RADICAL ECOSYSTEM

A BIO-HYBRID SYSTEM WHERE PLANT SIGNALS SHAPE TECHNOLOGICAL BEHAVIOUR.

FABRICADEMY 2026 FINAL PROJECT CARLOTTA PREMAZZI, HYBRIDASTUDIO

Fabricademy Final Project Thesis

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Radical EcoSystem

Bio-Hybrid Systems and Plant-Driven Technological Behaviour

Radical EcoSystem proposes a decentralisation of agency in technological systems, where biological signals are not reduced to data but operate as drivers of behaviour.

Through this shift, the project repositions plants as active participants within a shared techno-biological environment.

This thesis follows the development of Radical EcoSystem from conceptual motivation to technical implementation:

WHY
▼
THEORY
▼
HOW IT WORKS
▼
HOW IT WAS BUILT
▼
HOW IT WAS TESTED
▼
HOW IT IS EXPERIENCED
▼
REFLECTION
▼
CONCLUSION
▼
TECHNICAL DETAILS

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Bio-HybridSystemsand Plant-Driven Technological Behaviour
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Abstract

RadicalEcoSystem is a bio-hybrid installation that investigates how plant activity can influence the behaviour of technological systems. While contemporary plant–technology interactions are often based on monitoring, optimisation and control, this project proposes an alternative approach in which plant signals become active drivers of system behaviour.

The installation integrates a living plant, human physiological input and a soft robotic artificial flower into a responsive ecosystem. Soil moisture and plant bioelectrical activity define the baseline conditions of the system, while human heartbeat introduces transient rhythmic variations. These inputs are translated into pneumatic movement, LED modulation and generative sound.

The system operates through behavioural transformation. Plant activity does not simply trigger predefined responses; it modulates the temporal and expressive qualities of the installation. Behaviour emerges from the interaction between biological variability, material response and technological processes.

By repositioning plants from monitored entities to active participants, **Radical EcoSystem** contributes to a broader investigation of Human–Plant Interaction, bio-hybrid systems and more-than-human design. It proposes a shift from control-oriented infrastructures toward relational environments where living and artificial systems affect one another through shared signals.

Keywords

GENERAL KEYWORDS: Bio-hybrid systems; Human–Plant Interaction; biosignals; plant agency; soft robotics; responsive ecosystem; more-than-human design

MOOD KEYWORDS: Immersive; multisensory; meditative; symbiotic; organic; sensitive; transformative.

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I would also like to thank Marco Accardi for the conversations and possible future developments around the sound dimension of the project, and all the people who supported this work through discussions, feedback and shared time.

1. Introduction

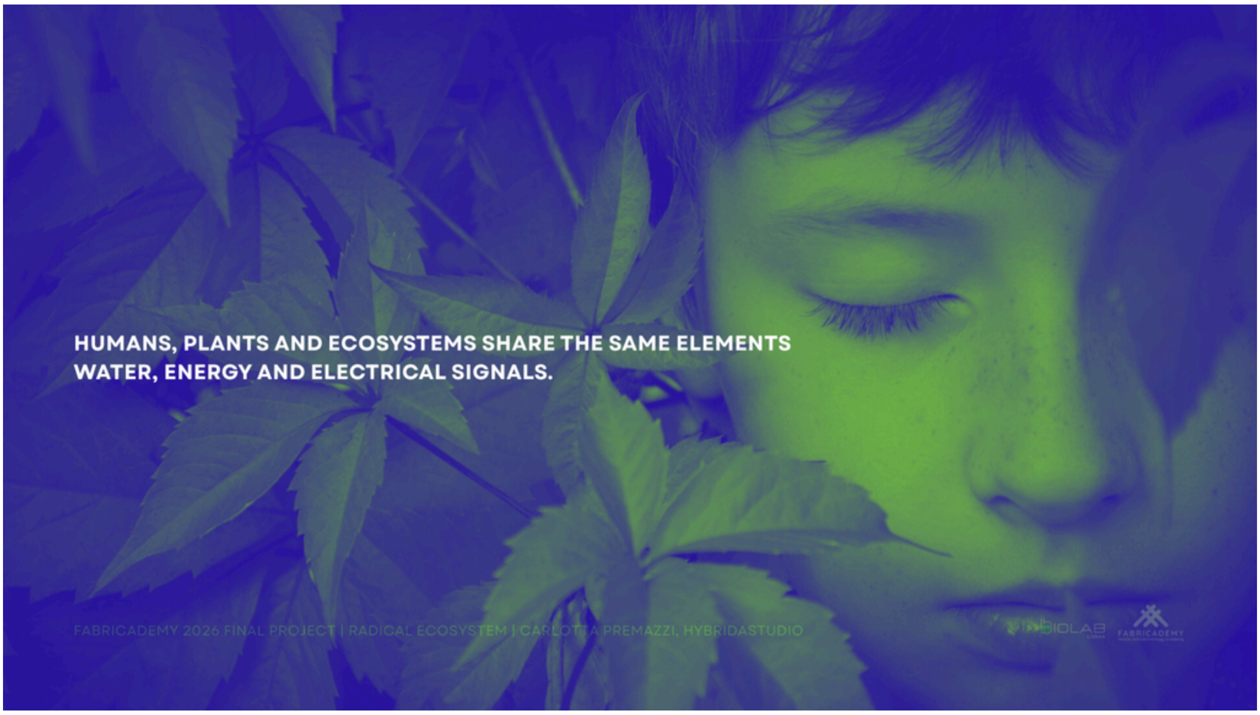
1.1 Context

Technological systems increasingly interact with living organisms through sensors, data collection and automation. In agriculture, smart gardening and environmental monitoring, plants are often connected to devices that measure variables such as soil moisture, temperature, light and humidity. These systems usually translate biological or environmental conditions into data used for regulation: watering, stabilising, correcting or optimising.

This model is useful, but it frames the plant mainly as something to be monitored. The living organism becomes a source of information for a technological system designed around human objectives.

At the same time, fields such as Human–Plant Interaction, bio-art, sustainable HCI, more-than-human design and soft robotics are opening different ways of working with living systems. Plants can be understood not only as passive organisms or decorative elements, but as sensing, responsive and relational beings. Their slow rhythms, environmental sensitivity and bioelectrical activity create possibilities for new forms of interaction.

Radical EcoSystem emerges from this context. It investigates how a plant can influence an installation's behaviour through its signals and environmental conditions. The project connects biological variation to technological expression, creating a system in which movement, light and sound evolve through the interaction among plant, human and machine.



Radical EcoSyste storytelling sequence. Carlotta Premazzi, 2026.


PLANTS CONSTANTLY SENSE THEIR ENVIRONMENT.
THEY RESPOND TO LIGHT, HUMIDITY AND TOUCH.
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THEIR ACTIVITY SHAPES ECOSYSTEMS.
MOST OF THESE PROCESSES REMAIN INVISIBLE TO US.
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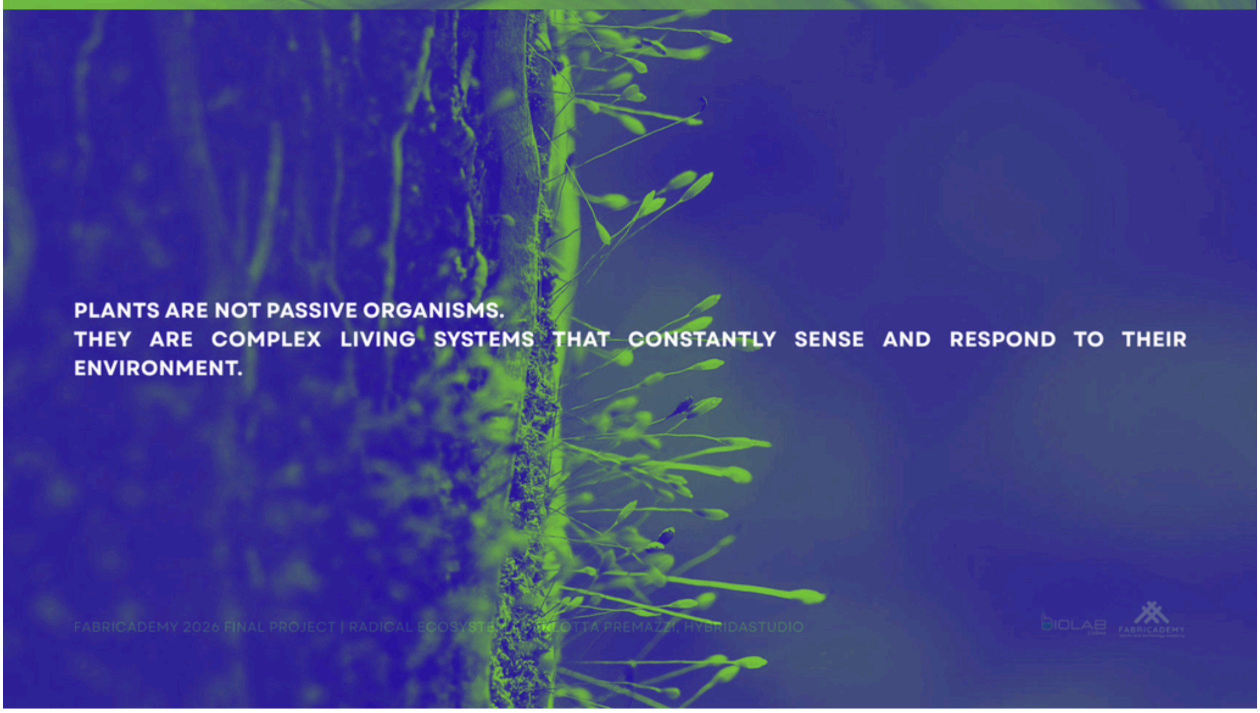
PLANTS ARE NOT PASSIVE ORGANISMS.
THEY ARE COMPLEX LIVING SYSTEMS THAT CONSTANTLY SENSE AND RESPOND TO THEIR ENVIRONMENT.
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1.2 Motivation

The motivation of **Radical EcoSystem** emerges from a critical engagement with control-based paradigms in plant–technology interaction.

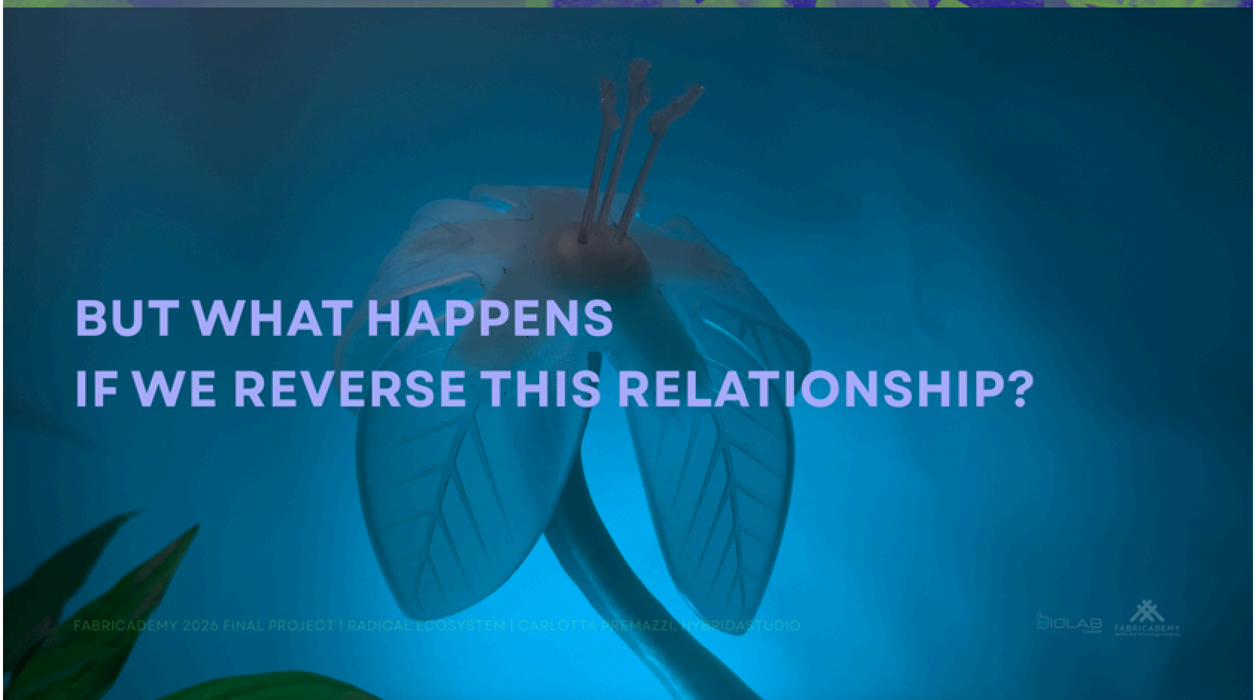
Sensor-driven systems are highly effective in measuring and regulating environmental conditions. However, they often frame plant activity primarily as information to be interpreted, managed or corrected. This perspective limits the possibility of exploring other forms of interaction in which biological processes are not subordinated to optimisation goals.

Radical EcoSystem investigates a different approach by separating sensing from control. Instead of using plant data to regulate the system, plant-related signals are allowed to directly influence its behaviour.

The objective is not to enhance plant growth, automate care or improve efficiency. The project aims to construct a system in which biological activity becomes perceptible and expressive. Soil moisture, plant bioelectrical activity, and human heartbeat are translated into pneumatic movement, light, and sound, creating a sensory environment in which living processes can be experienced as dynamic phenomena.

This approach also addresses the need for ecological awareness and interspecies empathy. By making plant activity perceptible through sensory and spatial behaviour, the installation invites visitors to slow down, observe and attune to forms of life that usually remain outside human perception. The project does not claim to translate the plant's inner experience, but creates conditions for a more attentive relationship with living systems.

The inclusion of human physiological input adds another layer of interaction. The human body does not dominate the system; it contributes temporary variations within an already active plant-driven environment.
The motivation of the project is rooted in exploring how technological systems can engage with living processes beyond dynamics of control, opening space for relational, behavioural, and emergent forms of interaction. In this sense, Radical EcoSystem proposes a techno-ecological experience in which empathy does not emerge from "anthropomorphising" the plant, but from recognising its presence, sensitivity, and active role within a shared environment.
This motivation also connects to a Symbiocene perspective: a shift from control and extraction toward coexistence, sensitivity and mutual influence. Radical EcoSystem explores this shift through an artistic system in which plant activity, human heartbeat, and technological behaviour enter into relation.



Conceptual shift from monitoring nature to allowing plant signals to influence technological behaviour.
Final Project Presentation. Carlotta Premazzi, 2026. Footage from Canva Pro Content and Pedro Rodrigues

1.3 Research Question

The central question emerging from the project is:
What if nature controls technology?

In **Radical EcoSystem**, this question is not understood as a literal reversal of power, where nature simply replaces humans as the controlling force. Instead, it opens a different way of thinking about technological systems: one in which living processes are not only monitored, interpreted or corrected, but allowed to participate in the behaviour of the system.
The research question can therefore be formulated as:

What happens when plant activity is allowed to shape technological behaviour instead of being used only to monitor or control it?

This question reframes the role of sensing within technological systems.
In **Radical EcoSystem**, sensing does not function primarily as a tool for regulation or optimisation. It becomes a way to establish relationships between biological, material and artificial processes.

The project investigates how plant-related signals, environmental conditions and human physiological input can interact within a shared bio-hybrid system. Soil moisture defines the environmental baseline, plant bioelectrical activity introduces continuous variation, and human heartbeat adds temporary rhythmic perturbations. These signals are translated into pneumatic movement, light modulation and sound.

