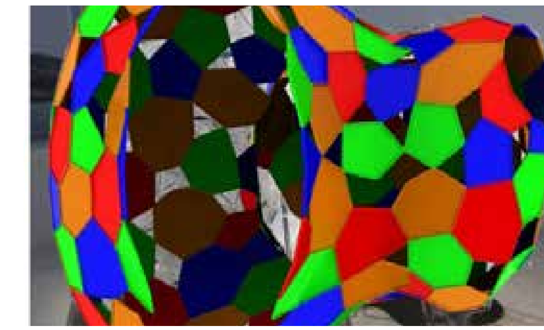
Puckett Research & Design

BioDigital Hybrids

- STEMcloud v2
- CyberGarden v4
- Urban Algae Folly
- METAfolly

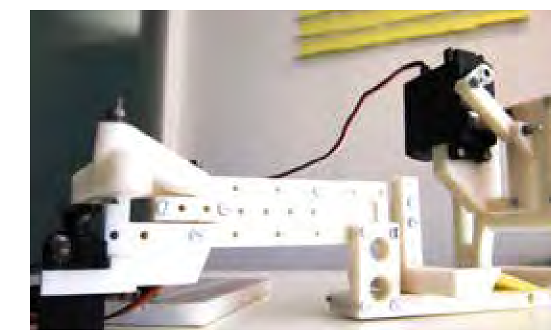


Custom Fabrication Systems

- RoboFold
- FieldCondition
- BlackBox
- FabNodes



Creative Surveillance

- Xiamen Masterplan
- Kinect Res. Framework
- MAI Livestreaming
- Pulse v1




BioDigital Hybrids

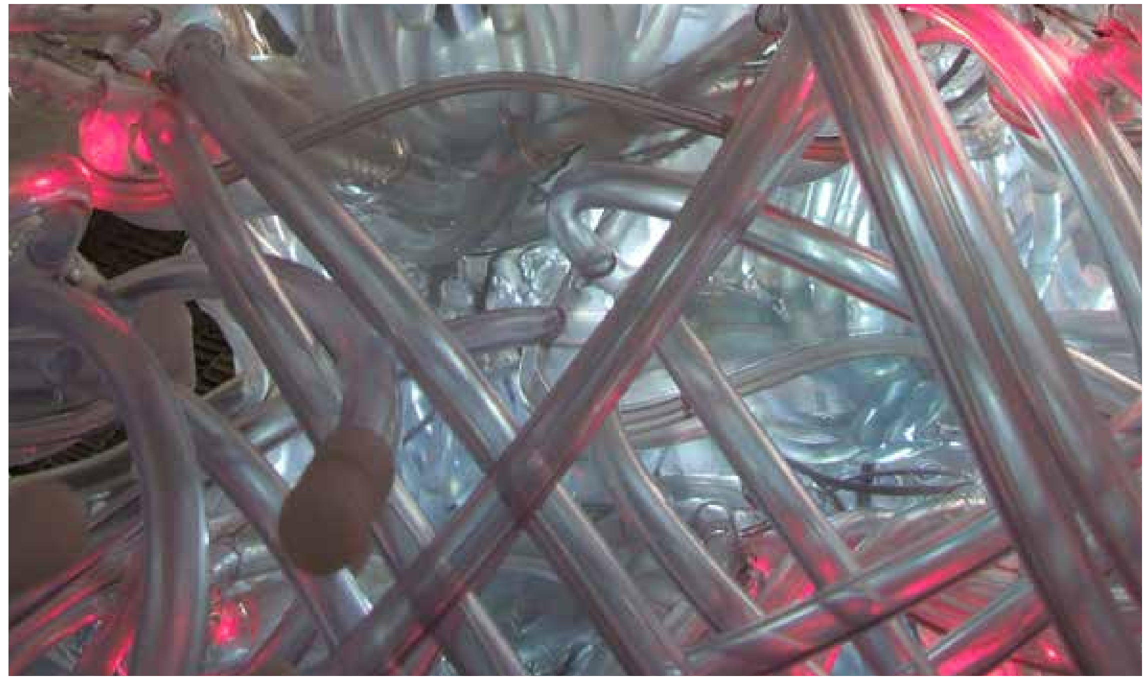
STEMcloud v2

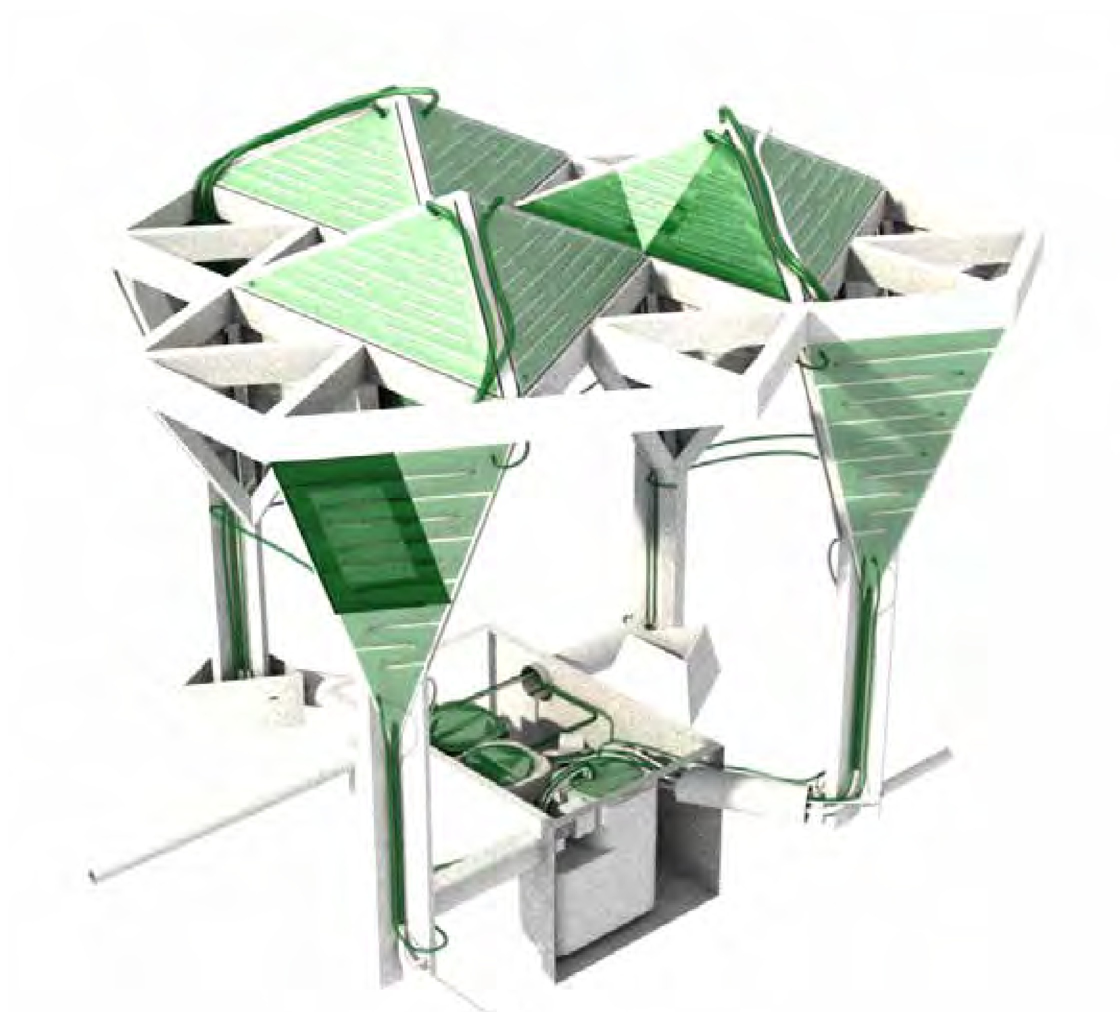
CyberGarden v4

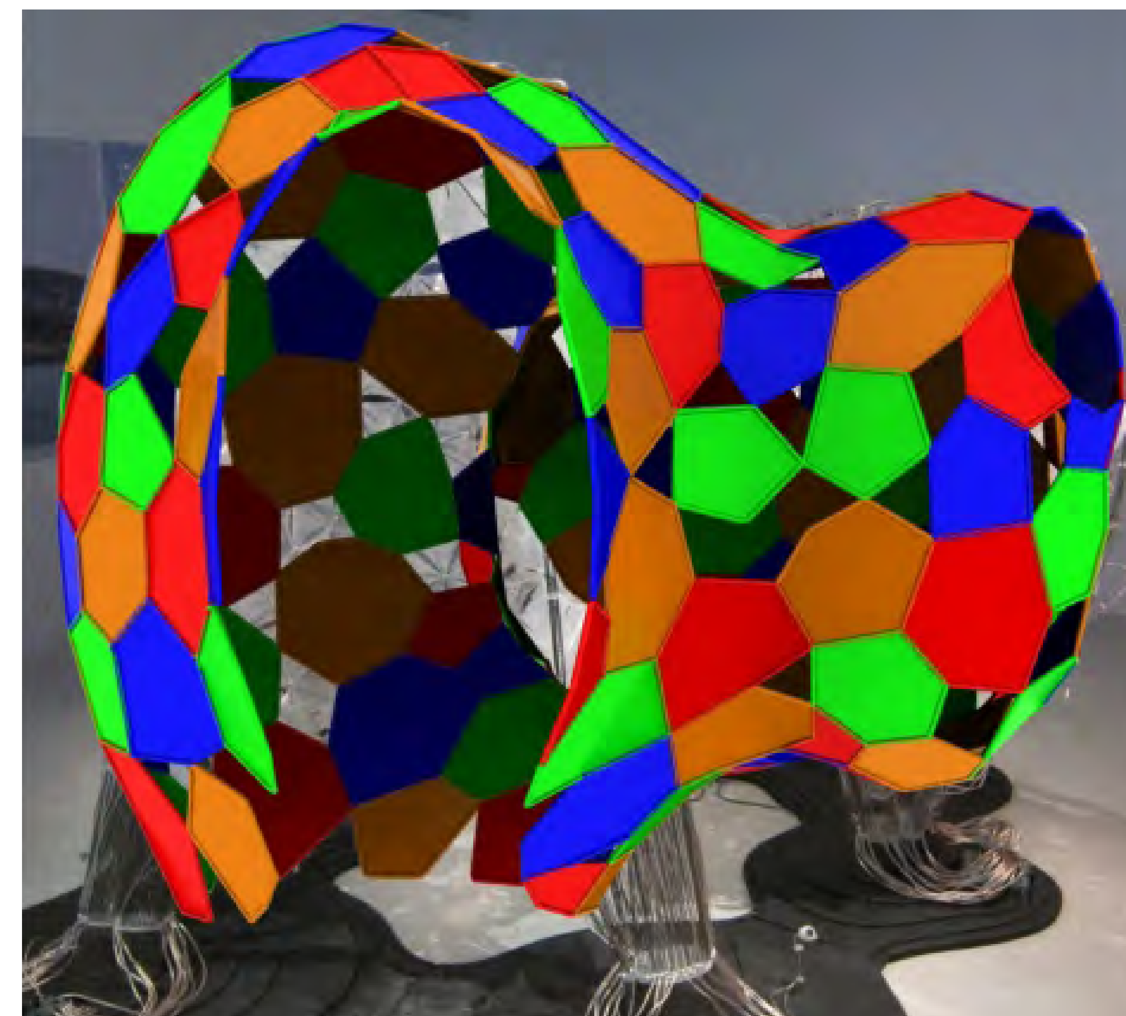
Urban Algae Folly

METAFolly

One of the significant areas of my work has been developing interactive installations that create new hybrids of biological and digital intelligence and response. The goal has been to investigate how modes of interaction, monitoring, and visualization can create a new relationship between visitors and the structures to create new typologies of natural systems. This has been developed in two ways: creating systems that physically entangle biological and electrical materials and creating new types of nature through the digital and physical manipulation of manufactured materials.







Top Left: STEM cloud
Top Right: CyberGarden v4
Bottom Left: Urban Algae Folly
Bottom Right: METAfolly

STEMcloud v2

Commissioned by The International Biennial of Contemporary Art Of Seville (BIACS)

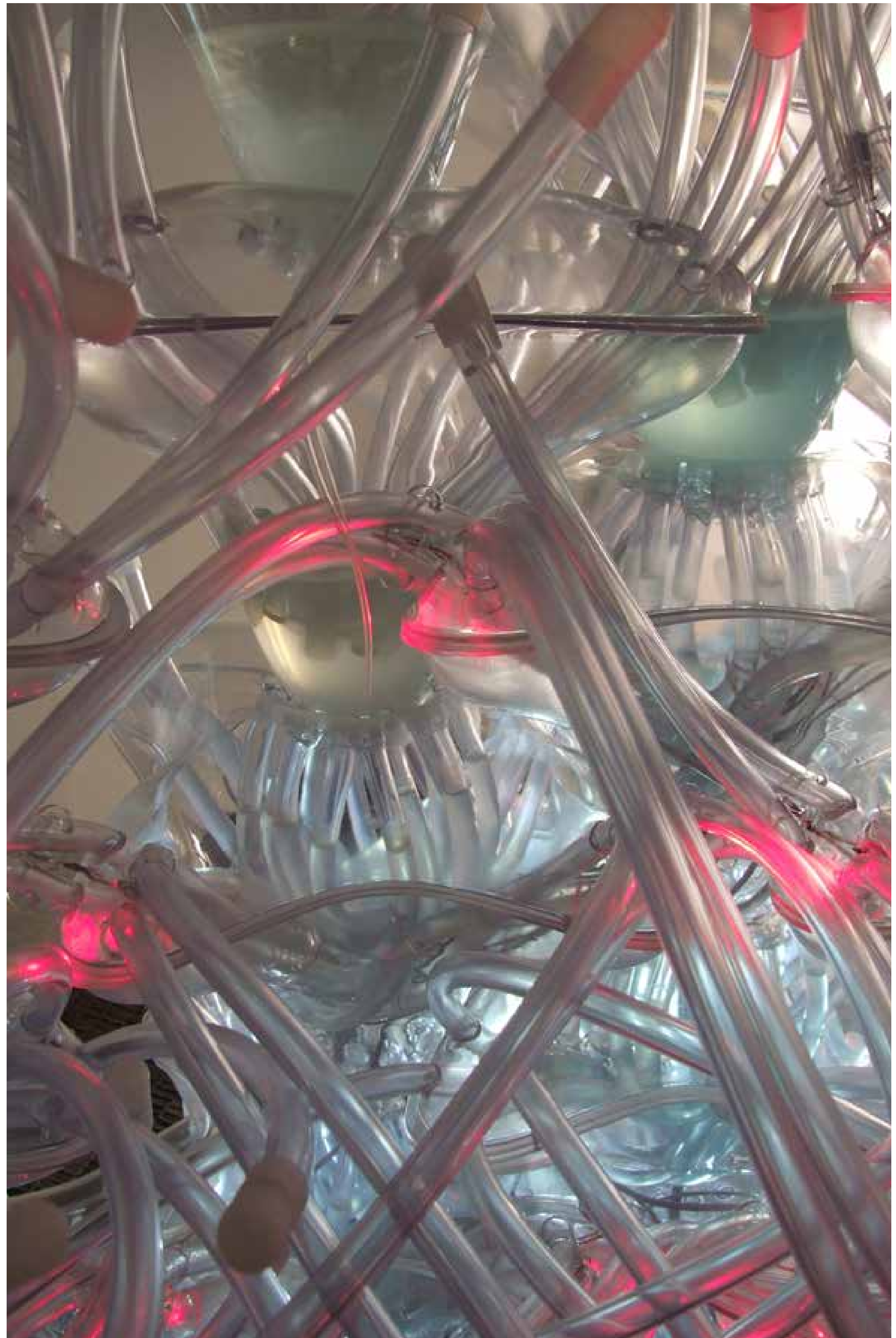
Collaborator:
EcoLogic Studio

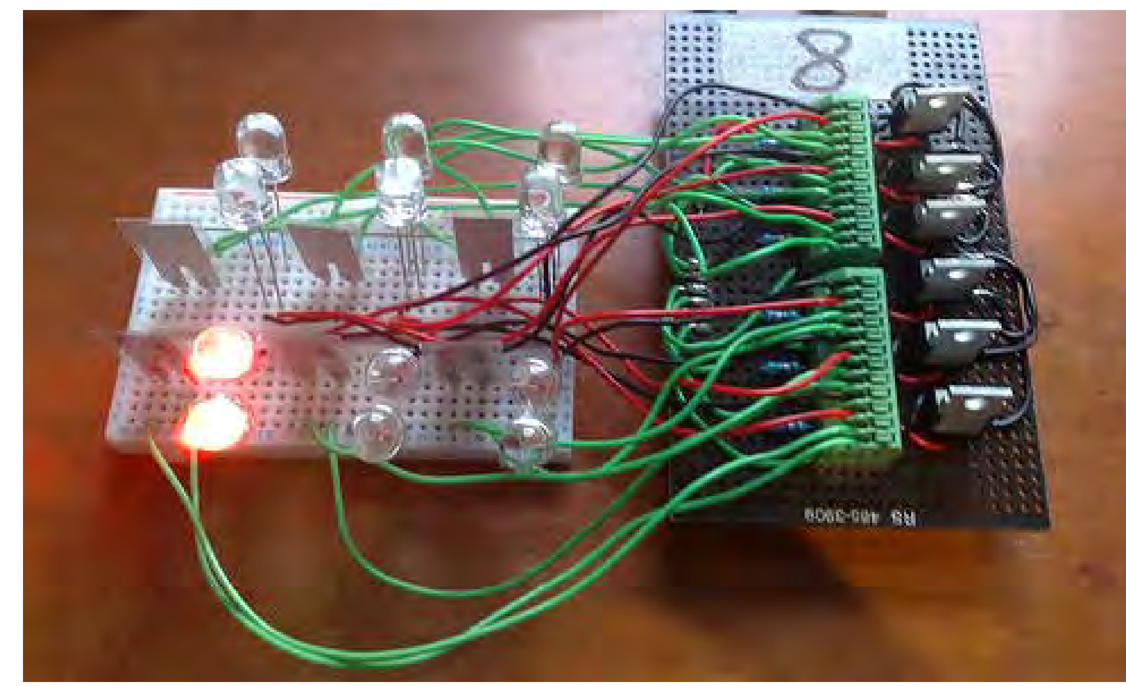
Exhibition:
2008 International Biennial of Contemporary Art Of Seville (BIACS)

Publication:
Systemic Architecture, Routledge, 2012

STEMcloud v2 was developed in collaboration with Ecologic Studio as an interactive installation that invited visitors to participate in the growth of algae that were collected in the water from a local river. A secondary digital monitoring system was created to monitor the health of the overall system and provide visitors with a visualization of their influence on the bioreactor.

The basic variables in the system were Water + Nutrients + CO_2. The CO_2 was to be provided by the visitors by blowing into the tubes. The goal for the monitoring system was to track the amount of interaction (and thus CO_2) units were receiving, save this to a database to compare to the other variables over time, and reflect this through the intensity of the LEDs. Units which received less CO_2 glow brighter to attract attention from visitors to gain theri CO_2. The LEDs also provided realtime feedback to users as to which units they were affecting.





Left: View of the STEMcloud after running for 1 week
Above: Visitors to the exhibition input CO_2 by blowing into the connected tubes.
Below: Prototype for testing the input sensors and resulting behaviour of the LEDs.

CyberGarden v4

Created for the 2011 Smart Geometry Conference Workshop Series.

Collaborators:
EcoLogic Studio

Exhibitions:
2011 Smart Geometry Conference, Copenhagen, Denmark

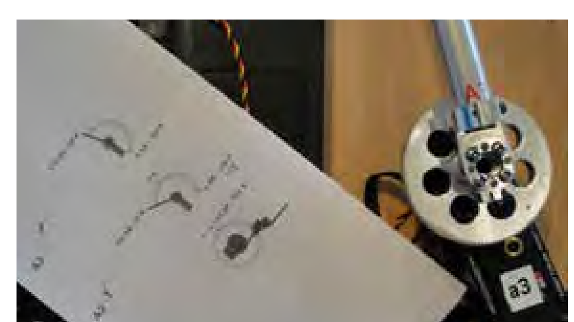
2011 ACADIA Conference, Banff, Canada

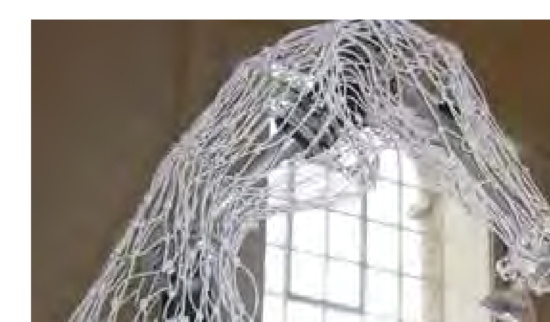
Publications:
Inside Smart Geometry, Wiley, 2013

Proceedings of 2011 ACADIA Conference.

CyberGarden v4 videos

CyberGarden v4 is a multilayered, intelligent system that passes electronic and biological information between layers of manufactured and biological materials. It utilizes a network of radiation sensors and custom robotic arms to create a self-regulated bacteria farming system. The system is shown as a scale model whereby bacteria could be cultivated at various rates to create different levels of shading within a transparent canopy structure through the density/opacity of the bacteria growth. The physical prototype and digital model engage in a generative dialogue and co-evolve over the course of each exhibition. The petri dish components are made of translucent perspex and when added to the physical model cause a change in the lighting field. This affects the digital plan and triggers the emergence of other gardening components to be designed, cut and added on.





Top Right: CyberGarden V4.0 prototype exhibited at Smart Geometry 2011.
Bottom Right: Development of the Bacteria, robotic and material systems.

Urban Algae Folly

Commissioned by Future Food District
EXPO Milan

Colloborators:
EcoLogic Studio

Exhibition:
EXPO 2015, Milan, Italy
(~ 20 million visitors)

Press:
EcoLogicStudio Transforms Cladding System Into a Bioreactor Ben Hobson, Dezeen.com

Urban Algae Folly
Federico Collela, revistaplot.com

Futuristic Urban Algae Folly grows food, fuel and shade.
Laylin Tafline, Inhabitat.com

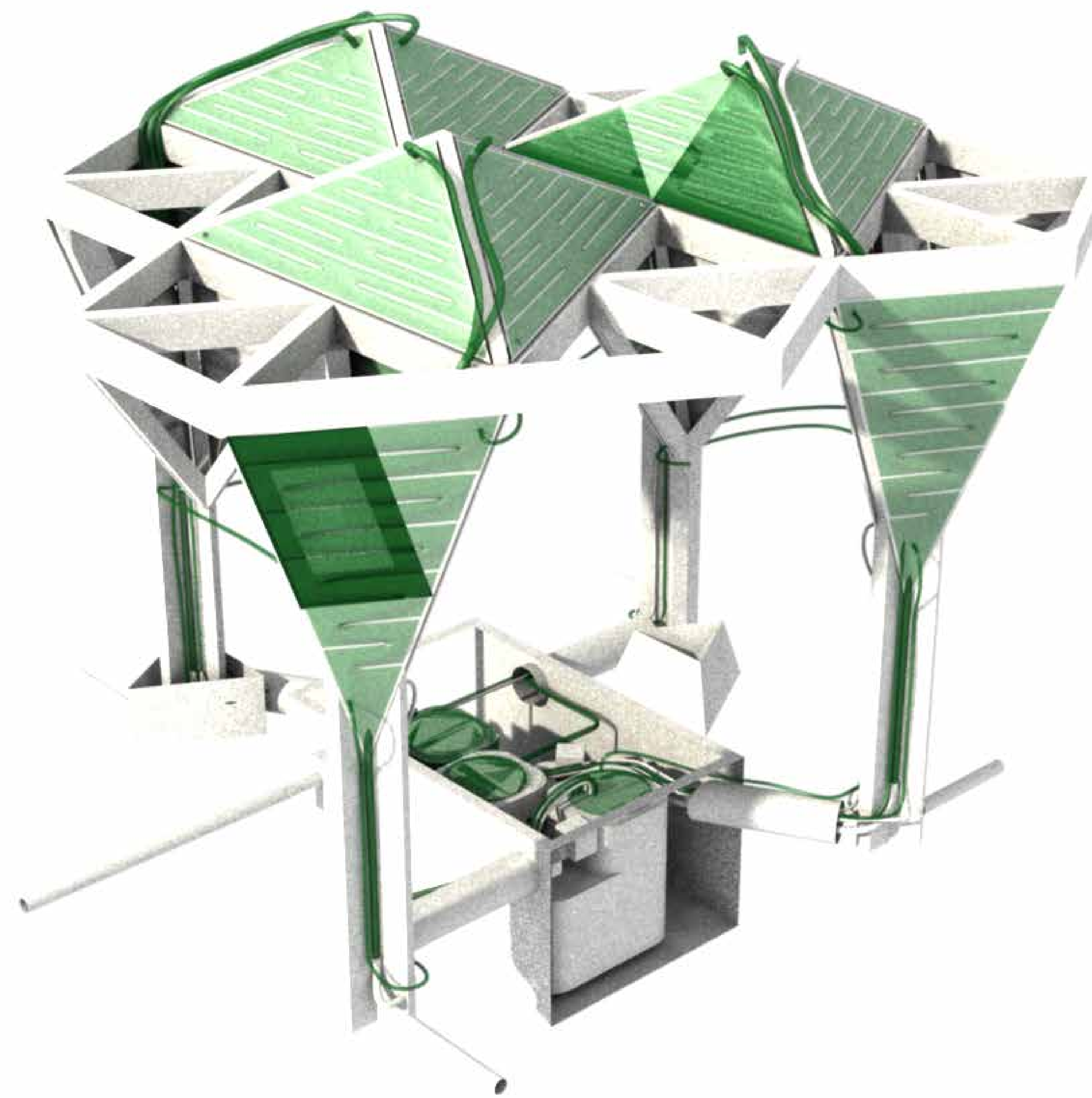
Urban Algae Folly
Marcos Cruz, syndebio.com

Will Buildings of the Future be Cloaked in Algae?
Emily Matcher, Smithsonian.com

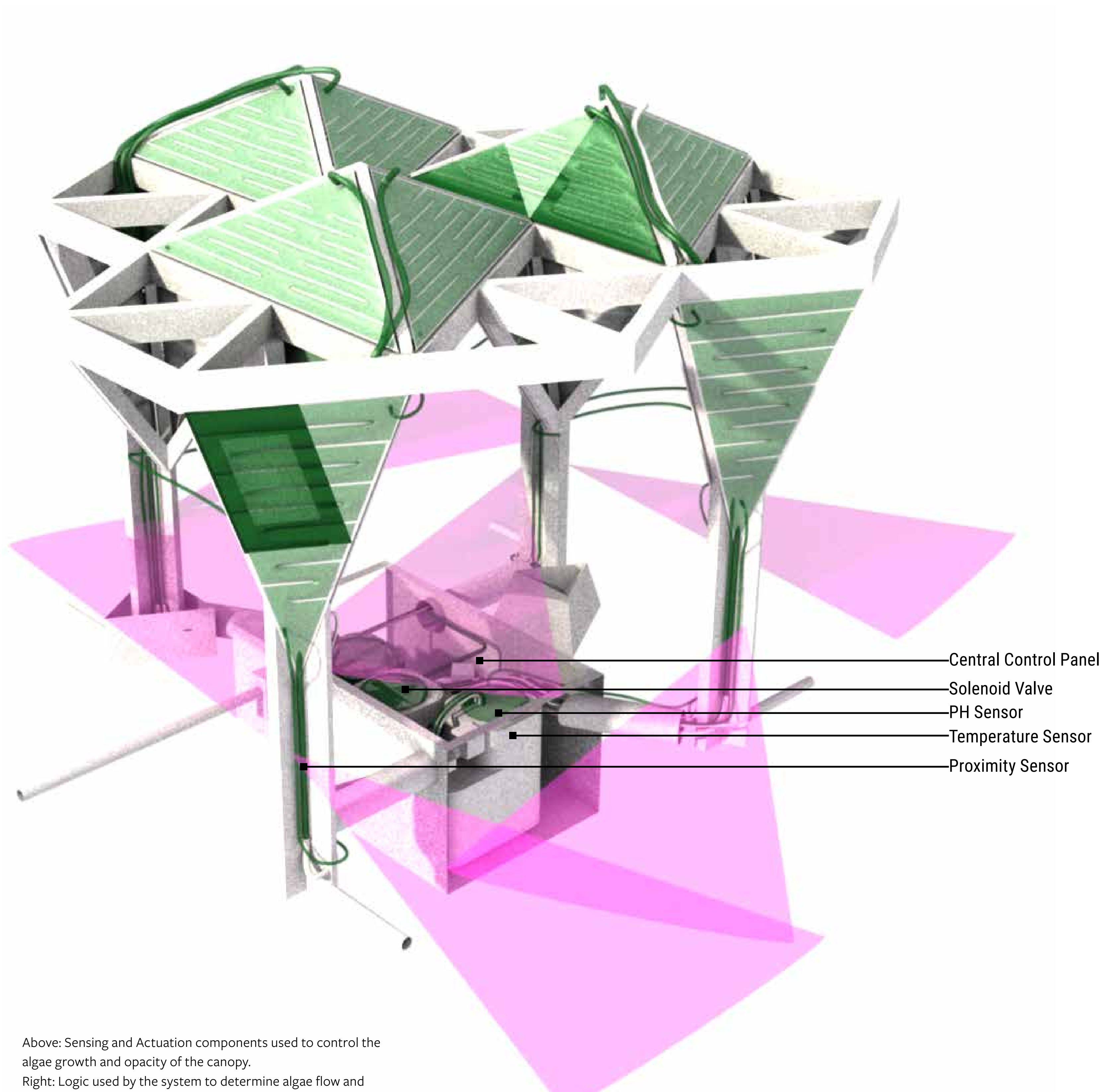
Urban Algae Folly videos

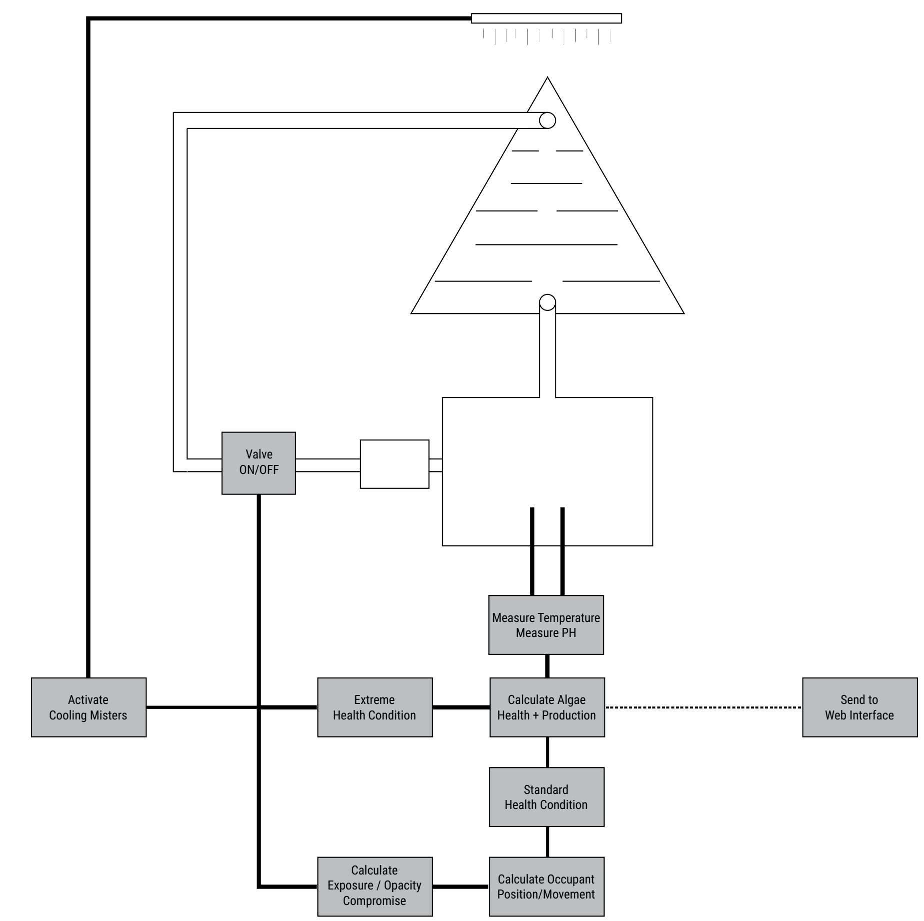
Urban Algae Folly is an interactive pavilion that links the movement of people to the growth patterns of algae embedded in custom ETFE panels. The system creates a dialogue between the environmental needs of the algae for oxygen production and the needs of the visitors for shade. The oxygen production and CO_2 consumption of the Folly are monitored in real-time and fed to a web interface that visualizes the values.

