

Selected Projects

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B.Arch '21 Dual M.S. '23
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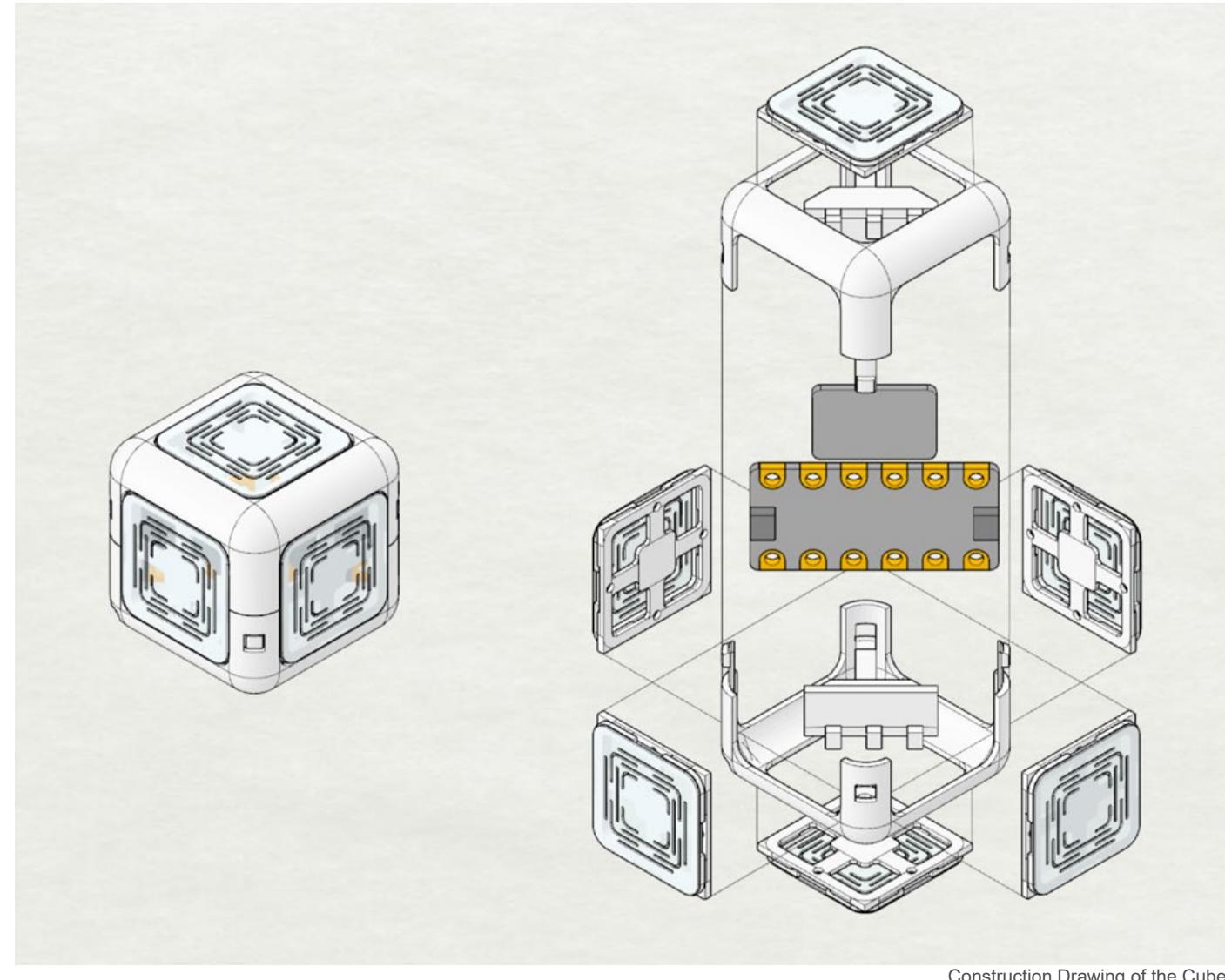
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THE CUBE

– An Interactive XR Device

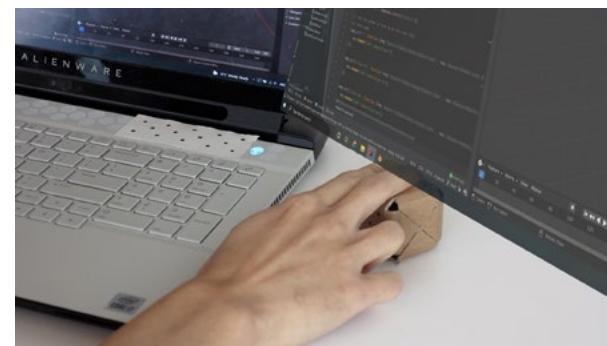
HCI Graduate Studio
Spring 2022
Advisor: Wendy Ju
Individual Work

This project proposes the Cube, an interactive device with minimalist 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 regrasp during transitions between physical and virtual interactions. Multiple Cube devices can be aggregated to form dynamic systems.



The Design Space

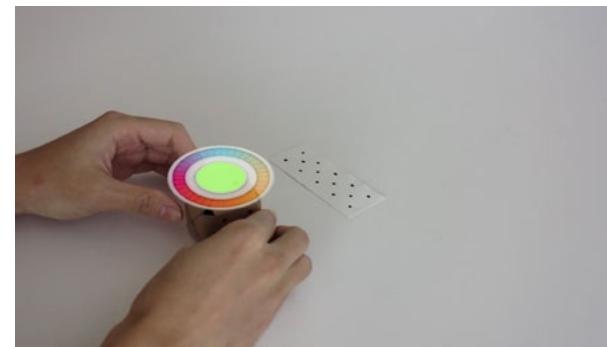
The cardboard prototypes and augmented video studies visualize and explore the manipulative gestures around the Cube, possible interactions based on input sensors, and the aggregation of multiple Cube devices.



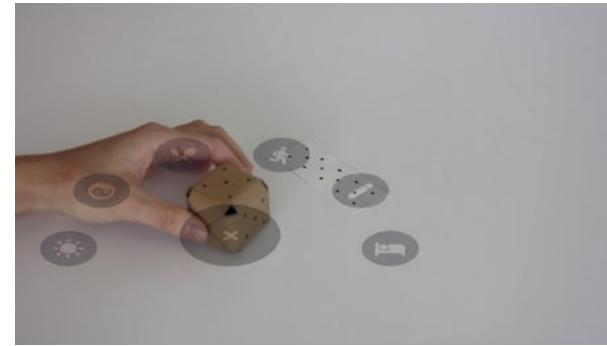
Trigger Event - Touch



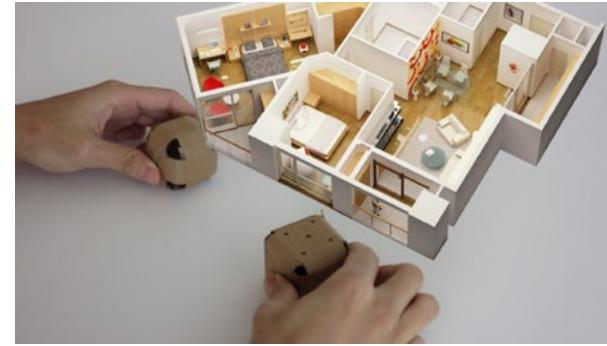
Trigger Event - Squeeze



Rotation - 1 DOF



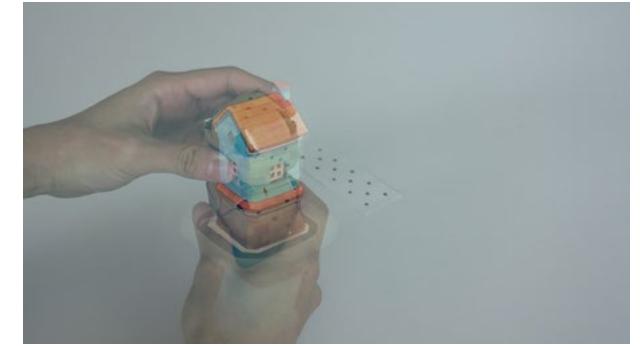
Translation - Bounce



Aggregation - Scale



Translation + Rotation - Move + Turn

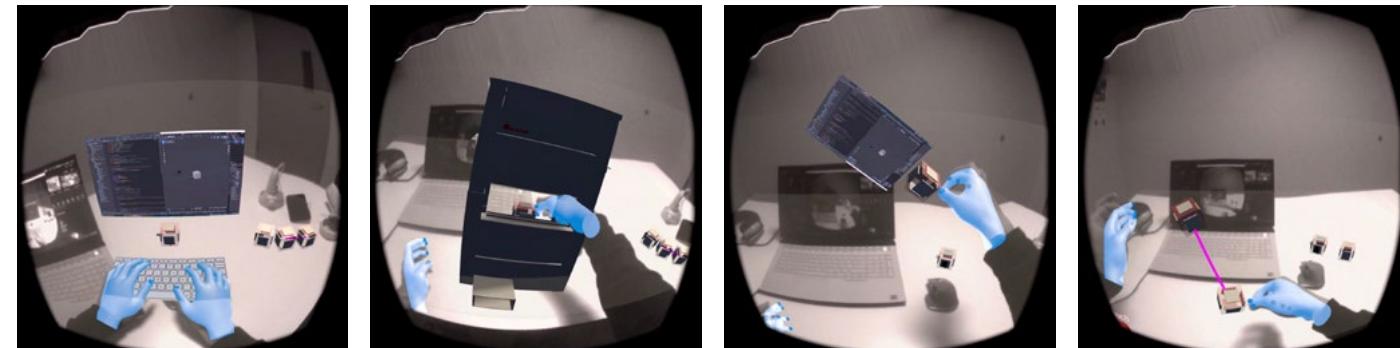


Aggregation - Stack

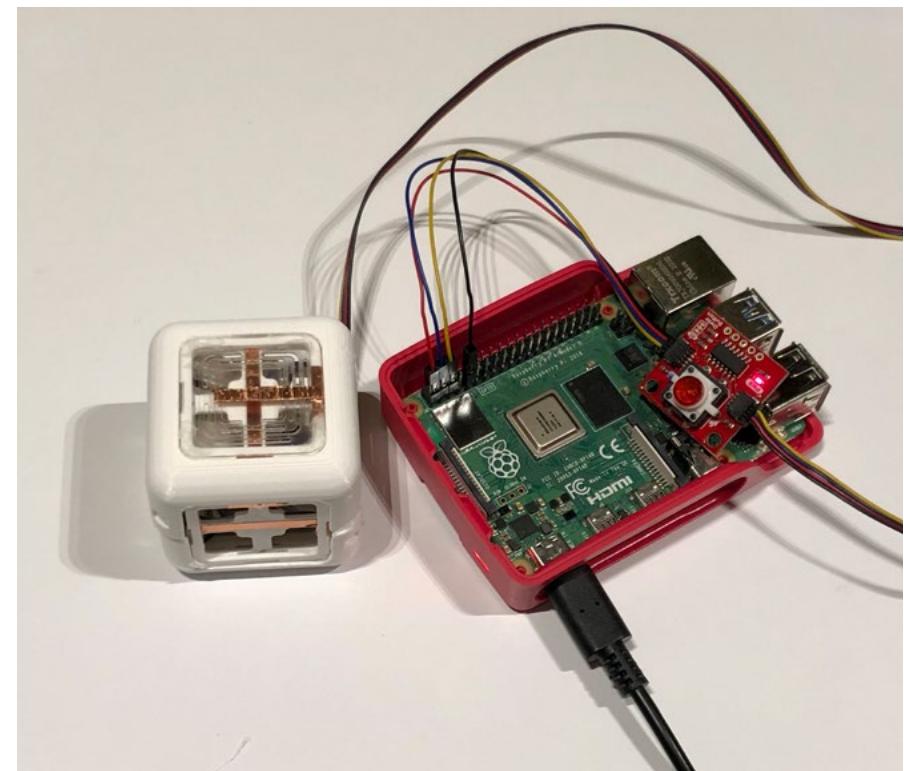
Virtual and Physical Prototypes

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.

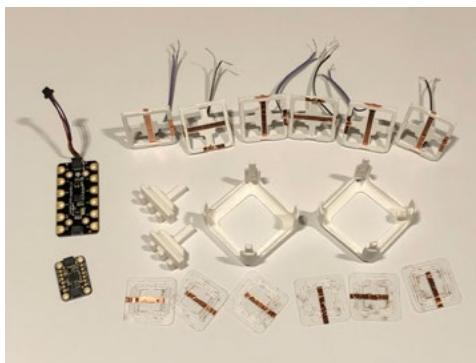
A proof-of-concept prototype with 3D printed frame, laser-cut deformable capacitive buttons, and Raspberry Pi hardware was built to study interaction from a physical approach.