Through this inquiry, **Radical EcoSystem** explores a model of interaction in which behaviour is not fully predefined. It emerges through the continuous relationship among living signals, material responses, and technological processes.
This research leads to three connected areas of investigation:

- how plant-related signals can be acquired, interpreted and mapped;
- how soft robotic movement can express biological and environmental variation;
- how human presence can enter the system as a temporary influence without becoming its central controller.

2. Conceptual Framework

2.1 Radical EcoSystem

Radical EcoSystem. Carlotta Premazzi, 2026

The term **Radical EcoSystem** operates on two levels. On one hand, it refers to plant roots, grounding the project in biological processes. On the other, it indicates a radical shift in how signals are interpreted within technological systems.

In conventional sensor-based systems, signals are often treated as data to be analysed and used for decision-making processes aimed at control, regulation or optimisation. In this project, signals are approached differently: they become active forces that shape behaviour.

Plant signals are not translated into commands or simple thresholds that trigger fixed actions. Instead, they modulate the temporal structure, intensity and qualitative characteristics of the system. Behaviour is therefore not fully predefined, but continuously influenced by biological variability.

This approach foregrounds the expressive potential of signals, allowing them to act as drivers of transformation rather than as inputs for control mechanisms.

2.2 Plant Agency and Technological Behaviour

A central concept in the project is the notion of plant agency within technological systems.

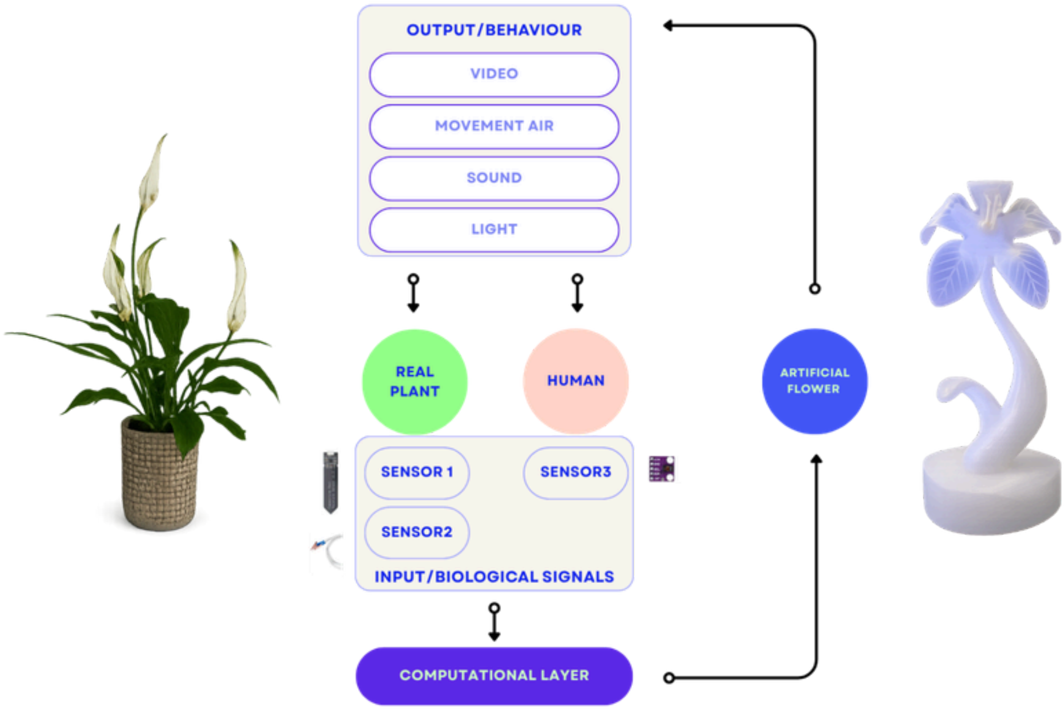
In many sensor-based applications, plants are reduced to data sources, and their activity is interpreted within frameworks designed by humans. Agency is assigned to the data-processing system, while the plant remains framed as a passive source of information.

Radical EcoSystem proposes a redistribution of agency. Plant signals directly influence the behaviour of the system, without being subordinated to optimisation logic. While the system is still designed and structured by humans, its behaviour is continuously modulated by non-human input.

This shift does not imply that plants control the system in a deterministic way. Agency is distributed across the interaction between plant activity, environmental conditions, human physiological input and technological processes. Behaviour emerges through this interaction, not from a single source.

The project therefore aligns with more-than-human perspectives that seek to decentralise human control and acknowledge the role of non-human entities in shaping shared environments.

2.3 Bio-Hybrid Feedback Logic



Bio-hybrid system feedback loop connecting plant signals, human heartbeat, computational mapping and artificial behaviour. Diagram. Carlotta Premazzi, 2026.

The installation is structured as a bio-hybrid system composed of three interconnected elements: a living plant, a technological infrastructure and a human interface.

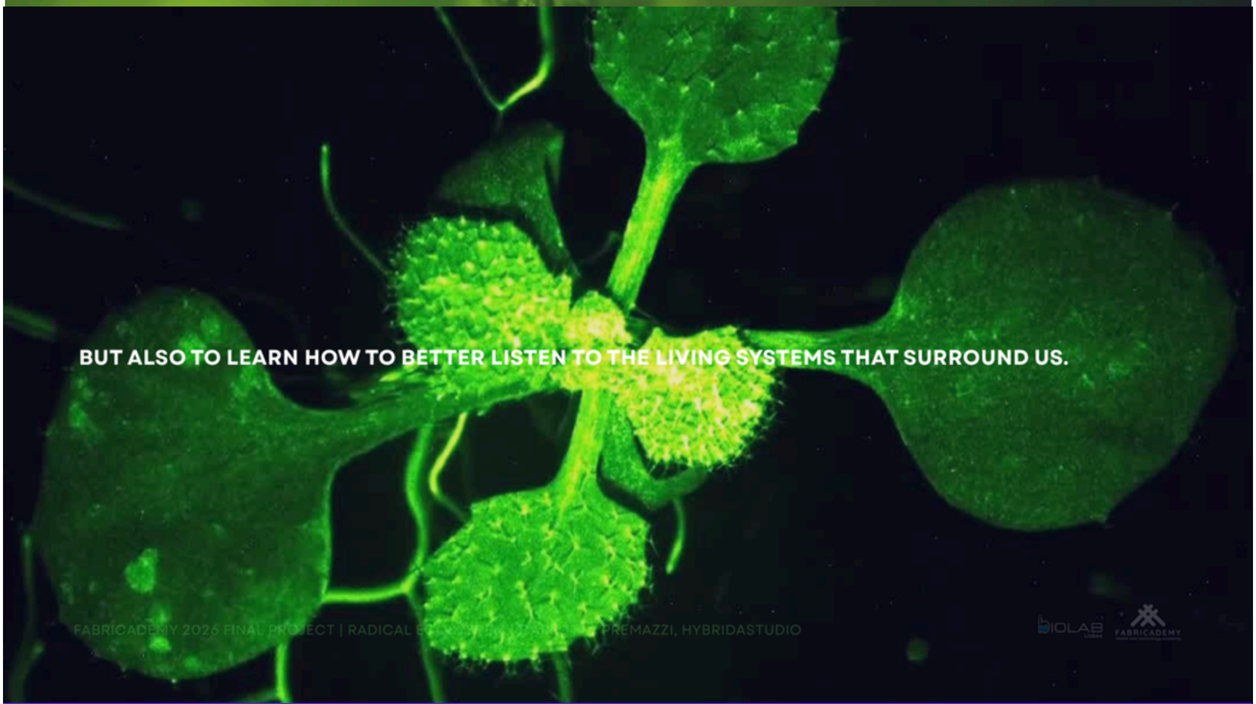
The plant provides two types of input: environmental data through soil moisture sensing and bioelectrical signals reflecting its physiological activity. These inputs define the baseline conditions of the system.

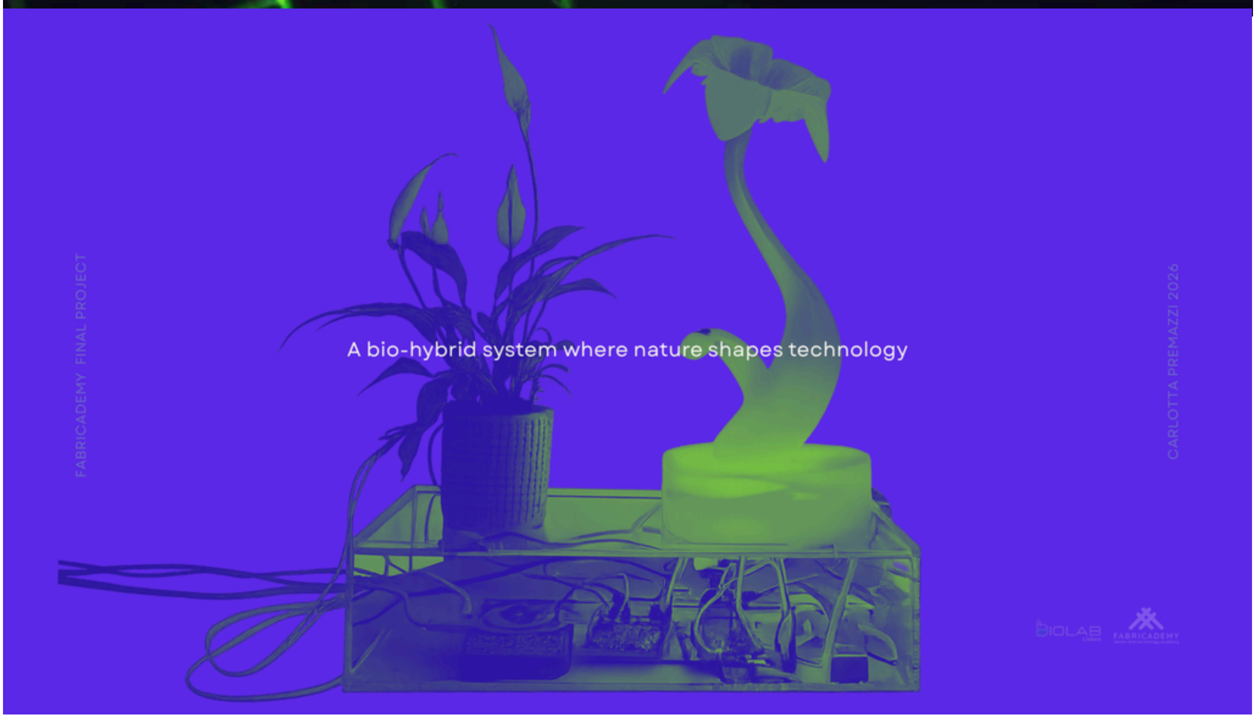
Human presence is introduced through a heartbeat sensor. Unlike plant signals, which establish continuous conditions, the heartbeat acts as a transient input that modulates the system in real time.

These signals are processed through a computational layer that maps biological and physiological input to behavioural parameters. The outputs include pneumatic actuation, light modulation and generative sound.

The artificial flower acts as the primary actuator, translating these processes into physical movement through cycles of inflation and deflation. The resulting behaviour is not scripted as a fixed sequence, but emerges from the interaction between different inputs.

Through this configuration, the installation operates as a dynamic ecosystem in which plants, humans and machines are interconnected. Behaviour arises from their interaction, rather than being imposed through predefined control structures.

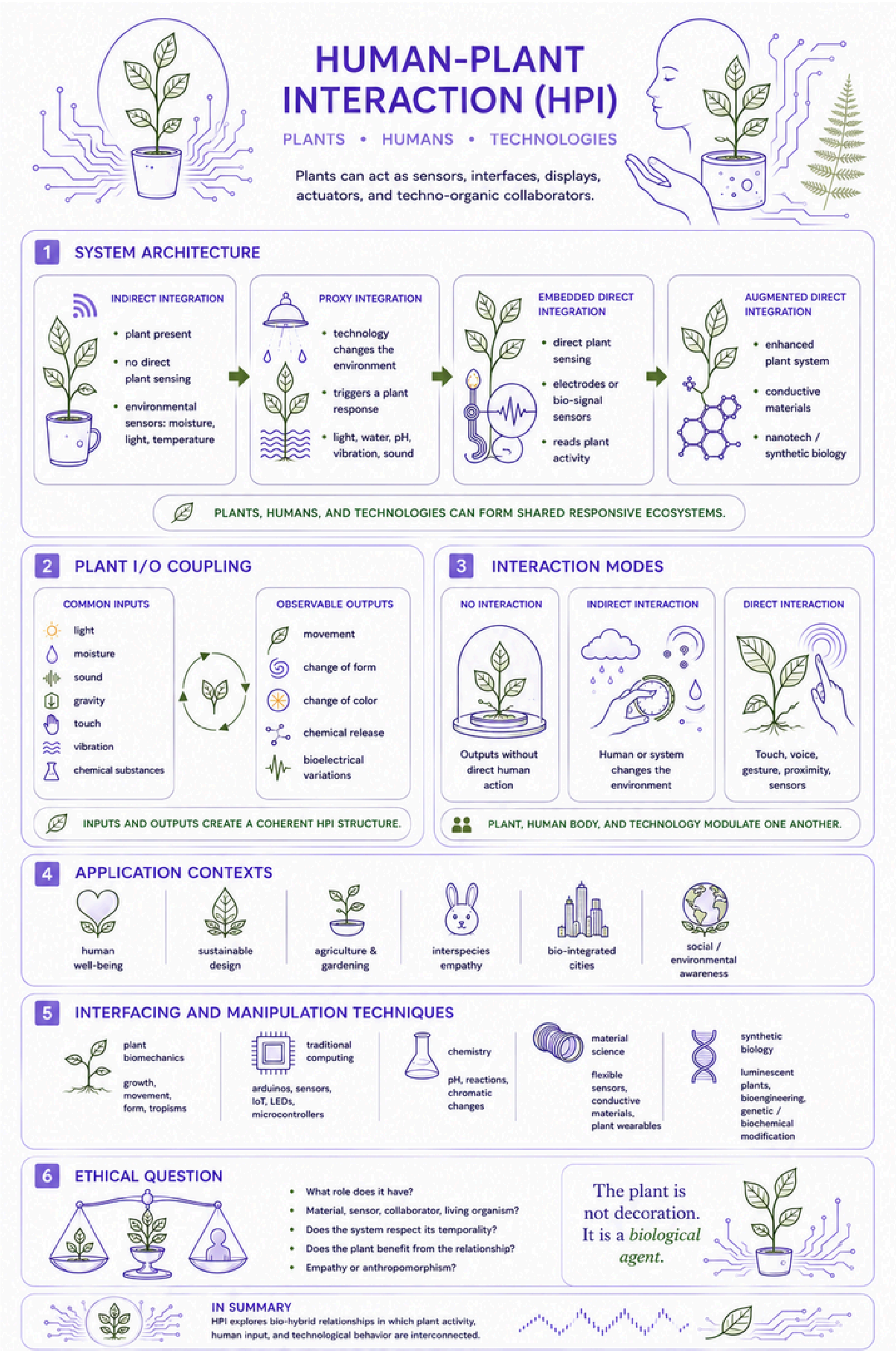




From plant data to plant-driven behaviour: the project asks how technologycanlistentolivingsystemsand artificial behaviour. Final Project Presentation. Carlotta Premazzi, 2026

3. Research Context

3.1 Human–Plant Interaction



AI illustration generated with DALL-E 3 via ChatGPT. Carlotta Premazzi, 2026.
Based on: Patterns and opportunities for the design of human-plant interaction, Chang, et al (2022)

Human–Plant Interaction is an emerging field that studies how humans, plants and technologies can interact through designed systems. Research in this area crosses HCI, art, design, architecture, bioengineering and sustainability.

