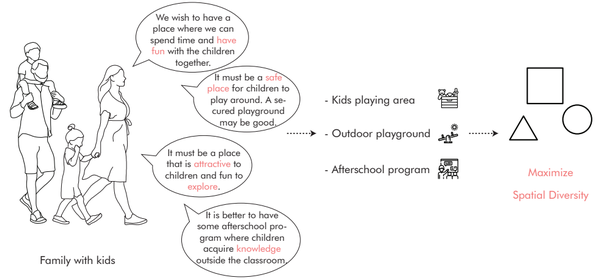
Site Analysis

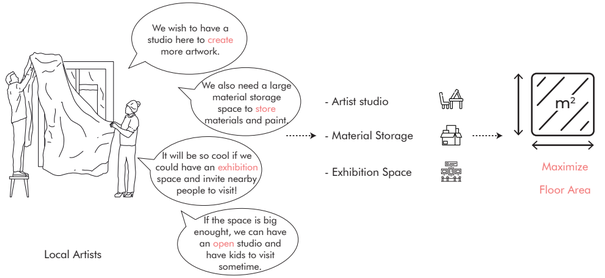


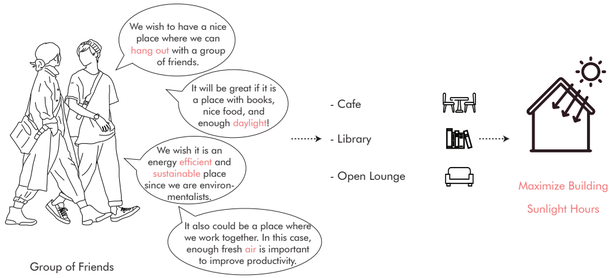


The site is located along the Gowanus Canal in Brooklyn, surrounded by a mix of residential neighborhoods, light industrial zones, a future greenway, and a subway station. This diverse context brings together a wide range of users—from local families and artists to casual visitors. To address varied needs, this project uses a multi-objective optimization approach that balances multiple stakeholder priorities. Before entering the design phase, a detailed stakeholder analysis was conducted, identifying three major user groups: families with kids, local artists, and groups of friends. Each group's spatial and functional preferences were translated into design goals. These needs helped determine the design direction and informed key spatial decisions throughout the process.

Stakeholder and Needs







MOO Summary

What Goals to Achieve	Maximize Floor Area	Maximize Building Sunlight Hours	Maximize Spatial Diversity
Why Choosing these Goals	- High Visitor Flow Rate - Program Requirement	- Future Community Centre - Less Artificial Light	- Attract to visitors - Fun to Explore
How to Achieve these Goals	- Sum Up Area of Each Floor	- Run Ladybug Sunlight Hour Analysis	- Calculate Perimeter of the Building

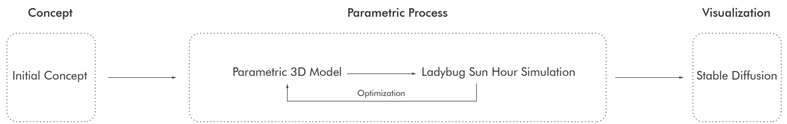
Software & Workflow

Rhinoceros

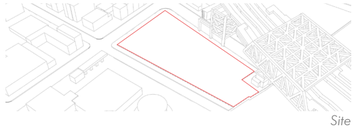
Grasshopper

Ladybug

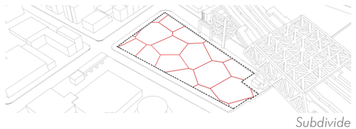
Stable Diffusion



Concept Diagram

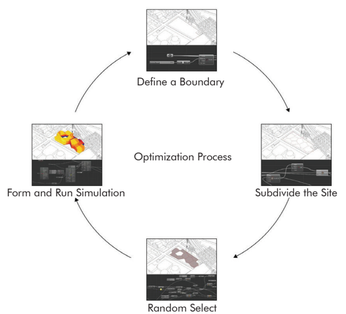


Site



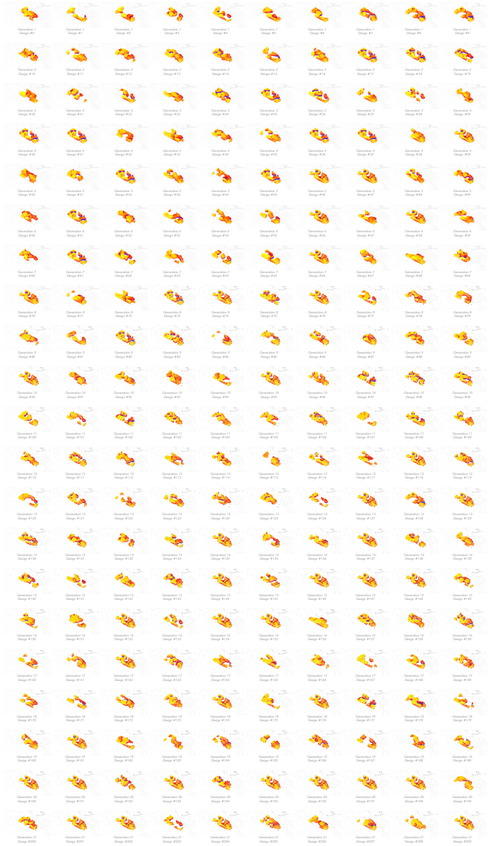
Subdivide

Form

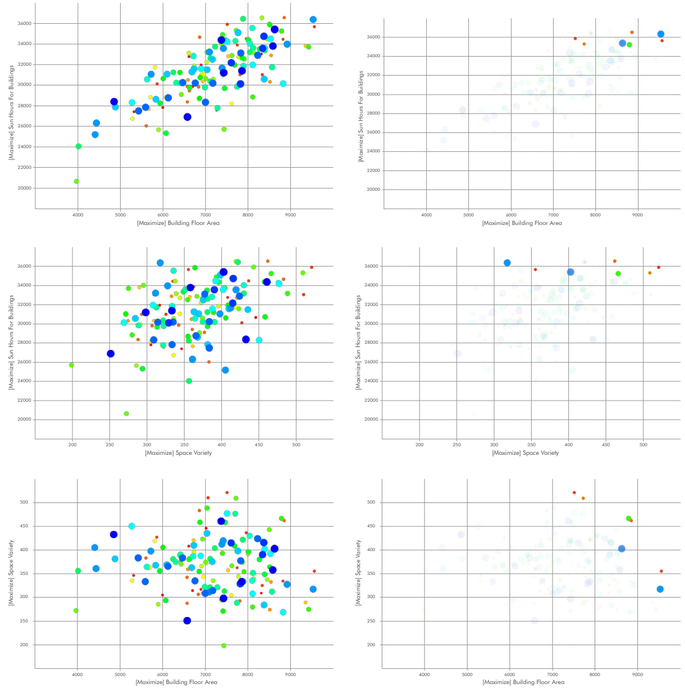


To address the stakeholder needs, three key goals were defined: maximizing floor area, increasing building sunlight hours, and enhancing spatial diversity. These goals were translated into measurable design parameters, such as total usable floor area (sqm), average sunlight duration (hrs), and perimeter complexity (l.m.), and embedded into the computational workflow. The design process begins with randomly subdividing the site into cells using parametric scripts in Grasshopper. From this base, multiple volumes are generated, producing hundreds of design iterations. Each iteration is then evaluated using simulation tools like Ladybug to analyze performance data related to the defined goals. The results are fed into a machine-learning-assisted optimization tool, Discover, which identifies optimal candidates based on multi-objective evaluation.Instead of a one-time selection, the process runs across generations: top-performing results from one round feed into the next as new design inputs, continuously refining spatial and environmental outcomes.

200 Solutions - 10 Designs per Generation, 21 Generations, Mutation Rate 5%

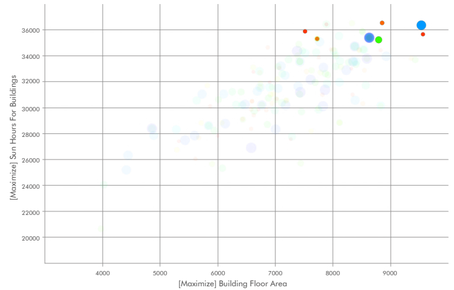


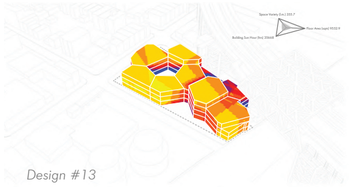
Multi-Objective Performance Evaluation



Over 200 design options were produced through 21 generations, with 10 iterations per generation and a 5% mutation rate. The scatter plots on the right compare the results across three main goals: floor area, sunlight hours, and spatial diversity. Each graph uses different combinations of these metrics on the X and Y axes, offering a clearer view of how the designs perform and where trade-offs occur. As the generations evolve, the results begin to cluster around stronger solutions, showing how the optimization process gradually narrows toward better-performing outcomes. This approach helps evaluate a wide range of possibilities and supports decisions based on both spatial quality and environmental performance.

