Tianle (David) Chen

SELECTED WORK SAMPLES

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Structural Details

The selected projects outline a journey exploring **web-based tools and computational methods** for improving architectural and urban design workflows. From generative urban planning to interactive visualization tools, each project demonstrates the integration of **front-end development, algorithmic design, and user experience considerations.** Each workflow showcases specific technical implementations with JavaScript, Grasshopper, or mixed reality platforms, demonstrating both technical proficiency and practical applications for the AEC industry.

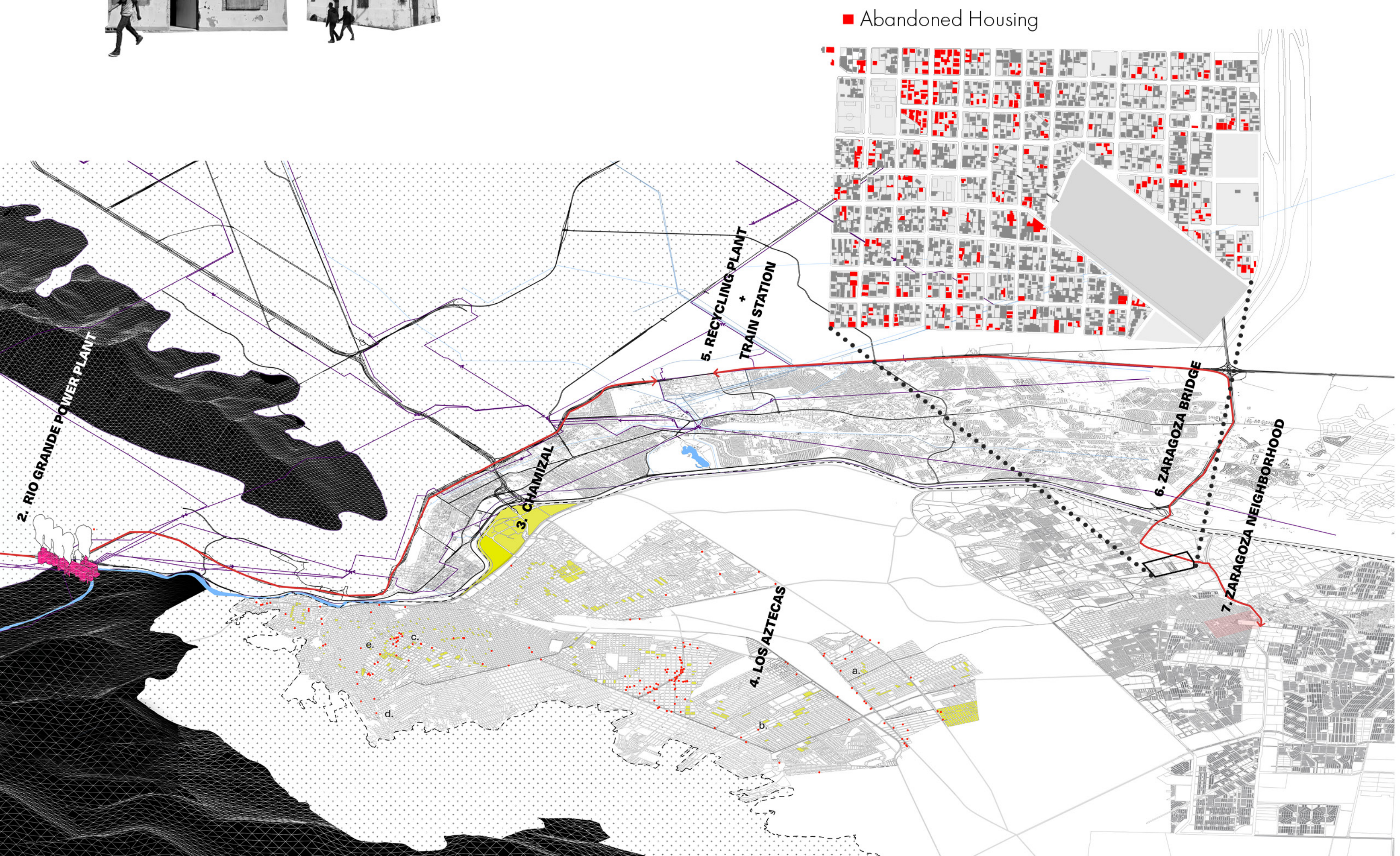
Urban Contextual Analysis — Site Quantitative Analysis — Program Layout Proposal

Abandoned House Identification | GIS Population Demographics Analysis | Evolutionary Algorithm Optimization

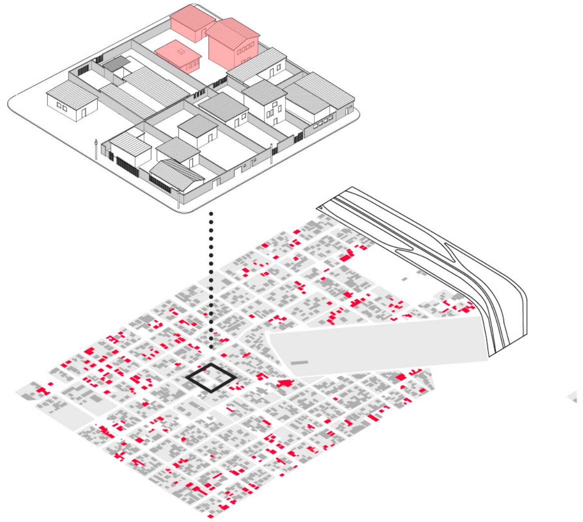
01
Generative Urbanism

Ciudad Juarez, Mexico

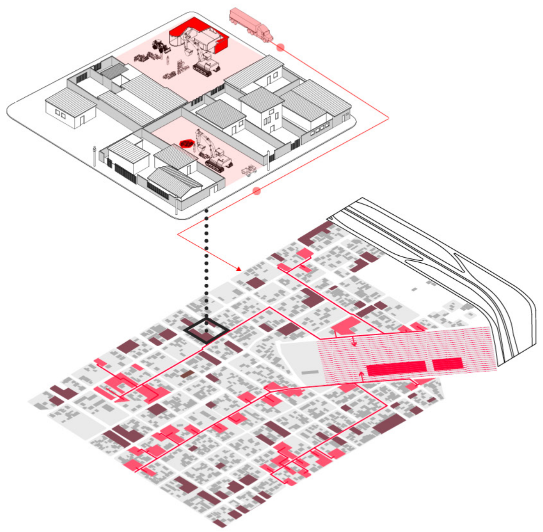
The Zaragoza community, situated among the large-scale informal residential areas in Ciudad Juarez, sees up to 60% of its dwellings uninhabited due to a high crime rate and emigration caused by neighborhood instability. The project aims to introduce flexible public spaces for civic gathering and economic activities to the dense area by selectively demolishing empty settlements in the neighborhood. The demolition material is sorted and transported within the community to engage the existing steel recycling economy that is prominent at the border. New programs are introduced by parametrically analyzing the existing communities.



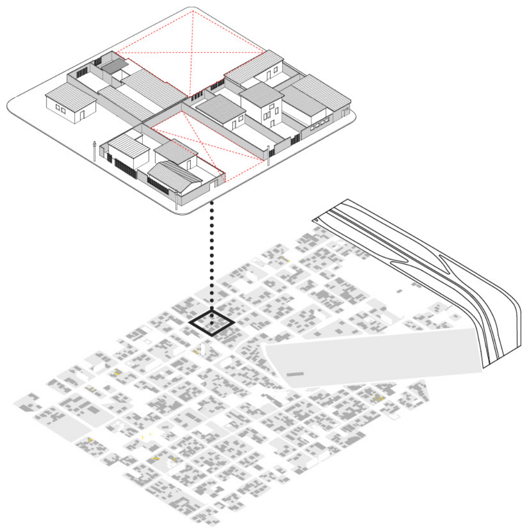
01 Identify Abandoned Houses:
The Zaragoza neighborhood, as highlighted on the map, currently has over 60% of its housing vacant due to high crime rates and poor social housing management.



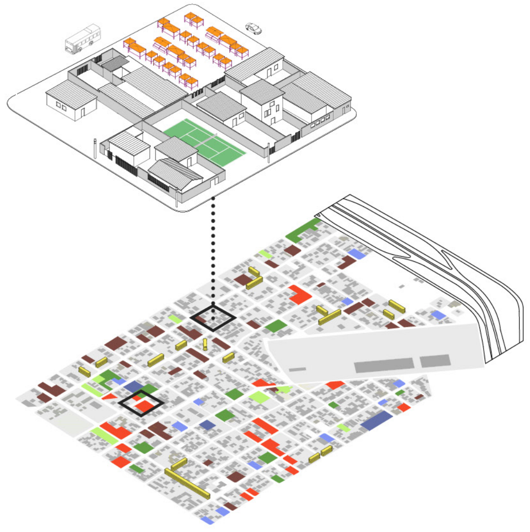
02 Scrap Extraction:
The abandoned houses are demolished, and the building materials are sent to a central processing scrap plant, engaging with the existing local scrap economy between the borders.



03 Empty Parcels:
Once all building materials are either recycled or used within the local community, parcels are reevaluated for future development.