The paper *Patterns and Opportunities for the Design of Human-Plant Interaction* identifies five useful dimensions for analysing plant-integrated systems: system architecture, plant input/output coupling, interfacing techniques, application context and scale. This framework is useful for positioning Radical EcoSystem within a broader research field.

The project belongs to this field because it uses a living plant as an active component in an interactive system. The plant is not only represented visually. Its environmental and bioelectrical activity enters the behaviour of the installation.

3.2 HPI System Architecture

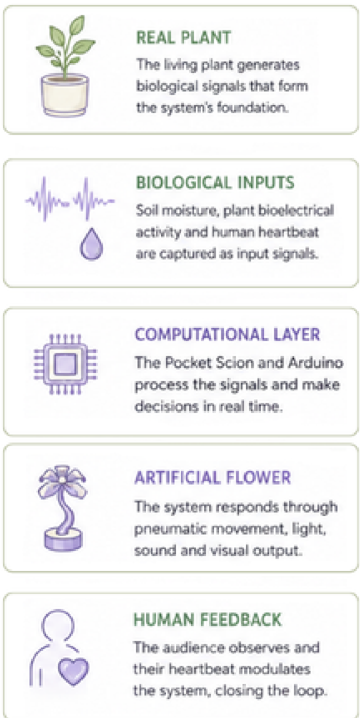
The HPI framework distinguishes different ways in which plants can be integrated into technological systems. Some systems use indirect integration, where sensors measure environmental conditions around the plant. Others use direct integration, where electrodes or embedded devices access signals from the plant itself.

Radical EcoSystem combines both approaches.

Soil moisture sensing works as an indirect environmental layer. It assesses the condition of the plant substrate and the overall state of the installation.

Pocket Scion and electrodes introduce a direct plant-signal layer. They capture bioelectrical activity and transform it into sound or data-driven modulation.

Together, these layers create a hybrid architecture:



Livingplant
↓
Soil moisture+bioelectrical activity
↓
Arduino / PocketScion/mapping system
↓
Pneumatic flower+LEDs + sound
↓
Audience perception andphysiological interaction

The architecture is modular. It can operate as a compact installation with direct sound from Pocket Scion, or expand into a larger audiovisual system using software such as Pure Data, Web Audio or TouchDesigner.

3.3 Plant I/O Coupling

In HPI, Plant I/O Coupling describes how a system uses plant inputs and outputs. Common plant-related inputs include light, moisture, touch, sound, gravity, vibration and chemical conditions. Common outputs include movement, colour change, shape change or biological signal variation.

In Radical EcoSystem, the plant-related inputs are:

LAYER	SIGNAL
🌱 Environmental condition	💧 Soil moisture
🪴 Biological signal	⚡ Plant bioelectrical activity
🫀 Human physiological input	❤️ Heartbeat

The system outputs are:

OUTPUT	BEHAVIOUR
🌸 Pneumatic flower	🌬️ Inflation, deflation, breathing rhythm
💡 LED	🌈 Colour states, heartbeat waves
🔊 Sound	🎵 Direct plant signal or expanded generative sound

The plant itself does not perform a visible movement like Mimosa pudica or Venus flytrap. Instead, its signals are externalised through the artificial flower and sensory system.

3.4 Interaction Modality

The interaction is **indirect, physiological** and **observational**.

Visitors do not control the plant or command the installation. They encounter a system that is already active. Their heartbeat adds a temporary layer of variation, but the system remains shaped by plant and environmental signals.

This creates a slower form of interaction. The audience is invited to stay, observe, listen and notice changes over time. The interaction is not based on immediate cause and effect. It is based on co-presence.

3.5 Application Context

Within the HPI framework, Radical EcoSystem aligns most closely with interspecies empathy, environmental awareness and artistic research.

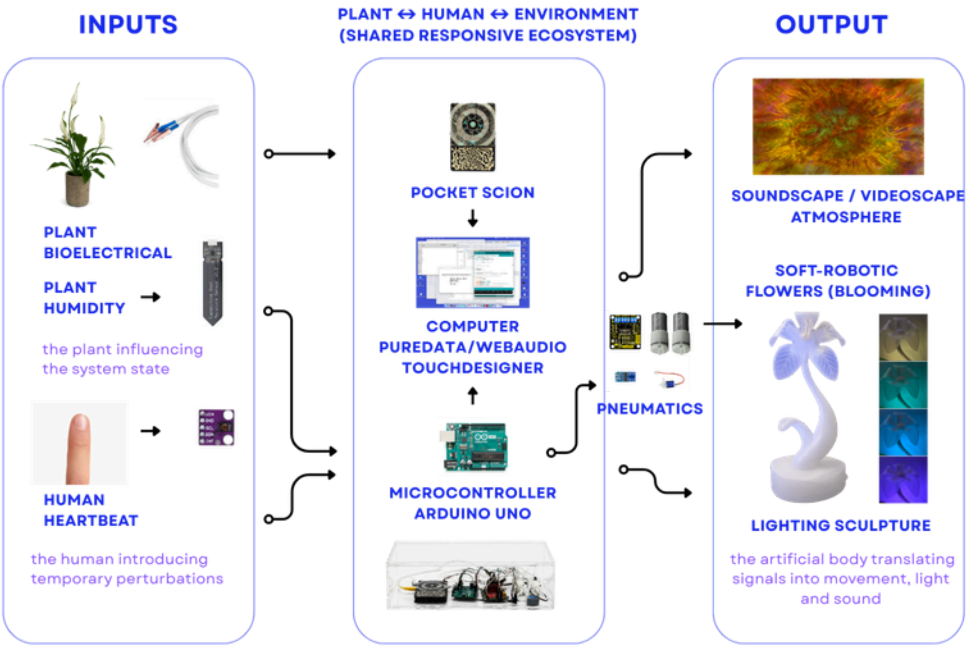
It is not an agricultural tool, a smart gardening device or a product-design prototype. It is an installation that uses technology to create a perceptual relationship between human visitors and plant activity.

The project contributes to HPI by proposing a bio-hybrid system in which plant signals influence technological behaviour through soft robotics, light, and sound.

3.6 Symbiocene and Ecological Imagination

The project can also be situated within a Symbiocene imaginary, understood as a movement away from human-centred and extractive models of relation toward forms of coexistence, mutual influence and ecological responsibility. In Radical EcoSystem, this perspective is explored through a small-scale bio-hybrid environment where plant activity, human physiology and technological behaviour are connected through shared signals.

4. System Design



System architecture diagram showing the relationships among plant inputs, human heartbeat, computational processing, pneumatic actuation, light and sound outputs. Carlotta Premazzi, 2026

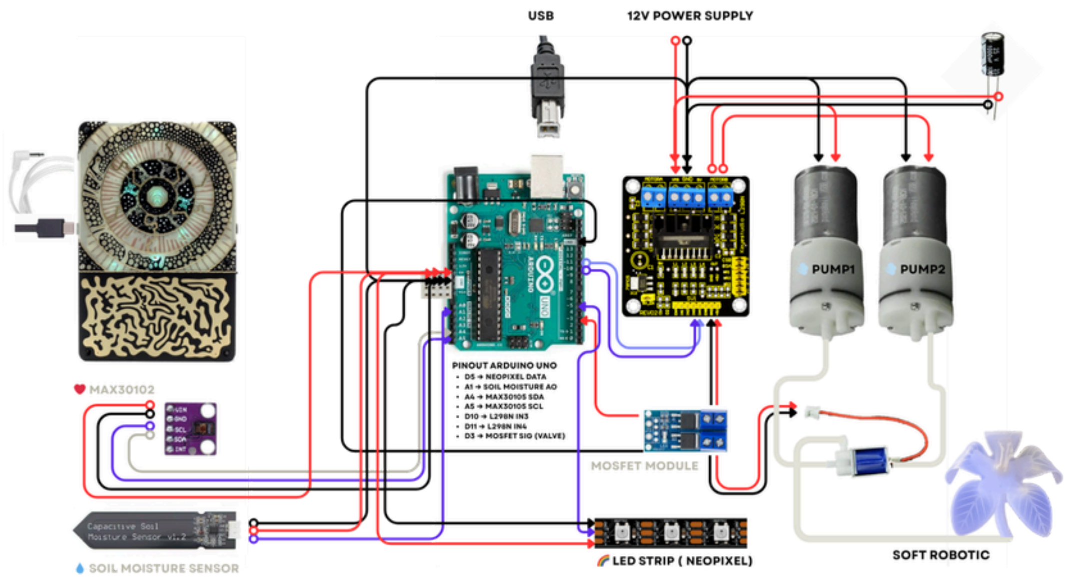
4.1 System Overview

The system is organised through inputs, processing and outputs.

LAYER	COMPONENTS
▶️ Inputs	Soil moisture sensor; Pocket Scion plant bioelectrical signal; heartbeat sensor
⚙️ Processing	Arduino microcontroller; serial data communication; behavioural mapping; optional computational layer for sound or visuals
◀️ Outputs	Pneumatic soft robotic flower; LED strip; sound system

The installation behaves through layered modulation. Soil moisture defines the main environmental state. Plant bioelectrical activity creates continuous variation. Heartbeat adds temporary pulses.

4.2 Sensors and Data Acquisition



Schematics diagram, Carlotta Premazzi, 2026

The soil moisture sensor is placed in the plant substrate. It provides a continuous analogue value that reflects hydration conditions. This value is mapped into three states:

DRY | OK | WET

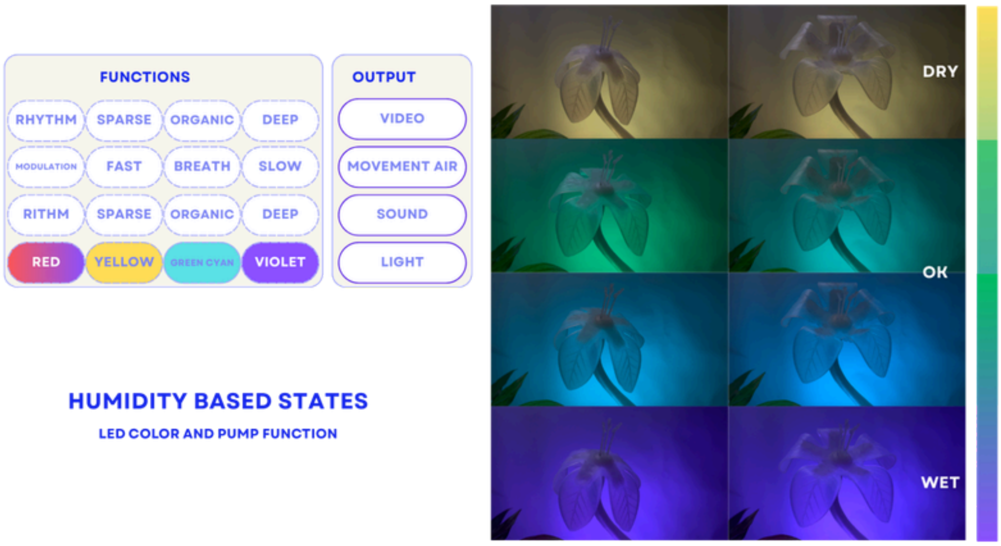
The Pocket Scion device reads plant bioelectrical activity through electrodes. In the compact setup, it can produce sound directly from the plant signal. In expanded versions, its data can be used to modulate sound synthesis, filtering, resonance or spatialisation.

The heartbeat sensor detects human pulse. When a visitor interacts with the sensor, each beat creates a short modulation in the system.

Each input has a different temporal quality:

Input	Temporal quality
💧 Soil moisture	🐢 Slow
⚡ Plant bioelectrical activity	🌊 Continuous and variable
🫀 Heartbeat	❤️ Rhythmic and temporary

4.3 Behavioural Logic



Behavioural logic diagram. Carlotta Premazzi, 2026.

The system maps signals to behaviour instead of using them as simple on/off triggers.

Soil moisture defines the baseline:

STATE	BEHAVIOUR
🌵 DRY	⚠️ Short, tense, irregular cycles
🌿 OK	🌬️ Smooth, balanced breathing
💧 WET	🫧 Slower, heavier, saturated movement

Plant bioelectrical activity modulates subtle changes in intensity, sound and timing.

Heartbeat creates accents:

🫀 HEARTBEAT	a short pressure variation in the pneumatic cycle; a red wave in the LEDs; a temporary sound modulation.

The system works through a hierarchy of temporal layers:

Moisture = environmental mood
Plant signal = continuous variation
Heartbeat = temporary accent

4.4 Pneumatic Actuation

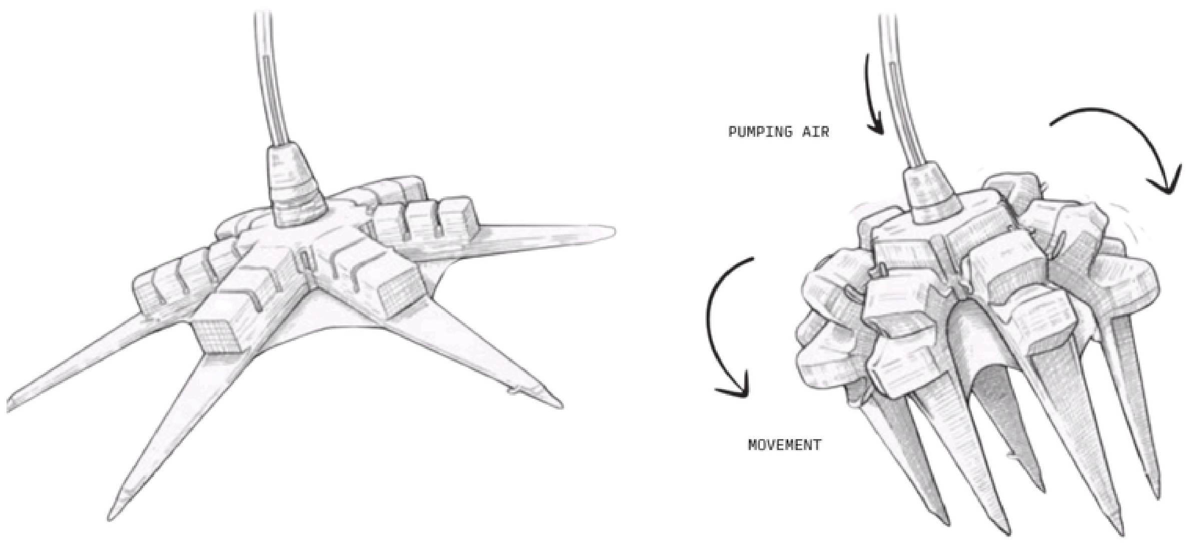
The artificial flower is the main physical output of the installation.

It is built as a soft robotic actuator using silicone chambers and textile reinforcement. Air pumps inflate and deflate the structure. Inflation causes the petals to close; deflation allows them to open.