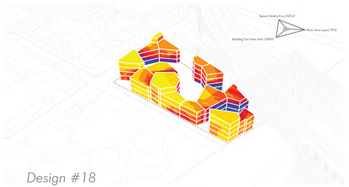
Optimal Solutions - 210 Total Solutions, 6 Optimals



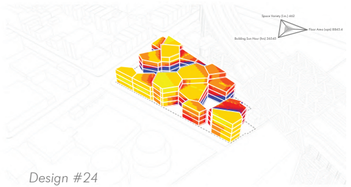


Design #13

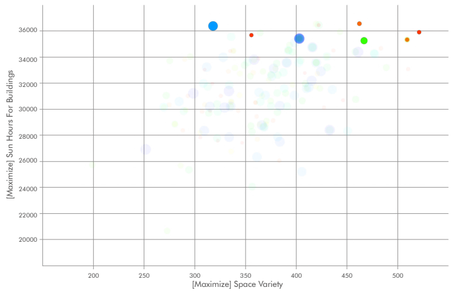
Design #17



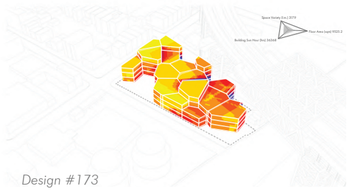
Design #18



Design #24

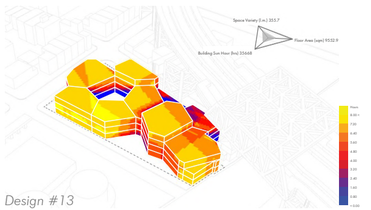


Design #99

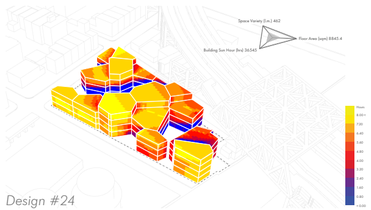


Design #173

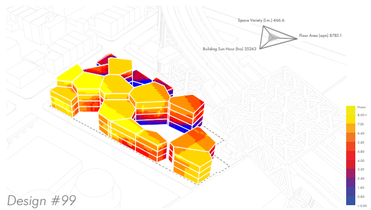
Top 3 Choices



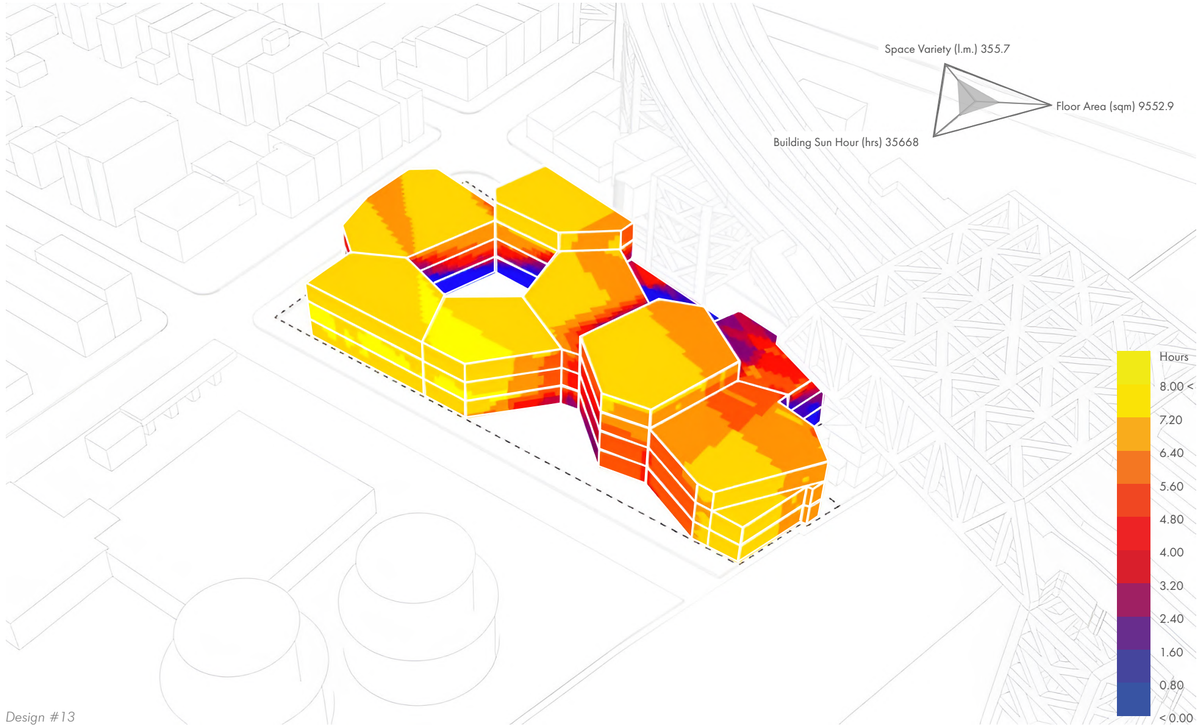
Design #13



Design #24



Design #99



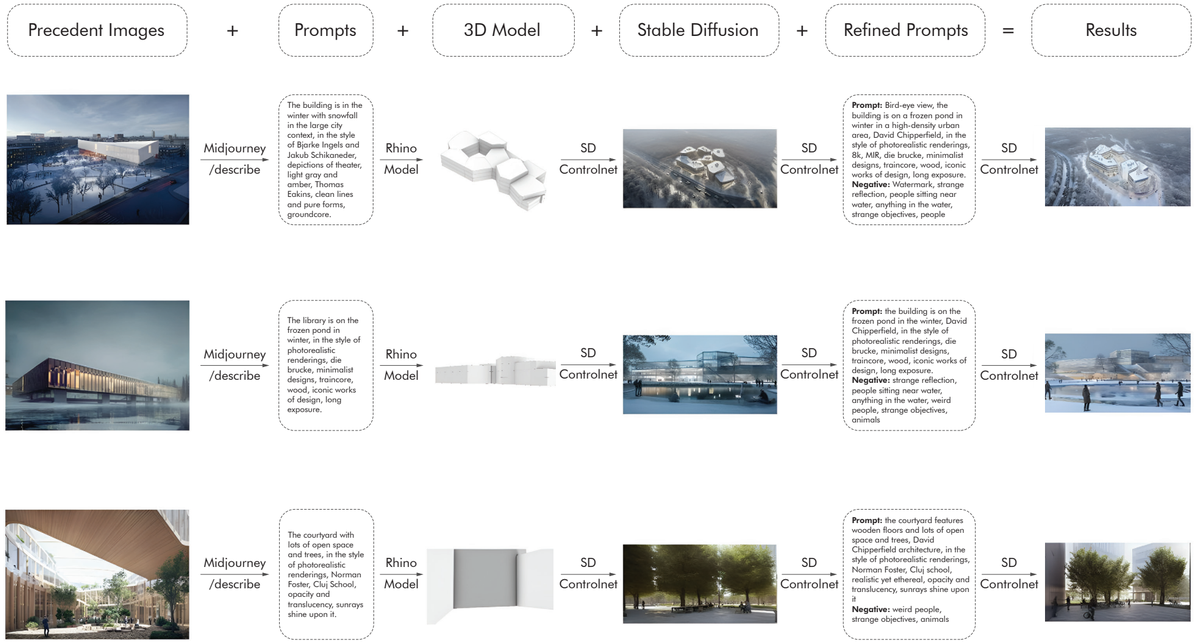
Design #13

Among the 210 generated iterations, six designs emerged as optimal when evaluated across all three performance goals: floor area, sunlight hours, and spatial variety. The scatter plots on the left illustrate how these options perform relative to one another under different metric combinations. From this group, three representative designs—#13, #24, and #99—were selected for closer comparison, based on their balanced performance and distinct spatial strategies. Each 3D diagram is paired with a sunlight analysis to visualize façade exposure and guide refinement.

While all three offer strong quantitative outcomes, the final selection was informed by architectural judgment. Design #13 was ultimately chosen for its overall clarity and spatial potential. Its central courtyard enhances daylight and airflow, provides a clear organizational core, and creates a welcoming open space within the dense urban fabric. The overall massing supports both visual continuity and future flexibility, making it a compelling foundation for further development.

Design #13 performs well across all metrics, with 9,552.9 sqm of usable floor area, 35,068 building sun hours, and a spatial diversity index of 355.7. The sunlight analysis reveals how different elevations receive daylight throughout the day, providing insight into facade usage and interior layout. The massing strategy combines compactness with permeability, ensuring efficient space use while preserving a sense of openness and spatial richness.

Visualization Workflow



A hybrid visualization workflow combines parametric 3D modeling with AI-based image generation to support early-stage exploration of massing and landscape design. Rather than focusing on interior layouts or detailed architectural elements, the process aims to test how large-scale forms respond to surrounding environments, seasons, and public spatial atmospheres.

The workflow begins by selecting precedent images to define the desired visual tone, materiality, and environmental character. These references inform the creation of prompt templates, which are paired with massing models developed in Rhino. Using ControlNet in Stable Diffusion, the base geometry is embedded into the AI generation process, allowing for a high degree of spatial consistency and contextual depth.

Initial outputs are then refined through iterative prompt adjustment focusing on elements like lighting condition, weather, vegetation density, and overall mood. Across multiple cycles, over 200 visualizations were generated, gradually improving coherence and narrative clarity. The matrix on the right visualizes this evolution across three key scenarios: aerial views, winter urban plazas, and enclosed central courtyard. Each sequence demonstrates how generative renderings can be tuned to test spatial atmosphere, seasonal qualities, and human-scale interaction.

Rather than producing finalized images, the goal is to use visualization as a design feedback tool. By evaluating emergent patterns, such as how massing casts shadows in a real-time scenario, defines public edges, or anchors into landscape, this process helps inform broader design directions and enrich the architectural narrative from an early conceptual phase.

Evolution of 210 Visualization Iterations

This project builds on the movement and mechanism principles of the Medina umbrella, developing a new modular unit capable of creating dynamic shading and adaptable space. The system uses simple operable mechanisms combined with parametric design to enable various spatial configurations which are flexible in size, density, and form. Designed for temporary urban events, the modules can be quickly reassembled to host different programs, from conference spaces and markets to exhibitions and performances. Through this adaptable system, the project explores how kinetic structure and parametric control can bring responsiveness and versatility to public space.

