Final Outcome:

Final Outcome: Flower Movement with Four Potentiometers

The following video showcases the final movement system of our mechanical flowers. In this version, four individual potentiometers are used to control four servo motors, each linked to a flower. This setup allows users to manually open and close each flower independently, demonstrating the responsiveness and variation in motion we designed into the system.

Link for the video:

https://drive.google.com/drive/folders/1M6ReX6JY-EmMwrdJRDrQgOUxkVYAQA7I

Light Sensor-Controlled Flower Movement

This video demonstrates how a Grove Light Sensor is used to control a servo motor connected to one of the mechanical flowers. In this setup, the motor responds to changes in ambient light:

- When the sensor detects darkness, the flower opens.
- When exposed to light, the flower closes.

Link for the video:

https://drive.google.com/drive/folders/1Cprs2xpY6NTTsv0c1ulCim4ESFazzC2G

LED Root Signal Simulation

This video captures the function of the sewable LED system used to simulate root-like signal transmission beneath the flowers. Controlled by a single potentiometer, the LEDs light up sequentially as the knob is turned, creating a flowing visual effect.

- Turning the potentiometer clockwise causes the LEDs to light up one by one, simulating a signal traveling through a connected root or mycelial network.
- Turning it back counterclockwise causes the LEDs to turn off in reverse, representing the signal retreating.

Link for the video:

https://drive.google.com/drive/folders/1NRo1InjukqJessbsmNgpKxh9RDQCZofG

Visual Aids

Magazine

COCO CAI, JOCELYN EDDY & OMAR YUSSUF

Pervasive Media Exploration

Exploring the Ecological Interactions of the Common Mycorrhizal Networks through Robotics

"These fungal networks appear to redistribute the wealth of carbohydrates from tree to tree. A kind of Robin Hood, they take from the rich and give to the poor so that all the trees arrive at the same carbon surplus at the same time."

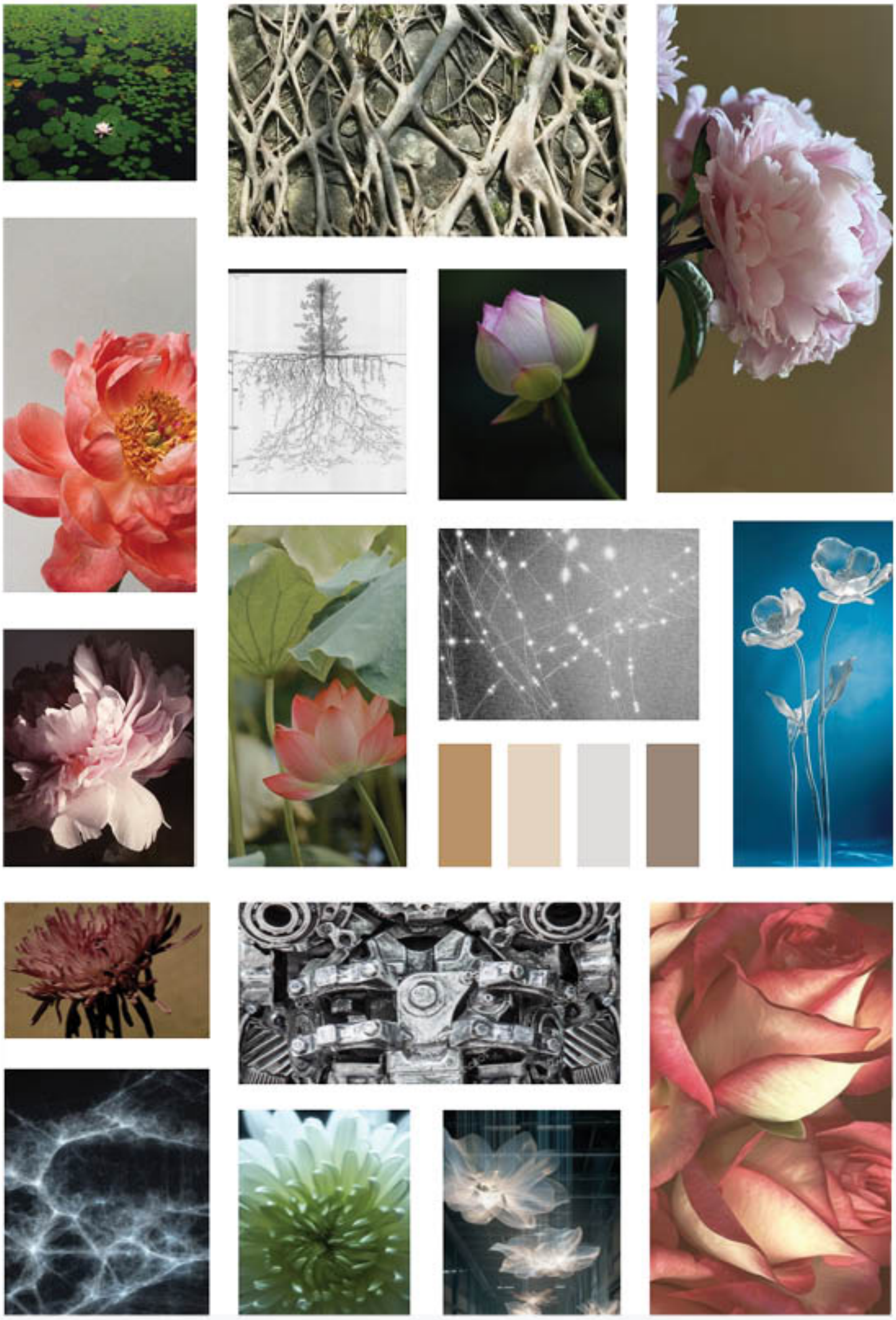
Robin Wall Kimmerer - Potawatomi botanist

TABLE OF CONTENTS

Our Concept

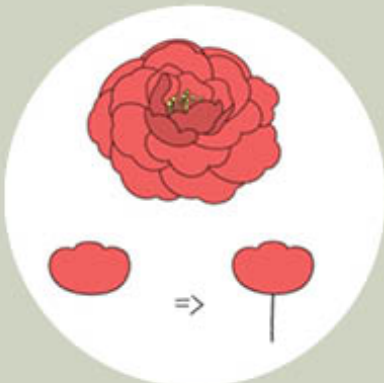
This project develops an interactive simulation inspired by mycelium-based communication, blending technology, art, and biomimicry and we feature a modular system where users send signals through a physical interface, prompting plant-like responses such as illuminated LED pathways, motorized movements, and other sensory outputs as a way to mimicking the decentralized flow of information found in fungal/floral networks and distributed computing, the simulation visualizes normally invisible biological processes.

Beyond its technical scope, the installation serves educational, artistic, and scientific purposes in an attempt to making bio-communication systems tangible and encouraging reflection on ecological intelligence and nature-inspired design. By revealing parallels between organic and digital networks, it fosters dialogue on sustainability, interconnectedness, and emerging technologies. Additionally, the project explores new forms of human-computer interaction that integrate living and synthetic elements, contributing to fields like bio-HCI and biohybrid robotics.



The Flowers

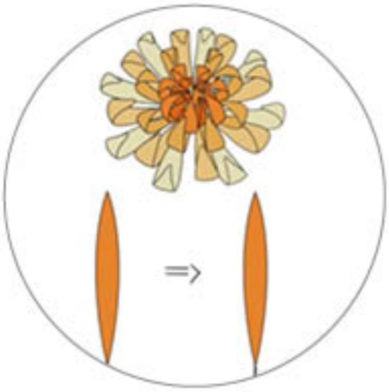
Through a programmable mechanical system, it is possible to replicate them flowering and responding dynamically to environmental changes, perfectly merging the beauty of nature with robotics. We can replicate the natural movements of petals unfolding layer by layer, slowly rotating, or gently swaying in the wind, increasing interactivity and viewing experience. Additionally a multi-layered mechanical construction can be utilized to manage the petals' slow blooming, replicating natural growth and giving it a more vibrant appearance. For example, it can cause flowers to gradually close and then blossom again, showing the theme of vitality and cyclical rebirth.



PEONY

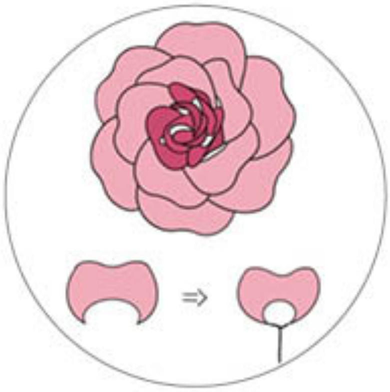
PAEONIA

THE STACKED PETALS OF THE PEONY CREATE A RICH THREE-DIMENSIONAL IMPRESSION



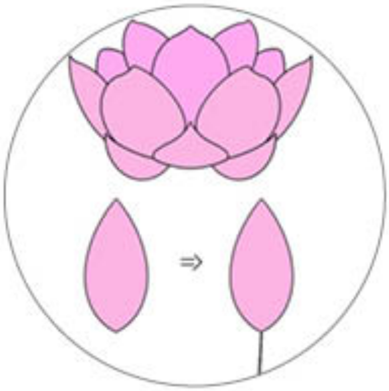
CHRYSANTHEMUM

CHRYSANTHEMUM INDICUM
FEATURE A RADIAL PETAL ARRANGE-MENT, WHICH ALLOWS FOR A DYNAMIC LOOK WITH SEVERAL LAYERS.



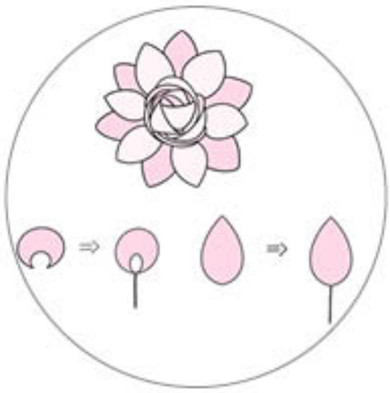
CHINESE ROSE

ROSA CHINENSIS
THE CHINESE ROSE HAS THE DISTINCT FEATURE OF FLOWERING ONCE A MONTH. IT CAN ENDLESSLY BLOOM, WITHER, AND BLOOM AGAIN.



LOTUS

NELUMBO NUCIFERA
THE PETALS OF A LOTUS FLOWER OPEN SEQUENTIALLY FROM THE OUTSIDE IN.