The movement is shaped by:

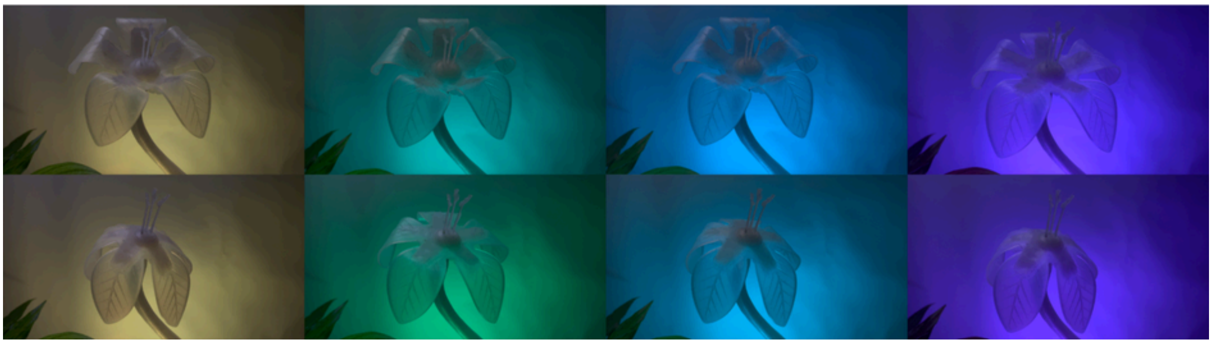
air pressure;
silicone elasticity;
chamber geometry;
textile constraint;
timing of pumps and valves.

This produces a breathing-like motion. The flower does not move like a mechanical robot.
Its movement is slow, elastic and partially unpredictable.



Air flow diagram. Carlotta Premazzi, 2026.

4.5 Light Behaviour



LED colour behaviour. Radical EcoSystem. Carlotta Premazzi, 2026.

The LED system translates the environmental state intocolour.

MOISTURE STATE	LIGHT COLOUR
🌵 DRY	🟡 Yellow / warm tones
🌿 OK	🟢 Green / cyan
💧 WET	🟣 Violet / purple

Heartbeat adds a red pulse wave. This creates a visible connection between the visitor's body and the system, while the main colour state remains connected to the plant condition.

4.6 Sound Behaviour

Sound exists in two possible configurations.

Compact Configuration

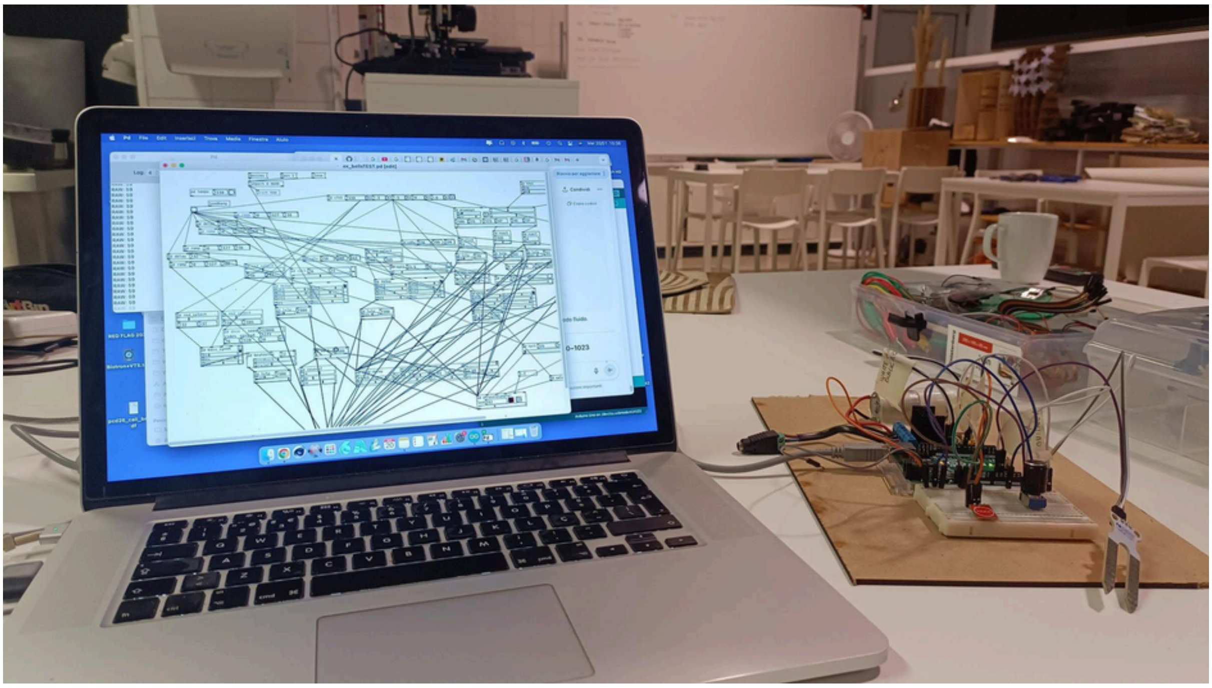
The Pocket Scion produces sound directly from plant bioelectrical activity. This creates a continuous sonic layer connected to the living plant.

Expanded Configuration

In a larger installation, the plant signals can be routed into Pure Data, Web Audio or TouchDesigner. These environments can control:

- filtering;
- resonance; granular synthesis;
- temporal modulation;
- spatial sound.

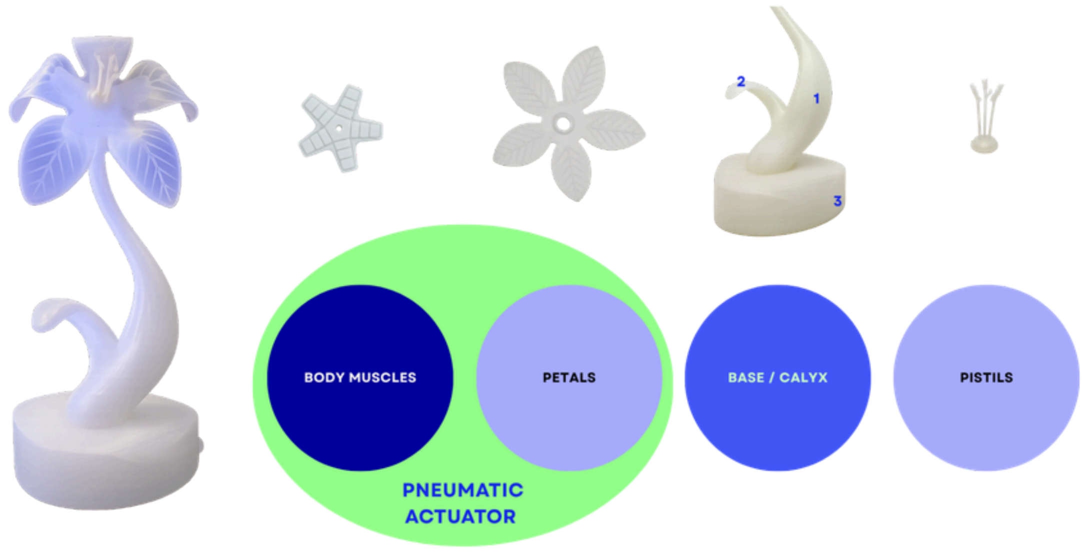
Sound is treated as an atmosphere rather than as a melody. It gives presence to the variability of plant activity.



Sound test with Pure Data. Carlotta Premazzi, 2026

5. Materials and Fabrication

5.1 Pneumatic Flower



Anatomy of the artificial flower. Carlotta Premazzi, 2026.

The soft robotic flower is designed as an artificial organism. Its form is inspired by botanical structures and jellyfish-like soft robotics.

The flower uses a radial arrangement of pneumatic chambers around a central axis. This geometry allows air pressure to create coordinated deformation across the petals.

The design process focused on producing movement that felt organic, slow and expressive. Early prototypes were more mechanical. Later versions introduced variations in height, curvature and thickness to improve the quality of movement.

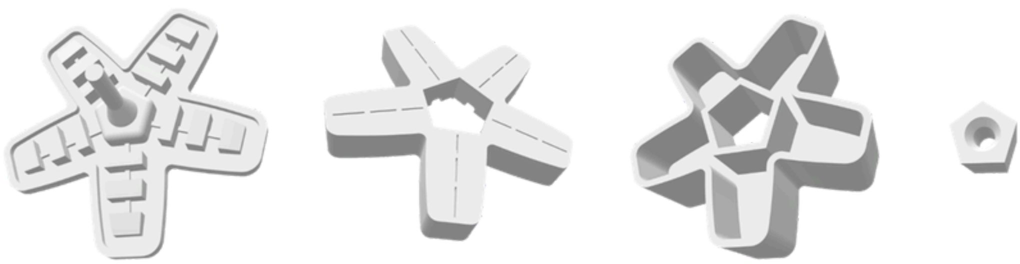
5.2 Mould Design and 3D Printing

3D printing workflow for the moulds and structural components, including modelling, material selection, printing and post-processing. Carlotta Premazzi, 2026.

The mould was designed in Fusion 360 and produced through FDM 3D printing.

Several mould iterations were developed. Early versions required external support to keep the parts aligned. The final mould uses a four-part interlocking system, making the casting process more stable.

The mould design was one of the most important parts of the project. Small changes in chamber height, air-channel width or silicone thickness strongly affected the final movement.



3D mould version n°6, Carlotta Premazzi, 2026.

5.3 Silicone Casting

Silicone pneumatic actuator fabrication workflow, from mould preparation and silicone mixing to demoulding, scaffold connection and inflation testing. Carlotta Premazzi, 2026.

The actuator is fabricated through silicone casting.

The process includes:

- casting the internal silicone layer with air chambers;
- placing a textile scaffold;
- casting the external silicone layer;
- sealing the chambers;
- connecting the pneumatic tube;
- testing inflation and deflation.

The silicone material provides transparency, flexibility and elasticity. The textile scaffold prevents uncontrolled ballooning and guides the petals' deformation.

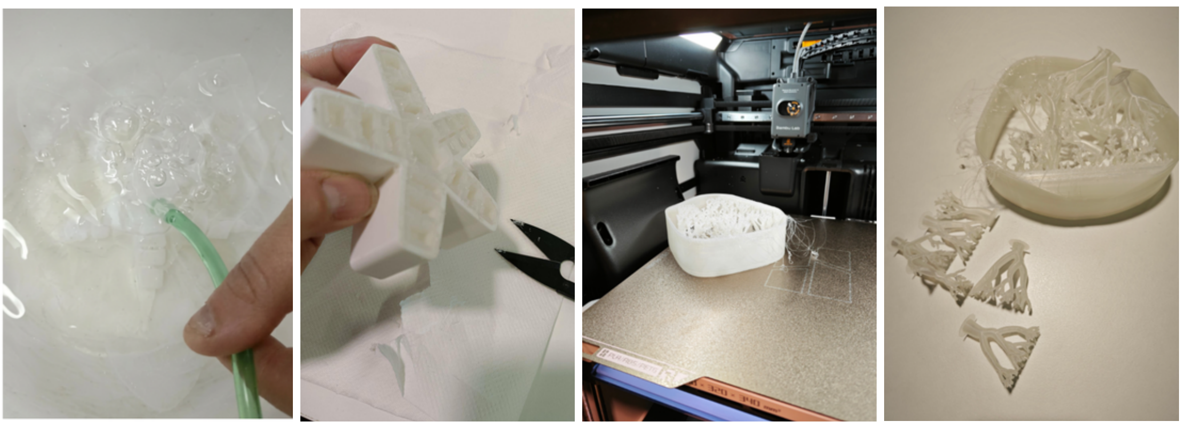
5.4 Fabrication Challenges, Iteration and Learning

The fabrication process involved repeated testing and failure across both soft and rigid components.

The main issues were:

- air bubbles inside the mould;
- blocked pneumatic channels;
- imperfect sealing;
- air leaks;
- excessive pressure;
- ruptures in the silicone;
- uneven deformation;
- fragile thin geometries in the calyx;
- excessive support material during 3D printing;
- loss of detail in organic branching elements.

These problems were addressed through iterative adjustments. Air bubbles were reduced by changing the silicone application method, pouring more slowly, tapping the mould and working the material into the smallest channels before closing the mould. Blocked pneumatic channels were reduced by cleaning the mould carefully, using less silicone during sealing and checking the air path before curing. Imperfect sealing and air leaks required additional silicone layers around the joints and repeated low-pressure tests before full inflation.



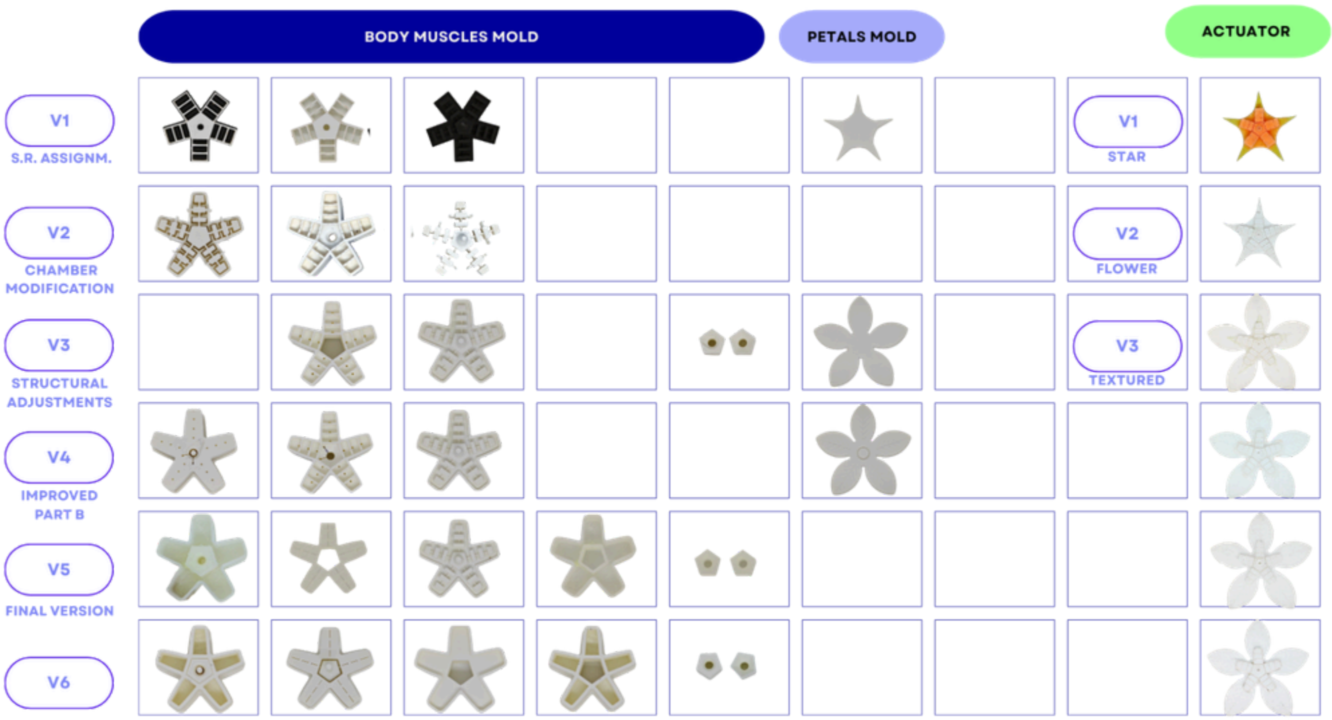
Challenges and failures during fabrication, including air bubbles, blocked pneumatic channels, excessive support material and loss of detail in organic branching elements. Carlotta Premazzi, 2026.

Excessive pressure and ruptures in the silicone were addressed by lowering the pump intensity, testing the actuator gradually and avoiding maximum pressure during early trials. Uneven deformation was improved by adjusting silicone thickness, refining the chamber geometry and adding the textile scaffold as a constraint layer.

The rigid calyx components also required several modifications. Fragile thin geometries were reinforced by increasing wall thickness, simplifying organic branching elements, adjusting infill settings and strengthening the connection points. Excessive support material was reduced by modifying the geometry and print orientation.

These problems were not only technical obstacles. They also revealed how material behaviour, fabrication constraints and structural design affect the final system. Each actuator exhibited slightly different movement due to small differences in casting, curing, sealing, silicone thickness and air pressure.