06

Dynamic Shade System

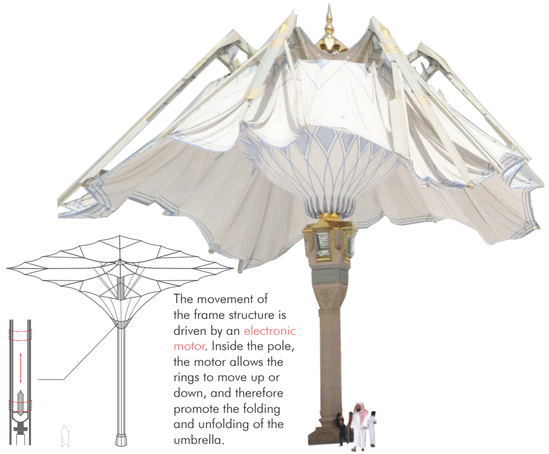
Project Type: Kinetic Architecture | Responsive Pavilion

Focus: Movement Manchnism | Parametric Design | Modular Assembly | Flexible Space Programming

Tool: Rhino | Grasshopper | Ladybug | Kangaroo | Karamba | Enscape

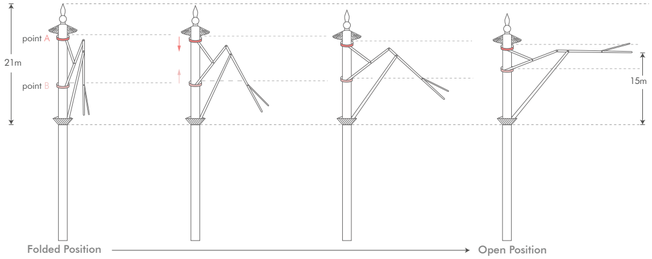
Project Context: Academic Project | University of Toronto

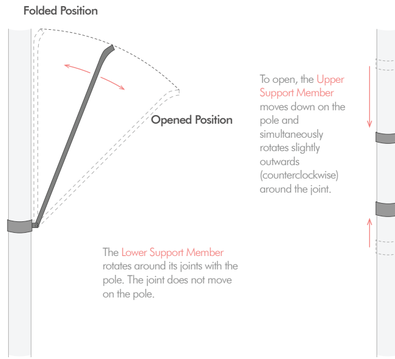
Research on Medina Harama Piazza Shading Umbrella



The movement of the frame structure is driven by an electronic motor. Inside the pole, the motor allows the rings to move up or down, and therefore promote the folding and unfolding of the umbrella.

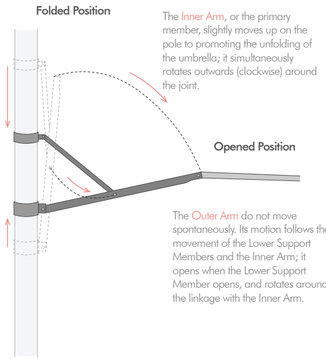
The physical prototype was made with 3mm wooden pieces and a metal rod which was stretched when the umbrella was closed. All the wooden pieces were made through laser cutting.





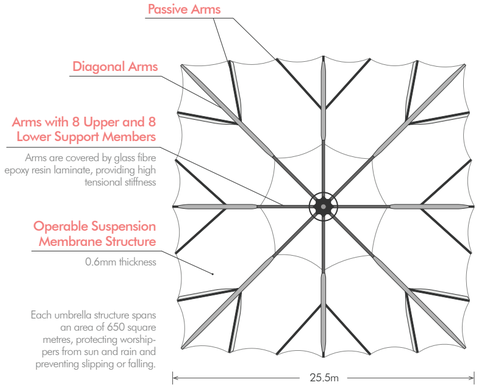
To open, the Upper Support Member moves down on the pole and simultaneously rotates slightly outwards (counterclockwise) around the joint.

The Lower Support Member rotates around its joints with the pole. The joint does not move on the pole.

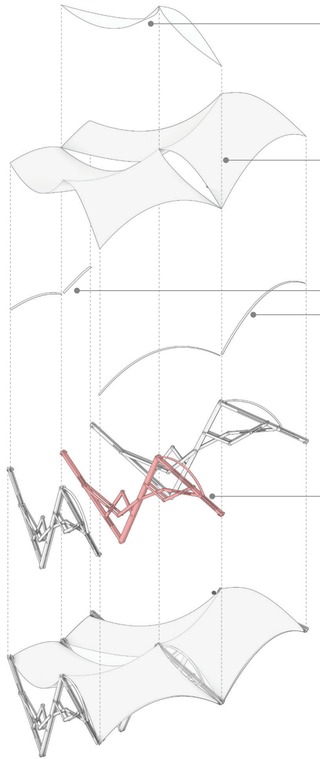


The Inner Arm, or the primary member, slightly moves up on the pole to promoting the unfolding of the umbrella; it simultaneously rotates outwards (clockwise) around the joint.

The Outer Arm do not move spontaneously. Its motion follows the movement of the Lower Support Members and the Inner Arm; it opens when the Lower Support Member opens, and rotates around the linkage with the Inner Arm.



Prototype Machanism and Movement Analysis

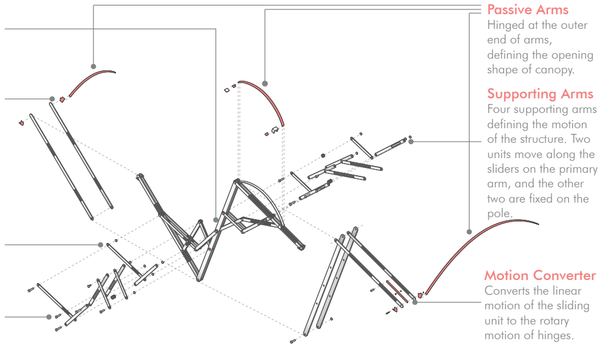


Transparent Fabric
Allows natural lightings through canopy.

Operable Tensile Fabric
Thin, high durability to sustain under different weather conditions, creating a soft roof for the venue.

Passive Arms
Hinged at the outer end of arms, defining the opening shape of the canopy.

Structure
Opens both sides, the motion of each arm is defined by a total of four sliding and rotating units.



Three fixed points on the pole

Hinges
Two static hinges control the opening of the inward canopy.

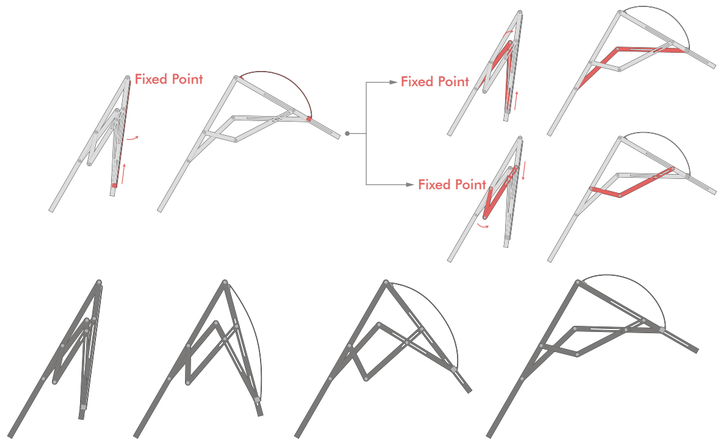
Since the opening angles are different, the inward supporting arms feature different lengths of sliders.

Connection Point
Allows the two sliding units to move together.

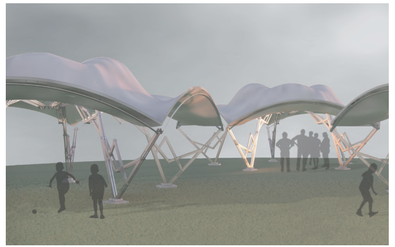
Passive Arms
Hinged at the outer end of arms, defining the opening shape of canopy.

Supporting Arms
Four supporting arms defining the motion of the structure. Two units move along the sliders on the primary arm, and the other two are fixed on the pole.

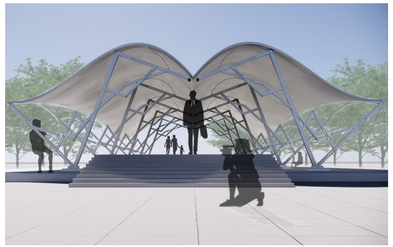
Motion Converter
Converts the linear motion of the sliding unit to the rotary motion of hinges.



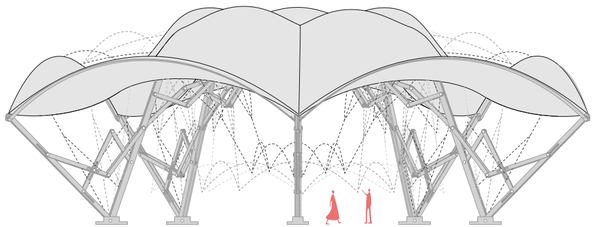
The Possible Forms Designed for Different Events

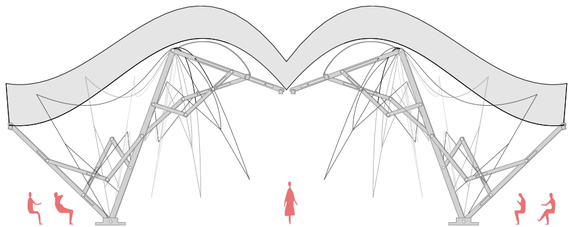


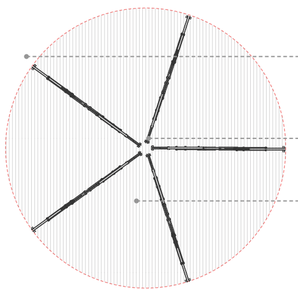
Type 1 The Circle
This circular configuration creates an enclosed yet open environment, ideal for group meetings and small gathering activities. Its compact scale and continuous form invite conversation, interaction, and casual engagement. It can serve as a temporary rest station, outdoor classroom, or community market. After the event, the structure can be transformed into an operable shading device for various outdoor activities.



Type 2 The Rectangle
Defined by a linear layout with a central axis, this form suits forums, street performances, public talks, or product launches. The main presenting area is in the middle and audience area is divided into two parts by the main stage. The clear separation between stage and audience allows for structured programming while remaining open to passersby. After the event, it can be transformed to a place for outdoor performances.



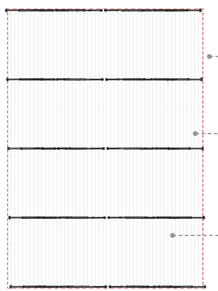




This structure could be placed at any locations and work as a place for small-scale gathering activities.

The *umbrellas* are arranged to form a continuous circular space.