CAPE JASMINE

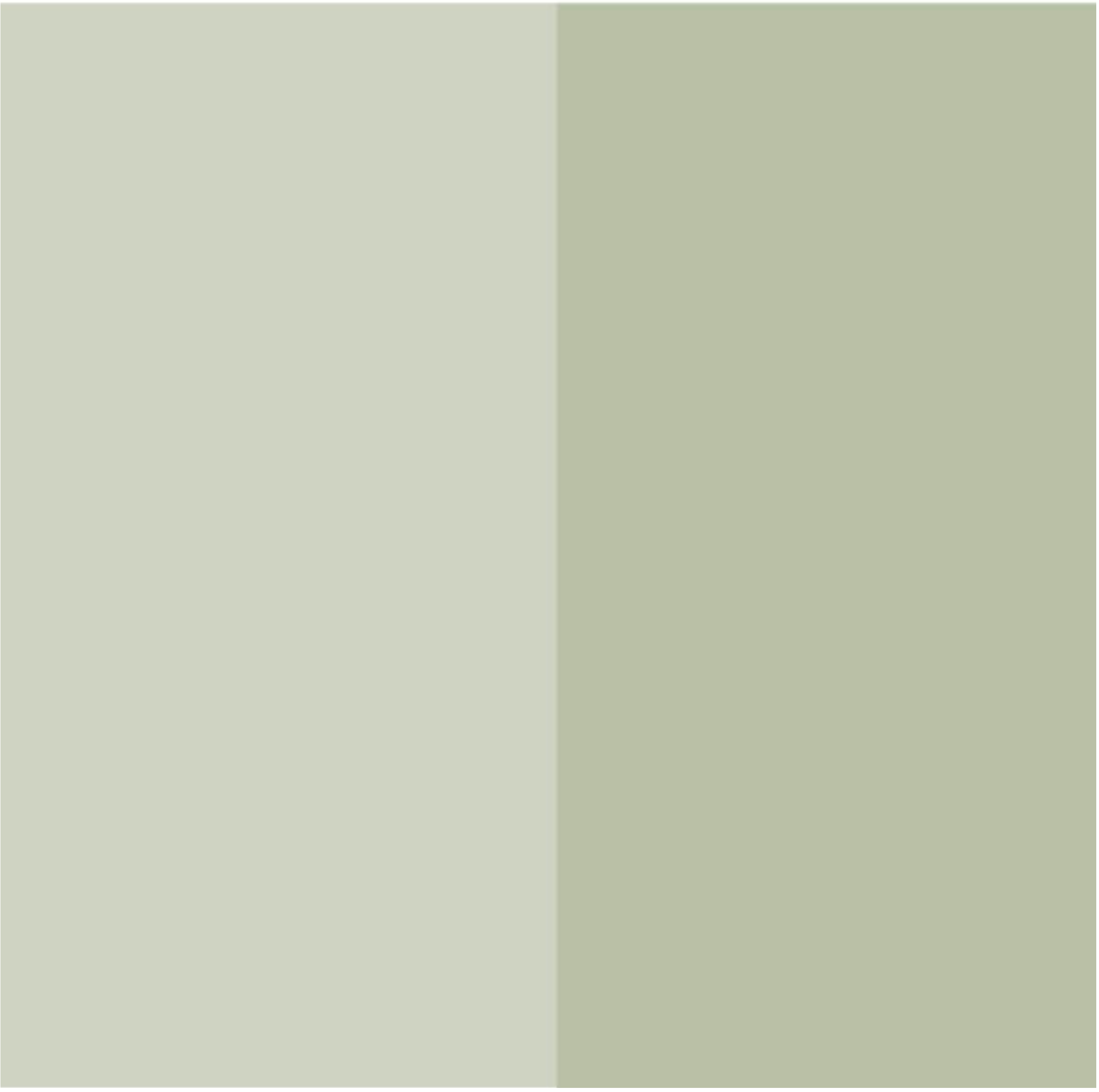
GARDENIA JASMINOIDES
GARDENIA PETALS ARE ORGANIZED UNIFORMLY AND CLOSELY, WITH A STRUCTURE THAT UNFOLDS IN A SPI-RAL PATTERN.

<table>
<tr><td>Resource</td><td colspan="2">Moisture</td></tr>
<tr><td>Sensor</td><td colspan="2">DHT11 or DHT22 humidity sensor</td></tr>
<tr><td>How does it relate to the Common Mycorrhizal Networks</td><td colspan="2">Water flows through the MCN, therefore if the amount of water in a plant has decreased, it will then increase the amount it takes from the flow, reducing the amount that the other plants will be able to receive.</td></tr>
<tr><td>How does this resource impact the plant and its local environment.</td><td colspan="2">Water makes up 80-95% of plants weight[29] and is necessary for transporting nutrients and maintaining turgor pressure[30], this is what helps the plant stand up without drooping. With reduced amounts of water, the processes of respiration, transpiration and photosynthesis are decreased.[31] Water aids in maintaining the temperature of plants and acts as a buffer.[32]</td></tr>
<tr><td rowspan="2">Visible Observations</td><td>Lack of Water[33]</td><td>Excess Water[34]</td></tr>
<tr><td>- Wilting
- Yellow Leaves
- Brown & Crispy leaves
- Leaf Drop</td><td>- Roots become brittle and damaged
- Root rot
- Leaf Mold</td></tr>
</table>

<table>
<tr><td>Resource</td><td colspan="2">Temperature</td></tr>
<tr><td>Sensor</td><td colspan="2">DHT11 sensor</td></tr>
<tr><td>How does it relate to the Common Mycorrhizal Networks</td><td colspan="2">'Both mycorrhizal colonization levels and length of extraradical hyphae (ERH)'[47] increased as the temperatures got warmer. Additionally, every time the temperature drops by 10 degrees, the mycelium's ability to do chemical processes halves.[48] This affects how effective the communication between the plants is, it is necessary that the temperature remains optimum.</td></tr>
<tr><td>How does this resource impact the plant and its local environment.</td><td colspan="2">Whilst the temperature from day to night fluctuates, it is recommended that it only decrease by 10 to 15°C. Any extreme temperature change can lead to stress which can hinder the plants growth.[49] This increases their risk of disease. Warmer temperatures lead to more photosynthesis and respiration.[50] Additionally warmer soil temperature boosts the amount of water and nutrients absorbed.[51]</td></tr>
<tr><td rowspan="2">Visible observations</td><td>Excessive Low Temperature[52]</td><td>Excessive High Temperature</td></tr>
<tr><td>- Wilting
- Red or purple discoloration
- Plant turns mushy / black
- Death of leaves, stems, or entire plants</td><td>- The leaves change angles and roll in on themselves.[53]
- Wilting
- Discolouration
- Scorching</td></tr>
</table>

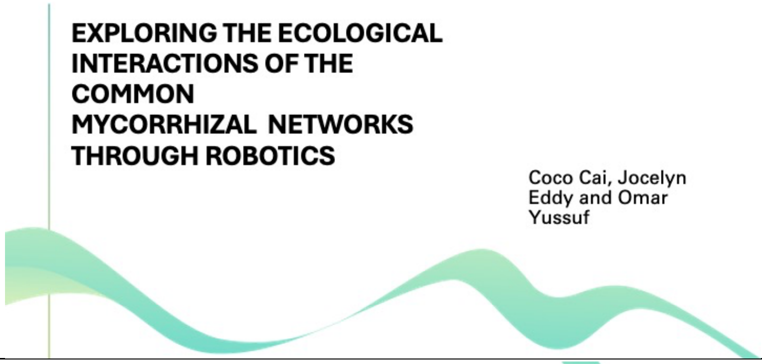
Resource	Air Flow
Sensor	Metal Pitot Tube, Acrylic 2.5mm ID Tubing, XGMP3v3 Differential Pressure Sensor[26]
How does it relate to the Common Mycorrhizal Networks	Whist the Air Flow doesn't directly impact the CMN, it stills influences the soil, which is where the processes occurring in the MCN are based. Where there is more air in the soil, it benefits the soil structure, soil biology and soil chemistry. This makes it easier for the plants to absorb the nutrients, water and oxygen.[27] It allows the transports of sugars from the plants to the MCN[28] to occur more effectively, improving their growth and ability to perform the necessary processes.
How does this resource impact the plant and its local environment.	When there are high amounts of air movement, it has a drying effect on the plants.[29] Therefore they require more water at shorter intervals. Without any air movement occurring the leaves become 'saturated with water vapour'[30]. This increases the risk of pathogen attacks as a warm and moist environment is the perfect place for bacteria to grow.[31] Overall this weakens the plant and can make it more susceptible to catching diseases which increases the likelihood of it spreading to the neighbouring plants[32].

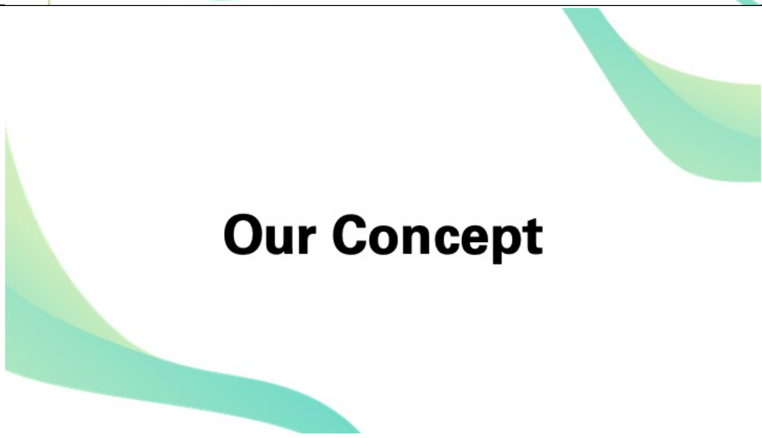
<table>
<tr><td>Resource</td><td colspan="2">Light</td></tr>
<tr><td>Sensor</td><td colspan="2">Grove Light Sensor</td></tr>
<tr><td>How does it relate to the Common Mycorrhizal Networks</td><td colspan="2">Depending on the type of light, different activity was promoted. For example, with Red Green LEDs, 'mycorrhizal development and nitrogen metabolism' increased improving the connections between the MCN and the plants. Whereas white increased the soil enzyme activities[41] which is very beneficial for nutrient cycling; the process where organic matter is converted into nutrients the plants can process. [42]</td></tr>
<tr><td>How does this resource impact the plant and its local environment.</td><td colspan="2">Light is used to regulate many of the physiological processes within plants. It is the main source of energy which is gained through the process of photosynthesis.[43] Therefore when the light decreases, so does photosynthesis. It is also a factor in 'germination, leaf proliferation and expansion', so without it the growth is slowed and stunted.</td></tr>
<tr><td rowspan="2">Visible Observations</td><td>Lack of Light[44]</td><td>Excess Light</td></tr>
<tr><td>- Dropped Leaves
- Longer & thinner stems.
- Turn from green to yellow to white.
- Fail to produce flower buds.</td><td>- Scorched & Bleached leaves
- Brittle[45]</td></tr>
</table>



Presentation

Slides



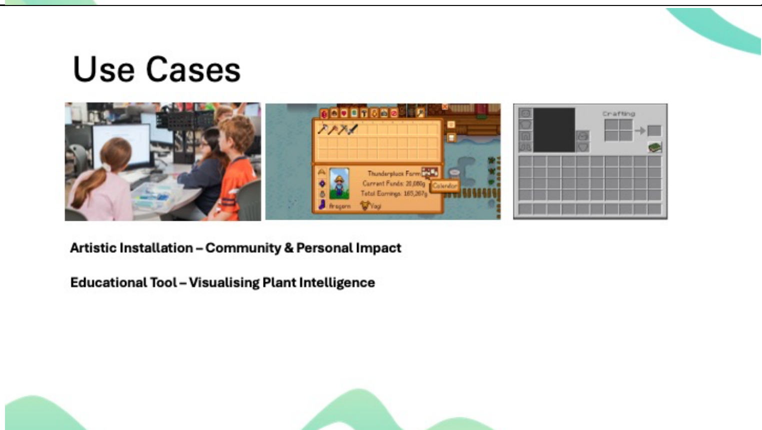


Concept & Inspiration
Our installation is designed to be a non-screen-based interactive experience. Our initial inspiration was Suzanne Simard’s "Wood Wide Web" theory from her 1997 PhD thesis. In it she described how mycorrhizal networks enable plant communication. Since then, there has been a lot of scientific debate, as a paper was published in 2023 by Justine Karst et al. where the theory was critiqued due to the citation bias and overinterpretation. But it was never fully dismissed. The idea was also compelling to us due to its parallels with network topologies, i.e. mesh networks.

Design Approach
We chose to combine bionics, robotics, and Human-Centered Interaction principles together. We want to create a microcosym simulating plant communication through visible, immersive interactions. Replicating how the CMN sends ‘messages’ and the resource sharing between plant roots.

