

PORTFOLIO

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Design Across Disciplines

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01 Egglo

– Collaborative Design Through Embodied Interaction

Design and Making Across Disciplines
Fall 2022

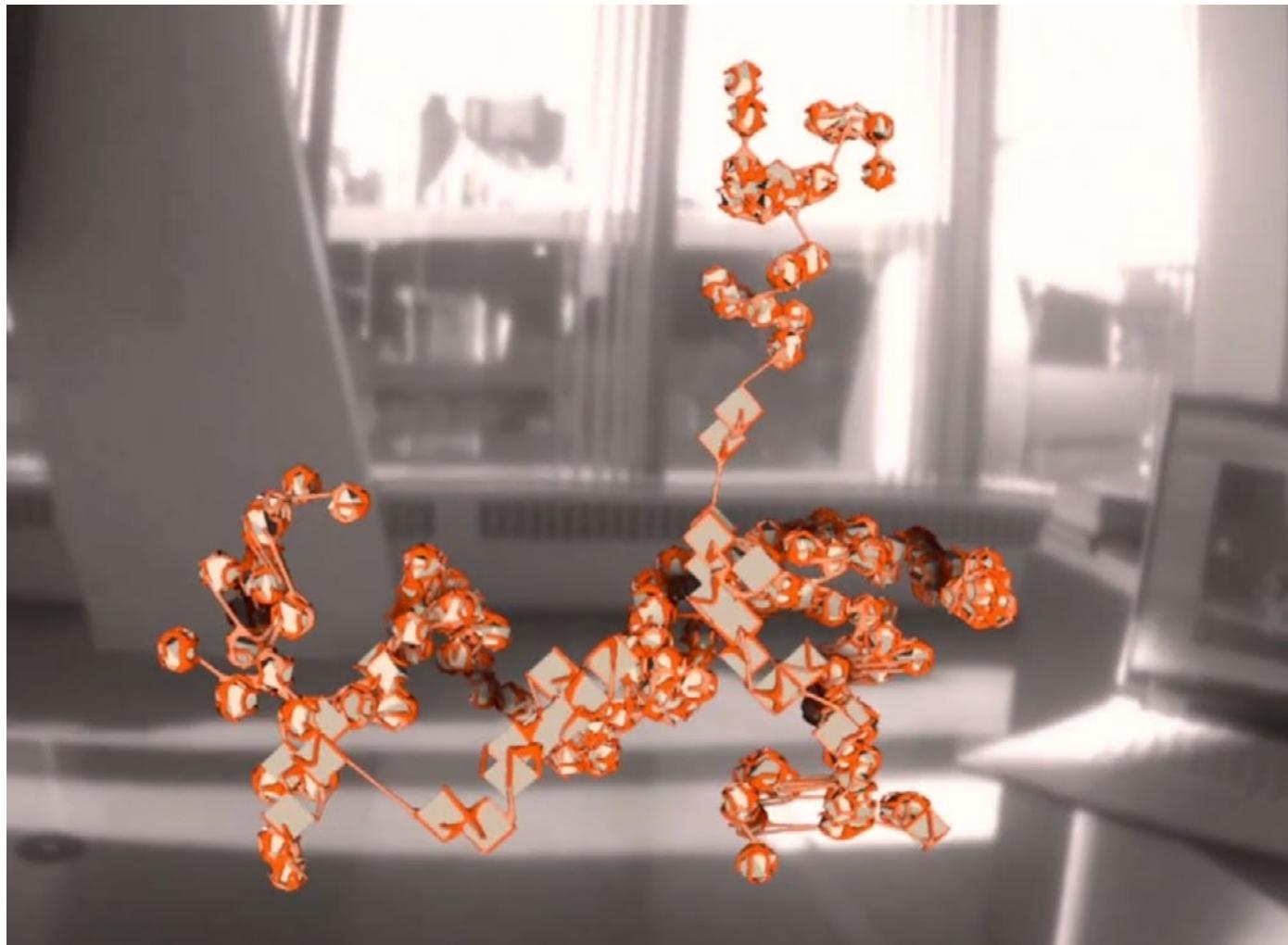
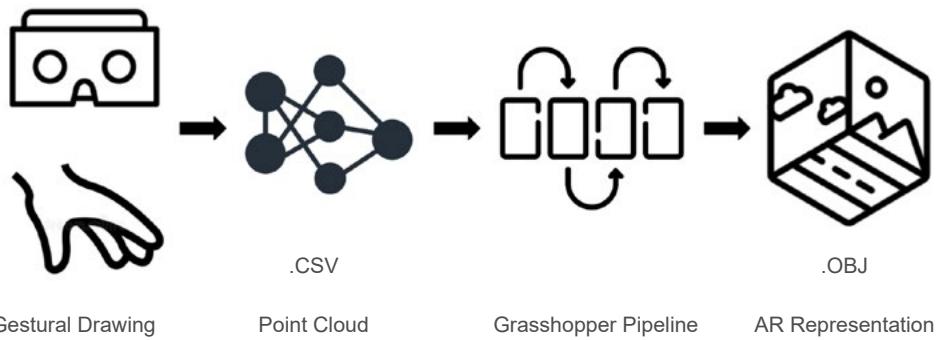
Instructor: Jenny Sabin

Collaborator: Julia Barnoin, Yibo Zhang

Contribution: Conceptual design, fabrication, implementation

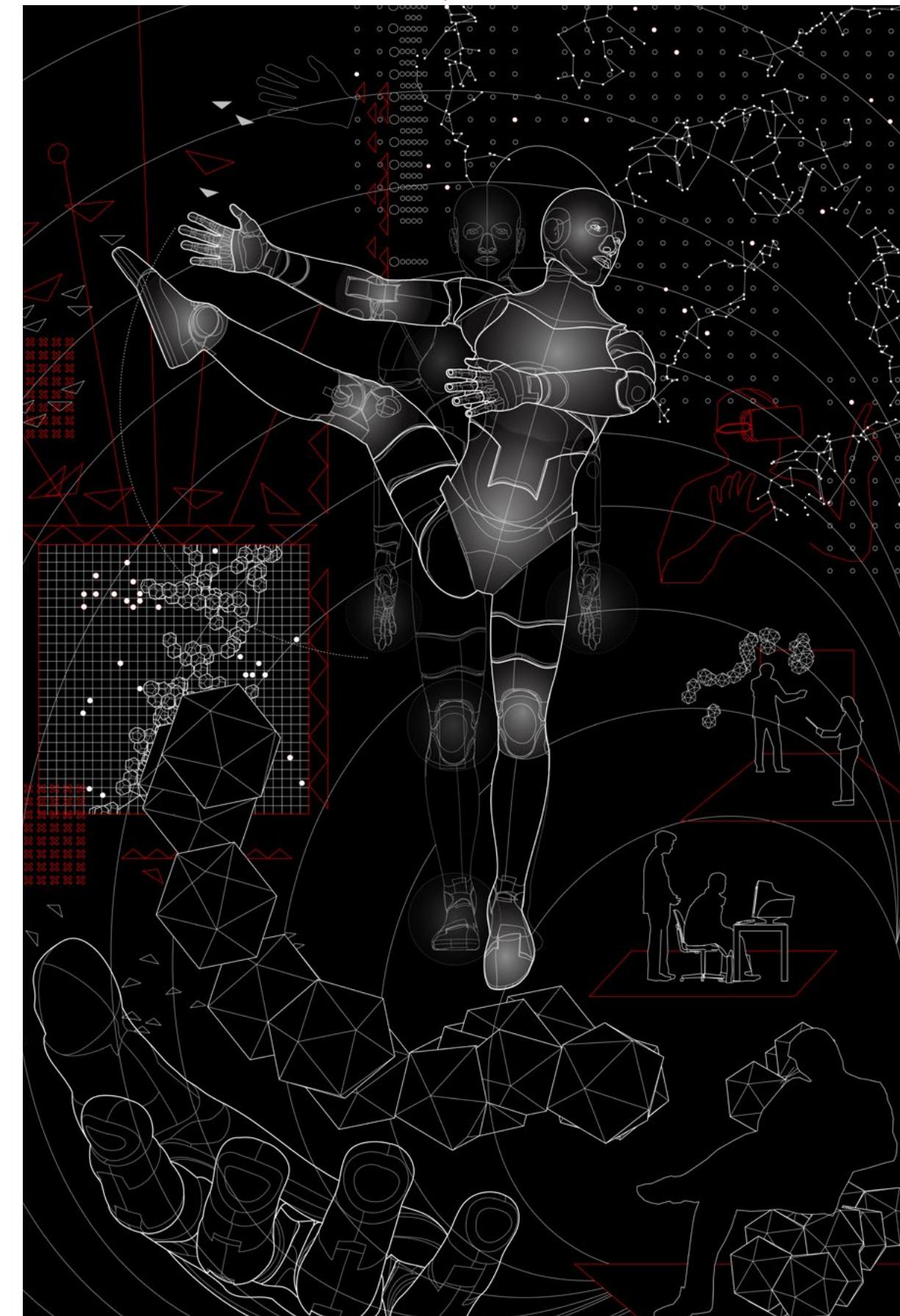
[<Video Documentation>](#)

Egglo is a collaborative parametric design system that bridges the expressive movements of performative activities with the rigorous reasoning of a designer. Wearing an Extended Reality headset, dancers, musicians, and other performers can translate their professionally trained bodily movements into spatial geometries. The design outcome will be displayed in the Augmented Reality space, and materialized through digital fabrication methods.



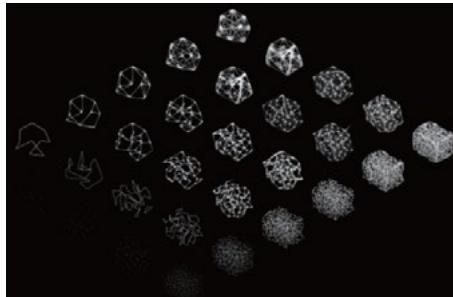
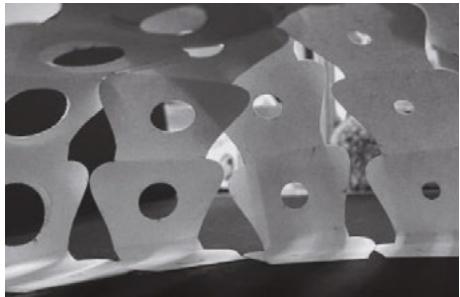
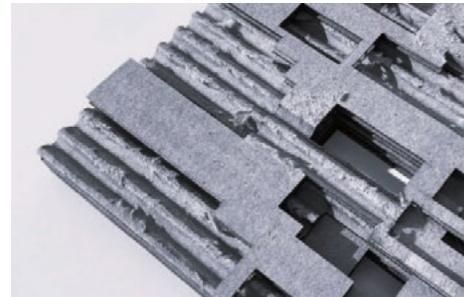
Gesturally Generated Geometry Visualized in AR Space

Embodied Movement Actualized in AR Space



Collage Diagram

Inspirations from Three Biological Patterns



Pattern Models of the Three Parametric Rulesets of Biological Patterns

Egglo Process

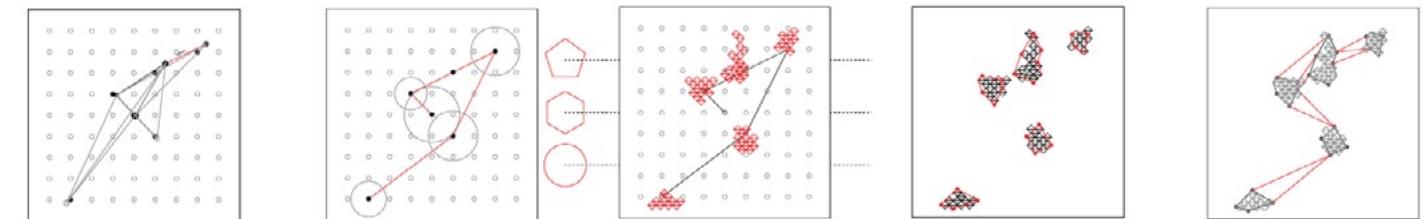
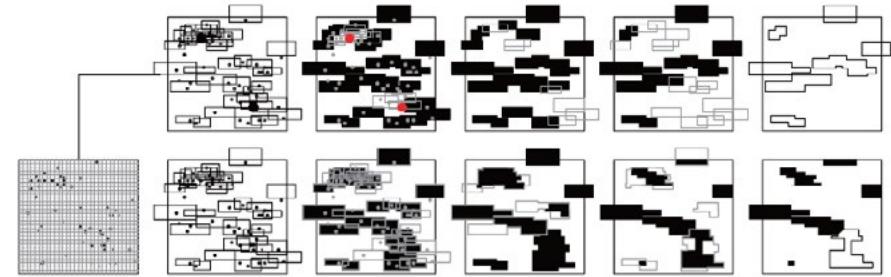
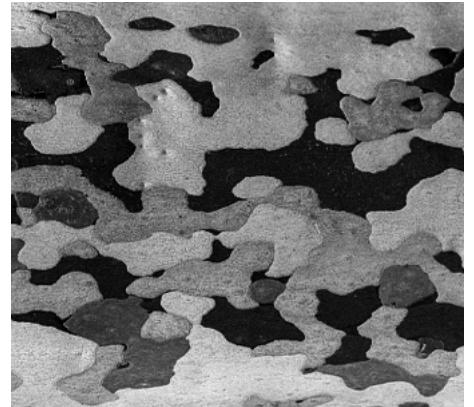
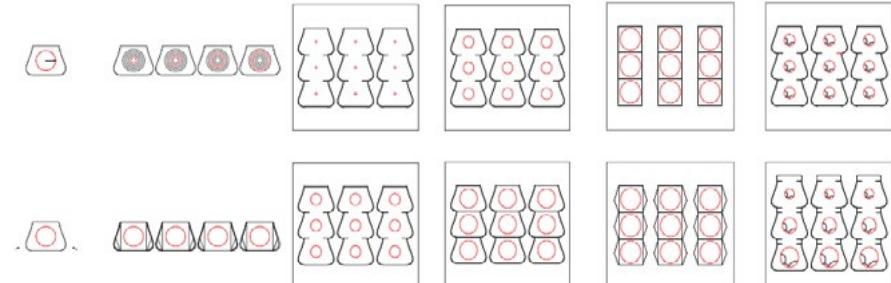
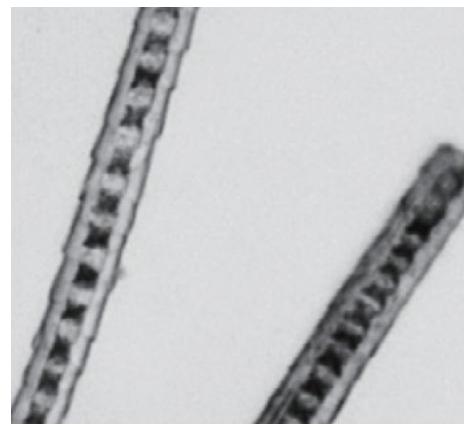


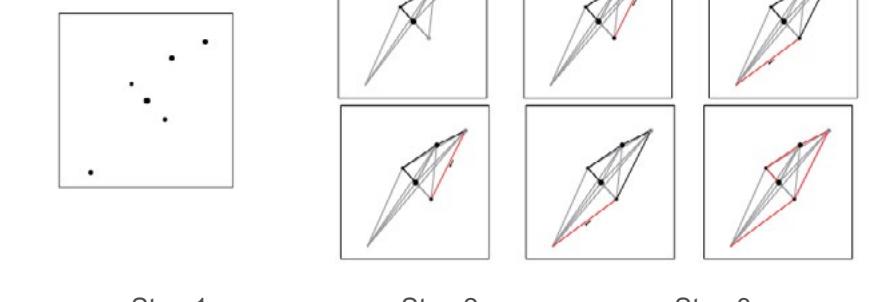
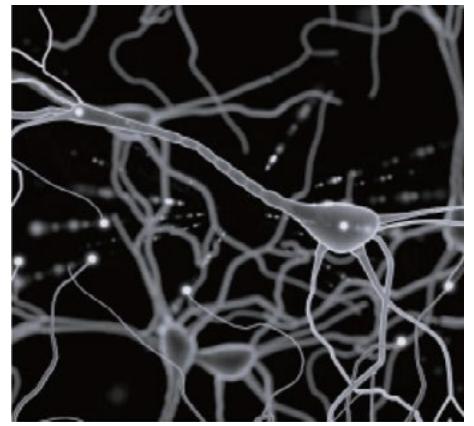
Diagram of the Generation Process from Point Cloud Inputs to Nested Geometries



Tree Bark

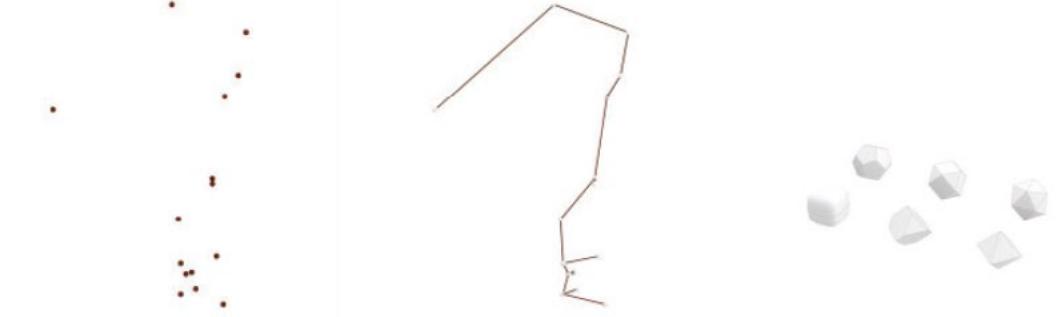


Cat Hair



Neural Network

Input
Input the gestural point cloud, connection type, and module selection



Agglomeration
Aggregate along the optimized connections between points



Nesting
Nest around agglomeration and connect the floating elements





Trace of Human Body Visualized in AR

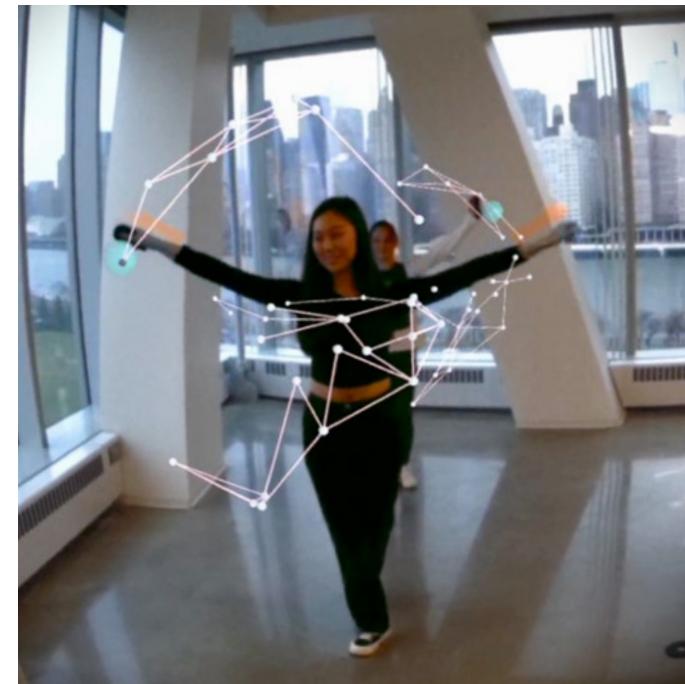


Sign Language as Input Enabled by Hand Tracking

The Collaborative Workflow

The project is collaborative in two dimensions:

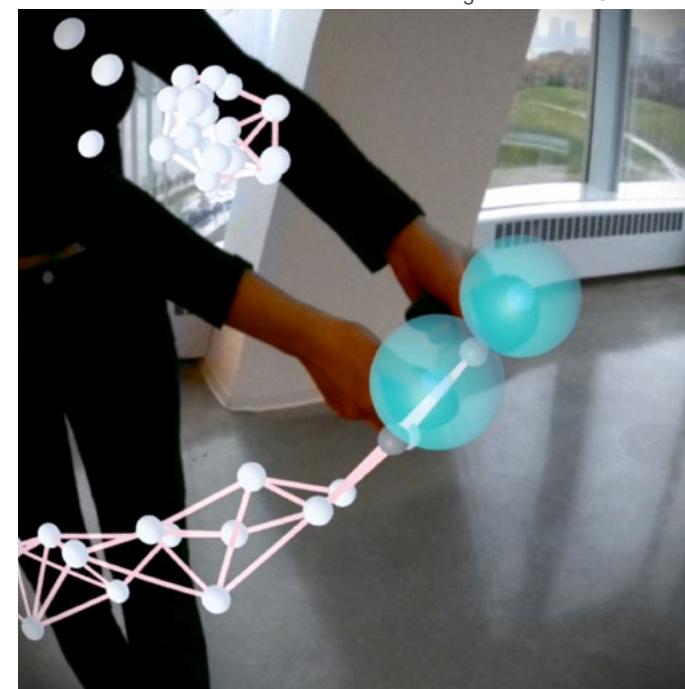
- The actualized geometry is based on the combination of the movement of the performer holding motion controllers for gestural tracking, the ruleset of the designer who developed the parametric ruleset, and the selection of module and nesting type by the observer wearing the Extended Reality headset.
- The design can be repetitively iterated and expanded over a timespan by multiple groups of people.



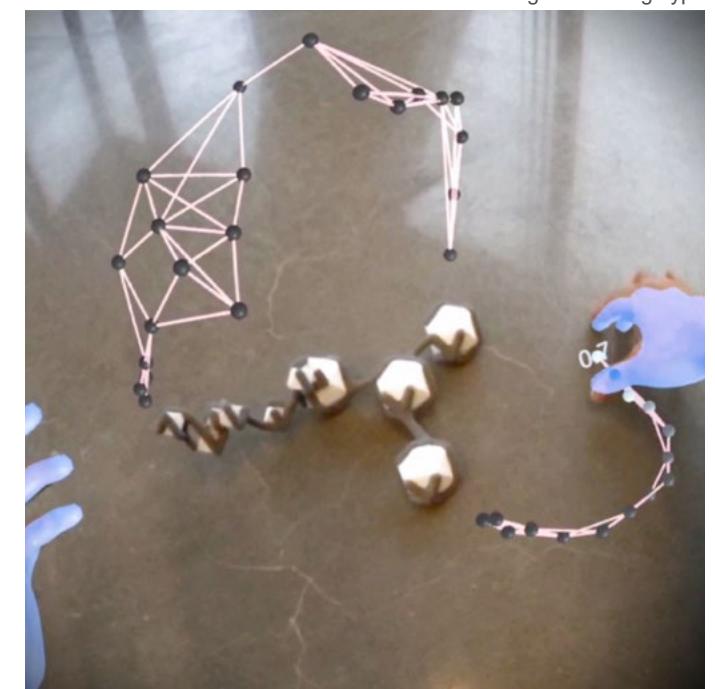
Duet Dancing with Motion Controllers



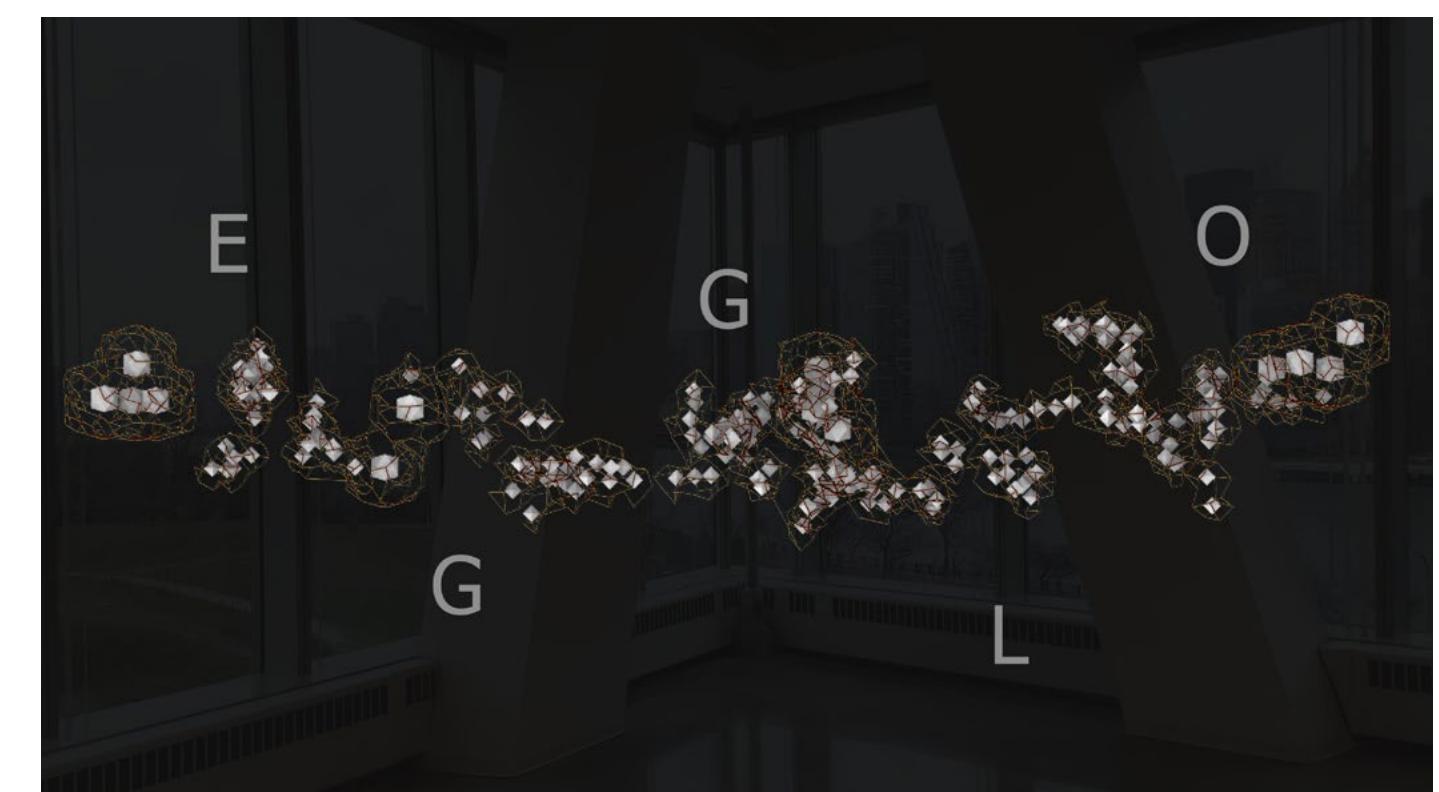
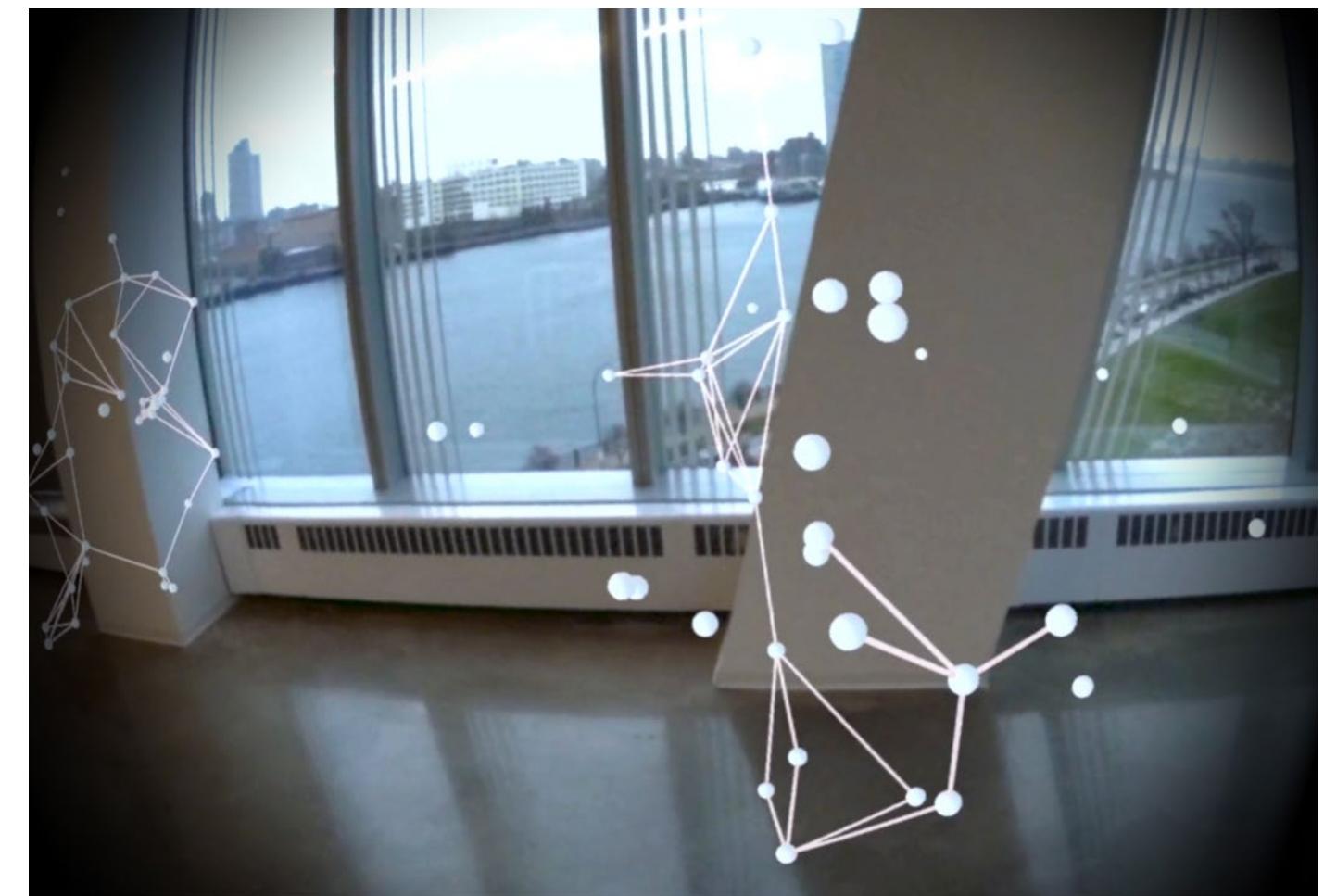
Selecting the Nesting Type