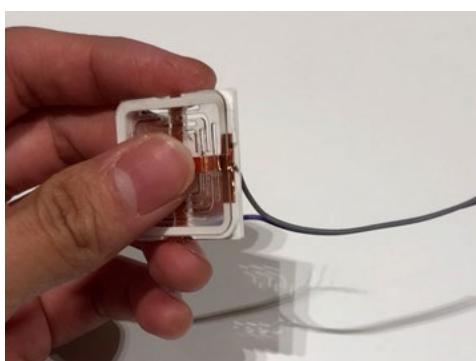
Virtual Prototype
Testing inputs through triggers, transform, acceleration, and relative transform



Physical Prototype
The proof-of-concept build



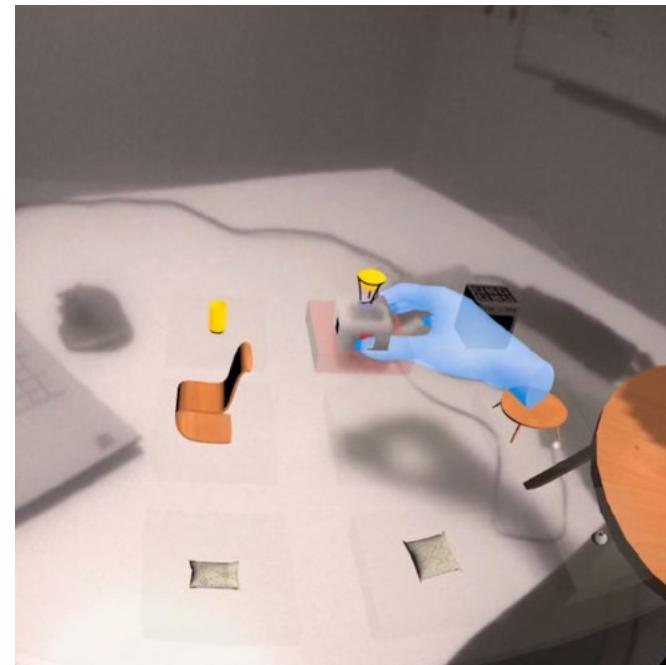
Components



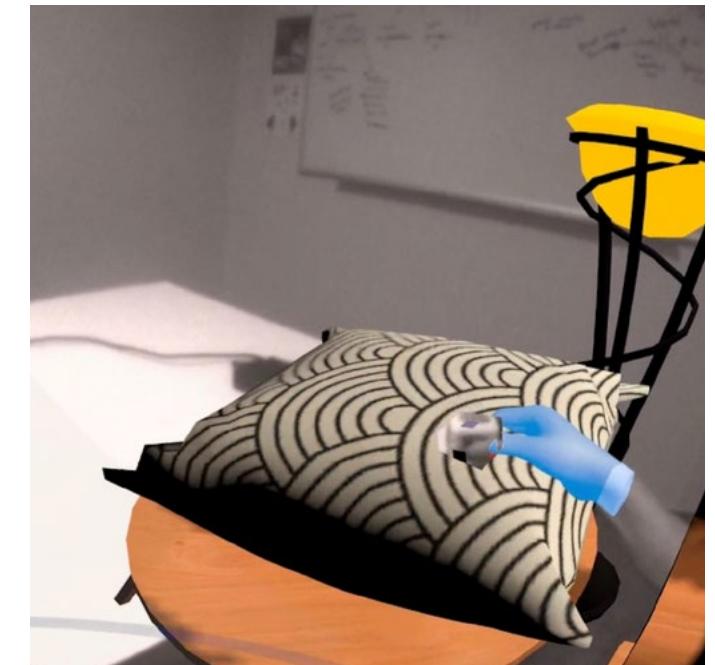
Layered capacitive button that can deform to support touch and forced press

The Extended Reality Interaction

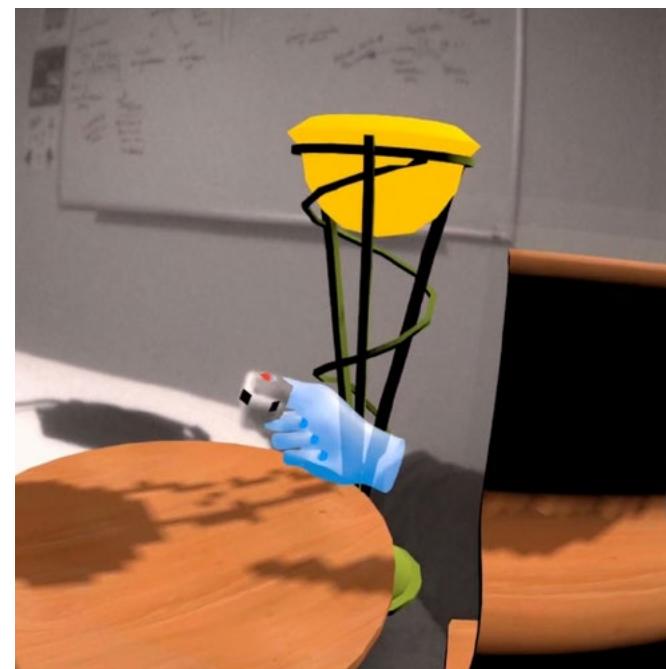
With the MQTT broker that joins the virtual and the physical systems, an hybrid interaction experience was created in Extended Reality. Here, the Cube and its virtual counterpart were overlapped spatially to manipulate both physical and virtual furniture to customize and study the interior layout of a habitable space.



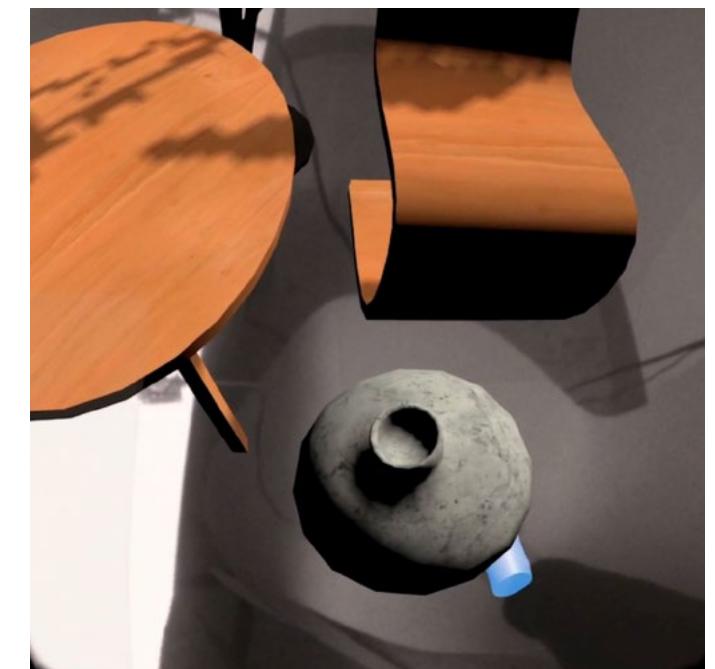
Furniture Selection with a 3D gestural menu



Furniture placement based on transform and trigger inputs



Furniture scaling and coloring based on rotation inputs



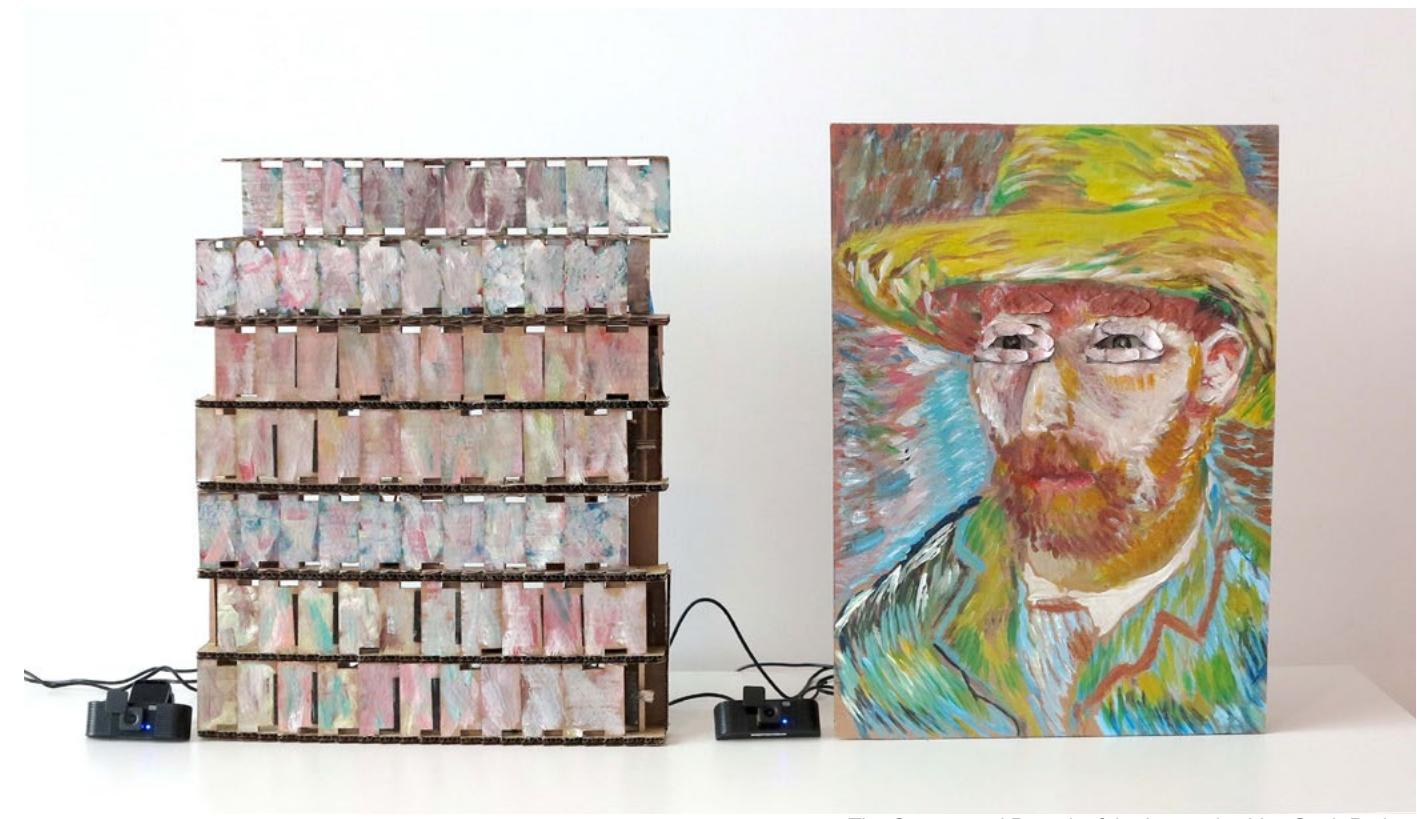
Hybrid Interaction with physical and virtual objects

INTERACTIVE PROTOTYPES

– Rapid Prototyping with Raspberry Pi

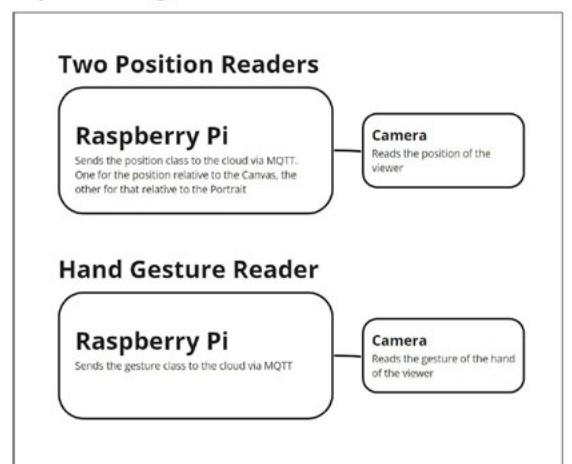
Interactive Devices Design
Fall 2021
Instructor: Wendy Ju