Plant Choice & Visual Design
Whilst the theories we looked at were about trees, we chose to create flowers instead. Because they are easier to scale up for robotic modelling and allow more dynamic movement and offer greater visual variety. Installation designed as a table-like environment with robotic flowers above and illuminated "roots" below to mimic the CMN. The LEDs in the roots will light up to show when the resources are being sent between the plants.

User Interaction & Environment
The users can interact through sensors and potentiometers to control the resources in the environment. Enabling them to observe the flowers responding in real time. Enabling them to feel 'God-like' with their control.



Artistic Installation – Community & Personal Impact

1. Transforms fungal signaling into a poetic, sensory interaction using LED roots & robotic flowers which was inspired by Suzanne Simard's "Wood Wide Web" and ecological media art (e.g., Akousmaflore, Biomodd)

2. Encourages relational aesthetics and public co-creation and Fosters emotional connection through responsive behavior (e.g., dimming or wilting)

3. Reflects empathic design (Fulton Suri, 2003) and vibrant matter theory (Bennett, 2010) and supports well-being via biophilia (the idea that humans possess an innate tendency to seek connections with nature and other forms of life) and embodied cognition that acts as a mindfulness space promoting ecological empathy.

Educational Tool – Visualizing Plant Intelligence

1. Simulates Common Mycorrhizal Networks (CMNs) via interactive environmental feedback and follows constructivist and embodied learning models (Piaget, Papert, Norman)
2. Offers hands-on STEM education via robotics, design, and biology
3. Enhances learning through gamified challenges and pixel-art UI (Minecraft, Stardew Valley) and supports equitable access with modular, low-cost, screen-optional design
4. Makes hidden biological processes visible and engaging

Target Audience

Academics and researchers studying biomimicry, biohybrid systems, and communication networks.

Museum and exhibit visitors, particularly those interested in immersive experiences, will engage with the project on a sensory and conceptual level.

STEM students and educators can utilize the installation as a learning tool to explore artificial ecosystems and bioinspired computing.

Academics & Researchers

- Interested in biomimicry, biohybrid systems, and communication networks.
- Can explore the project’s relevance to scientific inquiry and technological innovation.

Artists & Designers

- Focused on interactive installations and kinetic sculptures.
- Will appreciate the project’s aesthetic value and conceptual depth.

STEM Students & Educators

- Can use the installation as a learning tool.
- Provides a platform to explore topics like: Artificial ecosystems, Bioinspired computing, Interdisciplinary innovation, etc.

Museum and Exhibit Visitors

- Attracted by immersive experiences.
- Will engage on both sensory and conceptual levels.

Environmental Enthusiasts & Technologists

- Interested in ecological intelligence and sustainable design.
- Will value the project’s focus on nature-inspired technology and environmental consciousness.

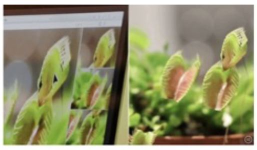
Human Computer Interaction

Biomodd Installation at Regeneration Movement, 2016 by The National Taiwan Museum of Fine Arts

Akousmaflore, ISEA 2009 / Ormeau Baths Gallery - Belfast (Ireland)

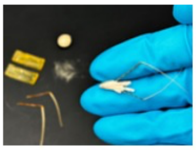
Christa Sommerer and Laurent Mignonneau, Eau de Jardin. Interactive installation. 2004

Bionics



Cyborg Botany, developed by the MIT Media Lab,

Flora Robotica



IIT's biohybrid robot

Cyborg Botany (MIT Media Lab)

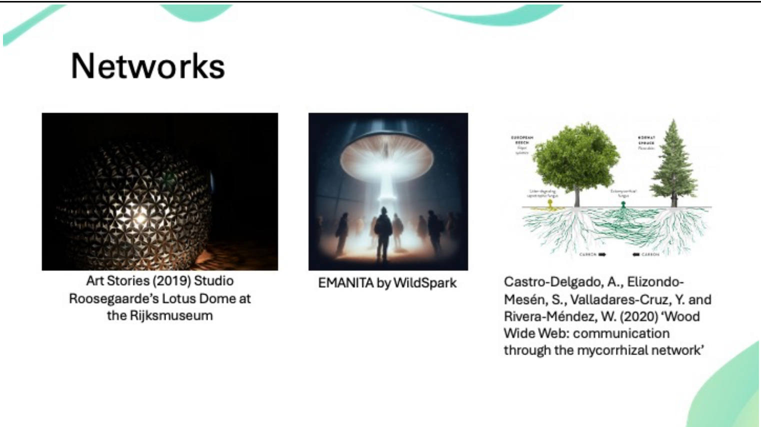
- Explores embedding sensors and electronics into living plants to create interactive systems.
- Demonstrates how plants can act as organic interfaces, functioning as both input and output devices.
- Emphasizes biohybrid systems that respond to environmental and human stimuli (e.g., touch, light, humidity).
- Highlights the potential of using natural organisms as responsive components in interactive installations.
- Supports the idea of real-time interaction, plants reacting visibly or kinetically based on user input.
- Informs our approach to bridging biological and technological interactions through embedded sensors/actuators.
- Reinforces the concept that fungi and plants can visually and physically communicate signals in an artificial system.
- Validates the use of natural interfaces as part of a larger mycelium-inspired communication network.

Flora Robotica

- Investigates plant-robot symbiosis, where each influences the other's development over time.
- Focuses on co-evolution, with robotic structures adapting to plant growth and vice versa.
- Highlights the potential of creating hybrid organisms that exhibit emergent behaviors.
- Aligns with our concept of a responsive, adaptive network, like how mycelium transmits and responds to information.
- Demonstrates the potential of self-organizing systems that evolve through interaction and feedback.
- Encourages a modular, iterative design that can grow or change over time based on stimuli.
- Reinforces the goal of developing a system that is not static but continuously adapting, like real biological networks.
- Suggests that long-term user engagement can influence the behavior or “growth” of the system.
- Offers a model for how biological and artificial systems can meaningfully interact to produce intelligent responses.

IIT's Biohybrid Robot

- Constructed from biodegradable materials like oat bran and flour.
- Exemplifies a sustainable approach to robotics, minimizing environmental impact.
- Combines soft robotics with organic substances, aligning form and function with ecological principles.
- Promotes the idea that artificial life systems should mimic both function and decomposition of natural organisms.
- Influences our material choices, encouraging organic and compostable components in our design.
- Supports the creation of eco-conscious installations that align with nature not just functionally, but ethically.
- Reinforces the message that biomimicry should include sustainability, not just biological aesthetics or mechanics.



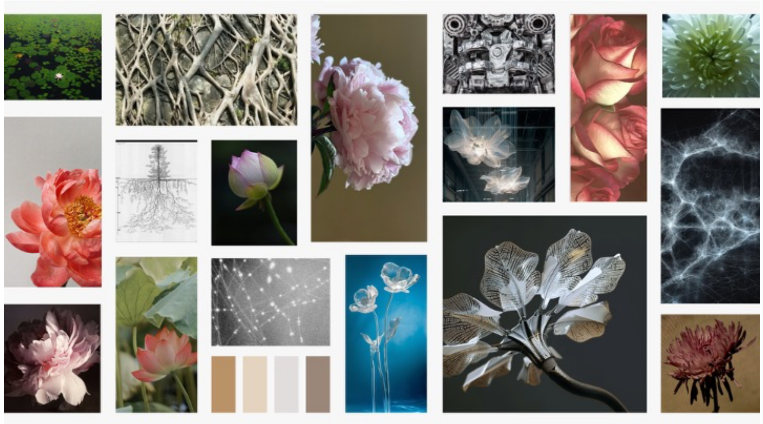
Our mechanical flower network draws conceptual and structural inspiration from a range of interactive artworks and ecological systems. Three key references were particularly influential in shaping both the technical and experiential aspects of the project:

1. Lotus Dome – Studio Roosegaarde (2012)
Lotus Dome is an interactive installation composed of hundreds of metal lotus petals that open in response to nearby movement. What particularly inspired us was the decentralized design — there is no central controller; instead, each petal responds locally, creating a ripple-like collective reaction. This model of distributed responsiveness directly informed how we designed our flowers to act not as isolated units, but as parts of a coordinated network, echoing the principles of swarm behaviour and emergent systems.

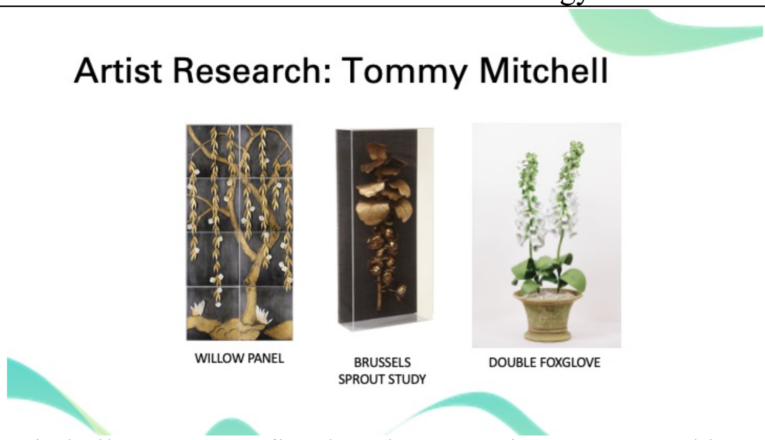
2. EMANITA – WildSpark
EMANITA is a developing installation inspired by mycelium networks, using glowing fiber strands and interactive feedback to represent the flow of information across living systems. The piece visualizes connection and communication in a poetic, biological way. This helped us think about how to represent signals (e.g., "water", "danger") traveling across our own flower system, transforming an invisible underground process into a visible, interactive experience.

3. Wood Wide Web – Castro-Delgado et al. (2020)

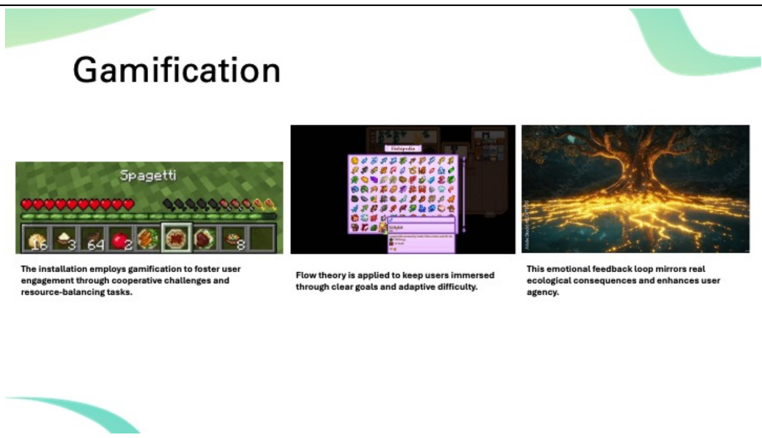
To ground our ideas in scientific understanding, we turned to research on plant and fungal communication networks. This paper outlines how trees and plants use mycorrhizal fungi to share nutrients, carbon, and even warnings about environmental stress. The paper emphasized non-linear, adaptive communication — an invisible but highly efficient underground exchange system. We drew from this logic to structure our flowers as interconnected nodes, capable of responding to shared signals in an organic and responsive manner.



Intentionally avoids the "humans vs. machines" narrative.
Aims to present both the natural and man-made worlds positively and in harmony.
Design blends natural aesthetics with mechanical elements in a creative and cohesive way.
Environment will feature a natural colour palette.
Flowers will appear metallic to emphasize their robotic, technological nature.
Visually represents the intersection of nature and technology.



Artist Tommy Mitchell creates 3D floral sculptures using copper and brass.
Some pieces are painted to look like real plants, but the unpainted, cruder pieces stood out more.
The raw metal finish emphasizes the shape and texture of the plants.
Inspired the decision to use metallic materials in your own project.
Reflects the robotic and technological aspect of your installation.