This variability became part of the project's behaviour.



Fabrication iterations of 3D printed moulds and silicone actuators. Carlotta Premazzi, 2026.

5.5 Structural Base and Calyx

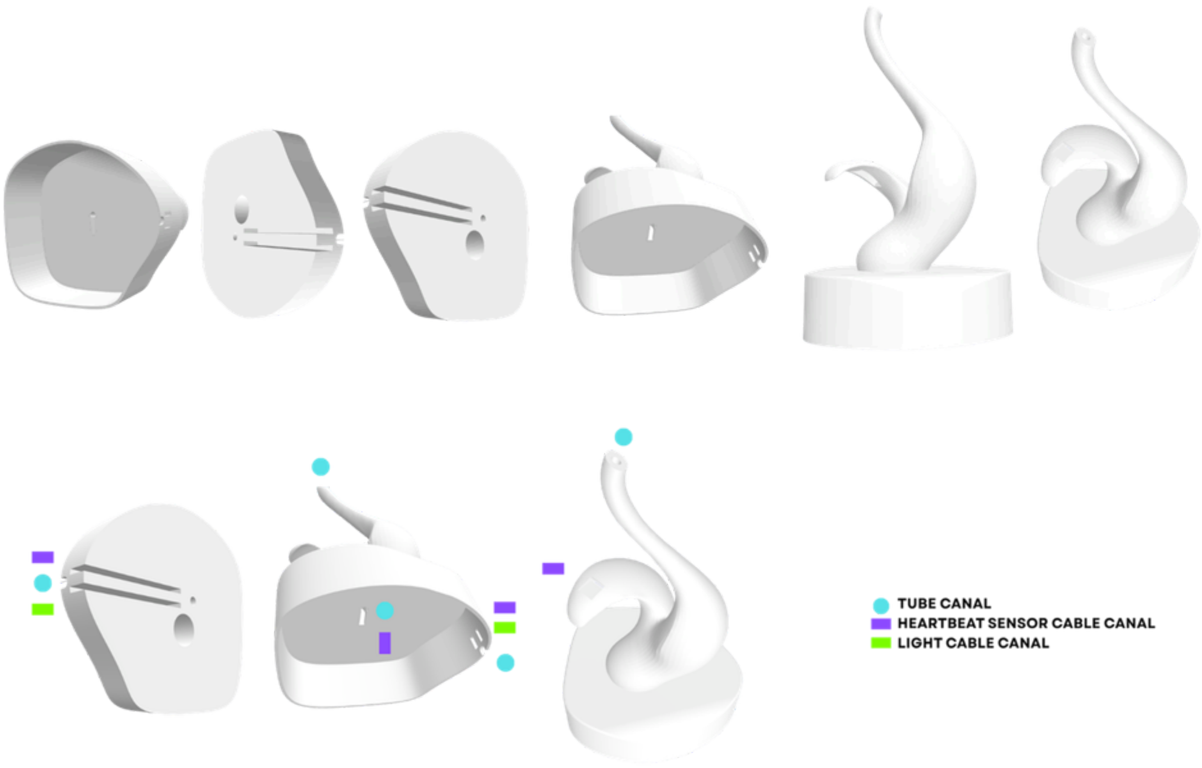
The artificial flower is supported by a 3D printed calyx and base.

The calyx holds the silicone actuator and organises the passage of:

- pneumatic tubes;
- LED wires;
- sensor cables;
- structural connections.

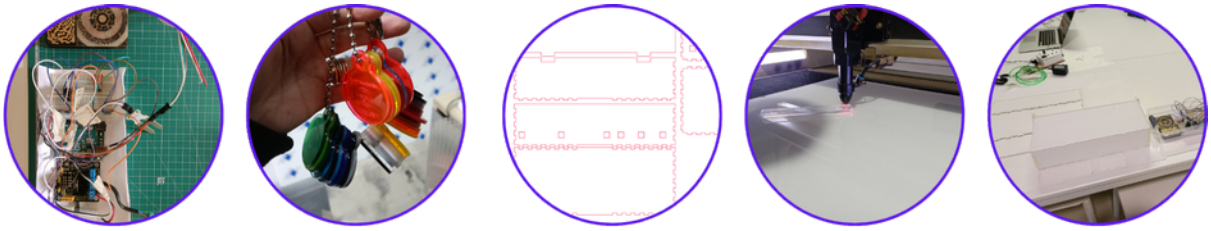
The base was adapted from an existing 3D model and redesigned to function as a technical interface. Decorative elements were removed, and internal channels were added.

The final structure connects the soft actuator to the electronic and pneumatic system.



3D printed calyx parts and cable channels. Carlotta Premazzi, 2026.

5.6 Control Unit



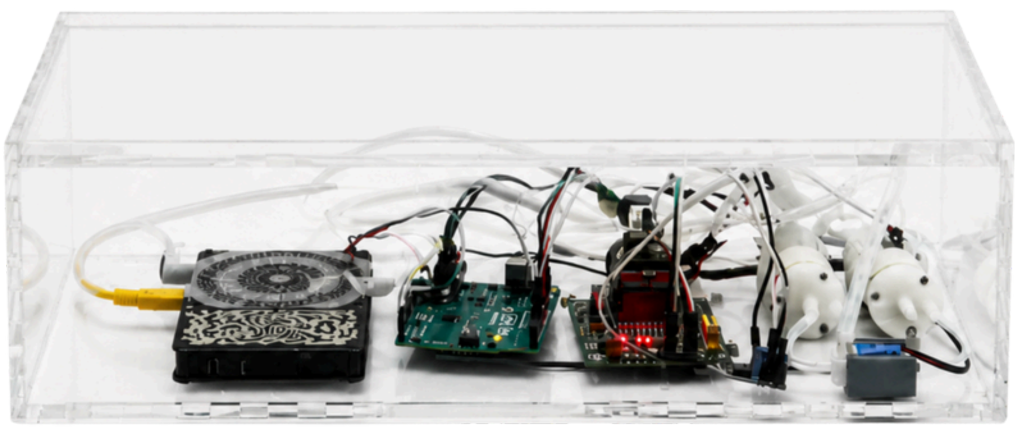
Laser-cut acrylic control unit fabrication workflow, including material selection, kerf calibration, finger-joint design and assembly. Carlotta Premazzi, 2026.

The control unit is built from transparent laser-cut acrylic.
Transparency is part of the project's aesthetic and conceptual language.
The electronics, tubes, wires and pumps remain visible. The installation does not hide its technological infrastructure.

The control unit separates low-voltage logic from higher-power components. This is important because the pumps and LEDs can create noise and instability in the system.

Inside the box, the system includes:

- Arduino;
- motor driver;
- pumps;
- valve;
- power distribution;
- sensor connections.



Control unit, Carlotta Premazzi, 2026

6. Prototyping and Testing

6.1 Early Tests

The first prototypes tested individual parts of the system:

- reading soil moisture;
- detecting heartbeat;
- controlling LEDs;
- inflating small silicone chambers;
- testing pumps and valves;
- listening to plant signals through Pocket Scion.

At this stage, the system was fragmented. Each component was developed separately before being connected into a full installation.

Prototype. Carlotta Premazzi, 2026

6.2 Sensor Testing

Resistive Soil Moisture Sensor testing. Carlotta Premazzi, 2026.

The first tests were conducted using a resistive soil moisture sensor. However, the sensor produced unstable readings over time and introduced electrical interference when used together with the Pocket Scion bioelectrical sensing system. This instability was related to oxidation effects, shared power noise and interference with plant bio-signal acquisition.

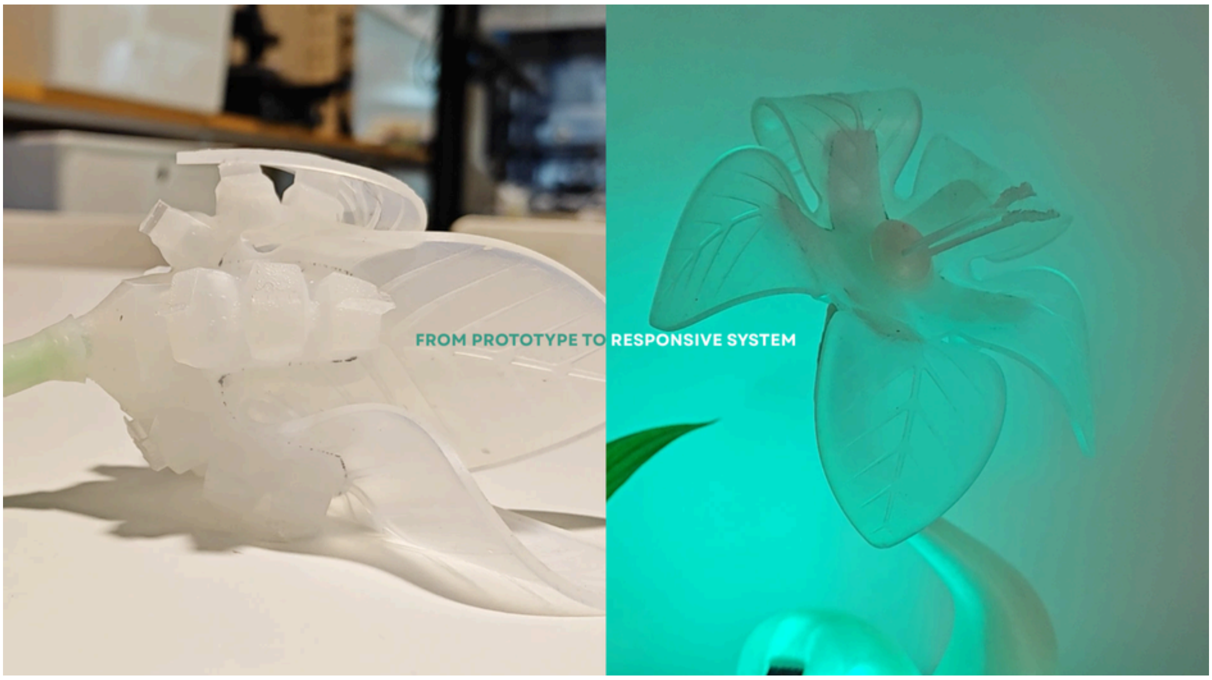
To reduce signal noise and obtain more stable measurements, the sensor was later replaced with a capacitive soil moisture sensor, which proved more suitable for integration within the bio-hybrid system.

The soil moisture sensor required calibration. Different sensors produced different values, and the readings were affected by the substrate, water distribution and electrical noise.

The heartbeat sensor also required testing. Finger position, pressure and movement influenced the signal. For the final behaviour, the heartbeat was treated as a modulation layer rather than as a precise medical measurement.

The Pocket Scion introduced a continuous sound layer connected to plant bioelectrical activity. This helped define the sonic identity of the project.

6.3 Pneumatic Testing



Soft robotic flower during pneumatic testing. Carlotta Premazzi, 2026.

The pneumatic system required many iterations.
The main tests involved:

- pump strength;
- valve timing;
- inflation speed;
- deflation behaviour;
- pressure limits;
- tube connections;
- sealing quality.

The actuator responded differently depending on material thickness and internal geometry. Some versions inflated too aggressively. Others did not close enough. The final behaviour emerged through repeated adjustment between mould design, silicone casting and code.

6.4 Integration Testing

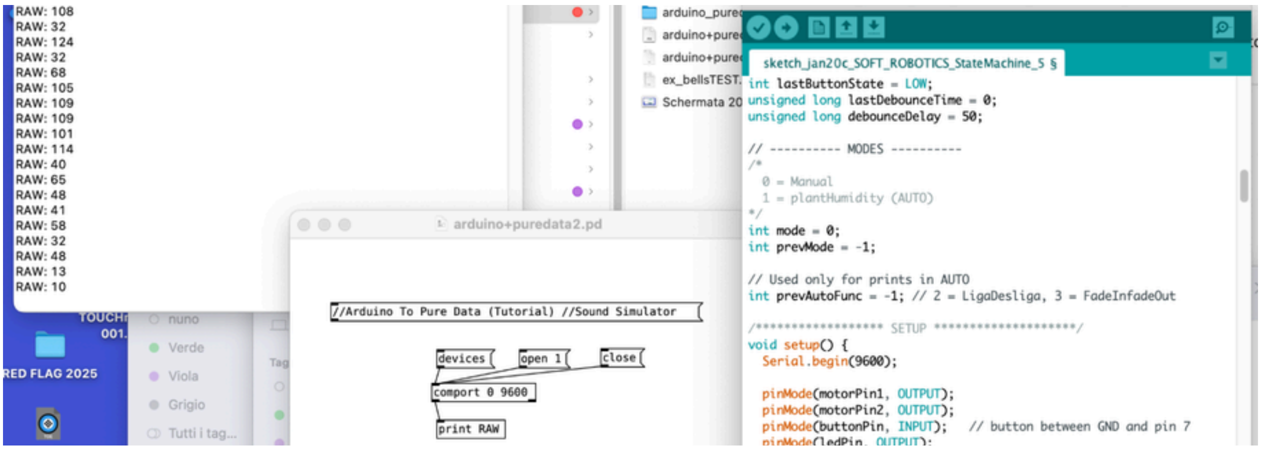
Electronic assembly workflow, including wiring, soldering, power separation and integration of sensors, pumps and LEDs. Carlotta Premazzi, 2026

Integration was the most complex phase. The system had to coordinate:

- sensor readings;
- state detection;
- pump control;
- LED behaviour;
- heartbeat pulses;
- sound output;
- power stability.

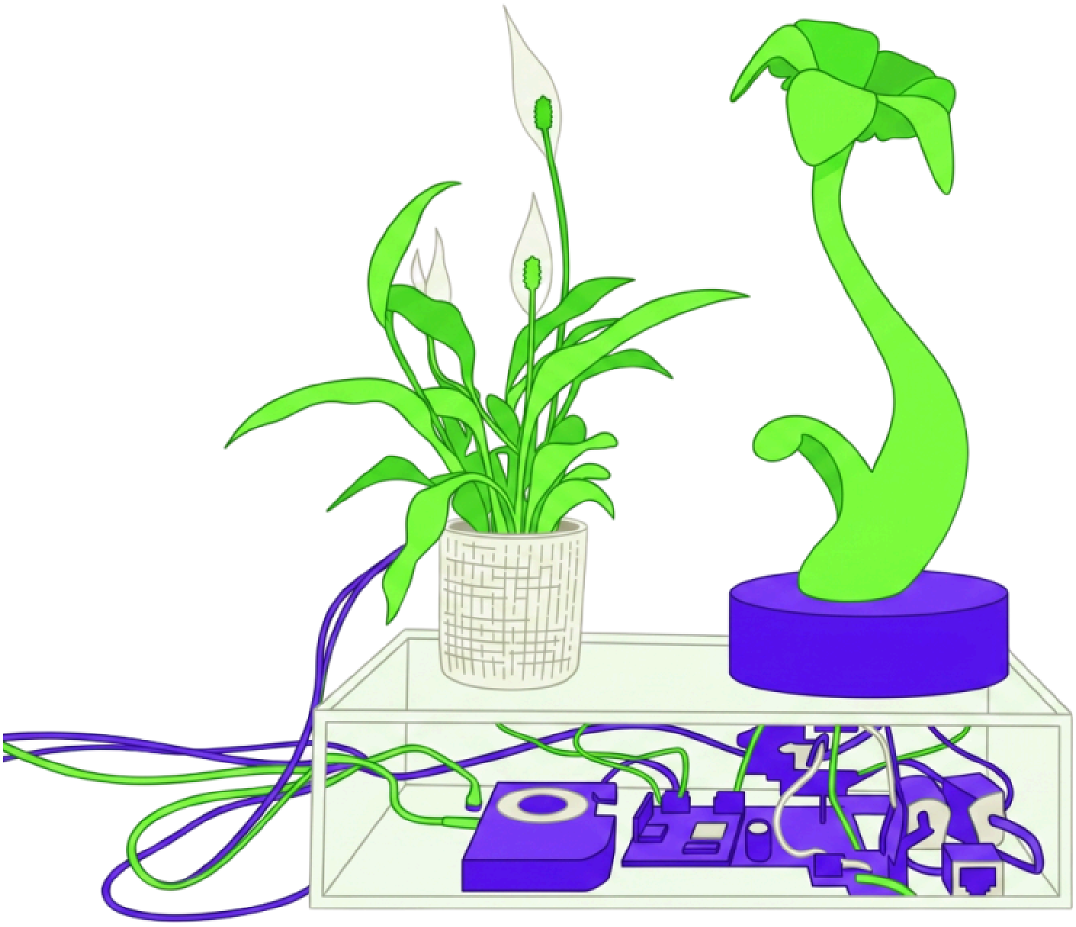
Power management became a critical issue because motors and LEDs demand more current than sensors and logic components. Separate power lines and careful grounding were necessary to reduce instability.