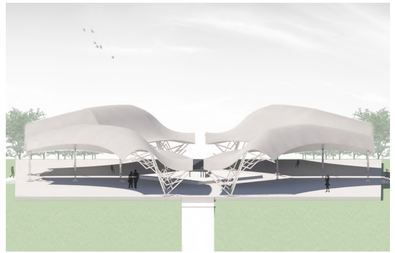
The 'interior' space is fully covered to provide shading for people inside and has no particular entrances.



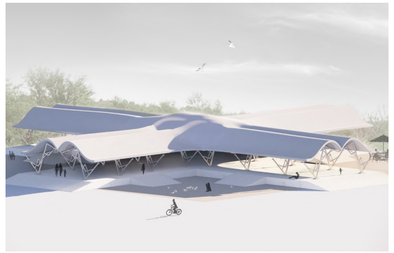
This structure is made for circumstances such as news conferences and presentations.

The *umbrellas* are arranged to form a rectangular space with a large presentation area in the middle and audience area on both sides.

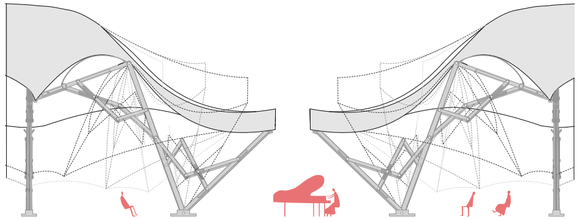
The 'interior' space is fully covered when the umbrellas are fully open to provide shading for both audience and presenters and two entrances to the middle presentation area are located on both sides of the structure.

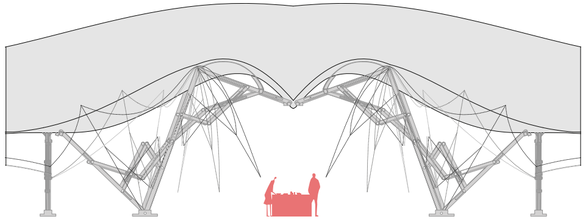


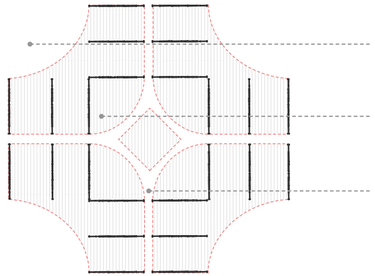
Type 3 The Concentric Circles
This configuration centers around a main performance area surrounded by multiple rings of audience space. It is ideal for music festivals, cultural ceremonies, or open-air cinemas, events that benefit from immersive viewing and large, flexible crowd capacities. After the event, the structure can be transformed into a ceremonial space or an outdoor amphitheater.



Type 4 The Cross
This configuration suits for exhibitions, cultural fairs, and service-oriented programs. The central part serves as the main event area, while the four extending wings can host dining, lounging, or workshops. Its open and symmetrical layout allows visitors to flow naturally between zones, making it ideal for events that combine gathering, display, and interaction. After the event, the structure can be repurposed as a multipurpose pavilion.



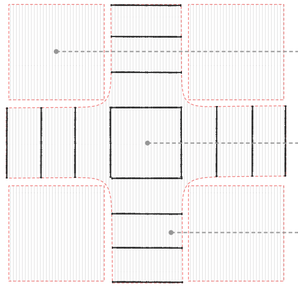




The visitor areas are outside the main activity area to provide visitors a glance of the performance.

The audience areas are all around the stage to provide people the best view of the performance.

Small passages are made between audience areas.



Areas with different functions are made on the four corners of the main activity area.

The 'interior' space is fully covered to provide a large-scale exhibition and shading area.

Four entrances are located on four directions to guide people from differnt places to enter the main activity area easily.

Other Works

This project explores how Indigenous cultural values around land and nature can inform architectural and spatial design. As part of this exploration, the designer recreated traditional Indigenous artifacts and engaged in hands-on material experimentation to better understand craft, process, and cultural meaning. The project develops a casting technique where earth serves as both mould and medium, allowing built forms to carry the texture and memory of the land. Extensive physical modelling and material testing informed the architectural language, where negative ground space is transformed into positive structural form. The approach was applied in both a cultural exhibition space and a research centre. Additionally, excavated soil was shaped into riverbed mounds designed to promote ecological restoration, integrating spatial and environmental strategies across scales.

01

Earth Imprint

Project Type: Material Exploration | Experimental Architecture | Cultrual Space

Focus: Earth Casting Process | Negative-Positive Space Transformation | Ecological Design

Tool: Rhino | Grasshopper | Physical Casting | Handcrafting

Project Context: Academic Project | M.Arch Studio | University of Toronto

The Water Drum, the Snapping Turtle Rattle and the Earth

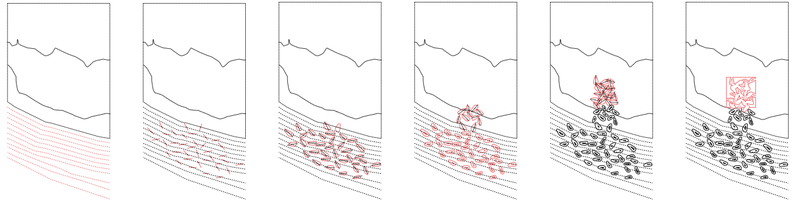
To begin the exploration, a miniature version of an Indigenous water drum and snapping turtle rattle was recreated by hand, carefully following traditional methods. The water drum, known for its resonant, earthy tone, symbolizes life, balance, and connection to the natural world. The turtle rattle, traditionally made from turtle shells which evokes the creation story of Turtle Island, a foundational narrative in many Indigenous cultures. Both objects embody a spiritual relationship with the land and nature. This hands-on process offered a deeply understanding of the reverence Indigenous cultures hold for the earth and becomes the experience that inspired the material and spatial explorations that followed.

Material Testing

To honor the cultural roots of the Indigenous artifacts, a soil-based casting method was developed to create a display space and a research centre that physically embody a connection to the land. Soil was used as both framework and texture generator, allowing the building surface to carry the imprint of the earth. Three mixtures were tested as casting mold: soil with flour gave a smooth surface with minimal residue, soil with clay left rough, clumped textures, and a mix of planting soil and red earth produced a rich, even imprint which is ideal for construction and design.

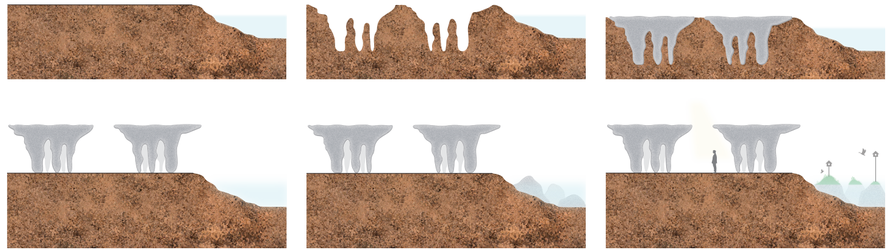
Site Location

Concept and Strategy



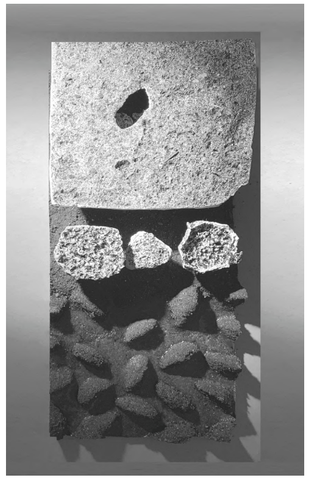
Site and Typology | Guidelines | Soil Mounds in the River | Buffer Zone | Building Negative | Building Positive

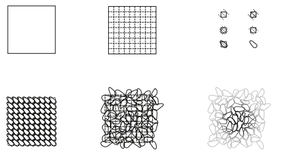
From Earth to Form



The site sits along the Grand River near the Six Nations and Kayanase communities, places rich in Indigenous heritage and ecological knowledge. Drawing from these values, the project proposes a land-based construction approach. A negative space is carved directly into the earth and used as a casting mold, embedding the land's texture and memory into the concrete. Once the mold is removed, the void becomes architecture. What was dug out becomes structure, what was once soil becomes negative space. Simultaneously, a system of soil mounds is introduced along the river to slow flooding and promote sedimentation, forming future habitats for wildlife. Instead of building on top of the land, the space is formed from within it, grounding the design in both ecological process and cultural meaning.

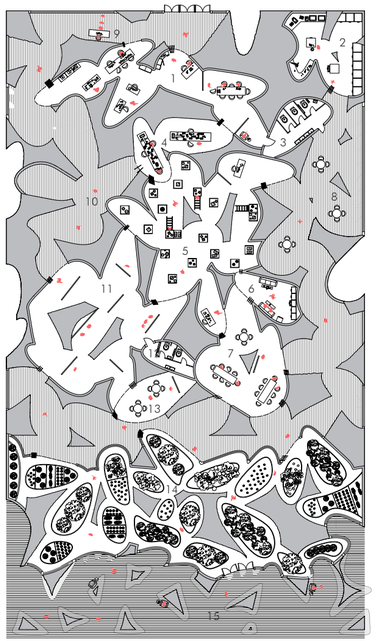
Earth Casting and Space Forming



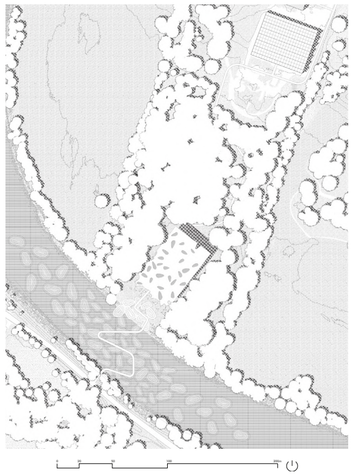


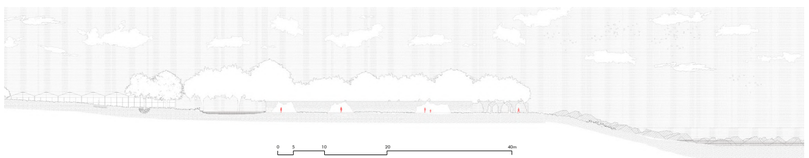
The display space of the artifacts is formed through a series of concentric circles, a spatial gesture rooted in Indigenous symbolism. In many Indigenous cultures, the circle represents wholeness, the cycle of life, and the interconnectedness of all beings. These circular layers gradually draw visitors inward, creating a maze-like journey of discovery. At the center is a quiet, skylit chamber for displaying crafted artifacts, offering a calm space surrounded by the architecture. Building on this concept, a larger cultural and research center was developed. Using overlapping soil mounds as both spatial dividers and casting bed, the interior is designed into adaptable volume of various sizes, tailored to different programs. Skylights bring in daylight and fresh air, connecting the architecture back to the land and nature.