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

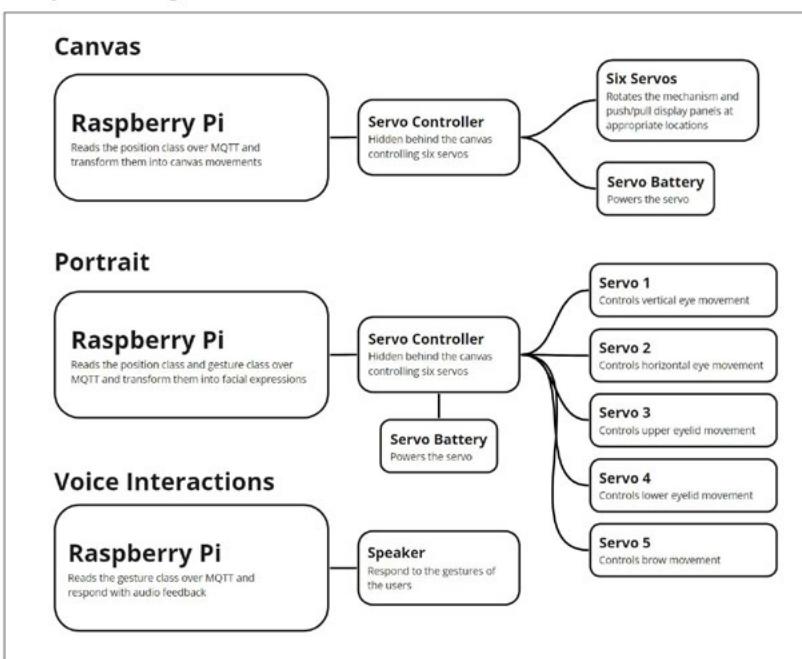


The Canvas and Portrait of the Interactive Van Gogh Project

Input Managers



Output Managers



Implementation

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

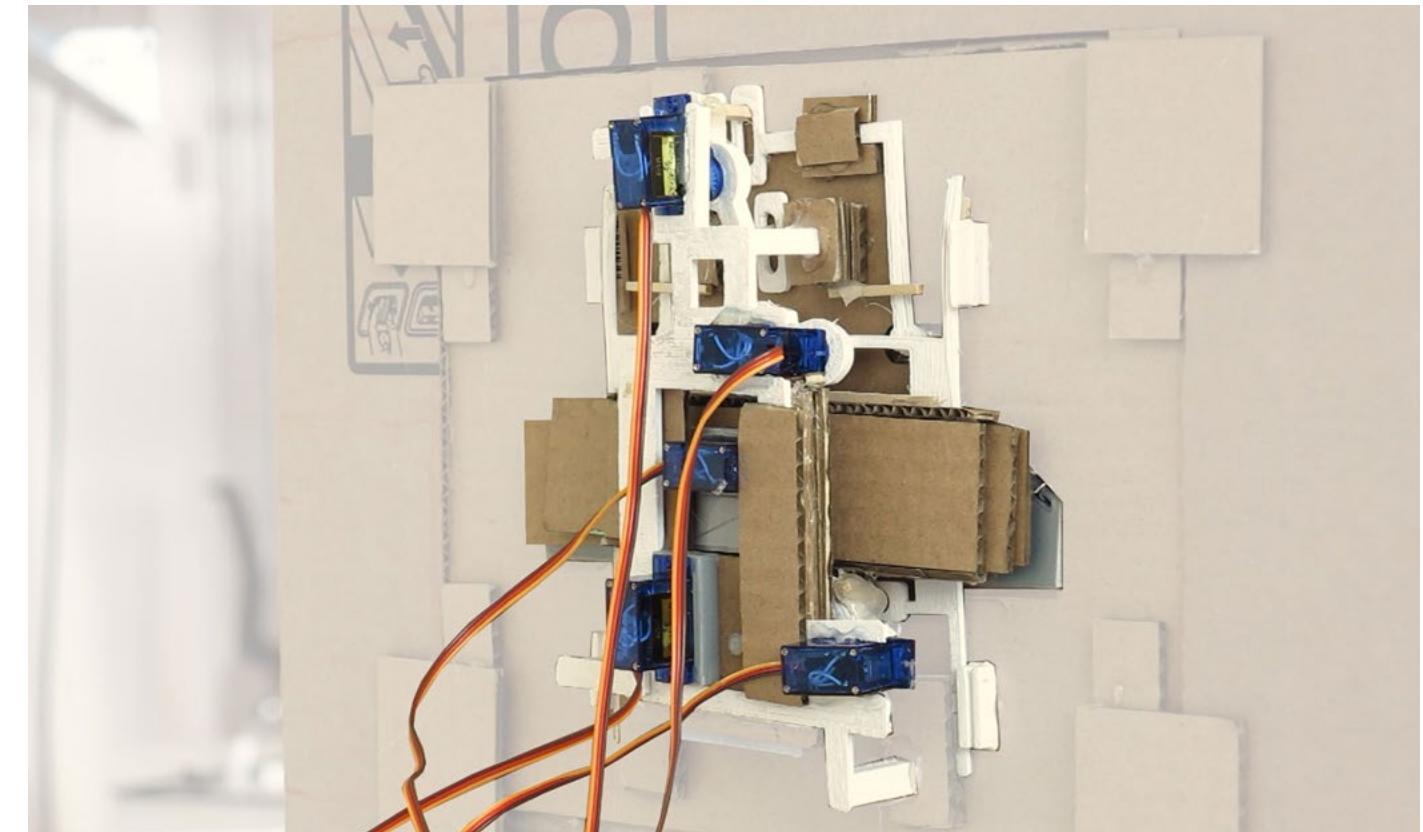
- Raspberry Pi #1: Canvas Position Reader and Canvas
- Raspberry Pi #2: Portrait Position Reader, Portrait, and Voice Interactions
- Raspberry Pi #3: Hand Gesture Reader

Interactive Van Gogh

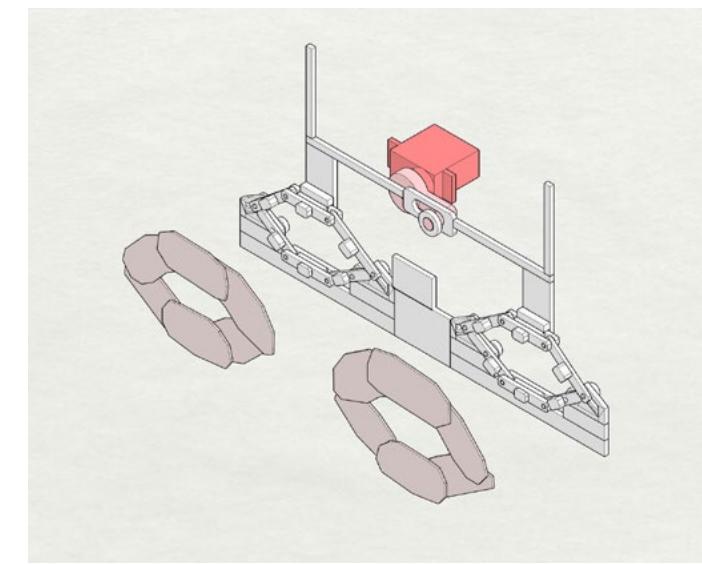
Collaborator: Angela Chen, Kaiyuan Deng, Esther Fang, Ken He
Contribution: Design, fabrication, program architecture

This exhibition consists of two interactive artworks:

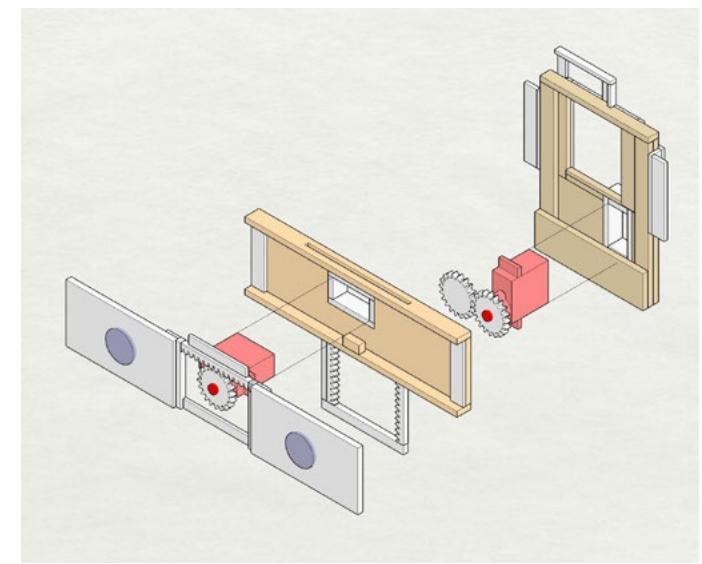
1. A portrait of Van Gogh whose eyelids, eyeballs, and eyebrows can move to form facial expressions in response to visitors' body movements. The virtual Van Gogh could also "talk" to the visitors when he recognizes their hand gestures through computer vision.
2. A canvas that constantly transforms its 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



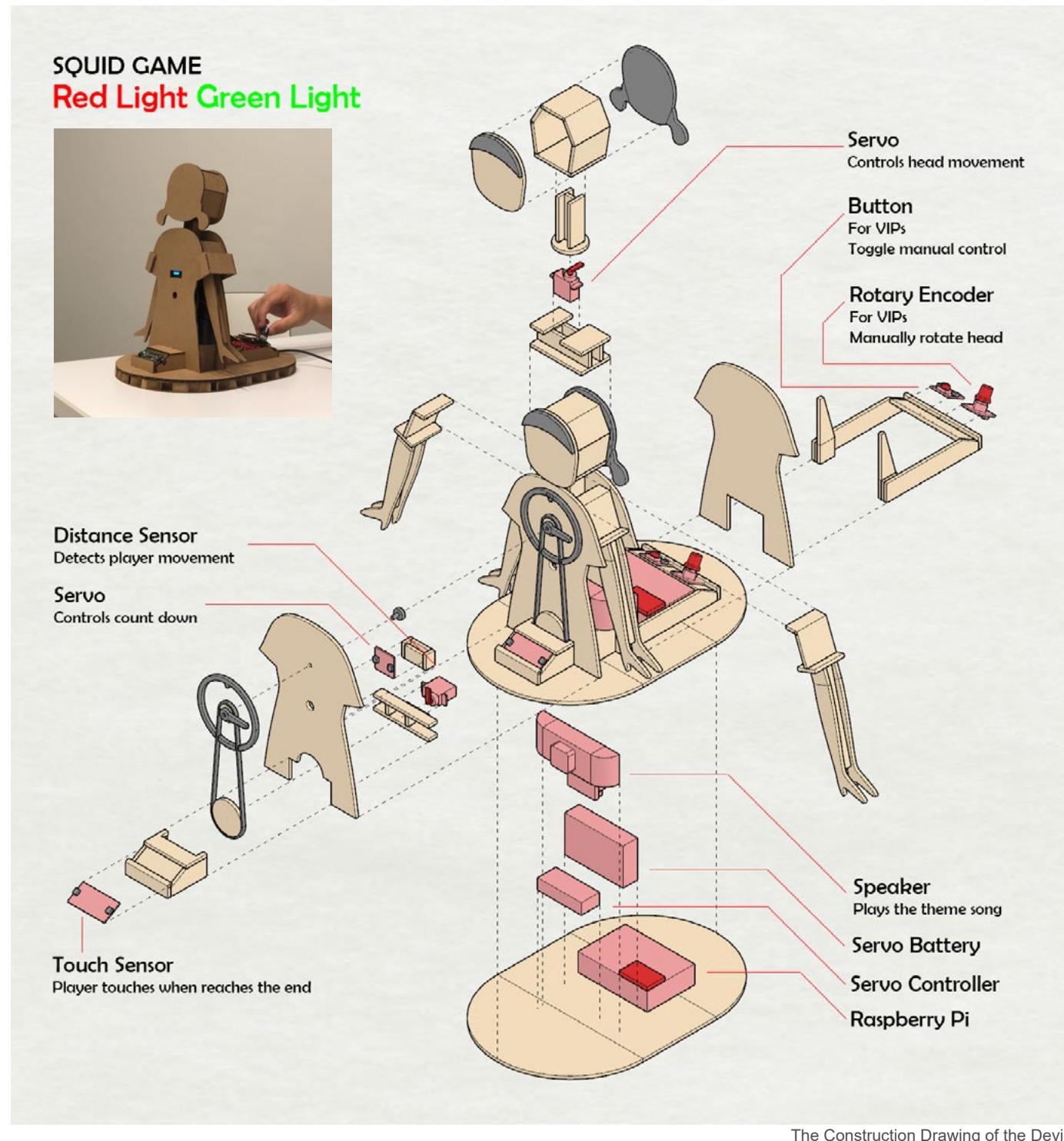
Mechanism of the Eyeballs

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.

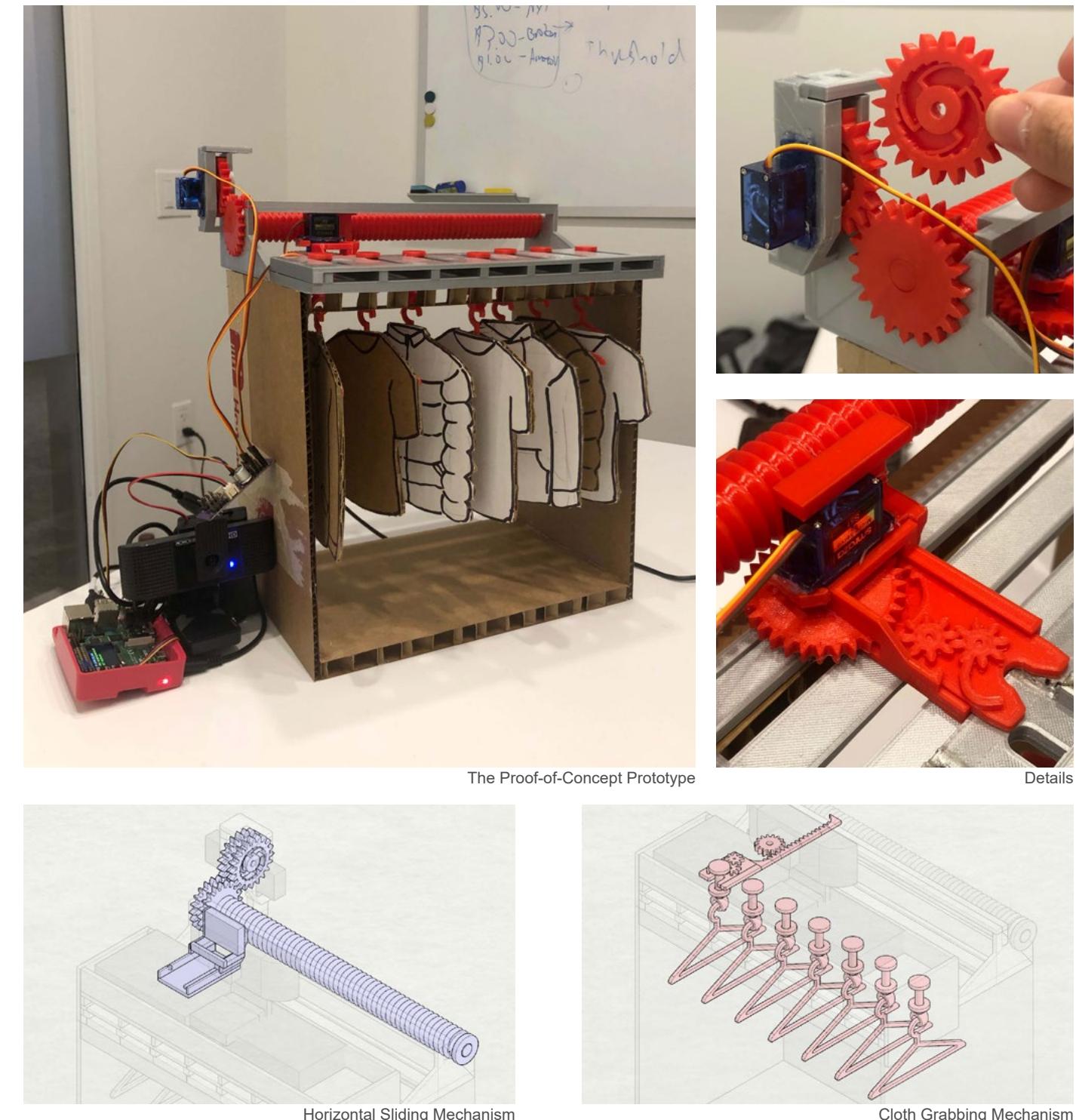


Smart Closet

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.