Gamification & Flow

- Gamification used to boost user engagement:
    1. Includes cooperative challenges and resource-balancing tasks.
    2. Example: Adjusting moisture or nutrients to maintain plant health.
- Real-time feedback shown through animated LED pathways tracking plant health.
- Flow theory applied:
    1. Keeps users immersed by setting clear goals and offering adaptive difficulty.
    2. Challenges escalate to maintain interest and engagement.

UI Theory & Interaction Design

- Rooted in Donald Norman's affordance theory:
    1. Interaction points (e.g. sensors, tactile plant interfaces) are intuitively designed.
    2. Users easily understand how to interact with the system.
- Incorporates feedback and feedforward mechanisms:
    1. Real-time responses shown via LEDs and movement.
    2. Users receive clear visual and tactile cues based on their actions.
- Inspired by Tangible User Interfaces (TUIs):
    1. Prioritizes physical interaction over traditional screens.
    2. Promotes direct engagement with organic and robotic elements.

Empathic Design & Emotional Engagement

- Designed with empathic design principles:
    1. Plants respond emotionally—e.g., dimming or wilting if neglected.
    2. Encourages users to care for the system, reflecting real ecological responsibility.
- Establishes a feedback loop that enhances emotional connection and user agency.
- Reinforces the ethical and relational dimensions of interacting with ecosystems.

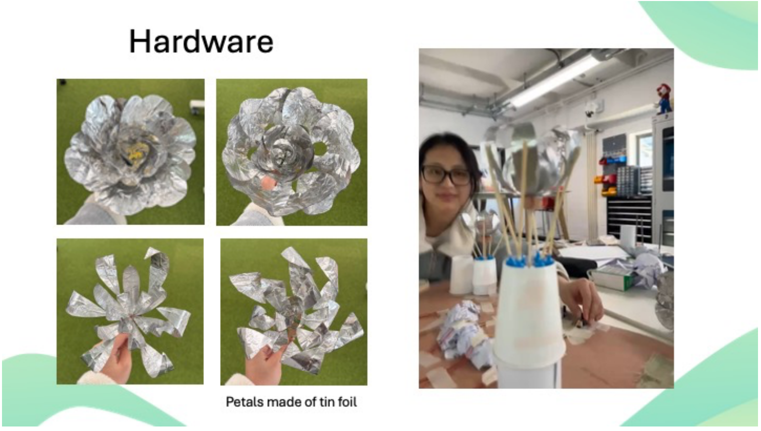
Cognitive Theories & Experience

- Based on embodied and extended cognition:
    1. Users externalize their influence on a simulated ecological system.
    2. Experience blurs boundaries between human, machine, and nature.
- Promotes a sense of integration and responsibility through physical interaction.

Pixel Aesthetic & Visual Language

- Uses a pixel-based aesthetic:
    1. References retro digital systems and early UI design.
    2. Visually mirrors the modular, node-based logic of mycorrhizal networks.

- Glowing pixel visuals turn root systems into data maps:
  1. These maps reflect plant health, resource flow, and user input.
  2. Creates a visual bridge between natural systems and digital abstraction.



Physical Construction of the Flower System
Each mechanical flower in our network follows a shared construction logic while varying slightly in size and proportion to create a more natural and diverse appearance. The system combines lightweight materials, servo-based mechanics, and manual assembly techniques to achieve responsive motion.

Structural Overview

- Every flower is built around the same core structure, with petals constructed from multiple layers of tin foil, reinforced by internal wire to maintain shape and allow for sculpting.
- These petals are individually hot-glued onto a circular disk in layered formations, enabling a volumetric, lifelike bloom.
- A servo motor is positioned at the base, responsible for driving rotational movement.
- A vertical support stick connects the motor shaft to the upper disk, transferring torque upward.

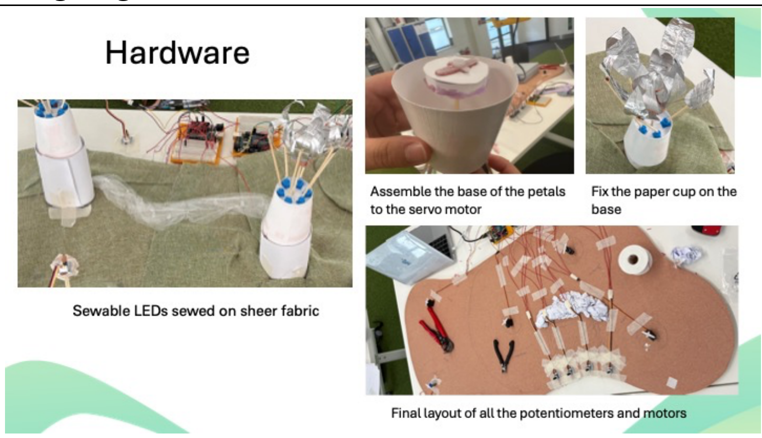
Mechanism Below the Disk

- Beneath each disk sits a paper cup, which serves both aesthetic and structural purposes — it conceals the mechanical components and holds a potentiometer used for control input or feedback.
- Universal joints are mounted to the sides of the cup, acting as pivoting connectors between the rotating disk and the flower's petal control system.
- Wooden sticks extend from these joints to the outer petals, functioning as levers to create coordinated petal motion.

Movement Logic

- As the servo motor rotates the disk, the fixed universal joints pull or release the wooden linkages, which in turn open or close the petals in a radial motion.

- By adjusting the lengths of the sticks and the diameter of the disk, we were able to vary the speed, range, and curvature of motion between different flowers — giving each one a distinct kinetic “character.”

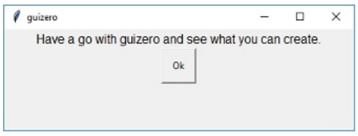


LED Integration and Root Network Simulation
To evoke the idea of underground fungal or root-like communication, we incorporated sewable LEDs into the physical layout of the installation. These LEDs are wrapped in sheer, semi-transparent fabric, which diffuses the light softly, mimicking the subtle glow one might imagine traveling through a mycelial network or root system beneath the soil.
Originally, each flower was intended to trigger a corresponding LED response. However, due to time constraints and system complexity, all LEDs were instead connected to a single potentiometer, which allowed us to demonstrate the concept of signal modulation and flow across the shared root-like structure.

Base Structure and Mounting
All elements were assembled onto a large wooden base, which served both structural and functional purposes. The base provided stability for the flowers and also allowed us to neatly embed and organize most of the electronics, including motors, potentiometers, and wiring systems.

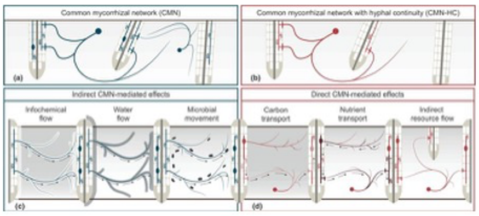
Wiring and Electronic Components
The servo motors and potentiometers for each flower were mounted directly through the base, with their shafts and knobs exposed for interaction and visual feedback. Behind the scenes, we used breadboards and jumper wires to connect all active components.
Wiring was carefully routed and labeled to minimize visual clutter and ensure easy debugging during prototyping and testing. The entire system remains modular and adjustable, allowing for further upgrades (such as per-flower LED control) in the future.

Software

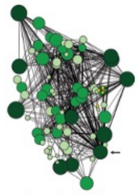


Used the guizero library to create the interface in Python for the DFRobot 7" LCD touchscreen.
The guizero library was chosen for being easy to learn and intuitive with its box-based structure.
Designed a simple user interface that can be controlled via Raspberry Pi.
Established a serial connection between Arduinos and Raspberry Pi to enable communication.
This connection allows motors and potentiometers to interact with the interface and update progress bars in real time.

The CMN

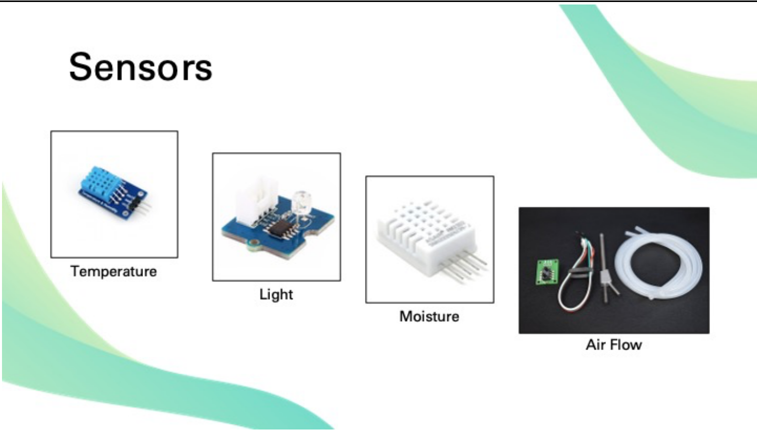


'FUNCTIONAL DIFFERENCES BETWEEN HYPHAL CYTOPLASMIC CONTINUITY AND NON-CONTINUITY— DIRECT AND INDIRECT CMN-MEDIATED EFFECTS'



A study showing individual Douglas fir were linked to other individuals, 2009

The Common Mycorrhizal Network (CMN) involves six types of activity, as shown in the diagram.
Not all activities can be represented in an interactive installation (e.g., lack of Arduino-compatible info-chemical sensors).
The installation will instead focus on plant behaviors that can be visually expressed through robotic movements.
Visual interest will be created by simulating how different environmental factors affect plant appearance.
Resources in the system are interdependent (e.g., increased airflow reduces water levels).
It’s essential to study each resource and its environmental impact—whether it's in deficit or excess—to accurately reflect interactions in the system.



TEMPERATURE

Warmer temperatures increase mycorrhizal colonization and extraradical hyphae (ERH) growth.
Mycelium efficiency halves with every 10°C drop.
Optimal temperature is crucial for effective plant communication through the CMN.
Fluctuations should stay within a 10–15°C range to avoid plant stress and disease.
Higher temperatures promote photosynthesis, respiration, and better nutrient/water uptake.

LIGHT

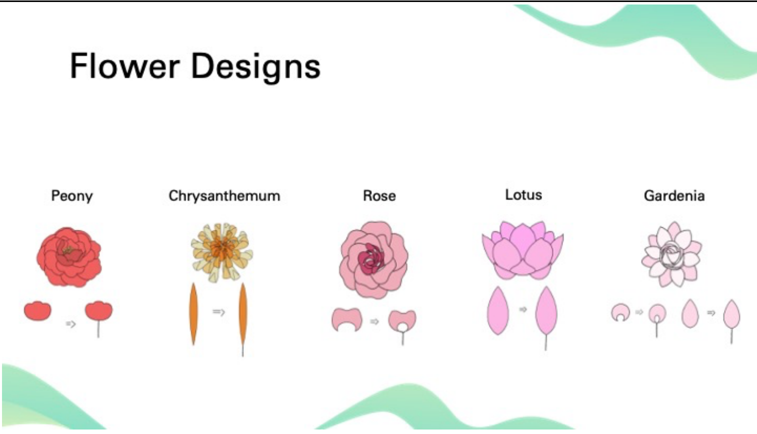
Red-Green LEDs boost mycorrhizal development and nitrogen metabolism.
White light enhances soil enzyme activity, aiding nutrient cycling.
Light is essential for photosynthesis, germination, and leaf growth.
Less light results in slower growth and stunted development.

MOISTURE

Water flows through the CMN—dehydrated plants draw more, leaving less for others.
Plants are 80–95% water; it's vital for nutrient transport and structure (turgor pressure).
Low moisture reduces photosynthesis, respiration, and transpiration.
Water helps regulate temperature and acts as a buffer against extreme heat.