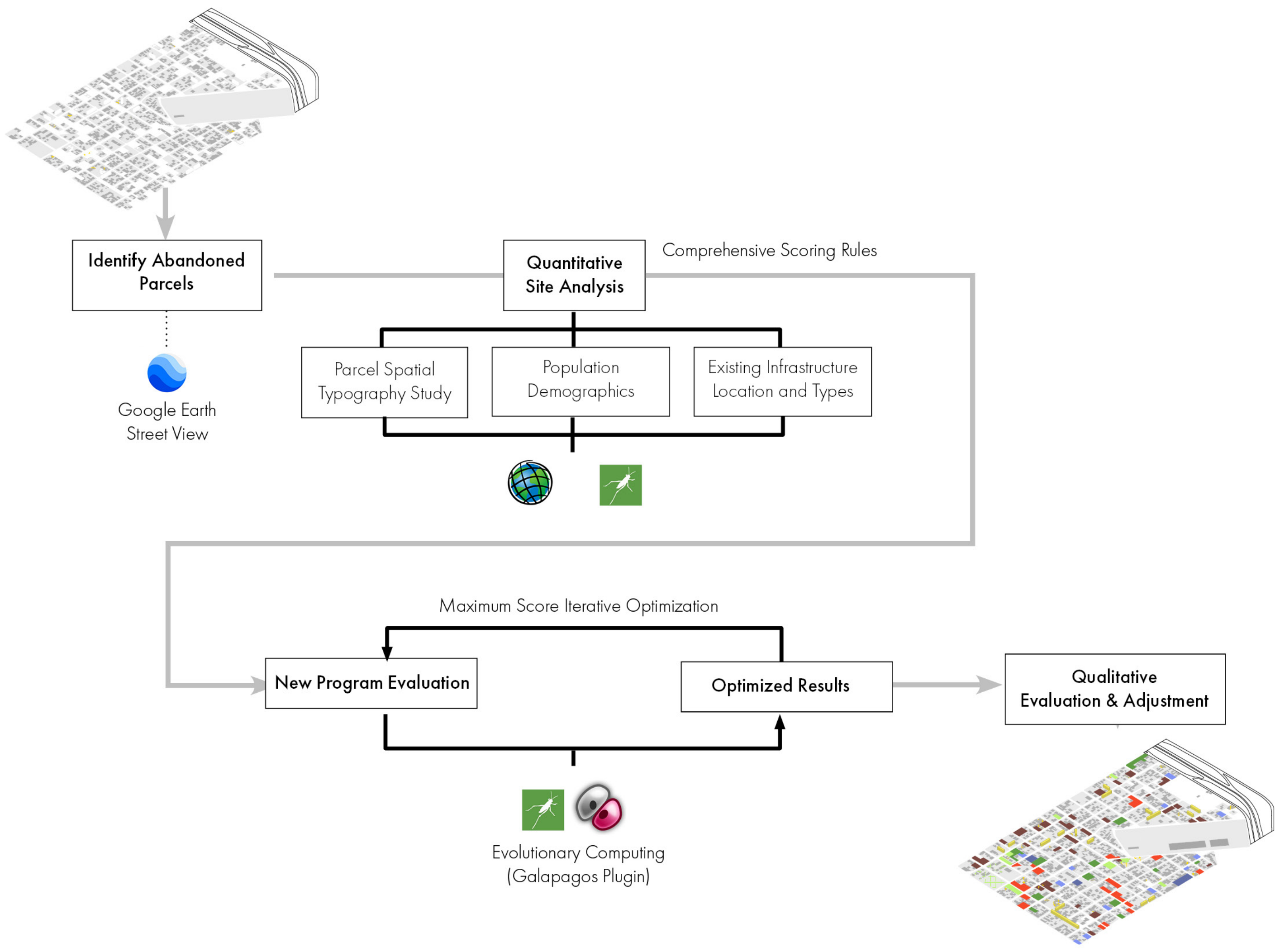


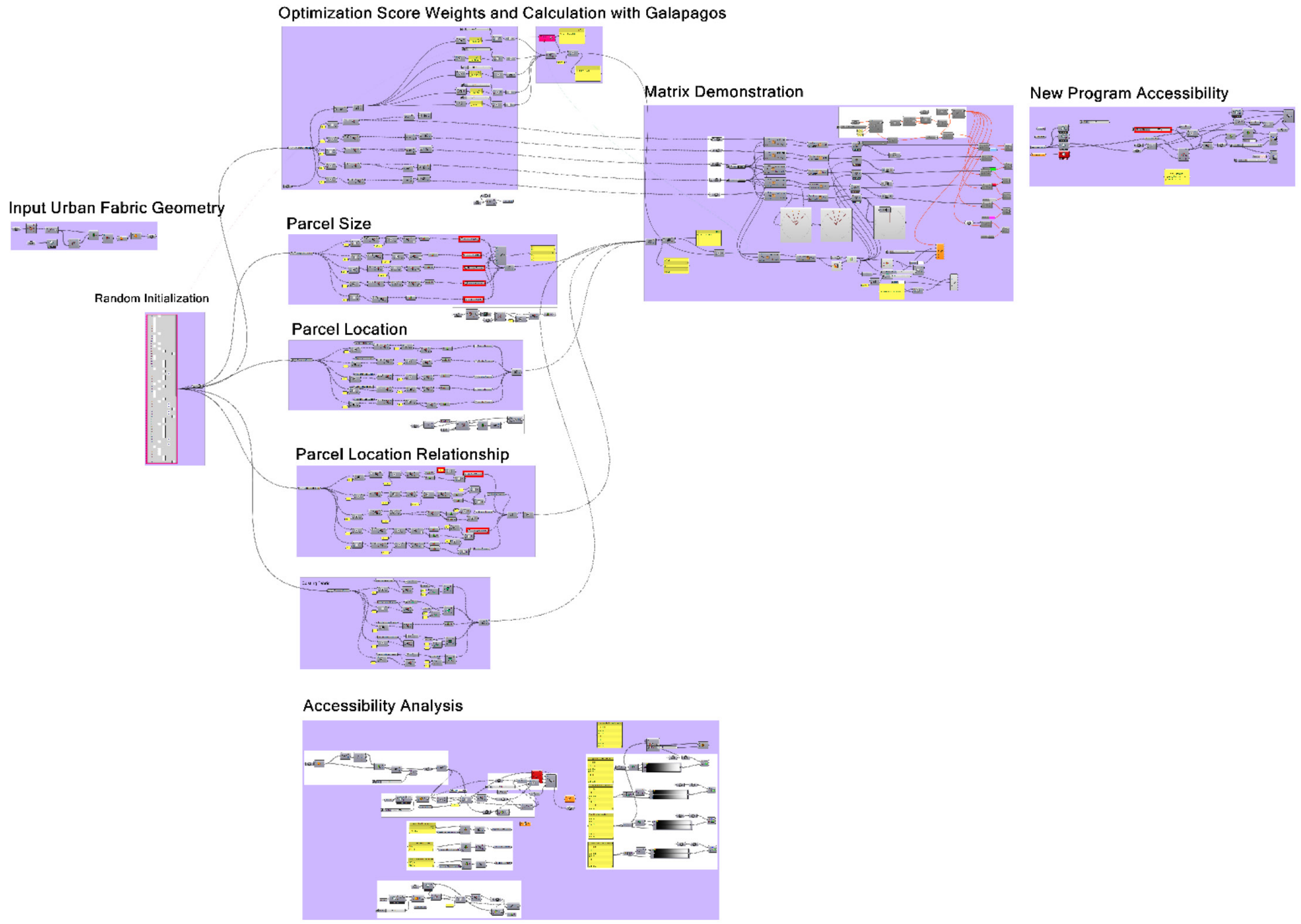
04 Populate New Public Programs:
Over time, new programs are identified based on local needs, taking into account parameters such as street accessibility, inter-block relationships, population distribution, demographics, and more.



Computational Workflow Project Vision

The parametric workflow and optimized results marked a key achievement in advancing my understanding of parametric design. This experience highlighted the significance of re-evaluating design processes by exploring the nuanced intersections of history, politics, and culture within urban contexts. The project utilized a data-driven approach to address complex social and environmental challenges, serving as a foundational step in my journey to leverage computational tools for impactful urban design solutions. I am eager to continue and deepen this exploration within your internship program, contributing my skills to innovative projects that integrate design computation and sustainability.





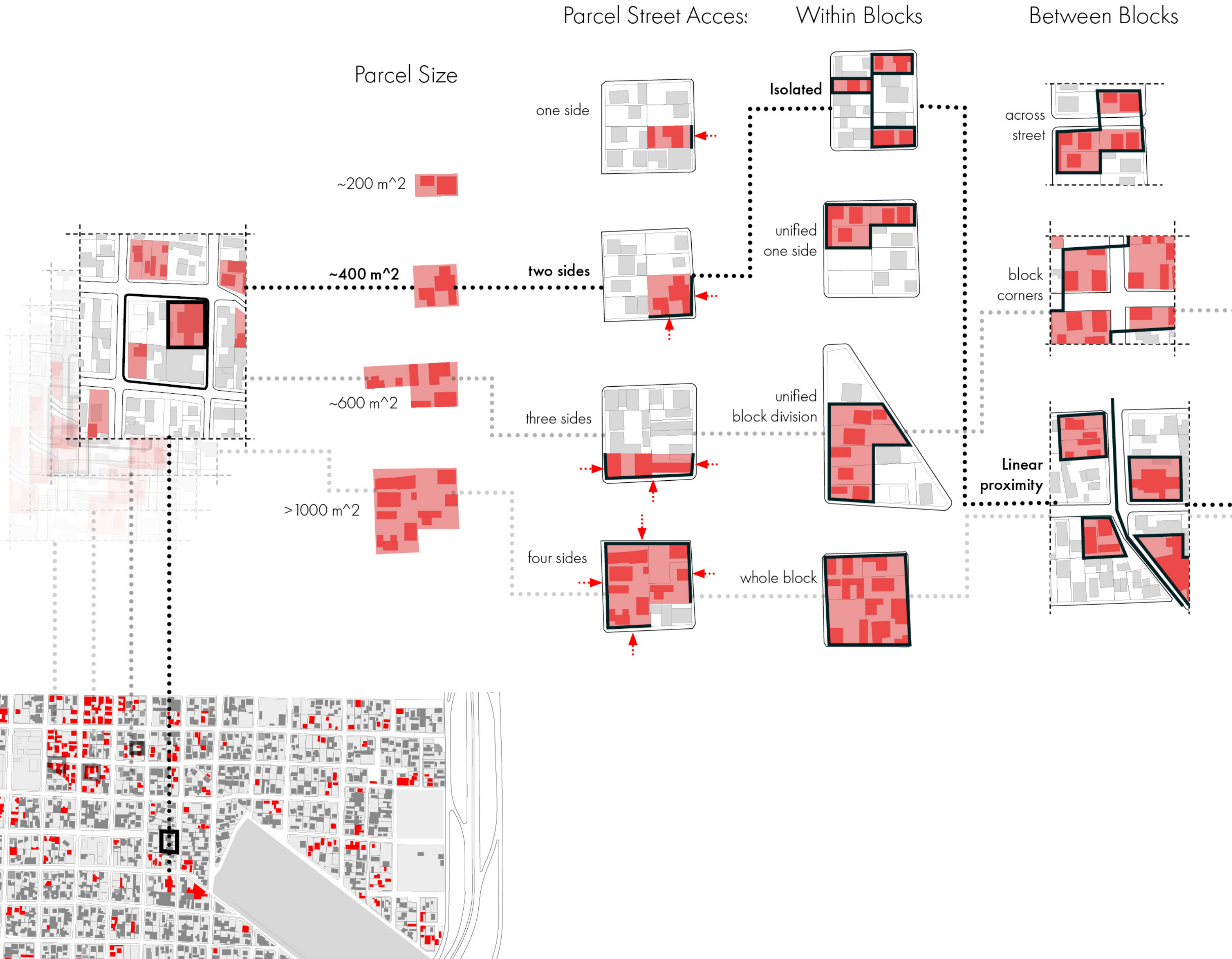
Central to this project was a comprehensive Grasshopper script that integrated multiple modules, including parcel size and location relationships, accessibility analysis, and optimization score weights calculation using Galapagos. The script processed input urban fabric geometry through a series of steps such as random initialization, followed by the calculation of relationships and accessibility within the urban layout. The modular workflow enabled the demonstration of matrix relationships and new program accessibility, effectively illustrating how algorithmic design can optimize urban environments. This systematic approach reinforced my ability to develop and refine parametric processes for practical, real-world applications.

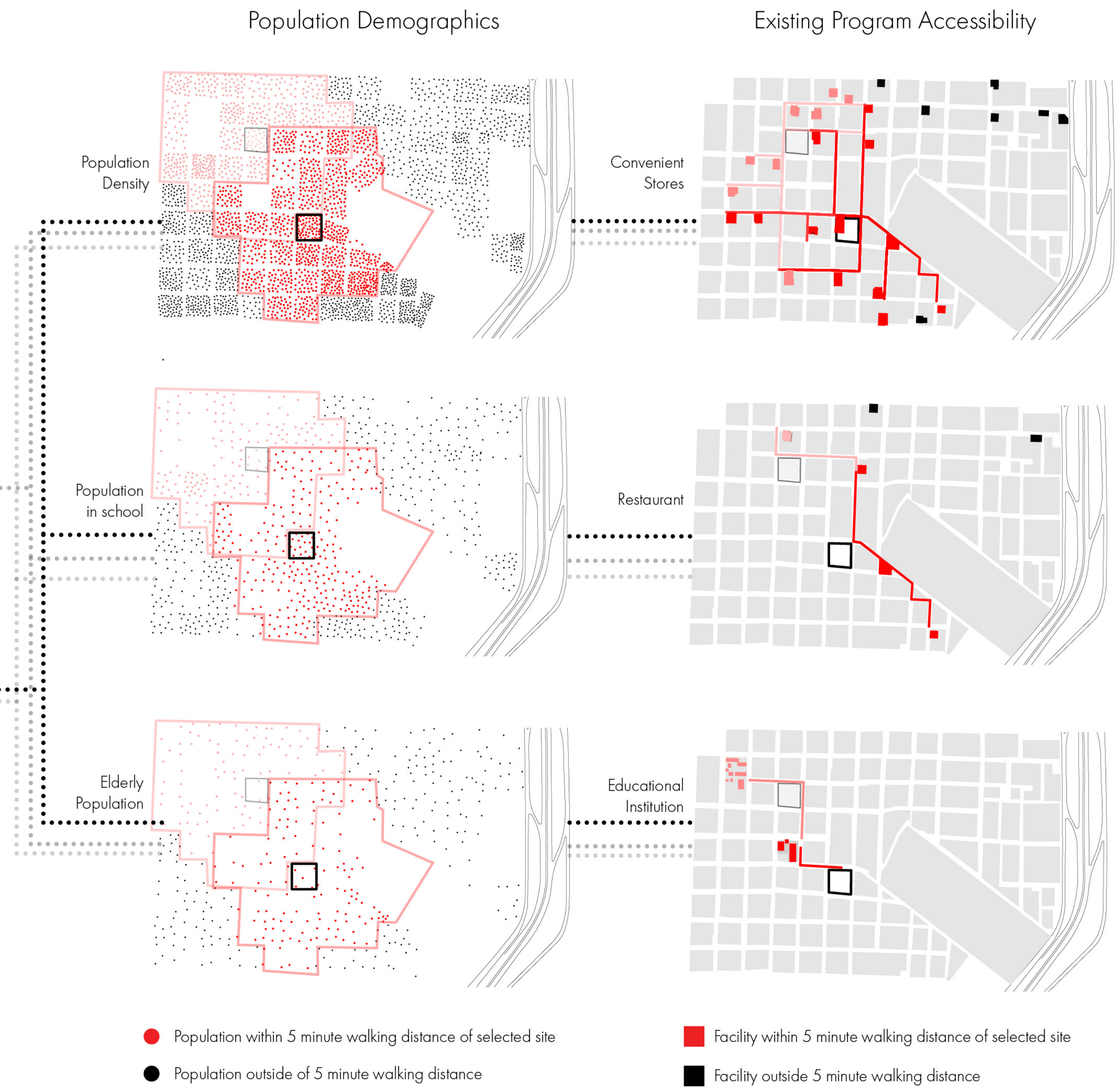
Urban Contextual Analysis · **Site Quantitative Analysis** · Program Layout Proposal

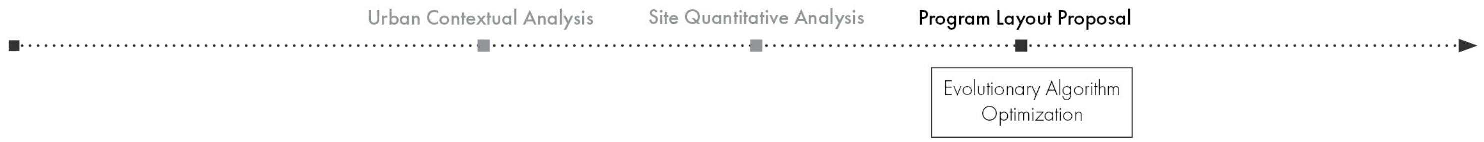
GIS Population Demographics Analysis

Parcel Site Analysis

Each emptied parcel is evaluated based on its size, street accessibility, inter-block relationships, surrounding demographics, and proximity to existing programs. The analysis provides the foundational database for determining the population of new programs.