Floor Plan, Site Plan and Site Section



1 Seed Lab
2 Micropropagation Lab
3 Staff Washroom
4 Cryopreservation Room
5 Cold Conservation Room
6 Drying Incubator Room
7 Research Meeting Room
8 Staff Common Area
9 Reception
10 Flexible Public Space
11 Exhibition Format Public Space
12 Public Washroom
13 Classroom Format Public Space
14 Conditioned Green House
15 Semi-Covered Open Space

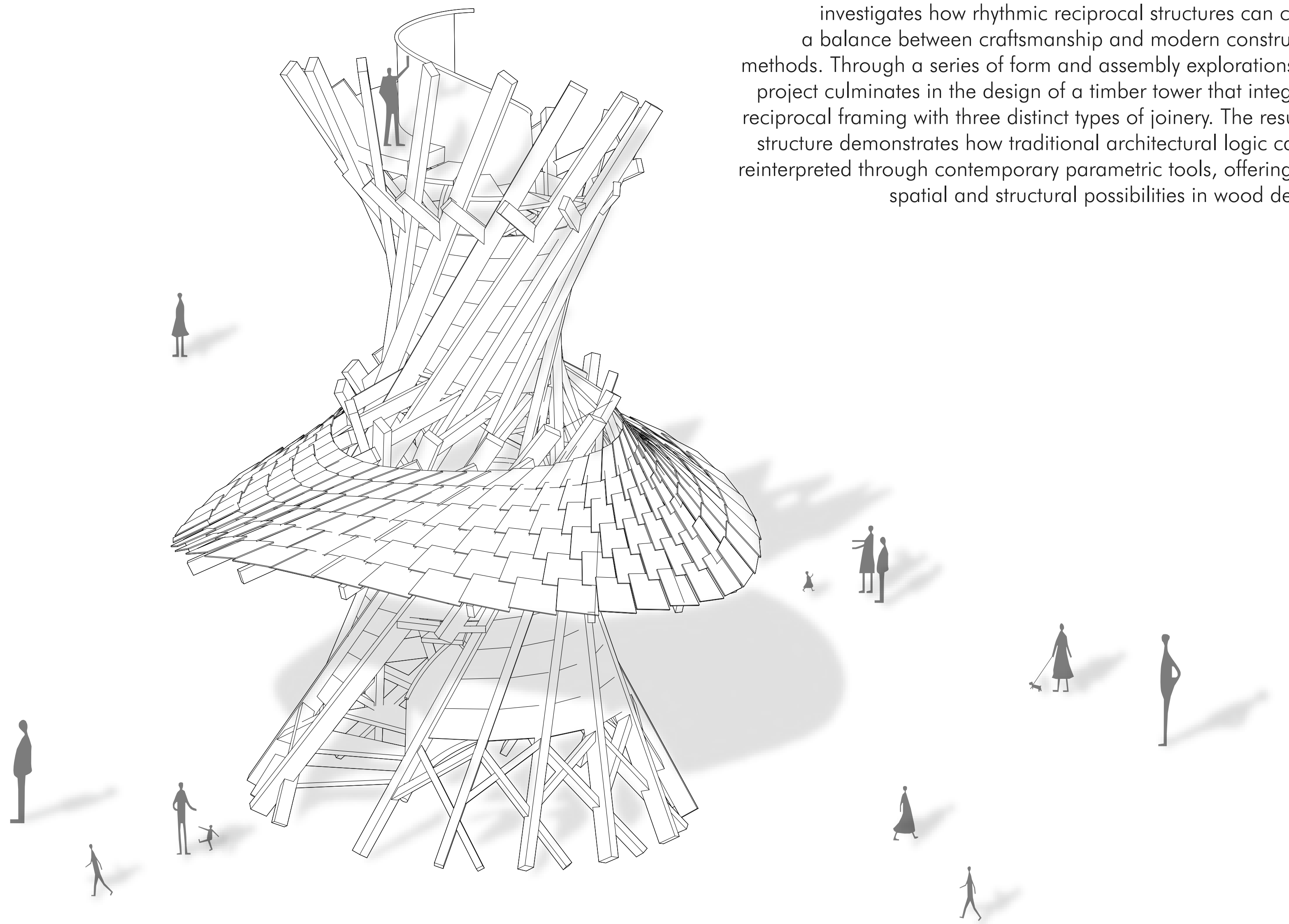




The interior layout of the cultural and research center is defined by cast soil mounds, where mound cluster's size determines the spatial volume of the programs it hosts. A diverse mix of functions is embedded within, labs and other research areas for staff on one side; exhibition spaces, classrooms, and a greenhouse for public engagement on the other. This division generates two parallel circulation systems including one for visitors, and one for researchers, with shared zones of research display and observation in between. The spatial strategy ensures that public interaction is welcomed without disrupting daily scientific work. At the river's edge, a flood buffer zone is introduced to mitigate potential water rise, while a series of semi-covered open spaces nearby invite gathering. The site section illustrates how the architecture gently grows from the land, textured with soil and embedded in its context, merging building and landscape into one continuous system.

Section

This research-based project explores the potential of reciprocal wooden frames and traditional joinery techniques. The study investigates how rhythmic reciprocal structures can create a balance between craftsmanship and modern construction methods. Through a series of form and assembly explorations, the project culminates in the design of a timber tower that integrates reciprocal framing with three distinct types of joinery. The resulting structure demonstrates how traditional architectural logic can be reinterpreted through contemporary parametric tools, offering new spatial and structural possibilities in wood design.



02

Rethinking Tradition in Wood Linear Assemblies

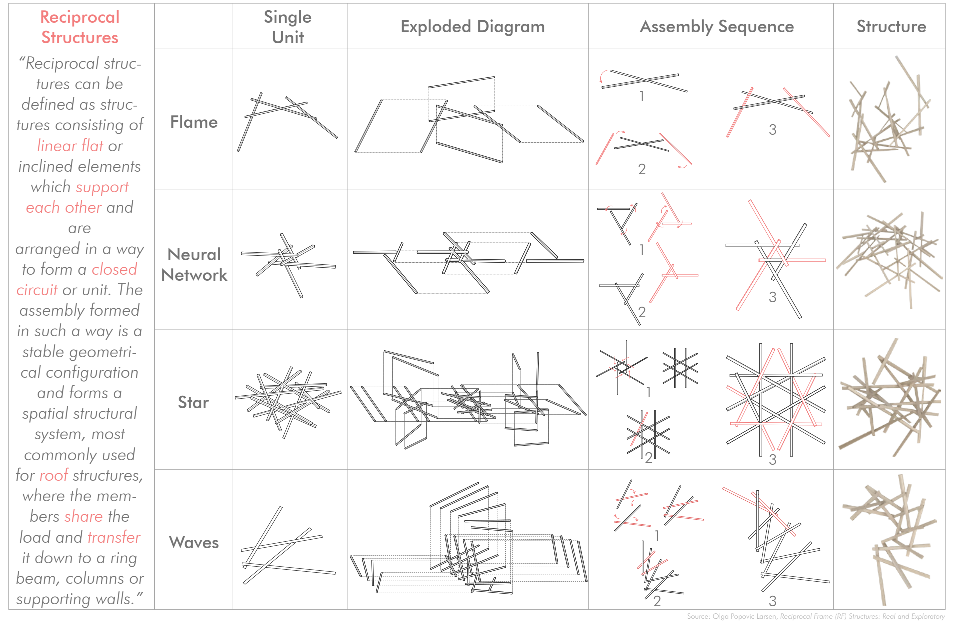
Project Type: Research based Design|Material Study

Focus: Reciprocal Wooden Structures|Joinery Techniques|Parametric Design|Spatial Assembly

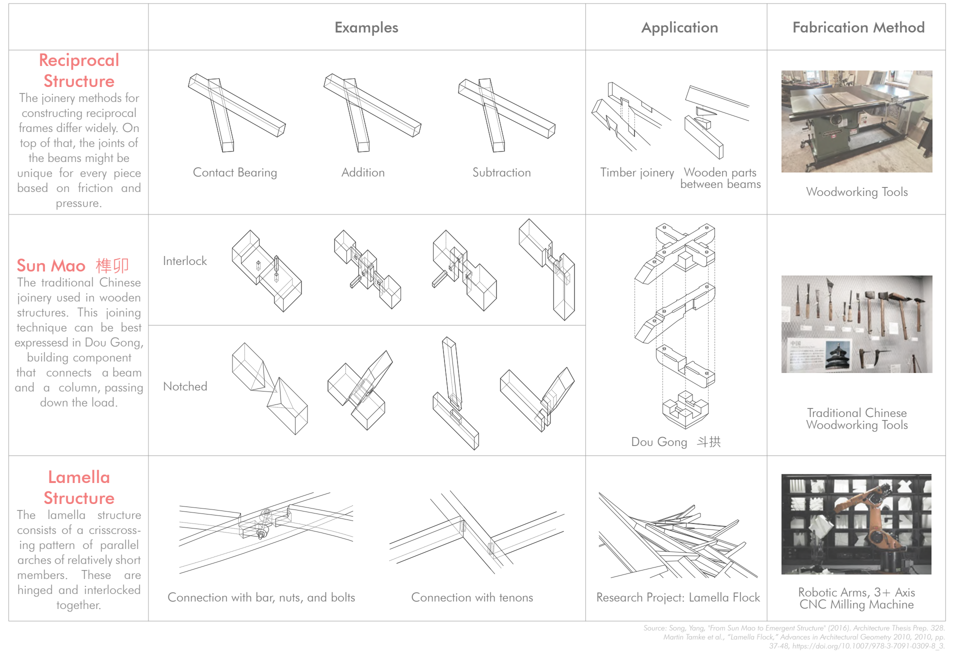
Tool: Rhino|Grasshopper|Kangaroo|Karamba|Enscape