The project is created as a self regulated bioreactor that allows for human interaction when the algae is in a healthy state. To achieve this a series of 9 circuits of algae + water are created to allow circulation between underground holding tanks and the transparent ETFE structure. When the algae passes through the structure it is exposed to sunlight which triggers the photsynthesis process and produces oxygen. Consequently, while passing through the structure the algae become heated by the sun. The overall health of each algae circuit is monitored via temperature and PH sensors in the tanks. When the algae are at a healthy operating range, users can interact. The interaction is created through 9 proximity sensors and 9 solenoid valves. The activity level and location of visitors is determined by the sensors and the valves open/close to provide shade to the visitors by pumping more/less algae through different parts of the structure. This competition between algae health and the need for shade played out over the course of the exhibition.



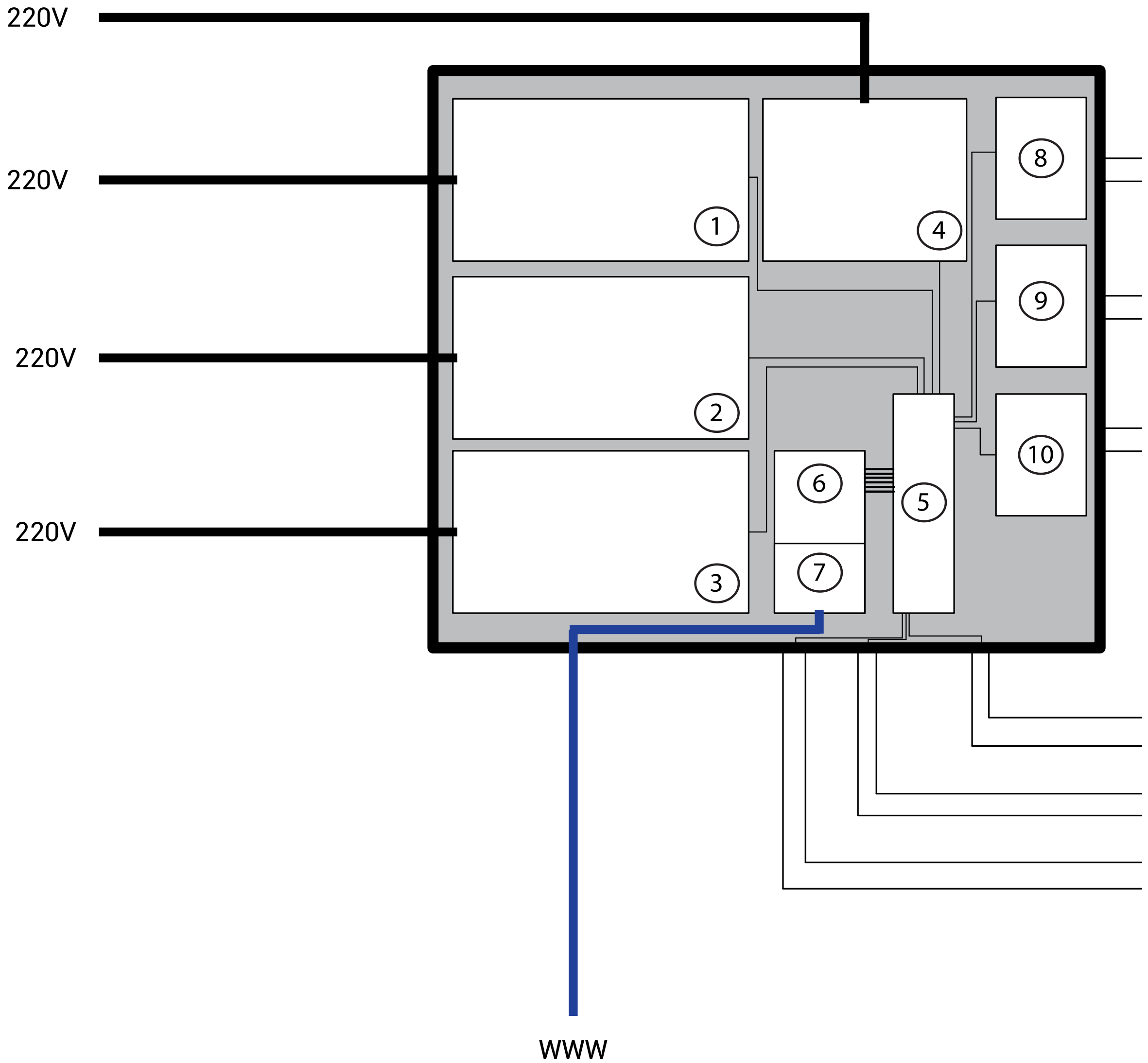
Right: Rendering of the Urban Algae Folly structure and underground mechanical system.





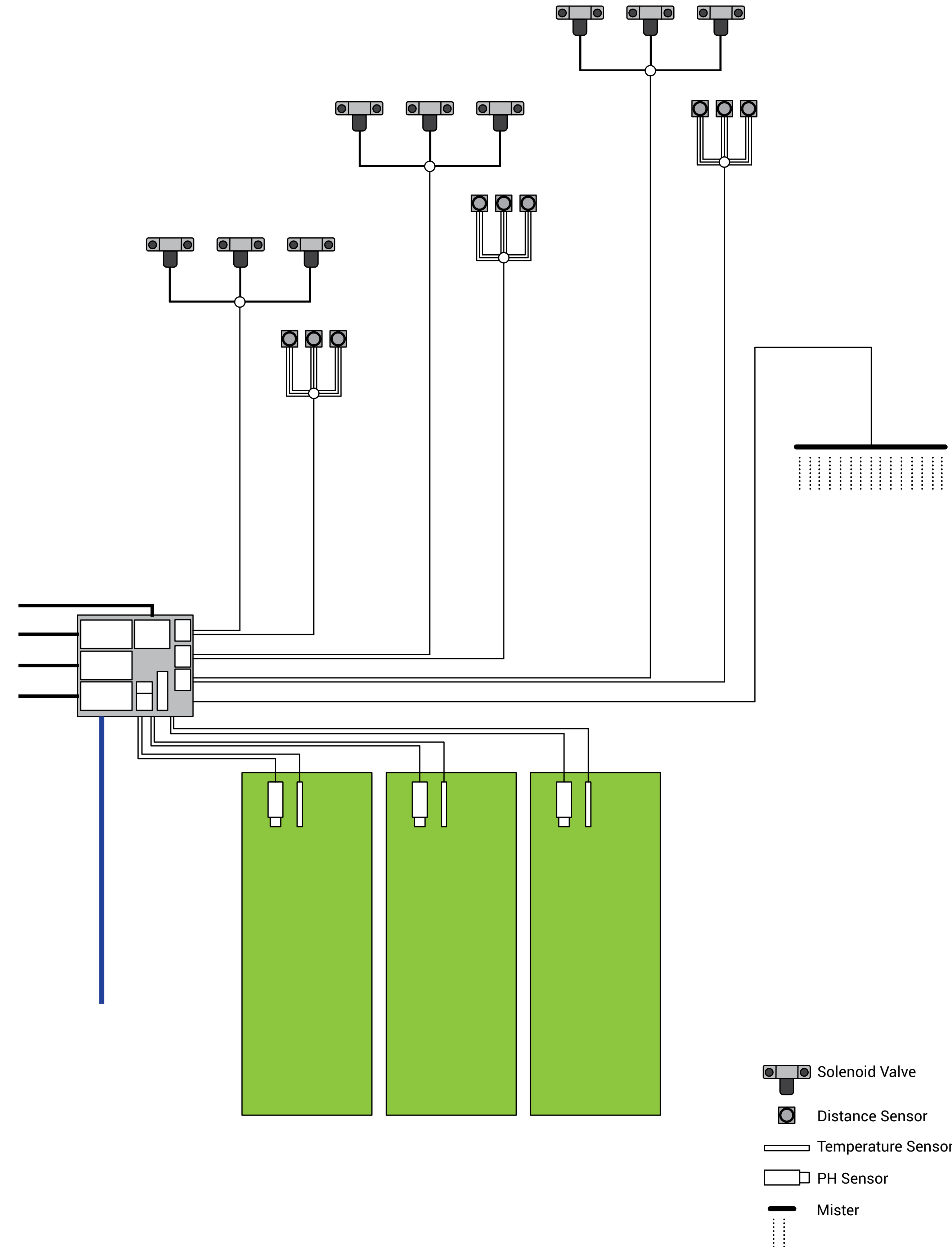
Above: Sensing and Actuation components used to control the algae growth and opacity of the canopy.
Right: Logic used by the system to determine algae flow and monitor oxygen production.

Next Page: Detail of the control unit, sensors, and actuators

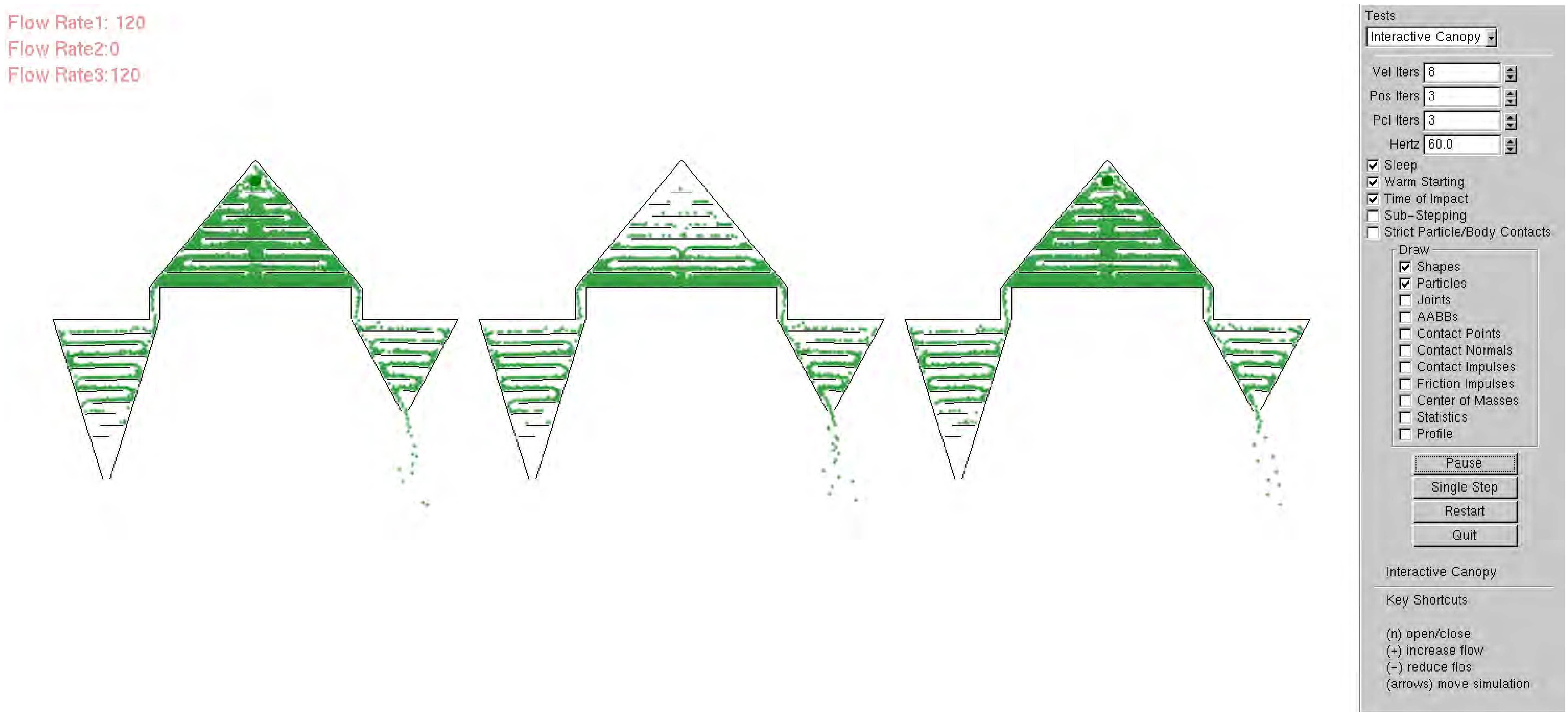


Central Control Panel

1. 12V Solenoid Power Supply
2. 12V Solenoid Power Supply
3. 12V Solenoid Power Supply
4. 9V Controller Power Supply
5. Custom PCB Connection Board
6. Arduino Mega w/ Bluetooth
7. Ethernet Shield
8. Solenoid Relay Controller
9. Solenoid Relay Controller
10. Solenoid Relay Controrller

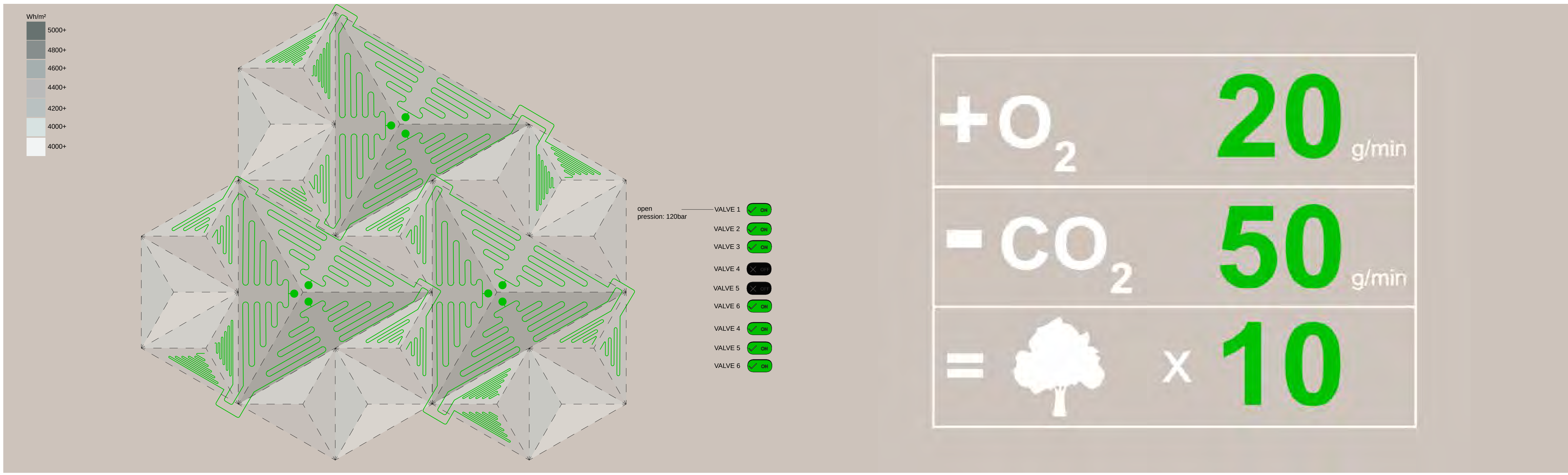


Above: Custom designed central control unit used to regulate the UAF and send data to the website.
Top Right: Custom solenoid valves created to control algae flow.
Bottom Right: Custom distance sensors and housings created to monitor the position and activity of visitors.



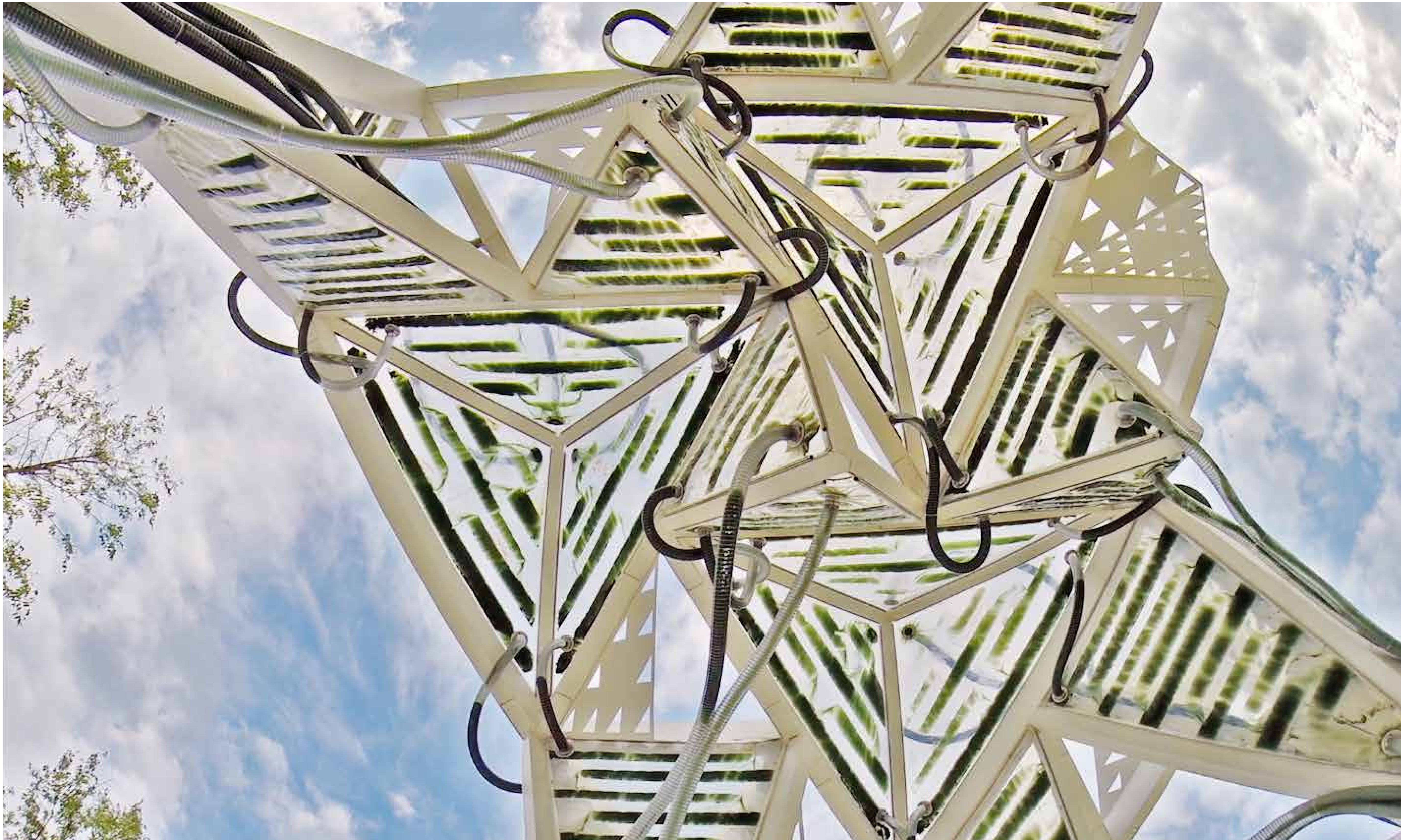
Software created to simulate the flow of algae through the ETFE panels. Panels were being designed in parallel to the control software, so a simulation was created to test overall system behaviour before installing the structure on site.

Variable opacities created through the regulation of the algae flows.



Above: Public web interface that displays current status of the valves and sensors in addition to the real-time statistics of Oxygen production and CO_2 consumption.

Next Page: View under the Urban Algae Folly.



Construction of the Urban Algae Folly


Urban Algae Folly at EXPO Milan

METAFolly

Commissioned by Fonds Régional d'Art Contemporain, Orleans, France

Collaborators:
EcoLogic Studio

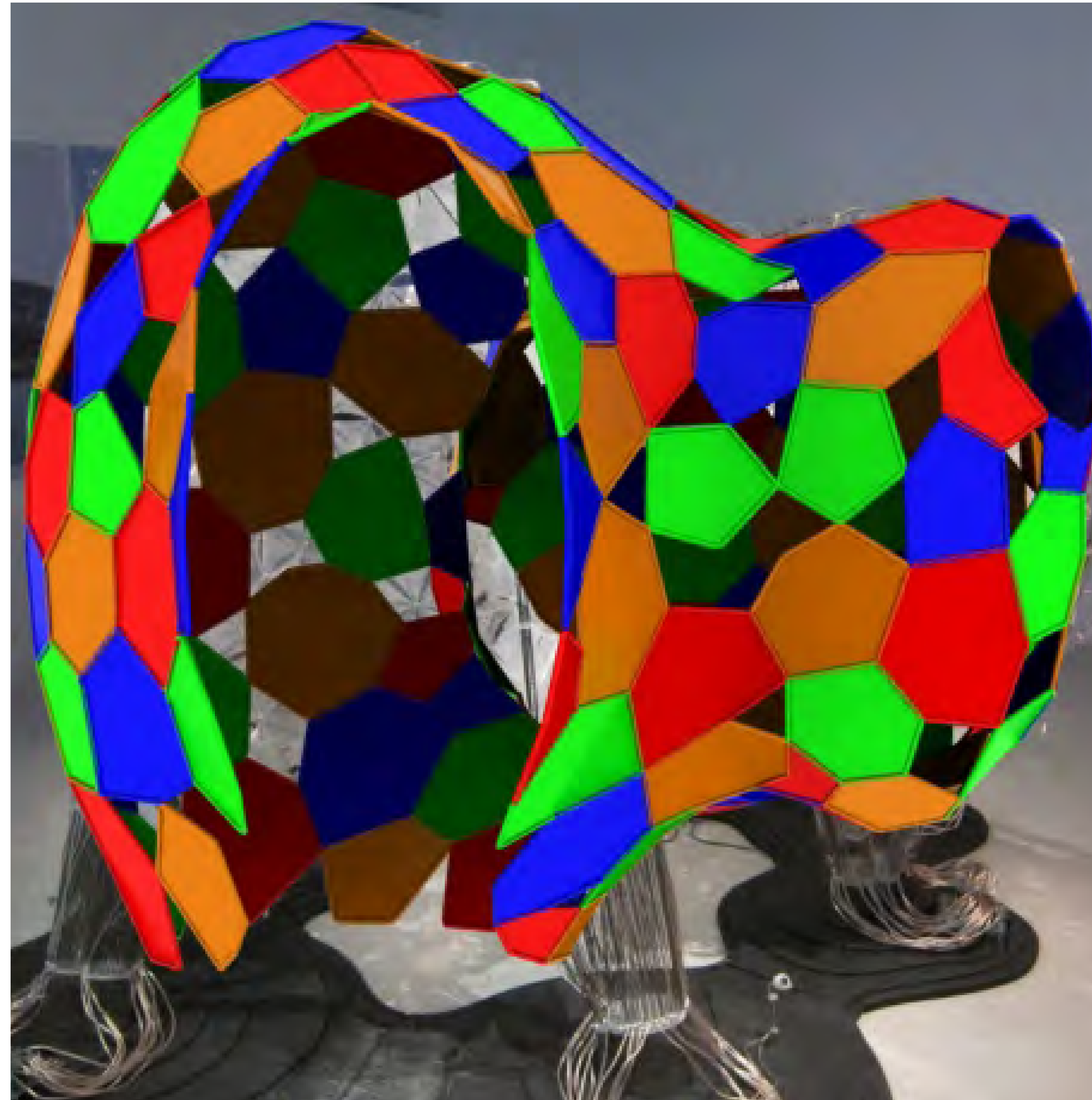
Exhibitions:
ArchiLab 2013: Naturalizing Architecture, FRAC Centre, Orleans, France

Globale: Exo-Evolution Exhibition
ZKM Museum, Karlsruhe, Germany

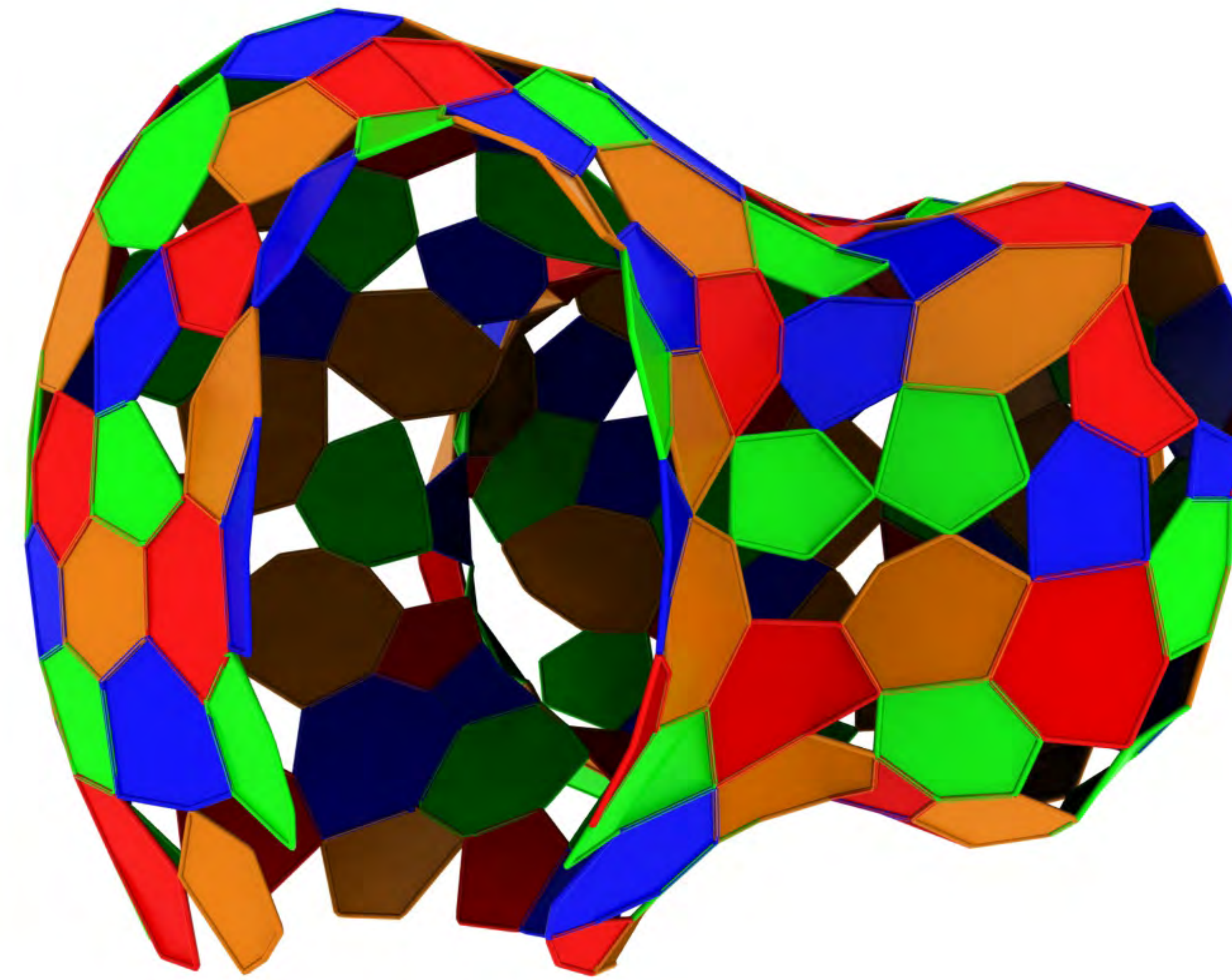
1000m2 of Desire
Centre de Cultura Contemporània de Barcelona, Barcelona, Spain

METAFolly videos

METAfolly is an interactive installation that creates an artificial swarm organism of material and sound that is linked to the movement of visitors around it. The project seeks to create a new type of "natural" system from manufactured materials, electronic components, and custom software. Embedded into the structure are 300 piezo buzzers that produce 1 of 4 distinct tones. These individual tones are created by a custom software control and a material buffer that combine to form the sound of an individual "cricket". The METAfolly works to keep each of the buzzers in a given tone in sync, while the movement of the visitors introduces a delay. The audio effect of the movement is that of a swarm of invisible entities scattering and then moving back into unison. This interaction creates a dynamic interaction between the visitors and the structure even though it is completely motionless. To develop this behaviour, a wireless control interface was developed to allow all variables to be tuned in real-time. The overall effect is an interplay of an invisible swarm of digital lifeforms in constant tension with the visitors.