Point Cloud Created Through Bodily Movements

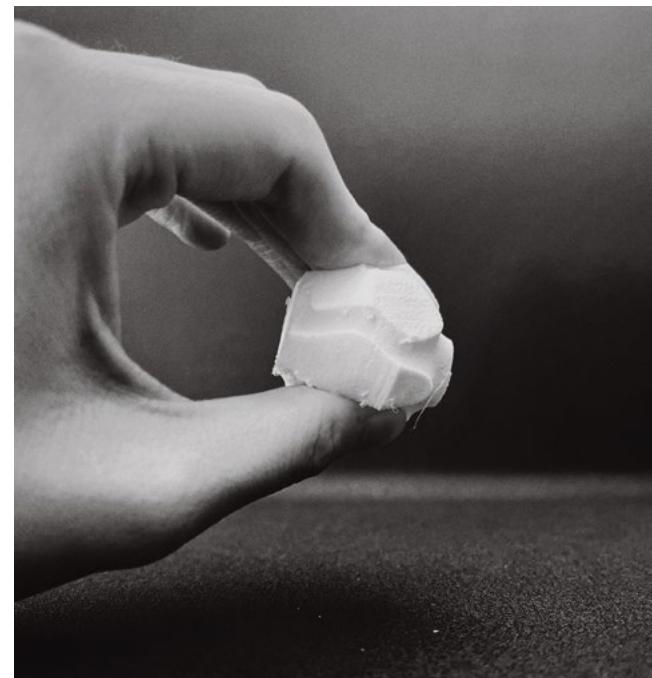
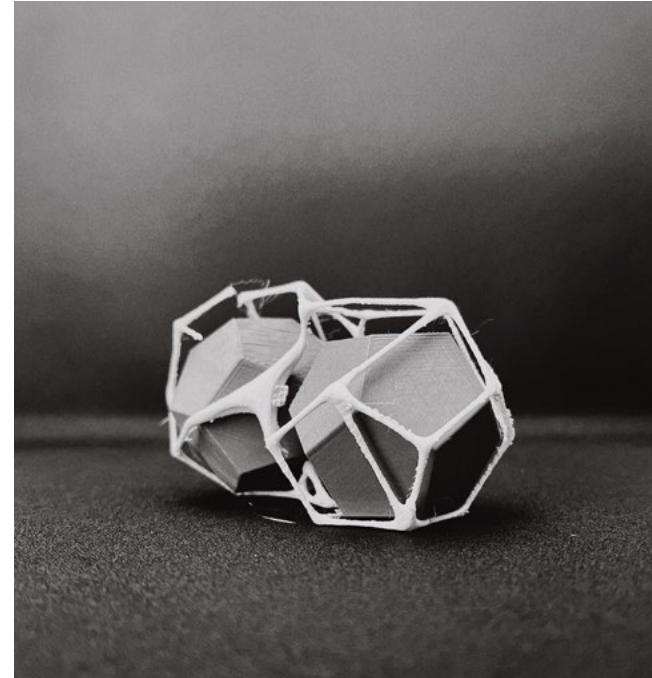
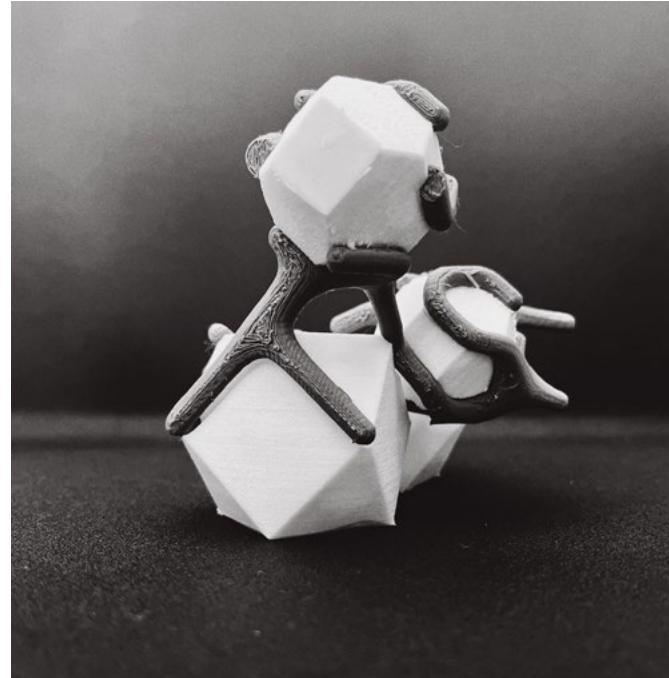


Iterative Gestural Drawing upon Fabricated Geometry



Materialization through Digital Fabrication

The generated geometries are fabricated with 3D printing and casting techniques. Materials of different elasticity are experimented. Different ways to split the complex geometry into printable and castable units are explored.



Making Design Accessible to the Community

Egglo was presented to the general public on the Open Studio, when anyone from the community was able to view the hybrid world through the Extended Reality headset, intuitively draw and create their unique gestural design, and experience the generated parametric geometries immersively in space. Egglo was able to document the concepts of and make design more accessible to people who have never been trained in a design program.



02 OCCUPYING CHAMBER

– Parametric Glass-Ceramic Facade

Coevolutionary Archetypes Studio

Fall 2019

Advisor: Naomi Frangos

Individual Work

[<Video Documentation>](#)

The project investigates the materiality of glass and ceramic, digital fabrication methods, and multimodal representations through a full-scale installation and an AR mobile application. Reconfigurable molds are designed and built for both glass and ceramic, to generate modules for a parametric façade that dynamically adapts to different lighting, ventilation, and heating conditions.



Glass Units - Side



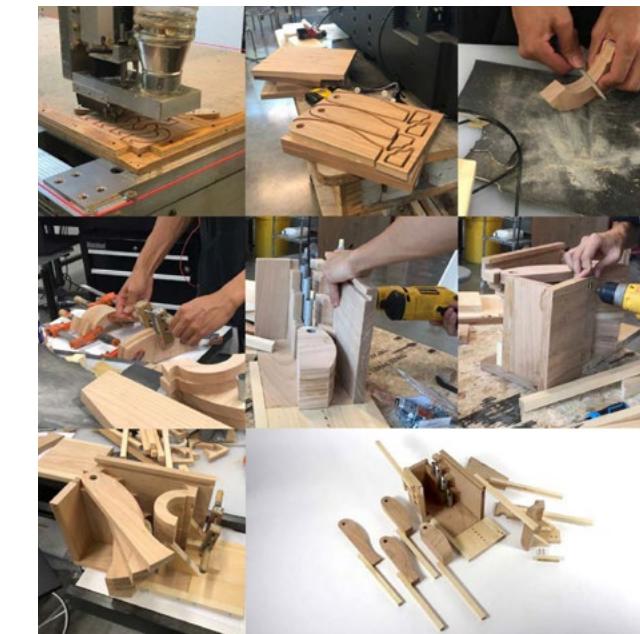
Glass Units - Top

Glass Blowing

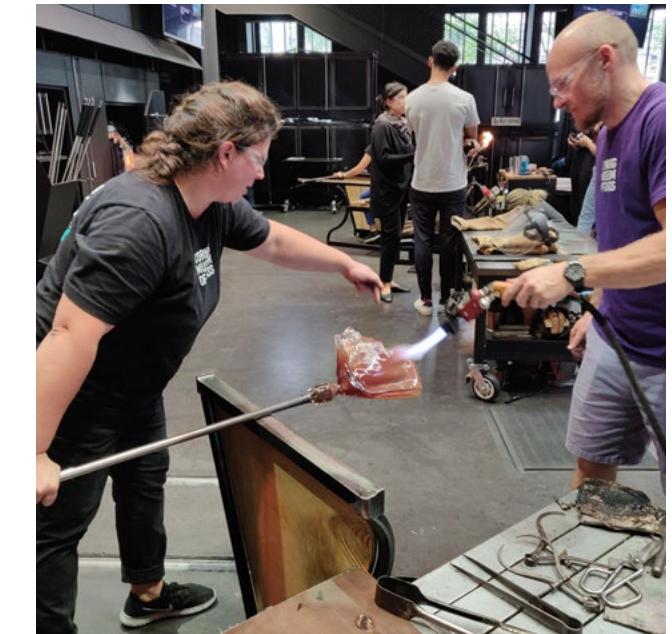
The reconfigurable cherry wood mold has four rotating wings applying pressure to the cavity where glass is blown into. This process documents the coevolution relation between arboreal ants and myrmecodia.



Cherrywood Mold After Glass Blowing



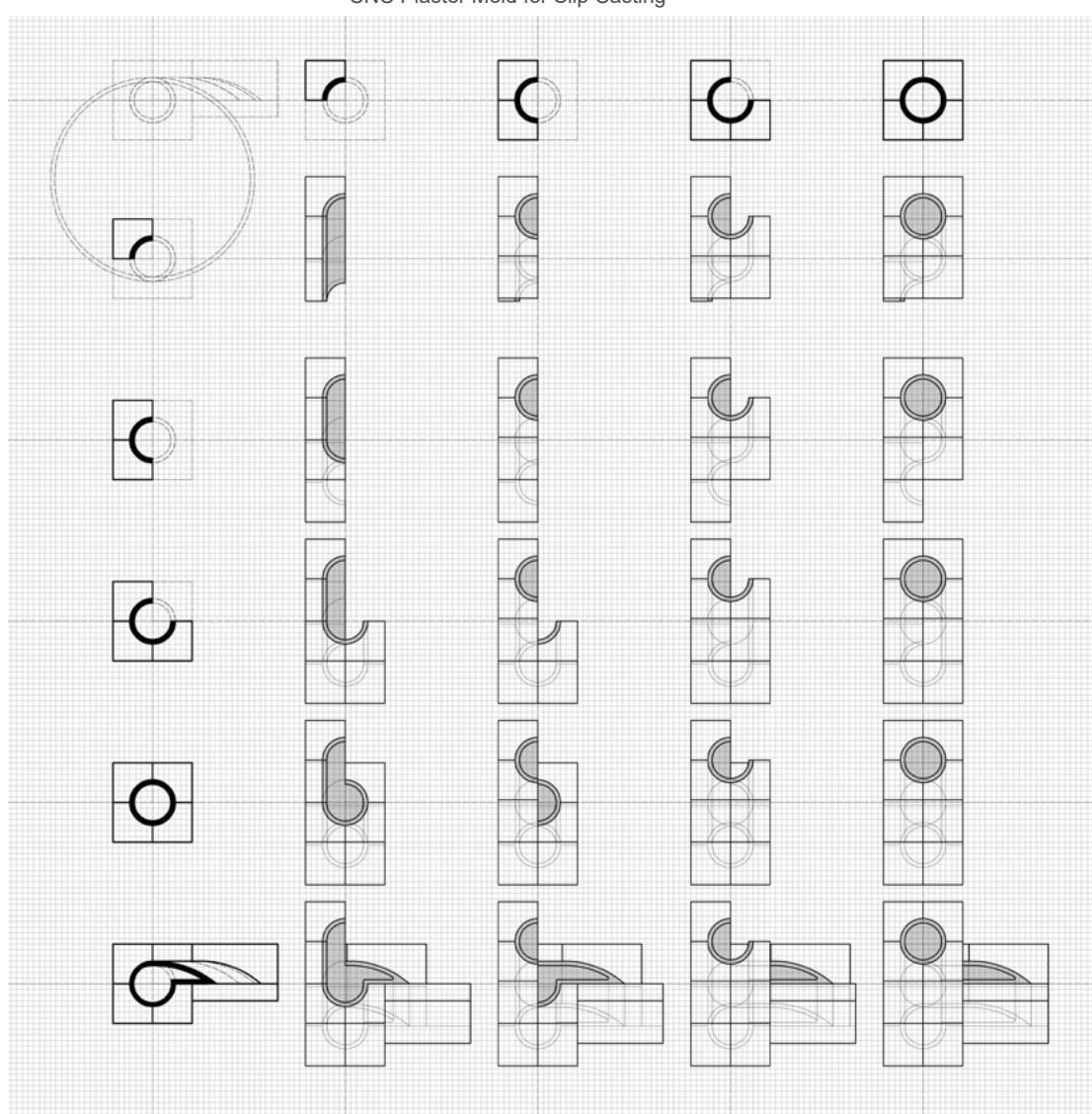
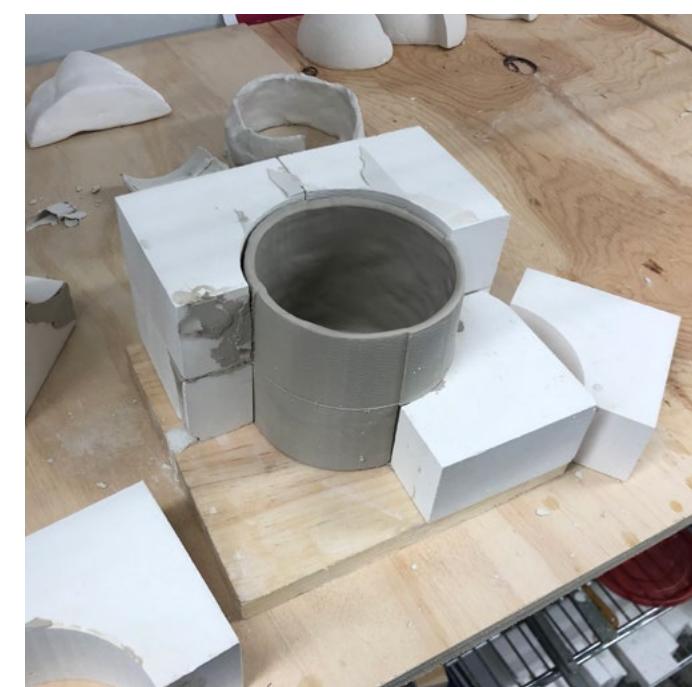
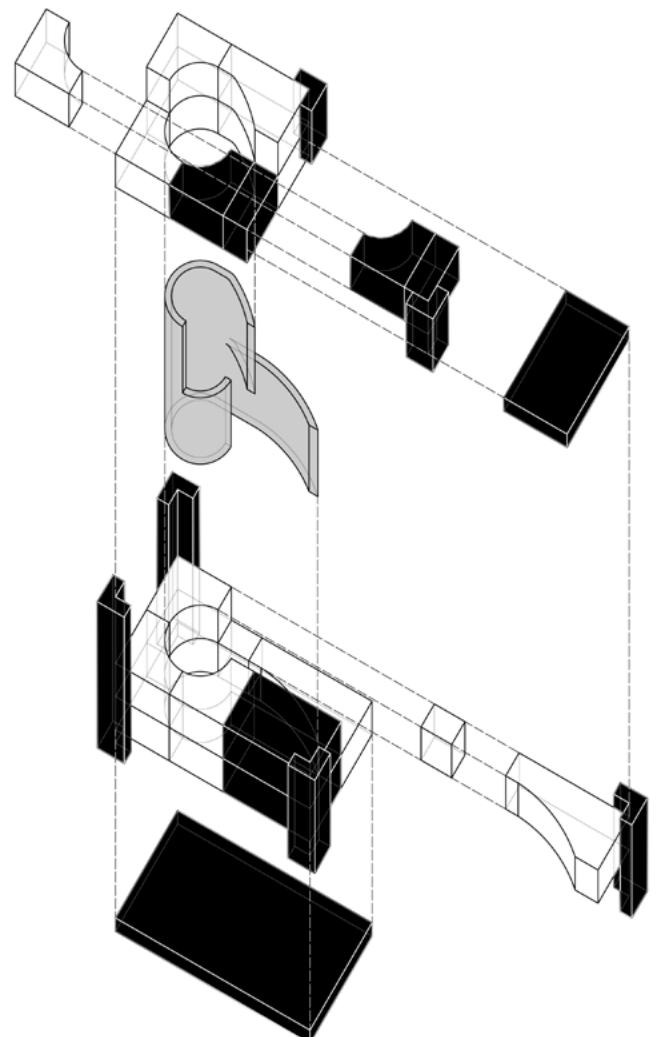
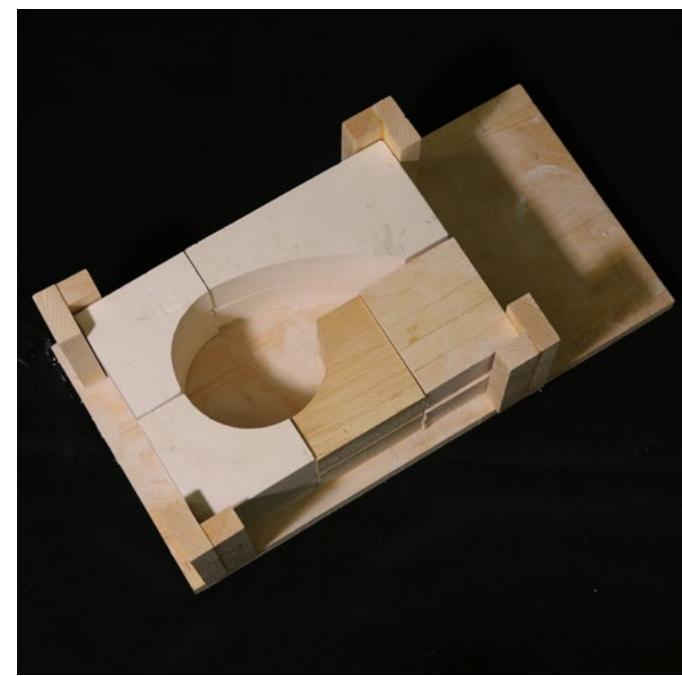
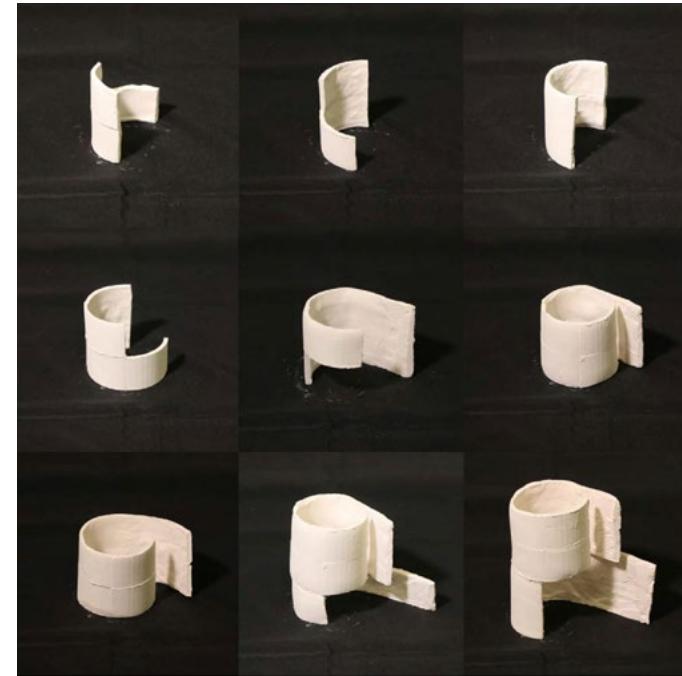
Construction Process of the Cherrywood Mold for Glass



Glass Blowing at Corning Museum of Glass

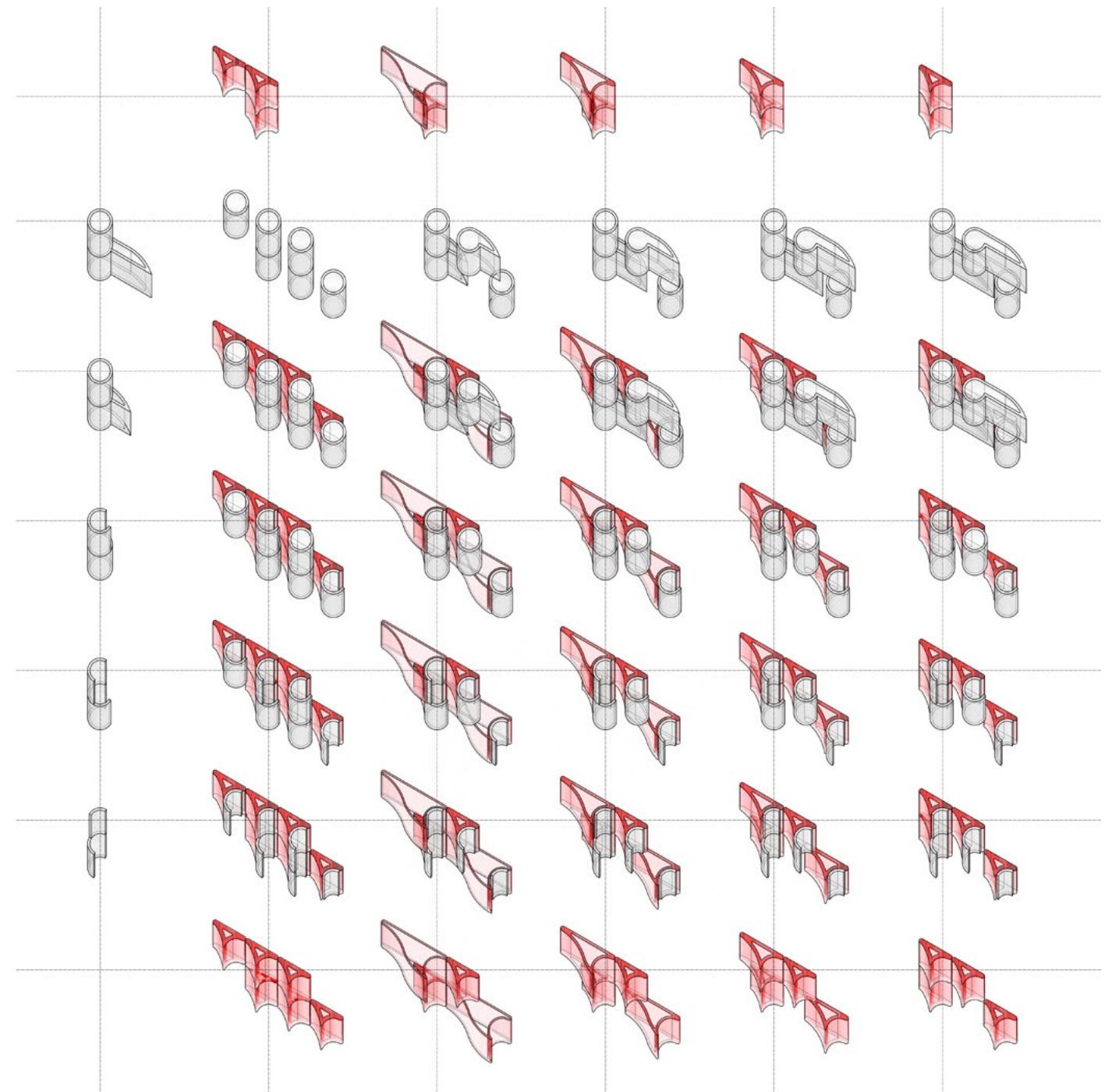
Ceramic Slip Casting

The mixed use of plaster and wood in the slip casting mold creates openings on the ceramic product in a controlled manner, which corresponds to the variations in the glass pieces.

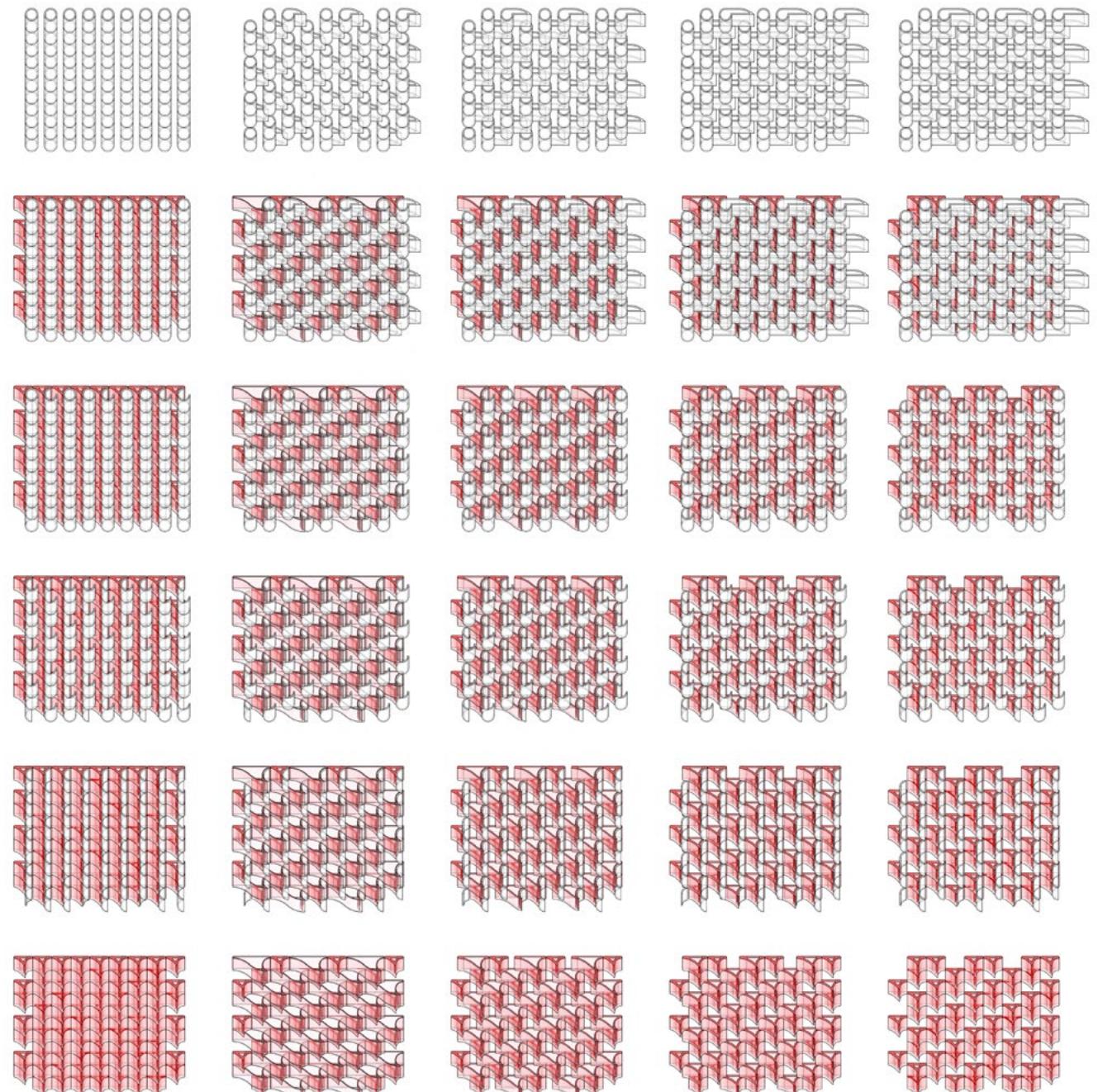


Parametric Aggregation Study

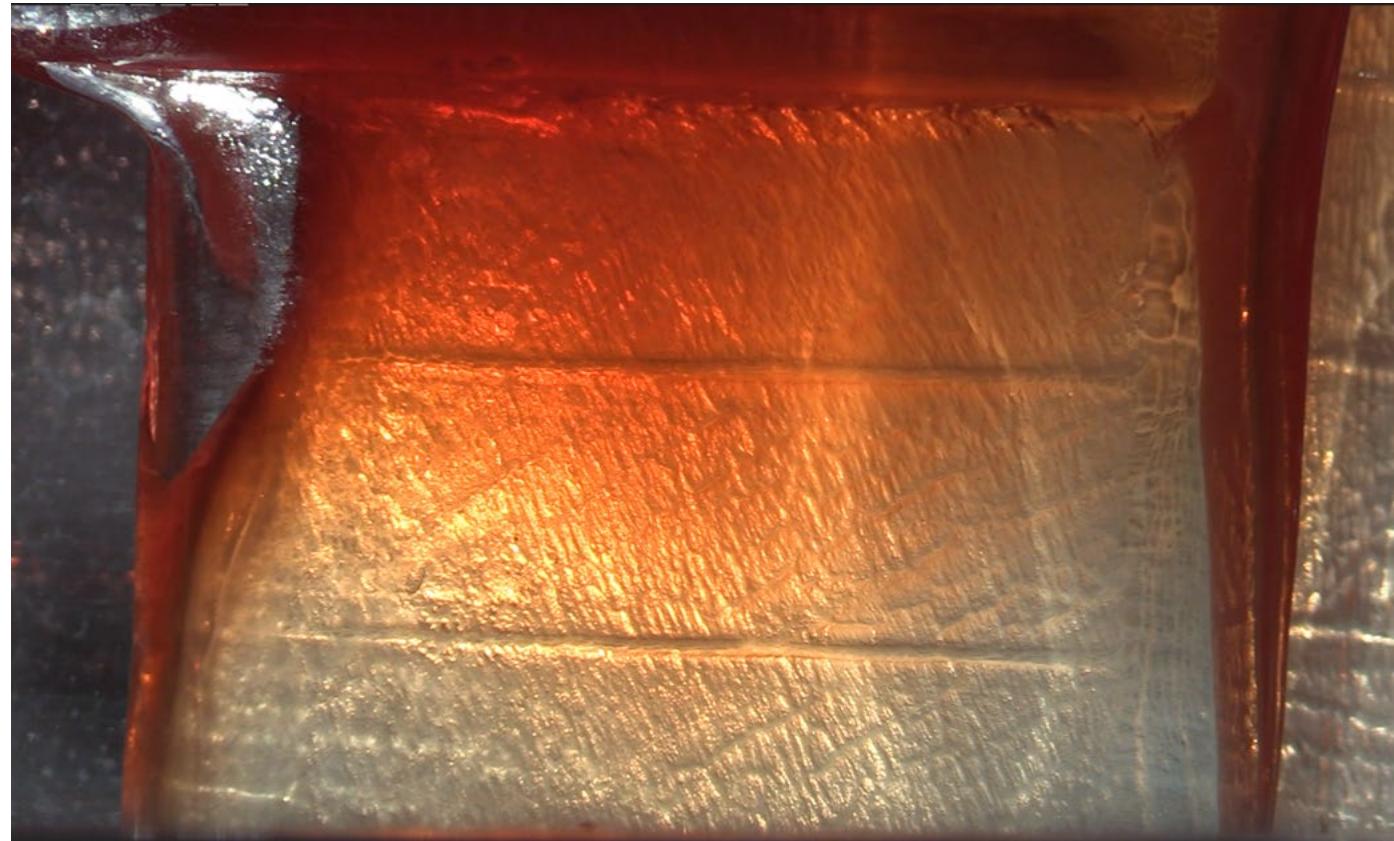
Aggregation matrices are created with Grasshopper in Rhinoceros. The unit variations as a result of the reconfigurable mold are selected to achieve different porosity and translucency to adapt to different environmental conditions.