Project Context: Academic Project|University of Toronto

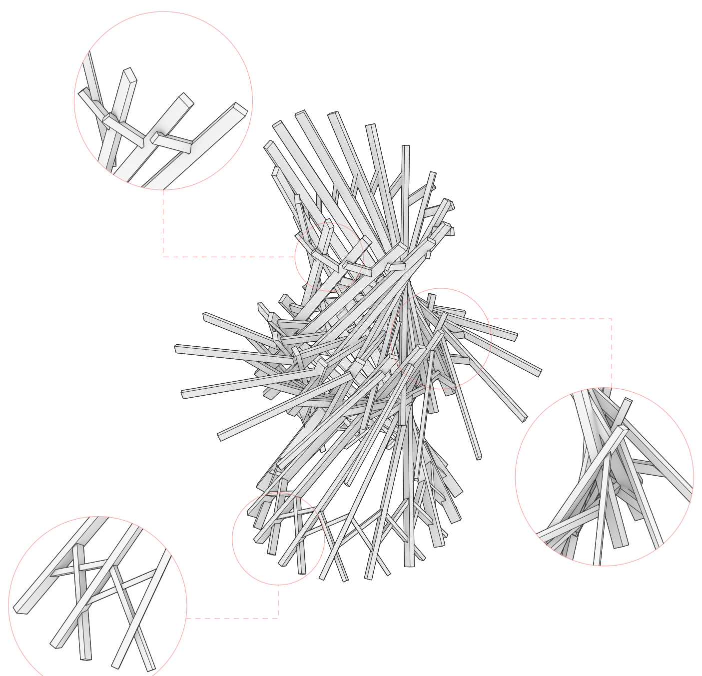
Research Taxonomy on Reciprocal Structures


Reciprocal Structures
"Reciprocal structures can be defined as structures consisting of linear flat or inclined elements which support each other and are arranged in a way to form a closed circuit or unit. The assembly formed in such a way is a stable geometrical configuration and forms a spatial structural system, most commonly used for roof structures, where the members share the load and transfer it down to a ring beam, columns or supporting walls."
Single Unit
Exploded Diagram
Assembly Sequence
Structure
Flame
Neural Network
Star
Waves
1
2
3
Source: Olga Popovic Larsen, Reciprocal Frame (RF) Structures: Real and Exploratory

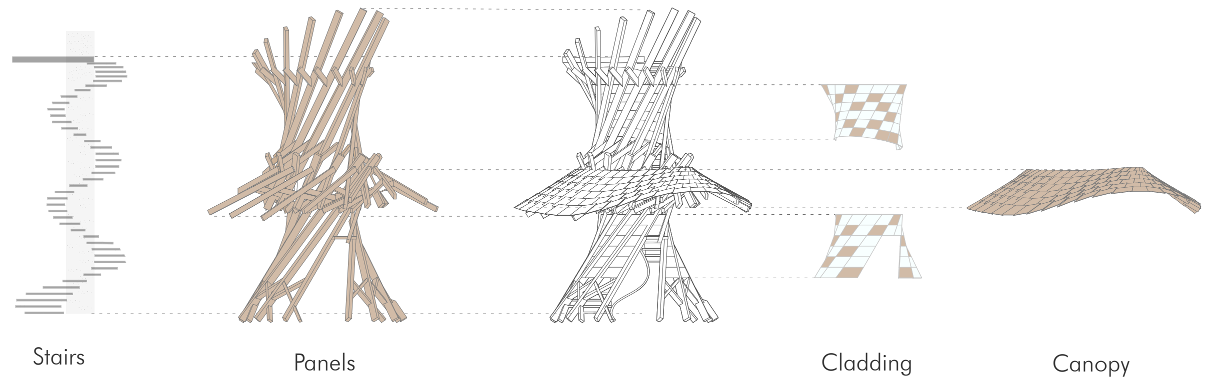
Wood Structure Joinery Methods

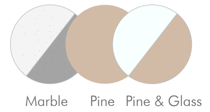

Examples
Application
Fabrication Method
Reciprocal Structure
The joinery methods for constructing reciprocal frames differ widely. On top of that, the joints of the beams might be unique for every piece based on friction and pressure.
Contact Bearing
Addition
Subtraction
Timber joinery
Wooden parts between beams
Woodworking Tools
Sun Mao 榫卯
The traditional Chinese joinery used in wooden structures. This joining technique can be best expressesd in Dou Gong, building component that connects a beam and a column, passing down the load.
Interlock
Notched
Dou Gong 斗拱
Traditional Chinese Woodworking Tools
Lamella Structure
The lamella structure consists of a crisscrossing pattern of parallel arches of relatively short members. These are hinged and interlocked together.
Connection with bar, nuts, and bolts
Connection with tenons
Research Project: Lamella Flock
Robotic Arms, 3+ Axis CNC Milling Machine
Source: Song, Yang, "From Sun Mao to Emergent Structure" (2016). Architecture Thesis Prep. 328.
Martin Tamke et al., "Lamella Flock," Advances in Architectural Geometry 2010, 2010, pp. 37-48, https://doi.org/10.1007/978-3-7091-0309-8_3.

Wooden Tower Design



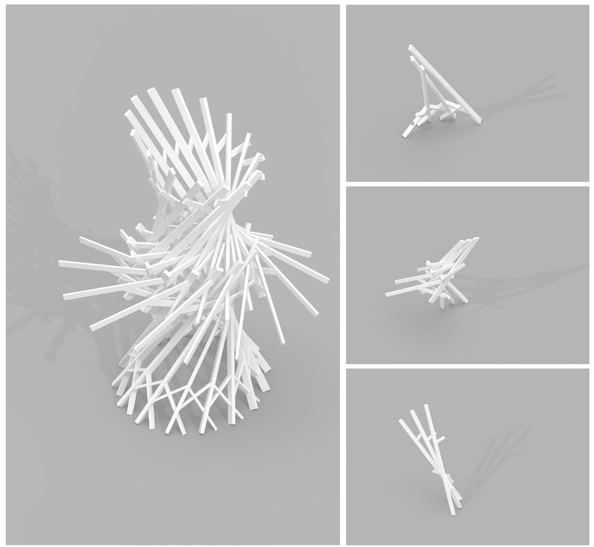
Joineries Details

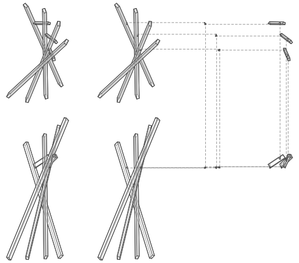


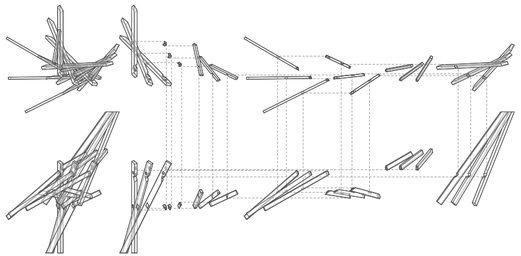


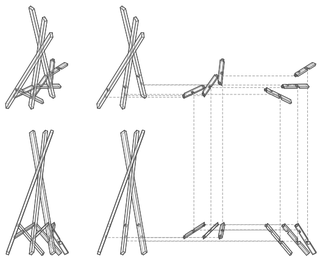
A taxonomy of reciprocal systems and joinery methods forms the structural foundation of the design. Variations such as flame, star, and wave configurations were studied for their spatial logic and assembly behavior. Traditional and modern joineries including Sun Mao, reciprocal interlocks, and lamella systems, were analyzed for their structual adaptability. These tectonic strategies come together in a designed timber tower that twists upward through layered interlocking frames, incorporating three distinct types of joinery. Each layer takes on a different role, from supporting the weight at the base to forming lighter cladding above creating a structure that gradually opens up from a solid base to an lightweight airy canopy.

Joinery Analysis

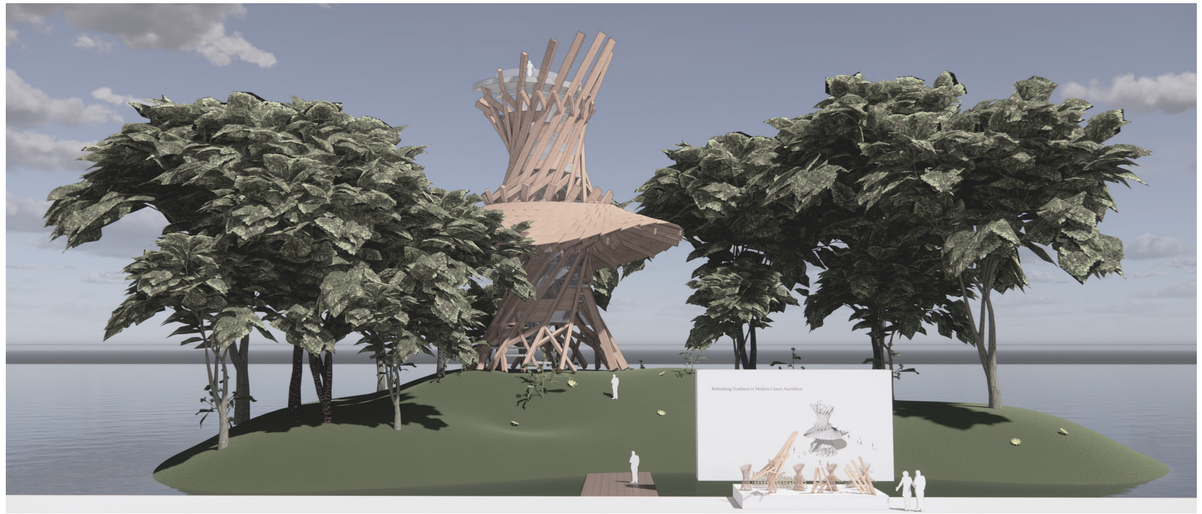


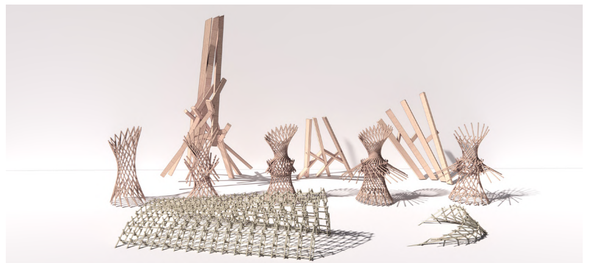


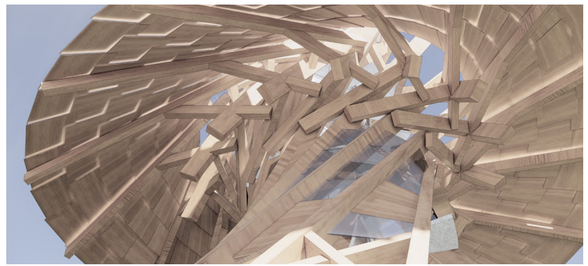




Three different types of joineries are used at different locations to support and enhance the whole structure.