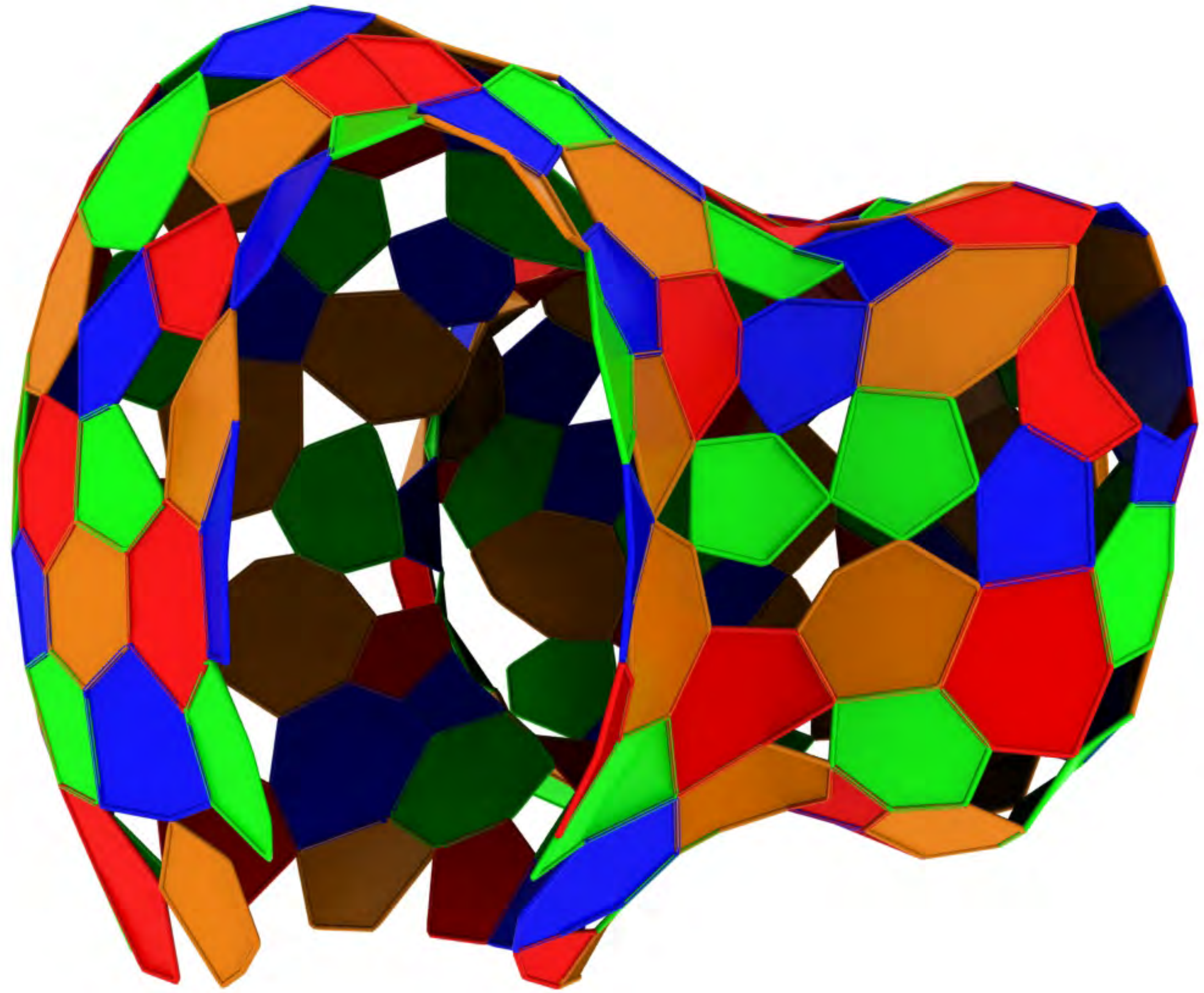


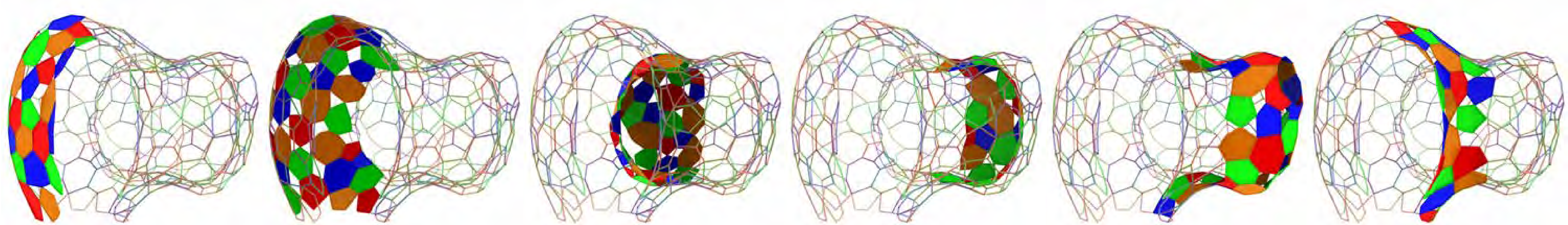
Right: The physical structure of METAfolly is overlain with the digital control structure of the software.

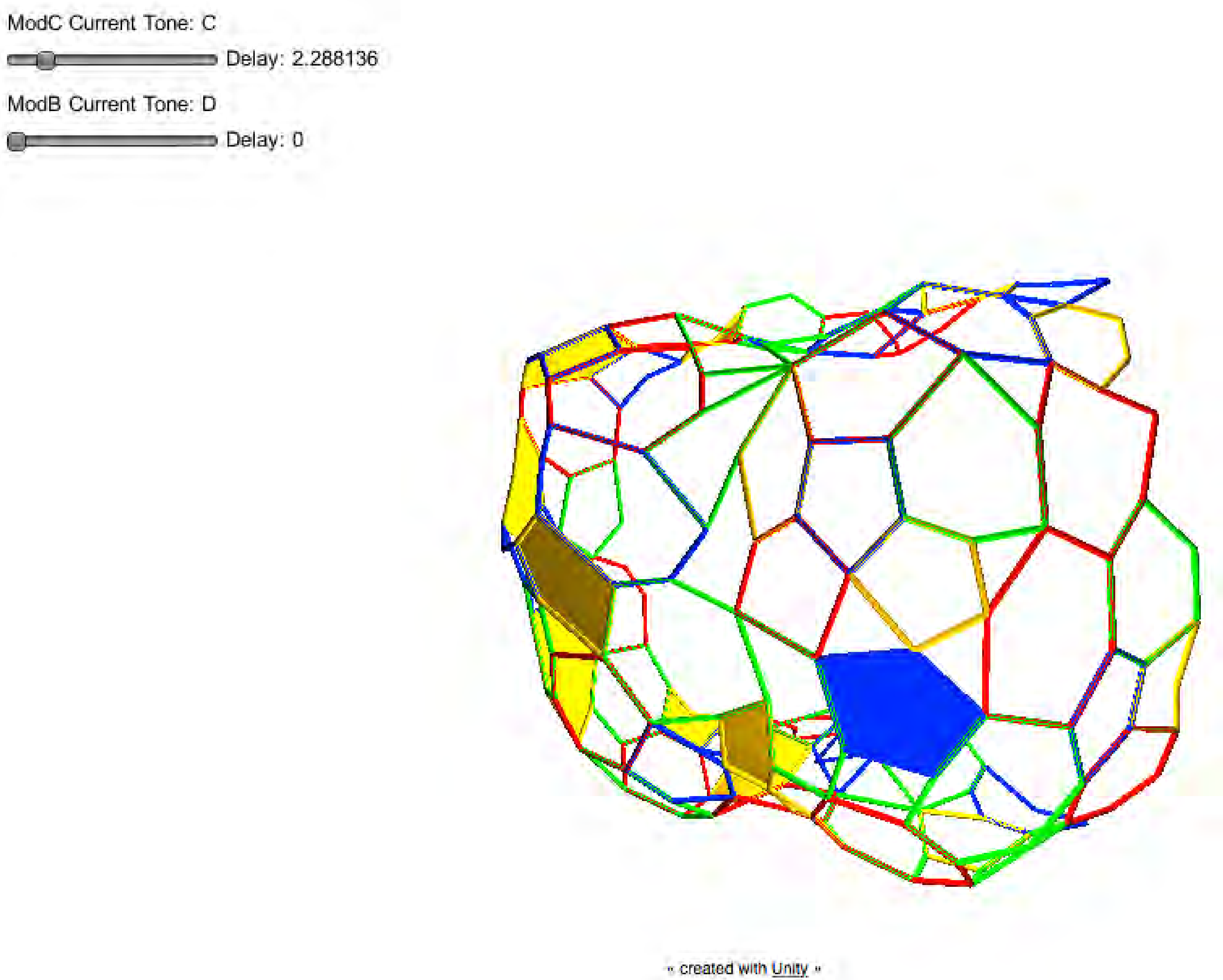


Above Left: View of METAfolly struture
Above Right: View of Software control model

The control system for the software divides the structure into 6 distinct sections.

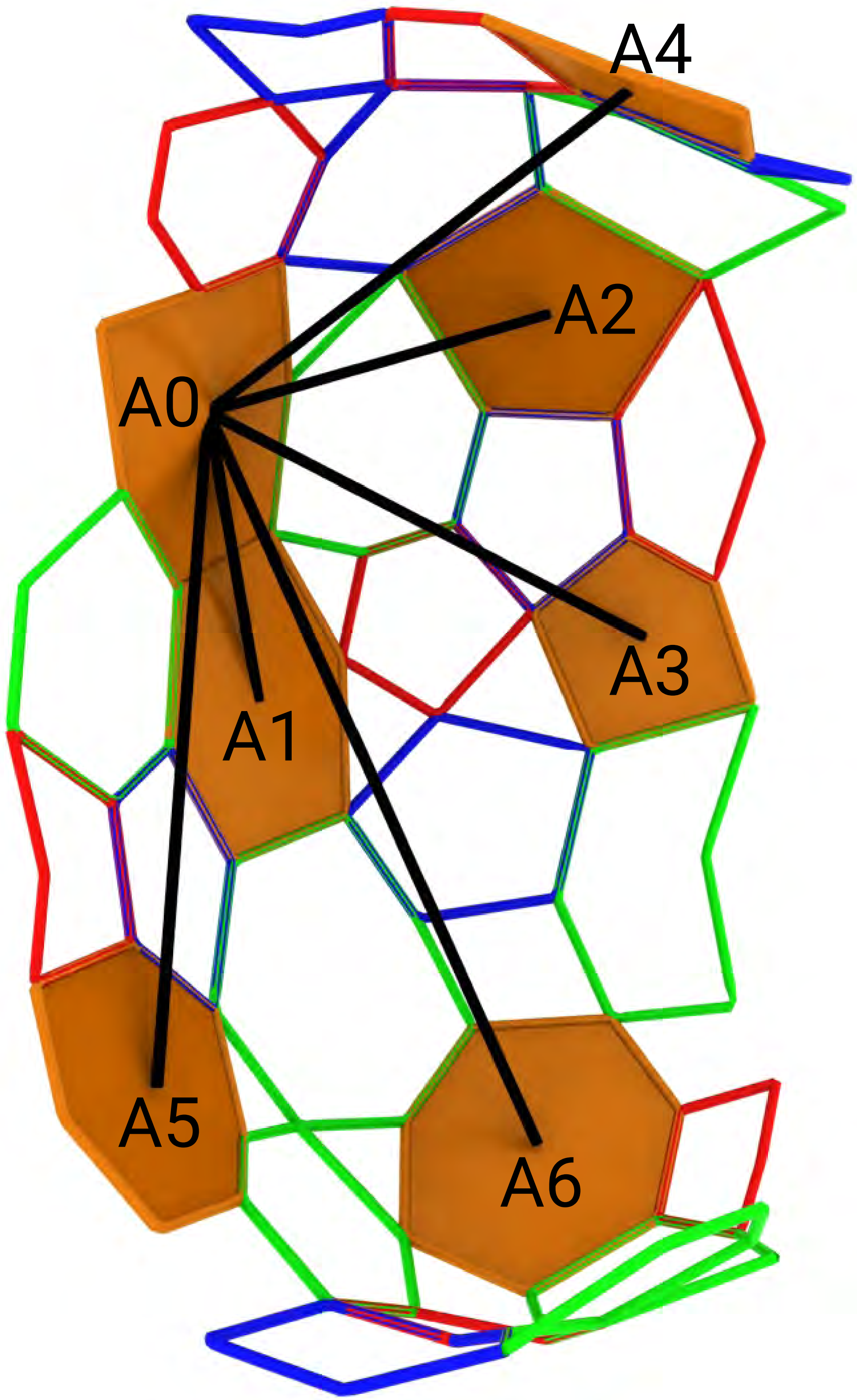


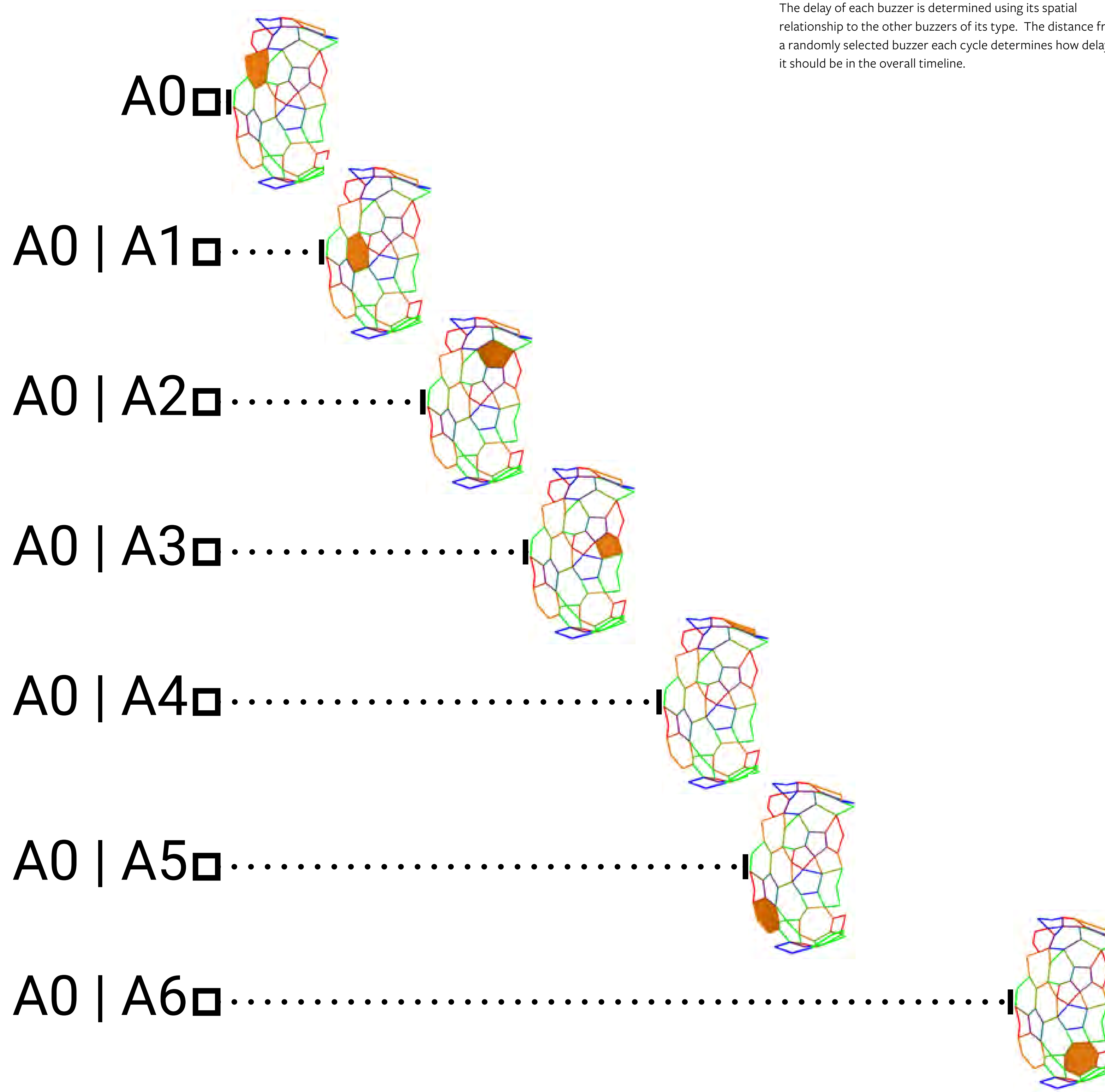




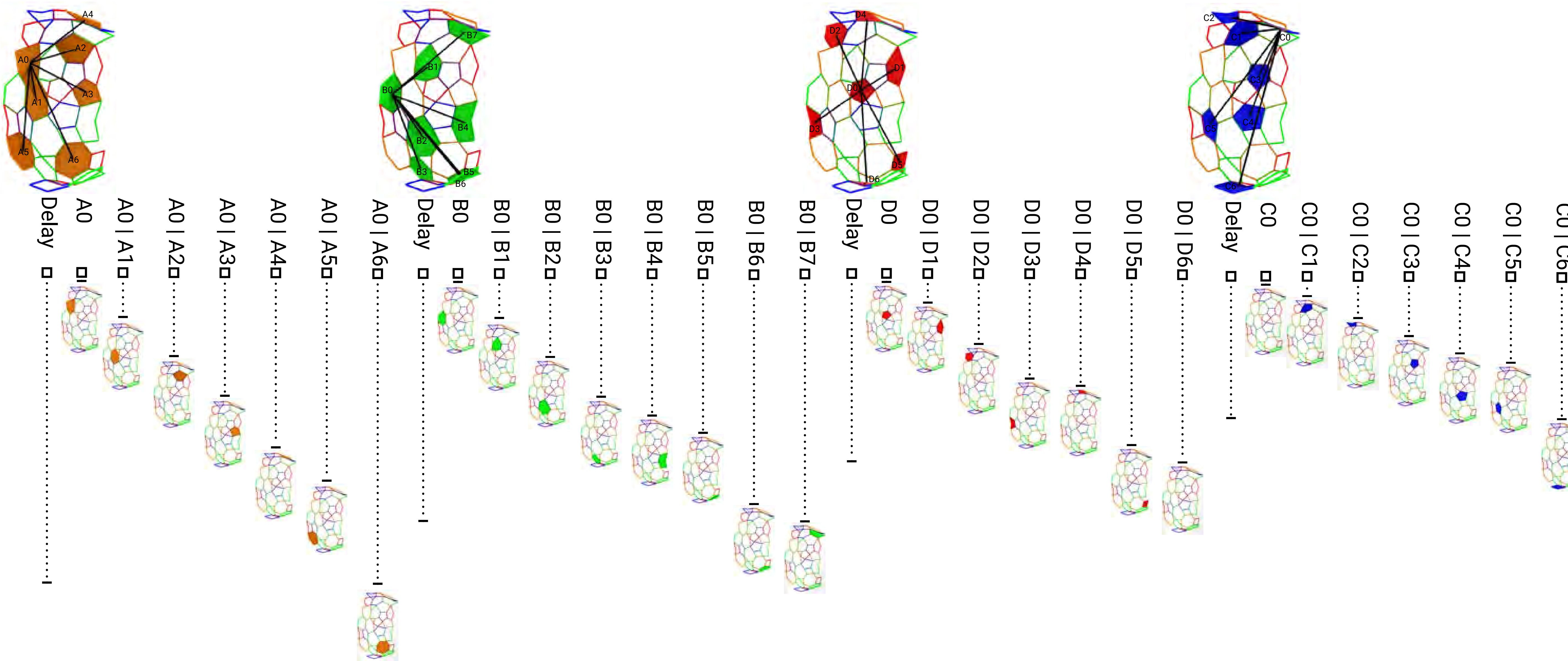
Interactive Simulation of the METAfolly software that shows the movement and delay of the sound based on spatial relationships.

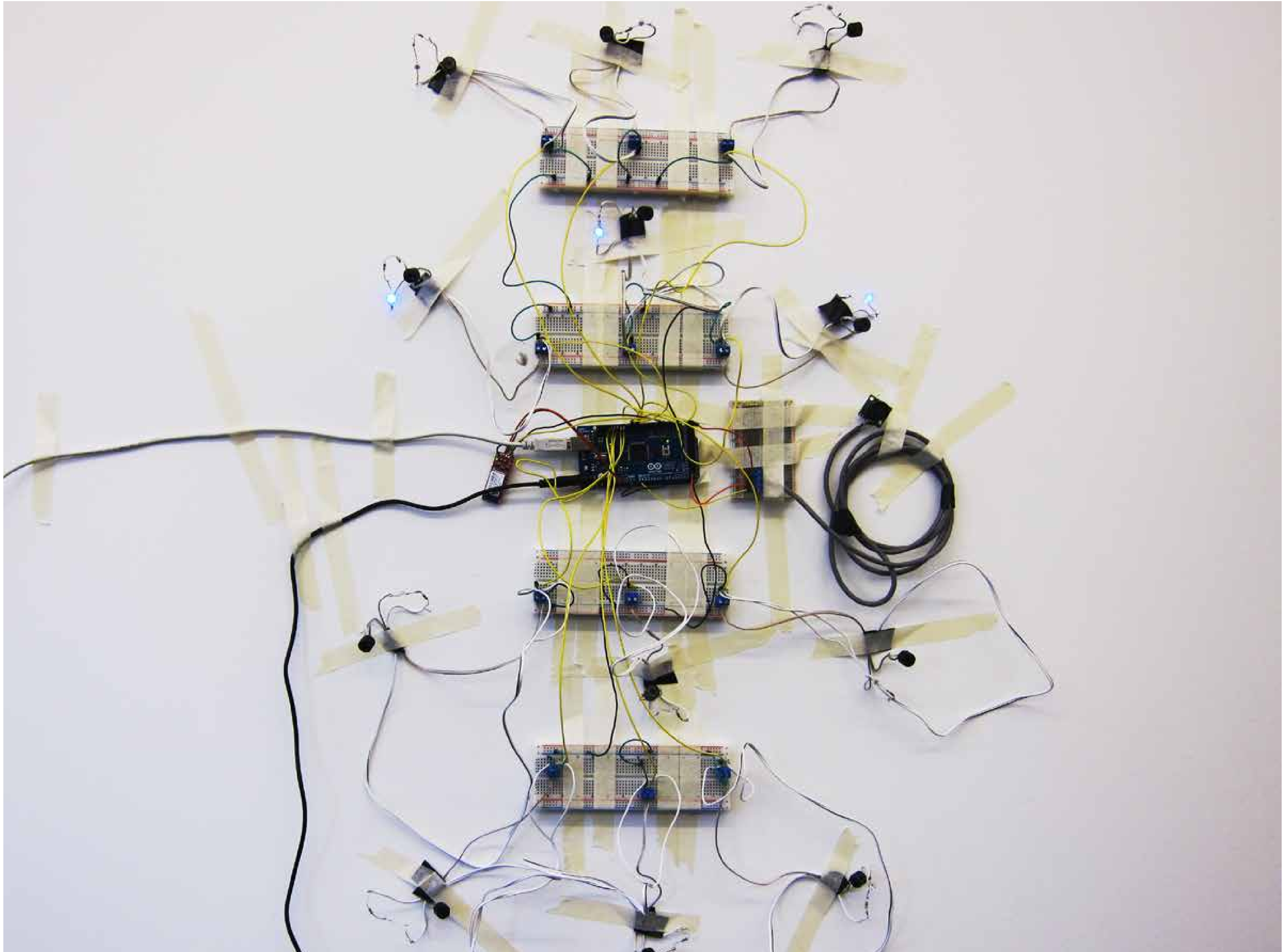
The delay of each buzzer is determined using its spatial relationship to the other buzzers of its type. The distance from a randomly selected buzzer each cycle determines how delayed it should be in the overall timeline.



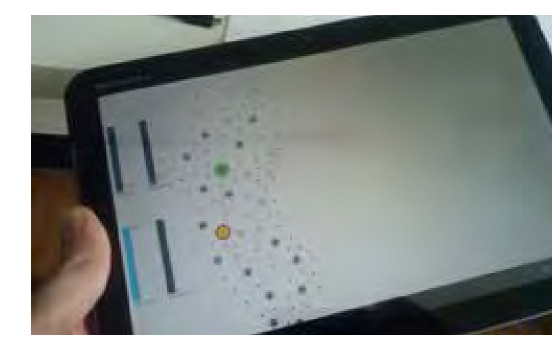


The spatial delay system plays out over all 4 tone typologies in repetition and in response to what the maximum delay is at any given moment. The folly attempts to bring that delay value to 0, but movement around the structure increases the delay.

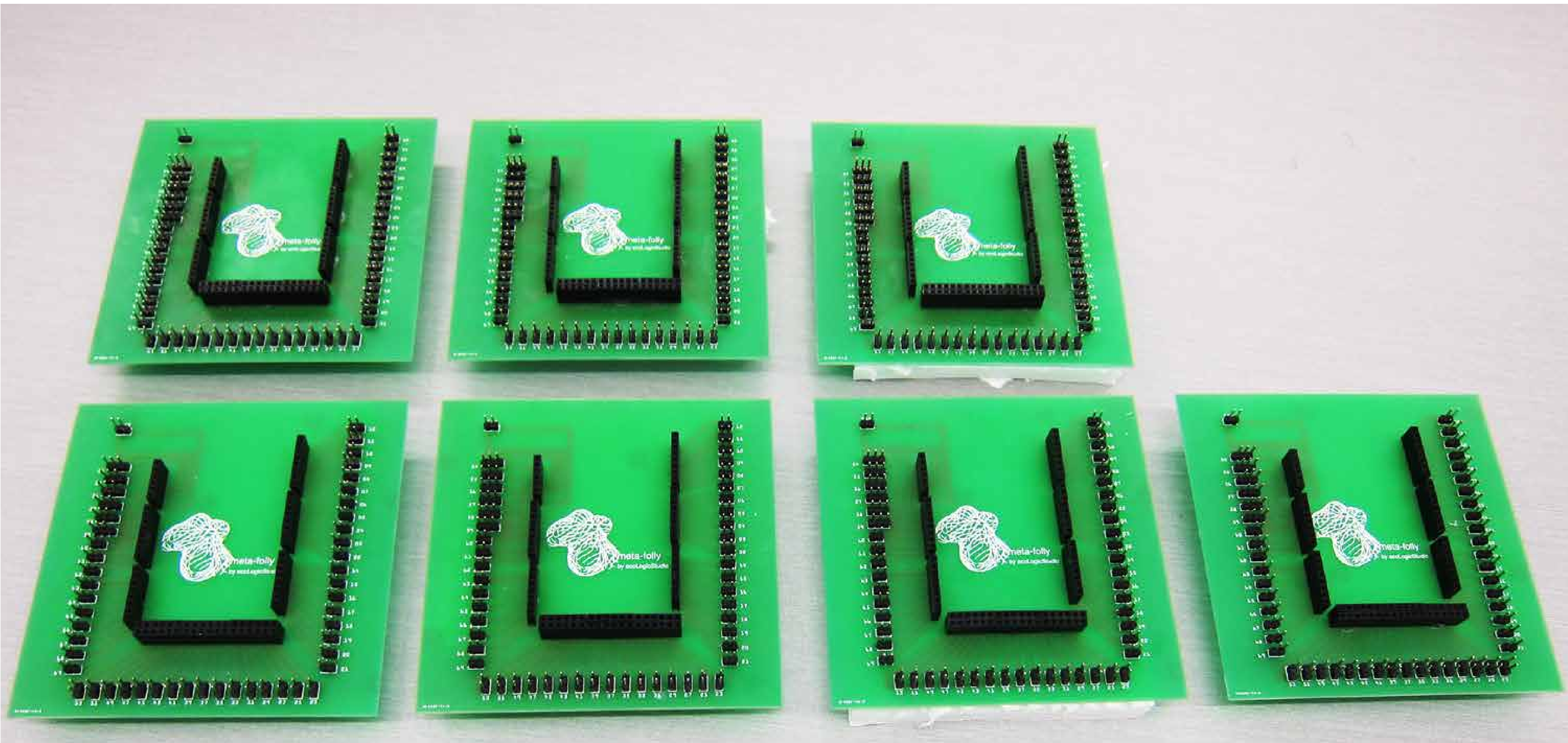




The prototyping strategy for METAfolly had 2 key components. 1 twin prototypes in Toronto and London, 2, a wireless interface for tuning the system. Pictured is the Toronto twin and we worked in real-time over video chat using the twins to make adaptations to the software.

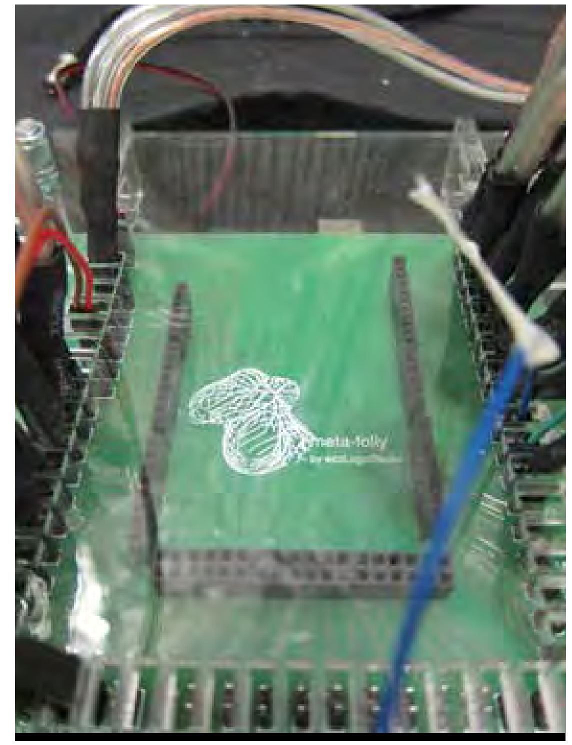


Custom interface boards created to control the Metafolly. Each board controlled a set of buzzers, read values from the distance sensors, and communicated with the control interface over Bluetooth.

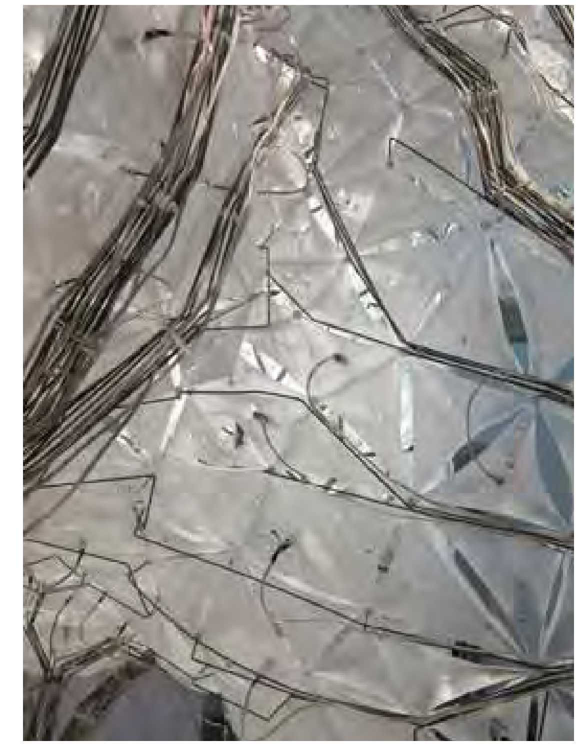


Peizo buzzer module embedded in the structure.

One of six distance sensors that monitored the amount of movement occuring around the structure. More movement created a greater delay in the system.



One of six controllers embedded in the folly.



A custom structure was designed and fabricated as a 3d bent tube structure.

The wiring and structure were tightly integrated to create a visual and electrical connection between the polypropelene units and the controllers.

Left: METAfolly as exhibited at Archilab 2013.
Right: Interior of the soundscape.