The final prototype demonstrates a functional relationship among plant condition, human heartbeat, and soft robotic movement.



Study for sending data from arduino to Pure Data. Carlotta Premazzi, 2026

7. Installation Experience



Radical EcoSystem installation vision. Carlotta Premazzi, 2026.

7.1 Spatial Setup

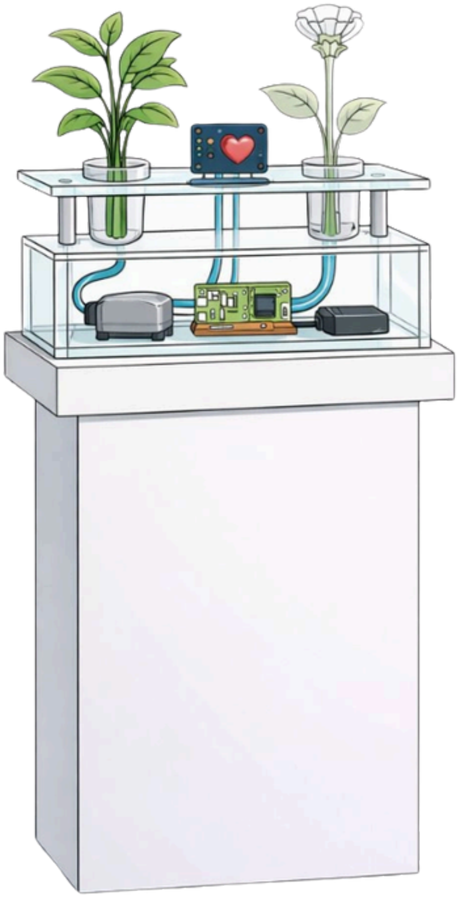
The final installation is conceived as a spatial configuration that integrates biological, technological and sensory elements into a unified environment.

At its centre is a living plant connected to a sensing system that captures both environmental and bioelectrical signals. These signals are processed and translated into outputs that affect the surrounding space.

The artificial flower, positioned as the main actuator, responds through pneumatic movement. Its opening and closing cycles make the system's internal dynamics physically visible.

Lighting and sound extend this behaviour into the environment, creating an immersive atmosphere. The installation is designed to function continuously, allowing behaviour to unfold over time rather than being activated only through direct interaction.

The technological infrastructure, including sensors, microcontroller and pneumatic components, is partially visible through the transparent control unit. This exposure reinforces the system's hybrid nature, revealing the processes that connect biological input to artificial behaviour.

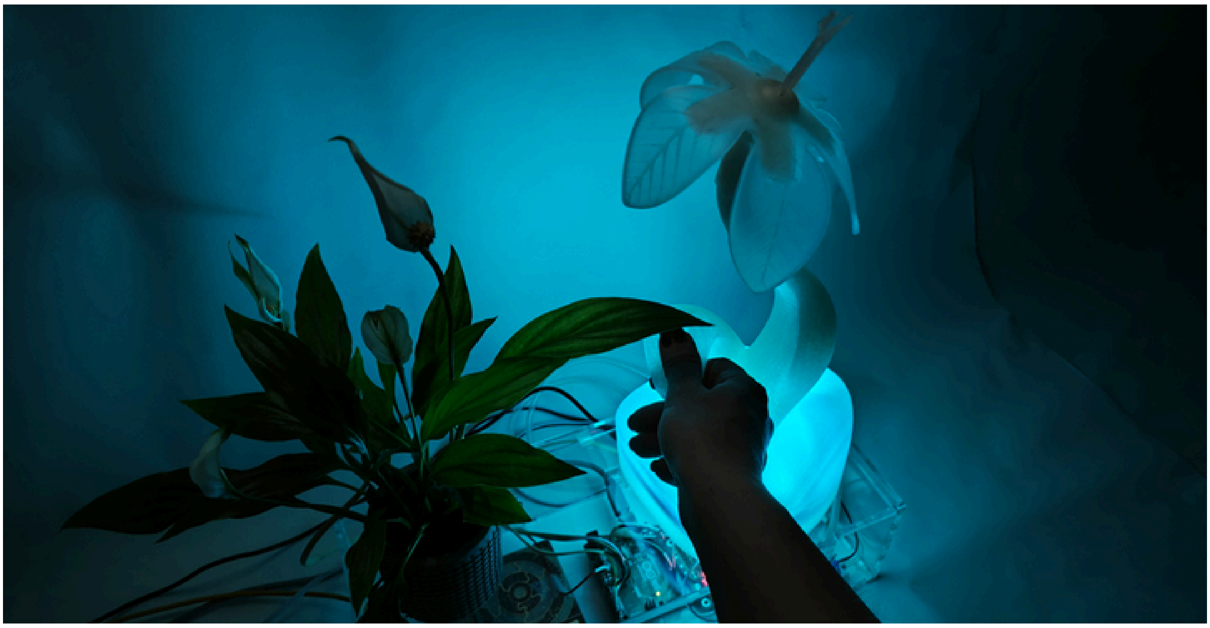


Conceptual rendering and physical implementation. AI illustration generated with DALL-E 3 via ChatGPT. Carlotta Premazzi, 2026.Carlotta Premazzi, 2026.

7.2 Audience Interaction

The visitor enters an already active system.
Interaction happens through observation, proximity and heartbeat. When the visitor uses the heartbeat sensor, their pulse temporarily affects the movement, light and sound.
This creates a moment of bodily connection with the system.

The visitor does not control the installation.
Their presence becomes one influence among others.



Radical EcoSystem. Human Interaction. Carlotta Premazzi, 2026

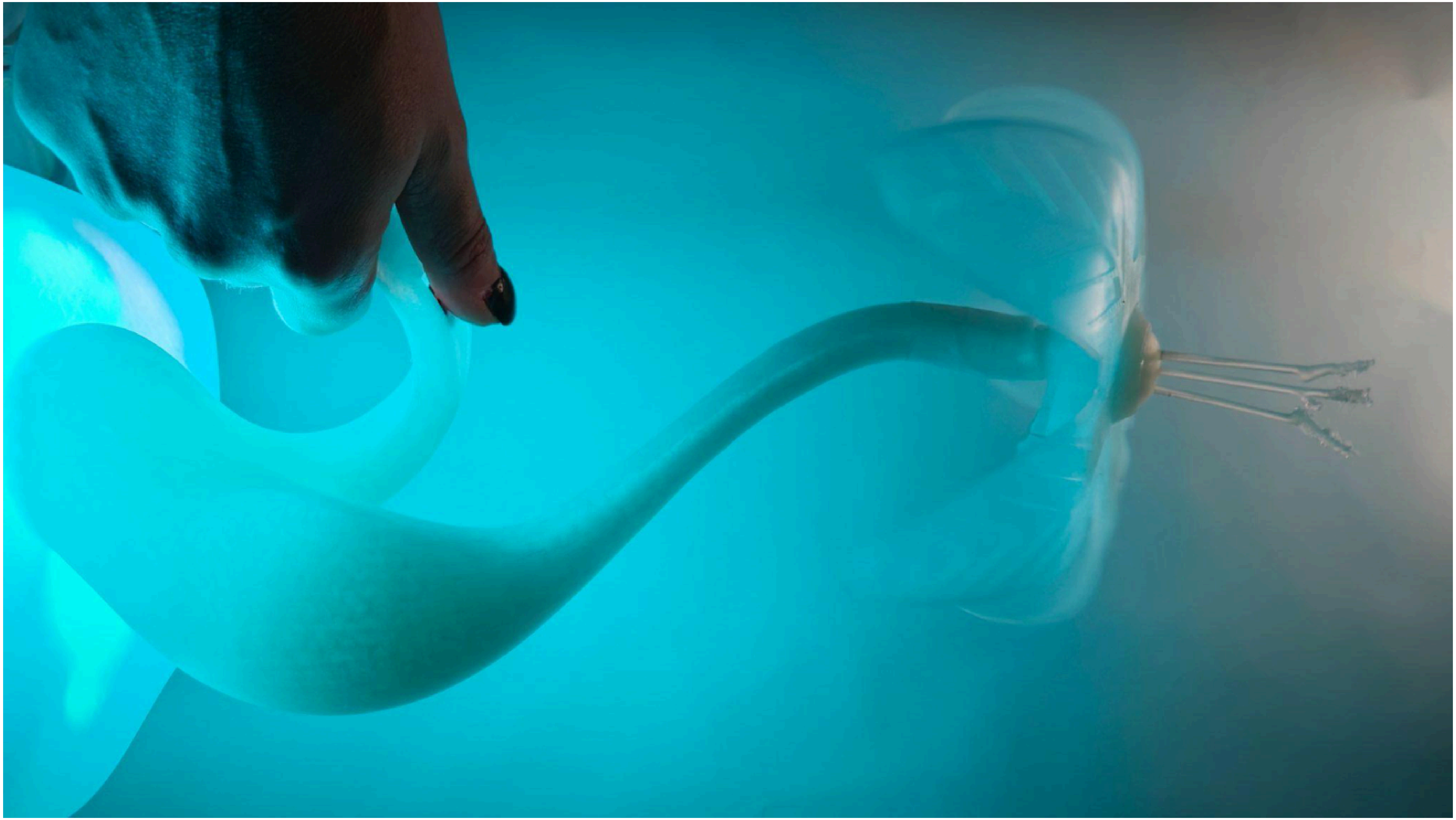
7.3 Temporal Experience

The installation asks for time.

Its behaviour is not immediately readable through a single action. The audience needs to observe changes in rhythm, colour, movement and sound. This slower temporal experience reflects the different speeds of the system:

- the plant changes slowly;
- bioelectrical activity fluctuates continuously;
- heartbeat appears as a pulse;
- the flower breathes through cycles;
- sound creates atmosphere.

The work invites attention to subtle variation.



Radical EcoSystem. Human Interaction. Carlotta Premazzi, 2026

Full video documentation available at https://vimeo.com/1185451965

8. Reflection

8.1 Discussion

Radical EcoSystem explores how plant signals can participate in the behaviour of a technological installation.

The project shows that plant-related signals can be used not only for monitoring but also for artistic expression. Soil moisture, bioelectrical activity and human heartbeat create a layered behavioural structure. The soft robotic flower gives this structure physical form through movement.

The project also demonstrates the importance of material behaviour. Silicone, air pressure, textile constraint and fabrication imperfections all influence the final movement. The system is therefore shaped by both code and matter.

The main outcome is a working prototype in which biological variation becomes perceptible through material, sonic, and luminous behaviour.

From this perspective, Radical EcoSystem can be read as a speculative gesture toward a Symbiocene imaginary. The installation does not claim to resolve ecological or technological conflicts, but proposes a different sensibility: one in which living systems are not treated only as resources, data sources or objects of control. Instead, the plant becomes part of a shared behavioural environment, where technological processes are shaped by biological variation and human presence becomes one influence among others.

8.2 Limitations

The project has several limitations.

Plant bioelectrical signals are highly variable and context-sensitive. Their interpretation remains complex. The system does not claim to reveal the plant's inner state in a scientific way.

The pneumatic actuator also has limits. Air-based movement is slow and difficult to control precisely. Leaks, pressure changes and material fatigue can affect reliability.

The prototype uses a small number of inputs. Future versions could include light, temperature, air quality or proximity sensing to create a richer environmental system.

The question of plant agency also remains open. The project allows plant activity to influence behaviour, but the system is still designed by humans. Agency is therefore distributed, partial and mediated.

8.3 Future Development

Radical EcoSystem-garden experience. Generated with DALL-E 3 via ChatGPT. Carlotta Premazzi, 2026.

Future development could move in several directions.

Technically, the system could include more stable sensing, improved pneumatic control and more robust actuators. The sound layer could be expanded into a spatial generative environment.

Artistically, the installation could grow into a larger ecosystem with multiple plants and multiple soft robotic organisms. Each plant could influence a different part of the environment, creating collective behaviour.

The project could also be developed for exhibition contexts where visitors spend more time with the work. Long-duration presentation would allow the slower aspects of the system to become more visible.

In future versions, Radical EcoSystem may become a larger bio-hybrid environment where plants, machines and humans share signals across movement, light, sound and space.

9. Conclusion

Radical EcoSystem is a bio-hybrid installation in which plant activity participates in the behaviour of a technological system.

By connecting a living plant, bioelectrical sensing, soil moisture data, soft robotic actuation, light, and sound, the project creates a responsive environment that changes over time. The plant is not presented only as a symbolic or decorative element; its environmental and bioelectrical activity contributes to the rhythm, movement, and atmosphere of the installation.

The project is positioned within Human–Plant Interaction and more-than-human design, but its contribution is primarily artistic and experiential. It creates a sensory situation in which visitors can perceive the relationship between biological variation, material movement, and technological expression.

The work remains open and materially unstable, shaped by living signals, air pressure, silicone behaviour, and environmental conditions. This instability is not treated as a failure,
but as part of the project's logic. Radical EcoSystem does not propose a fixed solution; it offers a framework for imagining technological systems that listen to living processes and translate them into shared environments.

FROM SIGNAL TO BEHAVIOUR.
▼
FROM OBSERVATION TO RELATION.
▼
FROM SYSTEM TO ECOSYSTEM

10. Technical Appendix

This appendix gathers the technical information used to build and document the **Radical EcoSystem** prototype and is intended as a practical reference for reproducing, adapting or further developing the system. While the main body of the thesis focuses on the conceptual, material and experiential dimensions of the project, this section documents the technical configuration of the prototype.

10.1 Bill of Materials

The system is composed of electronic components, pneumatic elements, sensing devices, soft robotic materials and structural parts. Components were selected according to availability, compatibility with the BioLab Lisboa infrastructure and adaptability during prototyping.