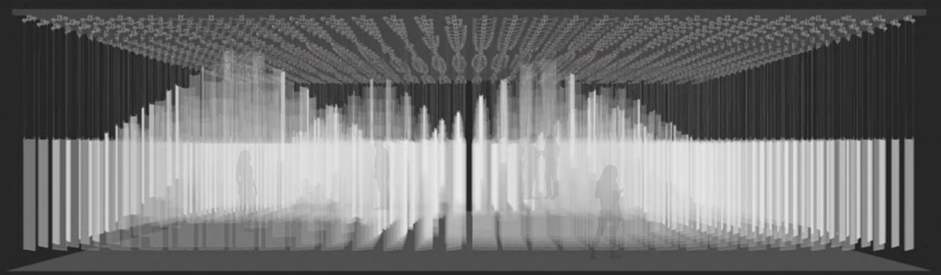






Without access to physical fabrication during the pandemic, the final presentation was staged entirely through real-time rendering. The scene simulates a full-scale outdoor exhibition, complete with scaled figures, study models, and presentation boards, blurring the line between digital and physical. A series of study models guided the design process, beginning with an analysis of Kengo Kuma's Wind Eaves, which offered insights into rhythmic layering and parametric assembly. These early explorations tested reciprocal logic, joinery behavior, and structural performance through iterative physical and digital form finding. The final tower, sited on a remote island, is conceived as a quiet observatory, offering panoramic views by day and a sheltered place for stargazing at night. Its twisting form builds on what was learned through the study models, using layered structures to create something both light and open. The final design opens up to the surrounding landscape and creates a peaceful place to enjoy the view, and take a moment to relax.

This project proposes an interactive spatial system inspired by the challenges of maintaining social distance during the Covid-19 pandemic. Rather than relying on static ground markers, the design envisions a kinetic isolation field that responds dynamically to human presence. The system is composed of a dense field of ceiling-mounted panels that adjust their height and rotation based on the real-time movement of visitors, creating individual spatial bubbles around each person. Through a layered mechanism of motors, sensors, and parametric control, the installation continuously reshapes its spatial configuration to maintain safe distancing, while also enabling fluid circulation patterns. The project explores how architecture can actively mediate social behavior through movement-driven responsiveness, transforming a public space into an adaptable and interactive environment.



03

The Isolation Field

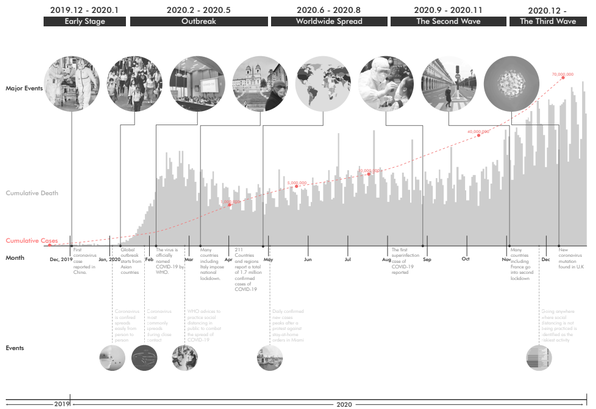
Project Type: Interactive Spatial Installation | Kinetic Architecture

Focus: Movement Manchnism | Kinetic Responsive Space | Parametric Design

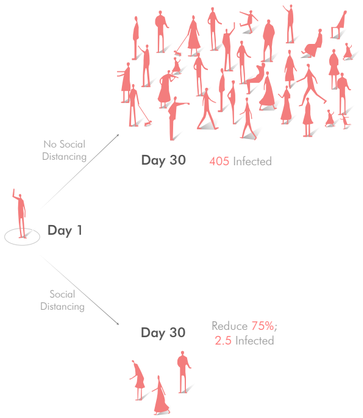
Tool: Rhino | Grasshopper | Firefly | Arduino | Processing | Enscape | V-Ray

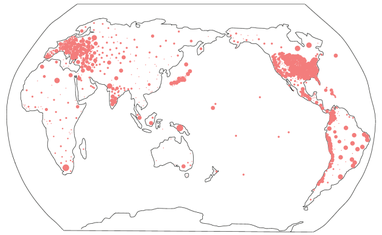
Project Context: Academic Project | University of Toronto

The Possible Forms Designed for a Fashion Week



The spread of Covid-19 mainly happens among people when an infected person coughs or talks and the droplet in the air caught by the people within about 2 meters. A study by *Statista* illustrates that practicing social distancing slows down the exponential spread of the virus by 75%. In a crowd with one infected case which practices social distancing, only 2.5 people will be infected after 30 days while not practing social distancing, the number of people infected will increased significantly by 404. Social distancing is also confirmed by WHO as the most effective way to stop the spread of COVID-19. It is also the most popular and common approach to keep people safe and healthy during the pandemic in the daily life.





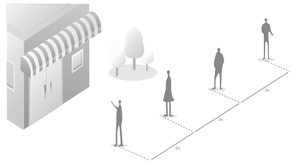
Source: Johns Hopkins University, Coronavirus Resources Center, https://coronavirus.jhu.edu/map.html

Distribution of Cumulative cases

Global Total Deaths
2,129,418

COVID-19 as the one of the most impactful, dangerous, and infectious diseases, has spreaded to more than 220 countries and causes a total number of 99,225,963 confirmed cases around the world. More unfortunately, the global total death cases has accumulated to 2,129,418 until January, 2021. Many countries including Canada, impose a national lockdown policy which brings a great influence to global economy and people's social life.

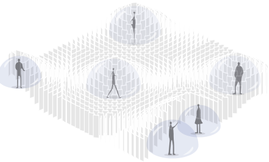
Concept and Strategy



The design starts from rethinking the existing approach to practice social distancing. People usually stand behind lines drawn on the ground and move between lines to keep a safe distance with others.

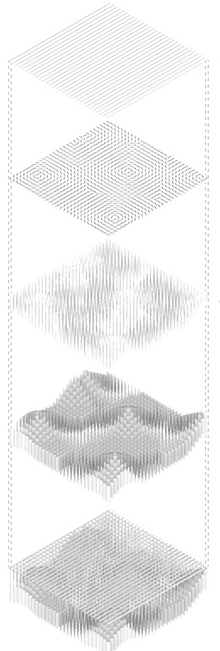
If there is a bubble with a radius of 1 meter around everyone and moves when people moves, practicing social distancing between each other consistanly would be much more easily achieved.

The idea of having bubbles around people can be achieved with floating panels surrounding them while they move. As the floating panels follow the movement of people, social distance is achieved.



If panels form a field, when people move inside the field, wherever they go, social distance is always kept between them. This field can be used not only in a queue but also in large-scaled public spaces.

System Analysis



Supporting Structure

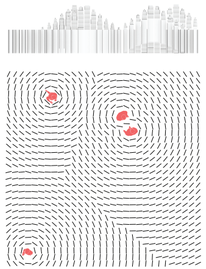
Motors
Contains 3 motors and load transfering bearings

Hinging Structure
Wires connecting motors and panels

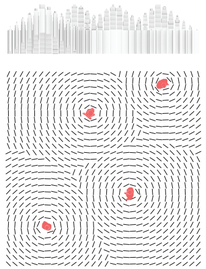
Panels
Space defining structure through rotary and linear movements

Possible Circulations

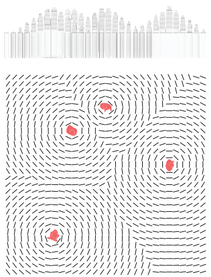
When two people move towards each other and meet in the field...



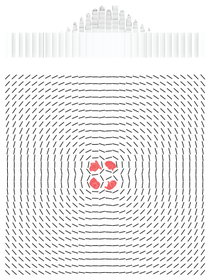
When four people moving towards different directions...



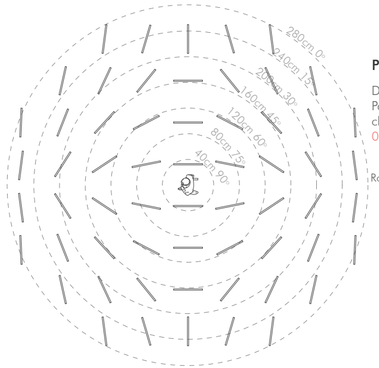
When two people move towards different directions and pass by...



When four people meet in the middle of the field...