Facade Unit Aggregation Matrix



Facade Aggregation Matrix



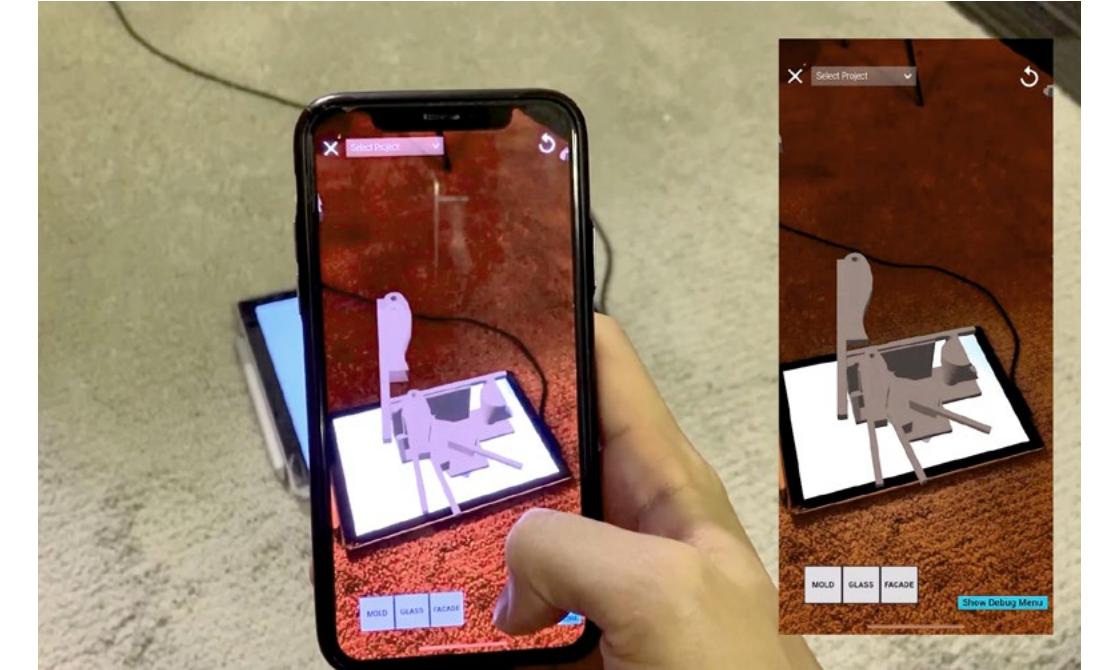
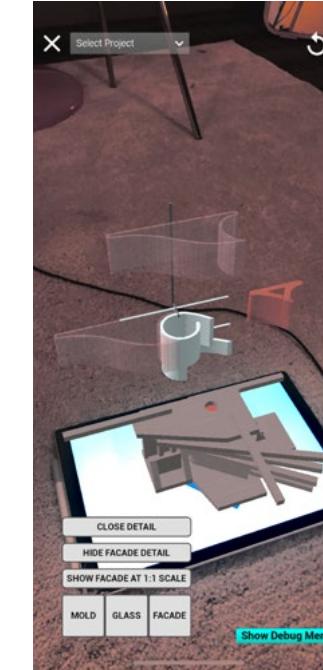
Details

Multimodal Representation

A full-scale installation of the parametric facade with translucent prints was exhibited at the Mui Ho Fine Arts Library at Cornell. An Augmented Reality IOS app was developed to interactively visualize the structural details and construction process of the facade.



Facade Installation at Mui Ho Fine Arts Library



Interactive Augmented Reality Representation

03 VR ANTHROPOCENE

– Spatial Composition Through Virtual Locomotion

Undergraduate Thesis Project

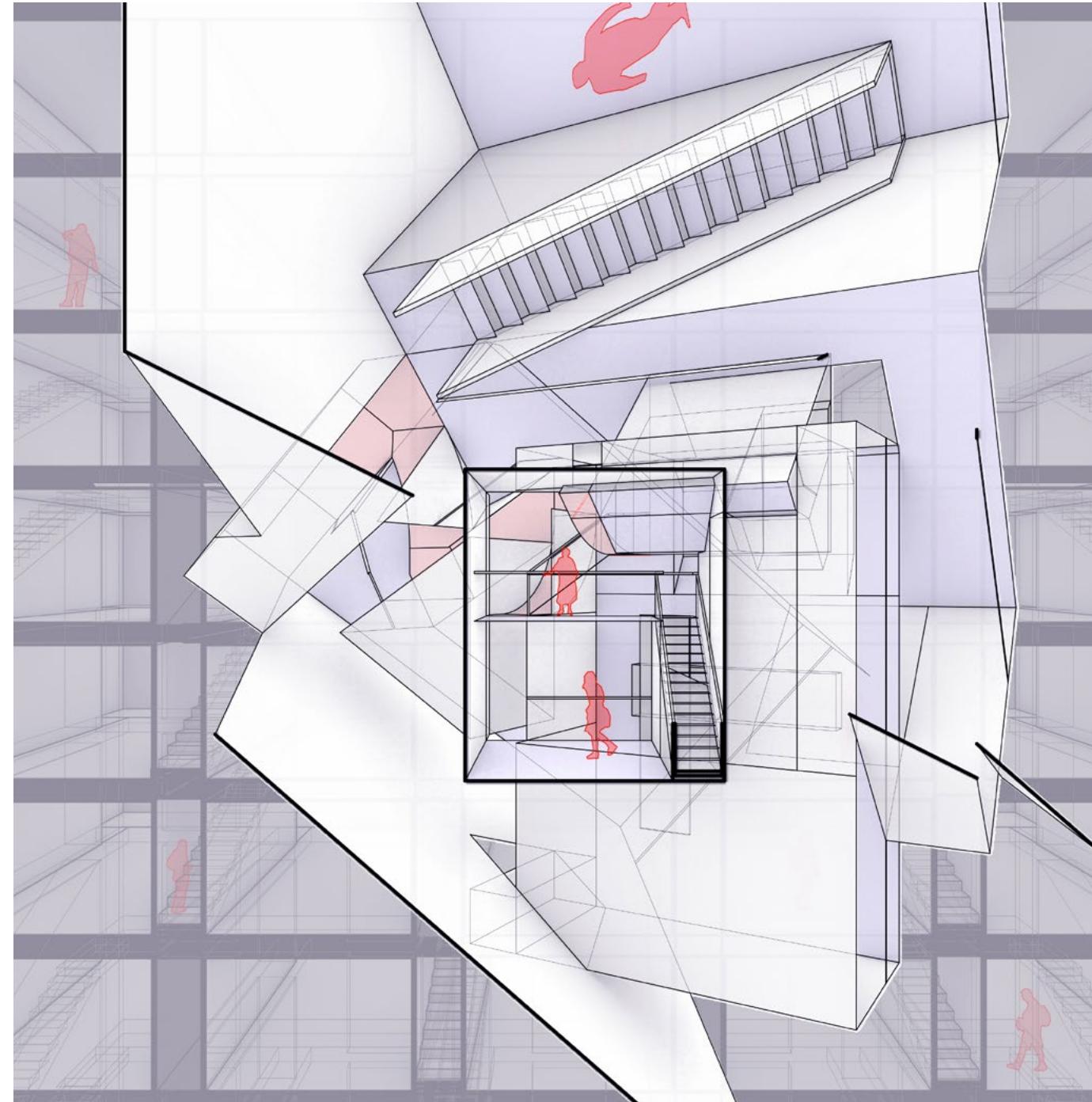
Spring 2021

Advisors: Jenny Sabin, Sasa Zivkovic

Individual Work

[<Thesis Book>](#)

Through the analysis of Redirected Walking with a series of VR demos, this thesis proposes spatial prototypes that unfold a physical space into a series of virtual vignettes. It investigates the impact of virtual augmentation on an urban housing unit in which residents could cognitively experience a series of real and surreal spaces. It ultimately studies how such intersection reforms physical boundaries and redefines residential programs, generating a prototype for the future way of living.

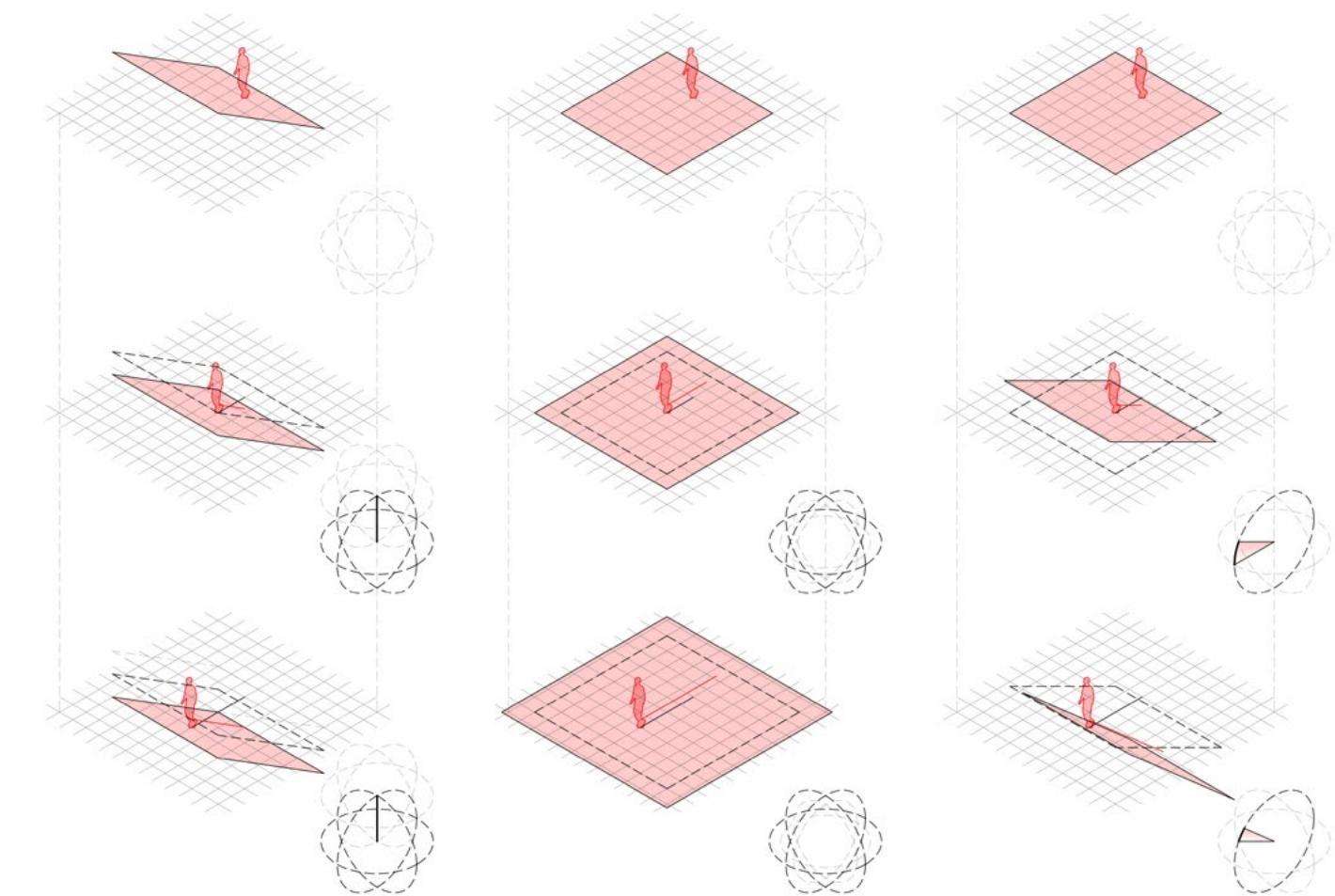


Section through a modular building with virtual augmentation

Redesigned Redirected Walking

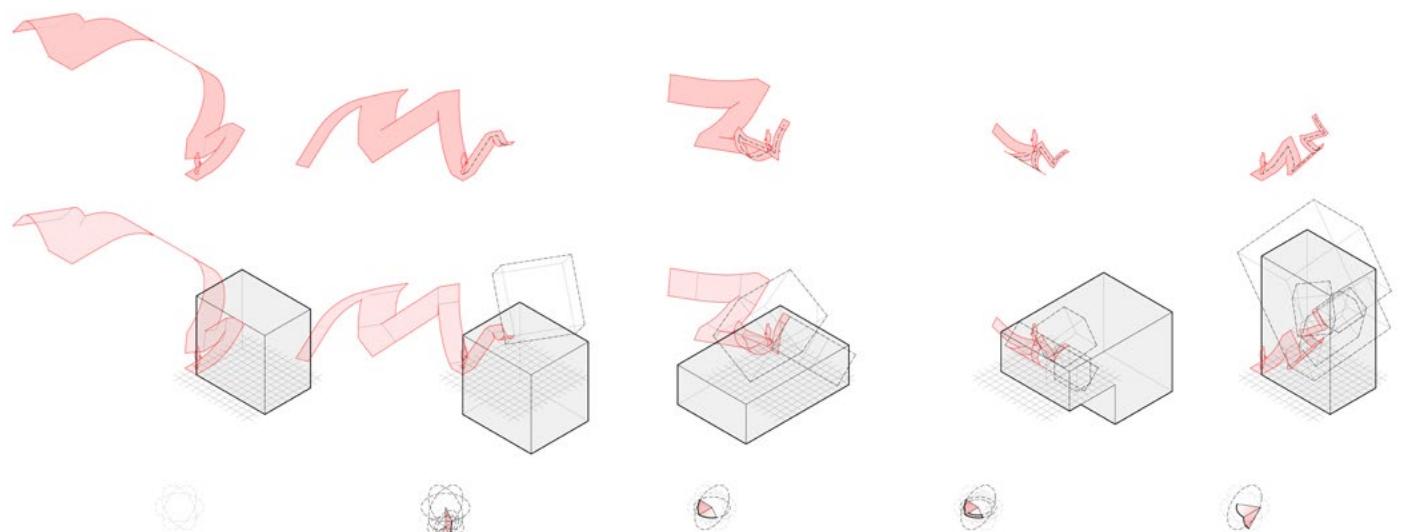
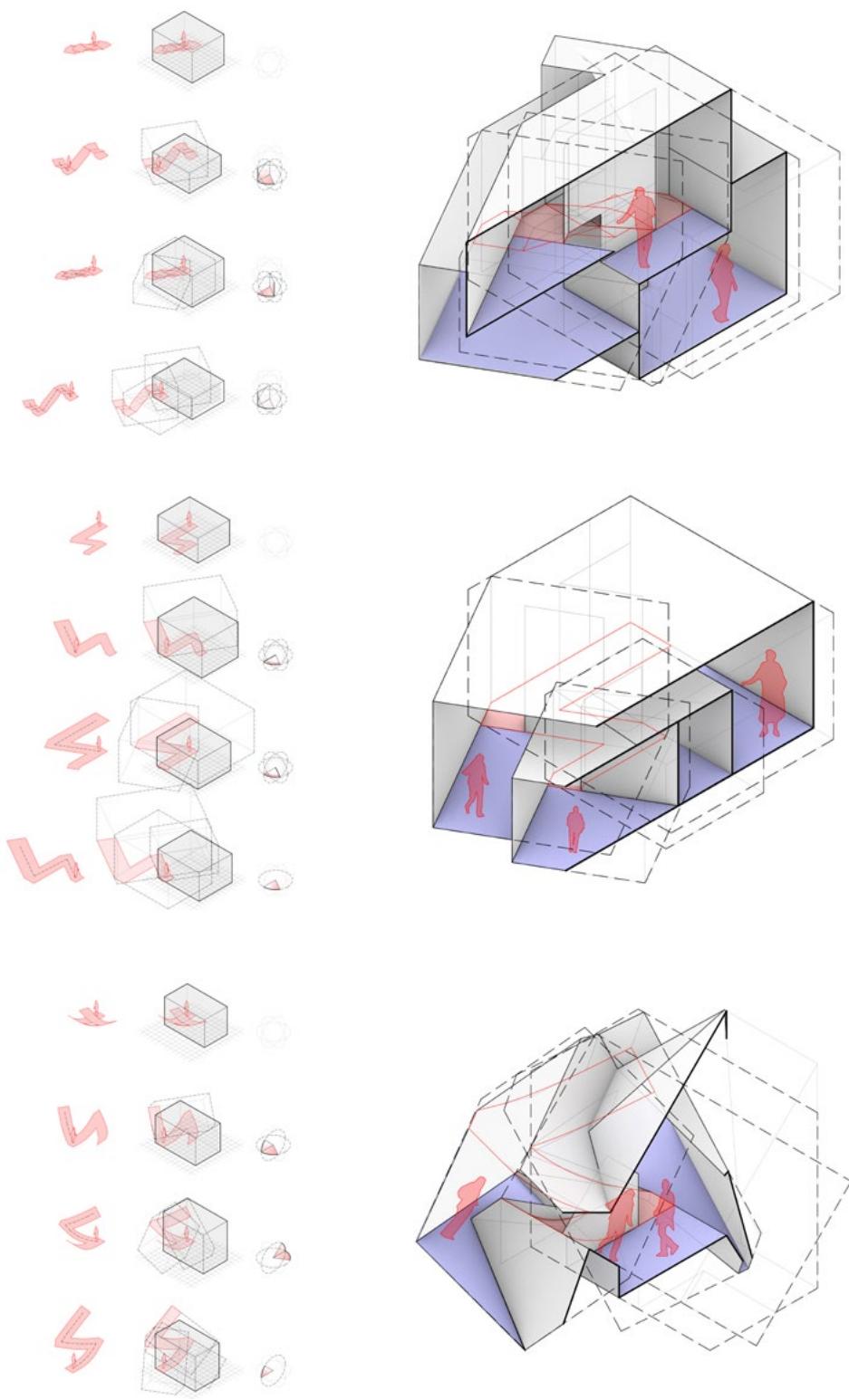
Evolving from the translation, rotation, and curvature offsets in the traditional Redirected Walking technique, this project proposes the vertical translation, scaling, and ground shifting offsets as the vocabulary for the generation of virtual spaces.

Diagrams of proposed locomotion techniques:
Vertical Translation, Scaling, and Ground Shifting

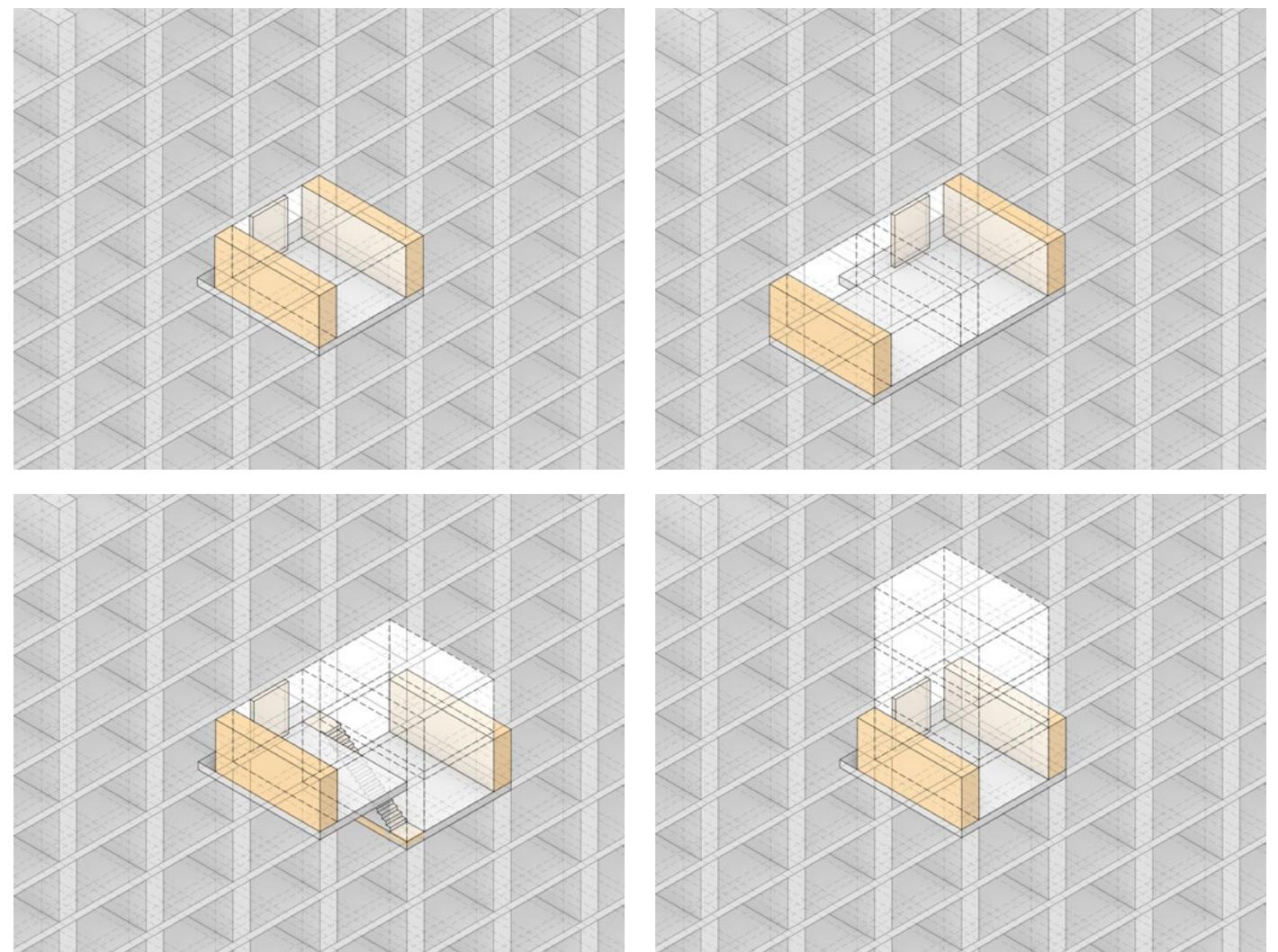


Spatial Prototypes

The virtual locomotion techniques unfold oscillatory movements into virtual paths, along which a series of virtual volumes is generated, intersected, and reformed, without the constraint of gravity, the limitation of space, and the constancy of scale.



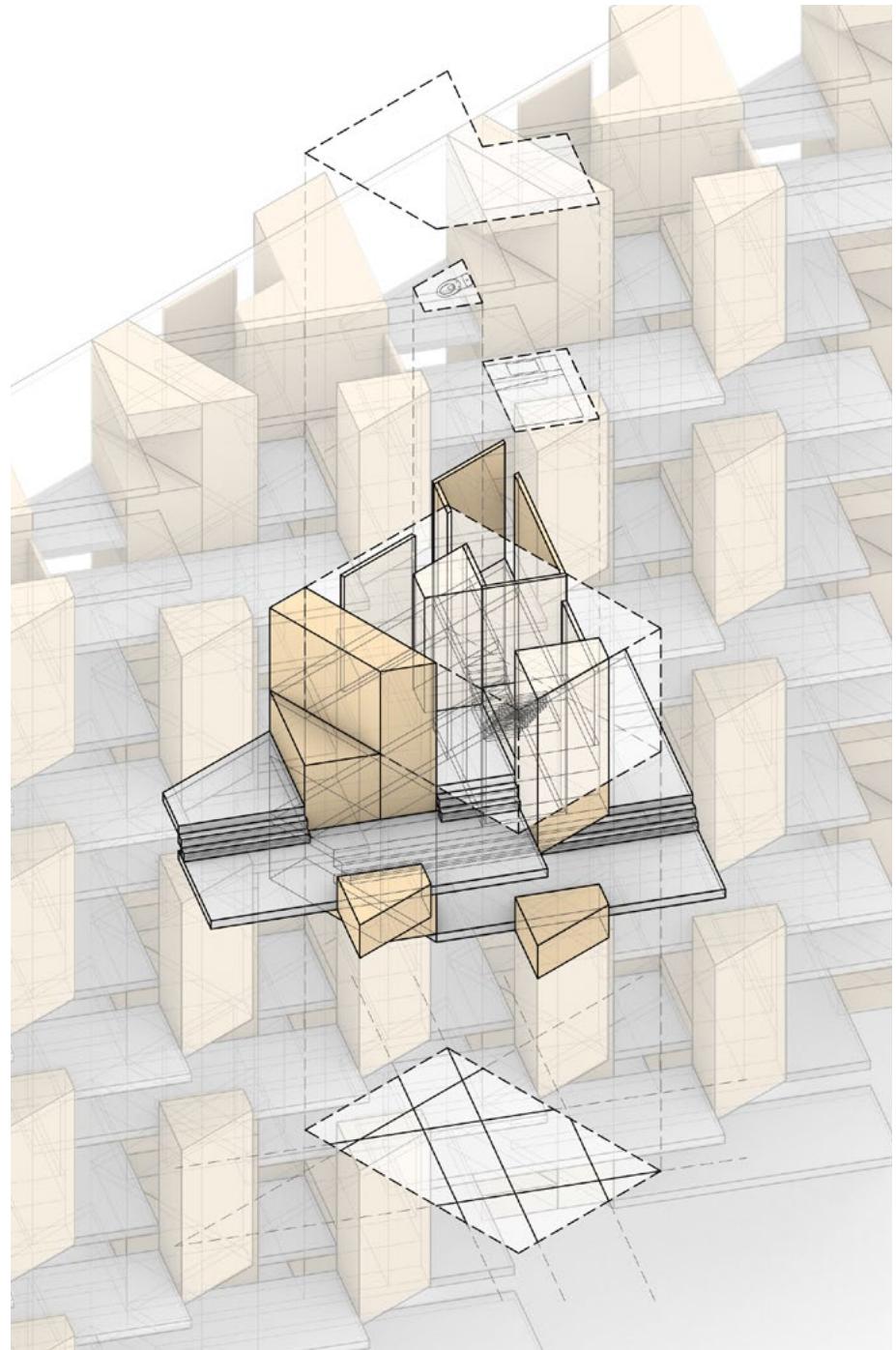
Navigating through shoebox units with combined Redirected Walking techniques



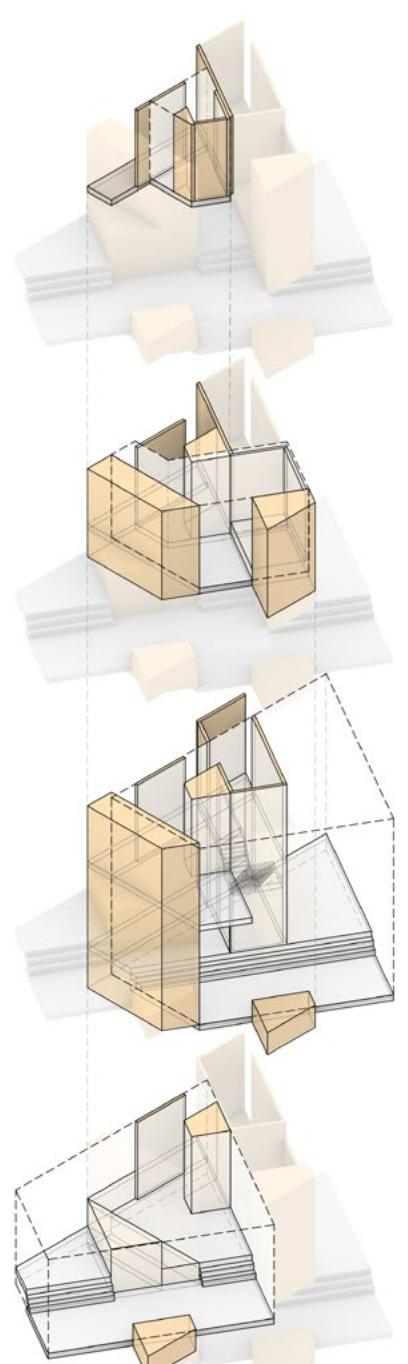
The virtual elements could extend through the physical constraints of walls and floors, resulting in various spatial modules

Virtual Housing

Focusing on the design of future urban housing, the project overlaps the spatial prototypes with a physical space, and studies how the design of the virtual could in return reformat the physical design through blurring physical boundaries and altering static programs. This leads to a final prototype where dwellers simultaneously live in, move through, and interact with the physical space and the cyberspace.