VR ANTHROPOCENE

– Spatial Composition Through Virtual Locomotion

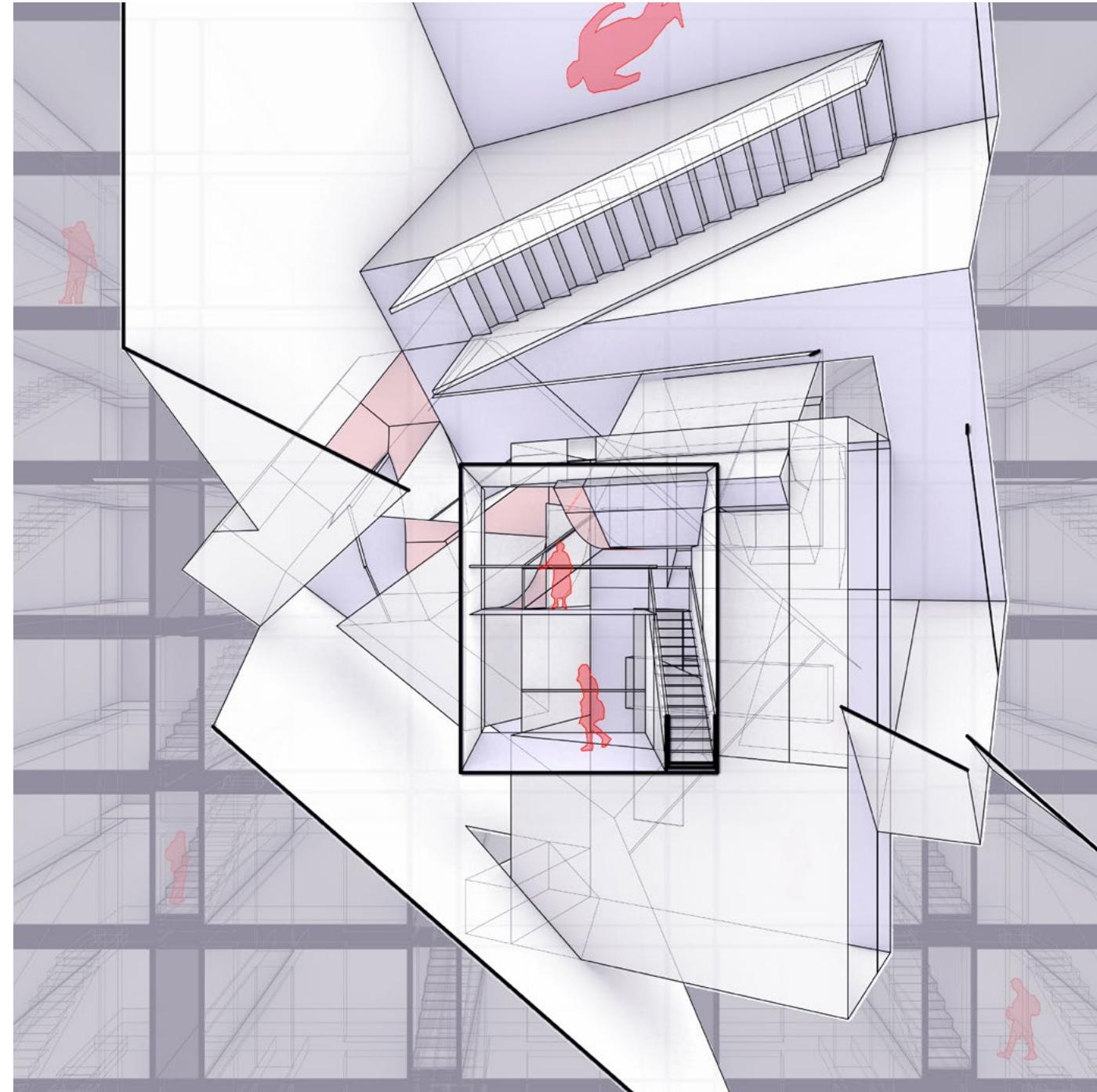
Undergraduate Thesis Project

Spring 2021

Advisors: Jenny Sabin, Sasa Zivkovic

Individual Work

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

Virtual Locomotion

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.

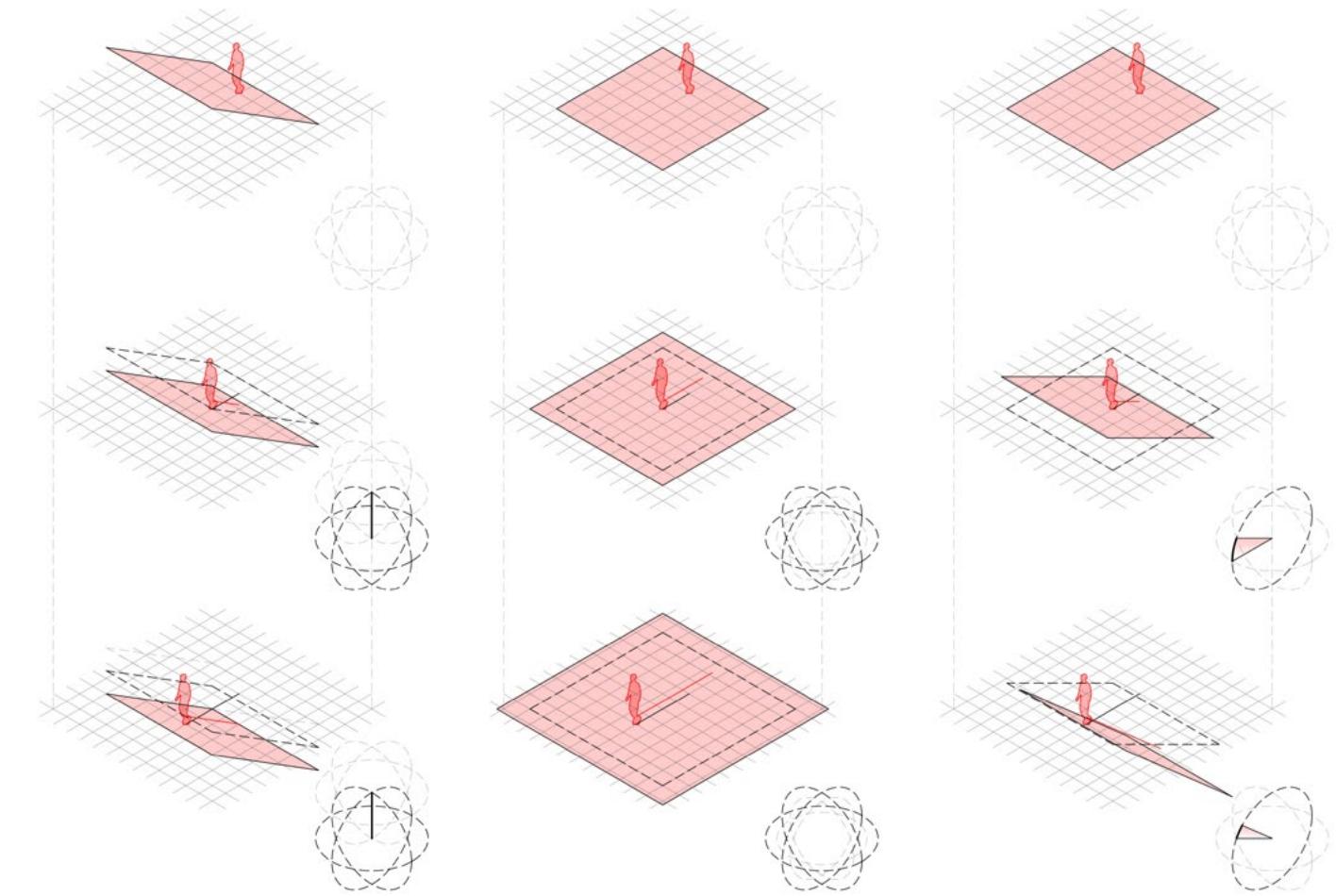
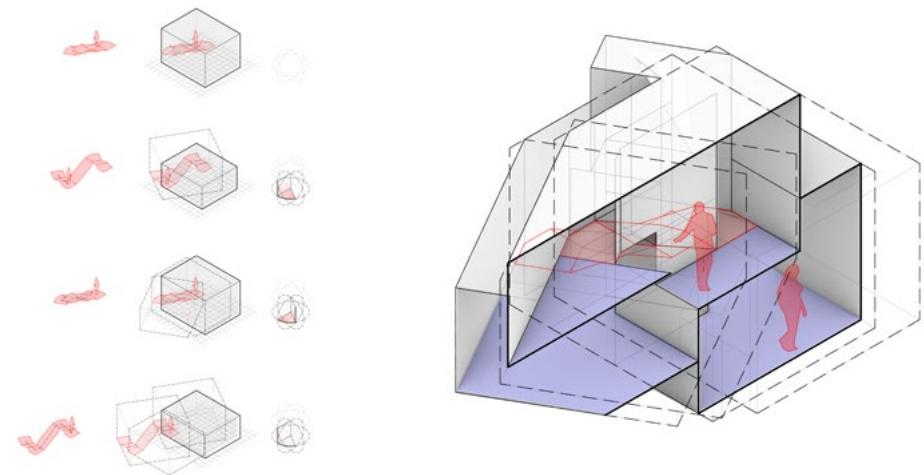


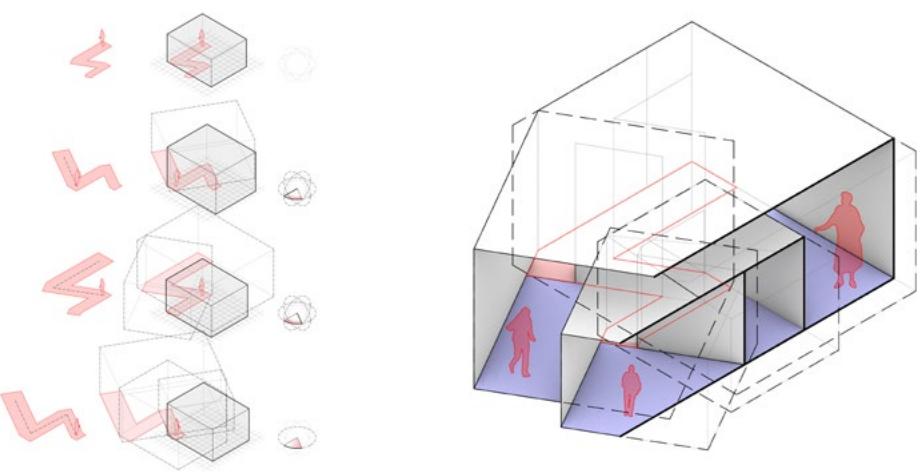
Diagram of proposed locomotion techniques:
vertical translation, scaling, and ground shifting

Spatial Prototypes

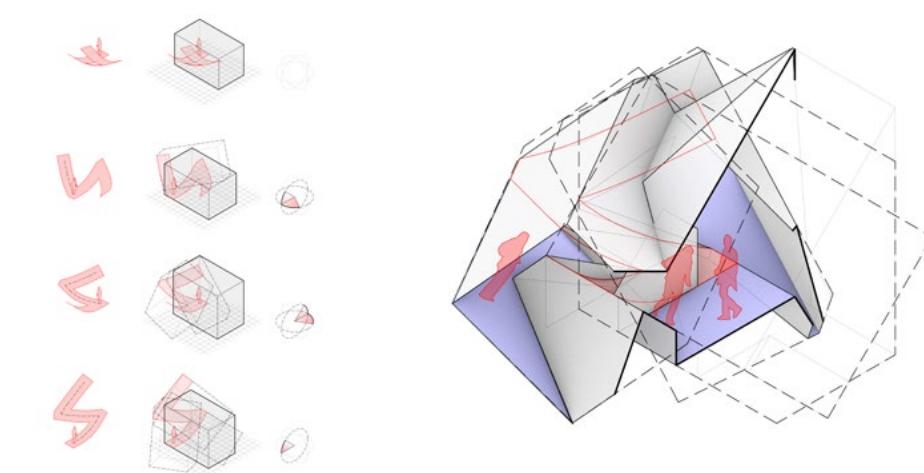
The virtual locomotion techniques unfold oscillatory movements into virtual paths, along which a series of virtual volumes is generated, intersected, and reformed, without the constraint of gravity, the limitation of space, and the constancy of scale.