AIR FLOW

Good soil aeration improves structure, biology, and nutrient absorption.
Aids sugar transport from plants to CMN, supporting fungal growth.
High airflow increases water loss, requiring more frequent watering.
Poor airflow traps moisture on leaves, increasing risk of disease and pathogen spread.



Floral Design and Variety

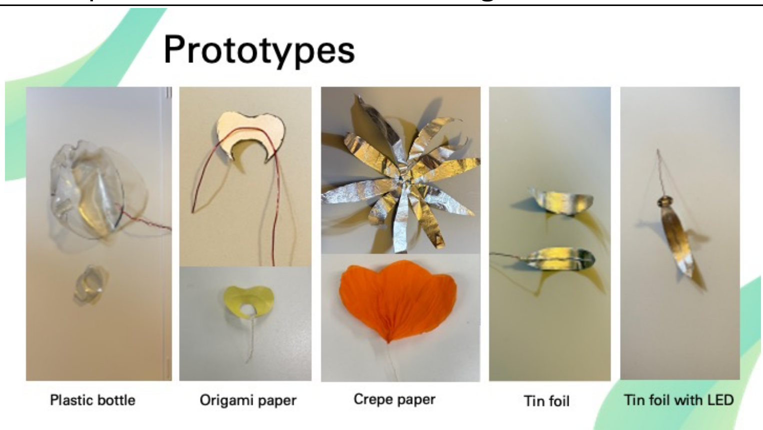
To emphasize both aesthetic richness and symbolic depth, we designed five distinct types of flowers: lotus, peony, chrysanthemum, gardenia, and rose. Each species was selected not only for its unique form and structure, but also for its cultural symbolism—evoking themes such as purity, elegance, resilience, and love.

This diversity of species reflects one of the core ideas behind our project: even within a connected system, individual identities and variations matter. By giving each flower a distinct form, we visualized how nodes in a network can be different yet still communicate and respond as a whole.

We also carefully considered visual contrast and composition. The flowers differ in:

- Size (e.g., the lotus is larger and flatter, while the gardenia is more compact).
- Petal layering (e.g., the rose features tightly curled petals, while the peony has soft, rounded layers).
- Structural complexity (some have more articulated petal movements based on the mechanics used).

To create a visually balanced installation, we arranged the flowers in a natural yet intentional sequence, spacing different shapes and sizes to avoid symmetry while maintaining harmony. The lotus, our original test flower, was placed on the far left, acting as an anchor point for the rest of the arrangement.



Material Exploration and Selection

Throughout the prototyping process, we experimented with various materials to find the most suitable one for our flower petals. Each trial helped us understand the trade-offs between weight, formability, and compatibility with servo motors.

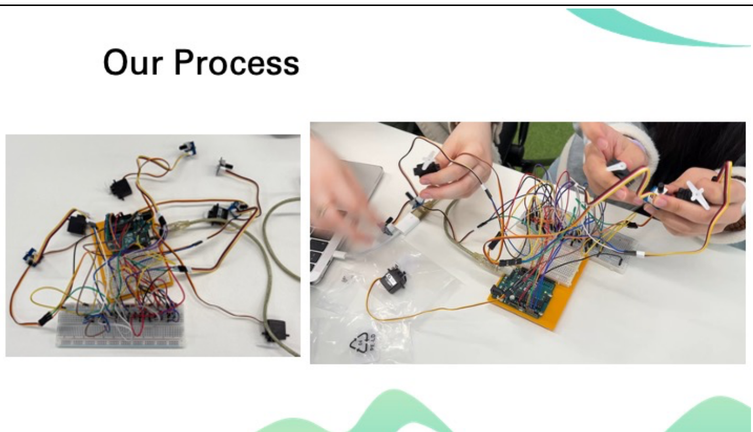
Plastic Bottle
Our first attempt used recycled plastic bottles. We cut petal shapes and softened their edges with a lighter to create organic curves. While the idea of reusing materials was appealing, the plastic was difficult to control during shaping and resulted in petals that were too heavy. This raised concerns about whether our servo motors could support the weight, and we ultimately ruled out this option.

Origami Paper + Wire
Next, we tested origami paper reinforced with internal wire. The paper was visually appealing and lightweight, but difficult to sculpt, and required a time-consuming process for each petal. Even with wire, it lacked the structural flexibility we needed and didn't provide the expressive form we were aiming for.

Crepe Paper
Crepe paper emerged as a strong candidate due to its natural texture and beautiful surface. It offered a realistic, organic feel. However, once layered for strength, it became too heavy for small motors. Although it was visually promising, it wasn't functionally feasible.

Tin Foil (Final Choice)
Eventually, we tried tin foil, which quickly proved to be the ideal material. It was lightweight, easy to mold, and retained its shape well. We created a quick prototype and found that it closely mimicked real petal structure. To improve stability and form control, we later layered the foil and inserted wire between the folds, allowing for more complex shaping while keeping the petals lightweight and servo-compatible.

Conclusion
After multiple iterations, tin foil with internal wire became the optimal material — striking the right balance between visual appeal, structural integrity, and motor compatibility.



System Integration Test

As part of the development process, we conducted a key integration test where we connected all four servo motors and four potentiometers to a single Arduino and shared breadboard setup. This was the first time we assembled the entire system together.

What We Tested

The goal of this test was to:

- Verify wiring correctness,
- Test the control code, and
- Ensure that each flower responded independently to its corresponding input.

Up until this stage, we had only tested one motor at a time, so this marked a crucial step toward a fully synchronized and functioning network of flowers.

Why It Mattered

Connecting all components simultaneously allowed us to:

- Confirm that the power supply was sufficient and stable under full load,
- Ensure that each potentiometer's signal correctly mapped to its respective servo motor,
- Identify potential signal interference or cross-wiring.

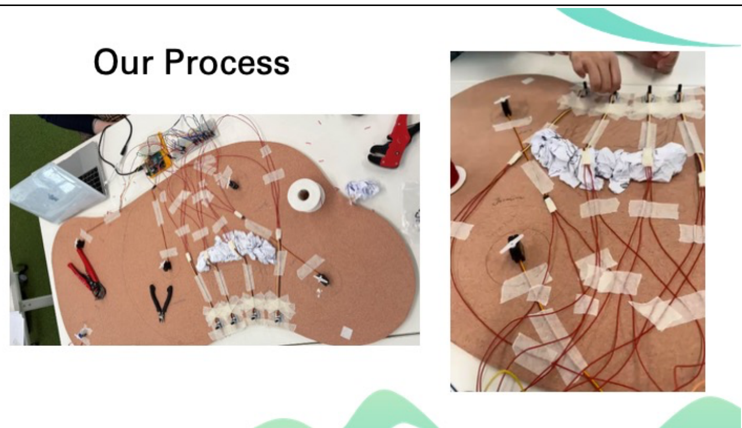
This system-level validation helped bridge the gap between isolated function tests and integrated behavior.

What We Learned

Through this test, we:

- Discovered and resolved several wiring mistakes,
- Adjusted the range of motion parameters in our code to better fit the physical limits of each flower,
- Realized the importance of clean and organized wiring, especially since much of it would later be hidden beneath the wooden base.

This test was a pivotal step in preparing the system for final assembly and public presentation.



Final Assembly and Wiring Management

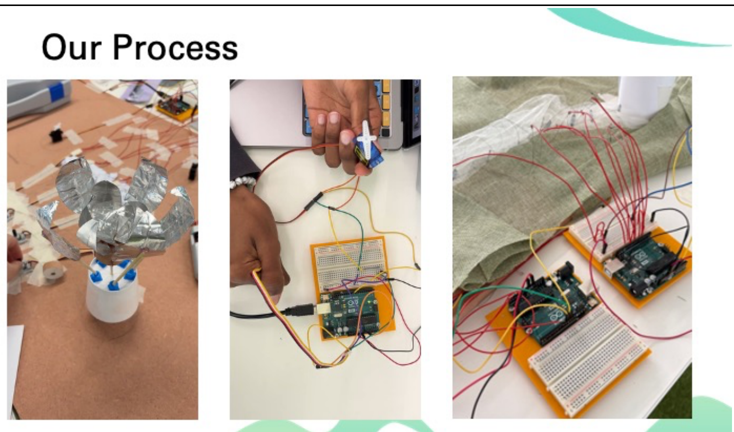
What We Did

Following successful circuit testing, we proceeded to the final installation phase. This involved securely mounting all servo motors and potentiometers onto the wooden base platform. Positioning was carefully considered to ensure mechanical functionality while maintaining accessibility for adjustment and maintenance.

Wire Management
Once the components were fixed in place, we focused on organising and securing the wiring beneath and around the base. This step was essential for several reasons:

- Ensuring a clean and professional presentation,
- Preventing short circuits and accidental disconnections,
- Allowing the system to be safely transported and repositioned without disturbing the electrical setup.

By using zip ties, labeling wires, and routing them carefully along the base's underside, we created a tidy and robust foundation for the project's final demonstration.



Motion and Interaction Testing
As we approached the final phase of assembly, we conducted a series of functional tests to ensure each component — mechanical, sensory, and visual — performed as intended. These tests were essential to validate real-world responsiveness, motion smoothness, and signal simulation across the system.

Motor + Flower Movement Test
We began by attaching the final flower structures to the servo motors to observe their full range of motion. This test helped us assess:

- Whether the servo torque was sufficient to support the weight and shape of each flower,
- How smoothly the petals opened and closed based on the internal mechanics,
- The need to adjust motor angles in code to ensure consistent, natural motion without overextension or strain.

This step was crucial in transitioning from theoretical structure to dynamic, working forms.

Light Sensor Test
To explore environmental interaction, we tested the Grove light sensor with a simple conditional code:

- When light is detected, the motor rotates the flower to an open position.

- When it becomes dark, the flower closes.

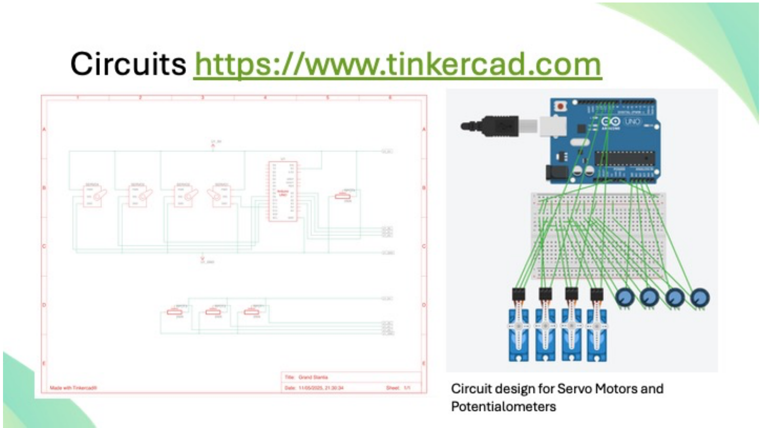
This created a basic yet effective form of light-responsive movement, allowing viewers to interact using a flashlight or hand shadow.

Sewable LED Test

We also completed testing of the sewable LEDs, which had been stitched into sheer fabric to simulate mycelium or root signals. The LEDs were connected to a separate potentiometer and programmed to:

- Illuminate sequentially as the knob turned clockwise,
- Turn off in reverse order as the knob turned back.

This behavior visually represented signal propagation through the root-like network, reinforcing the idea of distributed communication among the flowers.



Circuit Design and Wiring Logic

To better understand and plan the system, we created a circuit diagram using Tinkercad to visualise how all the servo motors and potentiometers would connect to the Arduino. This diagram was an essential reference during both the prototyping and troubleshooting stages.