METAfolly exhibited at Globale: Exo-Evolution Exhibition, ZKM Museum


METAfolly exhibited at 1000m2 of Desire, Centre de Cultura Contemporània de Barcelona

Custom Fabrication Systems

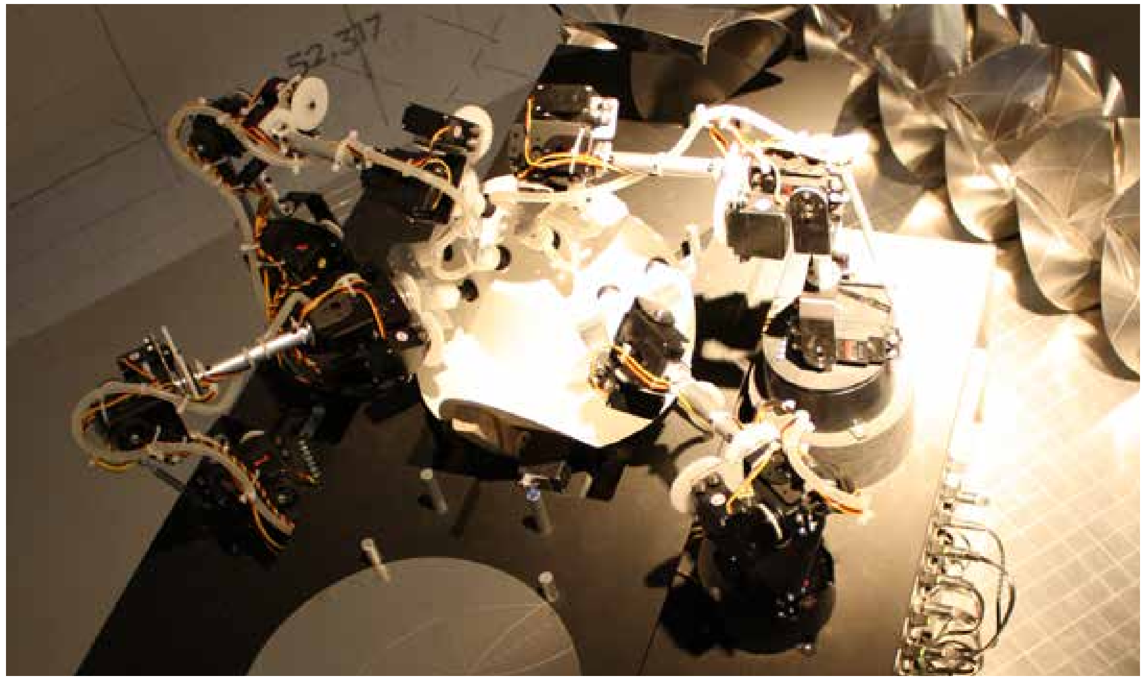
RoboFold

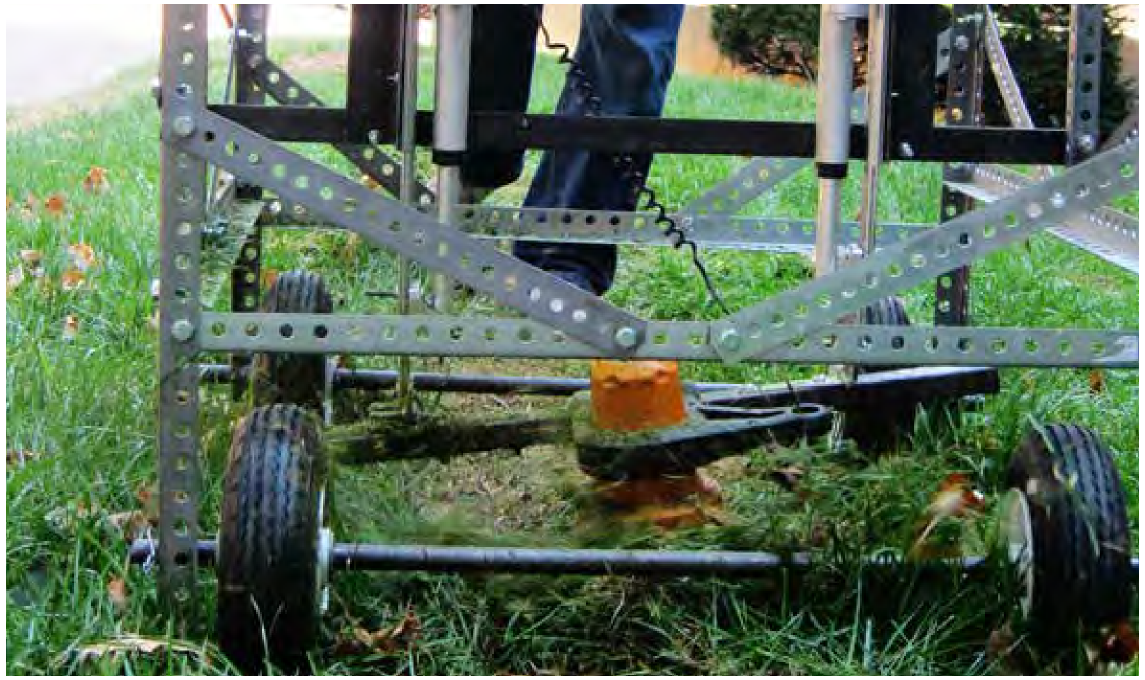
FieldCondition

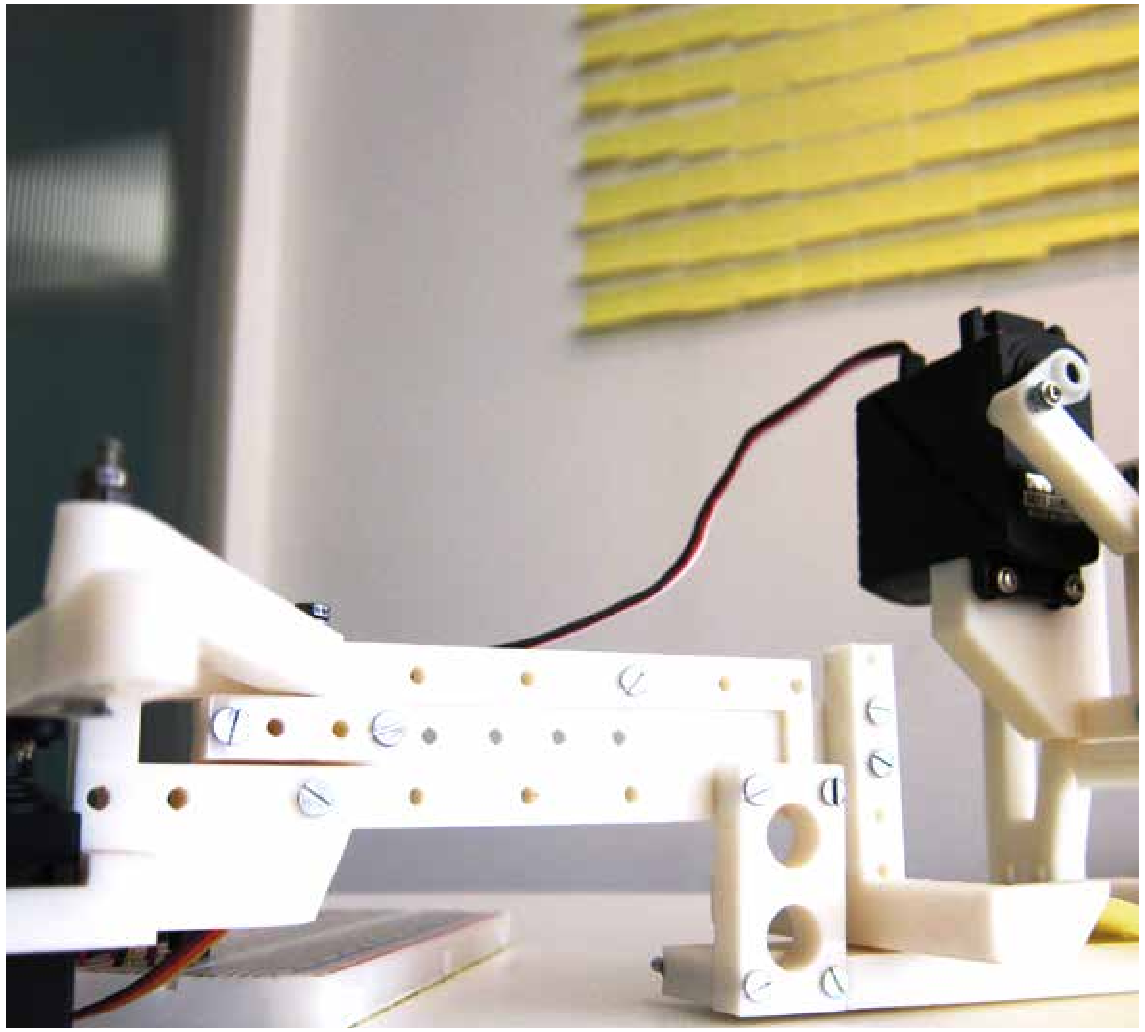
BlackBox

FabNodes

As digital fabrication systems become more ubiquitous some aspects of my work have focused on the role of systems that are completely customized to the project being produced. This interest arose from a background creating software tools that are specific to a design problem and an interest in the methodologies of mass manufacturing that use a series of highly specific machinic processes to produce a complex result. The two projects presented expand on these ideas by looking at fabrication as a means of programming physical materials and using 3d printing to enable the creation of complex actuation systems using simple motors.







Top Left: RoboFold
Top Right: FieldCondition
Bottom Left: BlackBox
Bottom Right: FabNodes

RoboFold

Commissioned by JorisLaarmanLab

Collaborator:
RoboFold

Exhibitions:
Hyperlinks: Architecture and Design
Art Institute of Chicago, Chicago, USA

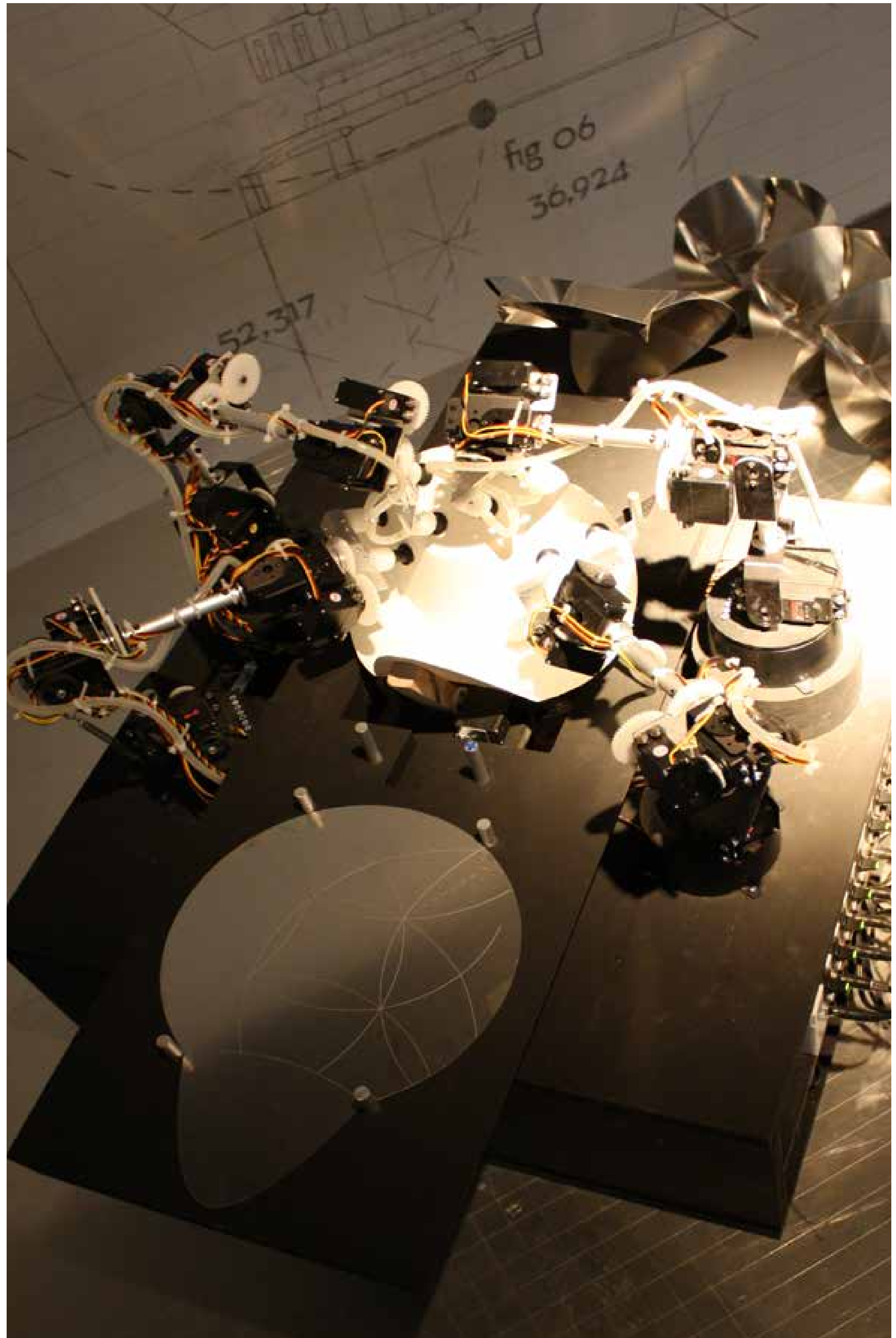
Laarman Lab
Friedman Benda Gallery, New York, USA

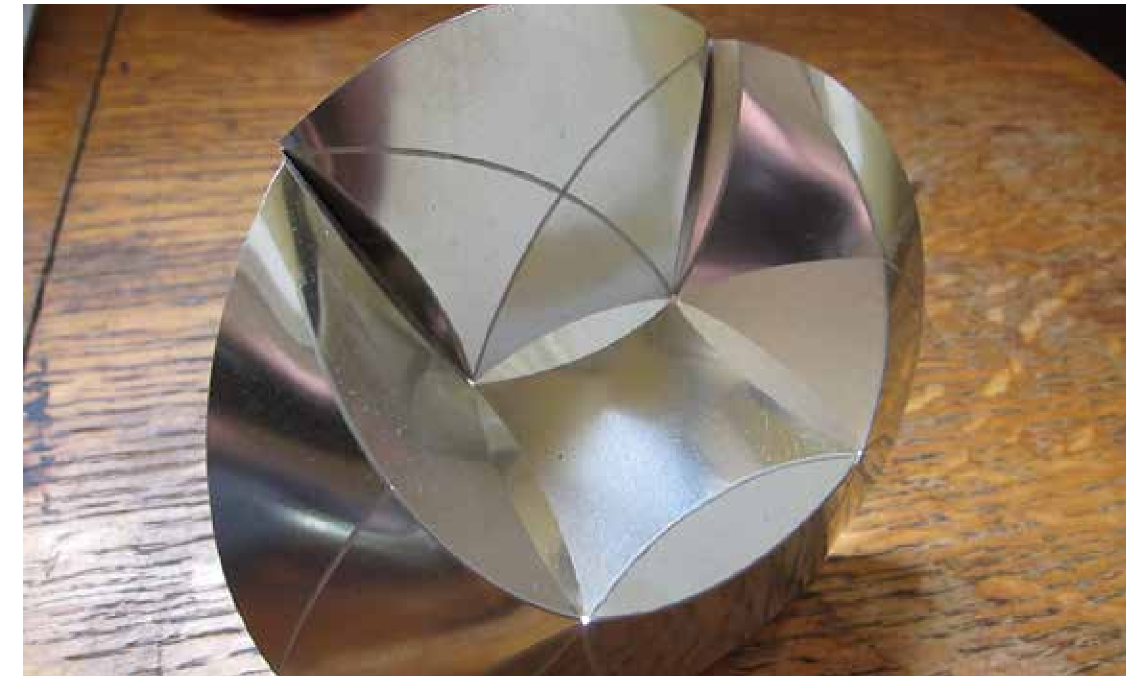
Publications:
Inside Smart Geometry, Wiley, 2013

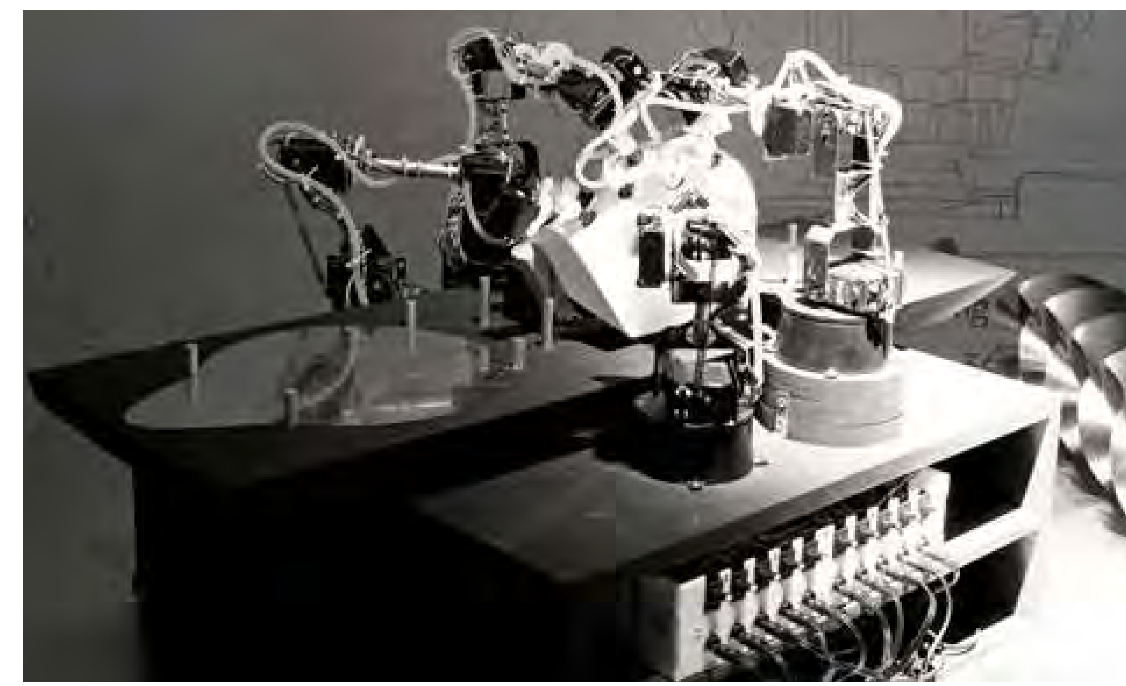
Hyperlinks: Architecture and Design, AIC/
Yale University Press, 2010

RoboFold videos

The collaboration with RoboFold was based around creating a proof of concept system for the company's proposed robotic manufacturing system. The concept of the system is that flat sheets can be CNC scored using curved fold lines and then folded into a 3d form using a group of collaborating robot arms. To create this system off the shelf educational robot arms were outfitted with custom end effectors, hardware controllers, and software. The behaviour was created using software developed in Maya that could be used to calculated the trajectory of each of the arms in tandem with the other robots. A test of this system was commissioned by Studio Joris Laarman as a means of prototyping a chair he had designed to be folded out of a single sheet of steel.







Above/Left: Robotic fabrication system folding a series of small scale Asimov chairs during the exhibition at the Friedman Benda Gallery.

FieldCondition

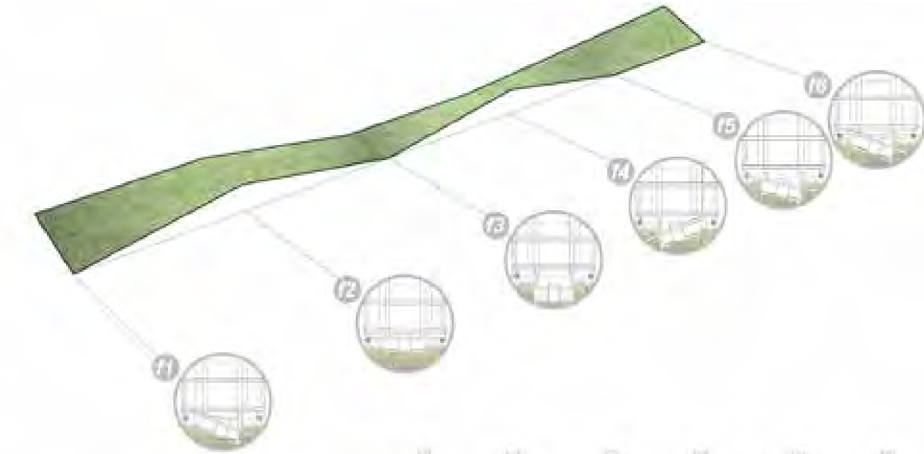
Exhibition:
New Faculty Show, Land of Tomorrow, Lexington, USA

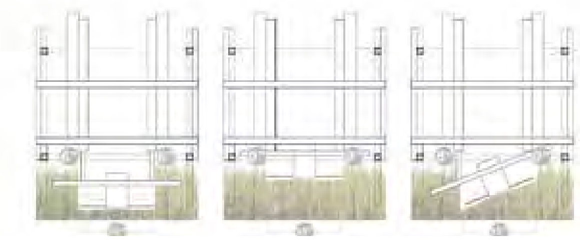
Conference Presentation:
Technarte 2011, Bilbao, Spain

Publication:
Fabricate: Making Digital Architecture, Riverside, 2011

Field Condition videos

Field condition seeks to push the boundaries of fabrication methods by shaping a rapidly regenerating material: grass. By adjusting its height an angle over the course of the cut, the mower can cut 3d patterns over an infinitely scalable surface. This is possible because the cutting mechanism is pushed by a human operator who must read the onboard speed and heading data to coordinate the speed of the actuators. To achieve this a prototype was created that allowed digital patterns to be created and then "printed" into the grass. Unlike typical CNC cutting the material being shaped responds over time by regrowing and setting up an interactive and ongoing relationship with the person and machine trying to shape it.





Left: Test cut using the CNC mower.
Above: Diagrams explaining how local movement of the cutting head can produce 3d patterns

Exhibitions:
Magic Materials, The Science Gallery, Dublin, Ireland

Responsive Patterns, Kasian Gallery Calgary, Canada

Conference Presentations:
Technarte 2014, Bilbao, Spain

Smart Geometry 2012, Troy, USA

Workshops:
Beyond Mechanics
Smart Geometry 2012, Troy, USA

Publications:
Paradigms in Computing, Evolo, 2014

Inside Smart Geometry, Wiley, 2013

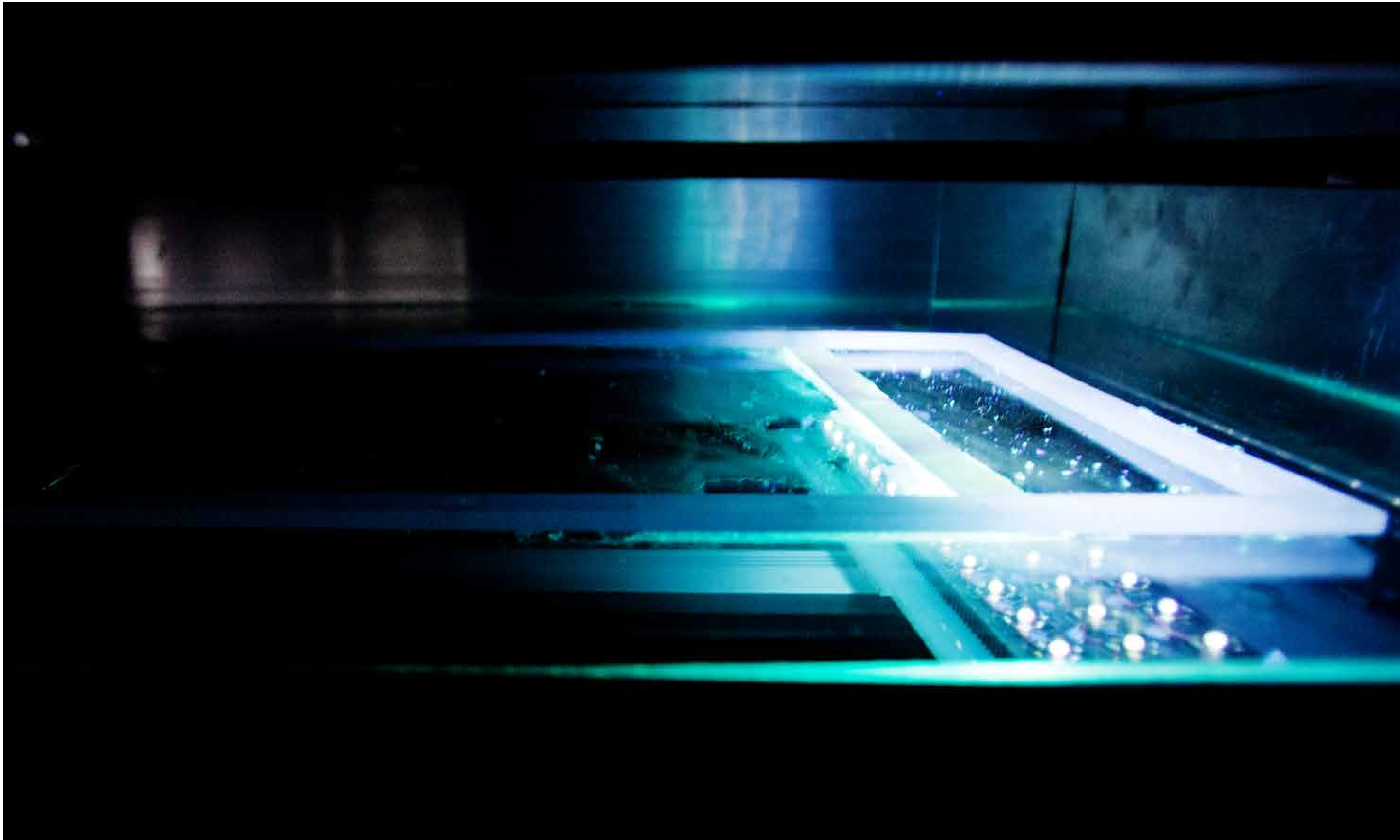
Building Dynamics: Exploring Architecture of Change, Routledge, 2015

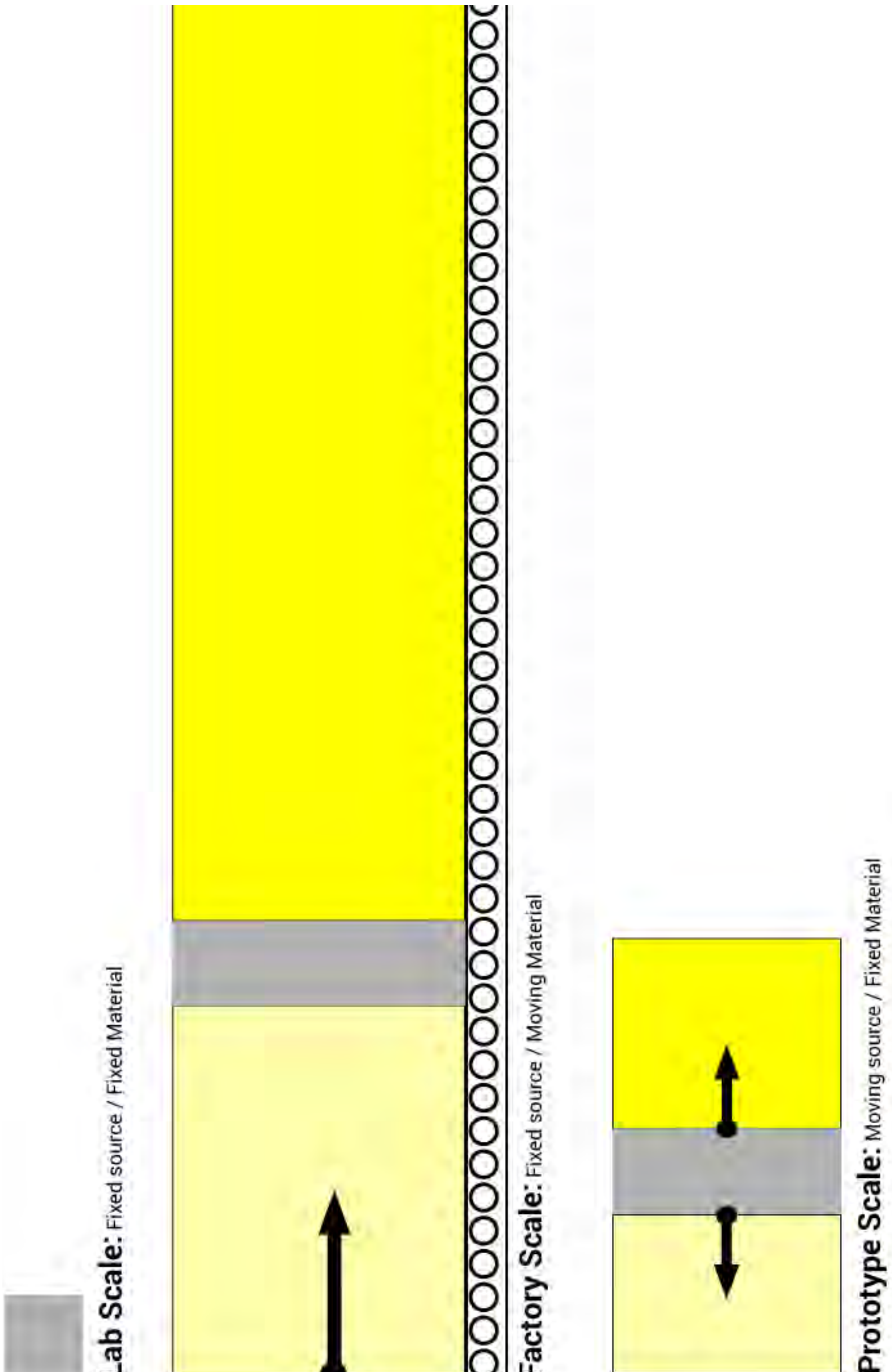
BlackBox videos

Project BlackBox brings together DIY and open source methodologies of software/hardware development with the field of material science. The goal of this work is to create the software and hardware tools that will allow designers to program and create responsive surfaces using smart materials. The initial phase of this work is focused on the programming and production of Shape-Memory Polymer, by creating a custom curing machine. The first step in this process involved two parallel strands of research into the methods of creating shape memory polymer. One strand was a hands-on, in depth look at how polymer is produced within a material science laboratory, and the second looked more generally at how polymer was created in a variety of scales and contexts. The latter revealed that production within this field occurs at 2 very distinct scales: the material science laboratory and the material factory. The material science lab is focused on developing new materials via small samples and the factories are focused on producing those materials at a very large scale. Typically the labs develop materials without any specific function in mind, and this distinct separation opens up the potential for a third scale in the overall scope: the material prototype. By creating a machine that can create material prototypes it allows designers to create material behaviours in the same way that they can create behaviours in software. This research represents a first step in this direction and creates interesting opportunities at the intersection of fabrication and programming.
The system created uses high intensity UV lights mounted to a linear actuator to cure larger sheets of material within a lab setting.