Openings and layering formed by the vertical translation technique



Nested surreal spaces generated by the scaling technique



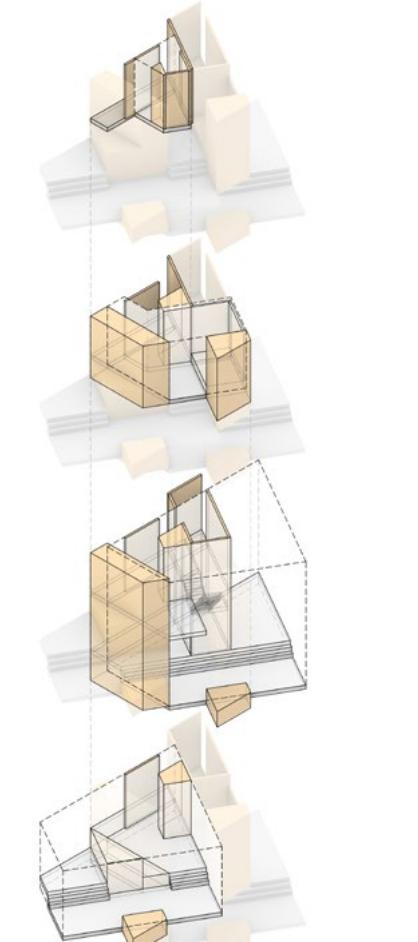
Intersections and spatial relations created by the ground shifting technique

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.



Section through redesigned physical units and corresponding virtual augmentation



Four augmented units that unfolds from a single physical space



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

OCCUPYING CHAMBER

– Parametric Glass-Ceramic Facade

Coevolutionary Archetypes Studio

Fall 2019

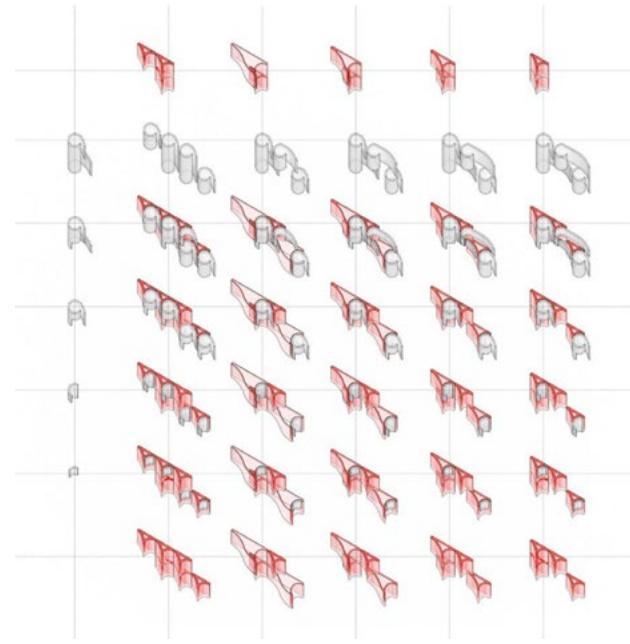
Advisor: Naomi Frangos

Individual Work

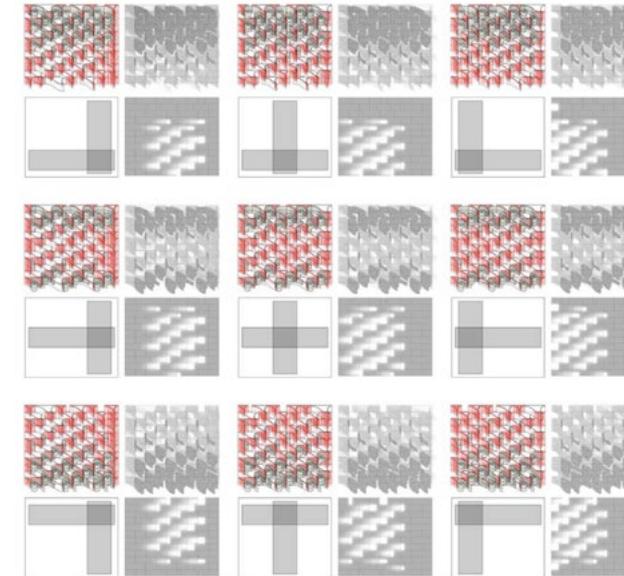
The project investigates the materiality of glass and ceramic, digital fabrication methods, and multimodal representations through a full-scale installation and an AR mobile application. Reconfigurable molds are designed and built for both glass and ceramic, to generate modules for a parametric façade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



Glass Units



Facade Unit Aggregation Matrix



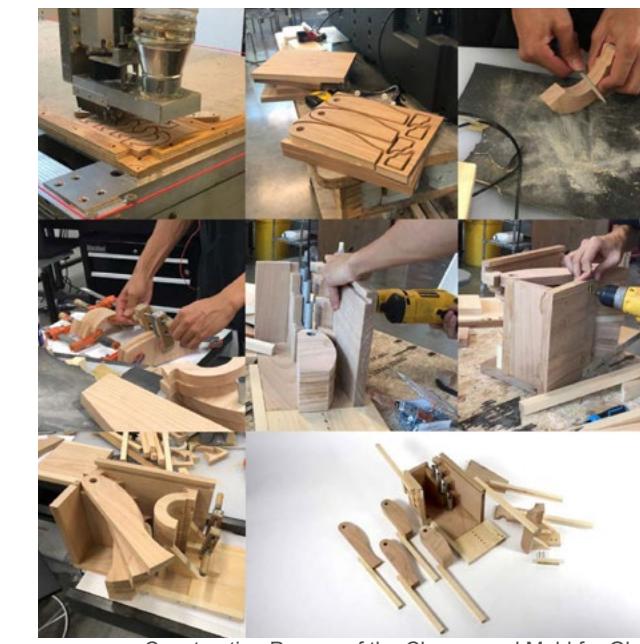
Facade Grasshopper Parametric Study

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



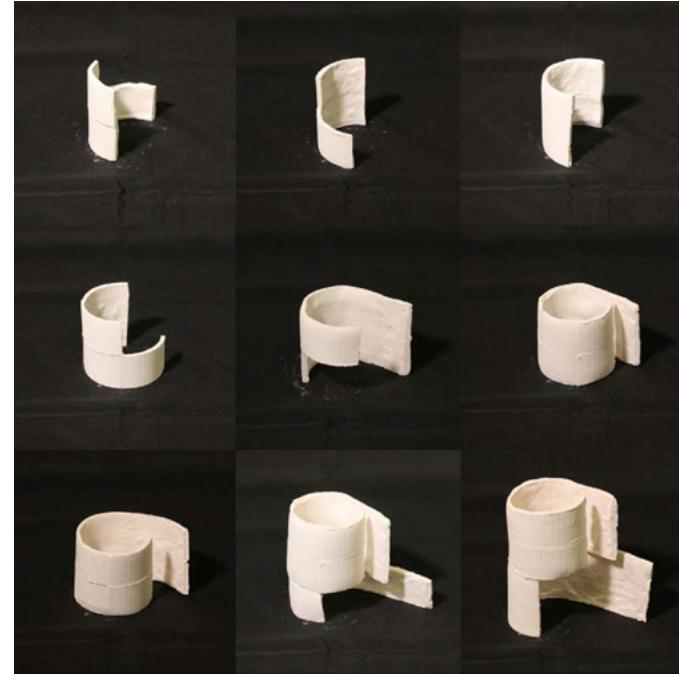
Construction Process of the Cherrywood Mold for Glass



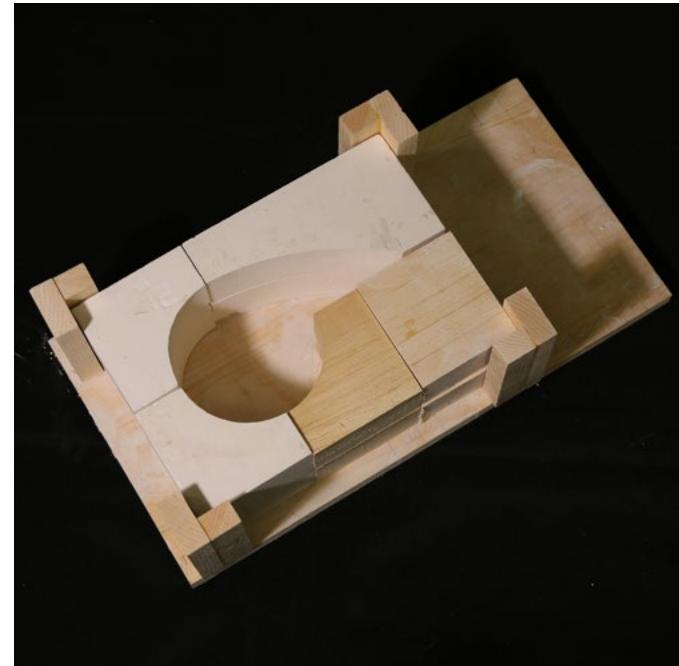
Glass Blowing at Corning Museum of Glass

Ceramic Slip Casting

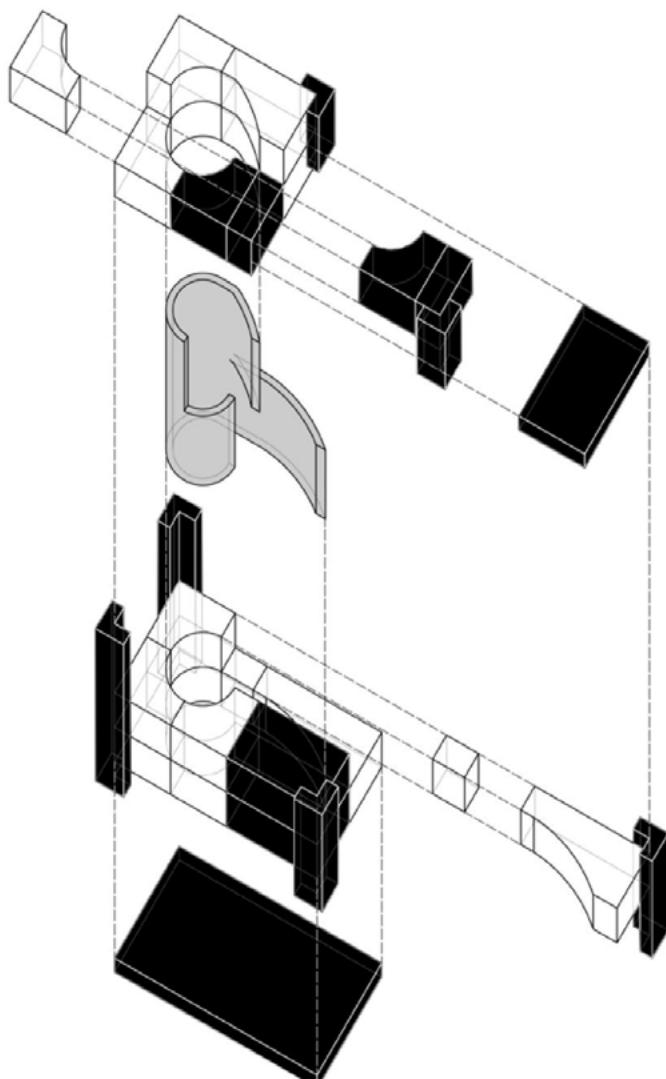
The mixed use of plaster and wood in the slip casting mold creates openings on the ceramic product in a controlled manner, which corresponds to the variations in the glass pieces.



Parametric Ceramic Units



CNCed Slip Casting Mold



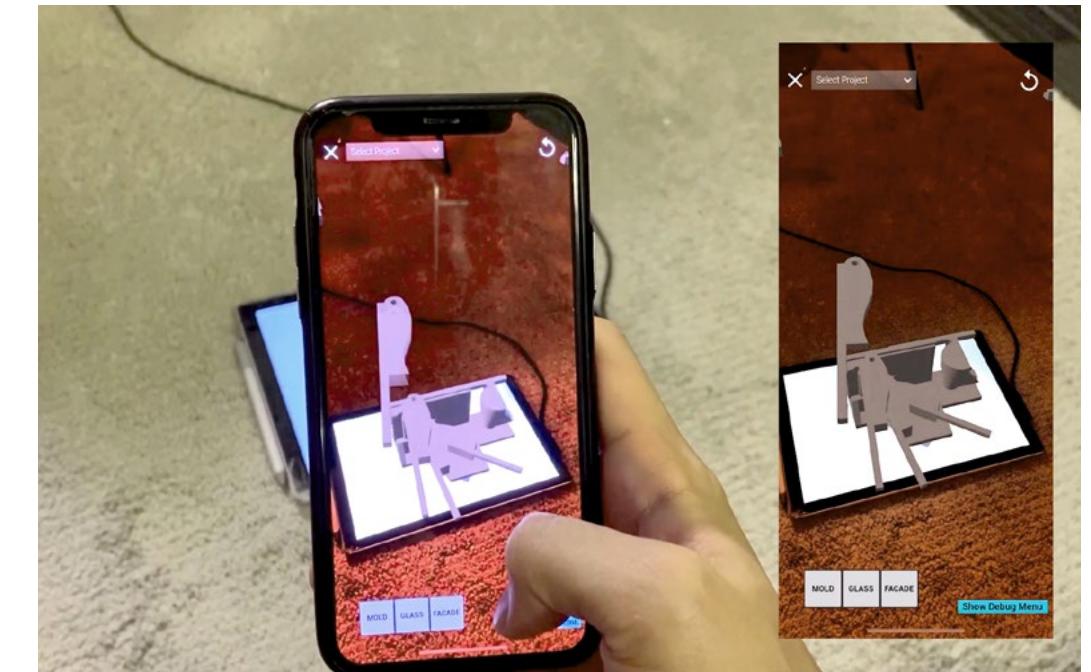
Construction Drawing of the Slip Casting Mold

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 details and construction of the facade.