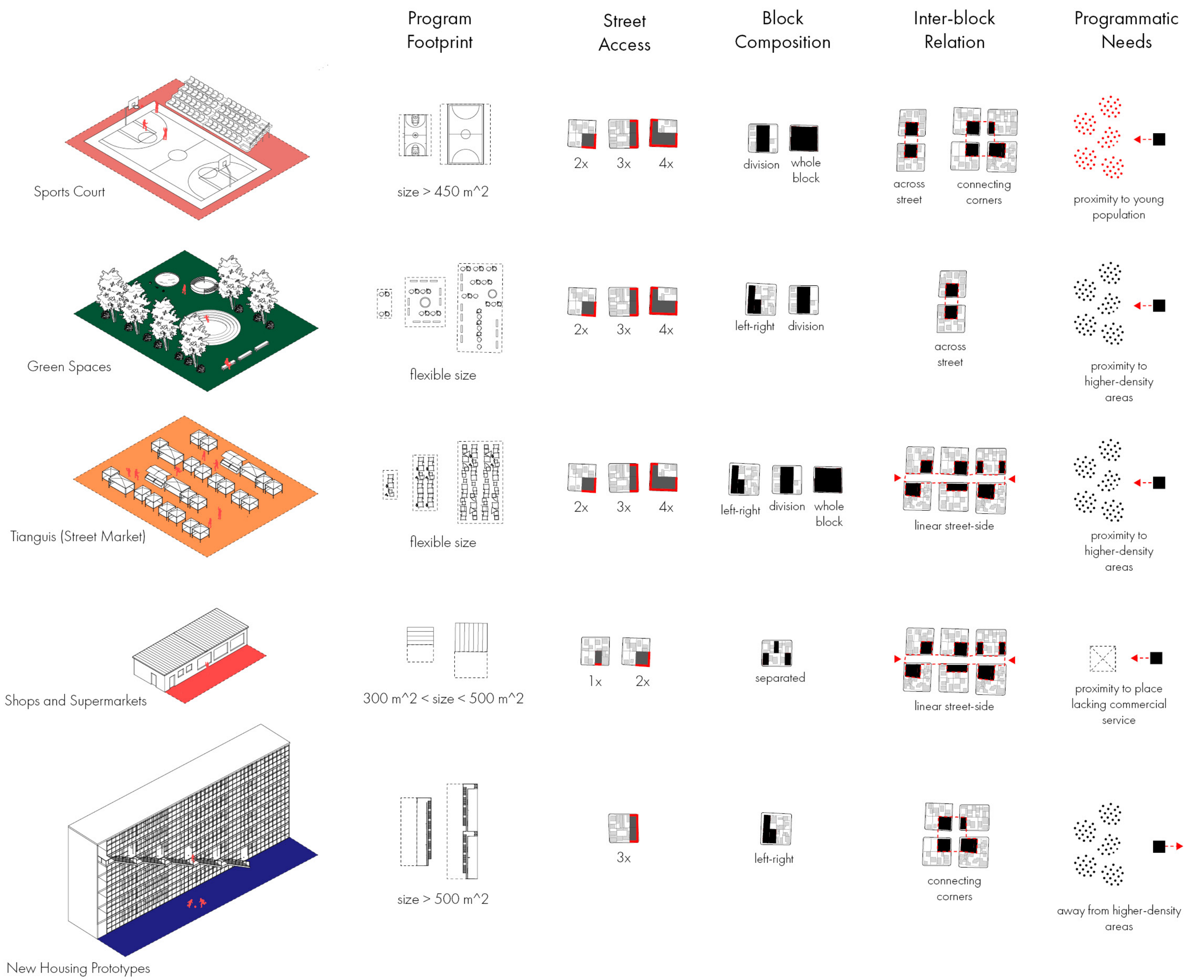






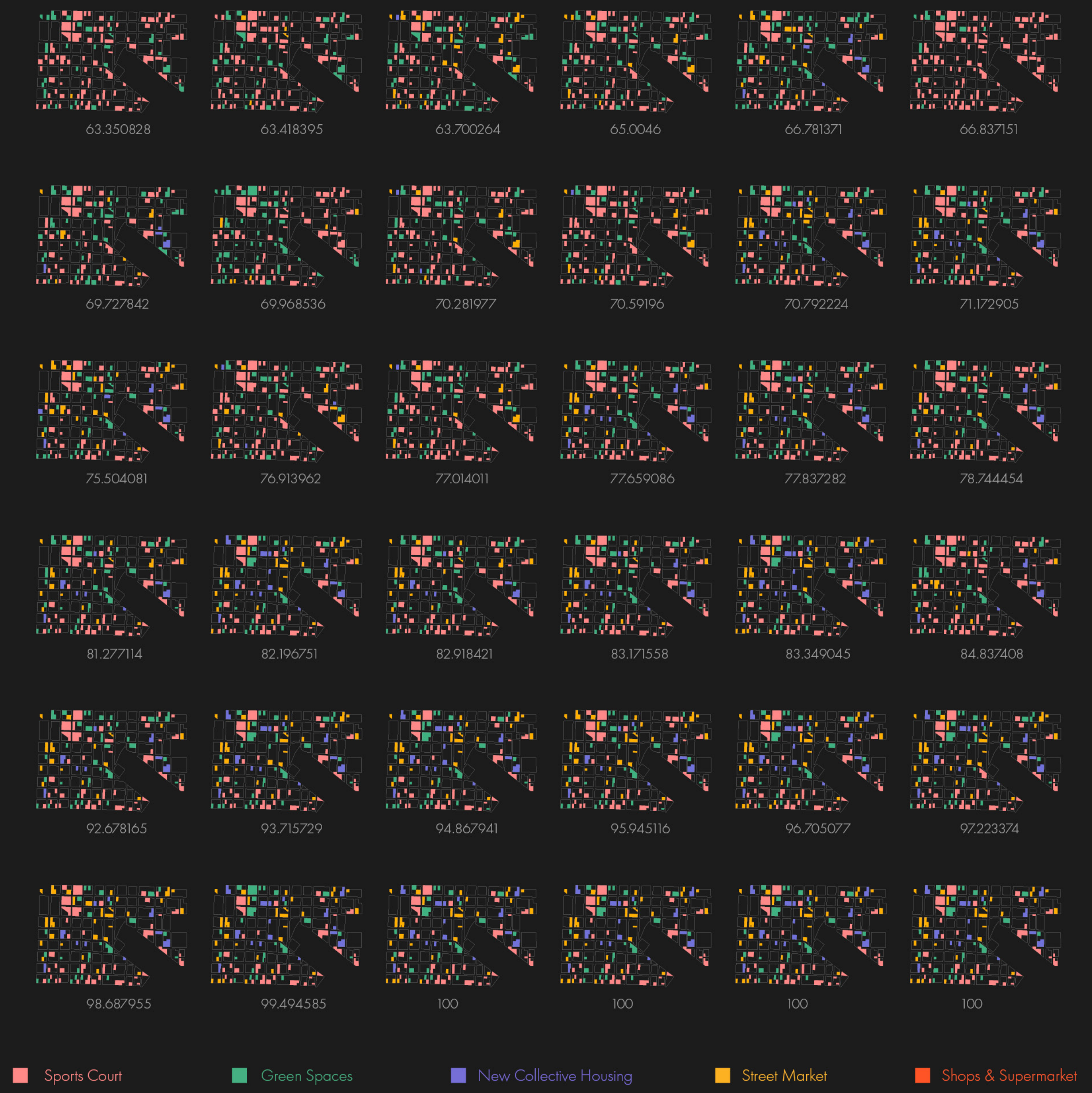
New Program Insertion Strategy

Given the comprehensive evaluation of individual parcels, a set of rules and preferences are assigned to each possible new program to find the block that best fits the criteria.



Optimization Iteration Matrix

A calculated overall score is assigned to programmatic iterations throughout the entire community. To determine the best layout, achieving the highest score and balancing all analyzed parameters, a genetic optimization algorithm is employed (Galapagos Plugin from Rhino Grasshopper). The matrix below illustrates the partially optimized results after around 10,000 iterations, with nominal scores provided below each iteration.