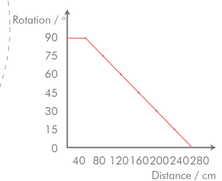


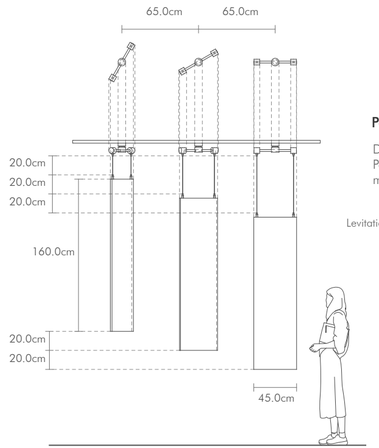
Mechanism and Components



Panel Rotation

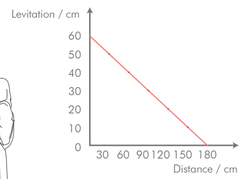
Detection range: 0 - 280cm
Panel Ratation range:
clockwise or counter-clockwise
0 - 90°

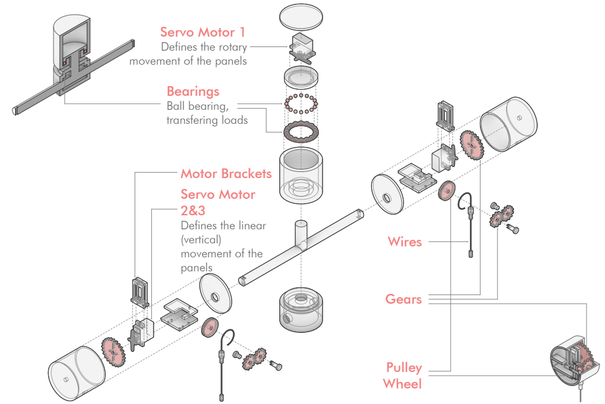




Panel Levitation

Detection range: 0 - 180cm
Panel Levitation range:
moving down 0 - 60cm

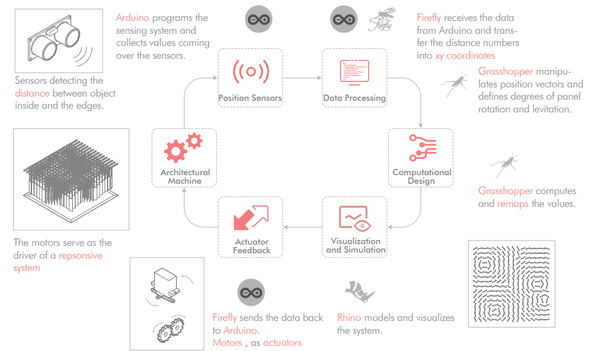




Workflow

Data Generation

Data Analysis



Data Actuation

Data Visualization

This project investigates the potential of robotic arms for spatial fabrication beyond conventional assembly tasks. The process began with scripting and testing robotic movement, and controlling direction, radius, and speed through parametric programming. Building on this control, the project explores an application where the robotic arm performs a task unachievable by human hands: precision “printing” of volumetric forms using crystallized sugar. A custom toolhead and workflow were developed to layer sugar syrup within a powder bed, forming stable 3D structures through material crystallization. The project demonstrates how robotic arms can enable enable new material-based fabrication and spatial outcomes through kinetic precision and iterative testing.

04

Robotic Arm Movement and Material Experimentation

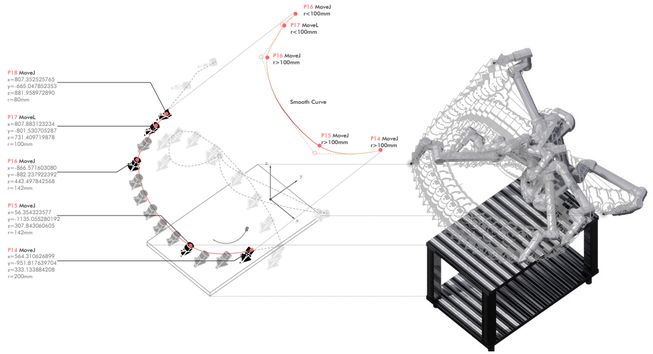
Project Type: Robotic Movement Study|Experimental Fabrication

Focus: Robotic Arm Control|Parametric Scripting|Material Study

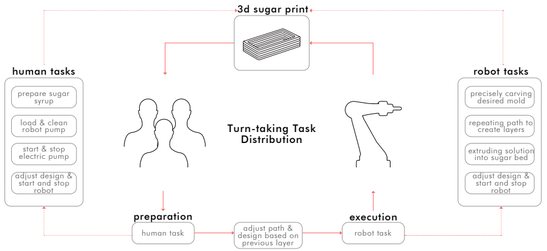
Tool: Rhino|Grasshopper|KUKA Robot|KUKA PRC|Custom Toolhead

Project Context: Academic Project|M.Arch Studio|University of Toronto

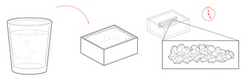
Robot Movement Test



Task Division

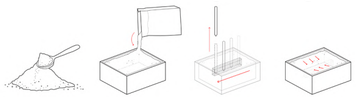


Concept



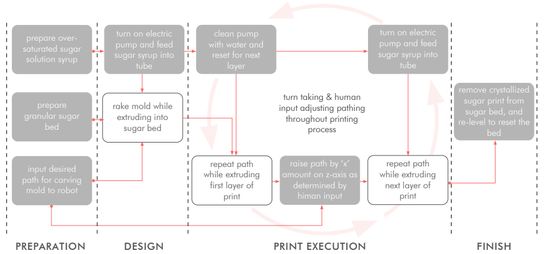
Oversaturate sugar and water solution to create syrup. Pour syrup into carved form in sugar bed. Over time,the sugar solution will crystallize becoming solid and removeable.

Sugar Printing Base

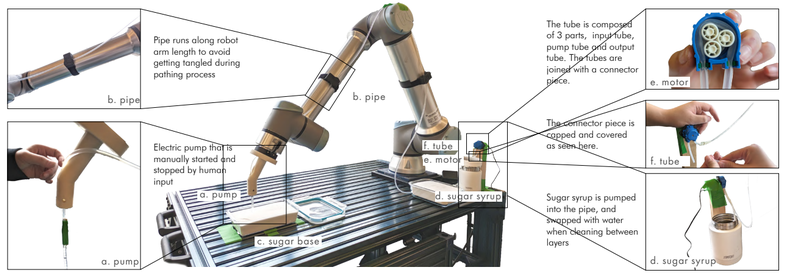


Disperse powdered sugar. Confine sugar in solid container. Rake desired shape into sugar bed and remove. Disturbed sugar will fall back into place and self-level.

Workflow



System Setup



Robot Movement Script

```
while (True):
    $ 2 "Robot Program"
    $ 5 "MoveL"
    $ 6 "Waypoint_1" "breakAfter"
    movel(Waypoint_1_p, a=1.2, v=0.25)
    $ 7 "MoveL"
    $ 8 "Waypoint_2" "breakAfter"
    movel(Waypoint_2_p, a=1.2, v=0.25)
    $ 9 "MoveL"
    $ 10 "Waypoint_3" "breakAfter"
    movel(Waypoint_3_p, a=1.2, v=0.25)
    $ 11 "MoveL"
    $ 12 "Waypoint_4" "breakAfter"
    movel(Waypoint_4_p, a=1.2, v=0.25)
    $ 13 "MoveL"
    $ 14 "Waypoint_5" "breakAfter"
    movel(Waypoint_5_p, a=1.2, v=0.25)
    $ 15 "MoveL"
    $ 16 "Waypoint_6" "breakAfter"
    movel(Waypoint_6_p, a=1.2, v=0.25)
    $ 17 "MoveL"
    $ 18 "Waypoint_7" "breakAfter"
    movel(Waypoint_7_p, a=1.2, v=0.25)
    $ 19 "MoveL"
    $ 20 "Waypoint_8" "breakAfter"
    movel(Waypoint_8_p, a=1.2, v=0.25)
    $ 21 "MoveL"
    $ 22 "Waypoint_9" "breakAfter"
    movel(Waypoint_9_p, a=1.2, v=0.25)
    $ 23 "MoveL"
    $ 24 "Waypoint_10" "breakAfter"
    movel(Waypoint_10_p, a=1.2, v=0.25)
    $ 25 "MoveL"
    $ 26 "Waypoint_11" "breakAfter"
    movel(Waypoint_11_p, a=1.2, v=0.25)
    $ 27 "MoveL"
    $ 28 "Waypoint_12" "breakAfter"
    movel(Waypoint_12_p, a=1.2, v=0.25)
    $ 29 "MoveL"
    $ 30 "Waypoint_13" "breakAfter"
    movel(Waypoint_13_p, a=1.2, v=0.25)
    $ 31 "MoveL"
    $ 32 "Waypoint_14" "breakAfter"
    movel(Waypoint_14_p, a=1.2, v=0.25)
    $ 33 "MoveL"
    $ 34 "Waypoint_15" "breakAfter"
    movel(Waypoint_15_p, a=1.2, v=0.25)
    $ 35 "MoveL"
    $ 36 "Waypoint_16" "breakAfter"
    movel(Waypoint_16_p, a=1.2, v=0.25)
    $ 37 "MoveL"
    $ 38 "Waypoint_17" "breakAfter"
    movel(Waypoint_17_p, a=1.2, v=0.25)
    $ 39 "MoveL"
    $ 40 "Waypoint_18" "breakAfter"
    movel(Waypoint_18_p, a=1.2, v=0.25)
  end
end
```

This project explores visual strategies for merging architecture and landscape, using AI-driven image generation as a conceptual design tool. Through an iterative workflow combining site, architectural form, environmental atmosphere, and cinematic style, the project investigates how spatial boundaries between built and natural environments can be blurred. The evolving image series demonstrates how layered prompts and controlled parameters can articulate design intentions and test aesthetic outcomes in a fast, flexible manner.

05

Architecture-Landscape Fusion through Visual Exploration

Project Type: Conceptual Study | Visual Exploration | AI-Enhanced Design

Focus: Iterative Image Generation | Prompt Crafting | Visual Narratives

Tool: Midjourney | Visual Workflow Mapping

Project Context: Academic Project | University of Toronto

Prompt & Image Evolution and Visual Workflow