What This Diagram Shows

The diagram illustrates the connection of:

- Four potentiometers to the Arduino's analog input pins (A0 to A3),
- Four servo motors to the Arduino's digital PWM output pins (D9 to D12).

Each potentiometer reads an analog value (0–1023), which is then mapped in the Arduino code to a servo angle between 0 and 180 degrees, allowing for precise control of petal movement.

Connections Explained

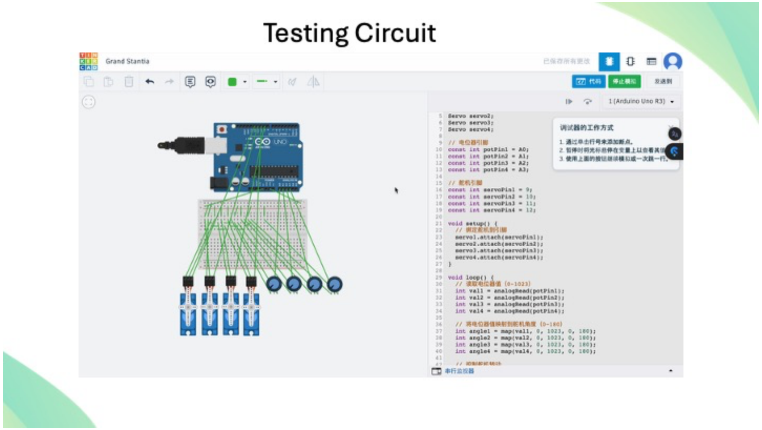
- Potentiometers serve as input devices, allowing users to manually control the position of each flower.
- Each servo motor receives a PWM signal from the Arduino based on the mapped potentiometer reading, which drives the motor to the correct angle.
- This setup allows independent control of each flower, while still using a single Arduino board.

Power and Layout

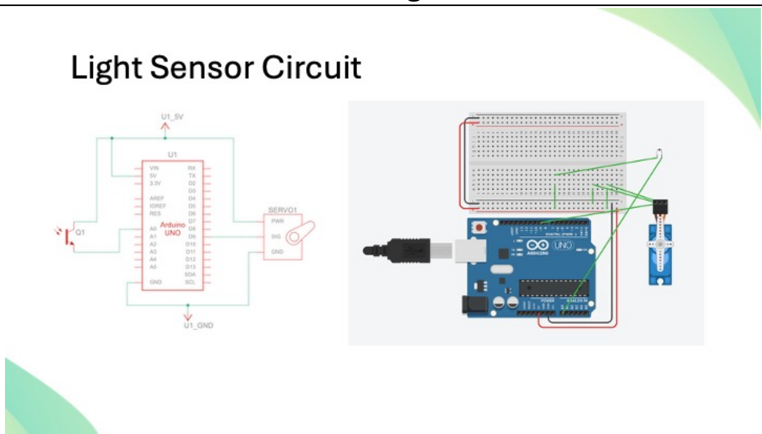
All components share a common 5V power line and GND connection, routed via the breadboard. This streamlined layout ensured:

- Stable power distribution
- Simplified debugging
- A clean, organized structure during physical assembly.

The Tinkercad simulation allowed us to verify our logic and layout before physically building the system, saving time and reducing wiring errors.



Test video demonstrating the circuit in action



Light Sensor Circuit for Reactive Flower Movement

To introduce environmental interaction into the system, we designed a dedicated circuit using a light sensor to control the servo motor of one specific flower — the rose. This flower responds not to a manual input like a potentiometer, but to ambient lighting conditions.

What This Diagram Shows

The accompanying circuit diagram illustrates how the light sensor is connected to the Arduino and used to drive a servo motor. This simple but effective setup enabled us to experiment with automatic movement based on environmental light levels.

How It Works

- The Grove light sensor is connected to analog pin A0 on the Arduino.
- The analog reading from the sensor (ranging from 0 to 1023) is mapped to a servo angle between 0 and 180 degrees.
- For our exhibition setup, we reversed the logic:

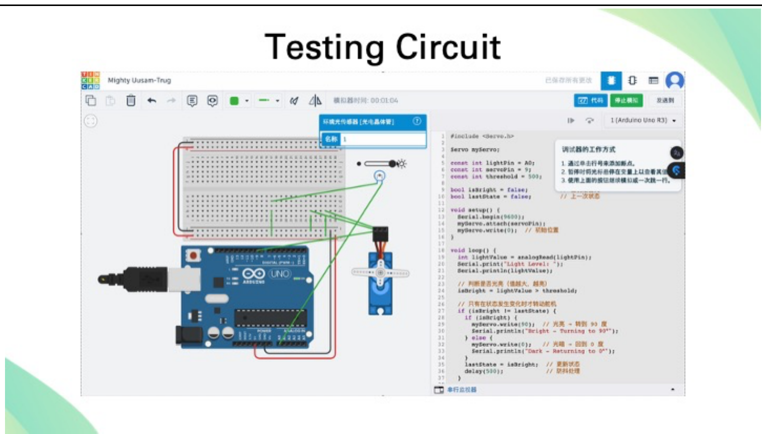
- In bright light, the flower closes,
- In darkness or shadow, it opens.

This inversion was intentional — the exhibition space had constant ambient lighting, so reversing the logic made it easier to demonstrate interaction using a flashlight or by casting shadows.

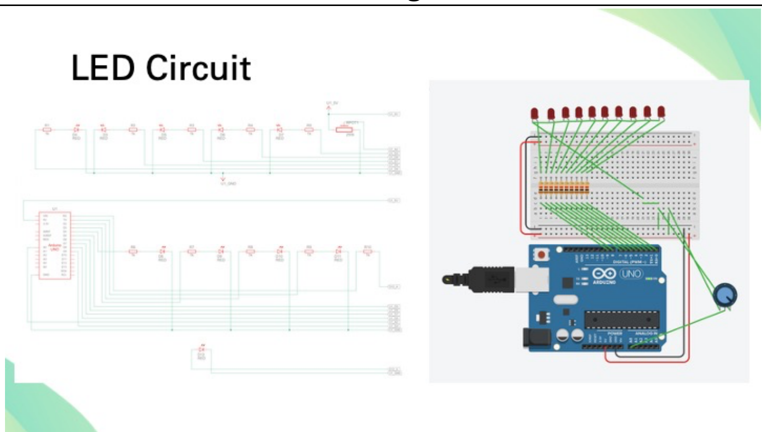
Other Components and Wiring

- The servo motor is connected to a PWM-capable digital pin (such as D9).
- Both the light sensor and the servo motor receive 5V and GND through the breadboard, powered directly by the Arduino.
- The layout was kept compact and modular, allowing quick adjustments during testing.

This light-driven interaction added another layer of autonomous behavior to the system, showcasing how environmental input could trigger lifelike, reactive movement in the mechanical flowers.



Test video demonstrating the circuit in action



LED Root Signal Simulation Circuit

To visually simulate information flow through a mycelial or root-like network, we developed a simple circuit using sewable LEDs embedded in sheer fabric. These LEDs were programmed to light up progressively, controlled by a single potentiometer, echoing the idea of signals traveling underground between plants.

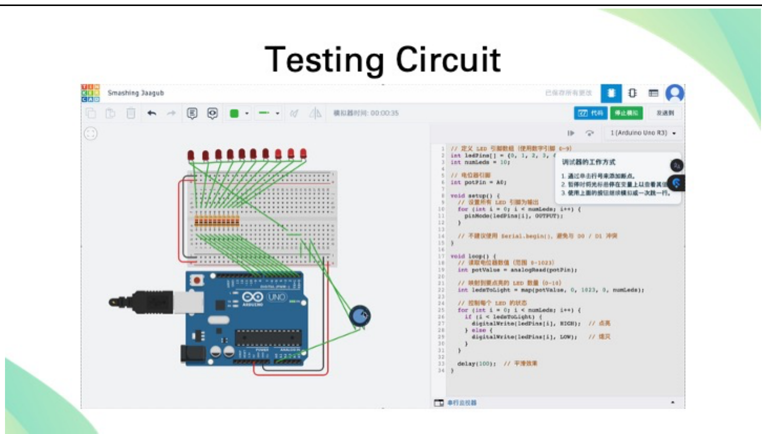
What This Diagram Shows

The circuit diagram illustrates how we connected a series of sewable LEDs to the Arduino, with each LED individually addressable via a digital pin. A potentiometer, acting as an input dial, allowed us to manually control the flow of this "signal." This system was both a functional lighting test and a symbolic visualization of networked biological communication.

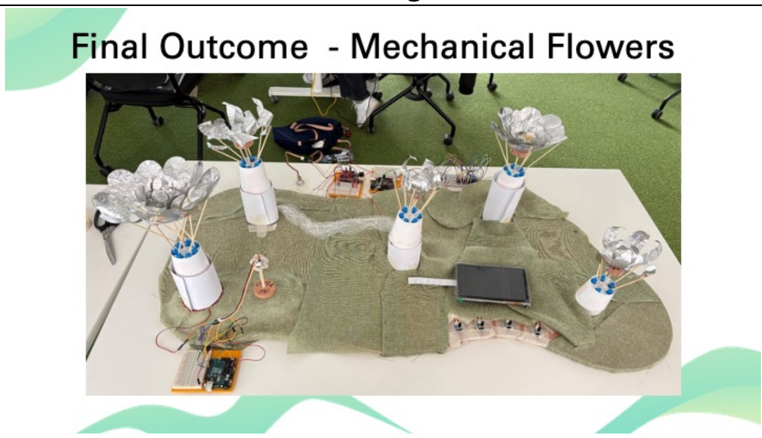
How It Works

- The potentiometer is connected to analog pin A0 on the Arduino.
- Each sewable LED is wired to an individual digital pin (e.g., D0 to D9).
- In the code, the analog reading from the potentiometer is mapped to **the number of LEDs that should be lit:**
- As the knob turns clockwise, LEDs light up one by one.
- When turned counterclockwise, the LEDs turn off in reverse order.

This behaviour created a flowing light sequence, visually evoking the movement of signals or nutrients through interconnected roots or fungal threads beneath the surface.



Test video demonstrating the circuit in action



Built a platform to separate user-controlled plants (via potentiometers) from the rose (controlled by a light sensor).
Covered the platform with green fabric to emulate a natural environment.
Used layered fabric sections instead of a single piece to avoid interfering with motor movement.
Considered 3d printing potentiometer covers to enhance user interaction but couldn't implement due to time constraints.

Final Installation Overview

The final version of our mechanical flower network brings together structure, interactivity, and environmental responsiveness into a single cohesive installation. All five flowers are securely mounted on a custom wooden base, with the full circuitry and physical system integrated beneath the surface.

What This Shows

This stage represents the completed system, where every component — from mechanical linkages to LED signal pathways — works in harmony. The project demonstrates how simple inputs can lead to complex, responsive behaviours across a network of interactive elements.

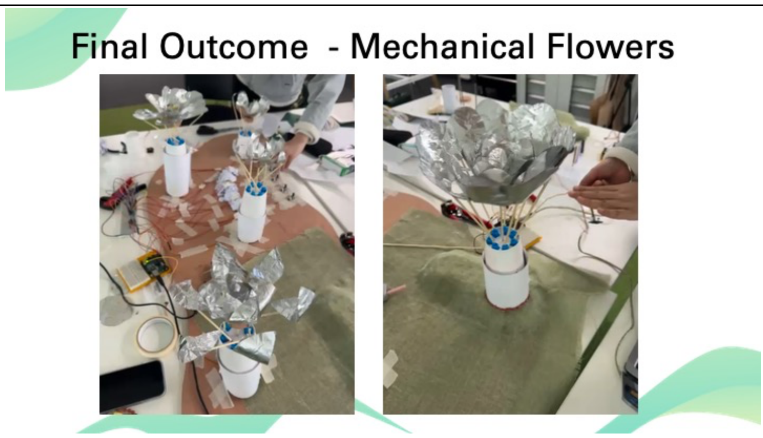
Key Features

- The installation showcases five distinct flower types (lotus, peony, chrysanthemum, gardenia, and rose), each with its own shape, size, and symbolic reference — yet all sharing the same mechanical foundation.
- Four flowers are individually controlled by rotary potentiometers, allowing users to manually open and close petals in real time.
- The fifth flower (the rose), located on the far side, is light-reactive, opening and closing based on ambient brightness detected by a light sensor.