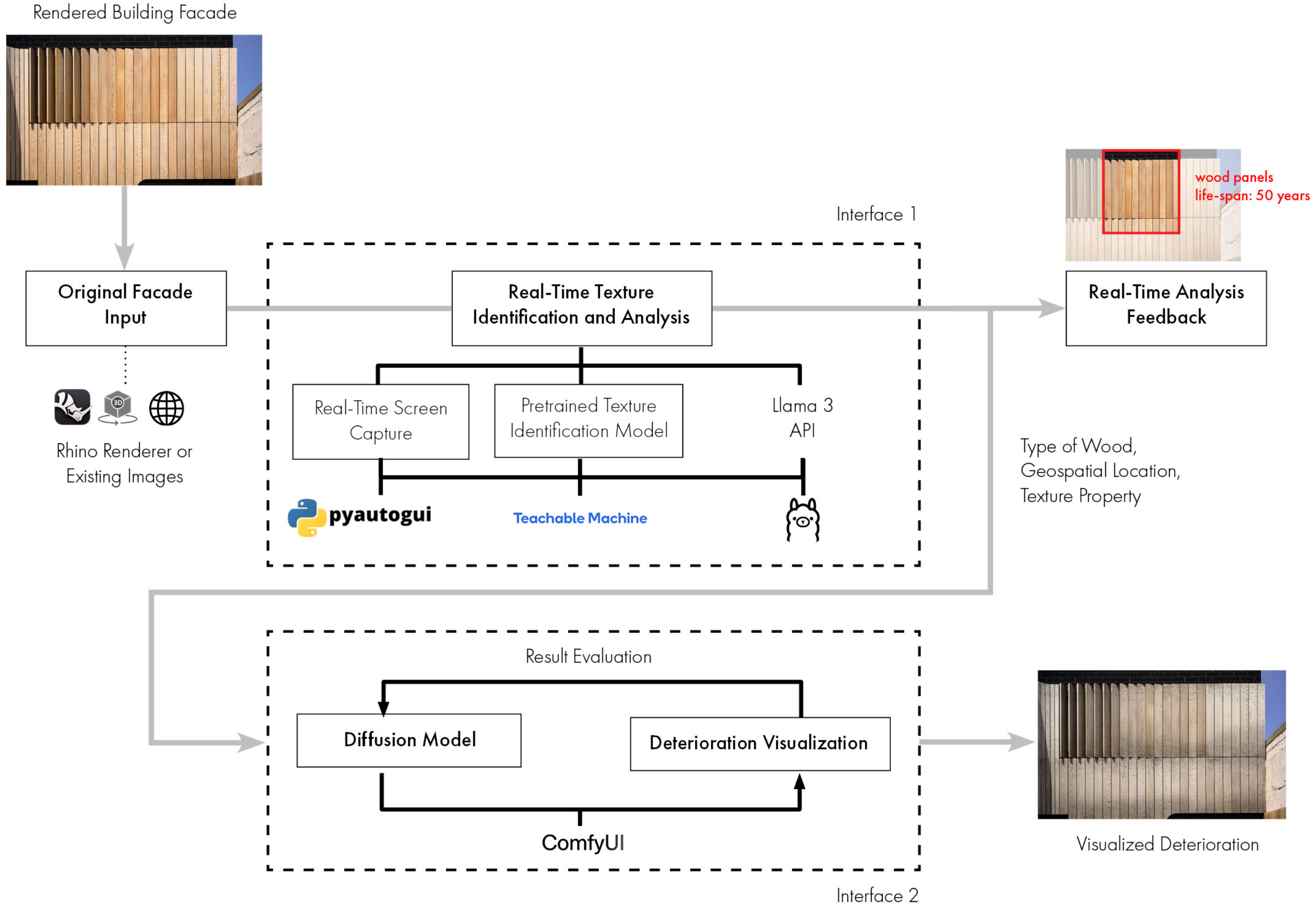


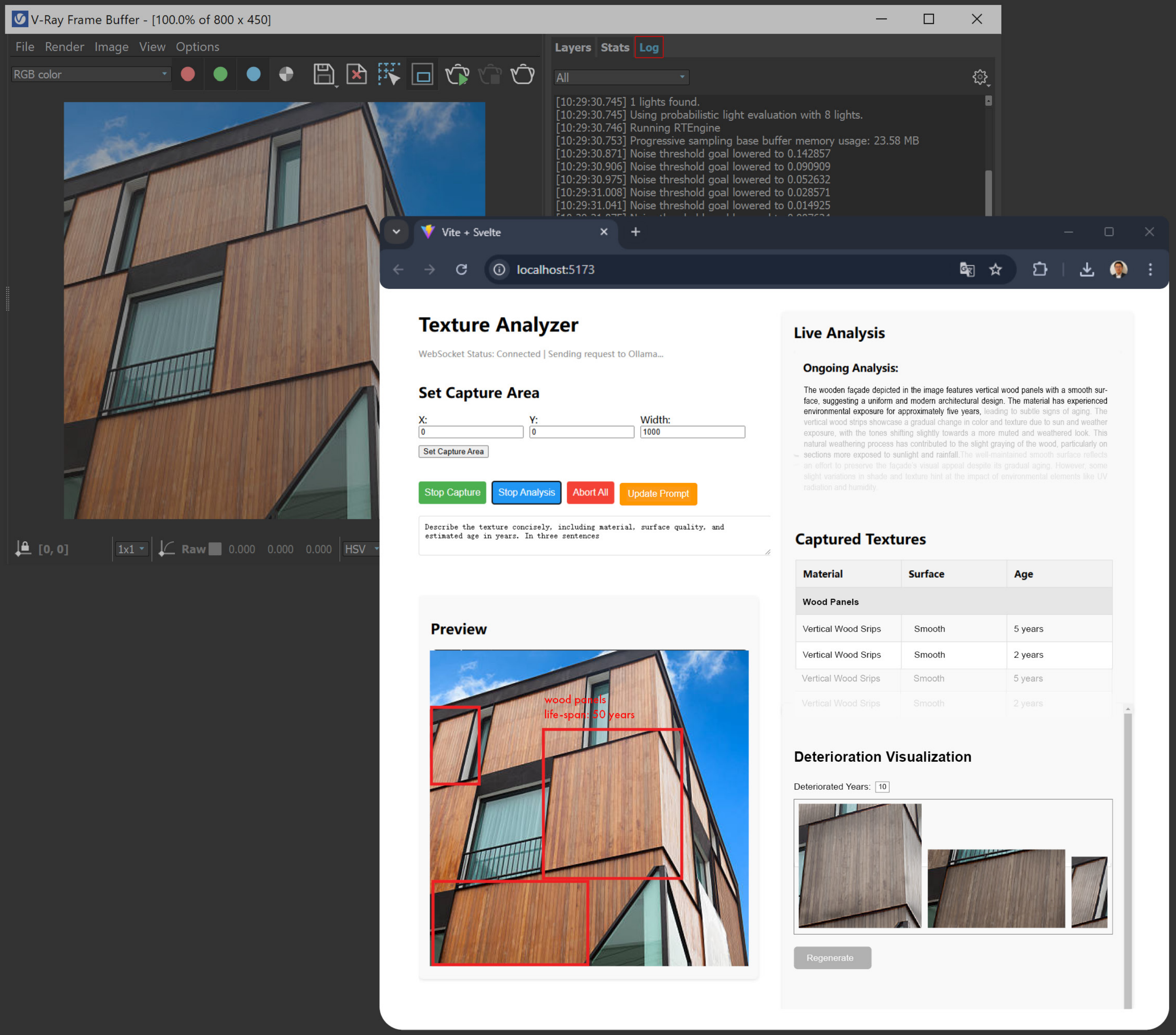
Real-Time Texture Capture & Anlsysis   Texture Identification   Visualizating Deterioration

front-end site building with svelte & javascript

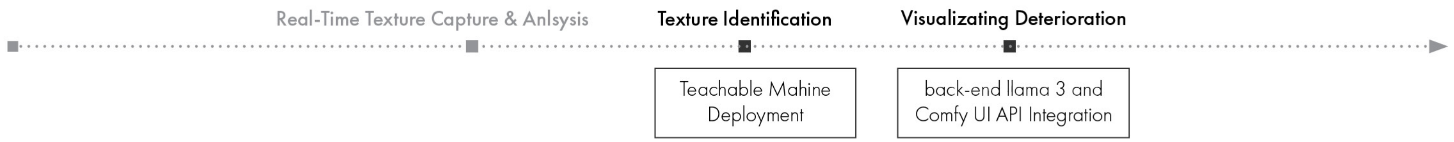
02
Synthetic Tool for Visualizing Facade Texture Deterioration
(work in-progress)

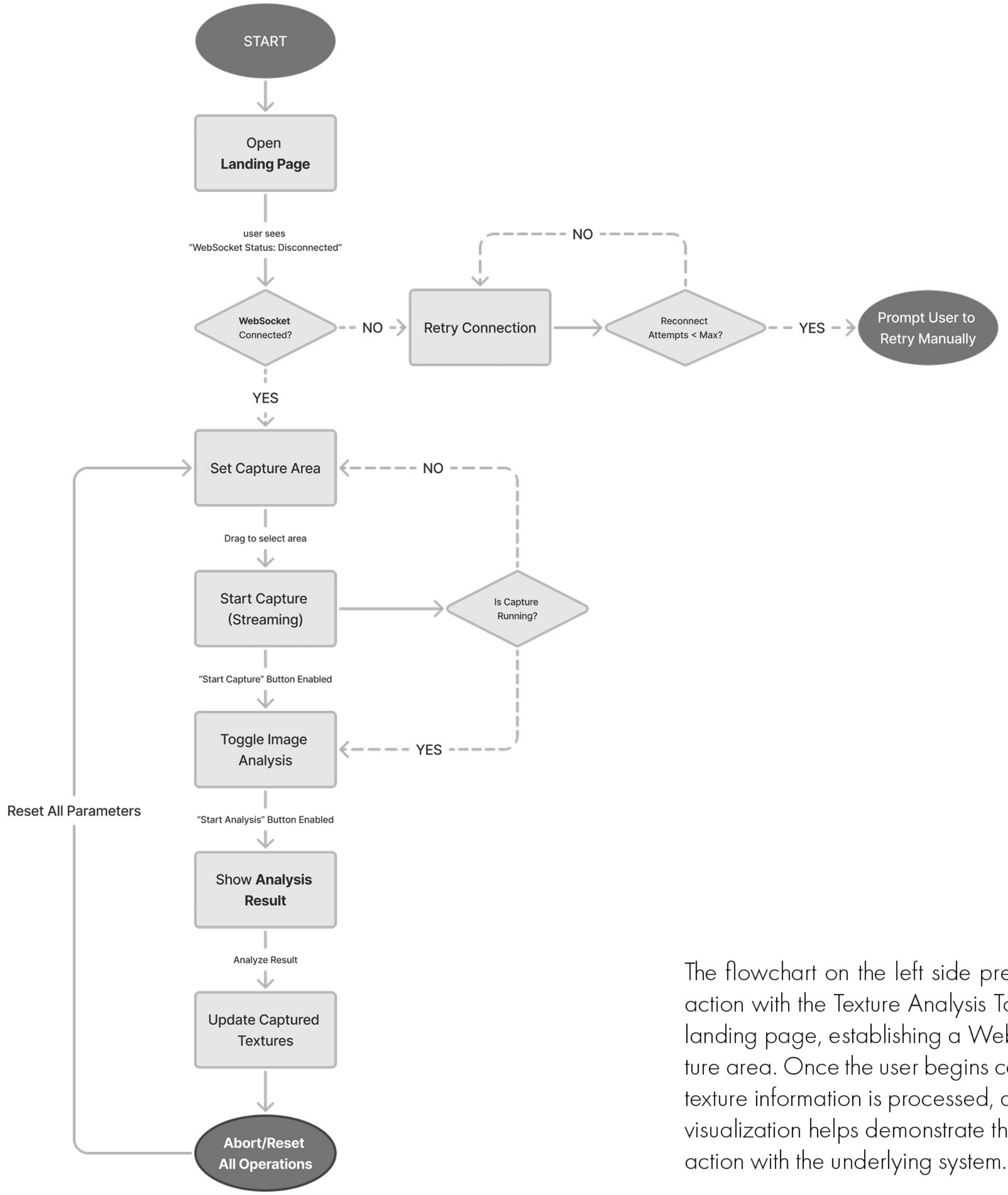
This project focuses on developing a generative AI framework to realistically simulate and visualize the long-term aging of architectural façades. Current generative models often emphasize idealized, pristine textures, overlooking the critical aspect of how materials naturally deteriorate due to environmental exposure. This research aims to bridge this gap by creating an interactive tool that enables designers to receive real-time feedback when applying textures to their models.





Use Case Demostration





The flowchart on the left side presents the overall user journey and interaction with the Texture Analysis Tool. The workflow starts with opening the landing page, establishing a WebSocket connection, and setting the capture area. Once the user begins capturing and analyzing images, real-time texture information is processed, displayed, and updated accordingly. This visualization helps demonstrate the tool's ease of use and its efficient interaction with the underlying system.

User Action Flow Chart

```javascript
onMount(() => {
  connectWebSocket();
  return () => {
    if (ws) ws.close();
  };
});

function sendWebSocketMessage(message) {
  if (ws && ws.readyState === WebSocket.OPEN) {
    ws.send(JSON.stringify(message));
  } else {
    console.error("WebSocket is not open. Current state:", ws ? ws.readyState : "ws is undefined");
    connectionStatus = "Disconnected";
    connectWebSocket();  // Attempt to reconnect
  }
}

function setCaptureArea(event) {
  captureArea = event.detail;
  console.log("Setting capture area:", captureArea);
  sendWebSocketMessage({ command: 'set_capture_area', area: [captureArea.x, captureArea.y,
  captureArea.width, captureArea.height] });
}

function toggleCapture() {
  isCapturing = !isCapturing;
  console.log(isCapturing ? "Starting capture" : "Stopping capture");
  sendWebSocketMessage({ command: isCapturing ? 'start_capture' : 'stop_capture' });
}

function toggleAnalysis() {
  isAnalyzing = !isAnalyzing;
  console.log(isAnalyzing ? "Starting analysis" : "Stopping analysis");
  sendWebSocketMessage({ command: isAnalyzing ? 'start_analysis' : 'stop_analysis' });
  if (isAnalyzing) {
    latestAnalysisResult = "";
    currentAnalysis = "";
  }
}

function abortAll() {
  console.log("Aborting all operations");
  isCapturing = false;
  isAnalyzing = false;
  sendWebSocketMessage({ command: 'abort' });
}

function updatePrompt() {
  console.log("Updating prompt:", prompt);
  sendWebSocketMessage({ command: 'set_prompt', prompt });
}
```

Web-socket Initialization & Status Update
(Javascript with Svelte)