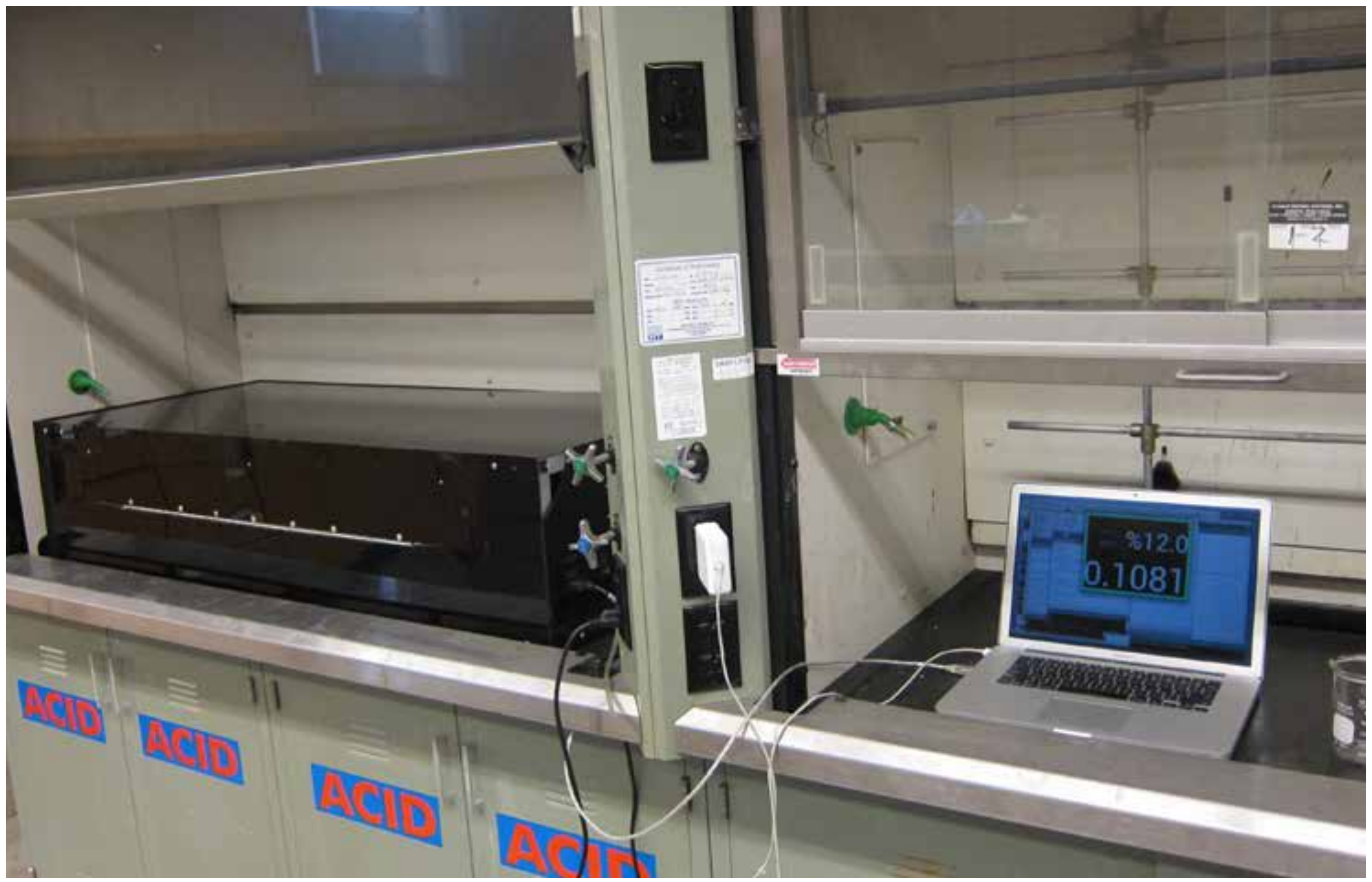
Above: Shape Memory Polymer sheet created using BlackBox. The material is programmed to respond to 35°C and has been laser cut to allow movement.

Next Page: BlackBox curing system

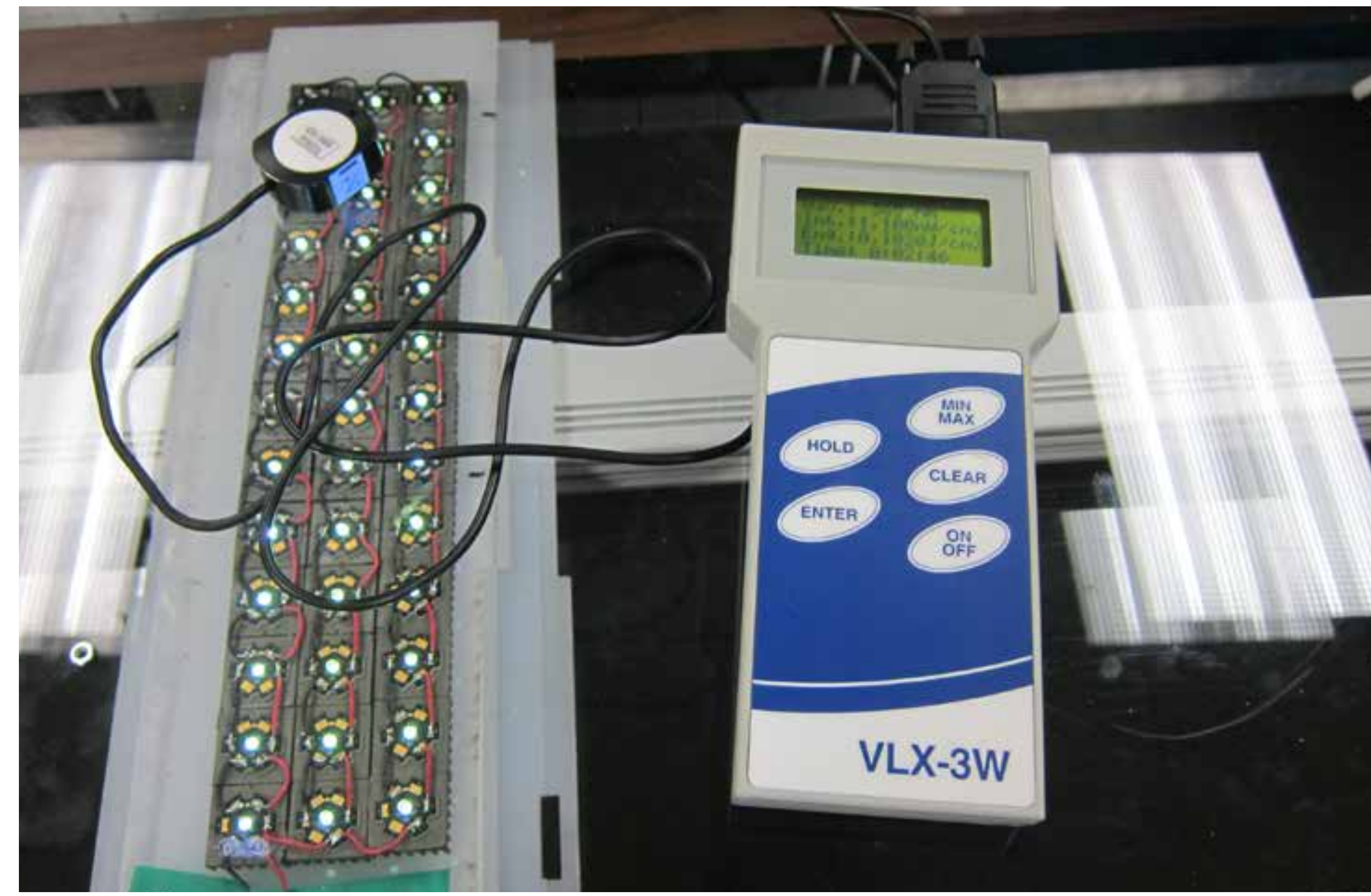




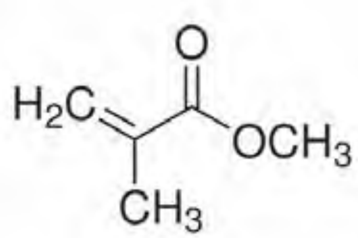
Left: After a study of existing curing equipment, a prototype was designed that uses high intensity UV LEDs mounted to a linear actuator to cure larger pieces of material within a confined space.

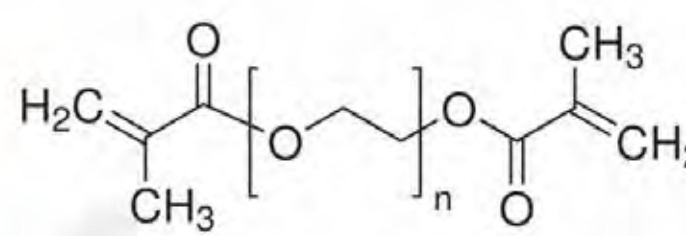


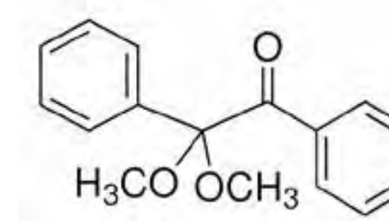
Testing the BlackBox system within a material science lab. The goal is to create a system that can interface with typical lab equipment, but produce usable material prototypes.



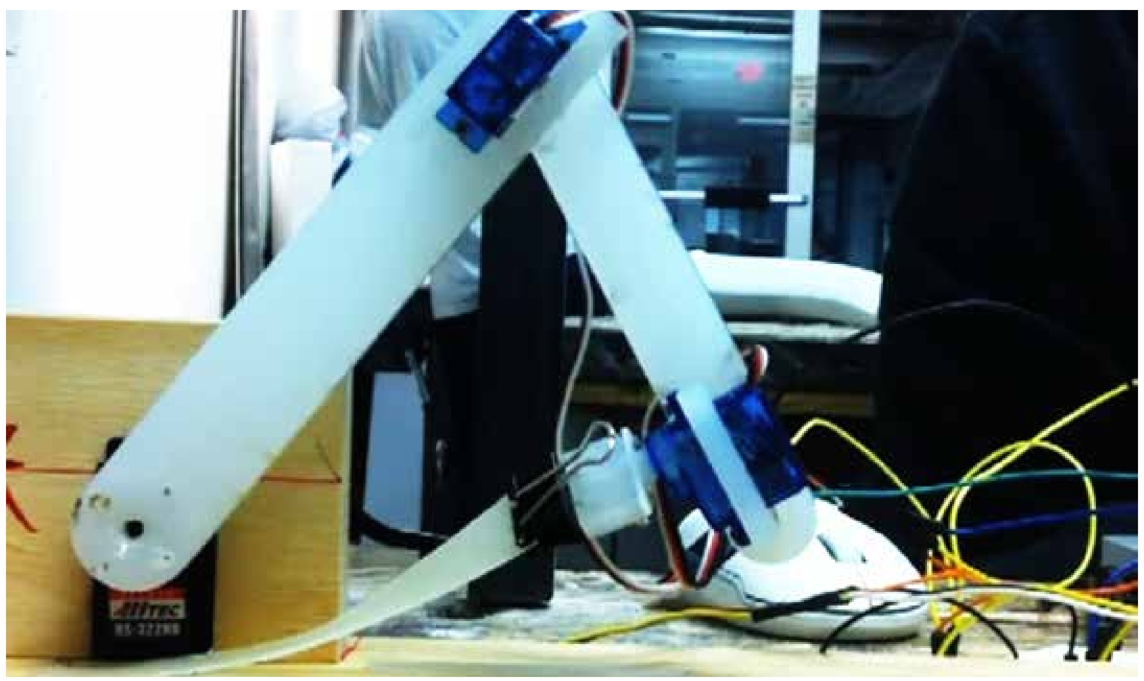
Using a radiometer to measure the overall energy produced by the UV LEDs.

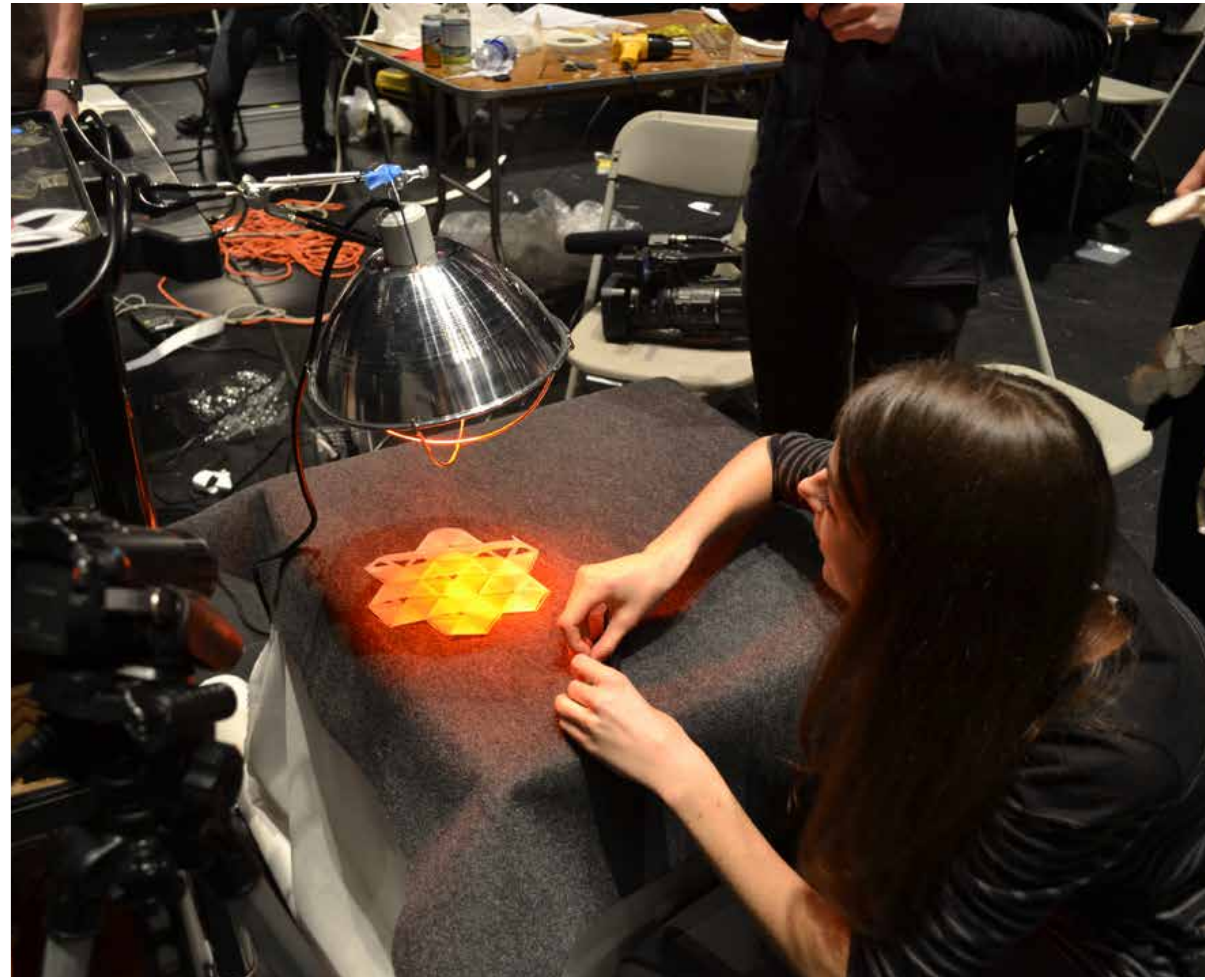






The process and chemicals required for producing Shape Memory Polymer using Blackbox.

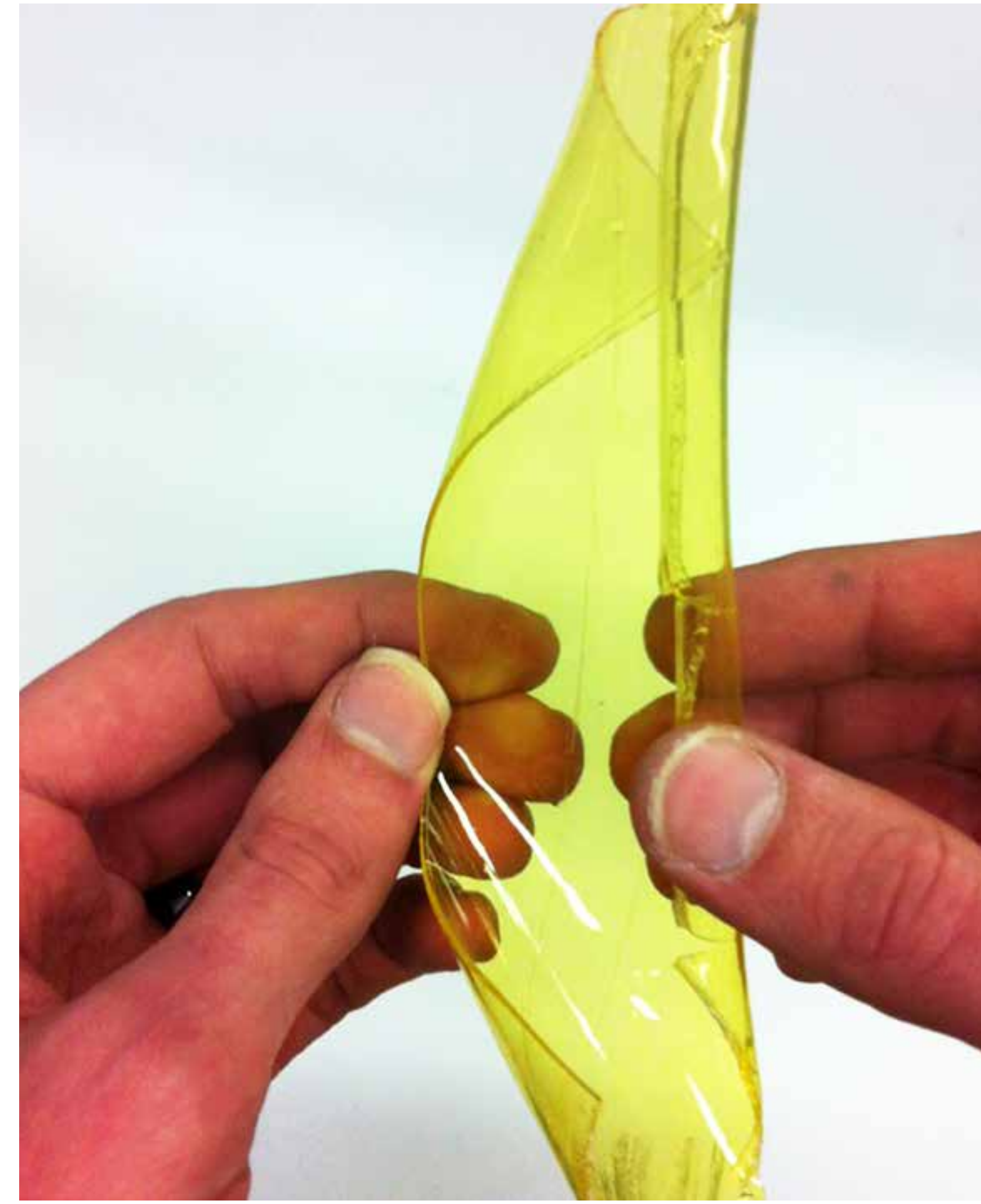




Top Left: First Shape Memory Polymer Sample created using BlackBox.
Bottom Left: Training the target shape of a Shape Memory Polymer sheet using a custom “grooming robot”.
Above: Creating heat responsive wearables for the Beyond Mechanics workshop at Smart Geometry using BlackBox.

Above: First sample to use laser cutting to manipulate the shape memory polymer sheet.

Next Page: Beyond Mechanics Workshop at Smart Geometry.



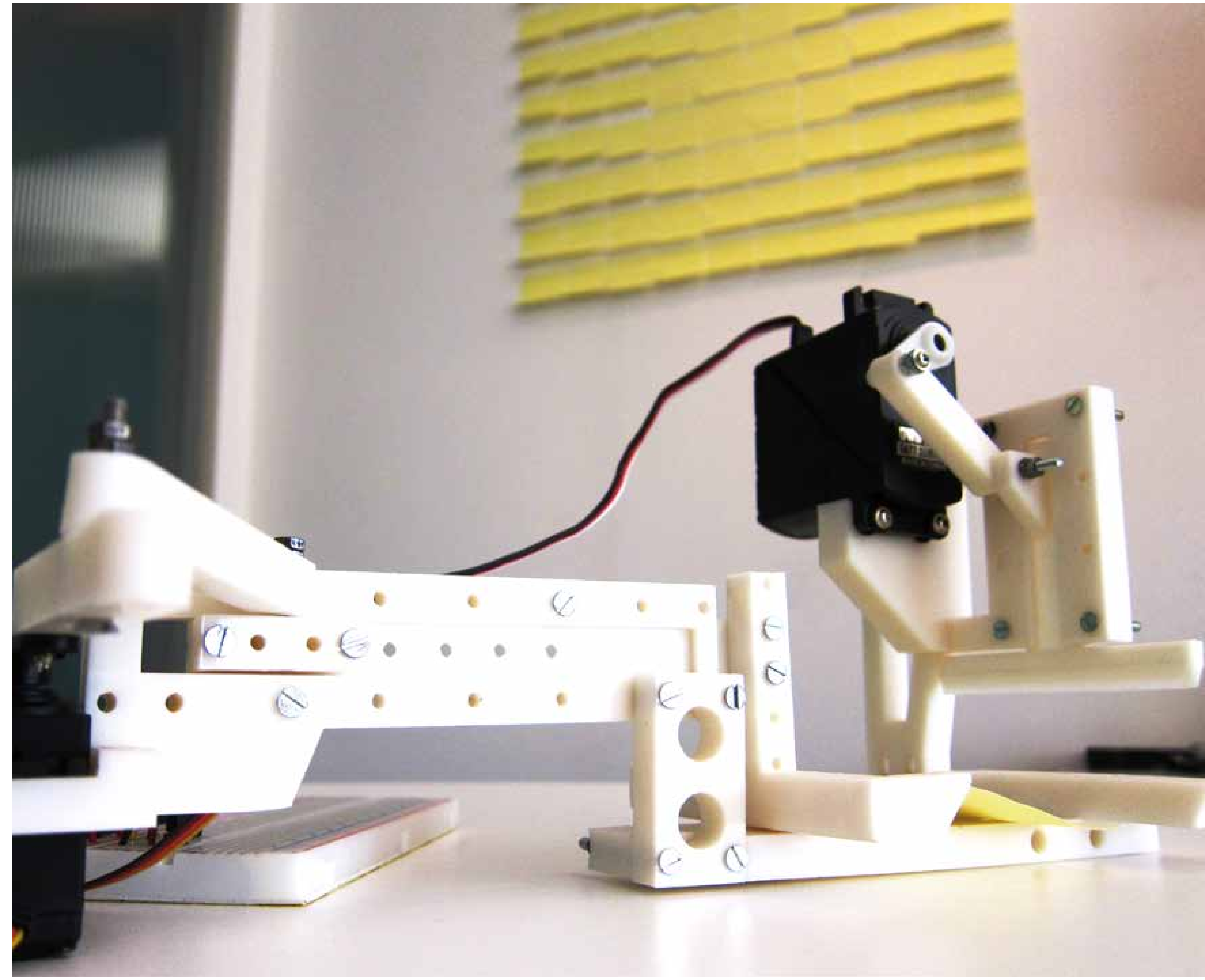
Pretensioned polymer sample that can be used as a functional, temperature-controlled spring.

Research Funded by GRAND NCE, AD Node

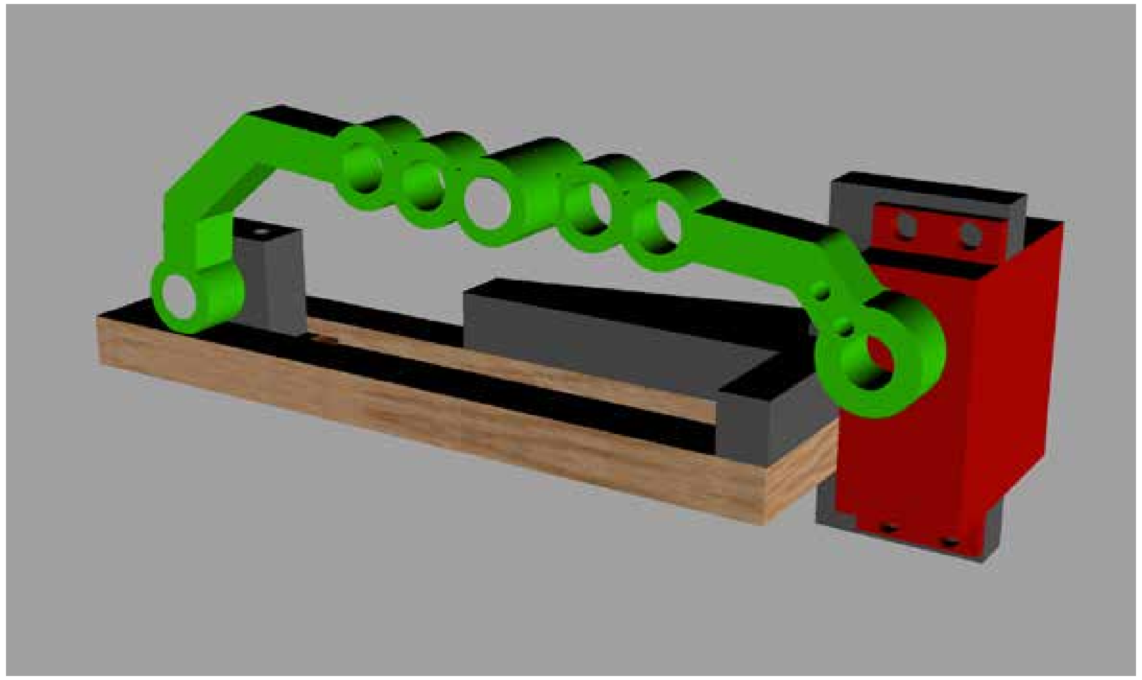
Conference Presentation:
TechNarte 2014, BilBao Spain

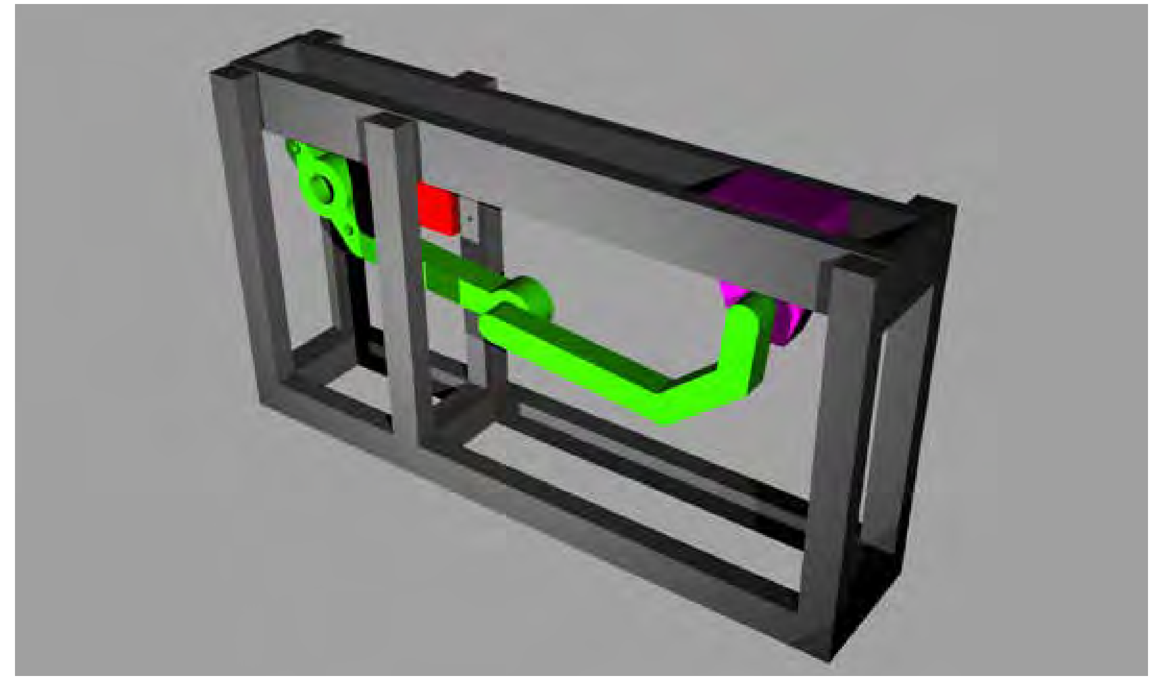
FabNodes videos

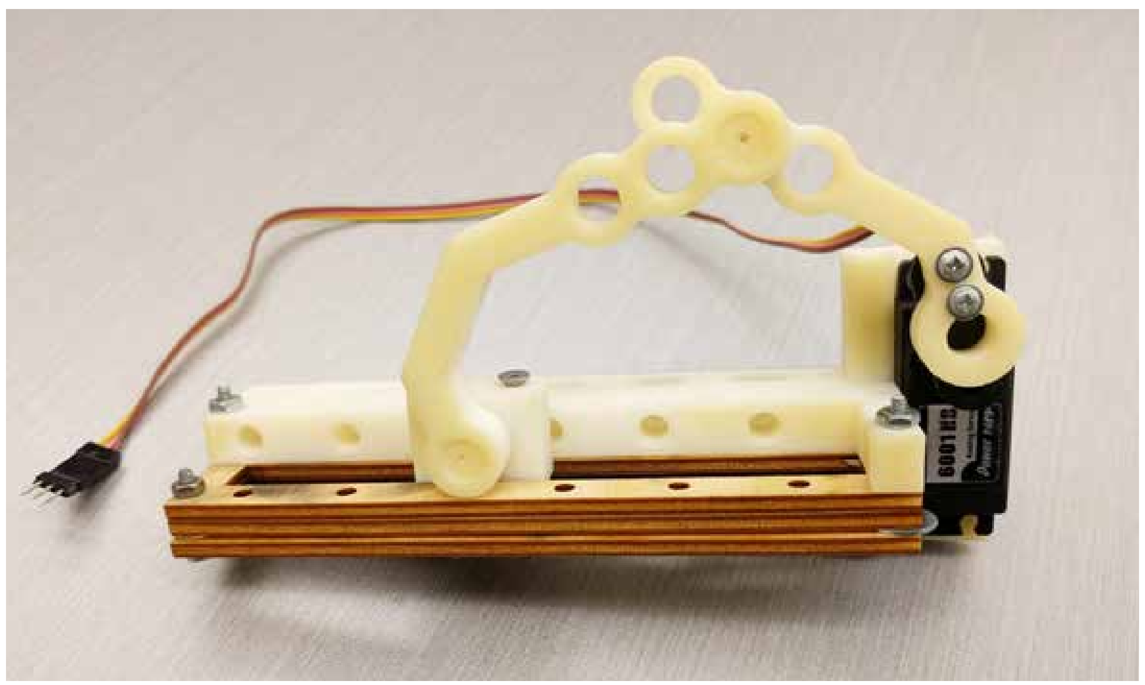
FabNodes was a research project to use 3d printing as a way to create modular, custom fabrication systems using simple electric motors and servos. The goal was to create a method whereby users could download print files and combine them with motors to create precise, small scale actuators. The research began by creating a system of printable linear actuators from servos. The final phase of the research built on this to create a custom fabrication system for a specific use. In this phase a system was developed for CNC folded sticky notes that were controlled by a digital drawing. A grayscale pattern or image can be created in the software interface and the machine folds each sticky note in relation to the gray scale value of the corresponding pixel. All 3d models are freely downloadable and open source.