CATEGORY	COMPONENT	FUNCTION
MICROCONTROLLER	**ARDUINO UNO**	MAIN CONTROL BOARD FOR SENSORS, LEDS AND PNEUMATIC BEHAVIOUR
PLANT BIOELECTRICAL SENSING	**POCKET SCION + PLANT ELECTRODES**	ACQUISITION / SONIFICATION OF PLANT BIOELECTRICAL ACTIVITY
ENVIRONMENTAL SENSING	**CAPACITIVE SOIL MOISTURE SENSOR**	MEASURES HYDRATION CONDITIONS IN THE PLANT SUBSTRATE
HUMAN PHYSIOLOGICAL INPUT	**MAX30102 / MAX30105 HEARTBEAT SENSOR**	DETECTS HUMAN PULSE AND INTRODUCES A PHYSIOLOGICAL MODULATION LAYER
PNEUMATIC ACTUATION	**12V MINI AIR PUMPS**	INFLATE AND DEFLATE THE SOFT ROBOTIC FLOWER
AIR CONTROL	**6V / 12V VALVE**	CONTROLS AIRFLOW AND RELEASE
TUBING	**FLEXIBLE PNEUMATIC TUBES**	CONNECTS PUMPS, VALVE AND SILICONE ACTUATOR
MOTOR CONTROL	**MOTOR DRIVER SHIELD OR MOSFET MODULES**	SWITCHES PUMPS AND VALVE FROM ARDUINO CONTROL SIGNALS
LIGHT SYSTEM	**WS2812B ADDRESSABLE LED STRIP**	PRODUCES STATE-BASED AND HEARTBEAT-BASED LIGHT BEHAVIOUR
SOFT ROBOTIC MATERIAL	**TRANSPARENT SILICONE**	FORMS THE FLEXIBLE PNEUMATIC ACTUATOR
CONSTRAINT LAYER	**TEXTILE SCAFFOLD**	GUIDES DEFORMATION
STRUCTURAL PARTS	**3D PRINTED PLA**	CALYX, BASE, PISTIL, MOULDS AND SUPPORT ELEMENTS
ENCLOSURE	**LASER-CUT TRANSPARENT ACRYLIC / PMMA**	HOUSES ELECTRONICS, PUMPS AND WIRING
POWER	**5V AND 12V POWER SUPPLIES**	SEPARATE POWER FOR LOGIC/SENSORS AND ACTUATION

The total estimated cost of the prototype during development was approximately €496. This value reflects the specific conditions of the project, including access to fabrication facilities, lab tools and already available materials. Costs may vary depending on suppliers, fabrication access and future design changes.

10.2 Tools, Software and Fabrication Equipment

CATEGORY	TOOL / SOFTWARE	USE
ELECTRONIC ASSEMBLY	**SOLDERING IRON**	SOLDERING WIRES AND ELECTRONIC CONNECTIONS
ELECTRONIC ASSEMBLY	**SOLDER WIRE**	CREATING PERMANENT ELECTRICAL CONNECTIONS
ELECTRONIC ASSEMBLY	**WIRE STRIPPER**	PREPARING WIRES AND REMOVING INSULATION
ELECTRONIC ASSEMBLY	**MULTIMETER**	TESTING CONTINUITY, VOLTAGE AND POWER STABILITY
FABRICATION EQUIPMENT	**BAMBU LAB 3D PRINTER**	PRINTING MOULDS, CALYX, PISTIL AND STRUCTURAL PARTS
FABRICATION EQUIPMENT	**LASER CUTTER**	CUTTING THE TRANSPARENT ACRYLIC CONTROL UNIT
DIGITAL FABRICATION	**FUSION 360**	3D MODELLING OF MOULDS AND STRUCTURAL COMPONENTS
DIGITAL FABRICATION	**BAMBU STUDIO**	PREPARING AND SLICING 3D PRINT FILES
PROGRAMMING	**ARDUINO IDE**	WRITING, UPLOADING AND TESTING ARDUINO CODE
AUDIOVISUAL TESTING	**PURE DATA**	TESTING REAL-TIME DATA AND SOUND PROCESSING
AUDIOVISUAL TESTING	**TOUCHDESIGNER**	POSSIBLE AUDIOVISUAL AND DATA VISUALISATION TESTING

10.3 Electronic System Overview

The electronic system is organised around the Arduino microcontroller, which acts as the interface between sensing, behavioural mapping and physical output.

The system integrates three input layers:

INPUT TYPE	COMPONENT	SIGNAL TYPE
Environmental input	Soil moisture sensor	Analog
Plant bioelectrical input	Pocket Scion	Audio / data, depending on configuration
Human physiological input	Heartbeat sensor	I2C / pulse input

The system controls three output layers:

OUTPUT TYPE	COMPONENT	CONTROL METHOD
Pneumatic movement	Pumps and valve	PWM / digital switching
Light	WS2812B LED strip	Digital LED data
Sound	Pocket Scion or external software	Direct audio / computational processing

The prototype uses a modular structure. The plant and environmental sensing layers can operate in a compact configuration with direct sound output from Pocket Scion, or expand into computational environments such as Pure Data, Web Audio or TouchDesigner.

10.4 Pin Mapping

The following pin configuration was used during development.

COMPONENT	ARDUINO CONNECTION	NOTES
Soil moisture sensor	A1	Analog input, 0–1023 range
Heartbeat sensor	A4 / A5	I2C communication: SDA / SCL
LED strip WS2812B	D5	Digital data pin
Pump IN / inflation pump	D10	PWM output
Pump OUT / deflation pump	D11	PWM output
Valve	D3	Digital output through MOSFET or driver
Pocket Scion	External audio / optional data input	Used primarily for plant bioelectrical sound

10.5 Power Management

The system requires separated power lines for stable operation. Special attention was given to the separation between low-voltage logic and higher-current actuation. Pumps and LED strips can generate electrical noise and voltage drops, which may affect sensor readings or cause unstable behaviour.

POWER LINE	USED FOR
5V	Arduino logic, sensors, LED dataline
12V	Pumps and pneumatic actuation
6V / 12V depending on valve model	Valve actuation

Recommended precautions:

- keep logic and motor power lines separated;
- use common ground between Arduino and motor driver/MOSFET modules;
- avoid powering pumps directly from Arduino pins;
- use external power for motors and high-current components;
- add a capacitor across the LED power line if flickering occurs;
- add a capacitor near the motor power input to reduce voltage dips;

The prototype uses a dual power structure, with 5V for logic, sensors and LEDs, and 12V for pumps and pneumatic actuation.

10.6 Sensor Data Inputs

The system uses three signal layers: environmental sensing, plant bioelectrical activity and human physiological input.

Soil Moisture

The soil moisture sensor provides an analog value between 0 and 1023. This value defines the environmental state of the system.

MOISTURE STATE	BEHAVIOURAL MEANING
DRY	Low hydration / tense behaviour
OK	Balanced hydration / smooth breathing
WET	High hydration / saturated behaviour

The thresholds must be calibrated according to the sensor type, plant substrate and humidity conditions.

Plant Bioelectrical Activity

Plant bioelectrical activity is acquired through electrodes connected to Pocket Scion.

In the compact configuration, Pocket Scion is used mainly as a direct plant-sound device. It produces a continuous audio signal derived from the plant's electrical variability.

In expanded configurations, Pocket Scion data or audio can be routed into computational environments such as Pure Data, Web Audio or TouchDesigner. In this case, plant activity can modulate: filtering; resonance; amplitude; density; temporal modulation; spatial sound parameters.

Heartbeat Input

The heartbeat sensor functions as a human physiological interaction layer. It detects the visitor's pulse and generates temporary modulation in the system.

Possible effects include:

- pressure accents in pneumatic movement;
- red pulse waves in the LED strip;
- temporary modulation in the sound layer.

The heartbeat input is not used as a medical measurement. It functions as a bodily rhythm that briefly enters the behaviour of the installation.

10.7 Behavioural Mapping

The prototype uses a layered mapping system:

Soil moisture → environmental state
Plant bioelectrical activity → continuous modulation
Heartbeat → temporary accent

The behavioural structure can be understood as three layers:

LAYER	SIGNAL	EFFECT
Baseline	Soil moisture	Defines DRY / OK / WET state
Modulation	Plant bioelectrical activity	Adds continuous variation
Accent	Heartbeat	Adds temporary rhythmic pulses and light

The mapping does not produce fixed sequences. It creates conditions for changing behaviour across movement, light and sound.

STATE	BEHAVES	EFFECT
DRY State	the system behaves in a tense and irregular way.	• shorter pneumatic cycles; • sharper pressure peaks; • irregular pauses; • warm yellow LED tones; • more nervous light or sound modulation
OK State	the system behaves through smoother breathing cycles.	• balanced inflation and deflation; • soft transitions; • longer inhale/exhale rhythm; • green/cyan LED tones; • stable but living movement.
WET State	the system behaves in a slower and heavier way.	• slower inflation; • saturated or delayed deflation; • longer pauses; • violet/purple LED tones; • denser or darker sound modulation.

10.8 Data Transmission

The system can operate locally through Arduino, or transmit sensor data to external software.

During development, serial communication was used to send structured data from Arduino to computational environments such as Pure Data or TouchDesigner.

Possible transmitted values include:

VALUE	DESCRIPTION
humidityRaw	Raw soil moisturevalue
humidityPct	Mapped humidity percentage
humState	DRY / OK/WETstate
heartNorm	Normalisedheartbeatsignal
fingerPresent	Finger-detection value for heartbeat sensor
BEAT	Binary beat detection
beatAvg	Estimated BPM
plantMean	Average value of the PocketScionplant signal over time
plantDelta	Difference between consecutiveplant signal values
plantVariance	Variability of the plant signal
plantDeviation	Standard deviation of the plant signal

A compact serial format can be used for real-time communication. In previous tests, the system used structured packets with a synchronisation header and an update rate of approximately 25 Hz.

Example CSV structure: humidityRaw, humidityPct, humState, heartNorm, fingerPresent, BEAT, beatAvg

Example line: 542, 48, 1, 620, 1, 0, 78

- 542 = raw humidity value;
- 48 = mapped humidity percentage;
- 1 = OK state;
- 620 = normalised heartbeat intensity;
- 1 = finger detected;
- 0 = no beat detected at that moment;
- 78 = estimated BPM.

10.9 Pneumatic System

The pneumatic system controls the movement of the soft robotic flower.

COMPONENT	FUNCTION
Pump IN	Inflates the silicone actuator
Pump OUT / release system	Deflates or assists air removal
Valve	Opens/closes airflow
Tubes	Carry air into the actuator
Silicone chambers	Deform under pressure

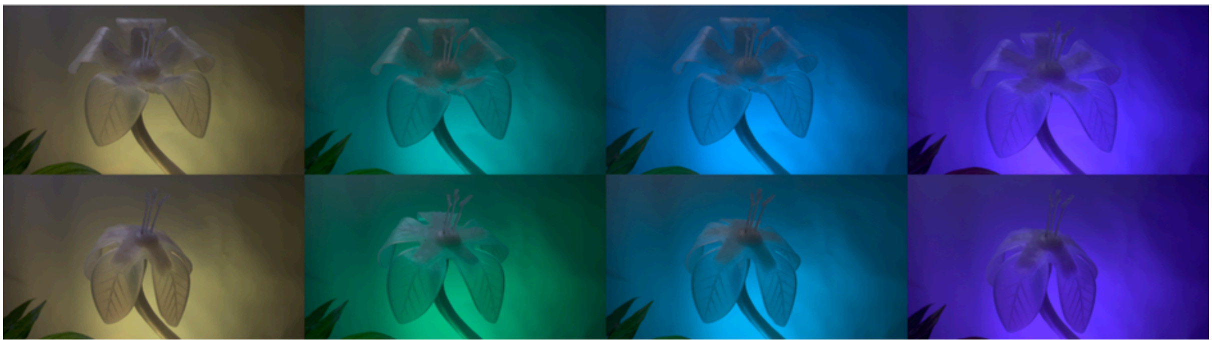
The actuator movement depends on both electronic control and material response. The code defines timing and pressure behaviour, but the final movement is shaped by silicone thickness, textile constraint, chamber geometry and air leakage.

Main parameters to tune:

- inflation duration;
- deflation duration;
- pump intensity;
- valve timing;
- pause between cycles;
- maximum safe pressure;
- heartbeat boost intensity.

During testing, excessive pressure caused ruptures in some silicone pieces. For this reason, pressure should be increased gradually and tested for each actuator.

10.10 LED System



Radical EcoSystem LED Colors. Carlotta Premazzi, 2026

The lighting system uses WS2812B addressable LEDs.

The LEDs communicate the environmental state of the system:

STATE	COLOUR BEHAVIOUR
DRY	Yellow / warm tones
OK	Green / cyan tones
WET	Violet / purple tones

The heartbeat layer adds a pulse behaviour. In this configuration, each detected beat generates a red wave or pulse across the LED strip.

The LED system is organised in two layers:

Base colour = environmental state
Pulse wave = heartbeat accent

This structure allows the plant condition and human physiological input to remain visually distinct.

10.11 Sound System

The sound system can function in two configurations.

Compact Configuration

In the compact version, sound is produced directly by Pocket Scion. This keeps the system simple and autonomous. The plant’s bioelectrical activity becomes immediately audible without requiring a computer-based sound environment.

Expanded Configuration

In the expanded version, plant signals can be routed into a computational environment.

Possible tools include:

- Pure Dat;
- Web Audio;
- TouchDesigner;
- Ableton Live;
- Max/MSP

Possible sound processes include:

- granular synthesis;
- filtering;
- resonance;
- amplitude modulation;
- spatialisation;
- temporal delay;
- layered drones or textures.

In this version, sound becomes part of a larger immersive environment. The plant signal does not need to become melody. It can act as a continuous modulation source for atmosphere, density and spatial behaviour.

10.12 Fabrication Files

The project is documented through a set of fabrication files that support reproduction and future development.

FILE TYPE	CONTENT
.stl	3D printedmould parts
.stl	Calyx / base/pistil components
.svg / .dxf	Laser-cut acrylic control unit
.ino	Arduino code
Diagrams	System architecture and signal flow
Tables	Bill of materials and cost tracking
Images / videos	Documentation of fabrication and testing
README	Setup notes and usage instructions

These files reflect the current prototype and can be adapted for future versions.

10.13 Fabrication Workflow

Physical and Digital fabrication workflow. Carlotta Premazzi, 2026

The fabrication process combines digital modelling, 3D printing, silicone casting, laser cutting and electronic assembly.

10.13.1 3D Modelling and Printing

FABRICATION

TOOLS	3D PRINTER
MACHINE	BAMBU LAB H2D,
MATERIAL	PLA FILAMENT (ELEGOO PLA 1.75)
SOFTWARE	FUSION 360 (MODELING), BAMBU STUDIO (SLICING)
PROCESS	3D PRINTING, POST-PROCESSING

SPECS

PRINT TIME	10 H
MATERIAL USAGE	150 G
LAYER HEIGHT	0.2 MM
INFILL	15% (HONEYCOMB)

3D printing workflow for moulds and structural components, including modelling, material selection, printing, support removal and assembly. Carlotta Premazzi, 2026.

The mould and structural parts were produced through a staged digital fabrication process.

DESIGN

- Model the parts:
  - silicone mould parts;
  - calyx;
  - pistil;
  - structural base;
  - support components.
- Define channels and joints
- Check alignment

PRINTING

- Slice the files
- Print in transparent PLA
- Remove supports
- POST-PROCESSING

POST-PROCESSING

- Clean printed parts
- Test fitting
- Assemble if needed

Important fabrication notes:

- Channel dimensions affect airflow
- Wall thickness affects movement
- Alignment between mould parts is critical
- Print settings may require adjustment

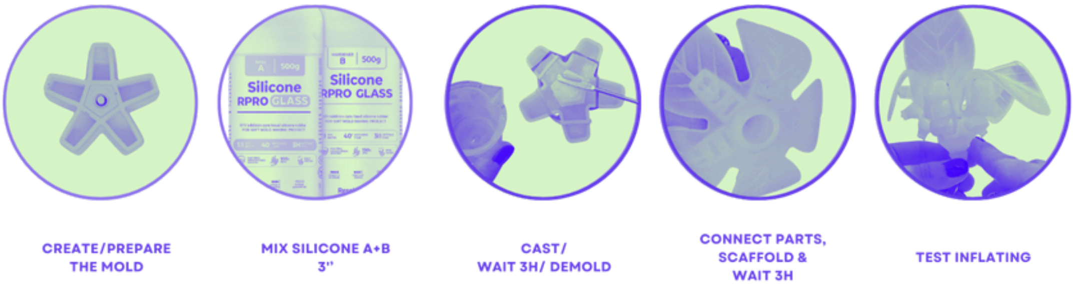
10.13.2 Silicone Actuator Casting

FABRICATION

TOOLS	3D PRINTER, MIXER, JAR
MACHINE	GCC BAMBU LAB H2D (MOLD FABRICATION)
MATERIAL	PLA FILAMENT, SILICONE A/B
SOFTWARE	BLENDER, FUSION
PROCESS	3D PRINT, CASTING

SPECS

MIX RATIO	1:1 (A/B)
MIX TIME	~3 MIN
CURING TIME	~3 H
MATERIAL USAGE	100 G



Silicone pneumatic actuator fabrication workflow, including mould preparation, silicone mixing, casting, scaffold connection and inflation testing. Carlotta Premazzi, 2026.