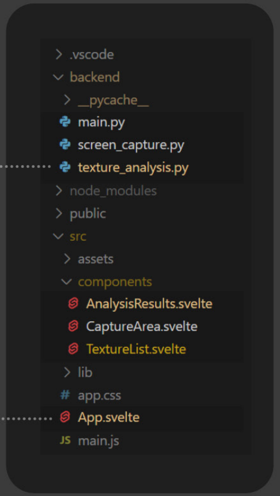


Image Description Generation with Llama 3
& Keyword Extraction
(Python)

```python
async def generate_image_description(self, image_bytes):
    logger.debug("Generating image description")
    try:
        await self.status_callback("Sending request to Ollama...")
        response = await asyncio.to_thread(self.ollama_client.chat, model="llama",
                                           messages=[{"role": "user", "content": self.prompt}],
                                           stream=True)
        full_description = ""
        for chunk in response:
            if 'content' in chunk.get('message', {}):
                content = chunk['message']['content']
                full_description += content
                await self.progress_callback({"type": "status", "message": content})
                await asyncio.sleep(0.05)  # Add a small delay between words
        logger.debug(f"Ollama response: {full_description}")
        return full_description
    except Exception as e:
        logger.error(f"Error in generate_image_description: {e}", exc_info=True)
        await self.progress_callback({"type": "ERROR", "message": f"Error in generate_image_description: {e}"})
        raise

def extract_details(self, description):
    material_match = re.search(r'(wood|stone|rock|concrete|metal|fabric|plastic)',
                               description, re.IGNORECASE)
    surface_match = re.search(r'(smooth|rough|polished|weathered|eroded|textured|patterned)',
                              description, re.IGNORECASE)
    age_match = re.search(r'(\d+)\s*(years?)', description, re.IGNORECASE)

    material = material_match.group(1) if material_match else "Unknown"
    surface = surface_match.group(1) if surface_match else "Unknown"
    age = f"{age_match.group(1)} years" if age_match else "Unknown"

    return material, surface, age
```

(In Progress)
Front & Back End Code Snippets

Wireframe Geometry Regulation

Hololense Integration and Feedback

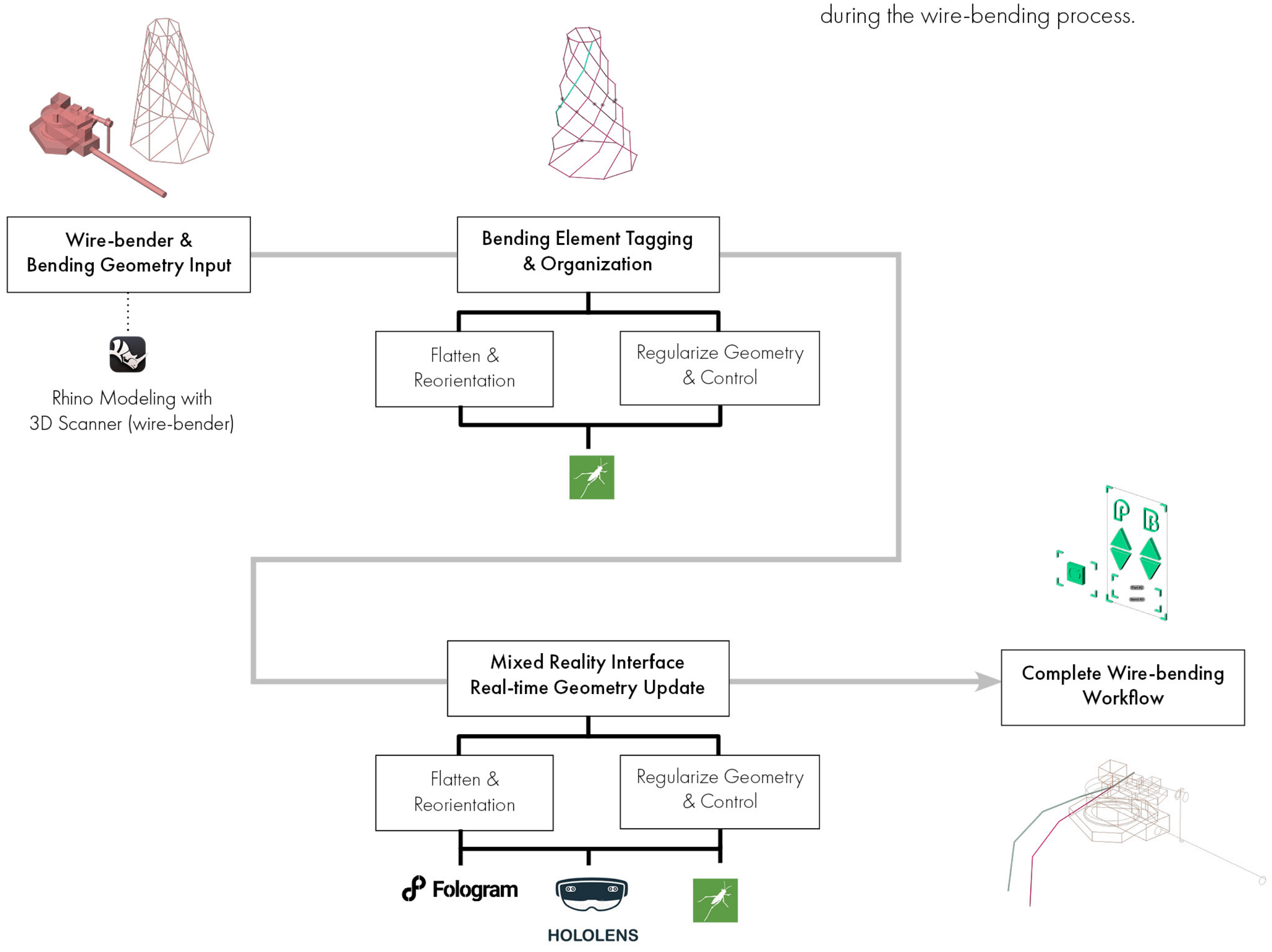
Grasshopper Script

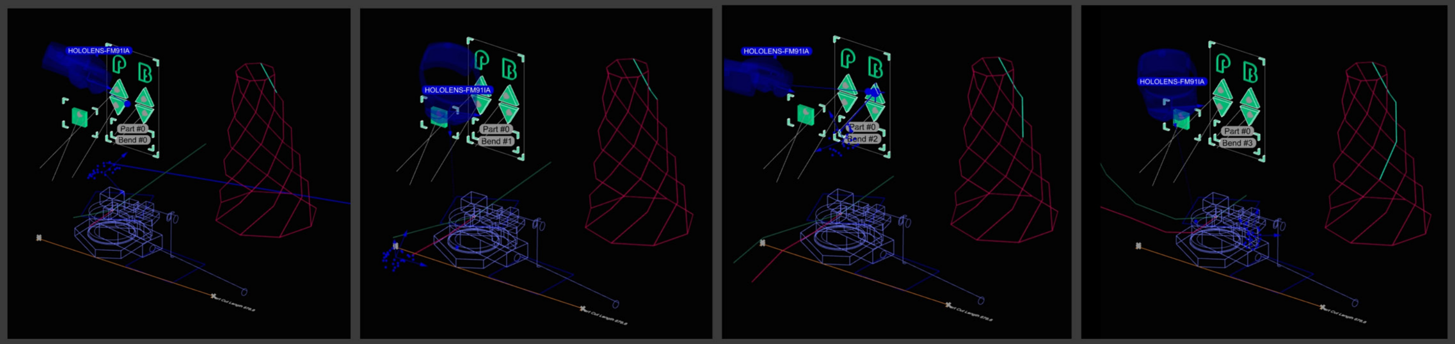
Fologram in Grasshopper Modules Integration

03
Wire-bending Parametric Workflow with Mixed Realiy (work in-progress)

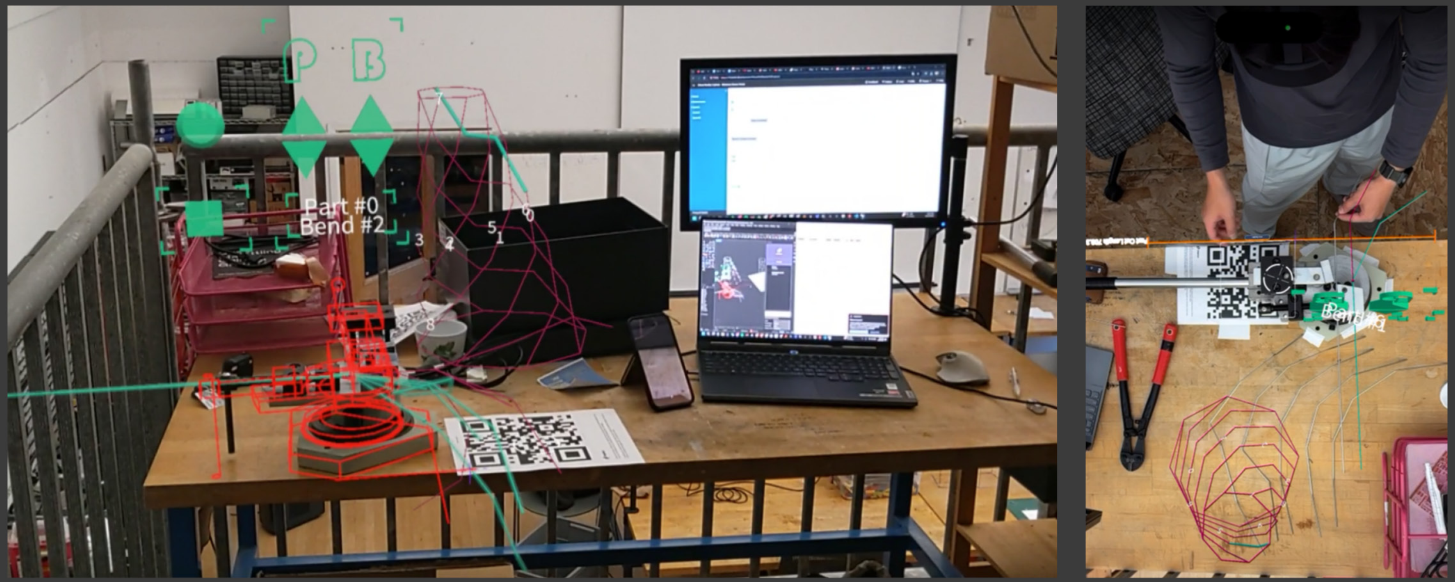
Mixed Reality Research Assitant, Carnegie Mellon University CodeLab

This research explores the integration of mixed reality technology with manual wire-bending fabrication, creating a novel workflow that combines traditional craftsmanship with digital guidance. The system utilizes Microsoft HoloLens 2 in conjunction with Fologram, a mixed reality platform integrated with Rhino/Grasshopper, to provide real-time holographic assistance during the wire-bending process.