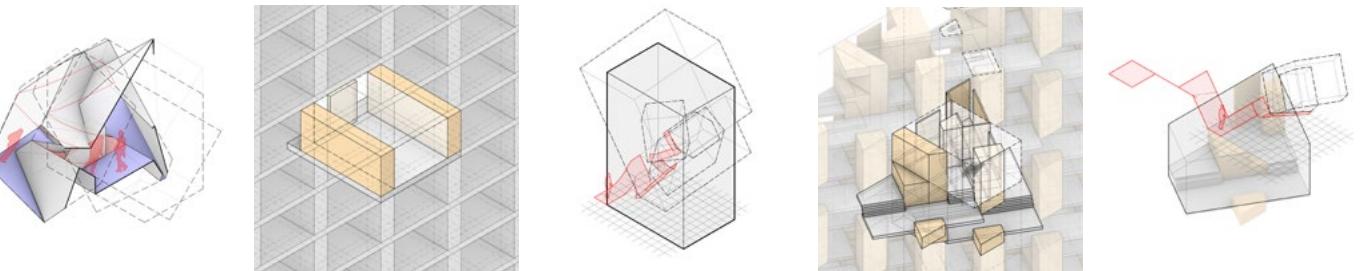
Reconfigured physical spaces based on datums of virtual composition



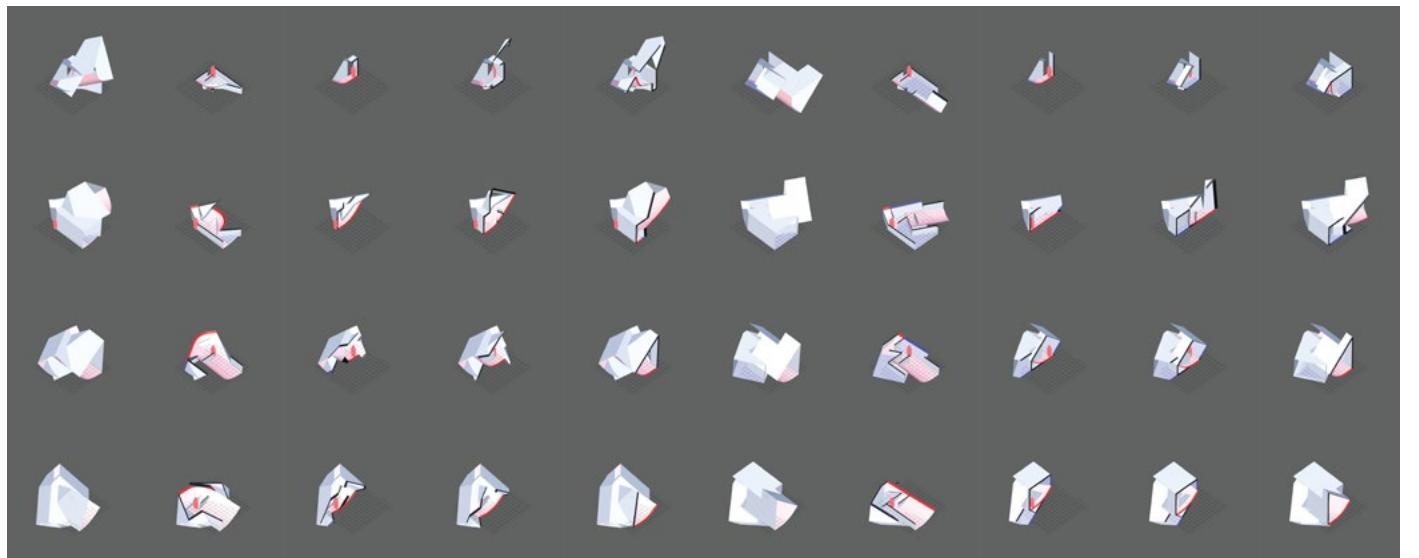
Four augmented units that unfolds from a single physical space

Design Workflow for Architecture in Extended Reality

Virtual Spatial composition from locomotion techniques	Physical Shoebox unit from spatial composition	Virtual Sequential hybrid experience within physical units	Physical Reconfigured boundaries based on virtual datums	Virtual Sequential experience based on redesigned physical space
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Visualization Tools Developed with Unreal Engine

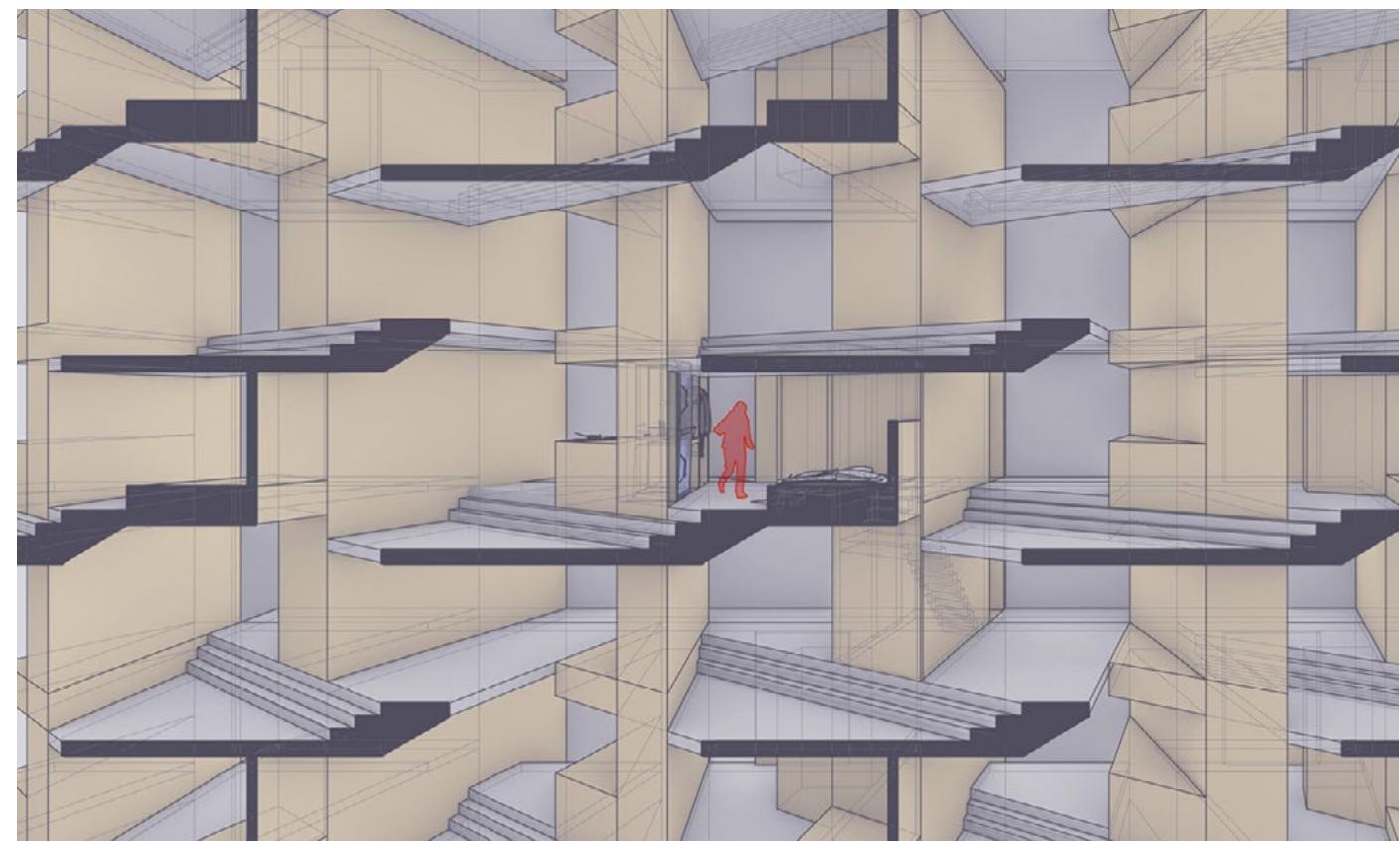


Interactive Visualizer for Spatial Compositions in Unreal Engine



VR Application: the first person view, third person rendering, and third person video of a moment in the hybrid architecture

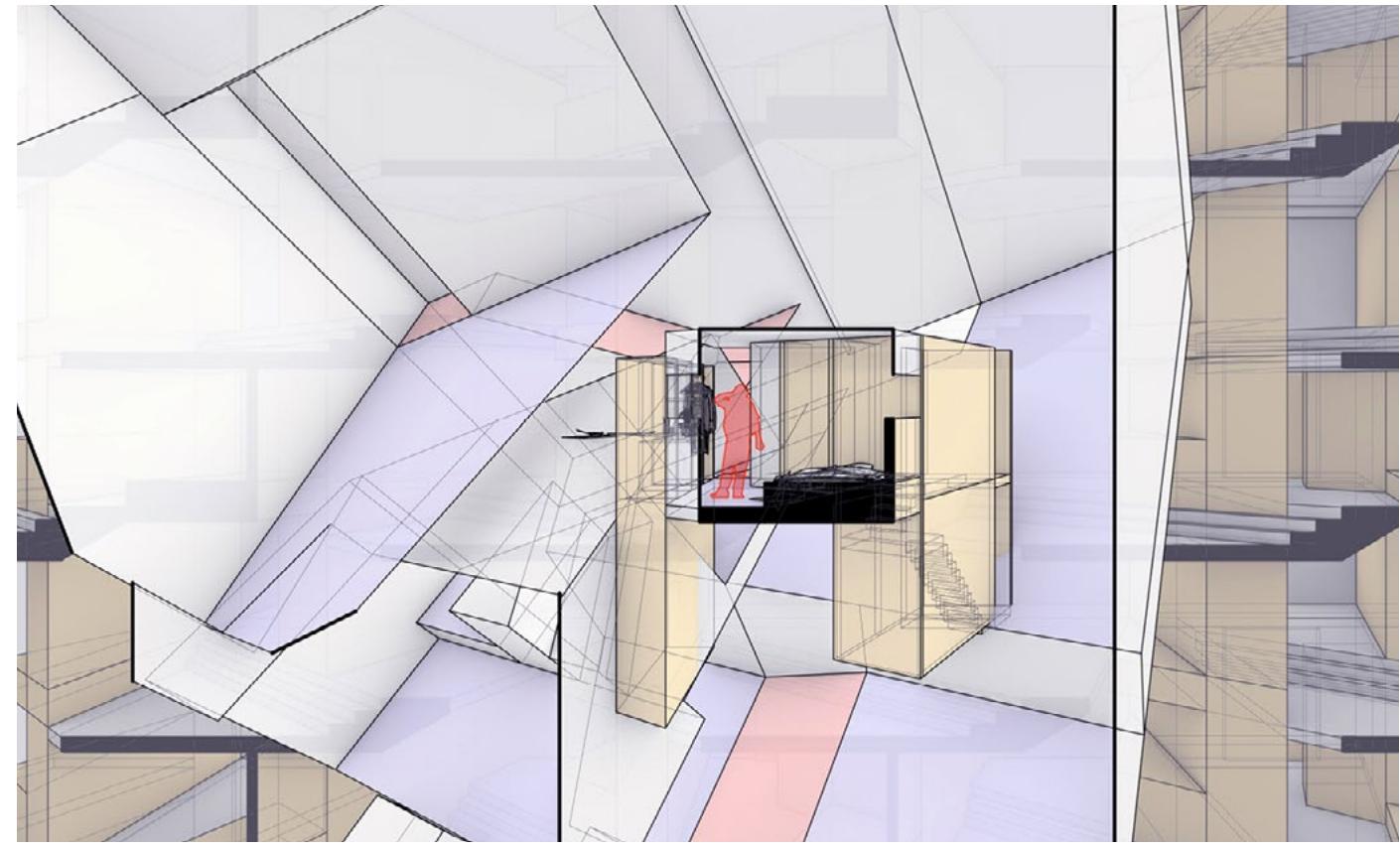
Sections of Virtual Housing



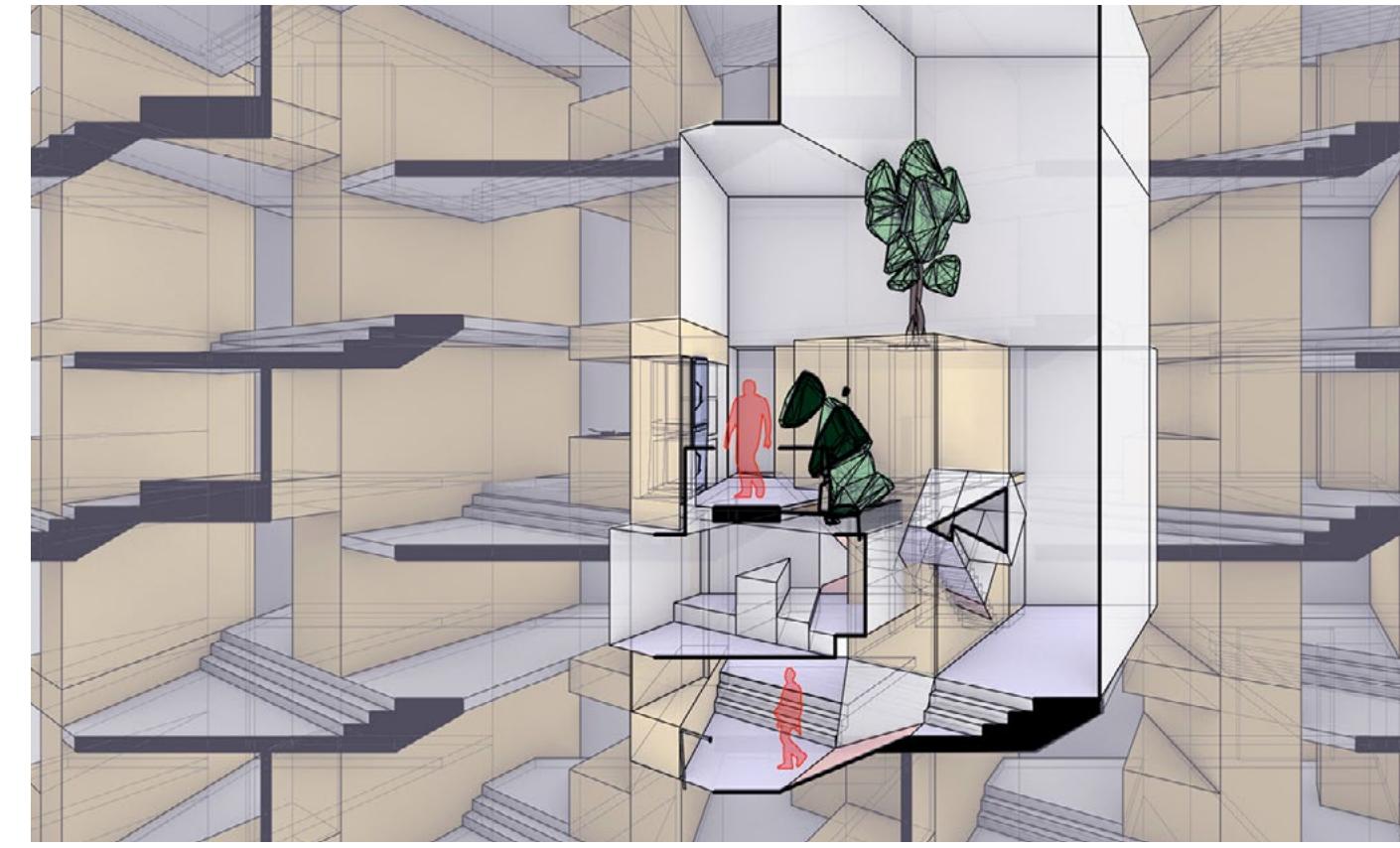
The Reconfigured Physical Space



A Public Space that Joins Two Physical Modules



Bedroom Bounded by Physical and Virtual Elements



Multi-story Living Space that Links Physical Modules Vertically

04 THE MEMORIAL LOOP

– Spatial Choreography with Virtual Reality

Virtual Places Research Studio II

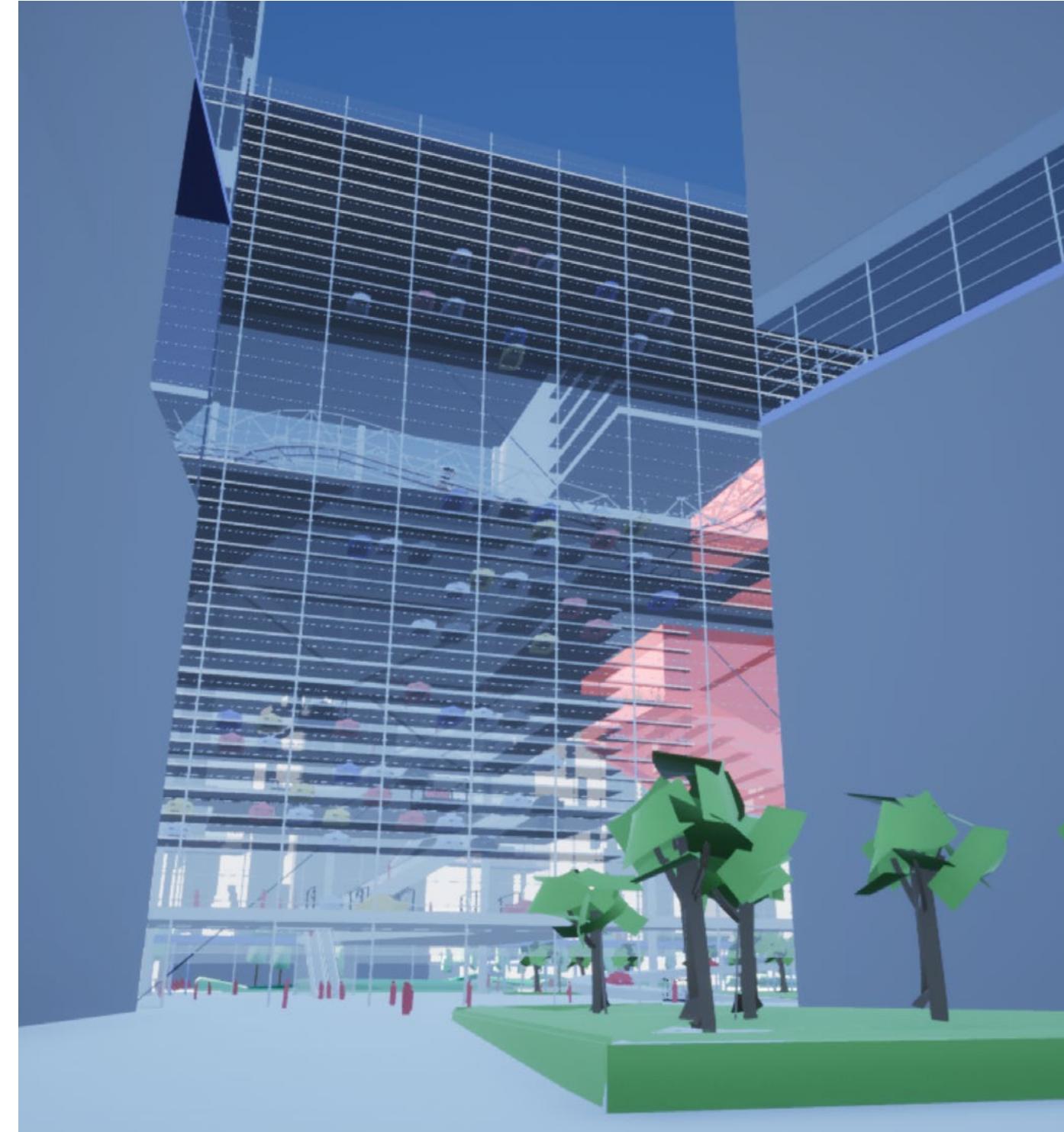
Fall 2020

Advisor: Henry Richardson, Christopher Morse

Site: Ground Zero, NYC

Collaborator: Zoe De Simone

Contribution: Conceptual design, implementation, representation



[<Video Documentation>](#)

The project redefines movements through urban spaces with a three-dimensional system of pathways that link atriums on the context buildings. Technically, it experiments the design workflow using Virtual Reality as a tool of creation, visualization, and presentation. During Covid quarantine, the design process tests various tools for virtual collaboration.

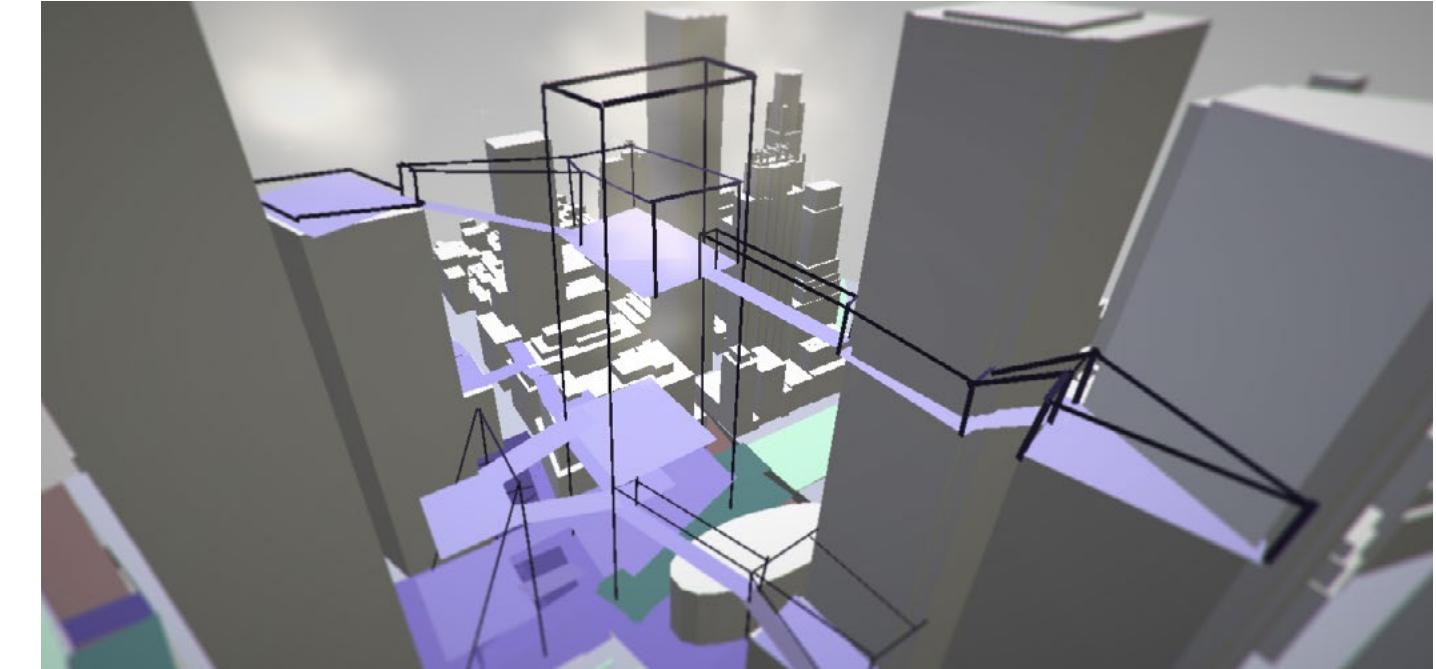
Design Workflow with Intuitive 3D Sketching in Virtual Reality

1. VR Spatial Design
Gravity Sketch & Tilt Brush & Arkio

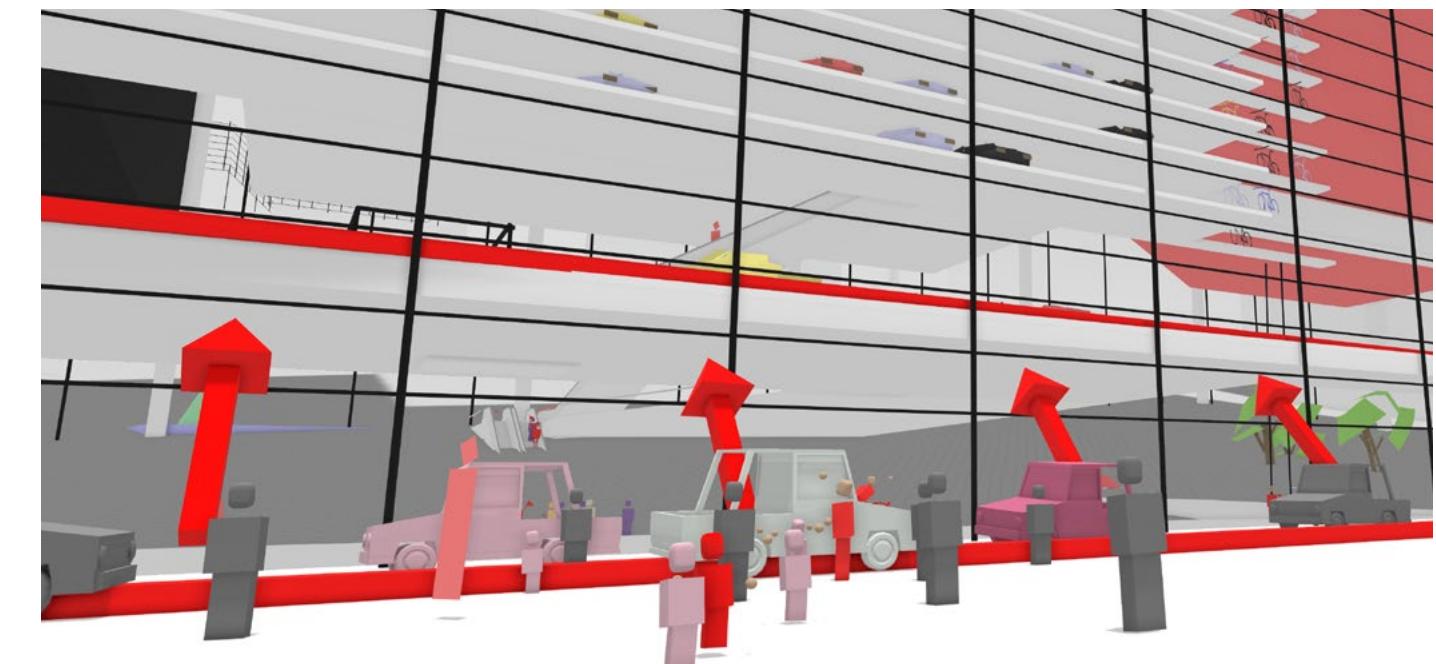
4. VR Mood Design
Gravity Sketch & Tilt Brush