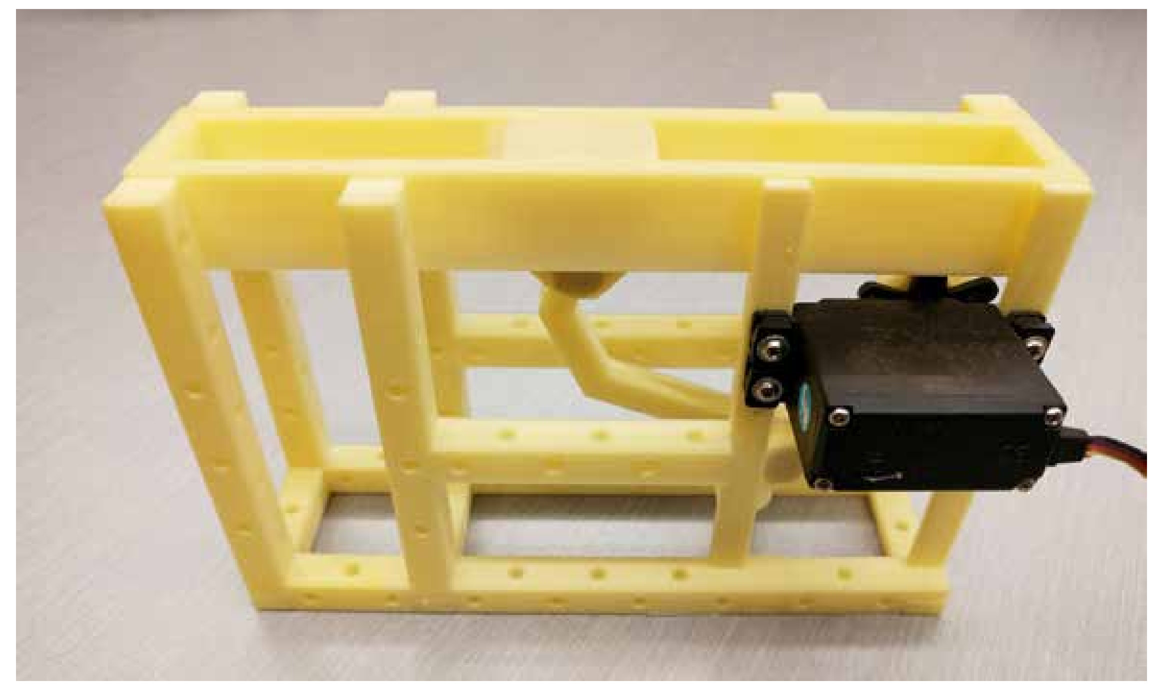


Final FabNode machine created and the resulting installation.



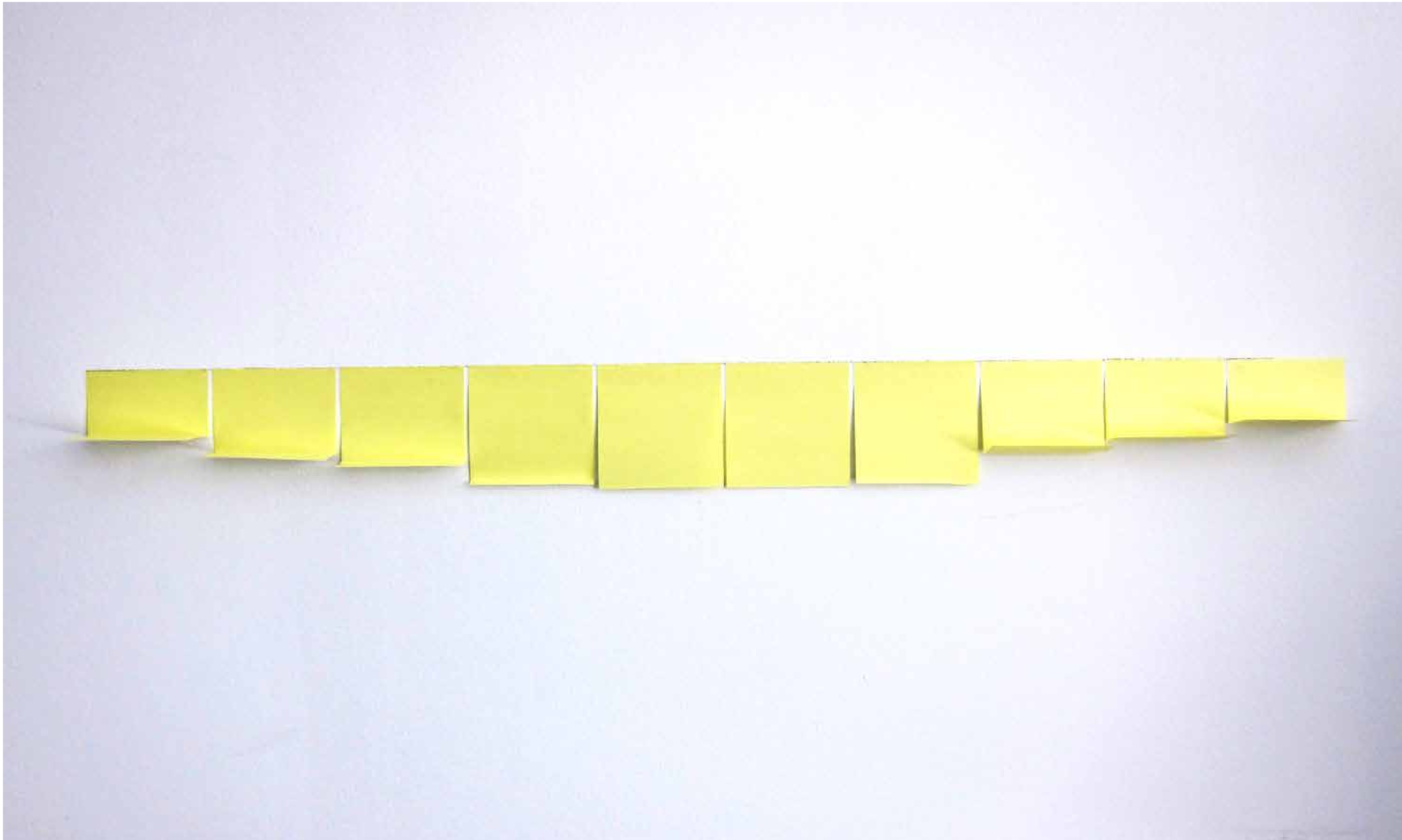


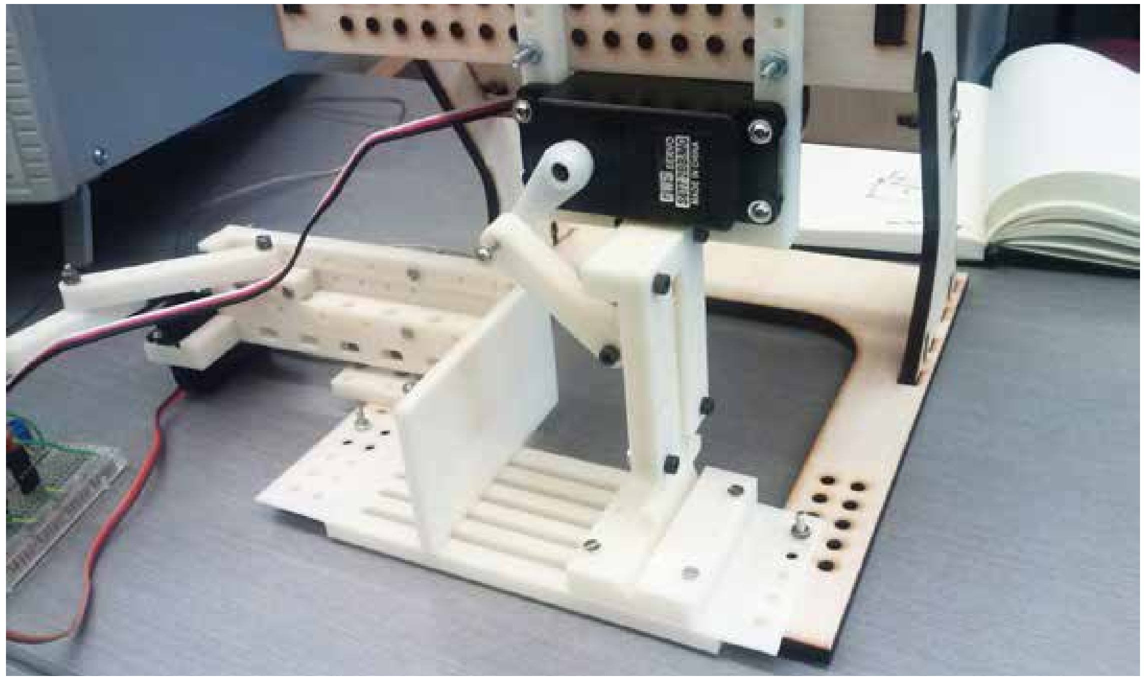
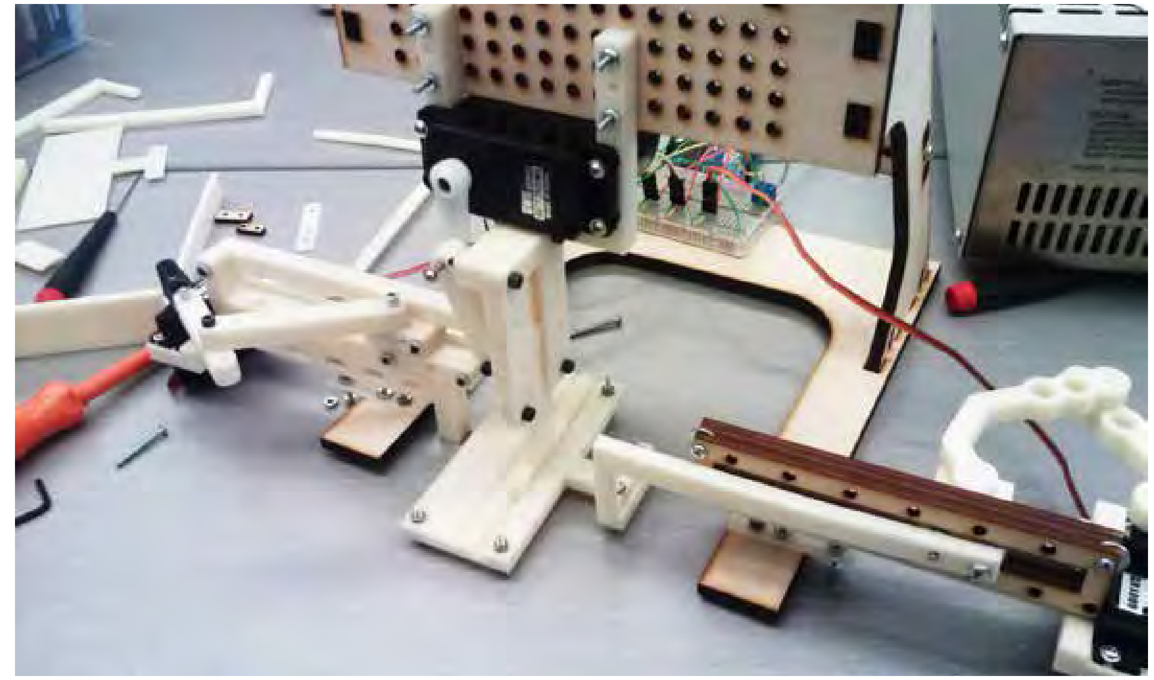
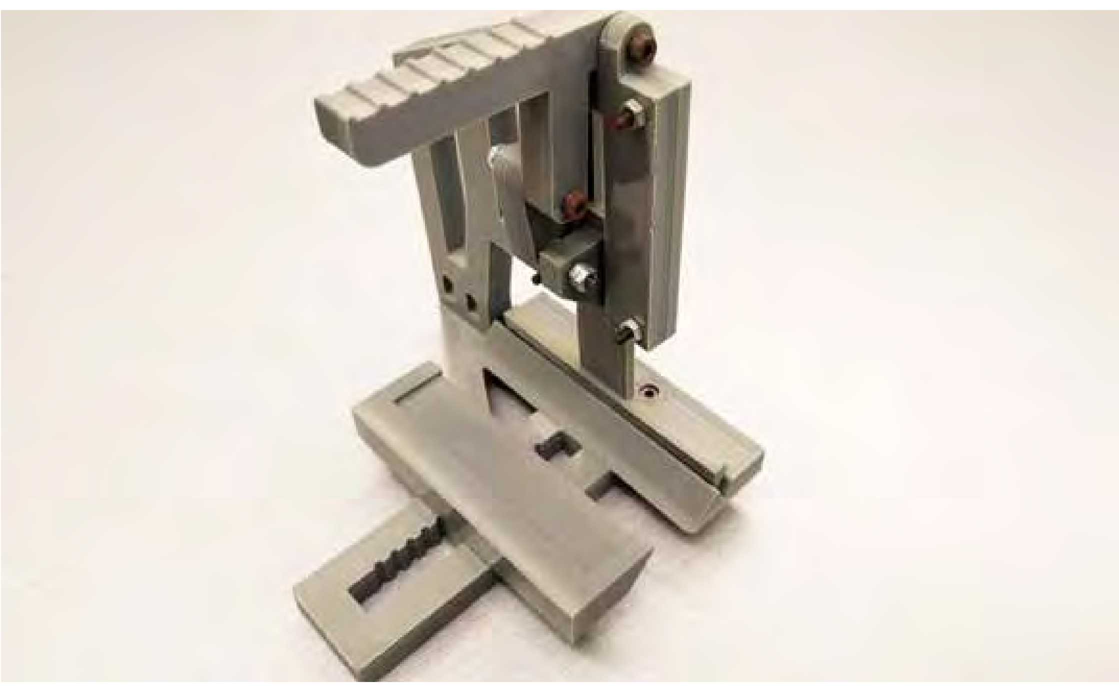
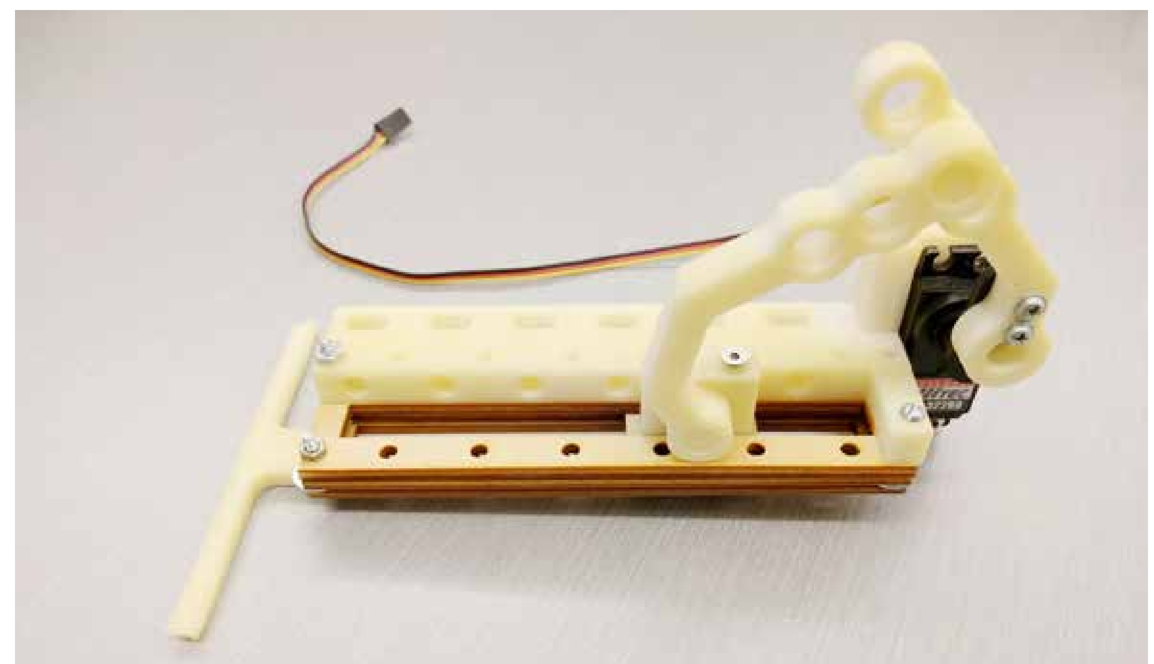




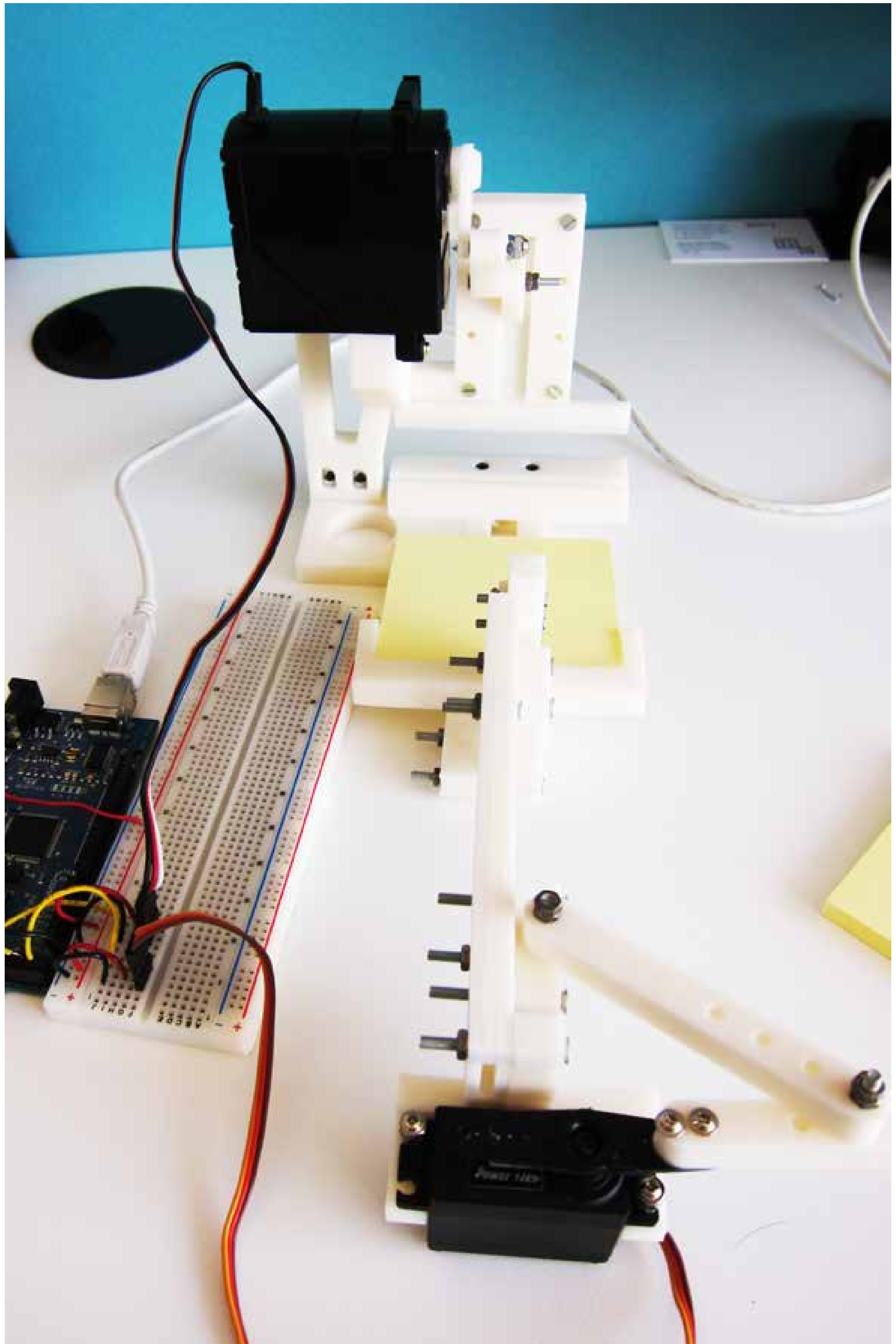
Left: Initial phase of the research. Actuators were digitally designed and then printed to transform simple hobby servos into linear actuators.

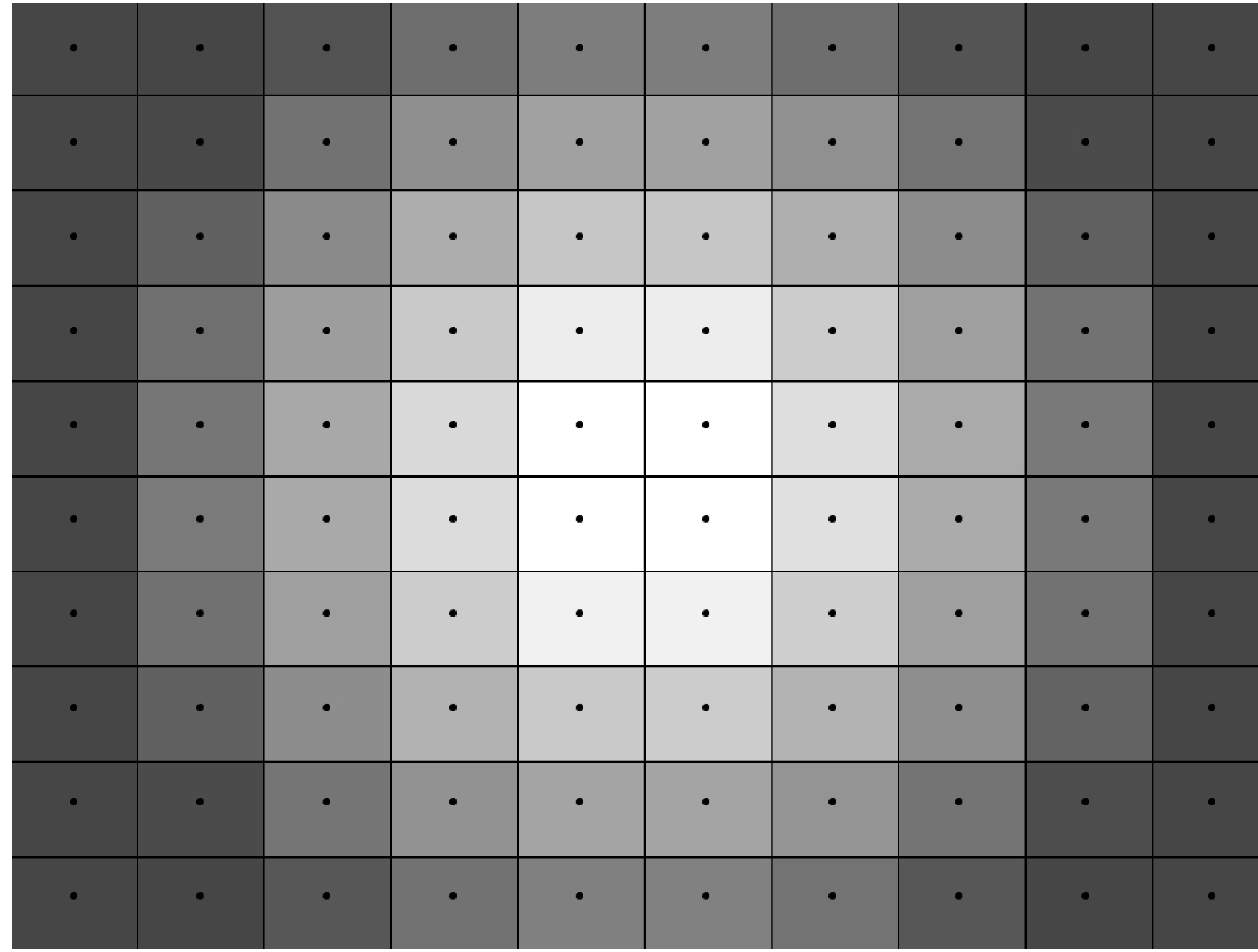
Next Page: First Pattern test for transforming gray scale values into folding points.



Left: Adapting the modules created in the first phase to create a paper folding machine.





Grayscale patterns are broken down in to appropriately sized pixels within the software and these values are then translated to the folding machine.

Final installation of folded paper created using a machine based on the FabNodes modules.

Creative Surveillance

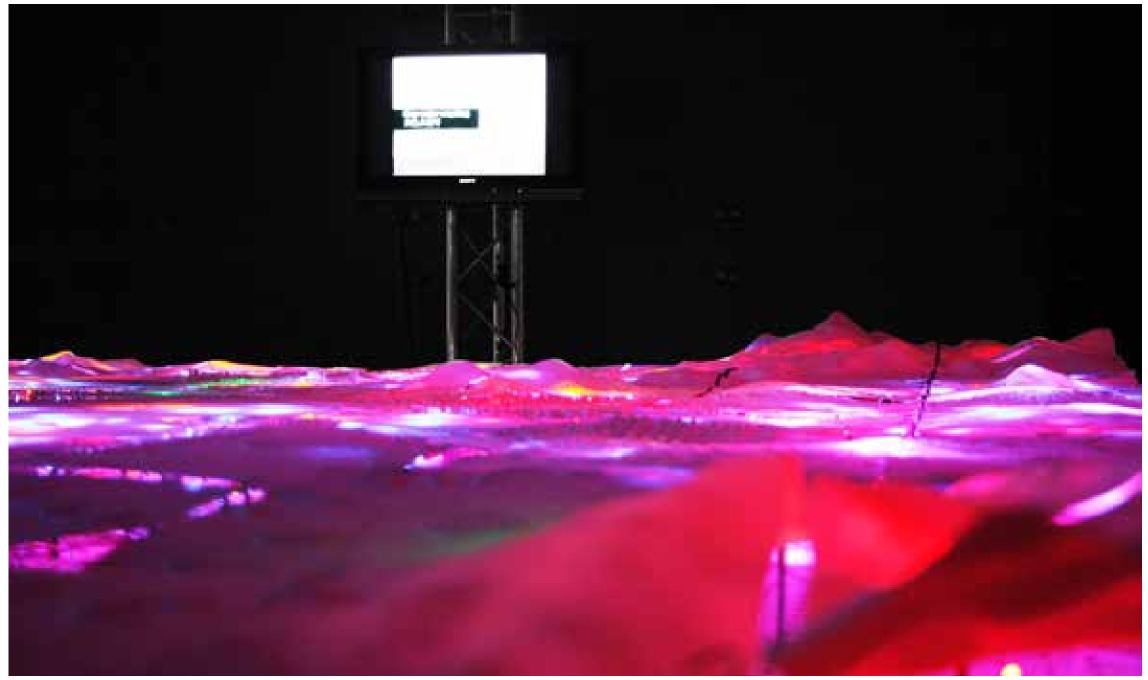
Xiamen Energy Masterplan

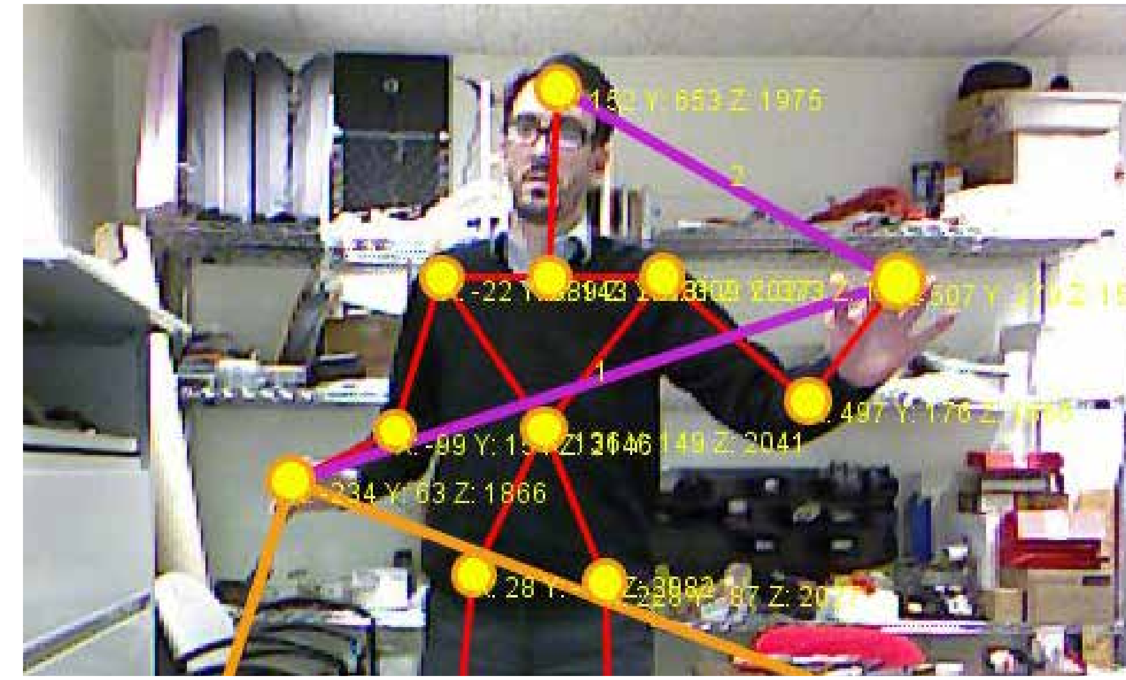
Kinect Research Framework

MAI Prototype LiveStreaming

Pulse v1

These projects focus on how systems of perpetual tracking and surveillance can be used experimentally as a method of interaction. Both of these works use persistent and invisible systems that gather data about people and the space to either visualize that data or dictate the overall response. Given the questionable use of these technologies in other situations, it is important to develop methods that show other potential for the data that they collect.