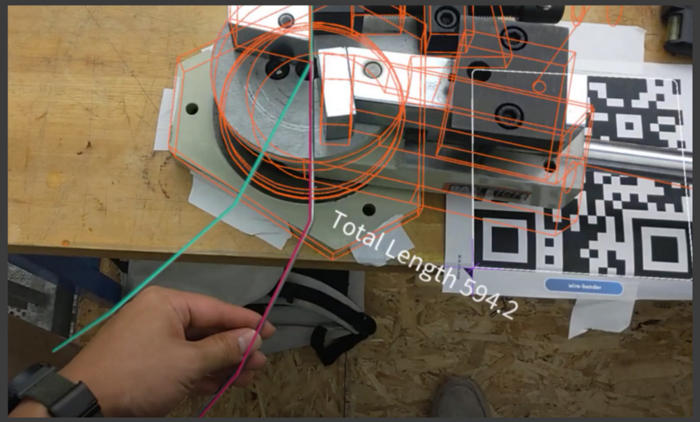


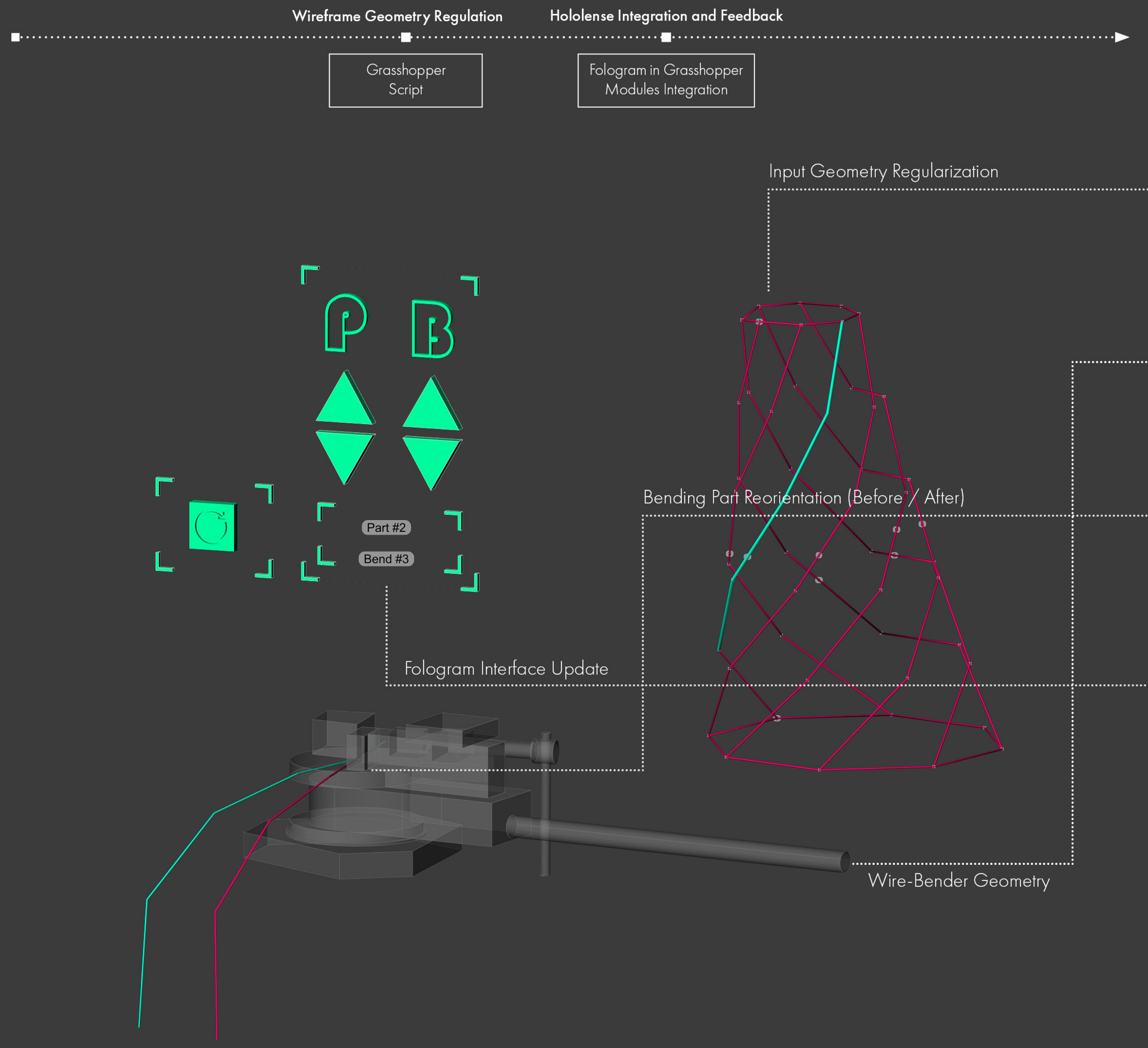
Virtual Rhino Geometry Display with Fologram Interface

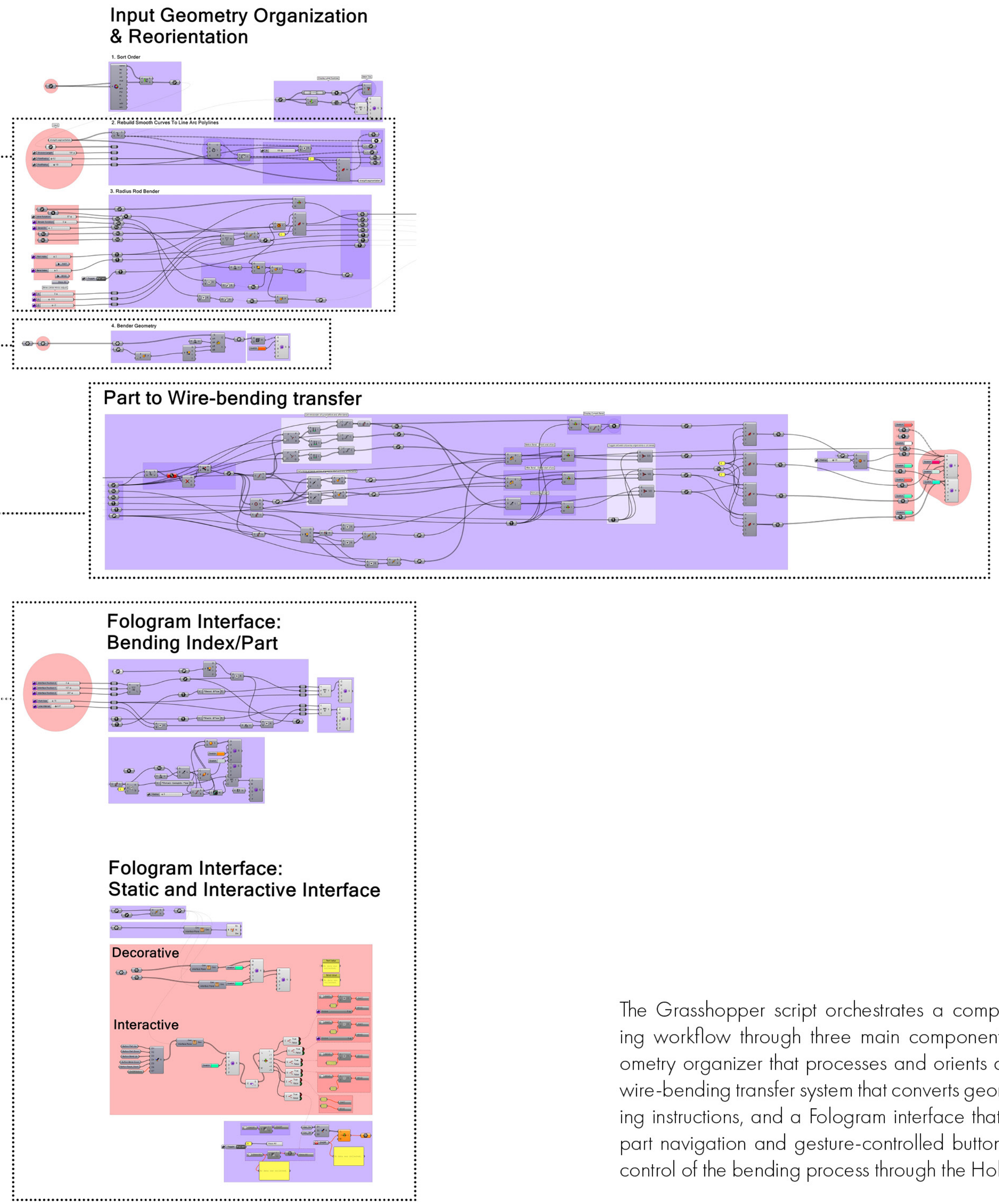


Mixed Reality Rojection onto Workspaces & Bending Processes

The technical implementation began with creating a digital twin of the wire bender through 3D scanning. A comprehensive Grasshopper script was then developed to manage geometry calculations and a gesture-controlled interface with five buttons for navigating bending steps. The system enables hands-free operation while streaming the HoloLens view to a web interface for documentation.

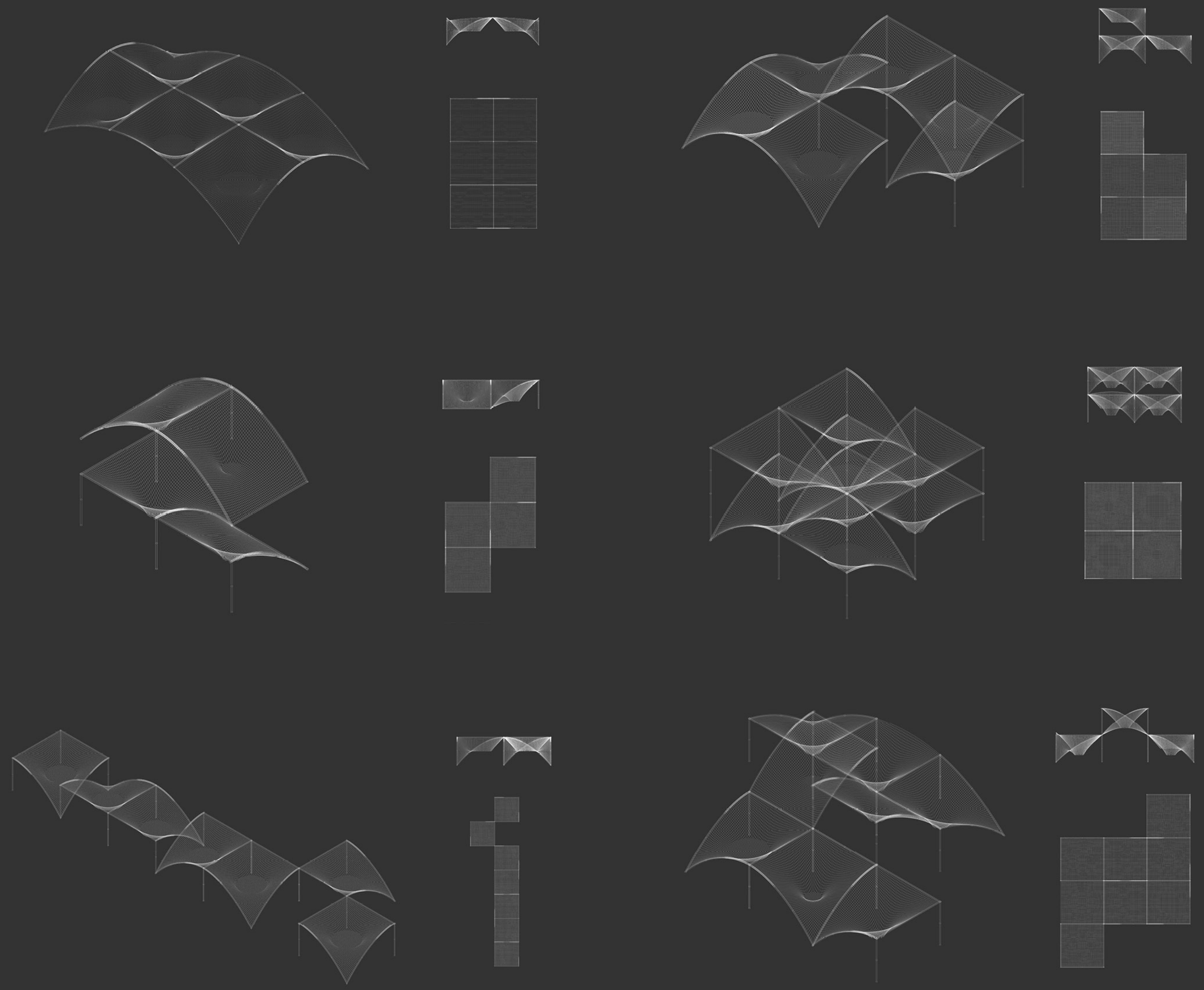






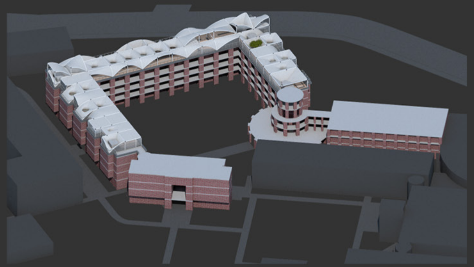
The Grasshopper script orchestrates a complete wire-bending workflow through three main components: an input geometry organizer that processes and orients curves, a central wire-bending transfer system that converts geometry into bending instructions, and a Fologram interface that combines both part navigation and gesture-controlled buttons for interactive control of the bending process through the HoloLens display.

Combined Modulations



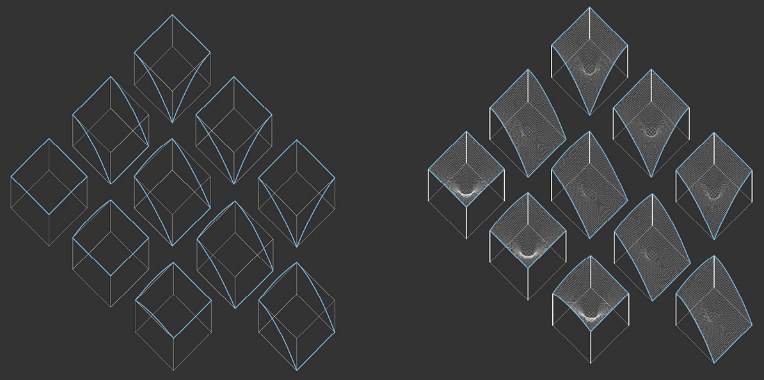
04
Membrane Parametric Form-finding

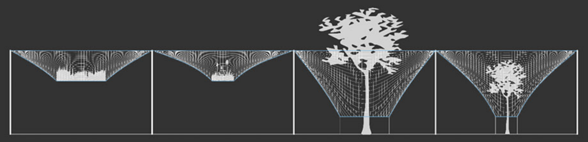
Rice University Martel College, Houston, Texas



Site: Rooftop of Martel College at Rice University

The project involves creating a lightweight, waterproof membrane canopy system that covers the entire roof of Martel College at Rice University. Designed and optimized with parametric tools, the membranes form a continuous topography, undergoing deformation due to the presence of planters, water tanks, inhabitable enclosures, and even human interactions.