2. Collaborative VR Annotation
Unreal Engine & Gravity Sketch

3. Translate Sketches to Geometries
Rhinoceros & Grasshopper

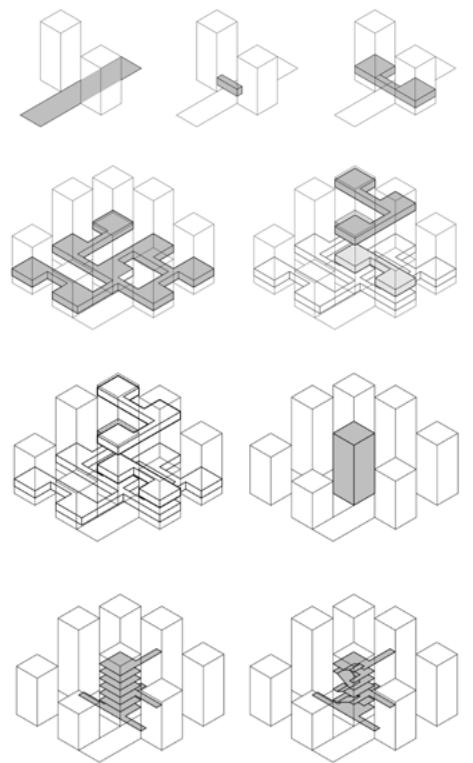


Site Analysis in Tilt Brush -
The Pathways Connecting Context Buildings

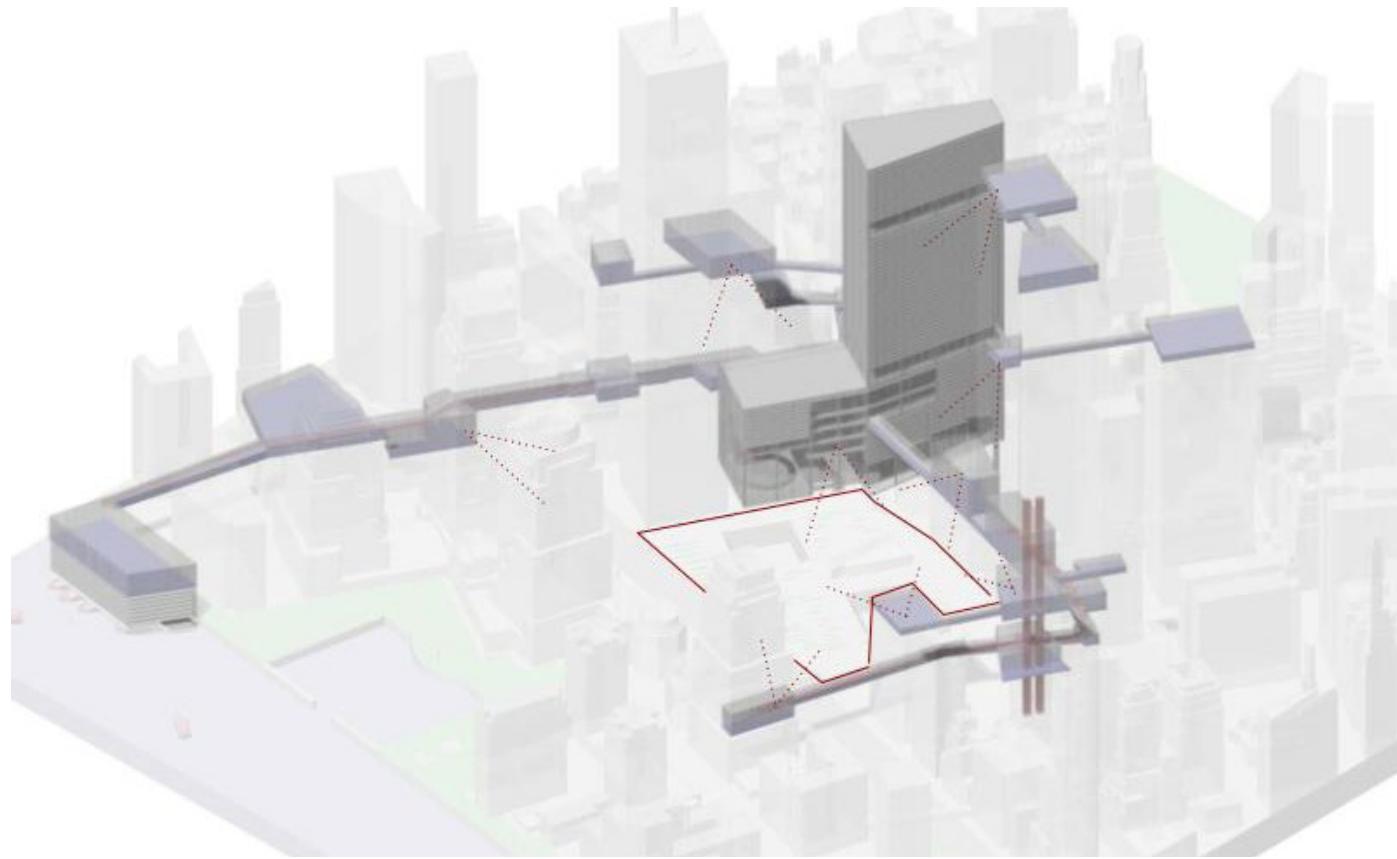
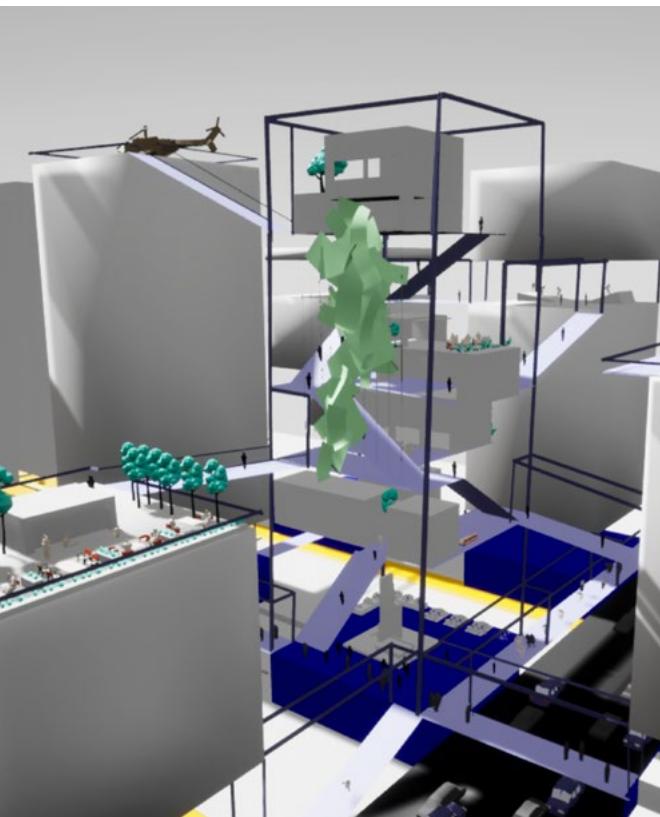


Spatial Annotation in Gravity Sketch -
Analyzing the Intersection between Automobile and Pedestrian Movements

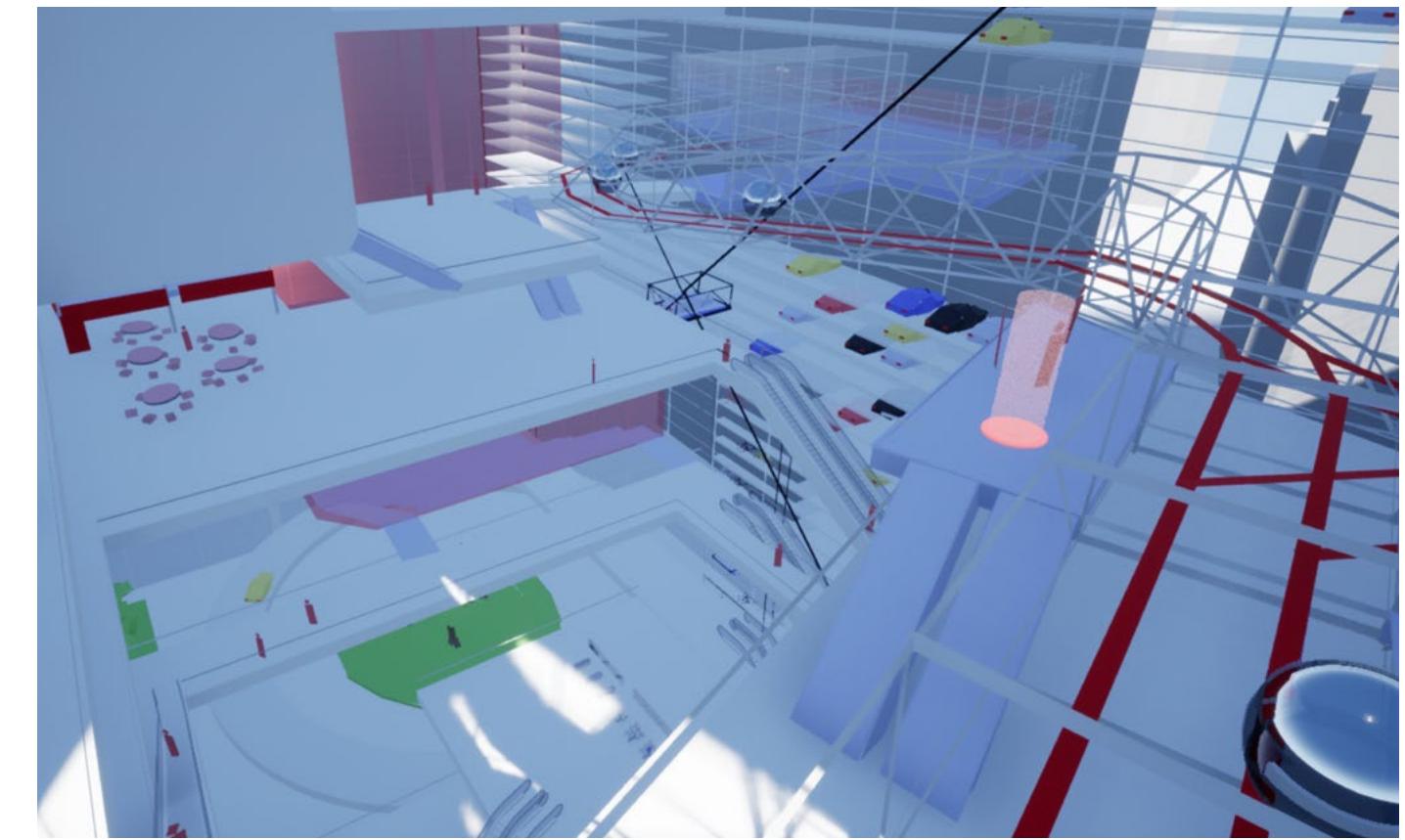
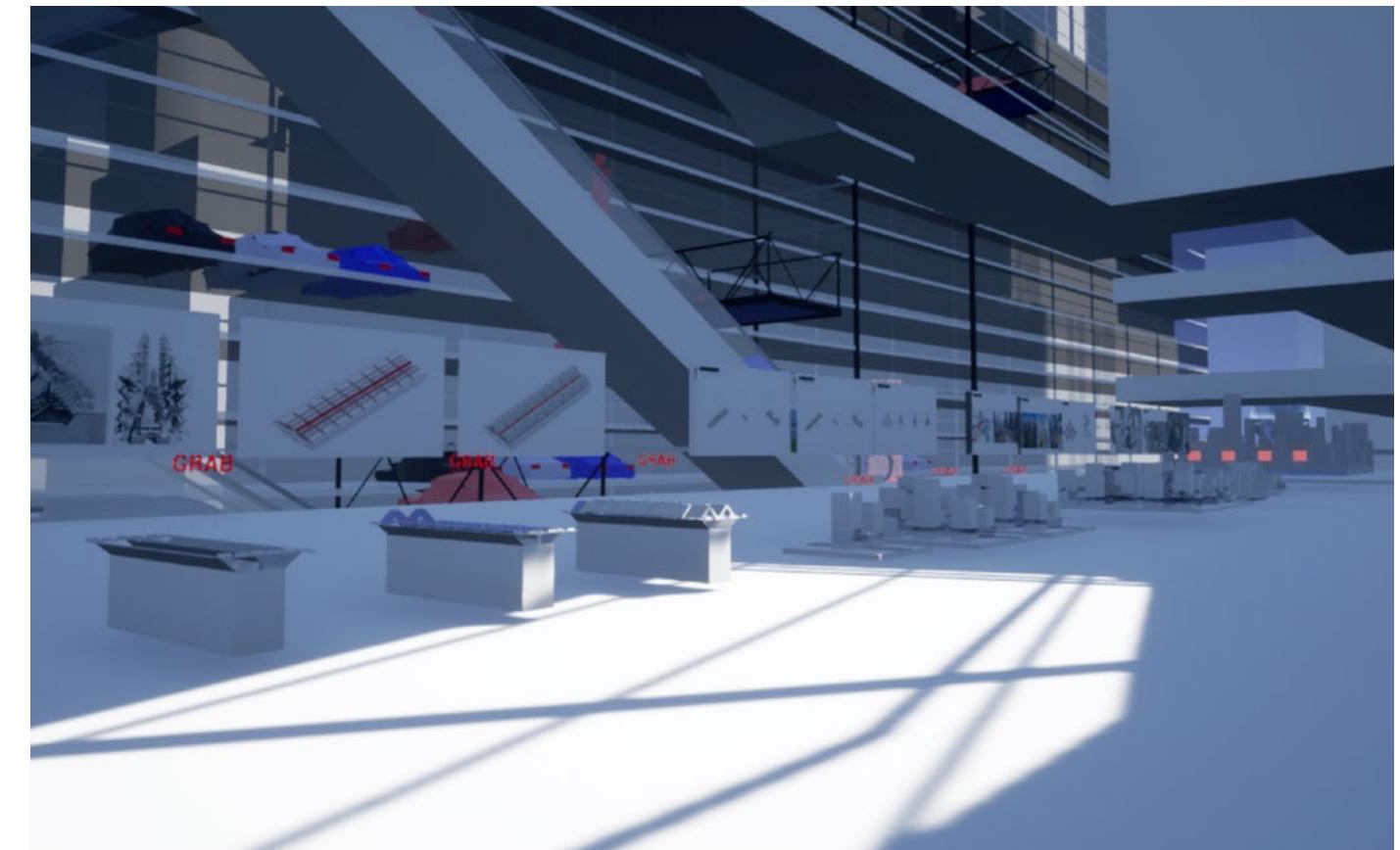
Designing an urban center with multiple ground planes



The bridging system and vertical circulation tower of Hong Kong Elevated Walkway generates multiple ground planes for the city

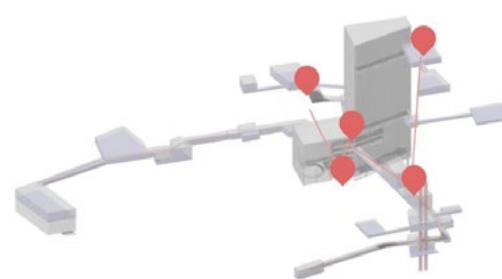


Experiencing the design in the multiuser VR environment created with Unreal Engine

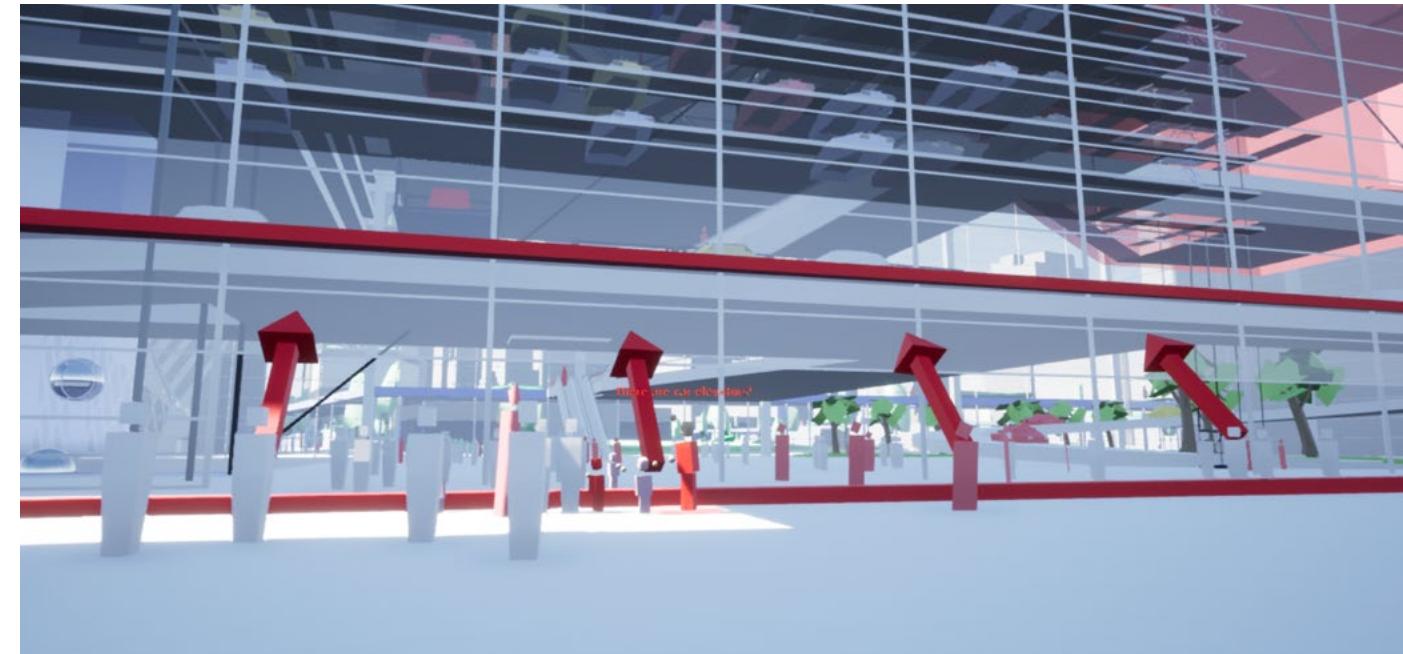


Choreographing experiences for pedestrians arriving from the city center

The narrative of pedestrians' arrival at this urban complex is choreographed in Gravity Sketch and imported into the Unreal Engine. It represents the "affect" of spaces, which leads to design decisions. The tour guide helps introduce design elements to visitors in VR.



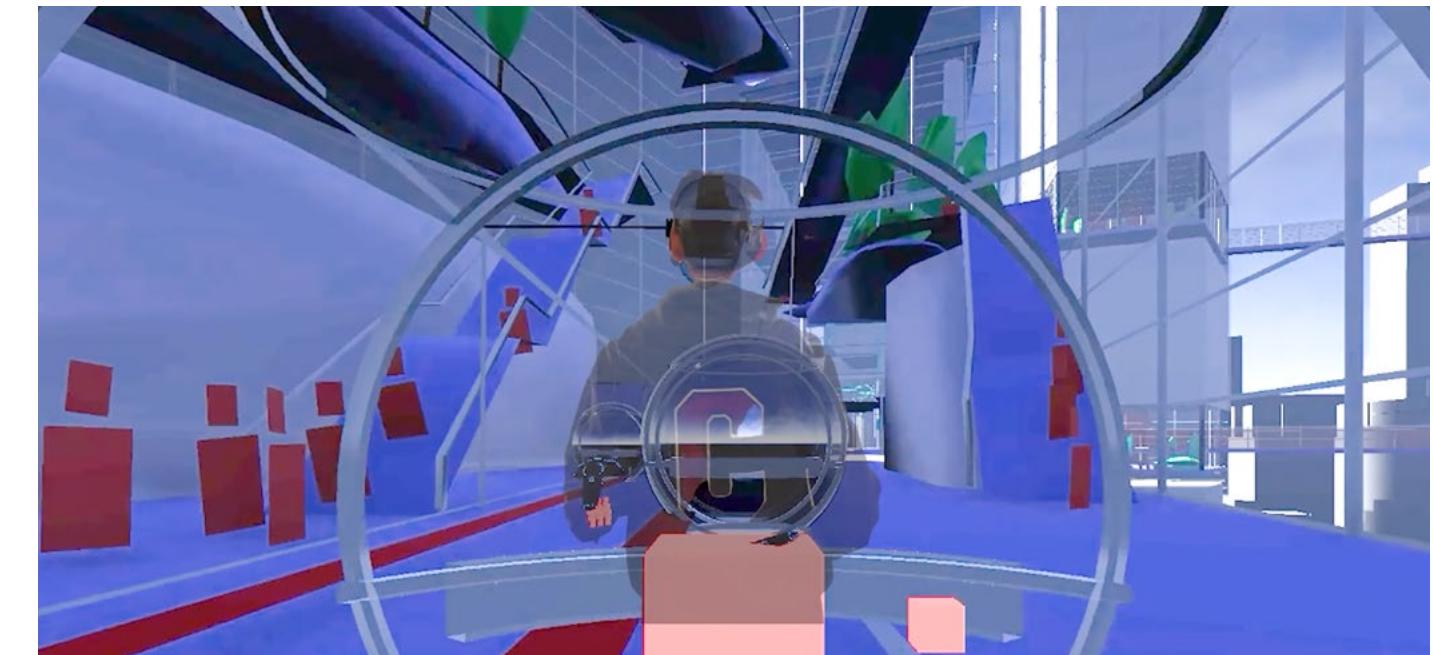
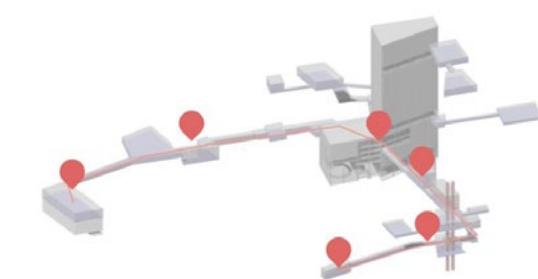
Guided VR Pedestrian Experience - Arrival



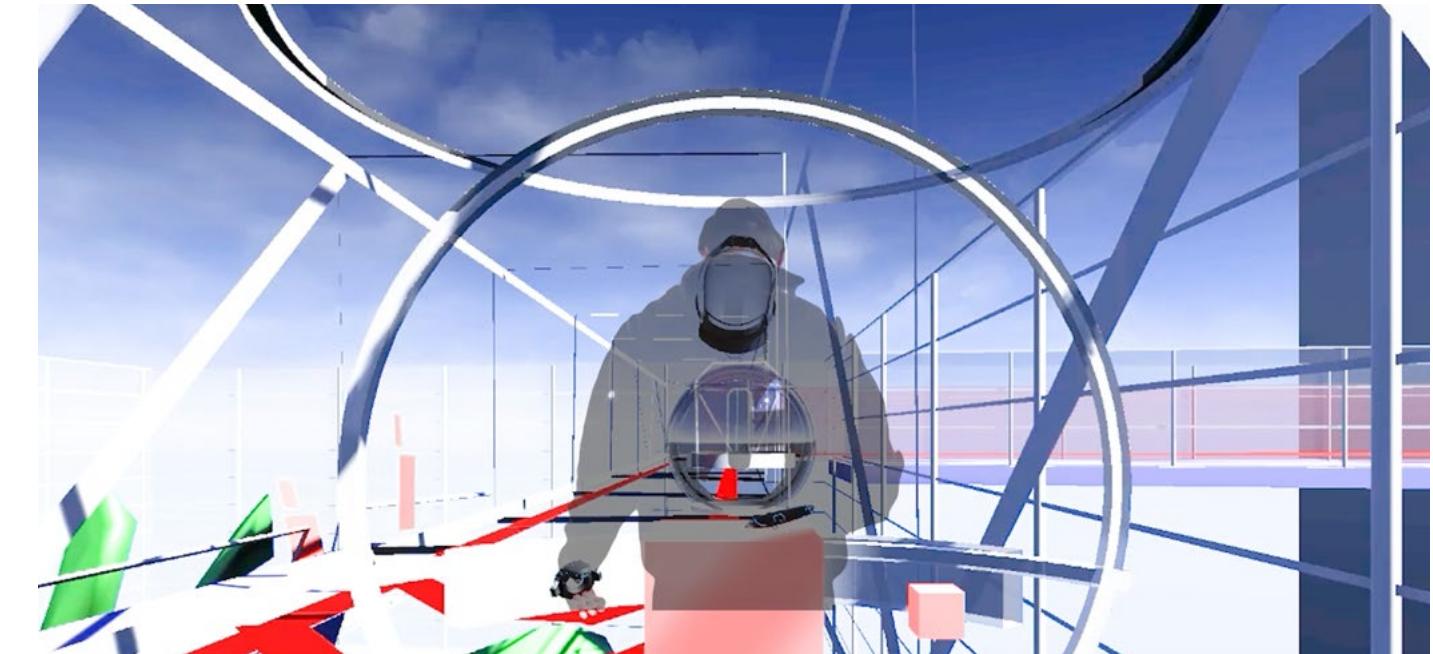
Elevating Street to Prevent Intersection between Pedestrians and Cars

Experiencing "People Mover" paths in VR

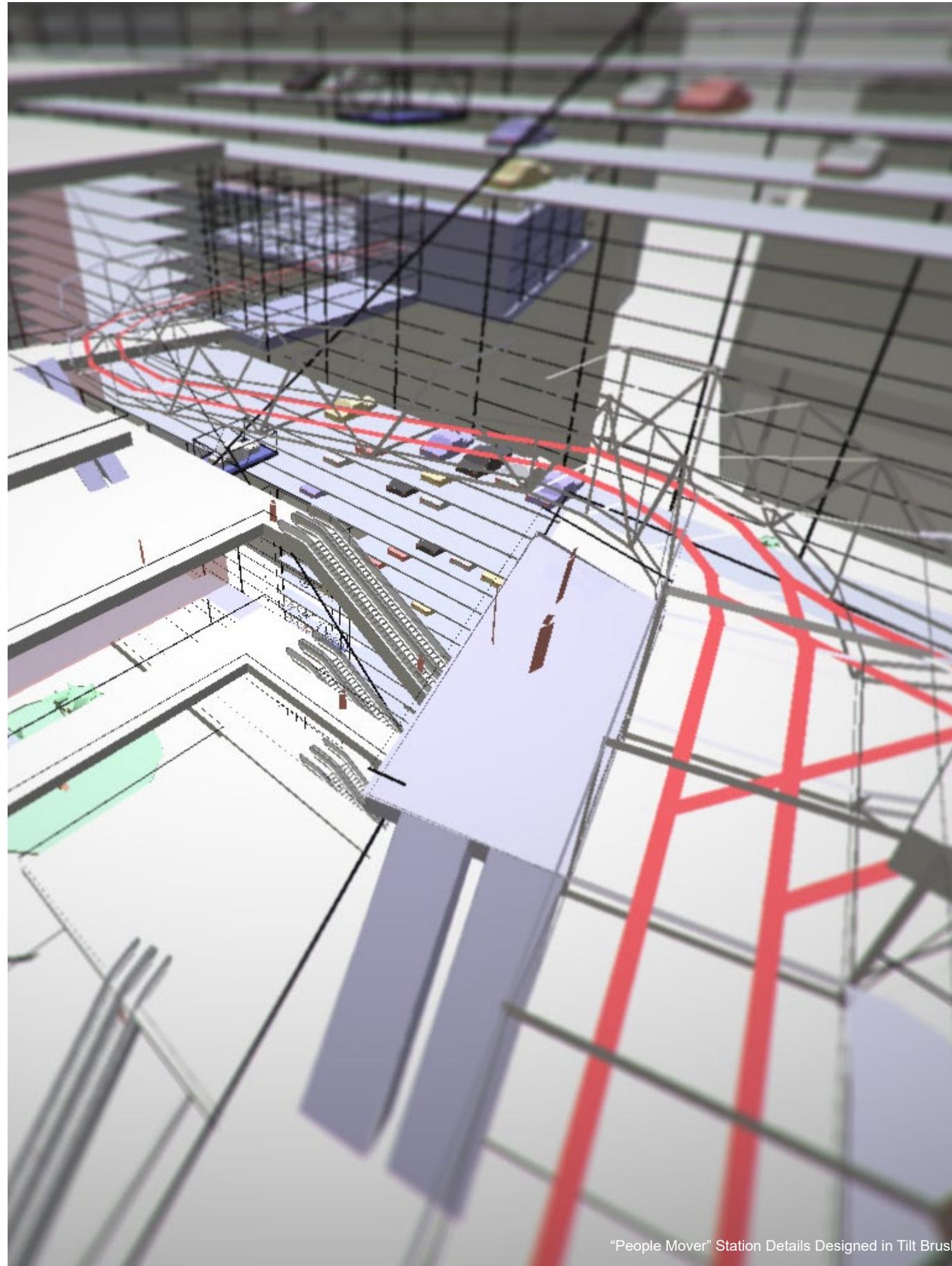
The "People Mover" system threads through the winter garden above the harbor, the restaurants, the main lobby, and other public spaces inserted on the context buildings. This experience allows visitors to drive a "People Mover" capsule on their own through the spaces and enjoy the nodes along the track.



Driving a "People Mover" Capsule in VR - Atrium



Driving a "People Mover" Capsule in VR - Winter Garden



Tools developed to improve user experience in VR

The following tools are implemented in Unreal Engine for smooth user experience in the virtual space. Upon arrival, users first go through the tutorials on spatial navigation, virtual interaction, and menu operation. The menu allows users to control the sun position, to change design phase across time, and to teleport to different vignettes. There are also two virtual headsets that transport users to the "Narratives of the Pedestrians" and the "People Movers".