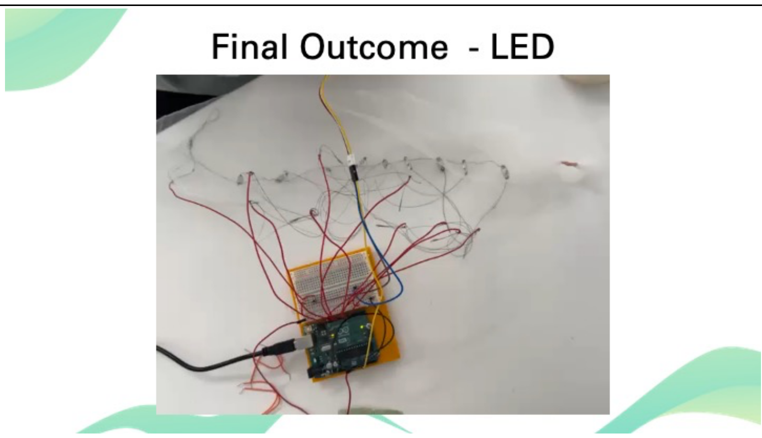
Visual & Interactive Elements

- A series of sewable LEDs, stitched into sheer fabric along the base, simulate mycelial or root signal transmission. These LEDs are controlled via a central potentiometer and light up in sequence, visually representing how signals travel through an organic network.
- A digital display (or screen output) shows real-time readings from the potentiometers, symbolizing changing environmental conditions — such as simulated sunlight, water levels, or stress signals — as perceived and responded to by the network.

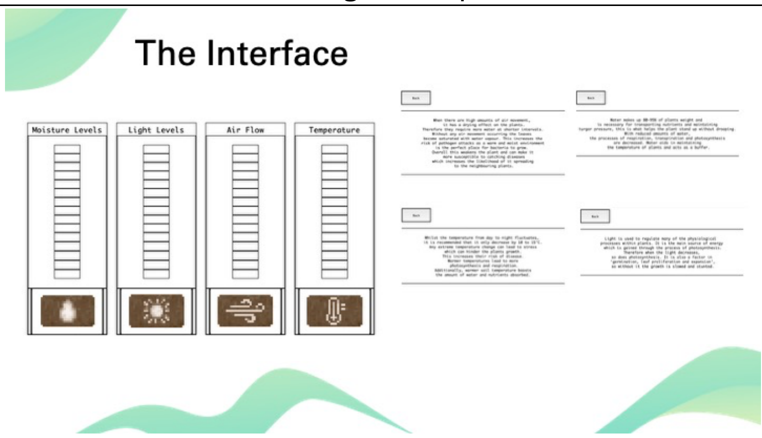
This final arrangement combines modular interactivity, biologically inspired design, and symbolic aesthetics, demonstrating how interconnected systems — whether natural or artificial — can communicate through responsive, distributed behaviours.



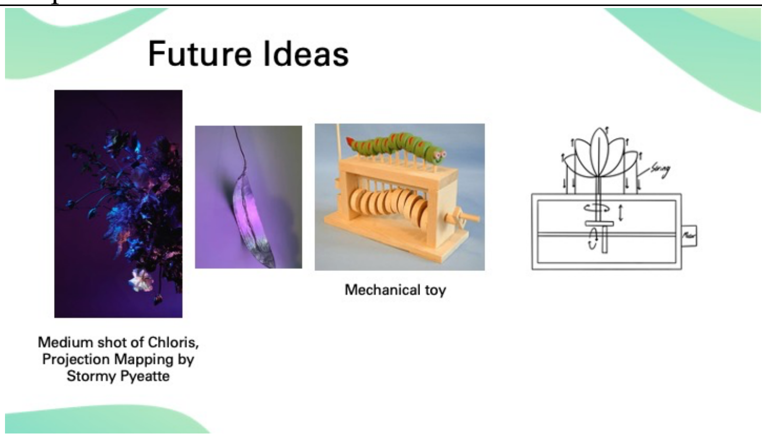
Test video demonstrating the mechanical flower in action



Test video demonstrating the sequential LED in action



The Initial interface concept was a pixelated aesthetic, inspired by Minecraft and Stardew Valley. However the final design only kept the pixel style for the buttons; whereas the rest had a minimalist layout. This ensured that the information was clear to understand and that the users attention was focused on the flower movements and LEDs. Whilst we managed to successfully send the potentiometer position data from the Arduino to the Raspberry Pi, we haven't calibrating the interface so that progress bars changed when the potentiometers turned.



Future Improvement: Cam-Based Flower Mechanism

Stormy Pyette Transforms floral arrangements into dynamic visual pieces using projection.
Utilizes custom animations and effects via Adobe Light form to create otherworldly scenes.

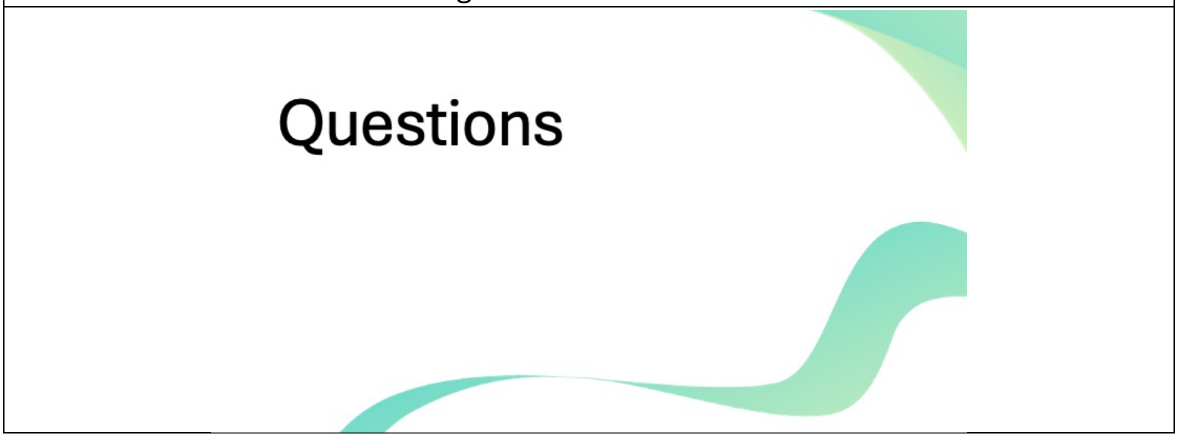
In our project, the projection could show decay, colour changes, and other resource-driven effects on the flowers for added depth.

Inspired the idea of enhancing robotic flower movements (e.g., opening/closing) with visual projections.
In future iterations of this project, we plan to explore a more stable and durable mechanical structure by adopting a cam-driven system, inspired by traditional wooden automata.

This improved design would use a camshaft with an eccentric disk to generate reciprocating motion. As the cam rotates (powered by a side-mounted motor), it would push the central flower stem upward. Strings attached to the petals would then be pulled in the opposite direction, creating a smooth opening motion as the center rises and the petals stay momentarily in place.
By relocating the motor to the side (where a crank handle would traditionally be), we can reduce the strain caused by weight imbalance and improve rotational efficiency.
This mechanism takes inspiration from historical cam-based automata systems (Reuleaux, 1876; Gearing, 2019) and offers several benefits:

- Stronger mechanical reliability
- Better alignment under repetitive motion
- Reduced stress on servo joints

We believe this approach could provide a more sustainable and scalable solution for future interactive flower designs.



Future Improvement

After completing the final installation, we were pleased with how the system worked both visually and mechanically. However, during testing and prolonged operation, we identified some structural weaknesses and began to explore ways the design could be improved.

Structural Observations

- The hot glue used to fix the wooden stems to the flower heads worked initially but proved unstable under repeated movement.
- As the servo motors rotated, especially at higher torque, the glued joints would sometimes loosen or detach, and over time, minor mechanical wear became visible in the flower structures.
- The positioning of the motor (directly beneath the flower shaft) also presented a balance issue, since the flower's weight is top-heavy, the motor required more force to turn, reducing efficiency and causing strain.

Future Idea: Inspired by Mechanical Toys

To address these issues, I began looking into mechanical automata, especially traditional wooden mechanical toys. One particularly inspiring example is the cam-driven caterpillar toy, shown below:

A mechanical caterpillar toy[1]

This example is a toy that uses a camshaft with eccentric disks to animate a caterpillar figure. As the cam mechanism rotates, the eccentric cams drive vertical rods up and down, producing a smooth reciprocating motion that mimics the undulating body of the creature — a motion style frequently seen in mechanical automata[2].

This design, based on rotary-to-linear conversion and controlled by a crank handle, demonstrates the principle of reliable mechanical motion that has been used in

[1] Pinterest (n.d.) *Mechanical toy ~ Everything You Need to Know with Photos*. Available at: https://www.pinterest.com/pin/mechanical-toy-everything-you-need-to-know-with-photos–649503577521536224/ (Accessed: 11 May 2025)

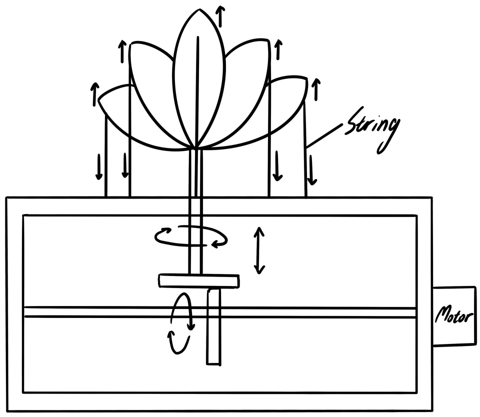
[2] Reuleaux, F. (1876), p. 45 *The Kinematics of Machinery: Outlines of a Theory of Machines*. London: Macmillan

automata for centuries[3]. Unlike servo-based digital systems, it reduces stress on joints and avoids electronic failure, making it a compelling reference for a more robust and repeatable flower mechanism.

Such systems are rooted in classical mechanical design and are still widely used today in kinetic sculptures and artistic automata[4].