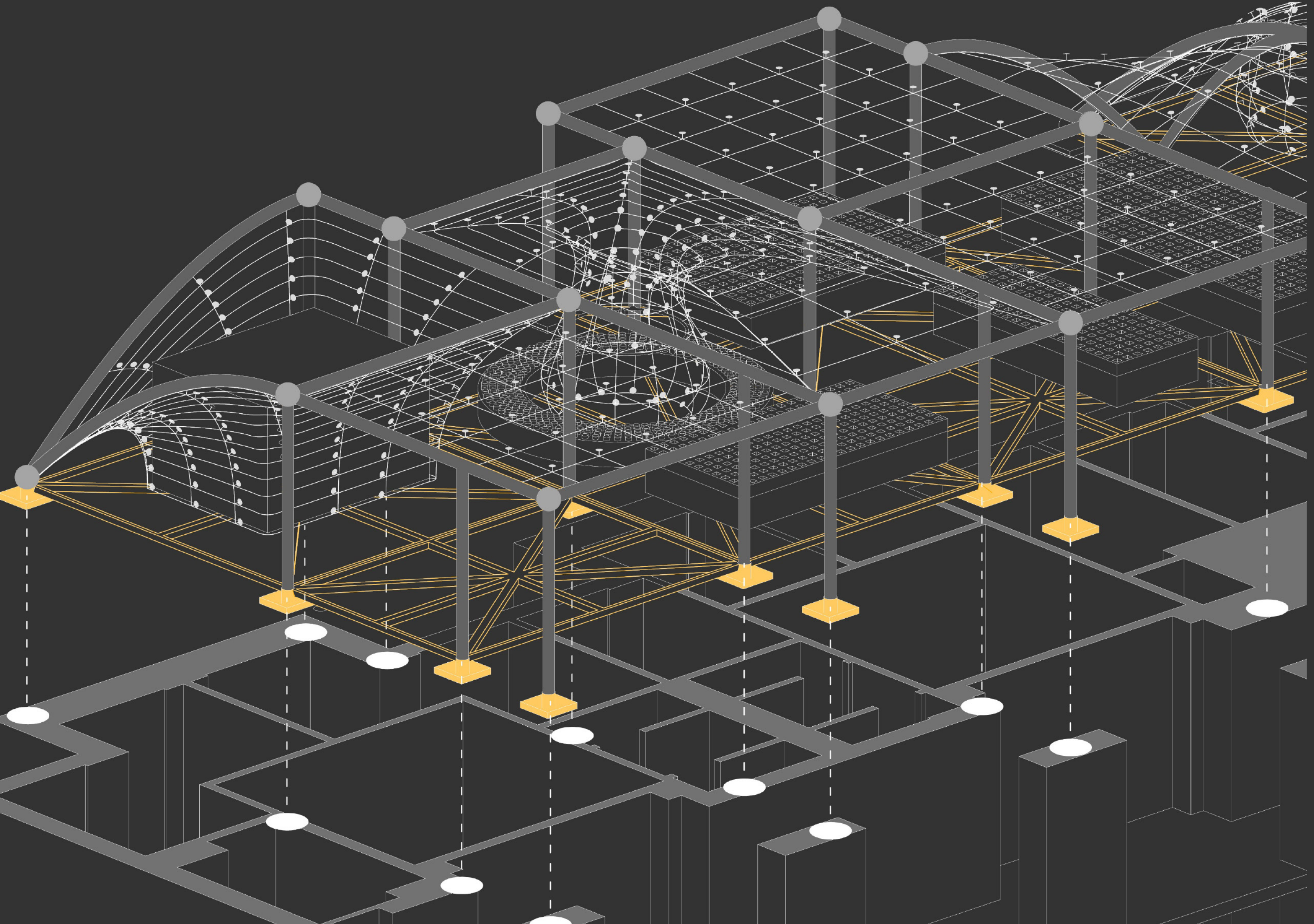
To generate the canopy form, Dynamic relaxation in Kangaroo is employed to apply the membrane to the modular framework. The position of the planters acts as a gravitational force to further deform the membrane for water collection purposes.

Water Runoff Path Simulation

*Grasshopper Gismo

Structure and Environmental Strategy

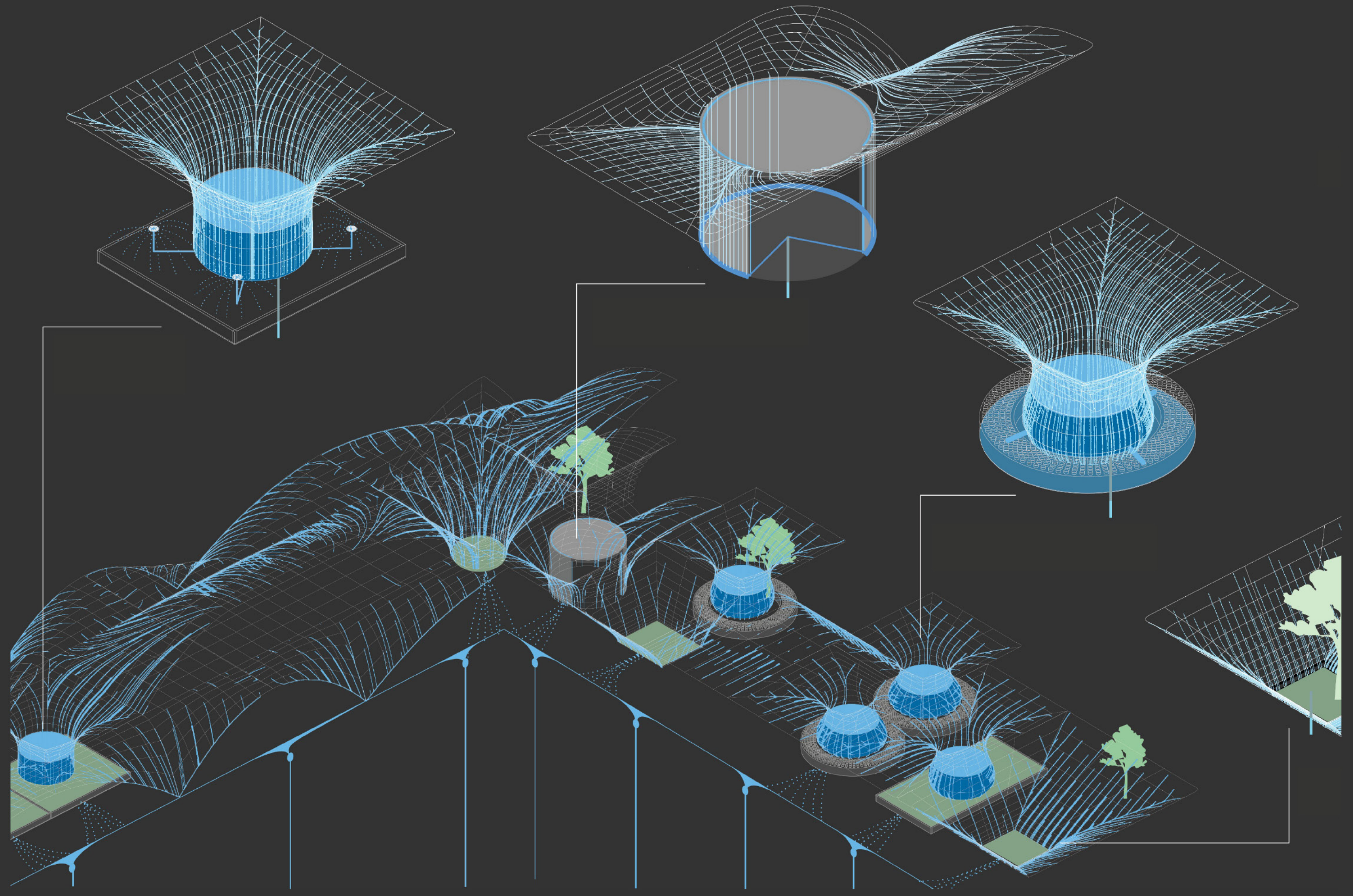
The structural strategy of the project takes the excess weight of the water tanks' canopy structure into account by utilizing an elevated platform that transfers the weight to lower load-bearing walls. Additionally, a compound system of cable netting and load-bearing columns is employed to stabilize both the membrane and the planters.



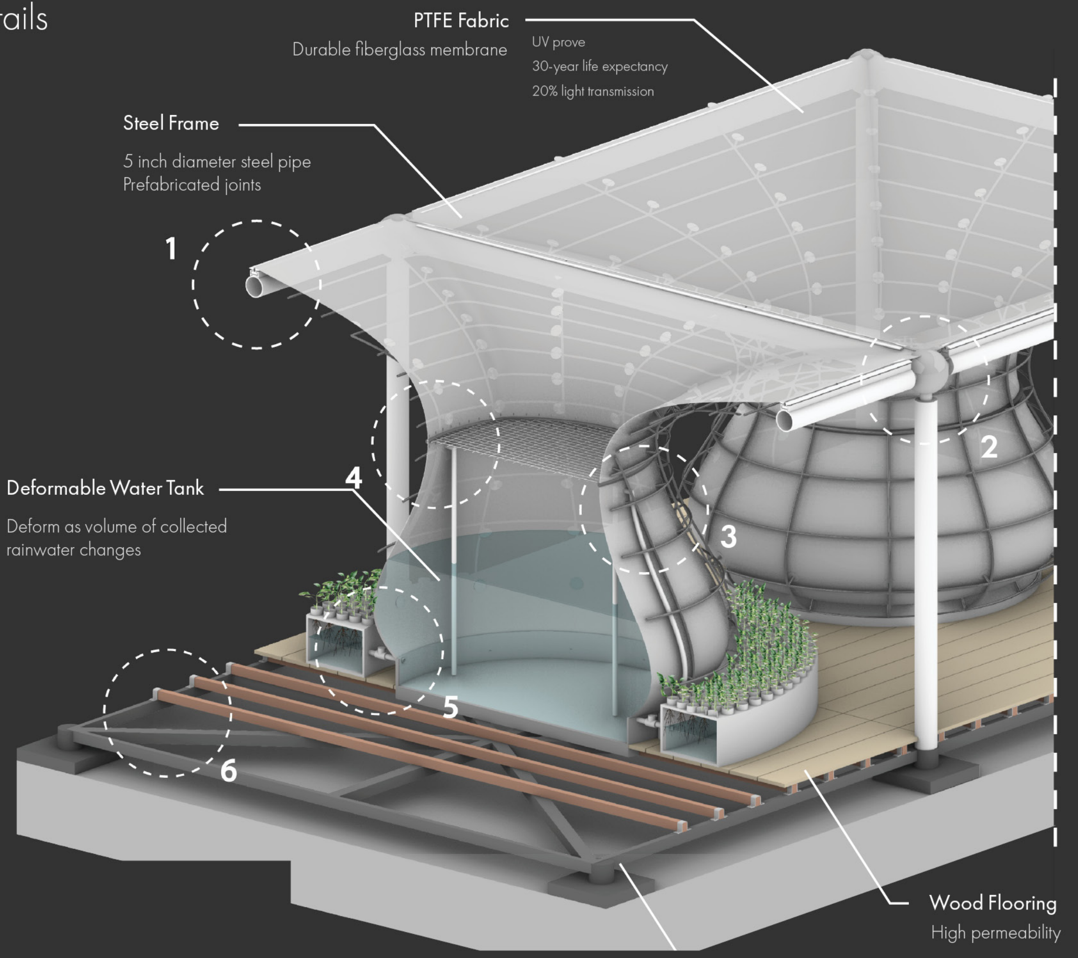
Water Collection Strategy

With over 50 inches of rainfall each year in Houston, various modular canopies generate a choreographed water runoff strategy, directing some rainwater straight into planters, water storage tanks, or side gutters.

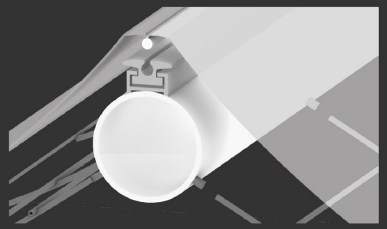
The Grasshopper Gismo plugin is utilized to simulate rainwater runoff on given surfaces.