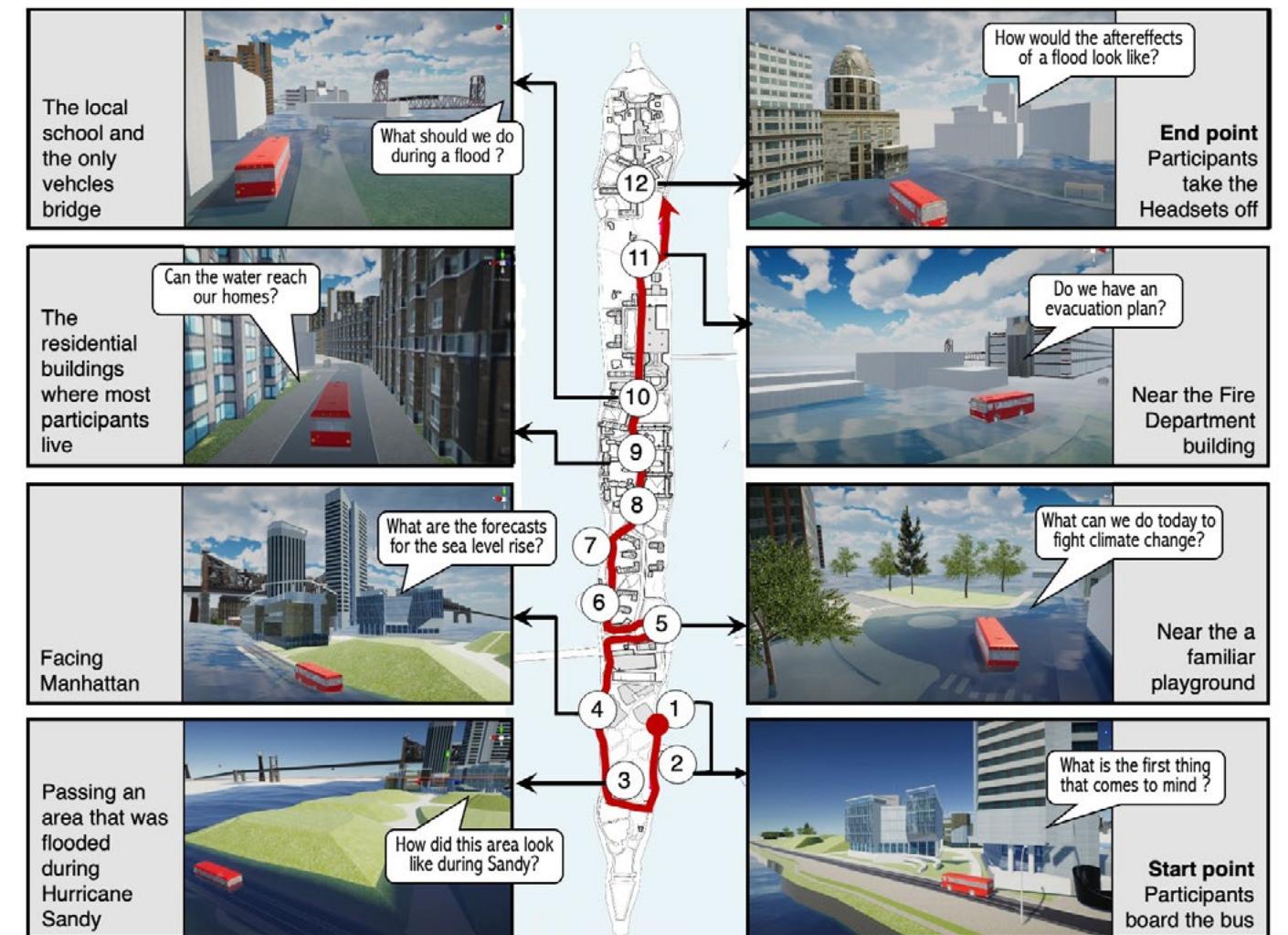


05 Communal eXtended Reality

– For Immersive Situated, On-Road Experiences

Yavo-Ayalon, S., Zhang, Y., Han, R., Joshi, S., Bu, F., Murr, C., Zhou I., Ju, W., "CXR: Communal eXtended Reality for Immersive, Situated, On-Road Experiences", Revise and Resubmit, CHI 2023.

Abstract: To engage communities in planning processes, we have developed a Communal eXtended-Reality (CXR) bus tour that depicts the possible impacts of climate change. This paper describes the geo-synchronized multi-user extended reality system we developed which provide a situated and shared experience to promote community engagement. We describe (a) our technical implementation of the CXR system, which geo-locates and orients the view each participant has of the virtual tour within the frame of the moving vehicle, (b) advances in the modeling of the digital twin environment of the tour critical to association with the real-life location, and (c) our fall-back system, which allows people who feel disoriented or motion-sick to continue along with the content of the tour. In addition to describing our system and protocol, we detail technical challenges we encountered and resolved in our preliminary deployment tests.



The situated narrative



The difference between seeing and believing: the NYC flood map and the immersive XR



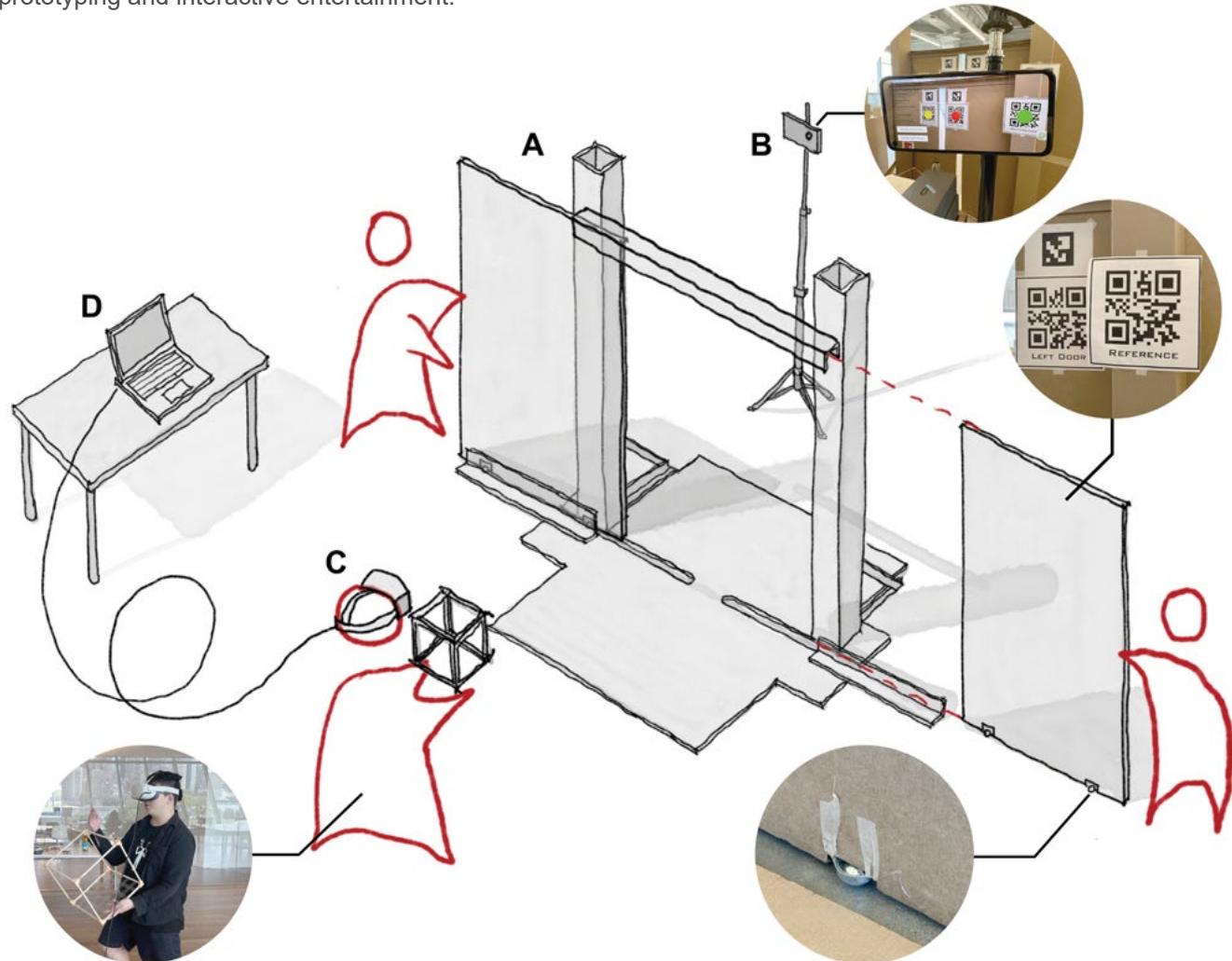
The participants and their XR perspective

06 Wizard of Props

– Integrating Physical Props and VR for Interactive Design

Zhang, Y., Han, R., Malte, J., Ju, W., Leithinger, D., "Wizard of Props: Integrating Physical Props and VR for Interactive Design", Submitted, TEI 2023 Work in Progress.

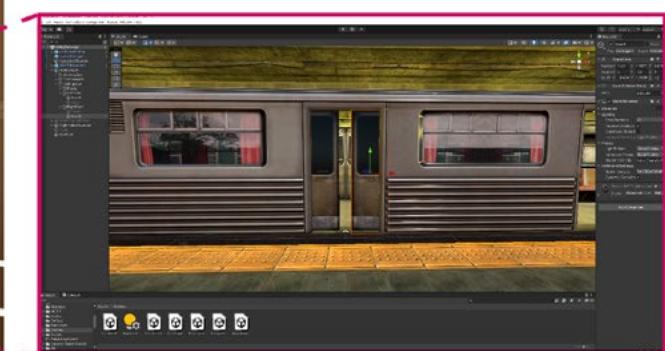
Abstract: Designers of physically interactive systems (e.g., architects, stage designers, and tangible device designers) often employ a mix of physical and digital methods in their workflow. However, a dichotomy can be observed between these methods, as constructing an elaborate physical prototype is time-consuming and costly, while interacting with virtual models lacks rich, embodied engagement with the product. This paper proposes a hybrid design system called Wizard of Props (WoP) that integrates full-scale physical props with Virtual Reality to support interactive design processes. Our formative study (N=8), where participants designed an interactive door, compares WoP with a conventional workflow based on hand-sketching and 3D design software. Our observations indicate that WoP fosters novel insights through enhancing spatial awareness, immersion, and tactile feedback, though its relationship with the conventional counterpart should be categorized as complementing, rather than replacing each other. Potential applications of WoP include tangible prototyping and interactive entertainment.



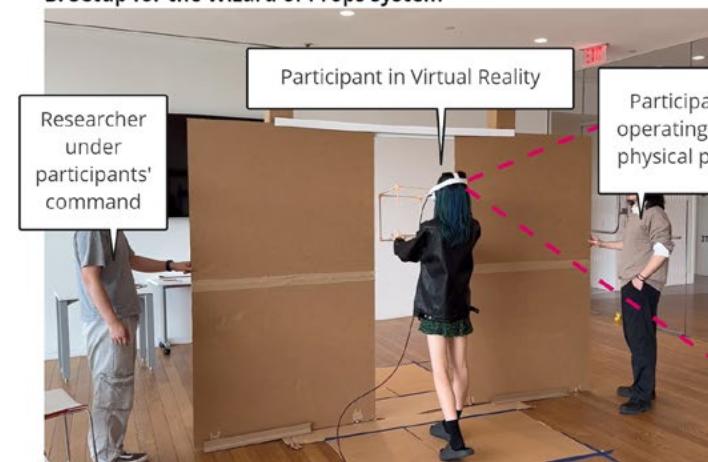
System Diagram

[<Video Synopsis>](#)

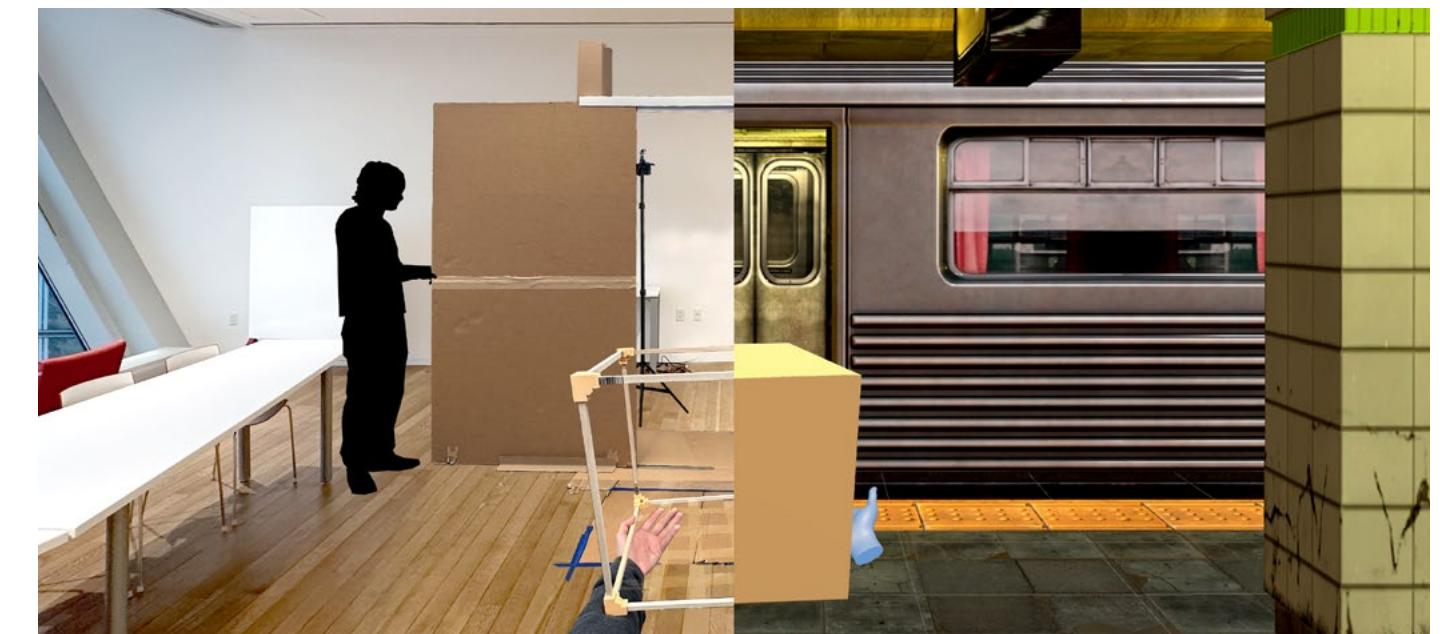
A. Setup for the tabletop system



B. Setup for the Wizard of Props system



Experiment setup for the tabletop and WoP systems

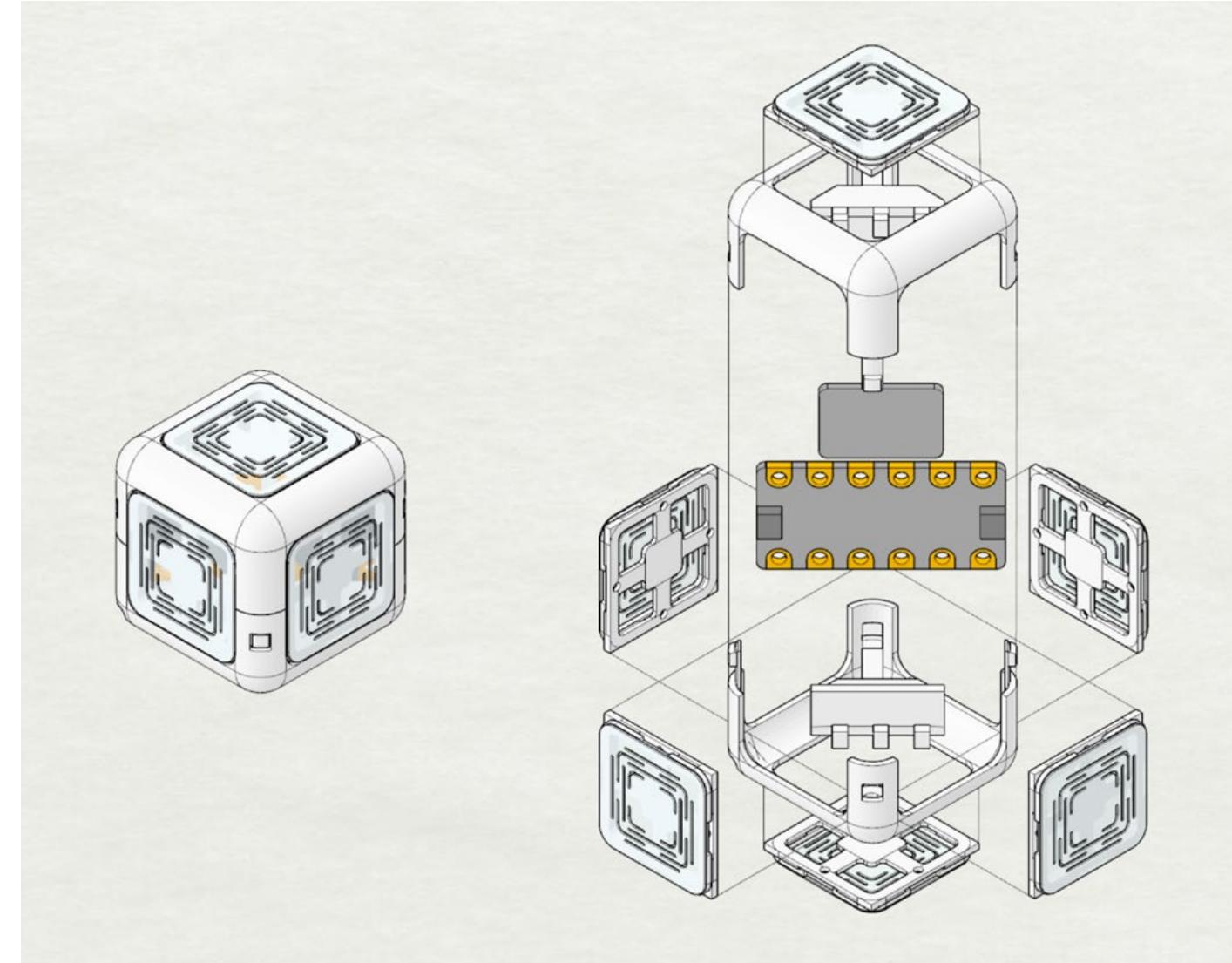


Hybrid Collage

07 THE CUBE

– An Interactive XR Device

HCI Graduate Studio
Spring 2022
Advisor: Wendy Ju
Individual Work



[<Animated Documentation>](#)

This project proposes the Cube, an interactive device with minimalistic design that redefines the manipulation of virtual objects through multimodal approaches. It transfers the user's gestures to digital input, allowing the user to easily release and regasp during transitions between physical and virtual interactions. Multiple Cube devices can be aggregated to form dynamic systems.

The Design Space

The cardboard prototypes and augmented video studies visualize and explore the manipulative gestures around the Cube, possible interactions based on input sensors, and the aggregation of multiple Cube devices.



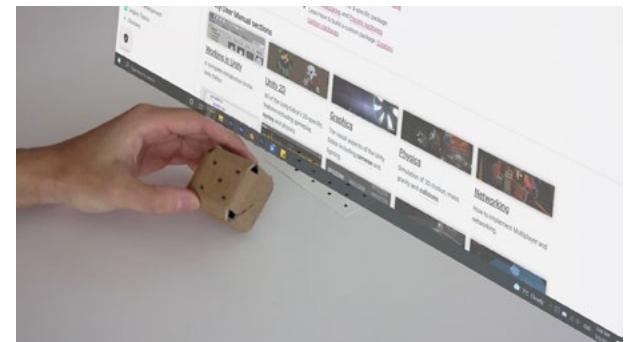
Trigger Event - Touch



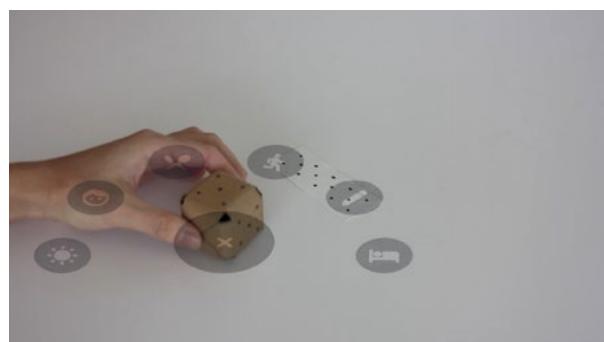
Trigger Event - Squeeze



Rotation - 1 DOF



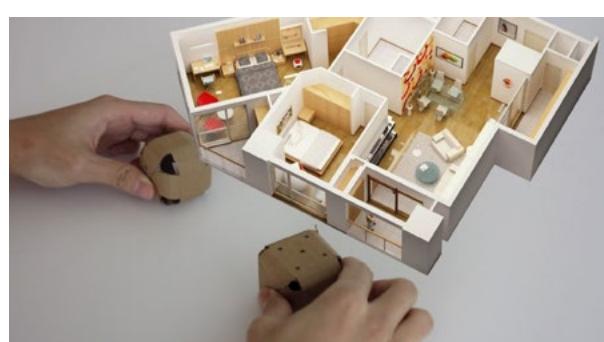
Rotation - 3 DOF



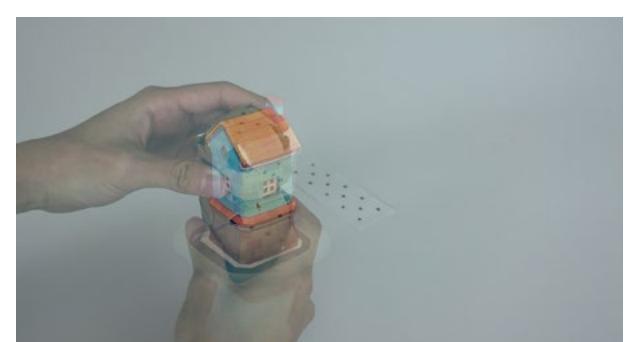
Translation - Bounce



Translation + Rotation - Move + Turn



Aggregation - Scale

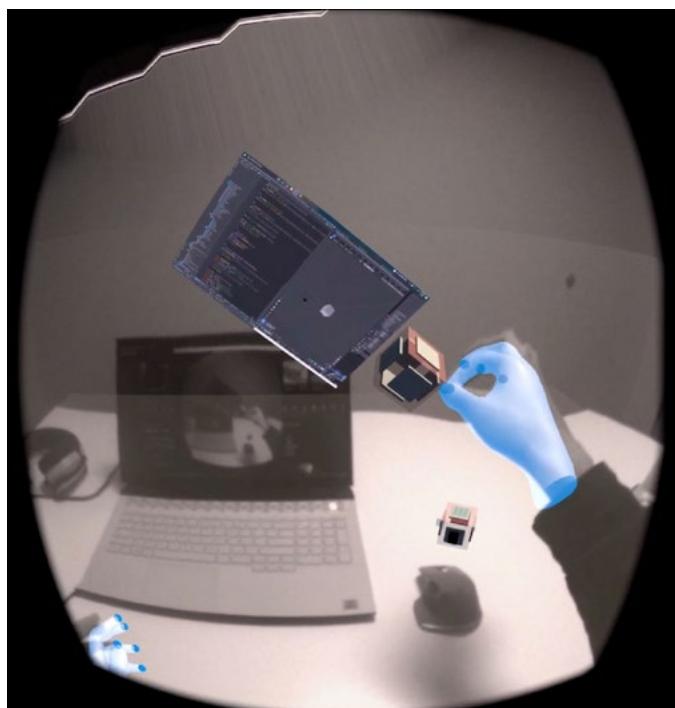
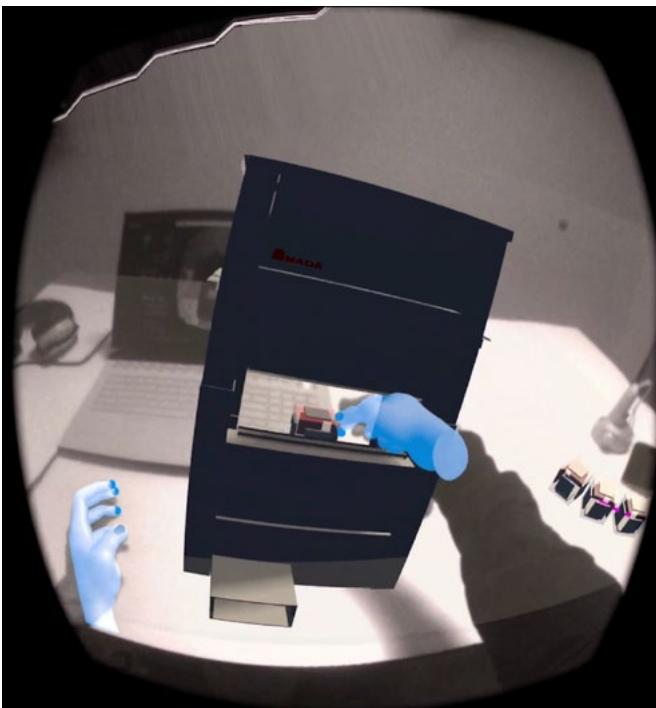
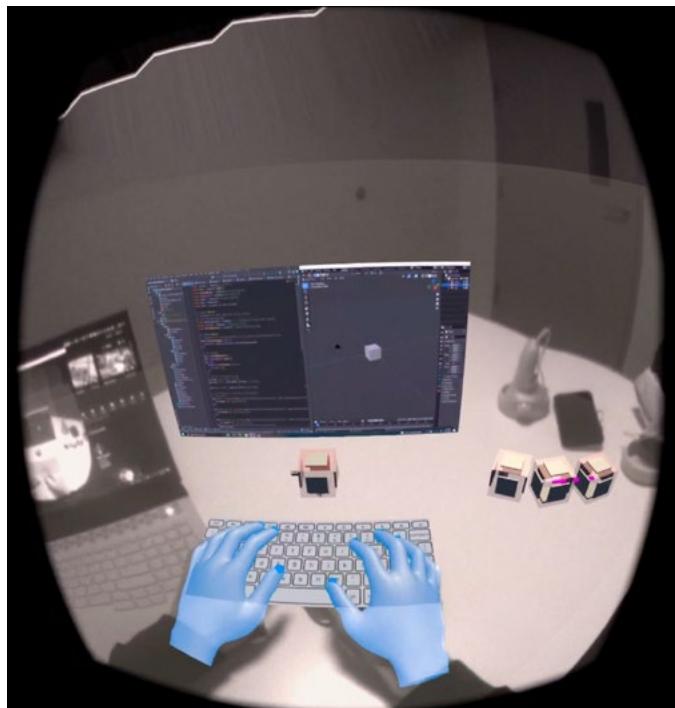


Aggregation - Stack

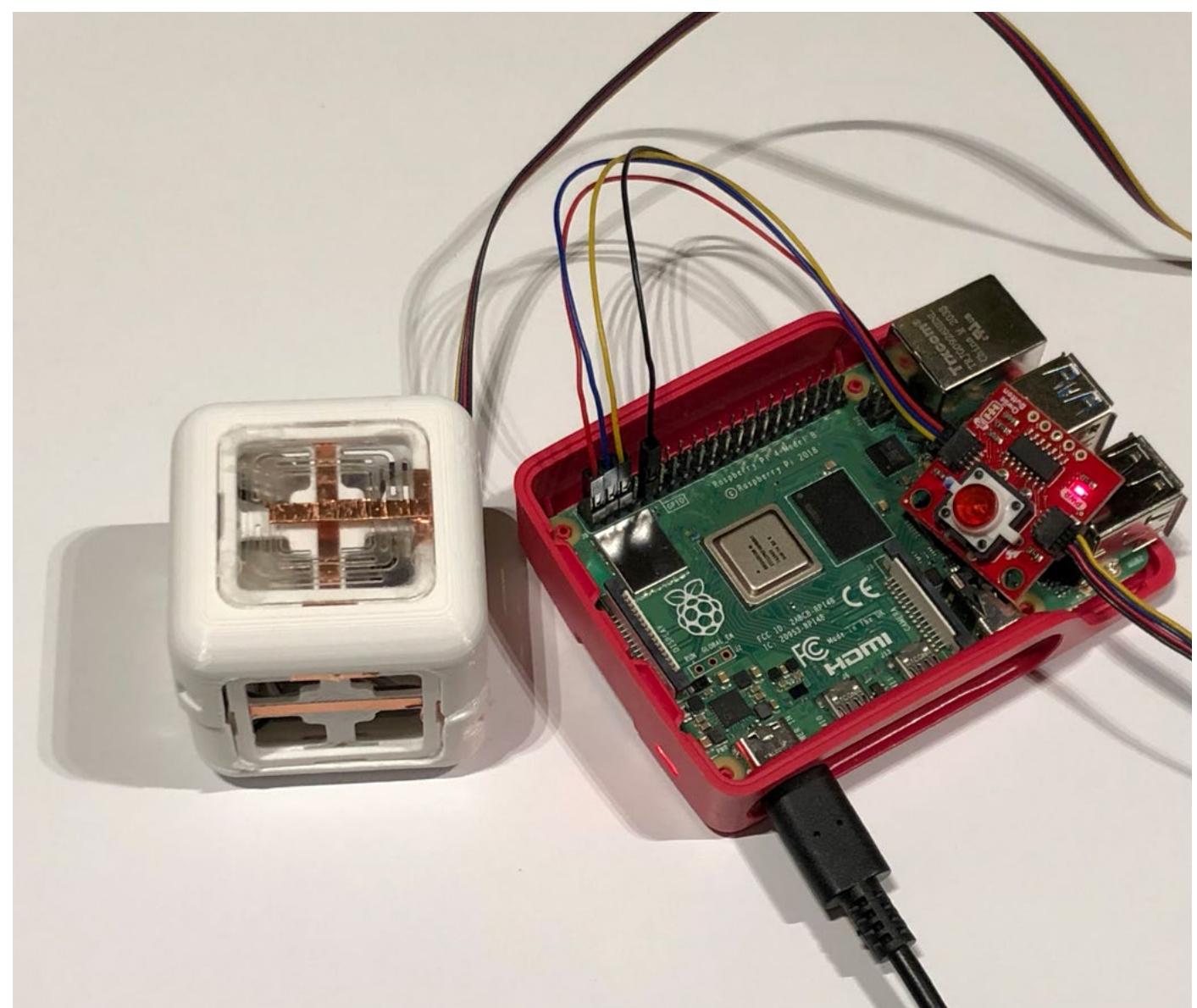
Virtual and Physical Prototypes

The game-like visual prototype utilizes the video-see-through and hand tracking features of the Oculus Quest platform. Such an immersive experience was implemented to analyze the versatility of the Cube.