Facade Installation at Mui Ho Fine Arts Library



Interactive Augmented Reality Representation

THE MEMORIAL LOOP

– Lyrical Pathways

Virtual Places Research Studio

Fall 2020

Advisor: Henry Richardson, Christopher Morse

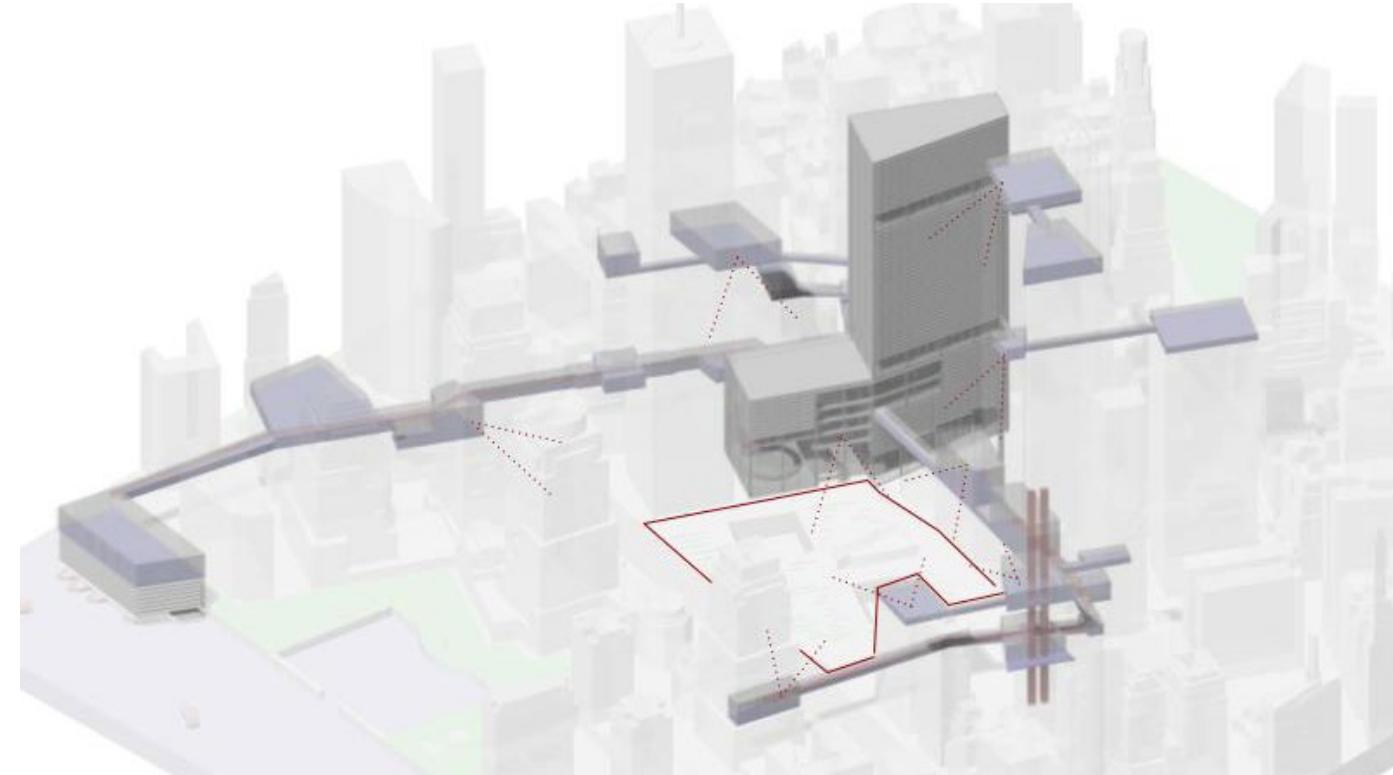
Site: Ground Zero, NYC

Collaborator: Zoe De Simone

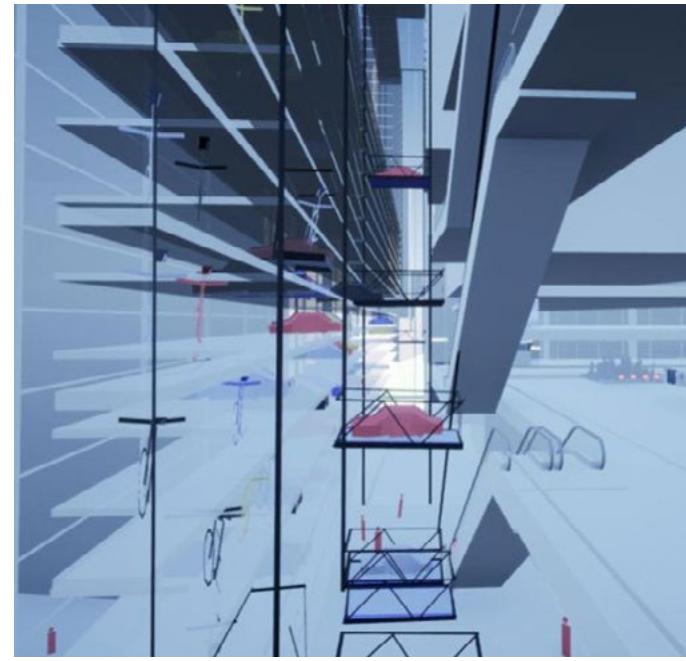
Contribution: Conceptual design, VR design and

implementation, representation

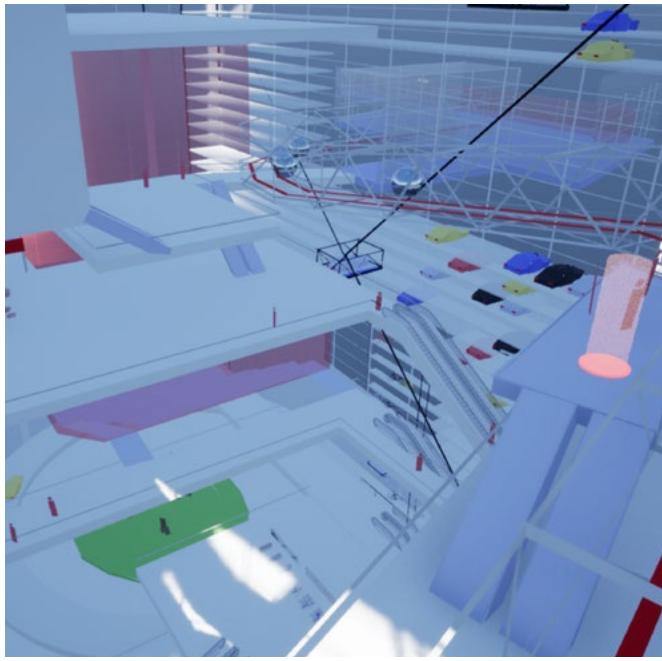
The project redefines movements through urban spaces with a three-dimensional system of pathways that link atriums on the context buildings. Technically, it experiments the design workflow using Virtual Reality as a tool of creation, visualization and presentation. During Covid-19, the design process tests various tools for virtual collaboration during quarantine.



Adapting to the site, the bridging system forms a loop around the 9/11 Memorial



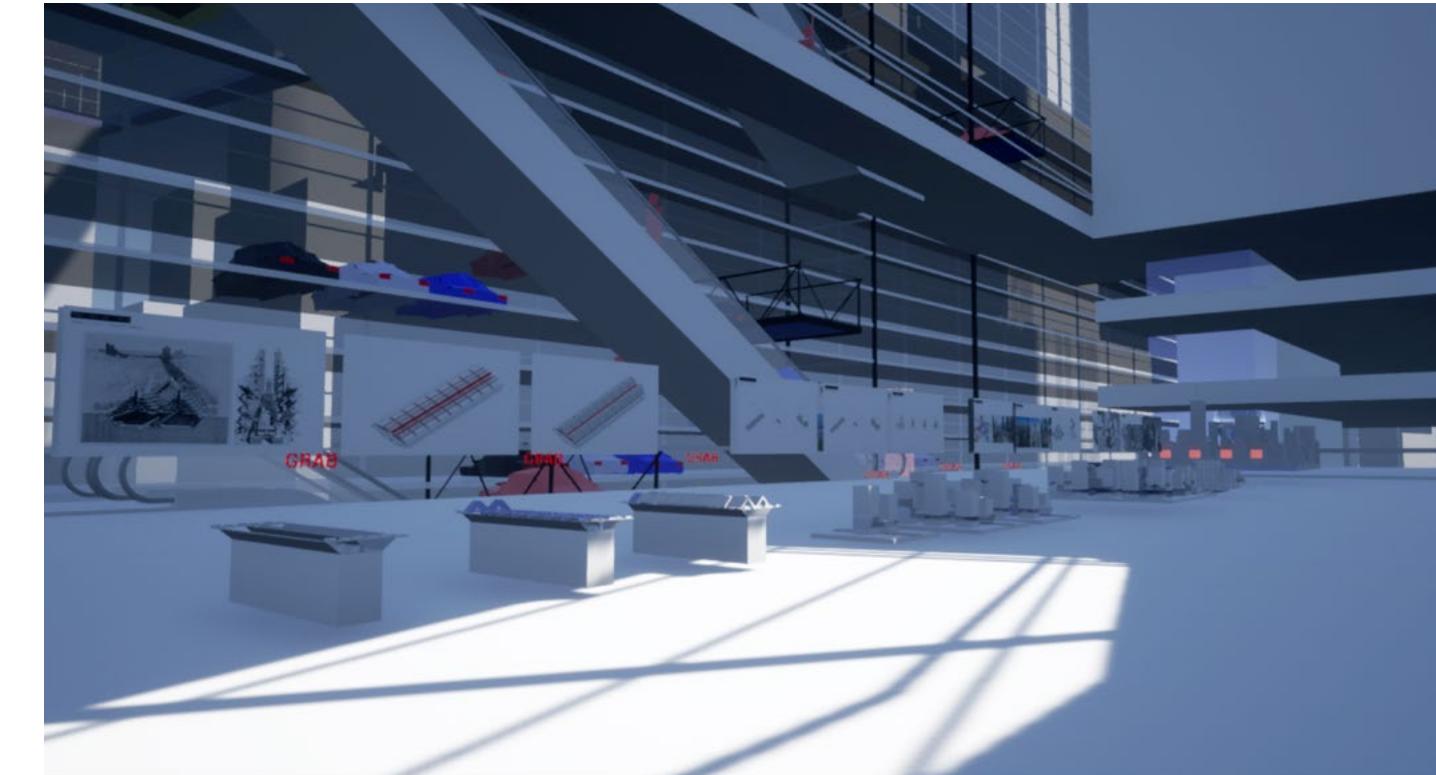
Car Parking Facade and Vertical Car Elevators



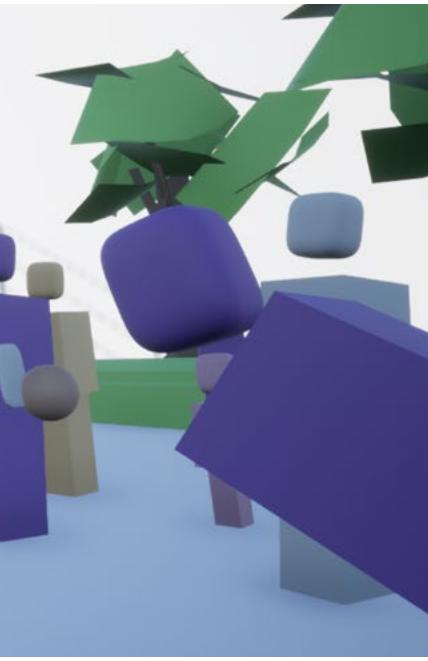
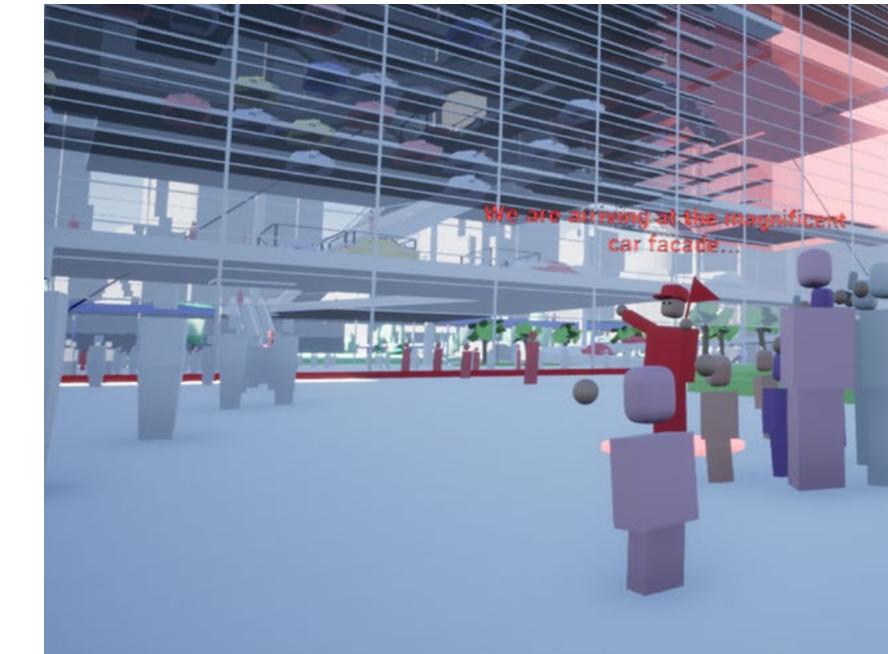
Main "People Mover" Station Overlooking the Main Lobby

Choreographing experiences with VR

The narrative of pedestrians' arrival at this urban complex is choreographed in Gravity Sketch and an interactive tour guide is implemented with Unreal Engine, communicating the "affect" of spaces, which leads to design decisions.