Proposed New Mechanism

Inspired by this concept, I designed a new mechanism (see sketch below) that modifies the way flower petals open:



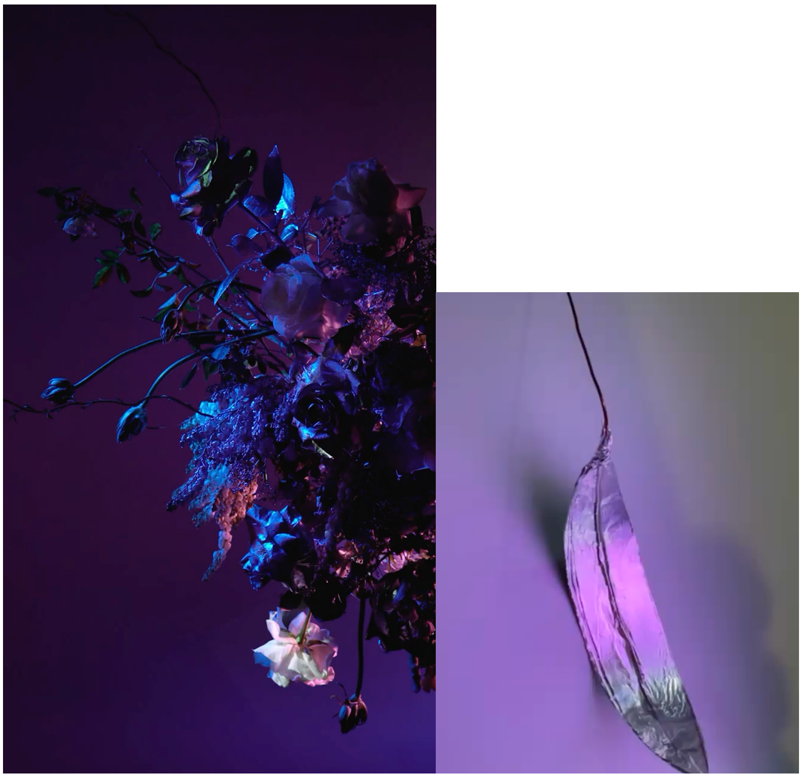
How it works:

1. A single cam disk is used instead of multiple cams, as we only need to control one flower.
2. The centre stem of the flower is connected to this cam and moves vertically as the cam rotates.
3. Strings are attached from the petals to a fixed base. As the flower centre moves upward, the strings pull the petals downward, creating the illusion of the flower opening.
4. The motor is repositioned to the side (where the hand crank would be), similar to traditional toys. This placement improves balance and torque efficiency compared to the original bottom-mounted design.

This system has the potential to offer a more stable, low-friction, and durable interaction model while staying true to the flower's responsive behaviour.

If this project is further developed, I would explore integrating this cam-based mechanical structure with sensor input and microcontroller control, combining digital interactivity with robust analogue movement.

[3] Gearing, M. (2019), p. 42 *Cabaret Mechanical Movement: Understanding Movement and Making Automata*. London: Cabaret Mechanical Theatre
[4] Sclater, N. and Chironis, N. (2001), p. 162 *Mechanisms and Mechanical Devices Sourcebook*. 4th ed. New York: McGraw-Hill



Medium shot of Chloris, Projection Mapping by Stormy Pyeatte[5]

We explored reflecting light onto the tin foil petals during our initial prototypes. If we had more time, we would have incorporated projection mapping, drawing inspiration from the artist Stormy Pyeatte. In her project, Lucid Suspensions, she transforms floral arrangements into dynamic pieces. By playing around with custom animations and effects from Adobe Lightroom, she creates these otherworldly scenes. This ethereal aesthetic and the movement of the flowers create interest, drawing in the viewer's attention; it feels surreal.
It evokes dreamlike imagery reminiscent of Lewis Carroll's Alice in Wonderland.[6] If we were able to apply it to our project, we would use it to complement the mechanical movements of the flowers. It could represent the physical changes of the flowers based on the effects of the resources. For example, with excess temperatures, the plant will begin to 'wilt, discolour and have leaf & branch burn'. Therefore, by projecting shades of brown and patches of decay, it will be easier for the user to understand what is happening to the flower. Whether they are seeing an excess or a lack of resources. This would enhance the educational aspect of our outcome. Enabling viewers to gain a better understanding of how plants live and how to keep them alive.

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[5] *LUCID SUSPENSIONS PROJECTION ART — stormy pyeatte* (no date) *Stormy.digital*. Available at: https://stormy.digital/LUCID-SUSPENSIONS-PROJECTION-ART (Accessed: May 13, 2025)

[6] Wikipedia contributors (2025) Alice's Adventures in Wonderland, Wikipedia, The Free Encyclopedia. Available at: https://en.wikipedia.org/w/index.php?title=Alice%27s_Adventures_in_Wonderland&oldid=1284541297. (Accessed: May 13, 2025)

Final Reflections

Coco

This project has been a deeply rewarding exploration of the intersection between biology-inspired design, interactive technology, and hands-on prototyping. From the initial concept to the final installation, we aimed to simulate the quiet intelligence of plant and fungal communication, using mechanical flowers as a metaphor for interconnected systems.

What Went Well

One of the biggest successes was our ability to translate abstract concepts, like mycelial networks and decentralised communication into a physical, interactive form. The combination of servo motors, LED lighting, and sensor input allowed us to create flowers that not only moved but also responded to environmental cues or user interaction. The iterative material testing, especially with tin foil and internal wire, helped us achieve the right balance between visual aesthetics and mechanical feasibility.

I also learned to work across disciplines: incorporating Arduino programming, circuit design, material crafting, and even 3D printing to bring our ideas to life. The project pushed us to refine both our technical problem-solving and our creative thinking.

Challenges We Faced

There were many challenges. Structurally, early versions of the flower mechanism were unstable, hot glue joints loosened under stress, and the power of servo wasn't always sufficient. In future I will exploring mechanical toy principles, particularly cam mechanisms and pivoting rod systems, which led to several promising prototypes.

On the electronics side, integrating multiple motors and potentiometers on one board introduced wiring complexity, which taught me the importance of clean circuit design and power management. Working with 3D-printed universal joints also proved difficult: early models were too small and fragile, while later ones required precision assembly that was not practical for scaling.

What I Learned

This project taught me that prototyping is rarely linear, it is full of trial, error, and surprising discoveries. We learned to approach problems from multiple perspectives, whether through mechanical redesign, code adjustments, or material substitutions. It also reinforced the value of modularity by breaking the system into flexible parts (flowers, sensors, LEDs), we could test and iterate more freely.

Working closely with Jocelyn and Omar throughout this project also taught me a lot about effective collaboration.

From Jocelyn, I learned the importance of clear structure and planning, her ability to organise our documentation and consistently record our meetings kept the project grounded and on track. Her attention to detail and commitment to maintaining a coherent narrative across all sections inspired me to be more methodical in my own work.

Omar contributed to areas like target audience research and gamification, which helped me consider how to make our installation more engaging and accessible. Working with him reminded me that even small elements of interaction like how people experience feedback or feel involved, can shape how a system is perceived.

Future development

If I am going to continue this project, I would:

- Refine the mechanical flower mechanism using a more stable cam-based system.
- Optimise for lighter, scalable structures using improved materials.
- Further explore the LED root signal visualisation with more synchronised or sensor-driven behaviours.
- And potentially integrate wireless or networked communication to simulate more complex, plant-like "intelligence."

Jocelyn

What went well

I liked the way we were able to combine technology and nature cohesively. Our installation featured four different points of interaction: the potentiometers, the light sensors, the LEDs and the screen. The movement of the flowers changed well, making it clear when they were opening and closing. All aspects were visually appealing, strengthened by the robotic aesthetic of the flowers. Communicating to the users the importance of every resource in the environment and how the common mycorrhizal network connects them all.

What You Would Do Differently?

If I were to do this project again, I would have begun developing our outcome earlier. Whilst we started developing the prototypes early on, we didn't implement them until the final couple of weeks before our deadline. This meant that when we faced difficulties with assembling the flowers, it was harder to connect the motors to the flowers than we initially thought. Therefore, we had to spend more time building them and connecting the wiring than expected. Additionally, the foam we ordered never arrived, leading to us improvising how to create depth on the board. leaving us less time to spend on decorating it, which meant it wasn't aesthetically pleasing.

What I learned?

Working in a team setting meant that I took a slightly different approach to this project. I had to ensure that for every step of the development, I was communicating with my teammates. It was an interesting experience as every member brought a different skill set. I admired how Coco developed the designs for the mechanical flowers, incorporating servo motors, 3d printed joints and handcrafted petals. Whereas Omar brought in a more theoretical angle, defining which concepts aligned with our vision and how we could use both philosophical and psychological approaches. Considering this, we learnt how to allocate tasks that suited our strengths and follow a chronological-based methodology.

Further Developments

If we had more time, I think that we could have experimented with using a wider variety of sensors. Changing the types of interaction will make it more interesting. To make the experience more coherent, we could integrate the effects of all the resources at different levels rather than just demonstrating either of the extremes. This way it would realistically simulate the effects. Making the experience more educational and beneficial for the users' learning.

Omar

This project has been a multifaceted journey that deepened my technical, conceptual, and collaborative skills across both hardware programming and interdisciplinary design. One of the most rewarding aspects of this project for me was how it merged ecological theory with tangible human-computer interaction. I focused on developing the insights from philosophy of mind, such as Clark and Chalmers' (1998) Extended Mind thesis and embodied cognition, which argues that intelligence is distributed across body-environment systems. This helped frame the project as more than a visual installation and it was a hybrid cognitive experience, in which the user, system, and ecological metaphor co-evolved. I also studied gamification theory, integrating feedback loops and emotional resonance (via empathic design) to ensure users cared about their "plants." Inspired by nostalgic UIs like *Stardew Valley* and *Minecraft*, we leaned into a pixel-art aesthetic to frame the interface as simultaneously educational and emotionally engaging. I gained an appreciation for spatial sequencing—how flower size, position, and LED flow direction affect both readability and user immersion. For instance, flowers were organized from smallest to largest, from edge to centre, creating a natural focal progression that mimicked ecological hierarchies. Materials like foam, tulle, and wire mesh were selected for specific tactile and visual qualities, and I learned how material design impacts user perception as much as the tech underneath.
The LED pathways, representing mycelium-inspired signalling, were initially constructed and planned to be using Neo Pixel LEDs, controlled via Arduino, from which I learned how to use Adafruit's Neo Pixel library, experimenting with different patterns and light behaviours that could visualise environmental changes in real time. This process involved testing resistor voltages, debugging ground loop errors, and calibrating potentiometer values to get accurate data flows. Planning to integrate these LEDs into water-soluble embroidered "roots" added another layer of complexity, but it gave the piece a biomimetic texture and an organic aesthetic that aligned with the overall concept and although we weren't able to go through with that idea I was still able to get great amounts of valuable knowledge of different fabrics and potential weaving methods and of course the sewing induction I was able to have also equipped me with machine skills that I was previously unfamiliar with.

I learned a great deal from my teammates, particularly regarding installation design and motor application. Jocelyn and Coco developed the layout logic for the board, flower creation and petal detailing and how to set up serial communication between the Raspberry Pi and the Arduino. Installing the Arduino IDE on the Raspberry Pi, configuring USB permissions, and establishing stable two-way communication using PySerial was a foundational step in synchronizing real-time sensor inputs with Python-controlled outputs. The GUI was prototyped with the Guizero Python library, and the design was informed by affordance theory and tangible interface principles (Norman, 1988). This supported a non-screen-based, intuitive design that prioritized sensory feedback and embodied interaction and helped me understand how to bridge gaps between the systems and evoked new ideas for my own personal endeavours.

Equally significant to my personal developments, I was also introduced to Tinker cad circuit planning from my teammates, which proved helpful in visualising wiring diagrams and testing resistor configurations for the LEDs. It was through this hands-on collaboration that I began to see the value of rapid prototyping, not just as a technical method but as a shared language between hardware and visual design teams.
In conclusion, this project broadened my understanding of how ecological models, psychology, technology, and art can be combined into a responsive, immersive system. It taught me the importance of cross-disciplinary communication, the nuance of nonverbal feedback design, and the power of collaborative prototyping. It challenged me to think critically about interaction, how it feels, how it works and how it communicates values beyond the screen.

If I was to continue with this project I would hope to expand on the set design, making the installation more immersive through more life-like flowers that still maintain their bionisism but simultaneously act within their scene, ie: set having natural scent diffusers, moss and soil being more well laid out and overall aesthetic being elevated to an even higher natural degree to counter reflect the bionic flowers and fungi for more user impact during the interaction. Furthermore, I do believe with more time and resources the LED NeoPixels alongside water soluble weavings could refine the vision better, enhancing the tangibility and boundaries between organic and synthetic life.