Top Left: Xiamen Energy Masterplan
Top Right: Kinect Research Framework
Bottom Left: MAI Prototype Livestreaming
Bottom Right: Pulse v1

Xiamen Energy Masterplan

Commissioned by the City of Xiamen, China

Collaborator:
CHORA

Exhibitions:
Post-Fact: Visualizing Information
Monterrey, Mexico

Post-Oil Cities, IFA Gallery
Stuttgart, Germany

Climate Incubator, PBSA
Dusseldorf, Germany

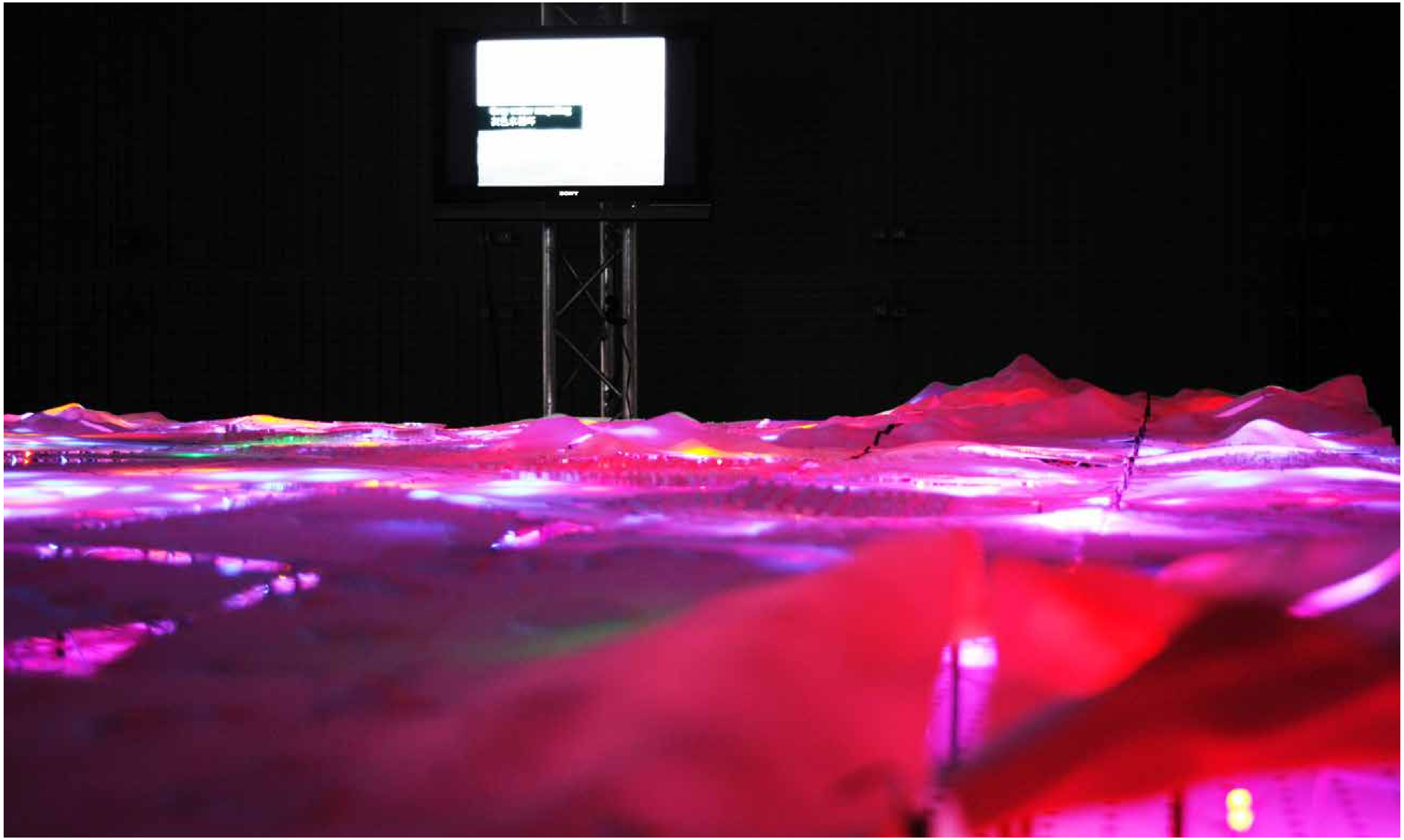
International Energy Expo
Xiamen, China

Publications:
Inside Smart Geometry, Wiley, 2013

Taiwan Strait Incubator, Arch+ 196/197

Xiamen Energy Masterplan videos

The Xiamen Energy Masterplan Model was developed with CHORA as part of the Taiwan Strait Incubator project. This portion of the scheme looks to establish Xiamen as the first "green" or energy efficient city in China. To achieve this the city commissioned an overall "Energy Masterplan" from CHORA which addresses this goal at a large scale through infrastructure and building projects, as well as local interventions by residents. The model looked to address the need to visualize individual projects in the context of the overall scheme to both educate the public and act as a planning tool for developers, designers, and city officials. This is achieved by combining unique animations in conjunction with detailed screen-based information.



Above: Xiamen Energy Masterplan at Post-Oil Cities Exhibition.
Right: Developing the Material and Visualization system.

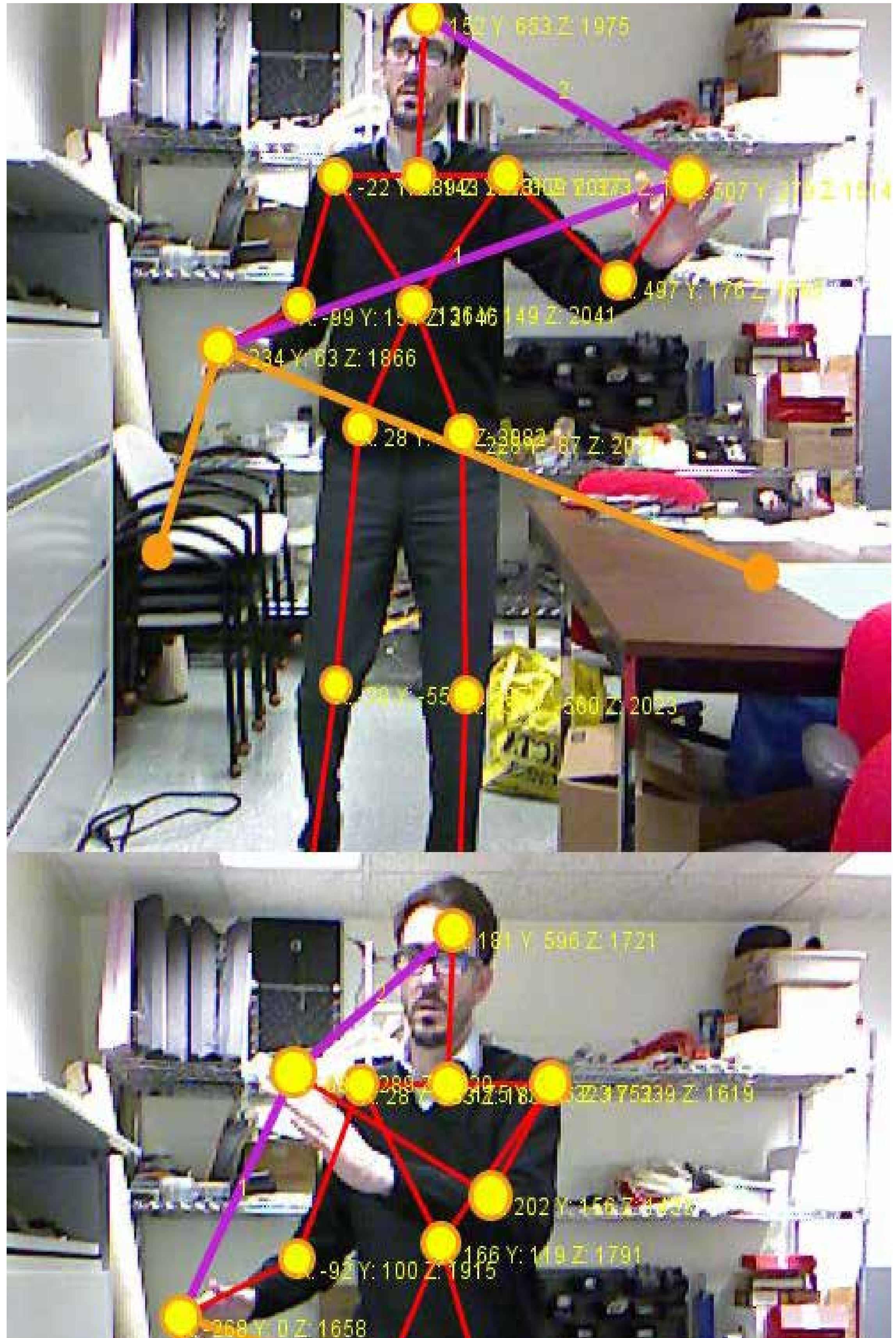
Kinect Research Framework

Workshops:
Adaptive Components, University of Arkansas
Fayetteville, USA

Tracking as Design, University of Calgary
Calgary, Canada

Kinect Research Framework videos

The Kinect Research Framework is an open toolset for developing new interfaces to media and spaces using the Kinect. It is based around skeleton / hand tracking servers written in Processing using simpleopenni that can send the tracking data to any program that can receive TCP/UDP data. The goal for the project is to create a simple, open protocol to simplify Kinect programming and create a dynamic network of interoperability between programs, hardware, and the physical world. This framework was created to allow designers easy access to the motion capture capabilities of the Kinect to allow for investigations in a variety of scenarios. The strategy of this framework was to present the users and environment as a series of connected points. Some of these experiments focused on creating new types of controls within the digital world, while others examined how digital game mechanics could be used within a physical environment. The framework was used as a tool set for a variety of courses and workshops taught to design students.



Left: Testing the KRF and the "linked points" concept.
Top Right: Workshop at University of Calgary developing digital interactive facades using KRF.
Bottom Right: Workshop at University of Arkansas using KRF to control responsive physical objects.

MAI Prototype LiveStreaming

Commissioned by the Metamatic Research Initiative

Collaborator:
Marina Abramovic

Exhibitions:
Metamatic Reloaded, Museum Tinguely Basel, Switzerland

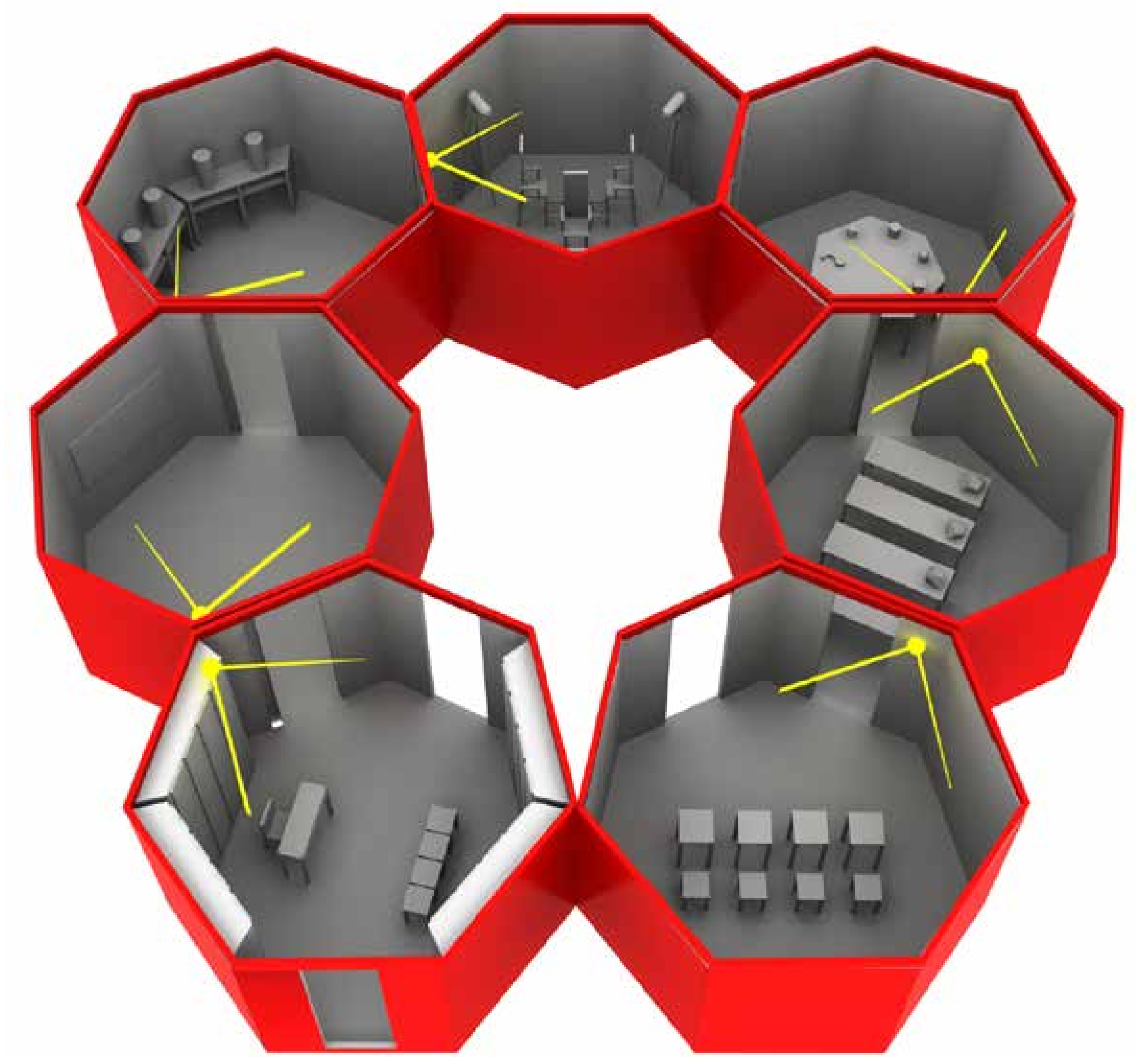
MAI Extension, Luminato Festival Pearson Airport, Toronto, Canada

MAI Prototype, Luminato Festival Toronto, Canada

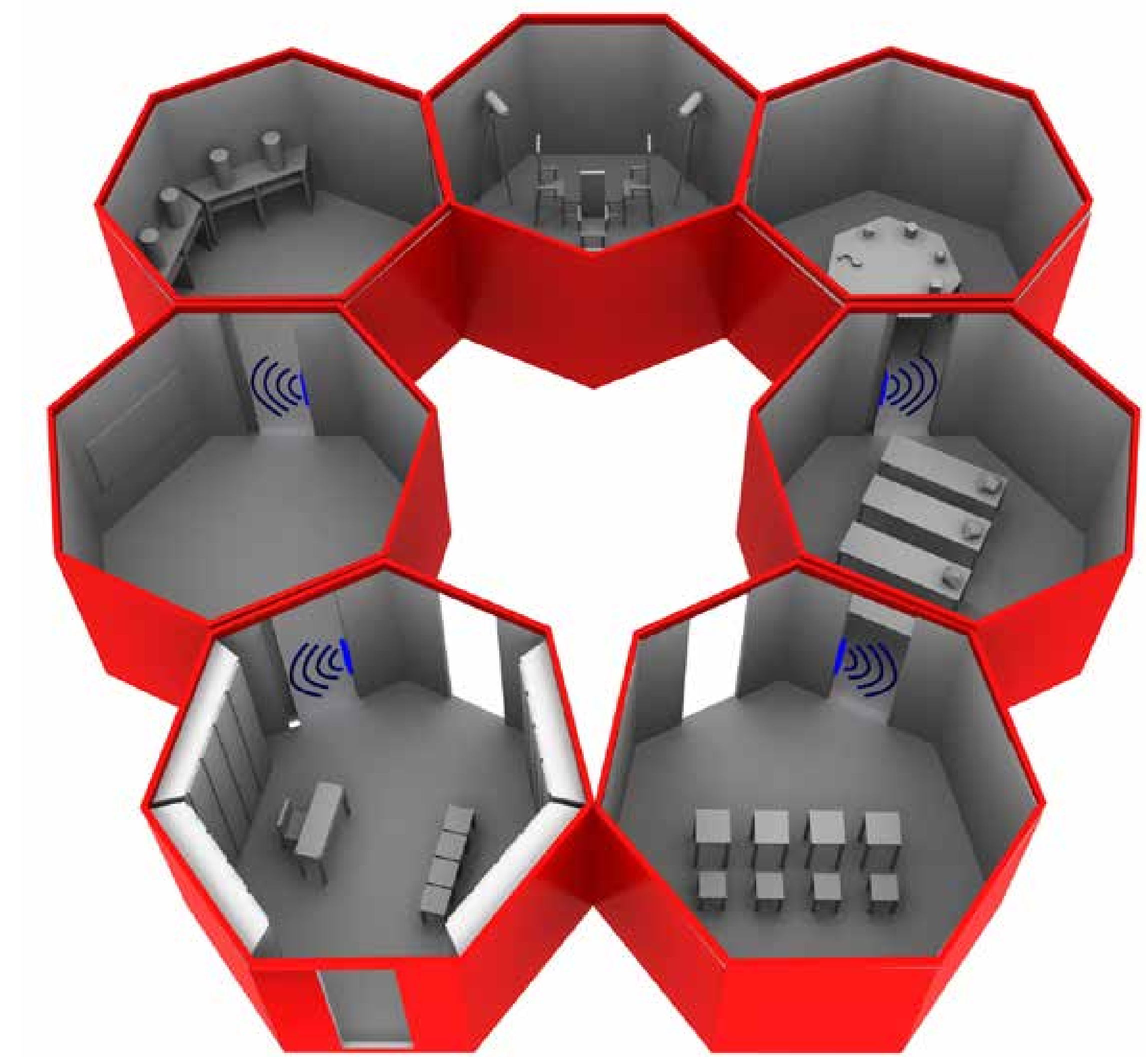
Publication:
Metamatic Reloaded, Kehrer, 2013

Marina Abramovic's MAI prototype represents a first test in the artist's initiative to develop an institute where visitors can learn the techniques and ideas she has developed in the field of performance art. This mobile prototype consists of 7 connected chambers and an interior courtyard that visitors move through in groups of four. Guided by an audio track created by the artist, the visitors perform a specific set of actions in each of the chambers. Working with Abramovic, we created a system that tracked a specific group of people as they moved through the prototype. The video was streamed to a website and during the Luminato Festival, to an installation at Pearson Airport. The streaming setup used a network of high frequency RFID tags/readers, cameras, and custom controllers linked to a video switcher. As the tagged visitors moved into a specific space, the RFID readers trigger the corresponding camera to activate, creating a continuous stream of the group's experience. This automated system created a continuous stream of the performance for 12 hours a day.

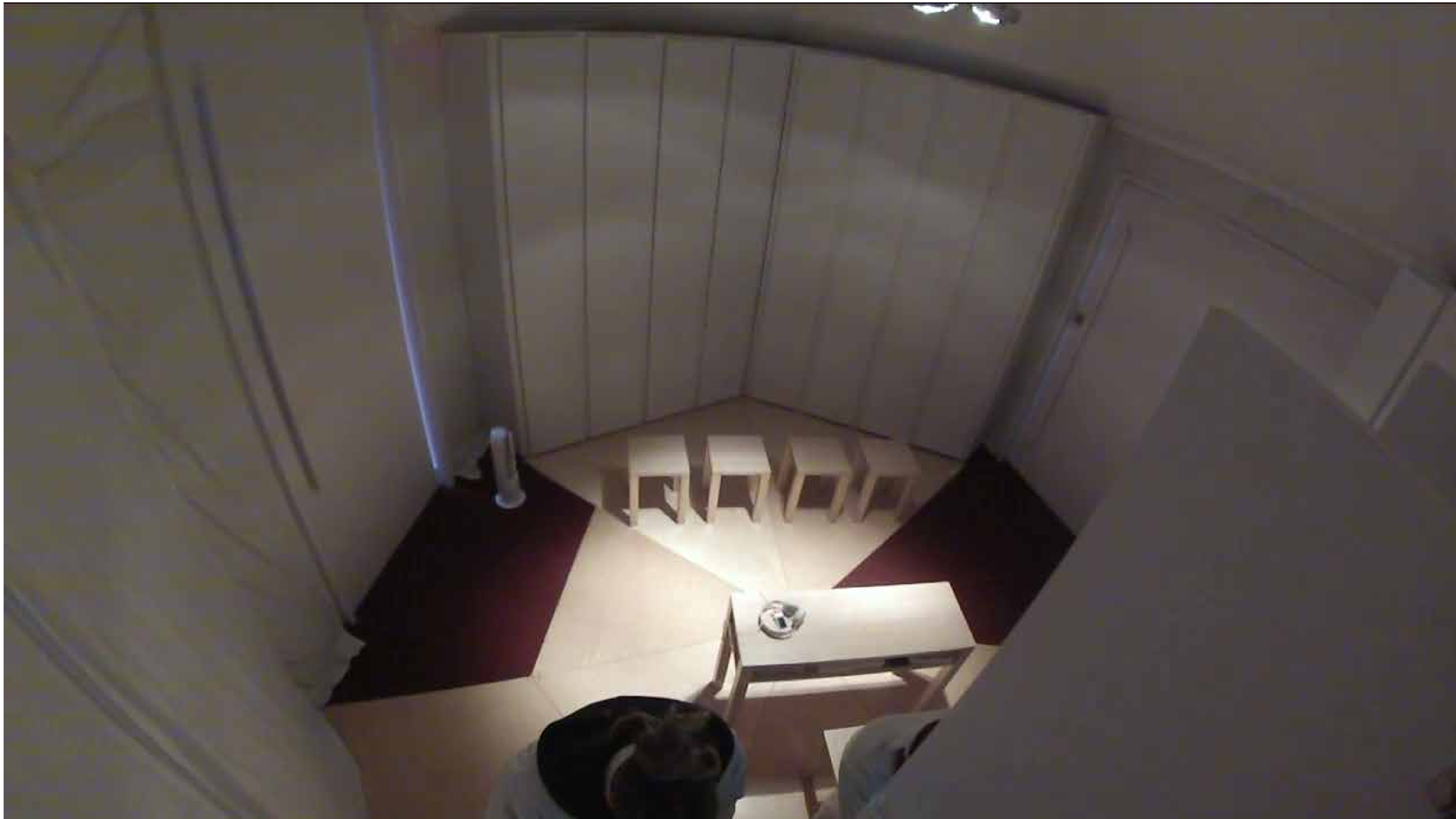
MAI prototype installed at Museum Tinguely

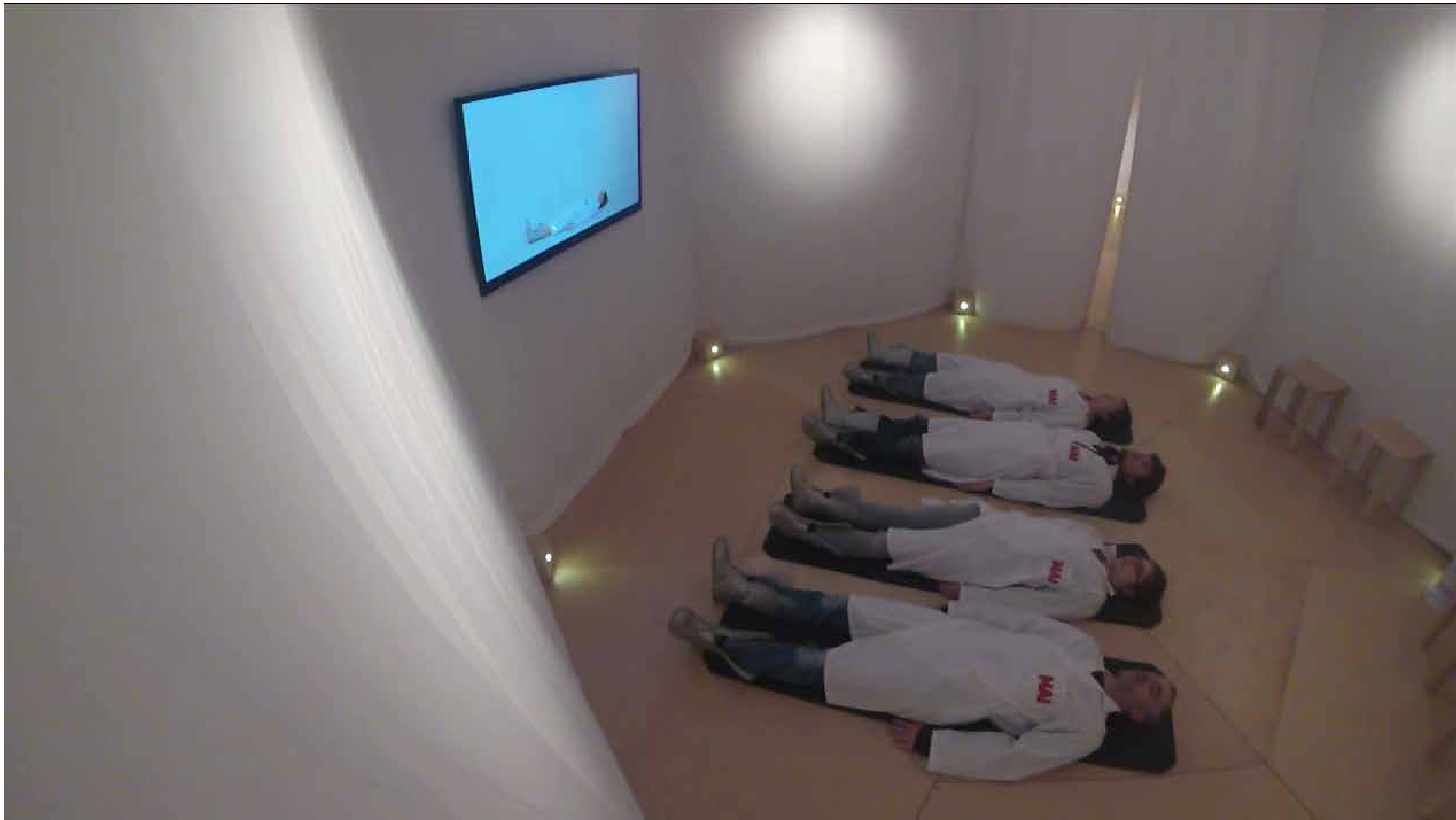


Placement of the cameras.



Placement of the RFID readers.


Reception Chamber



Exercise Chamber

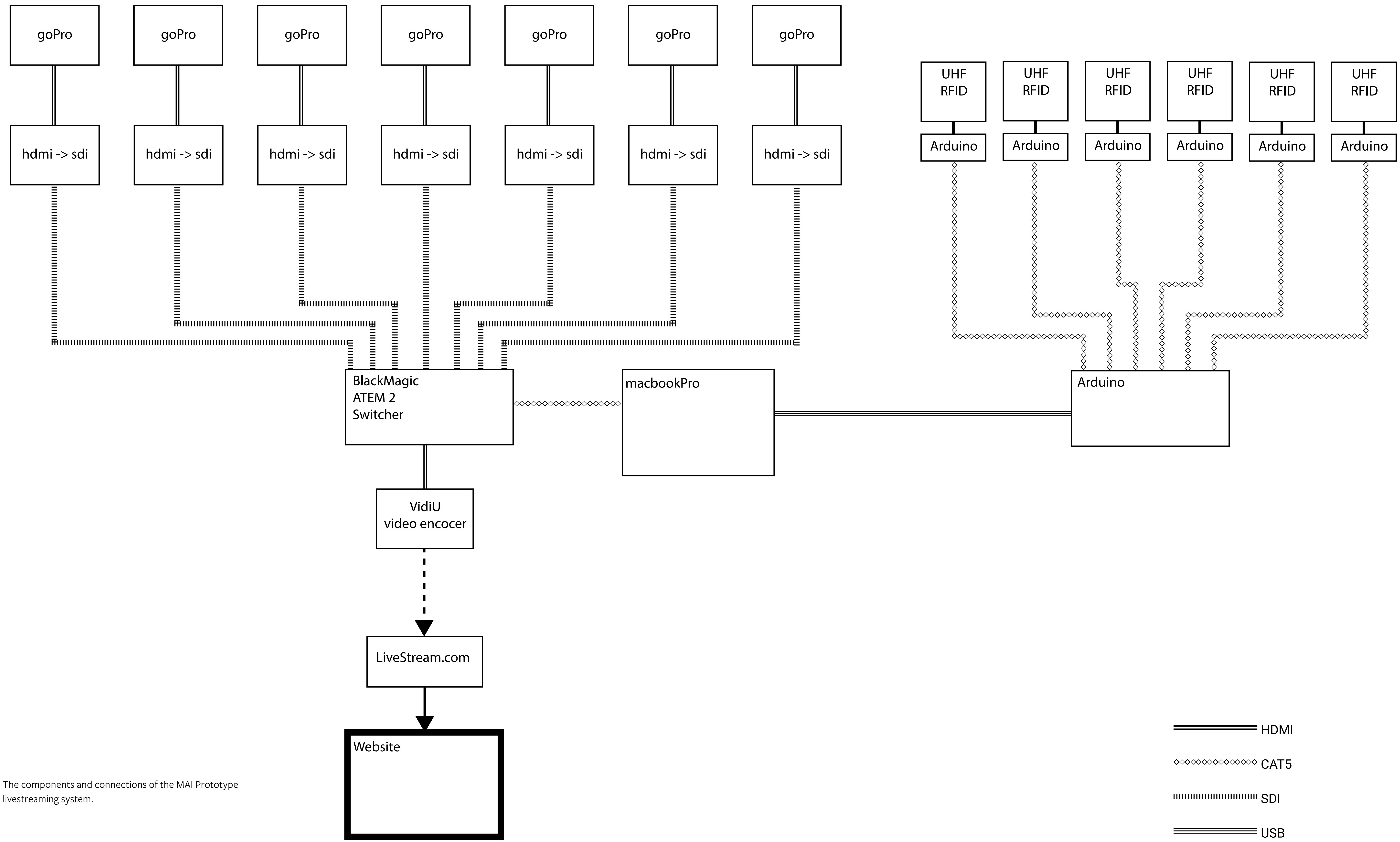
Water-Drinking Chamber


Looking Eyes Chamber

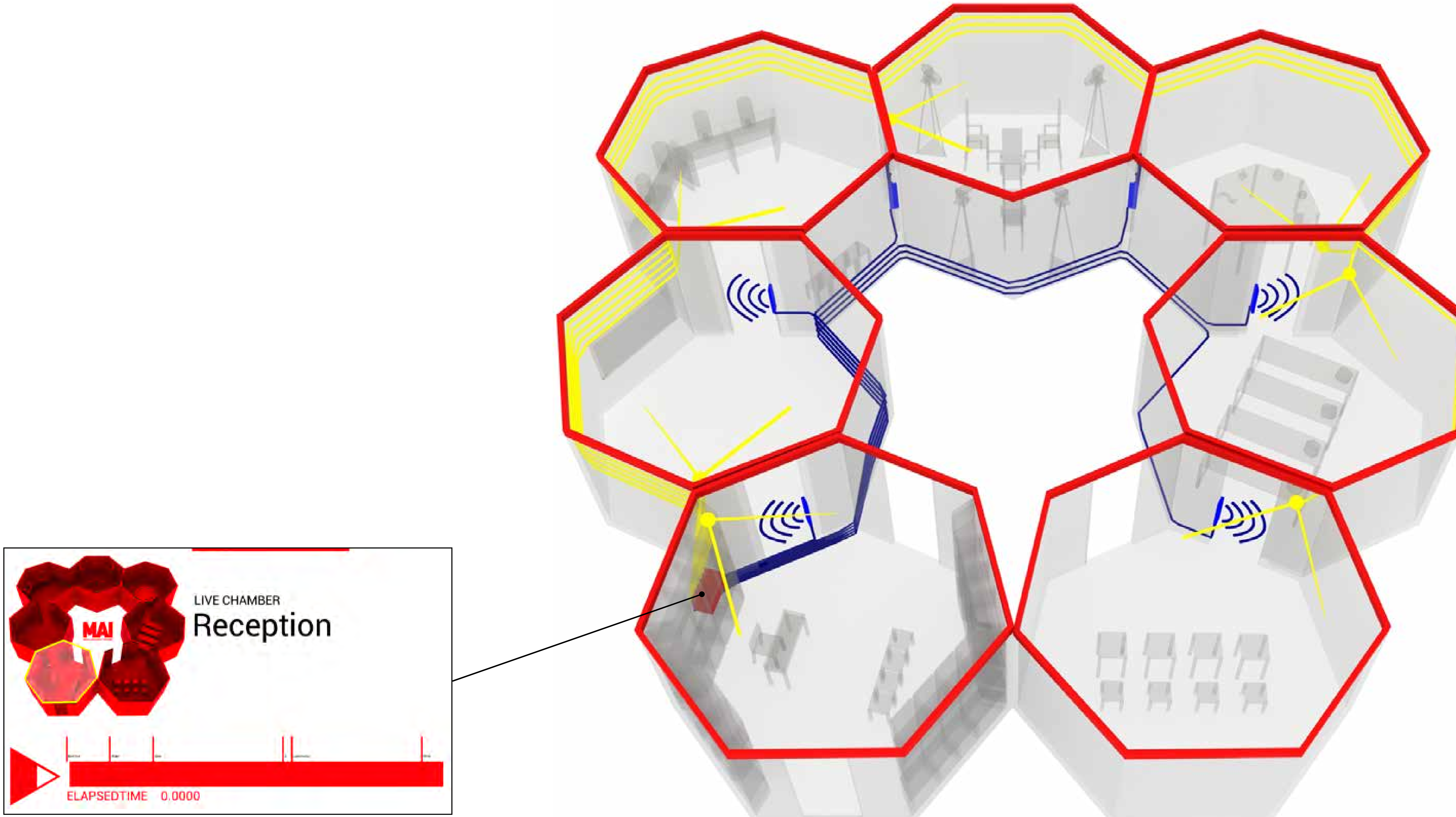

Electricity Chamber

Luminosity Chamber


Writing Chamber



The components and connections of the MAI Prototype livestreaming system.