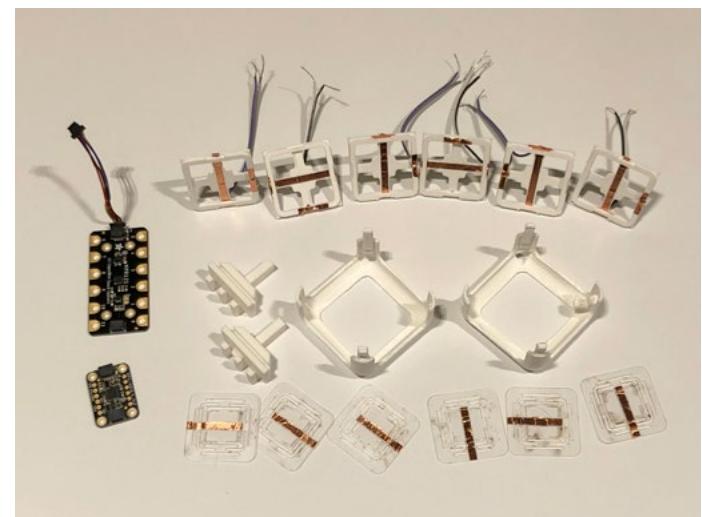
A proof-of-concept prototype with 3D printed frame, laser-cut deformable capacitive buttons, and Raspberry Pi hardware was built to study interaction from a physical approach.



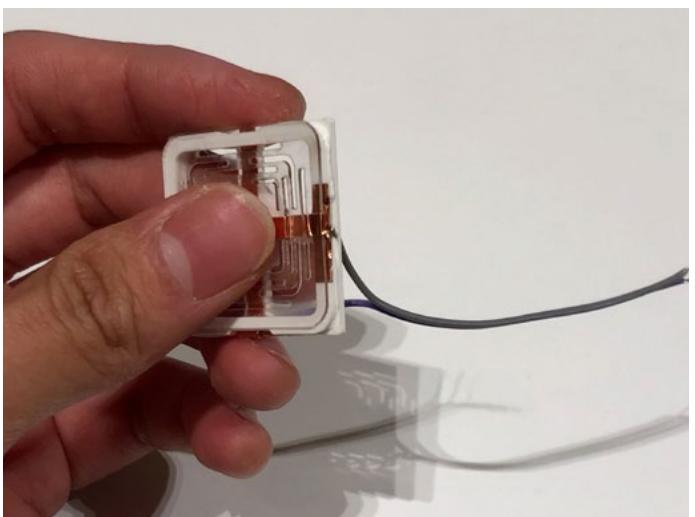
Virtual Prototype
Testing inputs through triggers, transform, acceleration, and relative transform



Physical Prototype
The proof-of-concept build



Electrical Components



Layered capacitive button that can deform
to support touch and forced press

08 INTERACTIVE PROTOTYPES

– Rapid Prototyping with Raspberry Pi

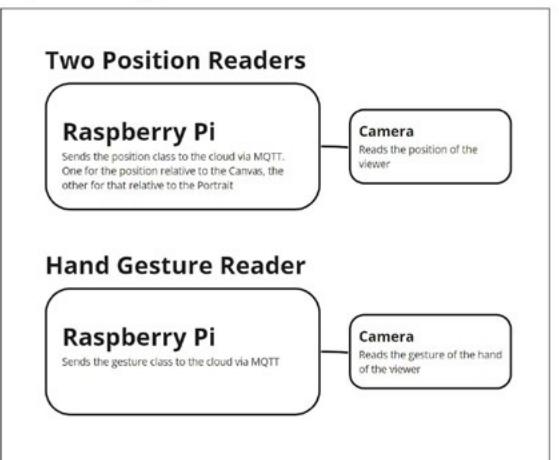
Interactive Devices Design
Fall 2021
Instructor: Wendy Ju

This series of two-week projects explores the potential of Raspberry Pi, digital fabrication, and Computer Vision in prototyping interactive devices and experiences.

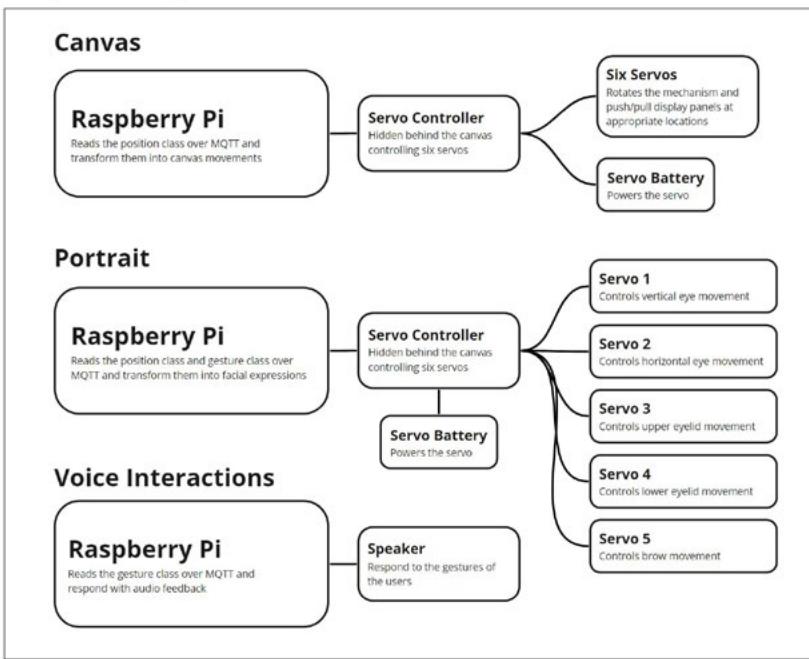


The Canvas and Portrait of the Interactive Van Gogh Project

Input Managers



Output Managers



Implementation

Three Raspberry Pies are used to run all the manager systems:

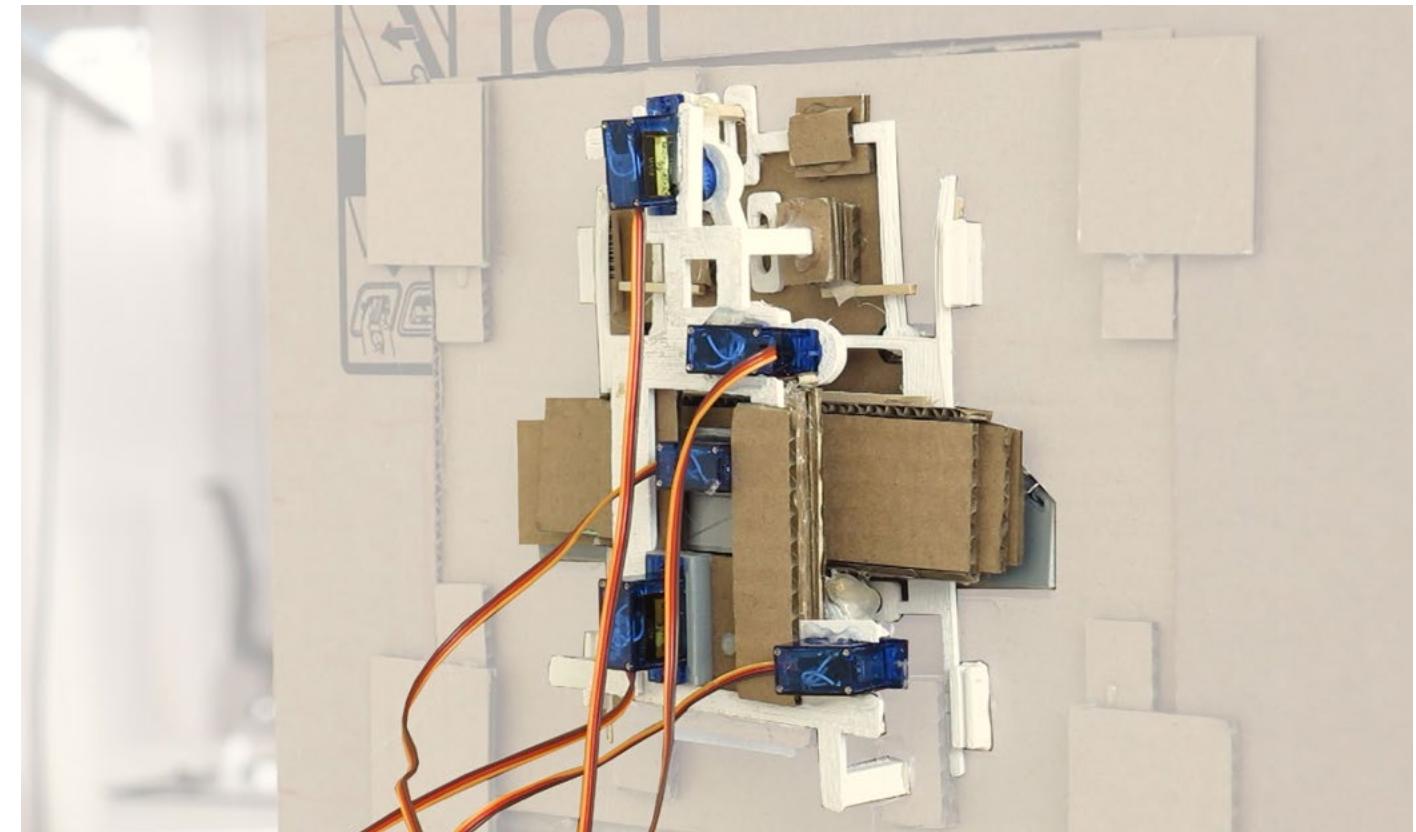
- Raspberry Pi #1: Canvas Position Reader and Canvas
- Raspberry Pi #2: Portrait Position Reader, Portrait, and Voice Interactions
- Raspberry Pi #3: Hand Gesture Reader

Interactive Van Gogh

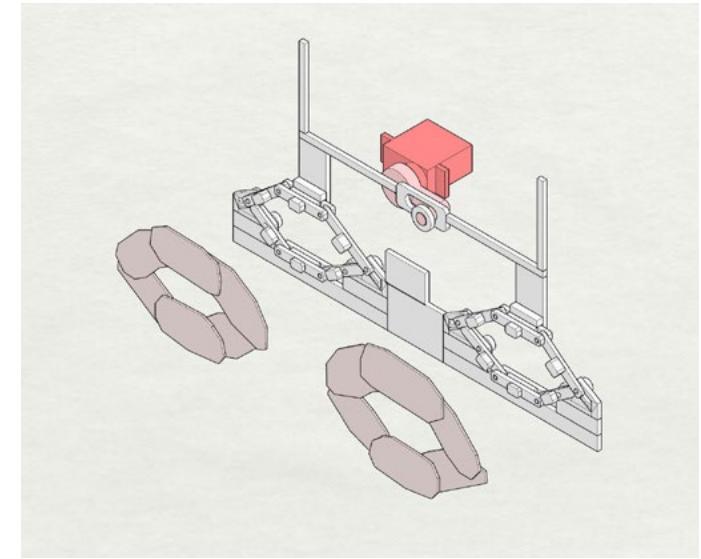
Collaborator: Angela Chen, Kaiyuan Deng, Esther Fang, Ken He
Contribution: Design, fabrication, program architecture

This exhibition consists of two interactive artworks:

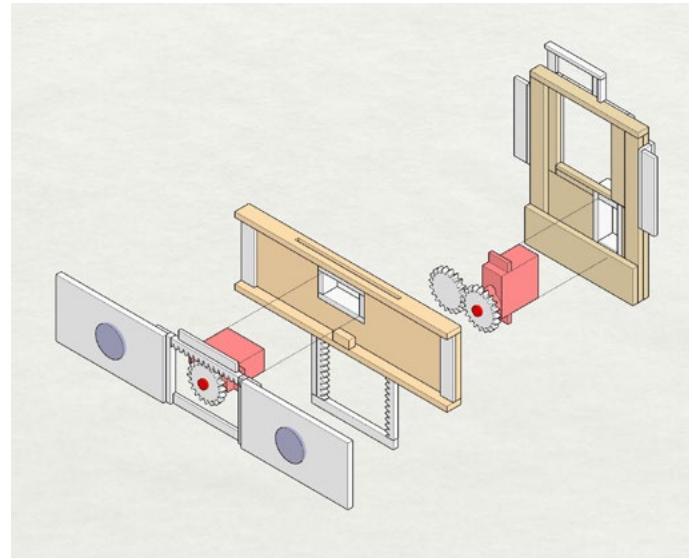
1. A portrait of Van Gogh whose eyelids, eyeballs, and eyebrows can move to form facial expressions in response to visitors' bodily movements. The virtual Van Gogh could also "talk" to the visitors when he recognizes their hand gestures through Computer Vision.
2. A canvas that constantly transforms its pixel colors between dark and light to reflect visitors' silhouettes. Three Raspberry Pis collaborate through MQTT broker.



The Mechanism Behind the Portrait



Mecahnism of the Eyelids



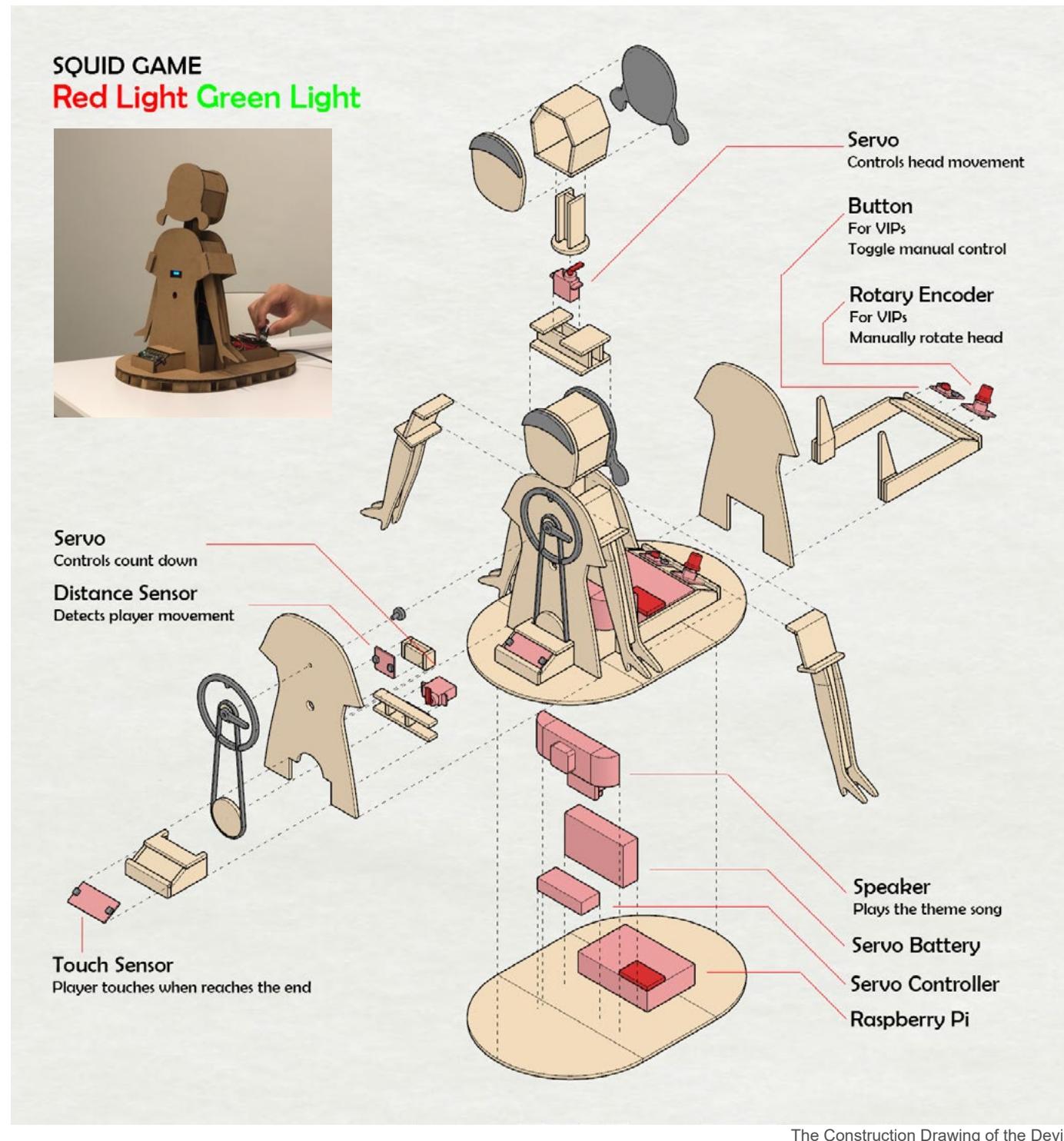
Mechanism of the Eyeballs

Squid Game - Red Light Green Light

Collaborator: Esther Fang, Ken He

Contribution: Design, fabrication, implementation

This project integrates a variety of sensors, and laser cut cardboard structure into the *Red Light, Green Light* game in the TV series, *the Squid Game*. The player's goal is to reach the capacitive sensor by the doll but has to freeze when the doll turns. A controller sits behind the doll and manipulates the doll's movement.

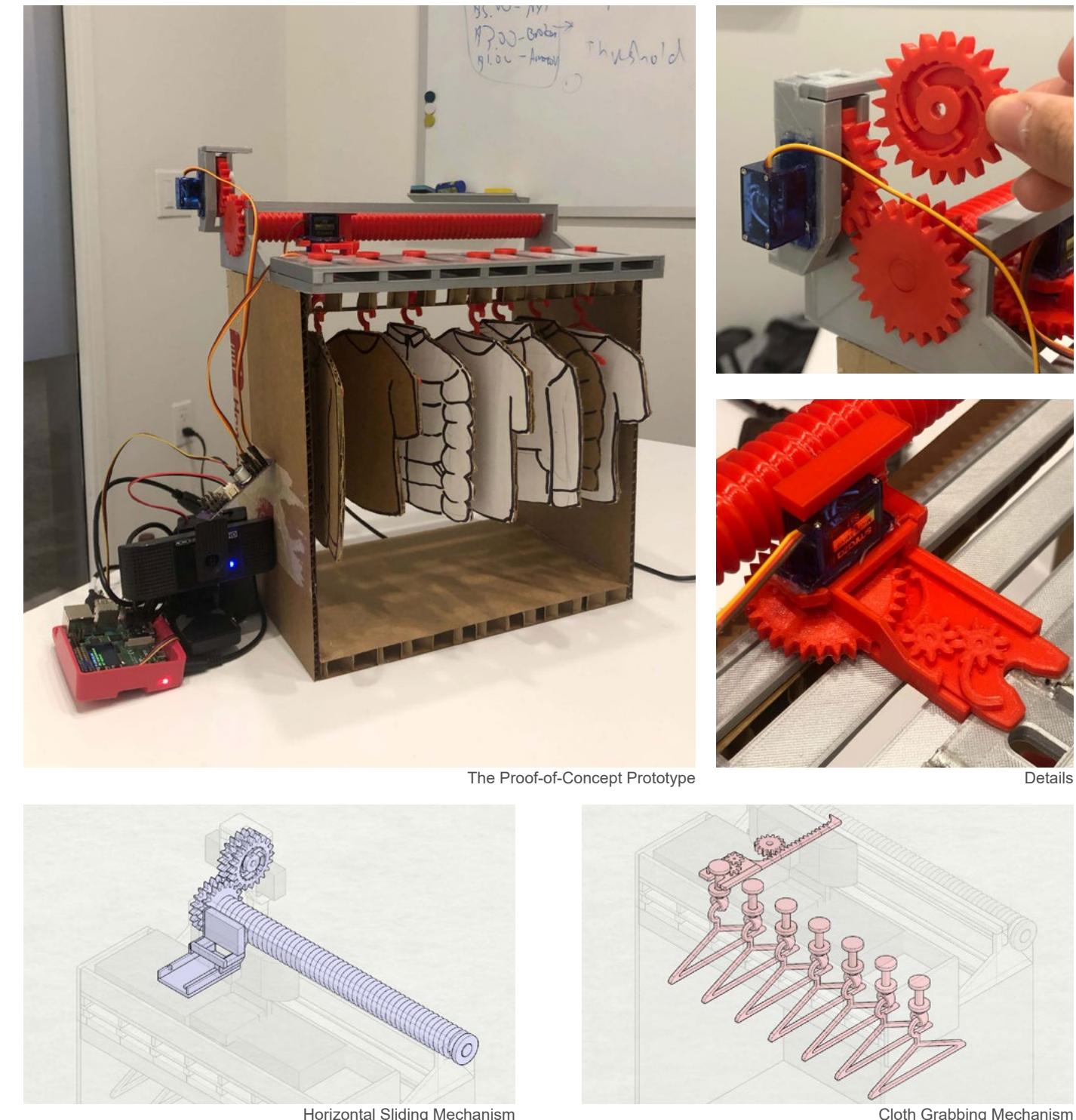


Smart Closet

Collaborator: Esther Fang, Ken He

Contribution: Design, fabrication, implementation

This smart closet obtains real-time weather data and detects the clothing the user is wearing with Computer Vision, based on which it gives the user recommendations about their outfit. Then a physical mechanism in the closet automatically brings the suggestion to the user. A to-scale proof-of-concept prototype was built with 3D printed components and cardboard.



ARCHITECTURE

Flushing Commons

Virtual Places Research Studio I

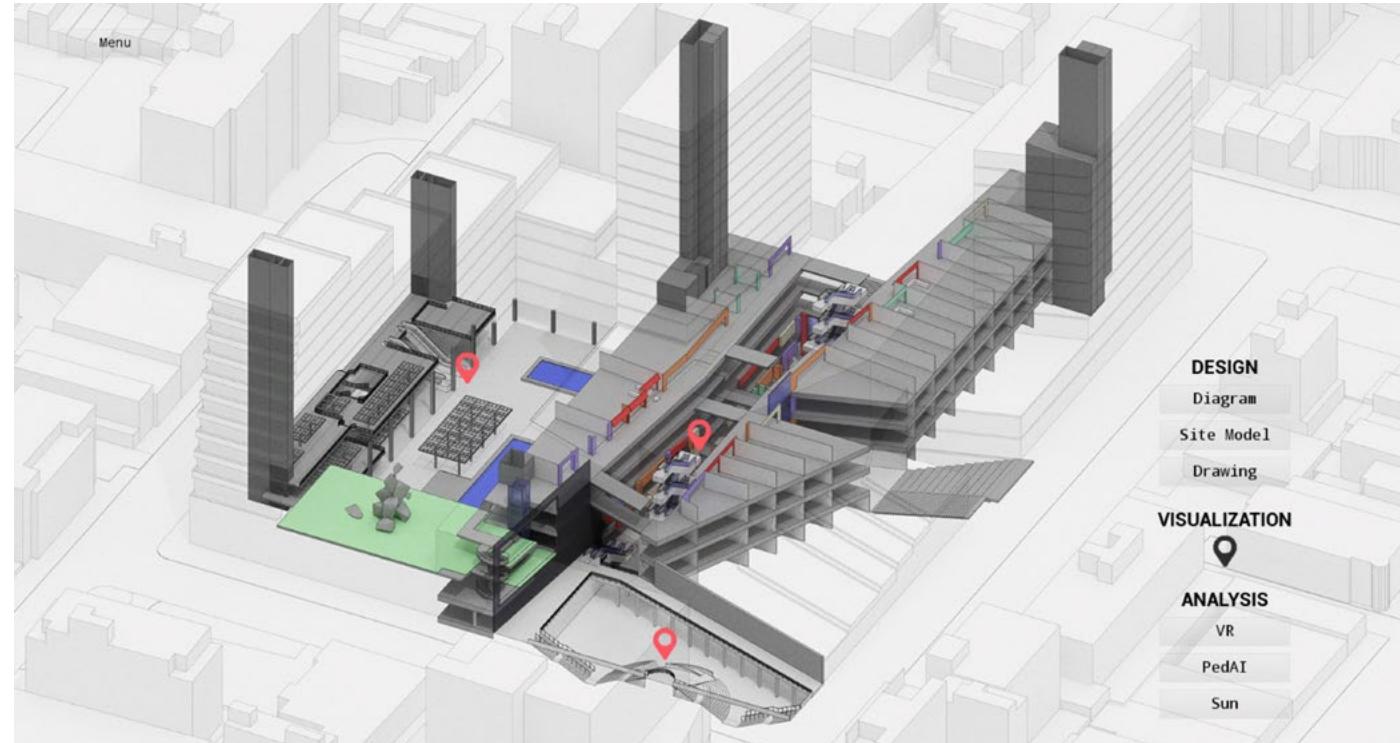
Spring 2020

Instructor: Henry Richardson, Christopher Morse

Site: Flushing, New York

Collaborator: Ting Wei Fan, Noah Gear

Contribution: Conceptual design, implementation, representation



Screenshot of the Interactive Interface Developed with the Unreal Engine



Virtual Commercial Street in Snow Represented with VR



Mixed Reality Collage

Carved Dwelling

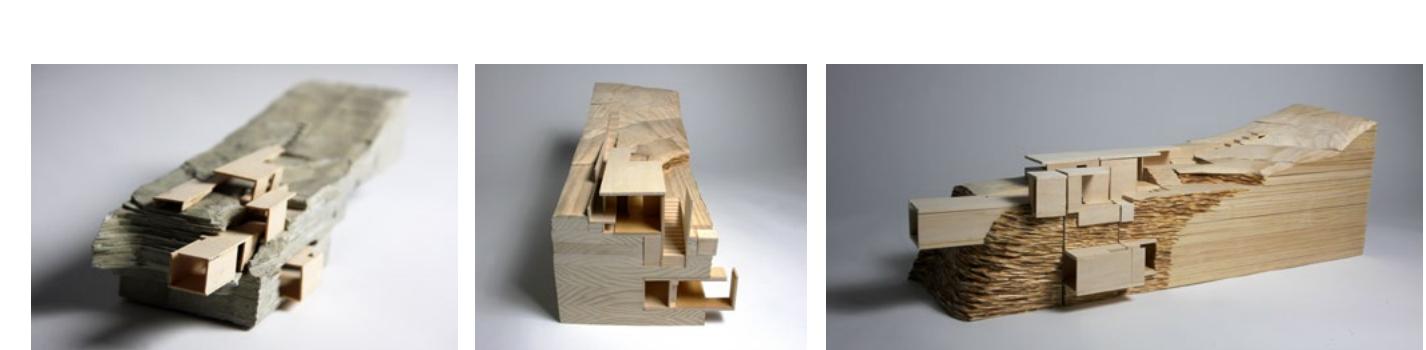
Design III Studio

Fall 2017

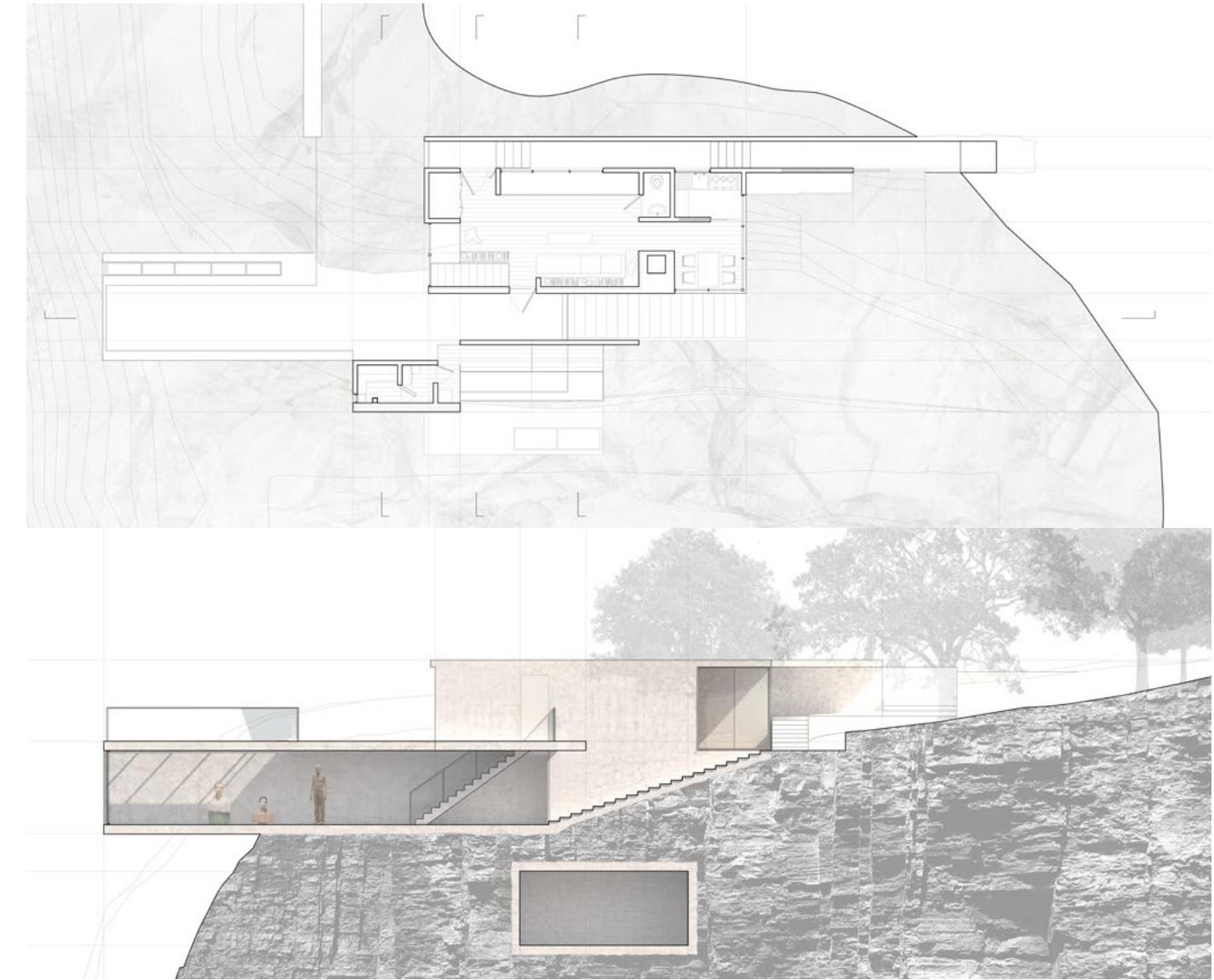
Instructor: Dasha Khatalova, John Miller