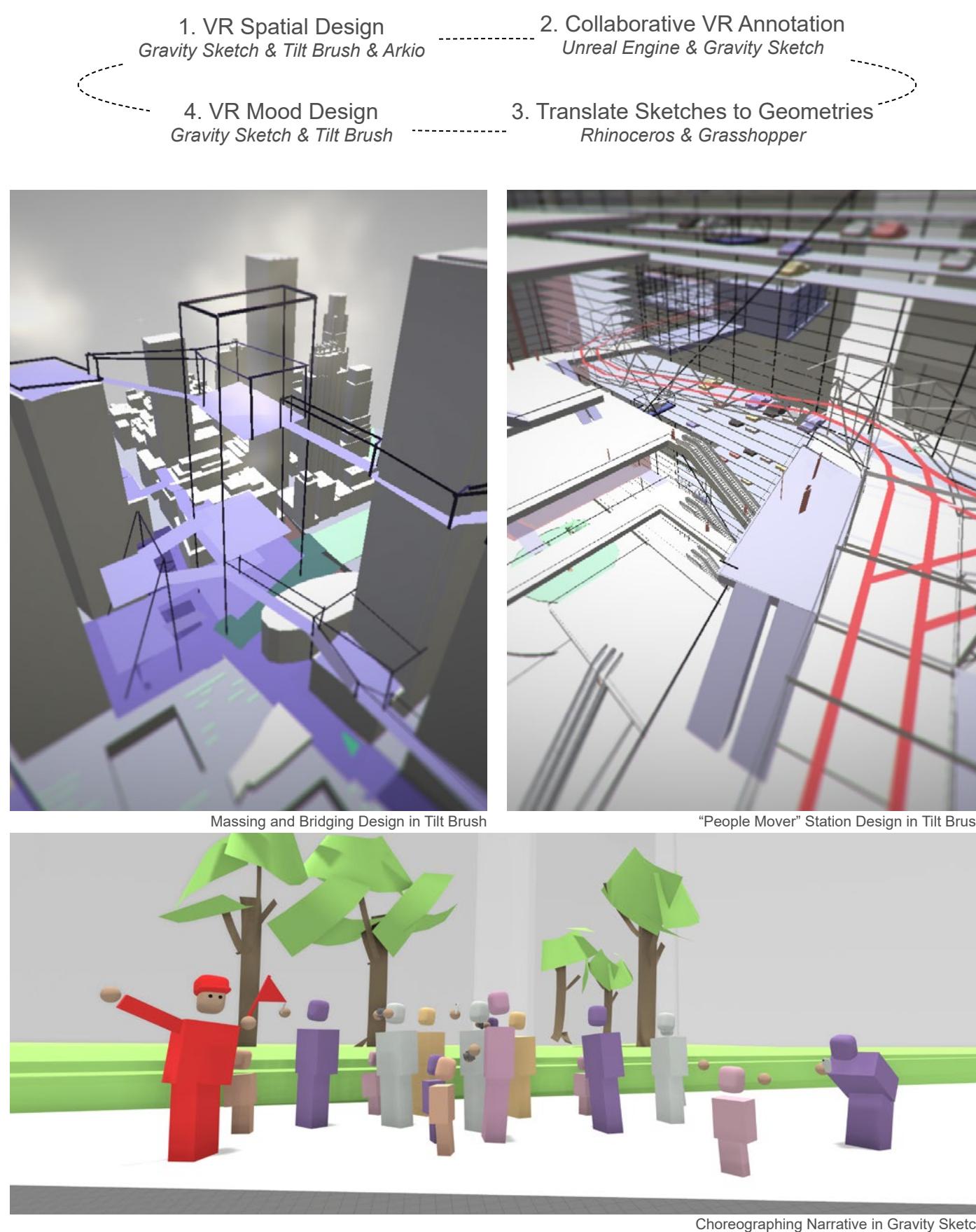


Virtual Final Review Installation at the Gallery in the Main Lobby



Guided VR Pedestrian Experience - Arrival

The Design Workflow



Interactive Representation

Interactive experiences are implemented to immersively narrate the design to visitors in VR, including an onboarding scene that familiarizes the visitors with the VR interfaces; grabbable diagrams in the gallery for closer inspection; VR headsets in VR to start the narrative pedestrian experience; and a VR Menu that supports teleportation, environmental simulation, and time traveling back to previous design phases.



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

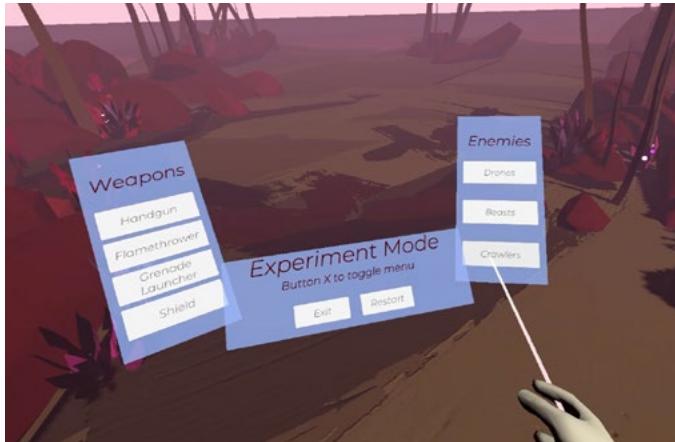
An Oculus Quest VR game built with Unity. The player is a space exterminator who travels across planets and eliminates alien encroachers that threaten dwellers of all space civilizations. An interactive onboarding is designed to teach players VR interactions. The alien planets, spaceship, and weapons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



The Spaceship Drawn in Gravity Sketch



The Onboarding Experience



The Experimental Mode

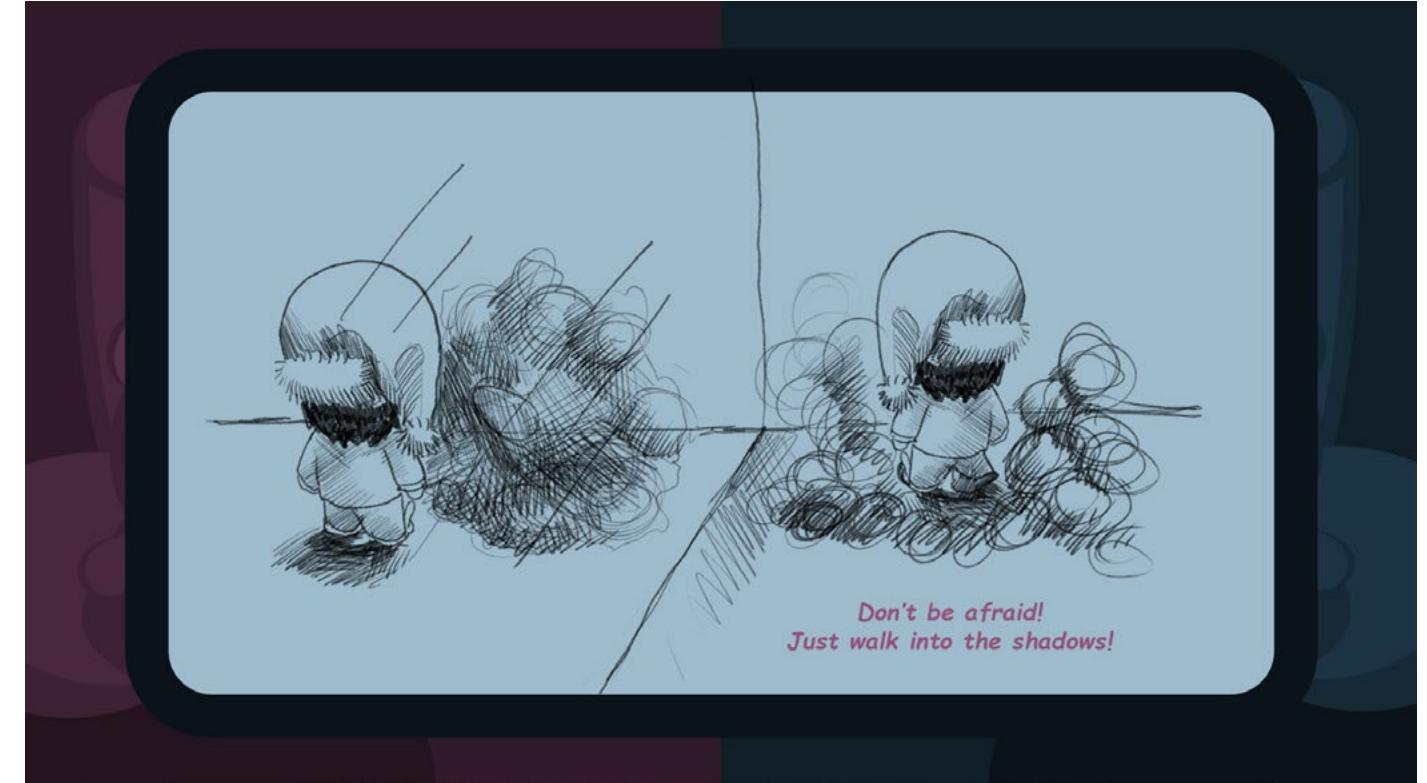
Spectrophobia

The Game Design Initiative at Cornell
Spring 2021

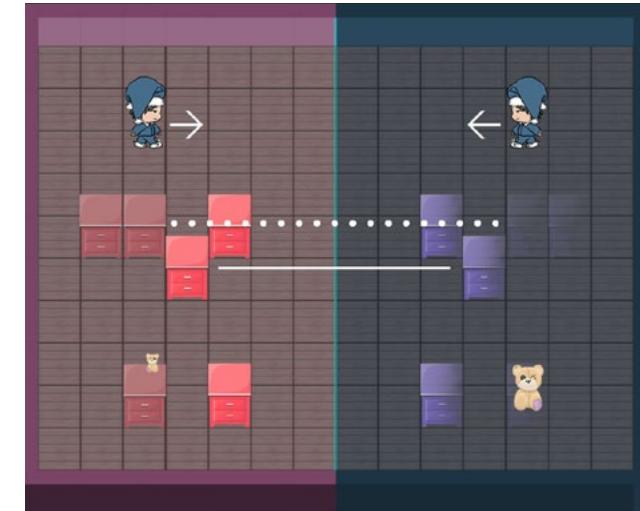
Instructor: Walker White, Traci Nathans-Kelly

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

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



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

MUSICAL INSTALLATIONS

The Music Device + Skin

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

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 Music Device

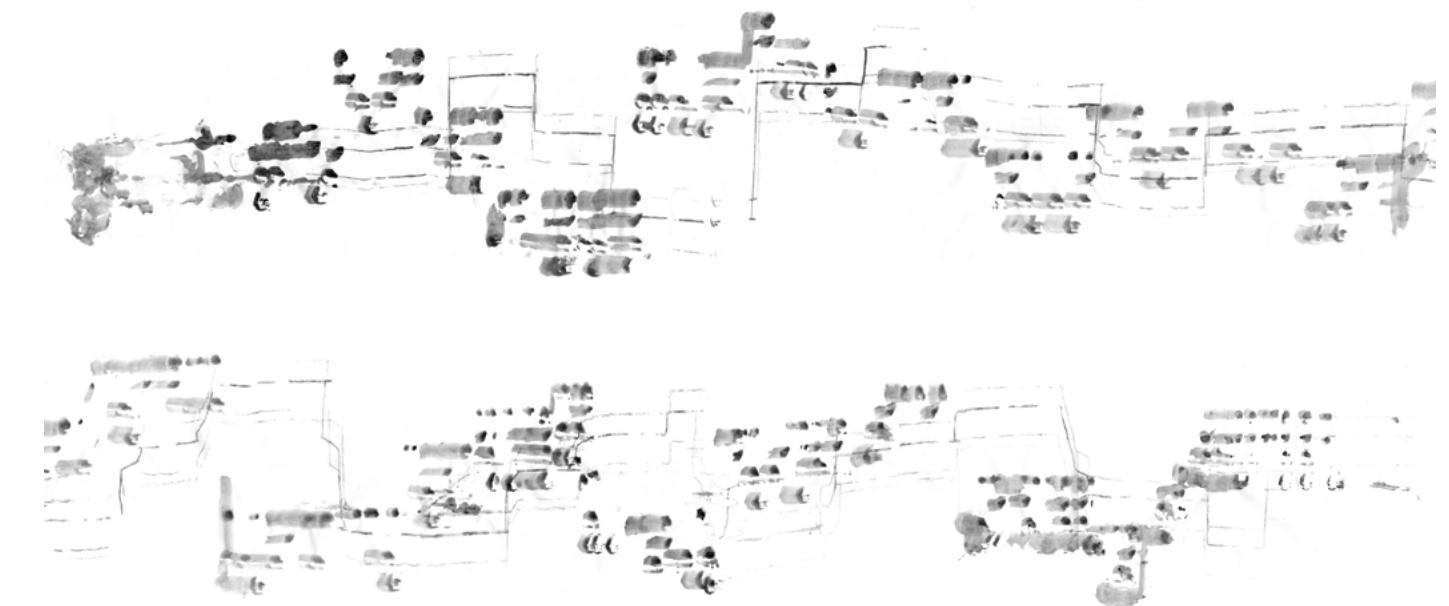


Diagram of the Skin

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.