The silicone actuator was fabricated through a multi-stage casting process:

PREPARATION

- Clean the mould.
- Mix silicone A/B.

CASTING

- Cast first layer.
- Remove bubbles.
- Let partially cure.
- Place textile scaffold.
- Cast second layer.
- Close / align mould.

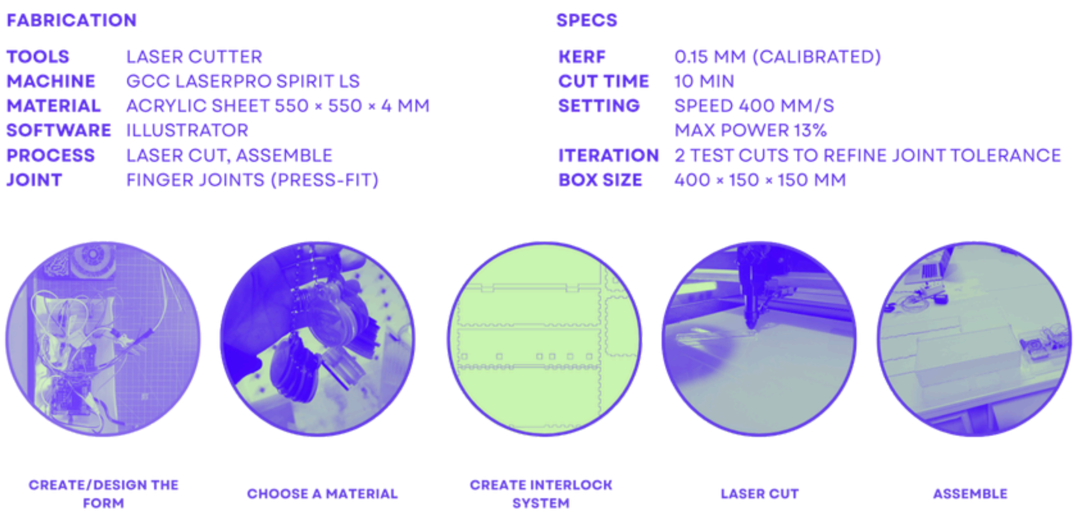
FINISHING / TESTING

- Let fully cure.
- Demould carefully.
- Clean air channels.
- Connect tube.
- Test at low pressure

Important fabrication notes:

- Trapped air bubbles can weaken the actuator
- Excess silicone can block internal channels
- The textile scaffold must not obstruct airflow
- Each piece should be tested gradually

10.13.3 Laser-Cut Control Unit



Laser-cut acrylic control unit fabrication workflow, including material selection, kerf calibration, finger-joint design and assembly. Carlotta Premazzi, 2026.

The control unit was produced through a staged laser-cut fabrication process.

DESIGN

- Draw the box layout
- Add ventilation openings
- Add cable and tube exits
- Prepare finger joints

LASER CUTTING

- Calibrate kerf
- Cut PMMA panels
- Check joint tolerance

ASSEMBLY

- Assemble the box
- Route tubes and cables
- Place electronics
- Keep 5V and 12V lines separated

Important fabrication notes:

- Kerf compensation affects the fit
- Ventilation is needed for electronics and pumps
- Cable exits should remain accessible
- The transparent enclosure keeps the infrastructure visible

10.13.4 Electronic Assembly

FABRICATION		SPECS	
TOOLS	SOLDERING IRON, WIRE STRIPPER, HELPING HANDS, MULTIMETER	POWER	5V / 12V SYSTEM
COMP	ARDUINO, SENSORS, CABLES, PUMPS	CONNECTION TYPE	SOLDERED + MODULAR CONNECTIONS
SOFTWARE	ARDUINO IDE		
PROCESS	WIRING, SOLDERING, INTEGRATION		

Electronic assembly workflow, including wiring, soldering, power separation and integration of sensors, pumps and LEDs. Carlotta Premazzi, 2026.

The electronic system was produced through a staged assembly and testing process.

WIRING	• Plan connections • Cut and strip wires • Connect sensors
POWER / CONTROL	• Connect LED data and power • Connect pumps and valve • Organise 5V and 12V power lines • Share ground between modules
TESTING	• Test Arduino communication • Test sensors • Test LEDs • Test pumps and valve • Run full behavioural test

Important fabrication notes:

- Motors and LEDs require stable power
- Power lines should be separated where possible
- Common ground is required between modules
- Components should be tested individually before integration

10.14 Documentation Workflow

The project was developed and documented using several digital tools.

CATEGORY	TOOL/PLATFORM	USE
Documentation	Canva	Presentation design and visual documentation
Documentation	MkDocs	Online documentation website
Documentation	Miro	System diagrams and conceptual mapping
Documentation	Google Sheets	Bill of materials, costs and component tracking
Documentation	Notion	Research notes, task organisation and process planning
Recording	Smartphone / camera	Photo and video documentation
Recording	Tripod / gimbal	Stable recording of tests and final prototype

These tools supported an iterative workflow where design, fabrication, testing and documentation developed together.

10.15 Reproducibility and Open System Considerations

The system is partially reproducible, but it should not be understood as a fixed technical object.

Some elements are standardised and easy to replicate:

- Arduino;
- sensors;
- LED strip;
- pumpstubing;
- basic electronic wiring;
- laser-cut box;
- 3D printed parts.

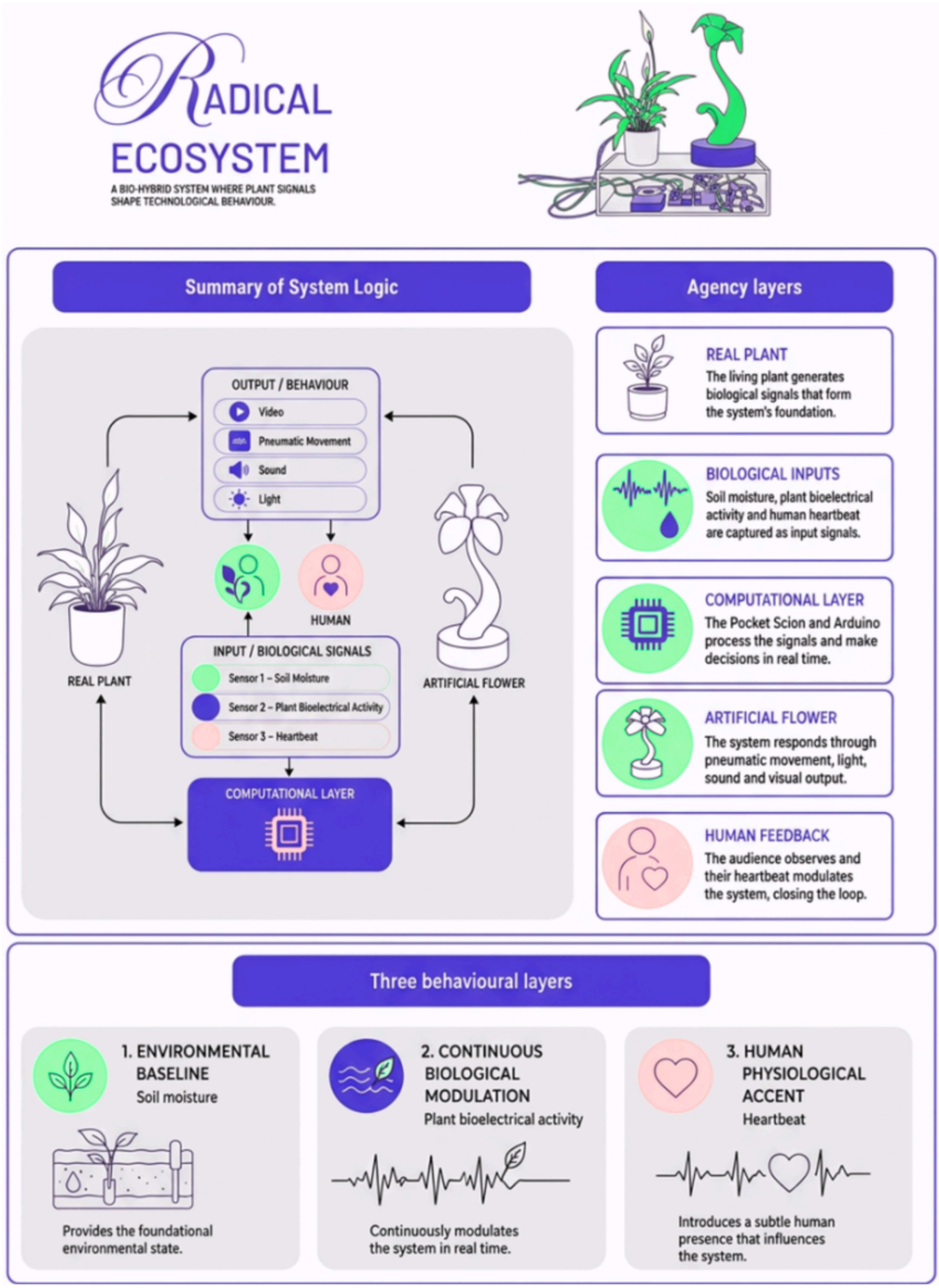
Other elements remain variable:

- silicone behaviour;
- mould accuracy;
- air tightness;
- textile constraint;
- plant condition;
- soil moisture calibration;
- plant bioelectrical signal quality;
- environmental context.

Because of this, the project is best understood as an adaptable framework. The same system architecture can be reproduced, but each version may behave differently depending on materials, plant species, fabrication quality and environmental conditions.

This variability is part of the project. The installation combines technical control with living and material uncertainty.

10.16 Summary of System Logic



Summary of the system logic of Radical EcoSystem, showing the relationship between living plant signals, computational processing, technological outputs and human modulation. Carlotta Premazzi, 2026

The final prototype can be summarised as a bio-hybrid feedback system in which signals from a living plant are processed through an electronic and computational layer, generating technological behaviours such as pneumatic movement, LED response and sound. Human presence closes the loop through observation and heartbeat modulation.

LIVING PLANT
▼
SOIL MOISTURE + BIOELECTRICAL ACTIVITY
▼
ARDUINO / POCKET SCION / COMPUTATIONAL LAYER
▼
PNEUMATIC MOVEMENT + LED BEHAVIOUR + SOUND
▼
AUDIENCE OBSERVATION + HEARTBEAT MODULATION

The system operates through three behavioural layers: an environmental baseline defined by soil moisture, a continuous biological modulation based on plant bioelectrical activity, and a human physiological accent introduced through heartbeat detection.

This technical structure supports the conceptual aim of the project: to create a bio-hybrid installation in which plant-related signals shape technological behaviour through movement, light and sound.

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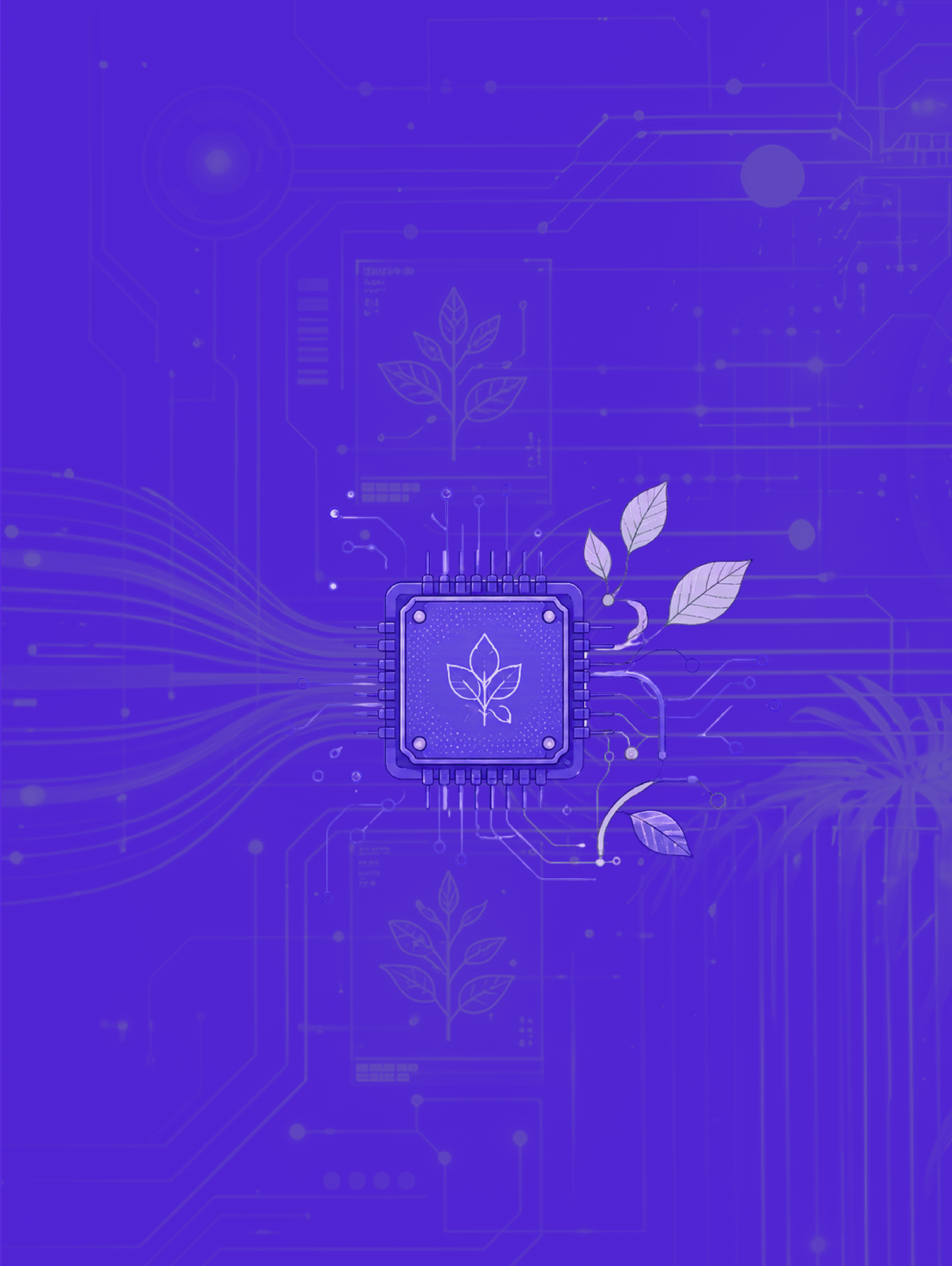
12. License

Full project documentation available through the Fabricademy archive:
class.textile-academy.org/2026/carlotta-premazzi/



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