Structural and Assembly Details

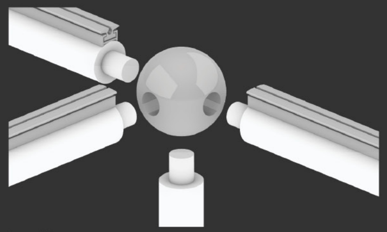


1



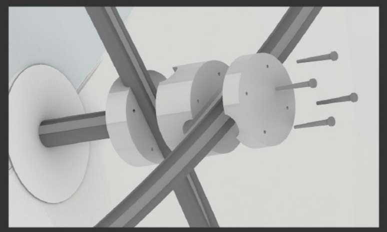
Membrane keder with frames

2



Steel frame joints

3

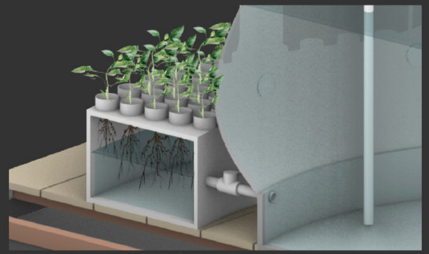


Cable overlap

4

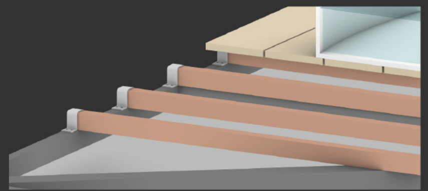
Leaf filter

5



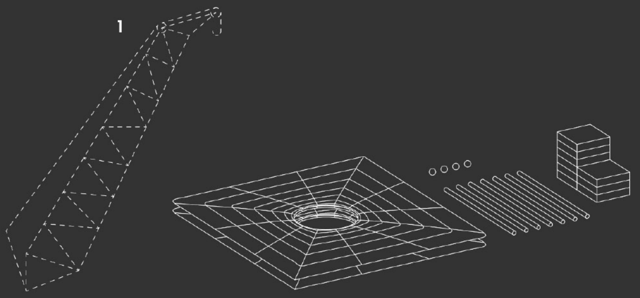
Hydroponics planter & pump

6



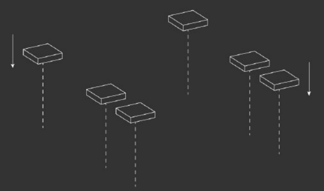
Elevated platform

1



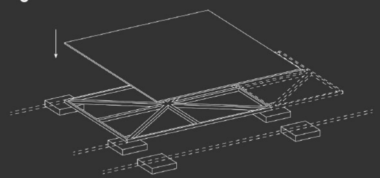
Parts transportation to rooftop with crane

2



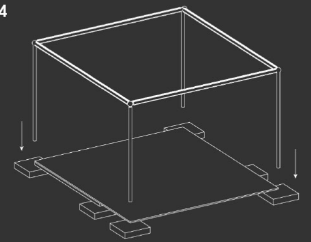
Lay foundtation on the roof

3



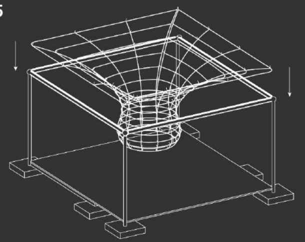
Install elevated platform

4



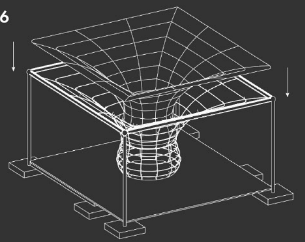
Install columns and beams on the foundation

5



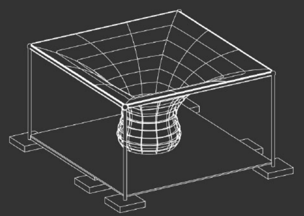
Install cable net for stablization

6



Install water-proof membrane

7



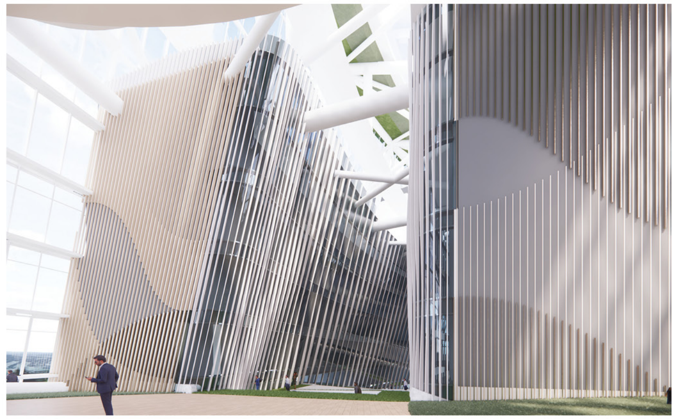
Finish Installation with water tank

05 Professional + Research

How can parametric tools being implemented in architecture research and professional projects ?

In addition to design studio projects, I am actively engaging in data-driven workflows in professional and research settings. These projects foster my critical reflection on the status quo of parametric tools in the industry.

Parametric Facade System Development

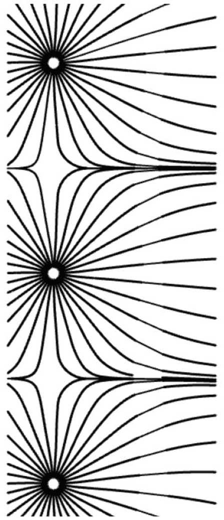


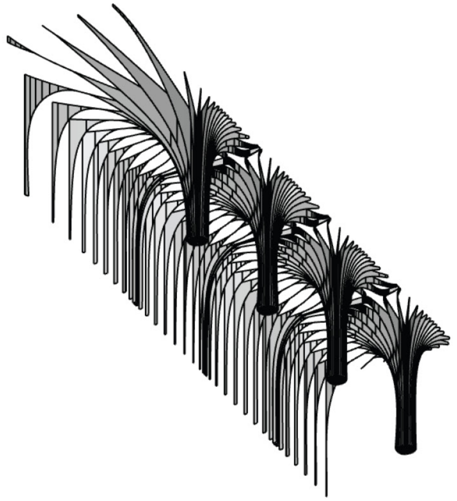
Tencent P1 Convention Center Facade Systems

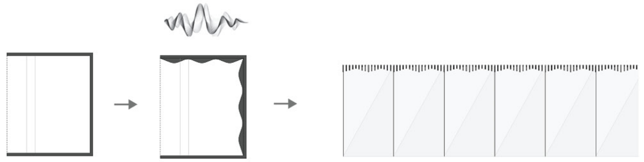
NBBJ Architects LA Office

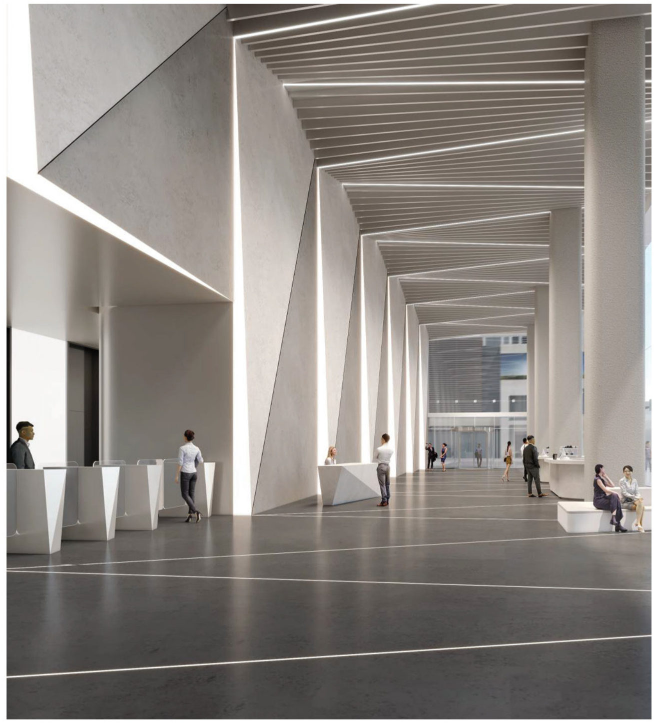
Grasshopper scripts were implemented to generate design iterations for three independent interior atrium facade systems. Renderings were created for client presentations and for further development in collaboration with facade consultants.

Parametric Building Interior Form-finding







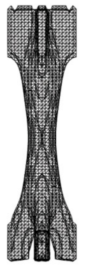


TP-Link Headquarter Lobby Design

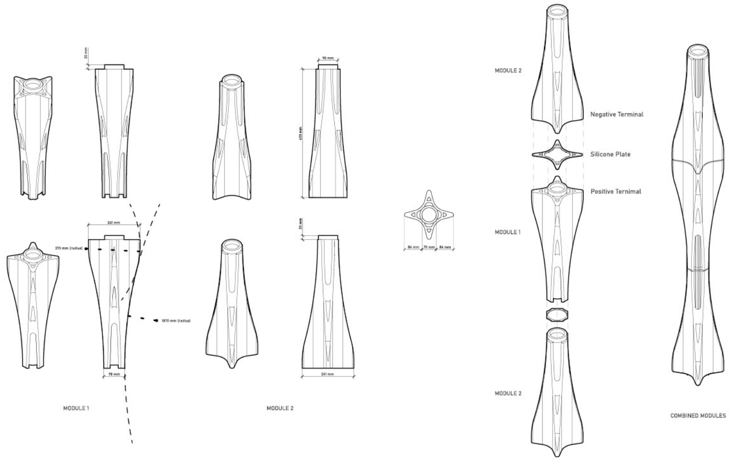
NBBJ Architects LA Office

Grasshopper magnetic force fields and Rhinoceros SubD are utilized to develop the interior design of a headquarters lobby. The design captures the concept of network linkages and the branching patterns of trees.

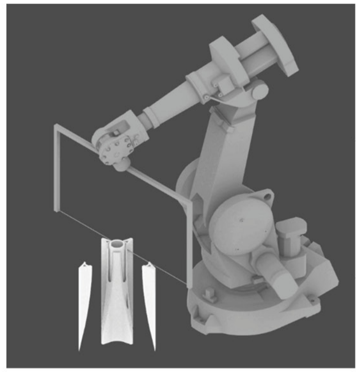
Parametric Form Optimization and Robotic Arm Simulation



Stereotomic Optimization Result



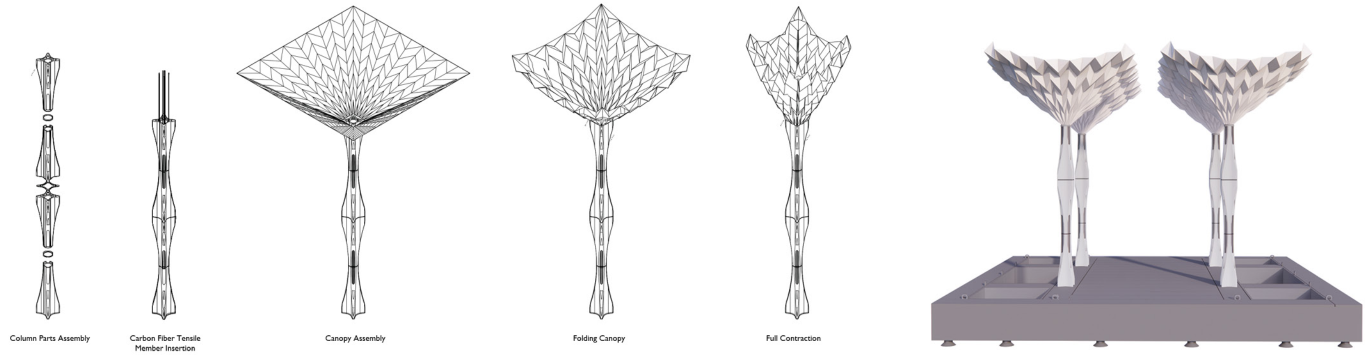
Ceramic Column Prototype Technical Drawings



Robotic Arm Simulation

Robotic Arm Cutting Prototypes with Ceramica Cumella

Kinematic Simulation and Parametric Tween for Folding Canopy System



Kinematic Folding Canopy Parametric Tween and Movement Simulation

Kinematic Folding Canopy Physical Model Prototype

Ceramic Column Prototypes*

Carbon Nanotube Research Group (2021-2023)

Professor Juan Jose Castellon

The project is a prototype for water-collecting ceramic columns. I used the Grasshopper plugin Millipede for stereotomic optimization of the column shape and robotics modules to simulate the cutting movement of robotic arms for final production in collaboration with Ceramica Cumella.

Kinematic Canopy Prototypes

Carbon Nanotube Research Group (2021-2023)

Professor Juan Jose Castellon

The project aims to design and simulate the movement for a kinematic folding canopy system. I used the Grasshopper plugin Kangaroo Physics to develop a parametric tween in parallel with the design exploration using physical models. The fully parametric system allows for the development of multiple iterations and real-time simulation of the physical performances.