Above: Overall control network for the livestreaming system and the control interface.

Next Page: Cameras and video encoder prototyping.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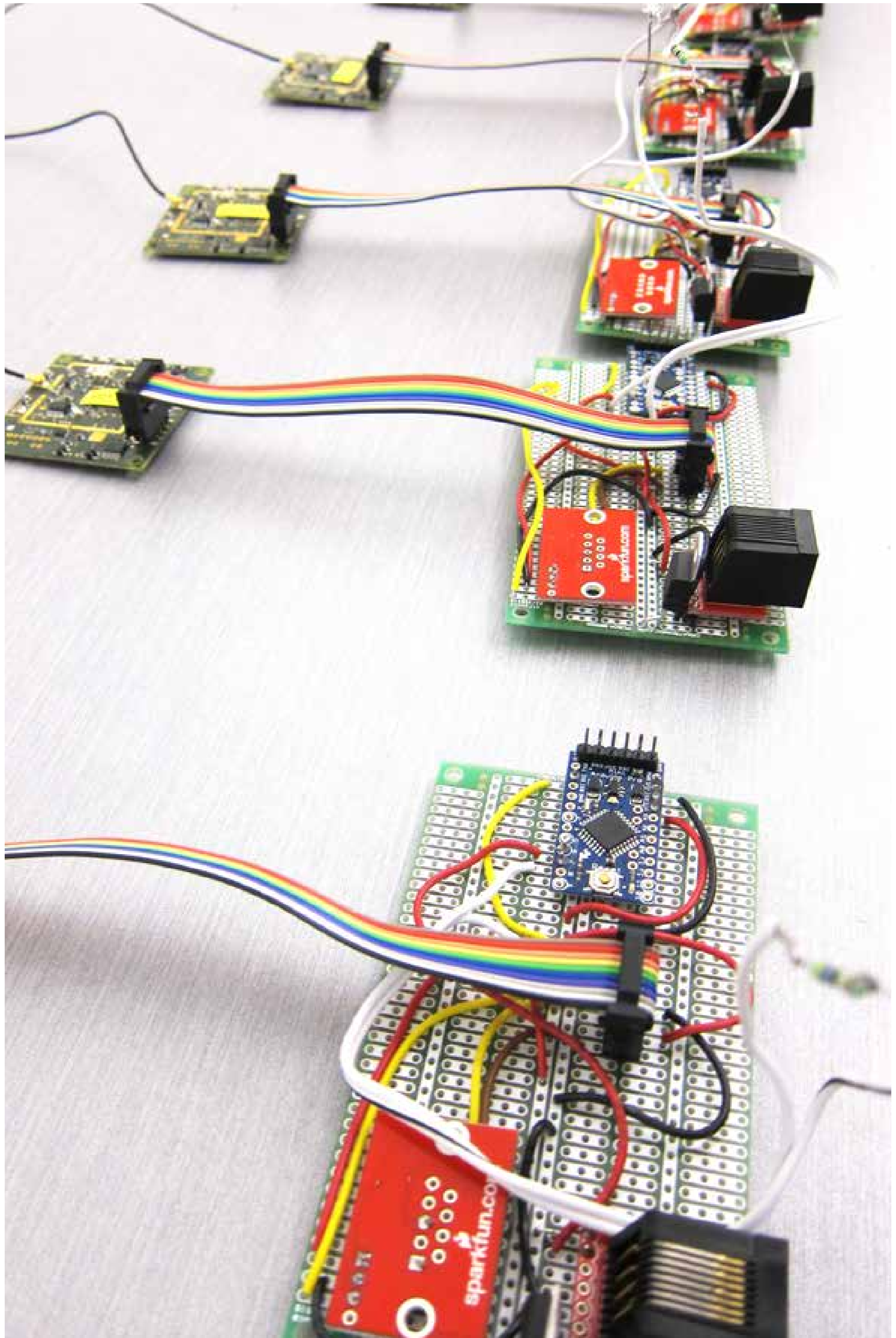
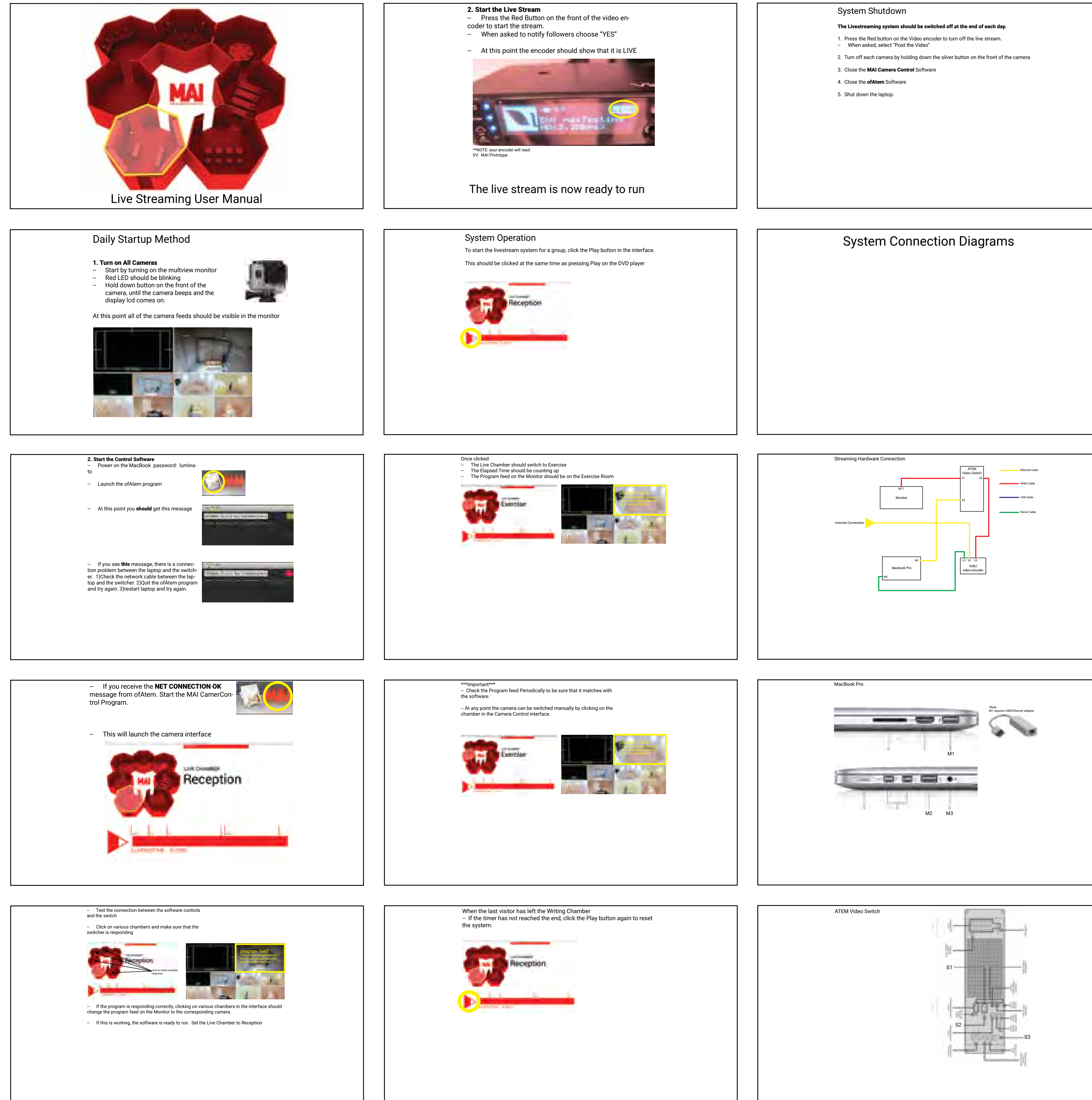


Left: Custom built RFID readers.
Right: RFID tag attached to a visitor's boot.

The livestreaming system ran for 12 hours a day for 2 months monitored by museum docents. An interface was created to allow them to control a system that has the complexity of a television studio.

Operations manual created for the livestreaming system.



MAI prototype at the Luminato Festival

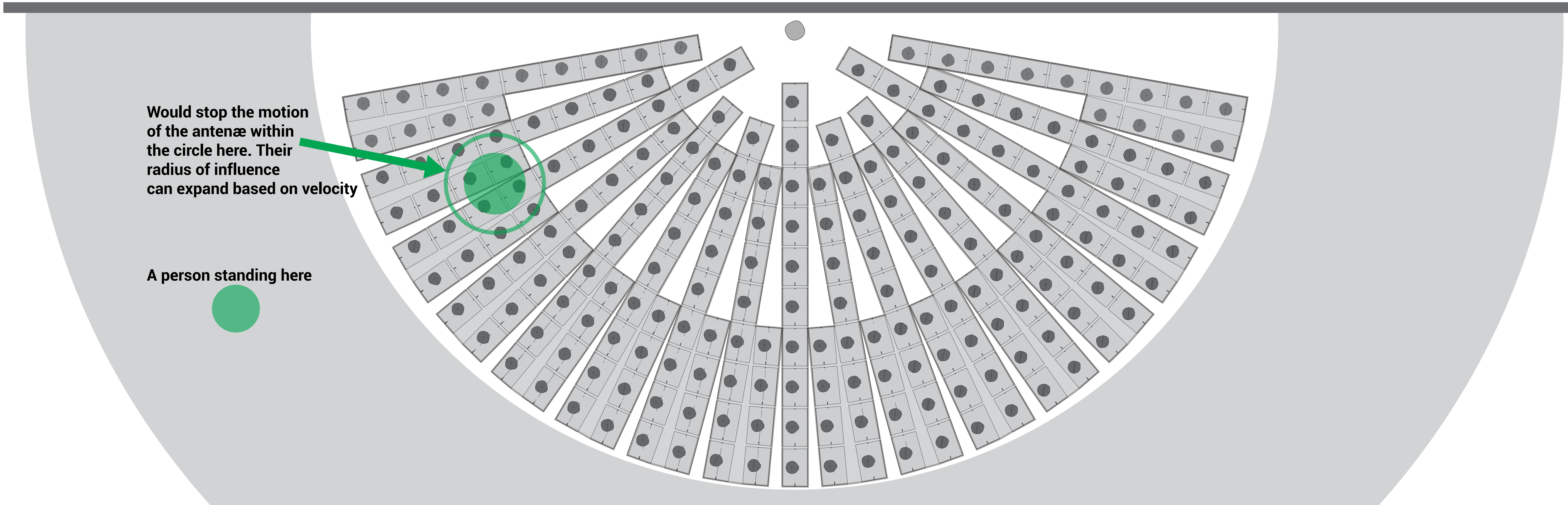
Commisssioned by The Bi City Biennale Of Urbanism & Architecture (UABB)

Exhibition:
Re-Living the City, 2015 Bi City Biennale Of Urbanism & Architecture.
Shenzhen, China

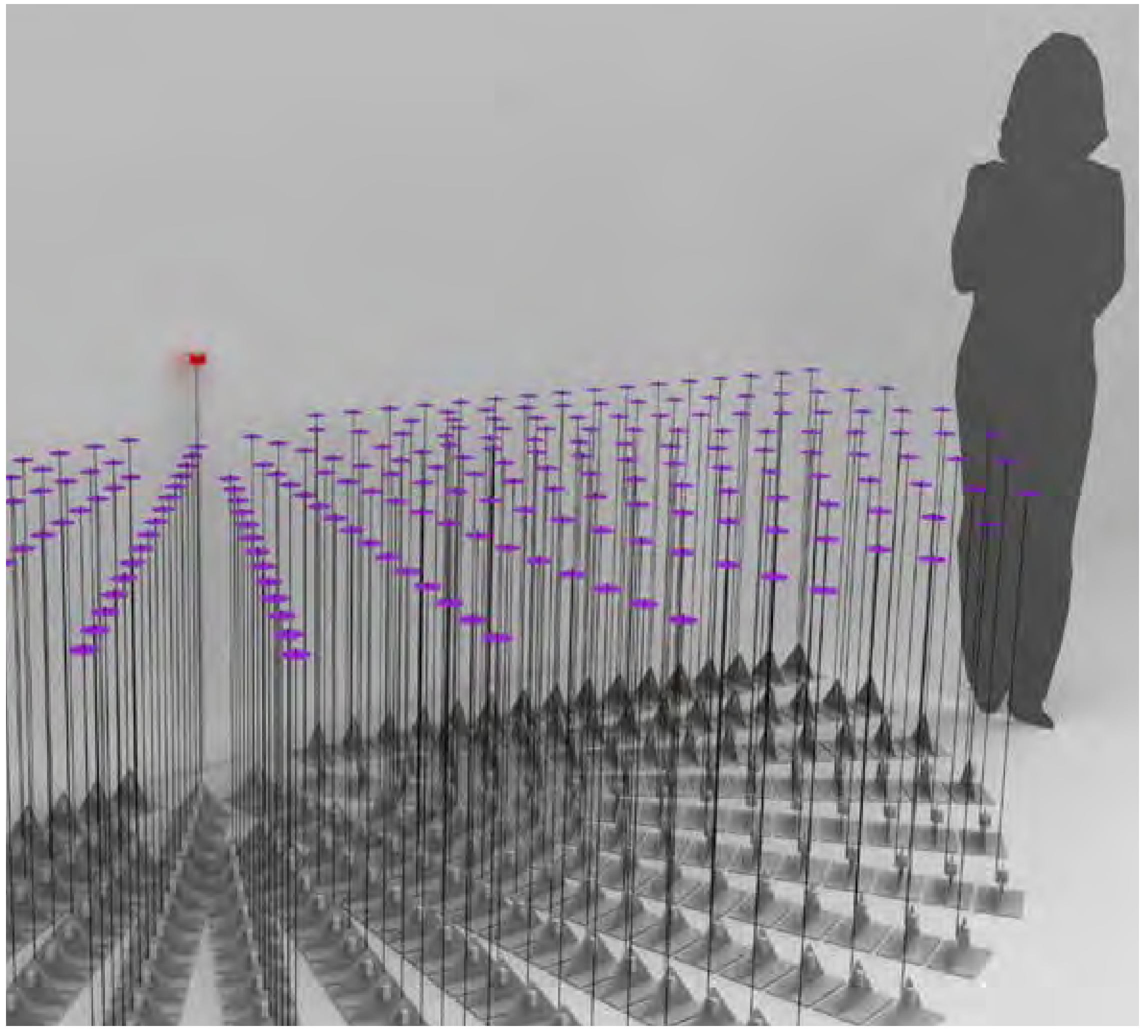
Pulse v1 videos

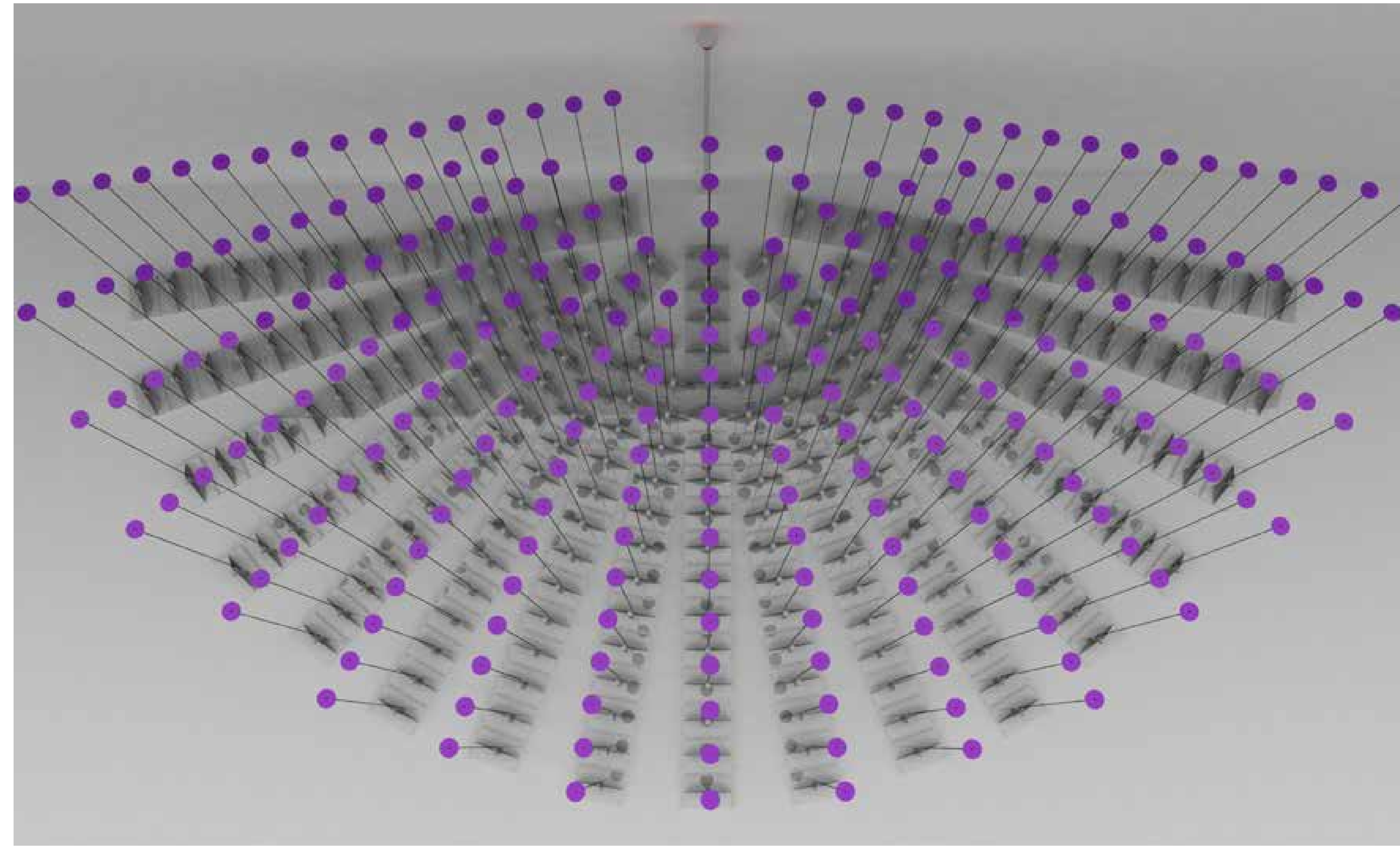
Resistor v1 scans and visualizes the shifting landscape of the exhibition as a field of vibrating antennae. A custom Lidar laser scanner is used to continually digitize the surrounding crowds, exhibits, and architecture to create a dynamic map of the space. With each scanning pass, these digital maps are translated into the movement of 250 robotic antennae, which vibrate in response to the current and historic activity in the space. Over time, each antenna builds up an inertia that multiplies or resists the current activity within the exhibition based on patterns of occupation. This process operates continuously during the exhibition, providing visitors with a visualization of the current state of the exhibition space in relationship to its history.

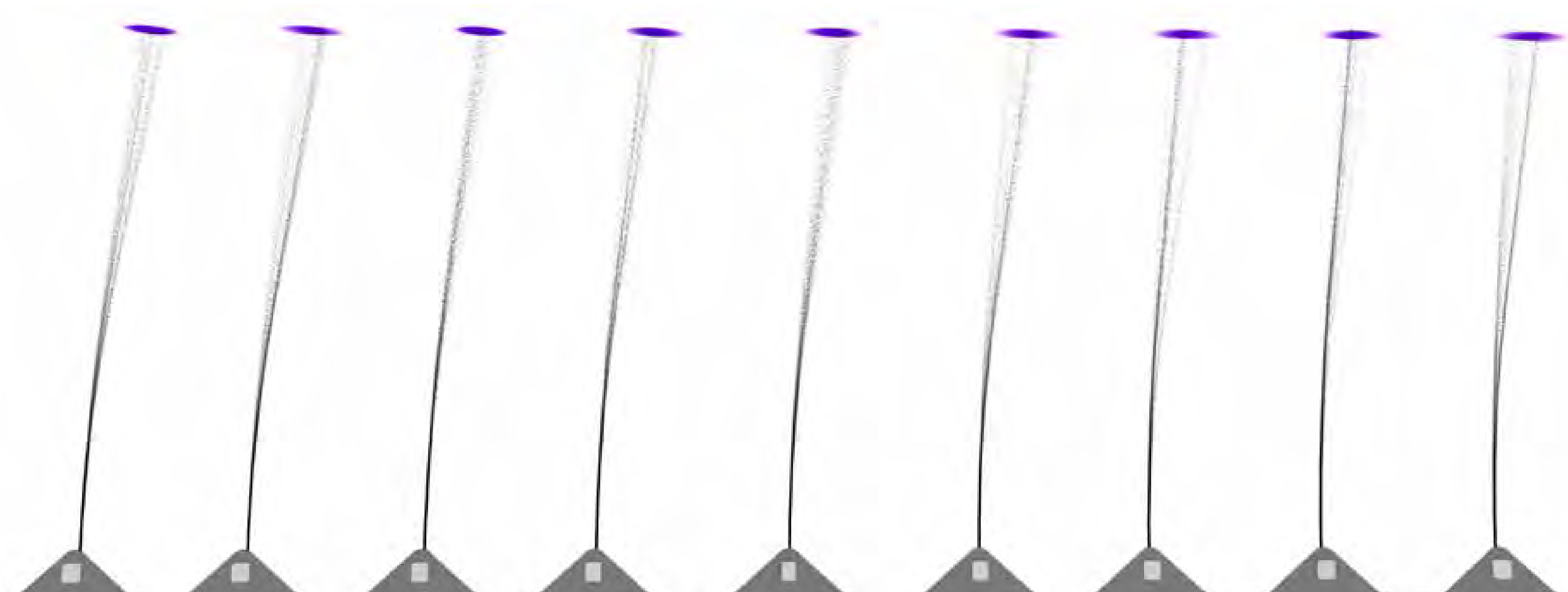
Resistor v1 installed at the 2015 Bi City Biennale Of Urbanism Architecture in Shenzhen.



The overall behaviour:
As the Lidar rotates, it creates a radial wave that passes back and forth in a constant loop.
If no-one is within the sensing zone/angle when the Lidar passes over it all of them pulse.
People interupt that wave with their presence. Only 1 column is sensed pulsed at a time, but people will generally be wider than 1 column. Their radius of influence could also be expanded through the velocity value.

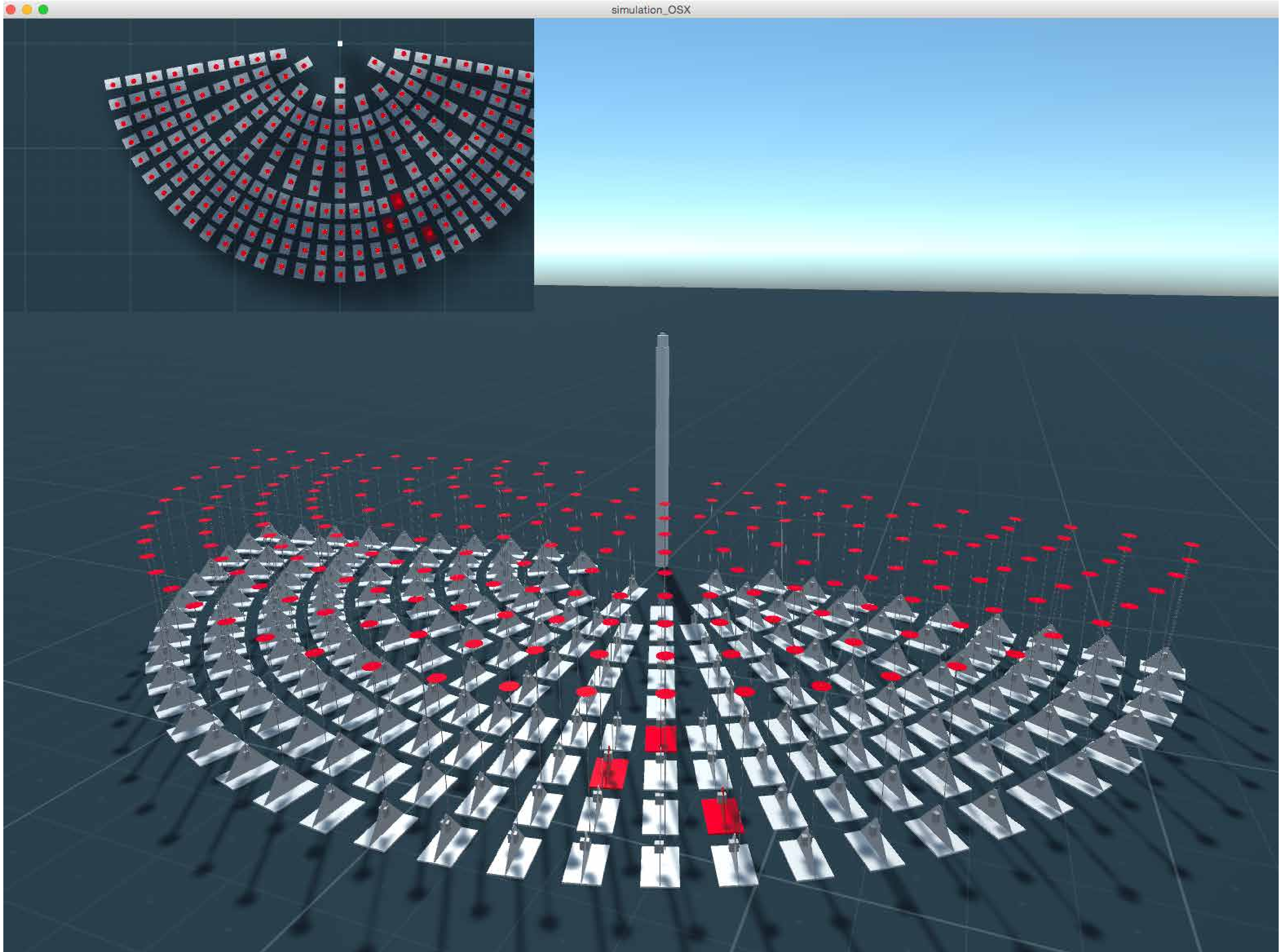






Above: Initial design concepts for the overall layout and behaviour.

Next Page: Resistor v1 installed at the BiCity Biennale of Architecture and Urbanism in Shenzhen, China.



An interactive digital simulation of Resistor was created as a way to prototype the material, behaviour, and interaction systems.

Left: Manufacturing the individual vibration unit antennas and connecting them to the servos.

Next Page: Venue for the BiCity Biennale of Architecture and Urbanism in Shenzhen, China.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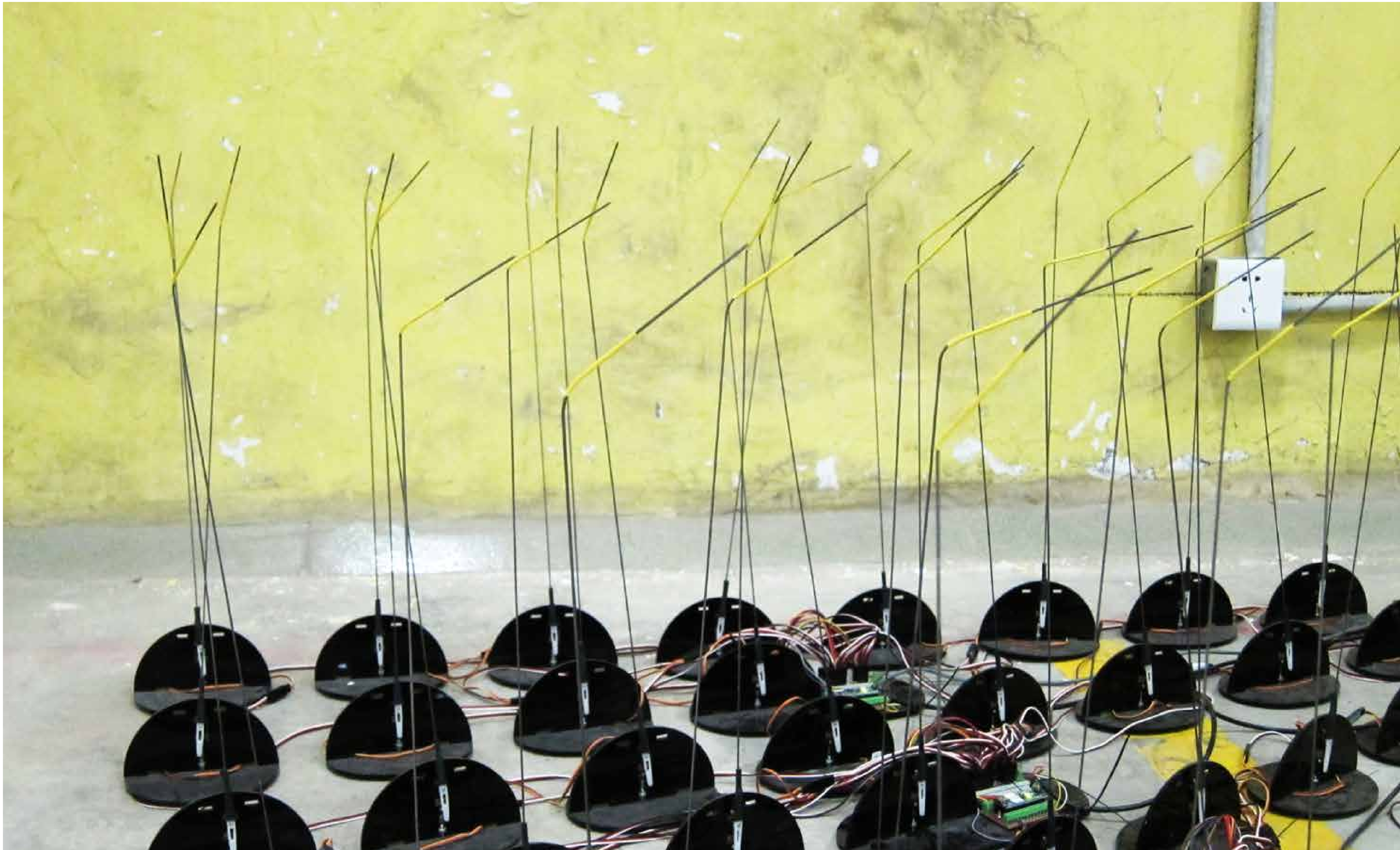

Previous Page: Detail of vibration response units.

Below: Visitors interact with Resistor v1 during the opening of the UABB.

Next Page: Resistor v1 installed at the BiCity Biennale of Architecture and Urbanism in Shenzhen, China.