Site: Ithaca New York

Individual Work



1/16" = 1' Study Model



Ground Floor Plan and Longitudinal Section

COMPUTATIONAL DESIGN

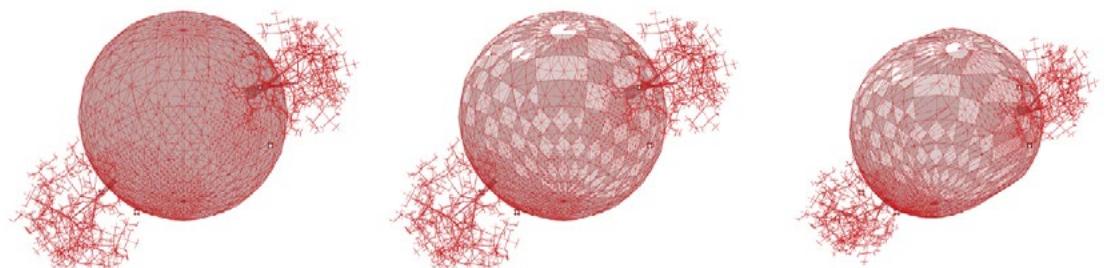
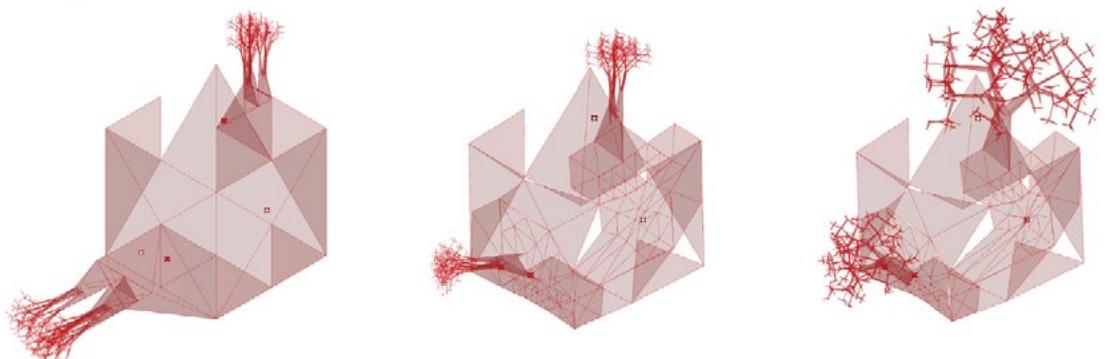
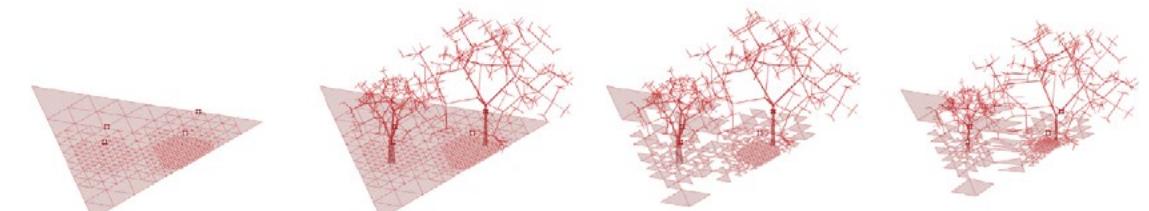
Procedural Landscape

Coding For Design
Fall 2020

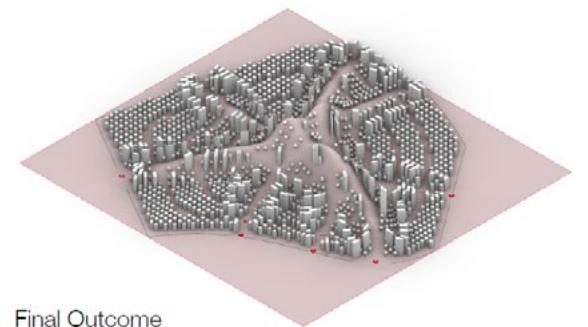
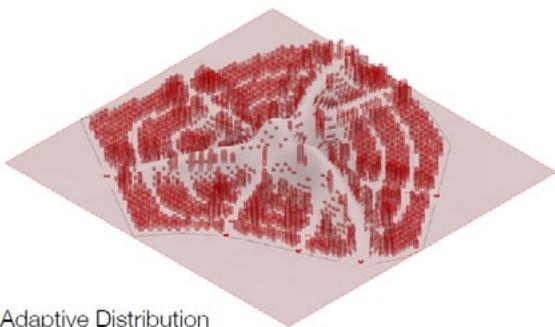
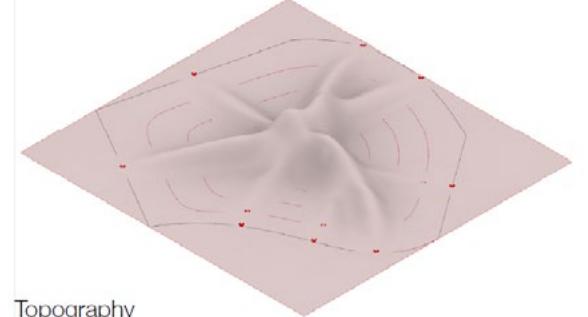
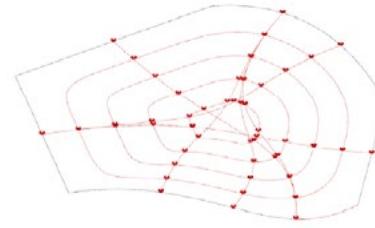
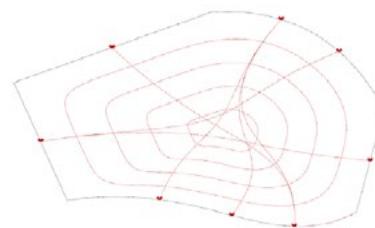
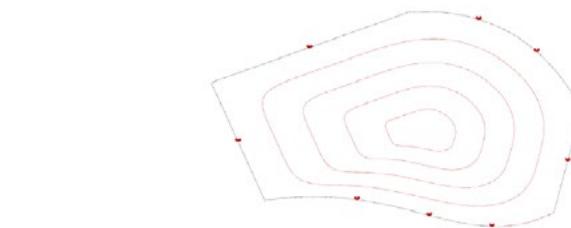
Instructor: Panagiotis Michalatos
Individual Work

[<Documentation>](#)

The Tree



The Mountain City



MUSICAL INSTALLATIONS

The Music Device + Skin

Design IV Studio
Spring 2018
Instructor: João Almeida
Collaborator: Zhenbang Xiong
Contribution: Conceptual design, modeling, fabrication



The Music Device

[<Video Documentation>](#)

The flute instrument consists of one organically-shaped wooden chamber and eight copper sound tubes. The protective skin can be flipped open and support the instrument to match the height of a seated performer. The product is manufactured through CNC machining.

The Drawing Machine

Design I Studio
Fall 2016
Instructor: Val Warke, Luben Dimcheff
TA: Danny Salamoun
Individual Work

The drawing machine translates the finger movements of a guitar player into a series of dots connected by intermittent lines. This pattern is then transformed into an architectural design named *the Dwelling of the Wind*, where chambers and paths interweave with the site and are represented with casted concrete in the final model.



Diagram of the Skin



The Musical Drawing Produced by the Machine



The Drawing Machine in Motion



1/8" = 1' Dwelling of the Wind Concrete Model

INDIE GAMES

Space Exterminator

Introduction to AR/VR
Fall 2021

Instructor: Harald Haraldsson

Collaborator: Fanruo Gu, Hoyoung Jun

Contribution: Game, level, onboarding design and implementation

[<Trailer>](#)

An Oculus Quest VR game built with Unity. The player is a space exterminator who travels across planets and eliminates alien encroachers that threaten dwellers of all space civilizations. An interactive onboarding is designed to teach players VR interactions. The alien planets, spaceship, and weapons are drawn with Gravity Sketch and Tilt Brush in VR.



The Spaceship Drawn in Gravity Sketch



The Onboarding Experience



The Experimental Mode

Spectrophobia

The Game Design Initiative at Cornell
Spring 2021

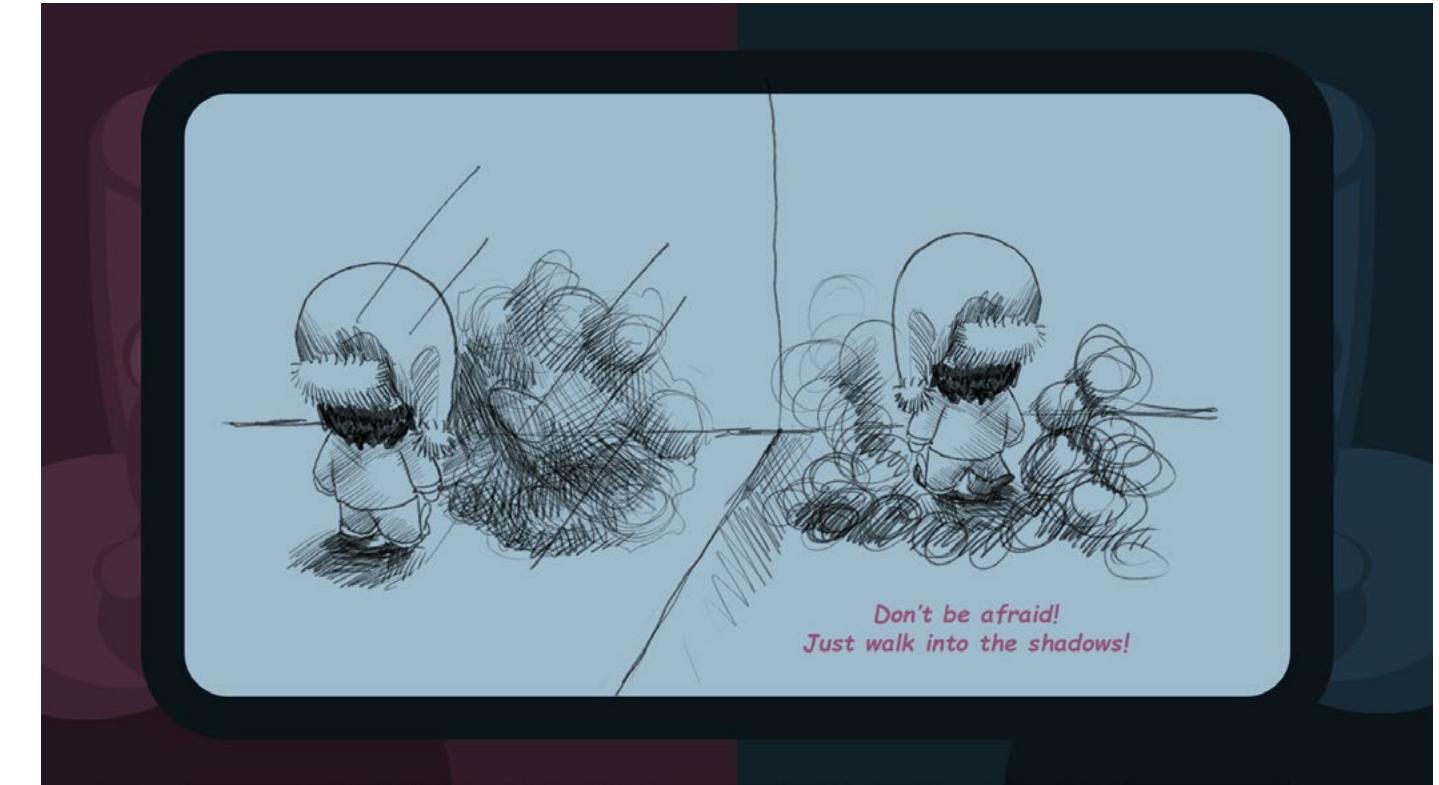
Instructor: Walker White, Traci Nathans-Kelly

Collaborator: Haoxuan Chen, John Chen, Alison Duan, Rachel Moon, Mokhtar Rajai, Shirley Ren, Aron Zhao

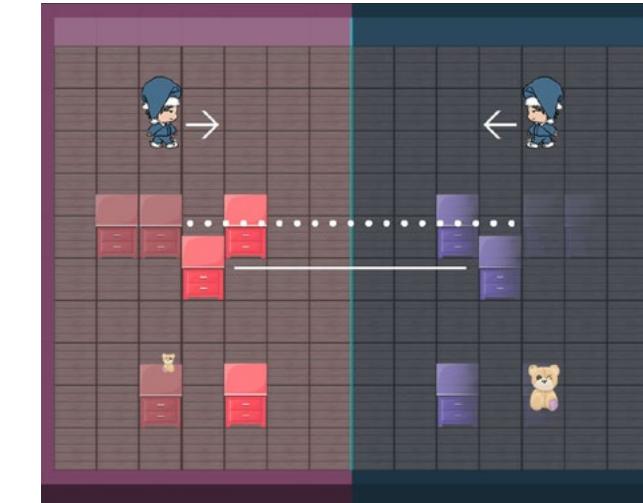
Contribution: Design lead; character, animation, level design and implementation

[<Trailer>](#)

A 2D game built with libGDX based on the mechanism of reflection. The player would forge a path and guide the protagonist Otto through the room to reach the lamp along with his reflected counterpart, while avoiding monsters and obstacles that are actually the reflections of Otto's toys and furniture.



A Storyboard in the Gameplay about the "Desync" Mechanism



The Flipped Control, the Hidden Furniture, and the Malicious Toys



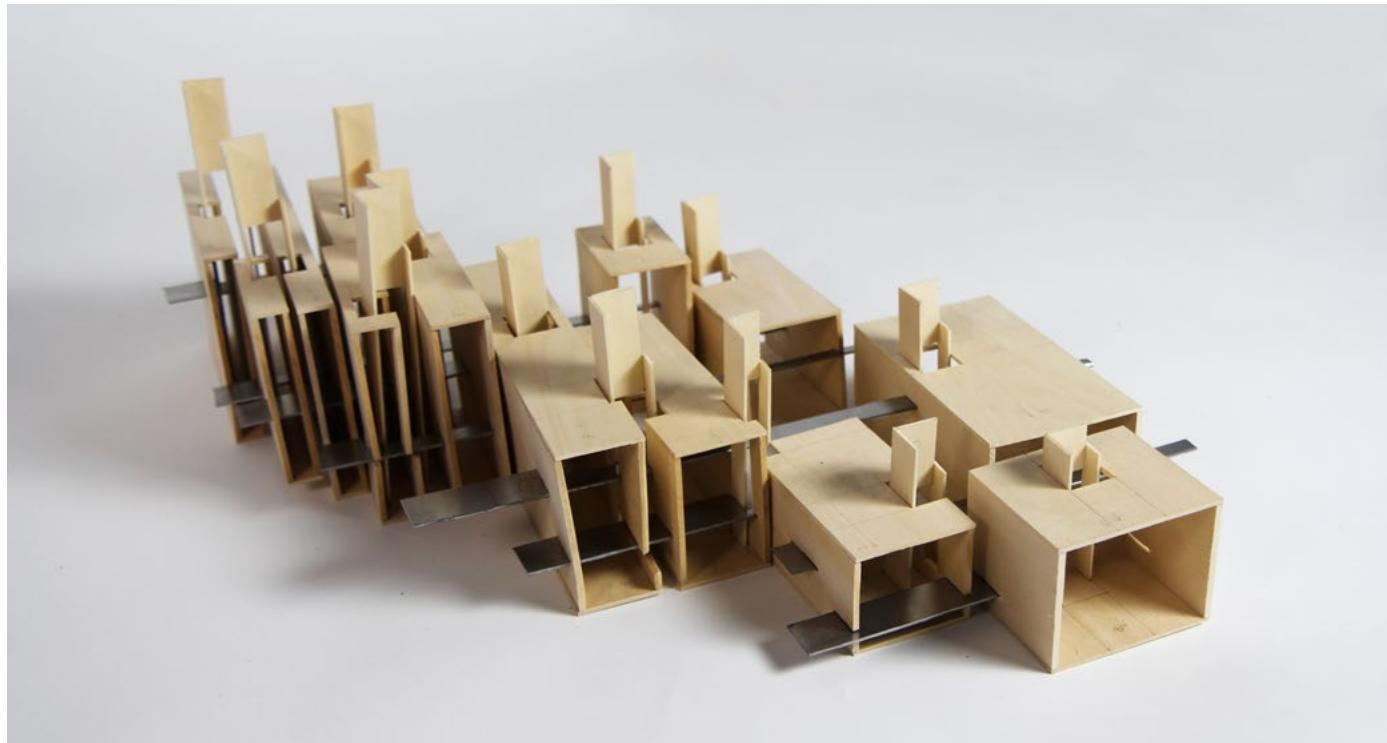
A Tutorial Level on the "FlashDark" Mechanism

Models & Arts

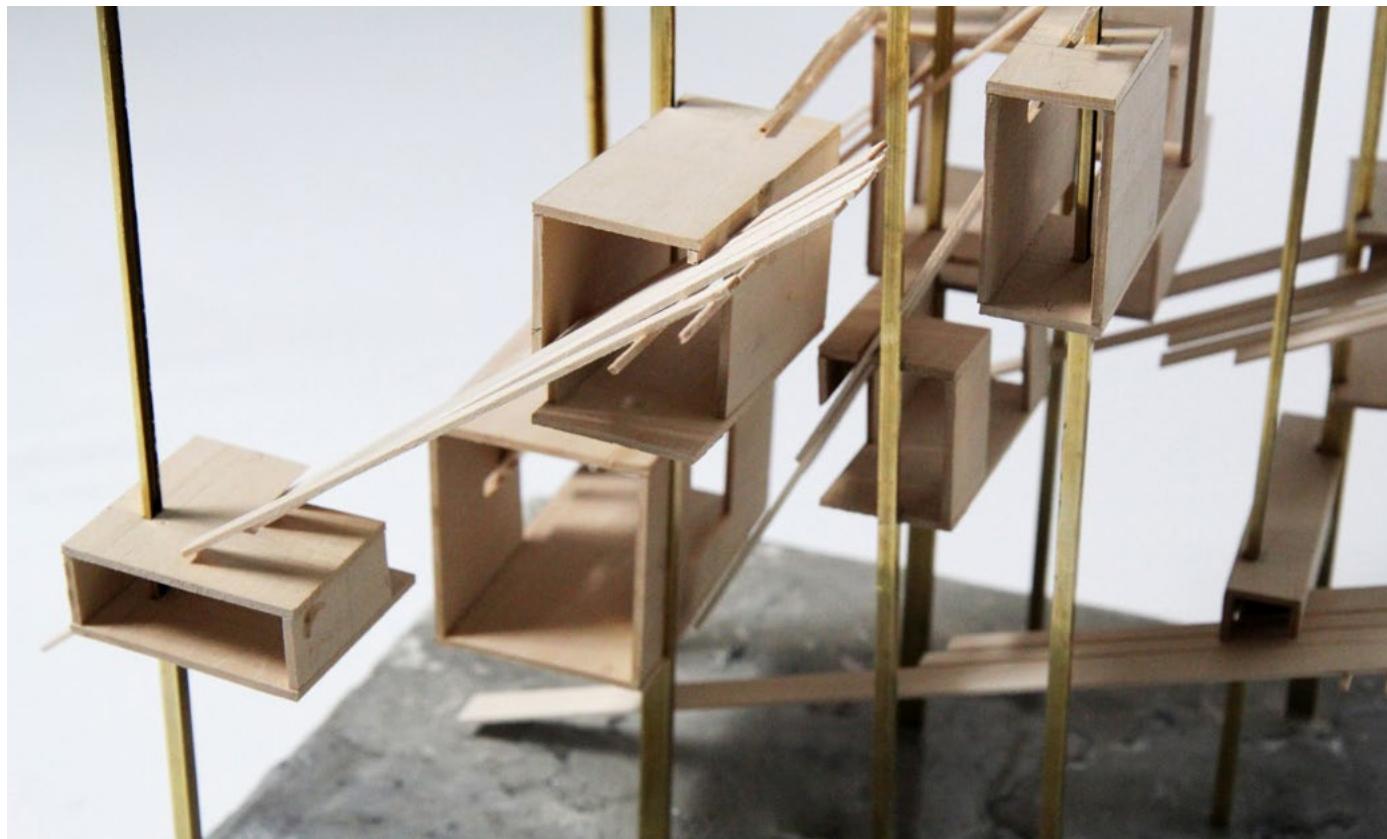
Adaptation

The Adaptation of Interlocking Systems
Design II Studio - Spring 2017

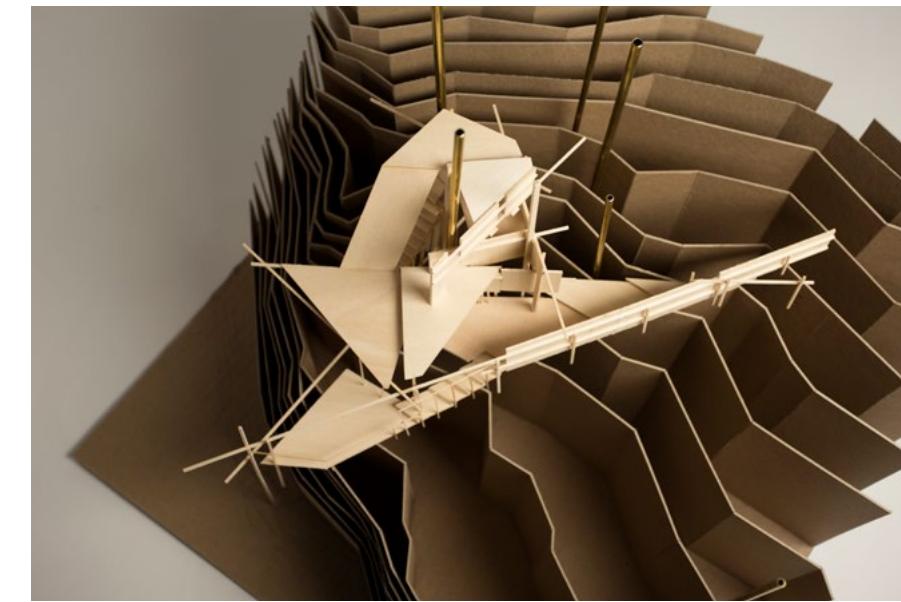
[<Documentation>](#)



Arid Adaptation



Tropical Adaptation



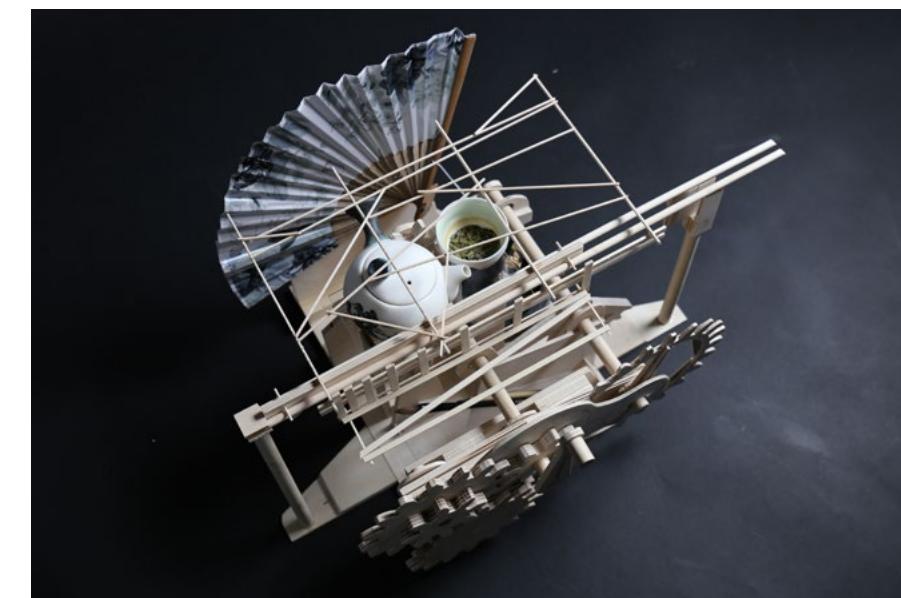
Nature Watching Station

Partform of the Fall & Room of the Wood
DBAIRD Prize, Winner - Fall 2017



The Soundscape

An Urban Node for Music
Design IV Studio - Spring 2018



The Clockwork of Zen

A Mechanical Collection Box
Spring 2017

[<Video>](#)

Models & Arts

Imagining Rome

Art Studio and Creative Writing Workshops in Italy
Summer 2017



The Street to Pantheon with Pen and Paint



Laocoön and His Sons with Pencil

Watercolor

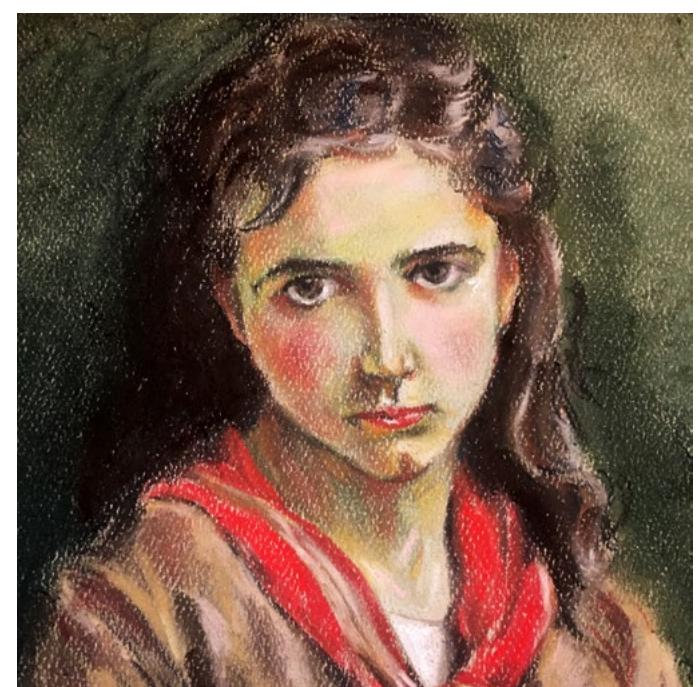
Prose and Lyricism of My Time in China before Covid
2017 - 2020



Yuzhen Zhang 17.07



Farmers Market in Baoji



Reproduction of Bouguereau's Portrait with Pastel



Aeneas, Anchises, and Ascanius with Pen and Ink



Yuzhen Zhang 17



Monochromatic Summer in Xi'an