The Musical Drawing Produced by the Machine



The Drawing Machine in Motion

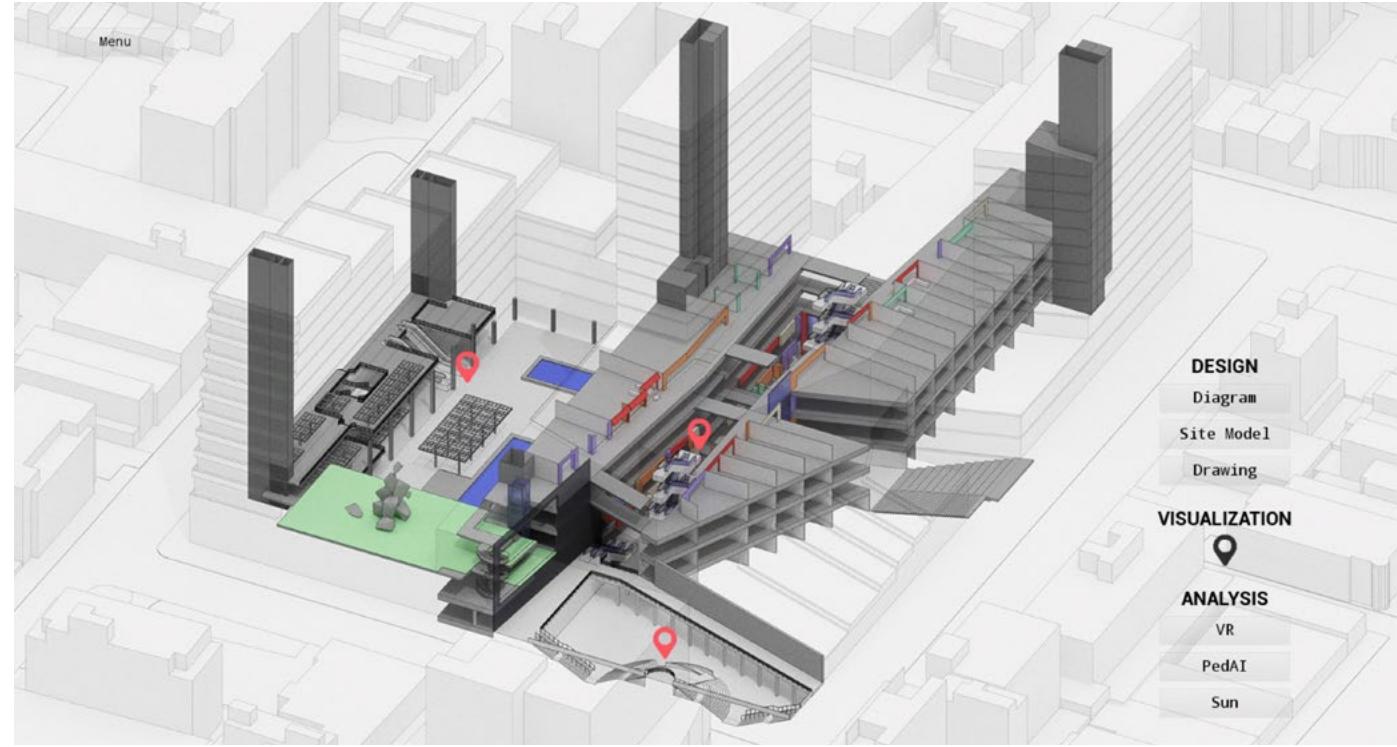


1/8" = 1' Dwelling of the Wind Concrete Model

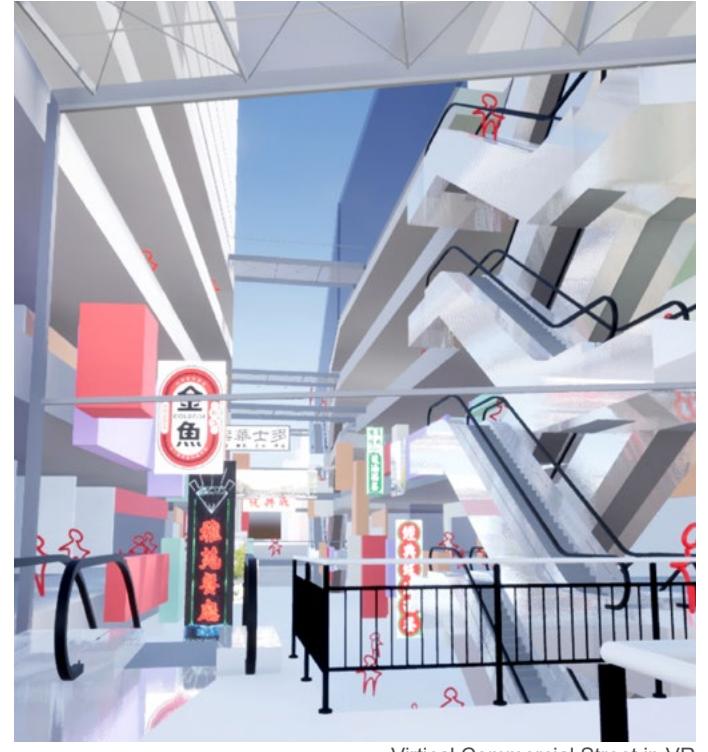
ARCHITECTURE

Flushing Commons

Virtual Places Research Studio
Spring 2020
Instructor: Henry Richardson, Christopher Morse
Site: Flushing, New York
Collaborator: Ting Wei Fan, Noah Gear



Screenshot of the menu of the Unreal Engine application



Virtual Commercial Street in VR

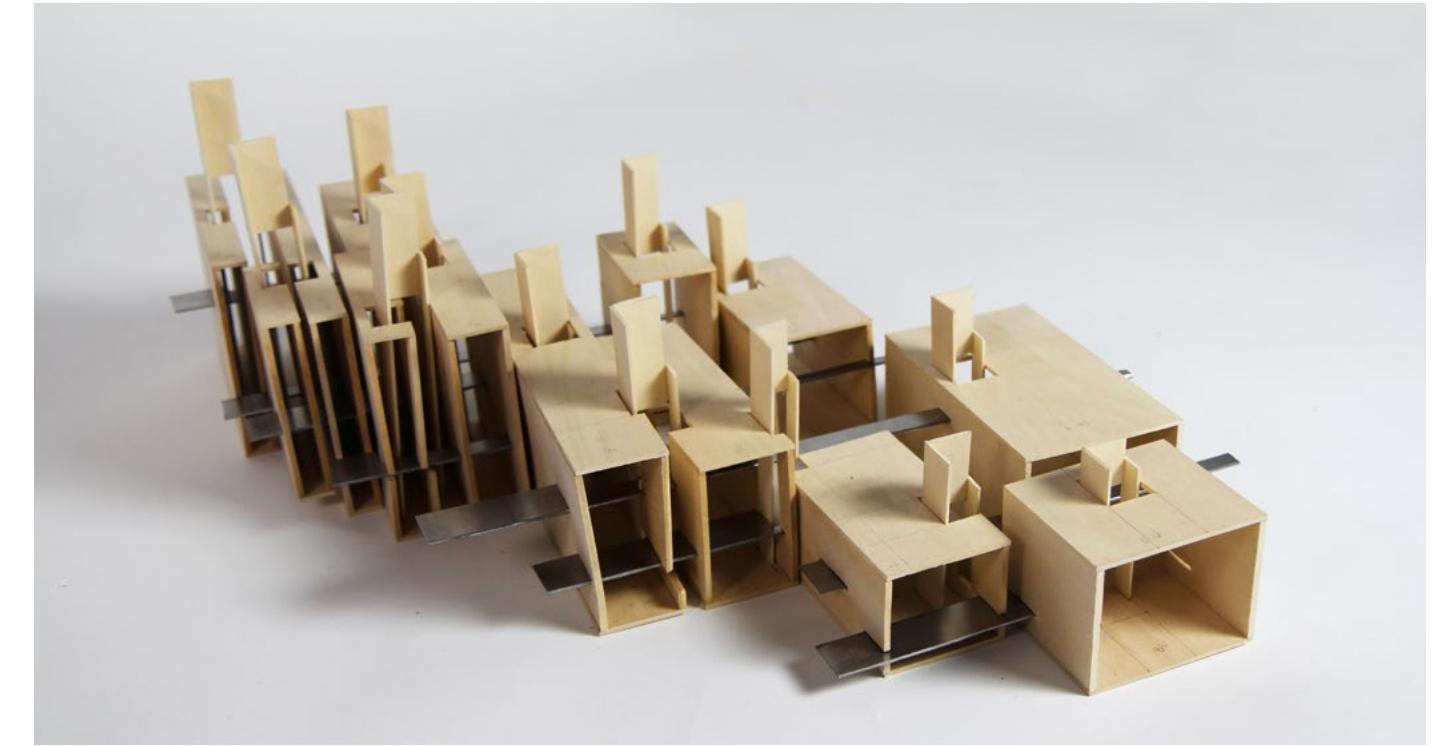


Mixed Reality Collage

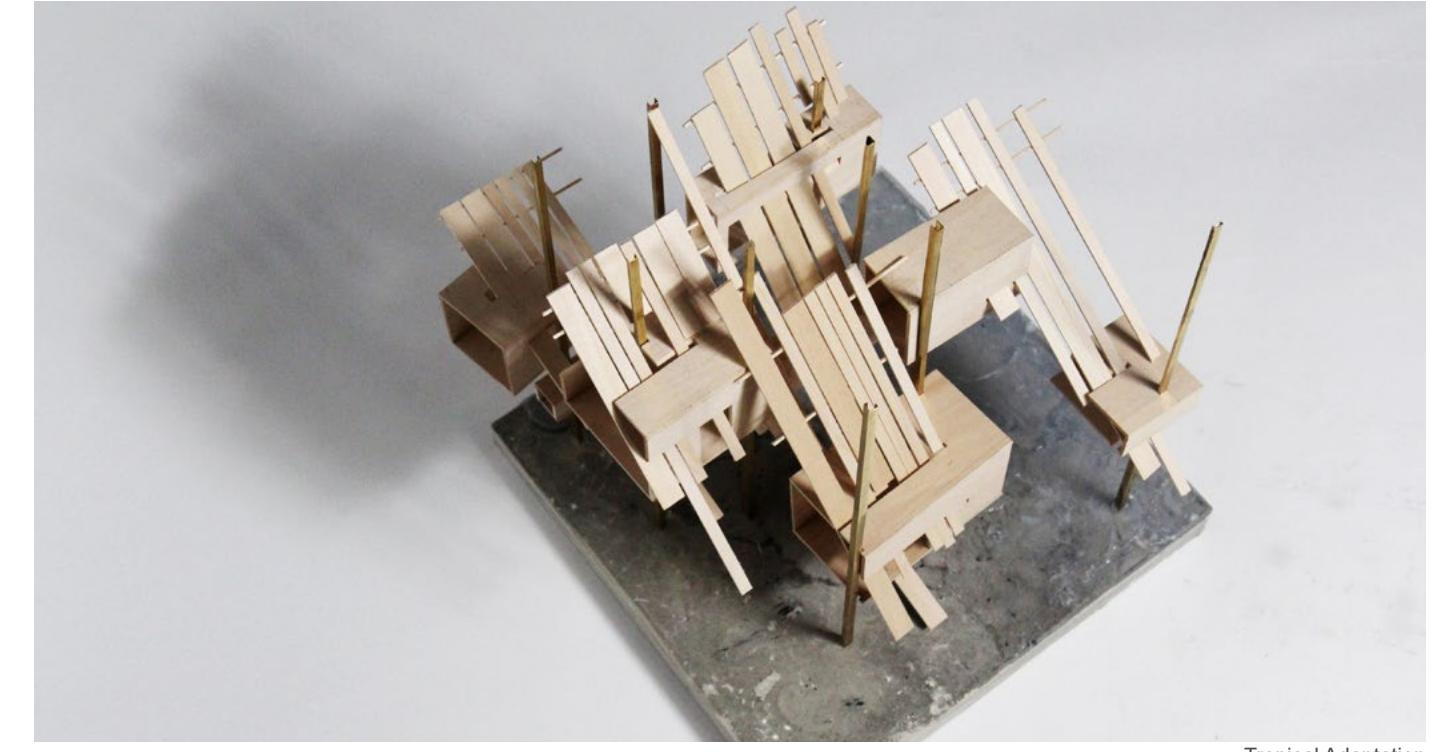
Adaptation

Design II Studio
Spring 2017
Instructor: Val Warke, Luben Dimcheff
TA: Isabel Oyuela-Bonzani
Individual Work

The project proposes ways of adaptation for three interlocking systems: volumetric blocks, vertical extrusions, and planar sheets. The three elements penetrate through, create openings, and lock with each other.



Arid Adaptation



Tropical Adaptation