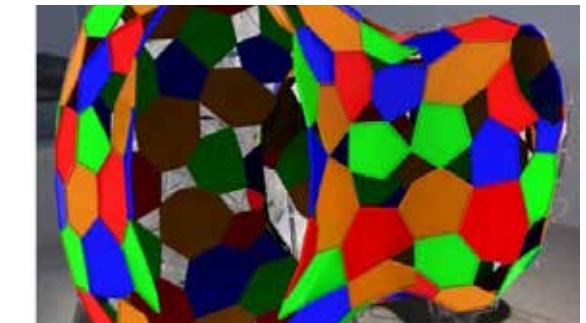


# Puckett Research & Design

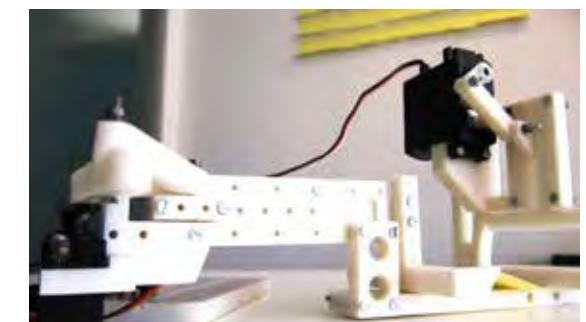
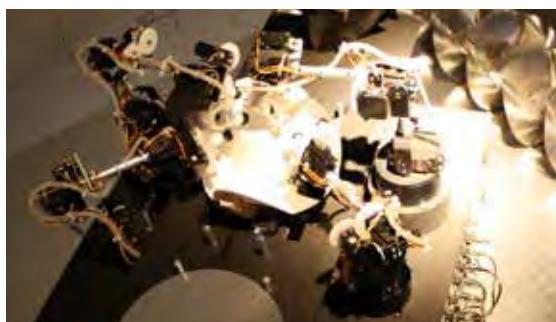
## BioDigital Hybrids

STEMcloud v2  
CyberGarden v4  
Urban Algae Folly  
METAfolly



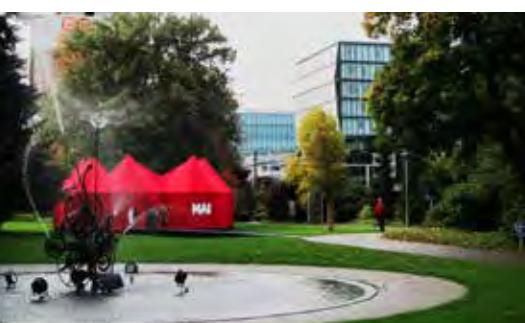
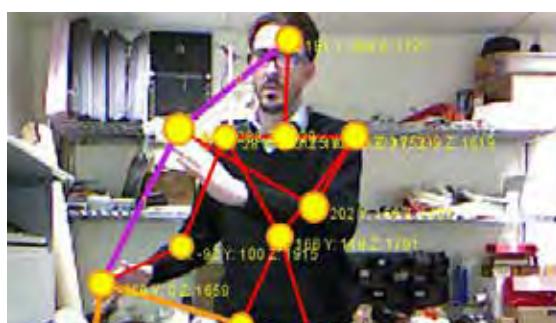
## Custom Fabrication Systems

RoboFold  
FieldCondition  
BlackBox  
FabNodes



## Creative Surveillance

Xiamen Masterplan  
Kinect Res. Framework  
MAI Livestreaming  
Pulse v1



# BioDigital Hybrids

---

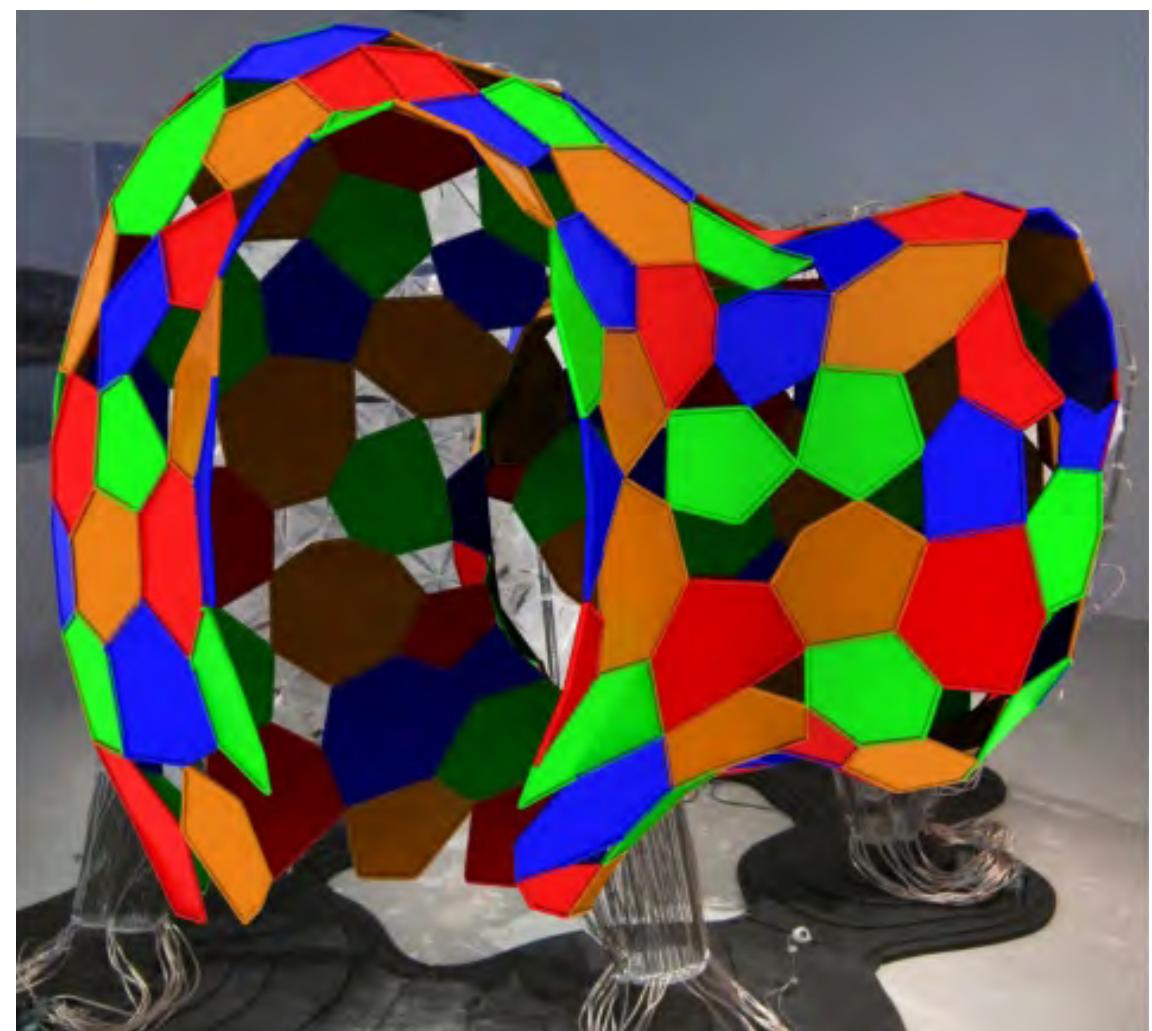
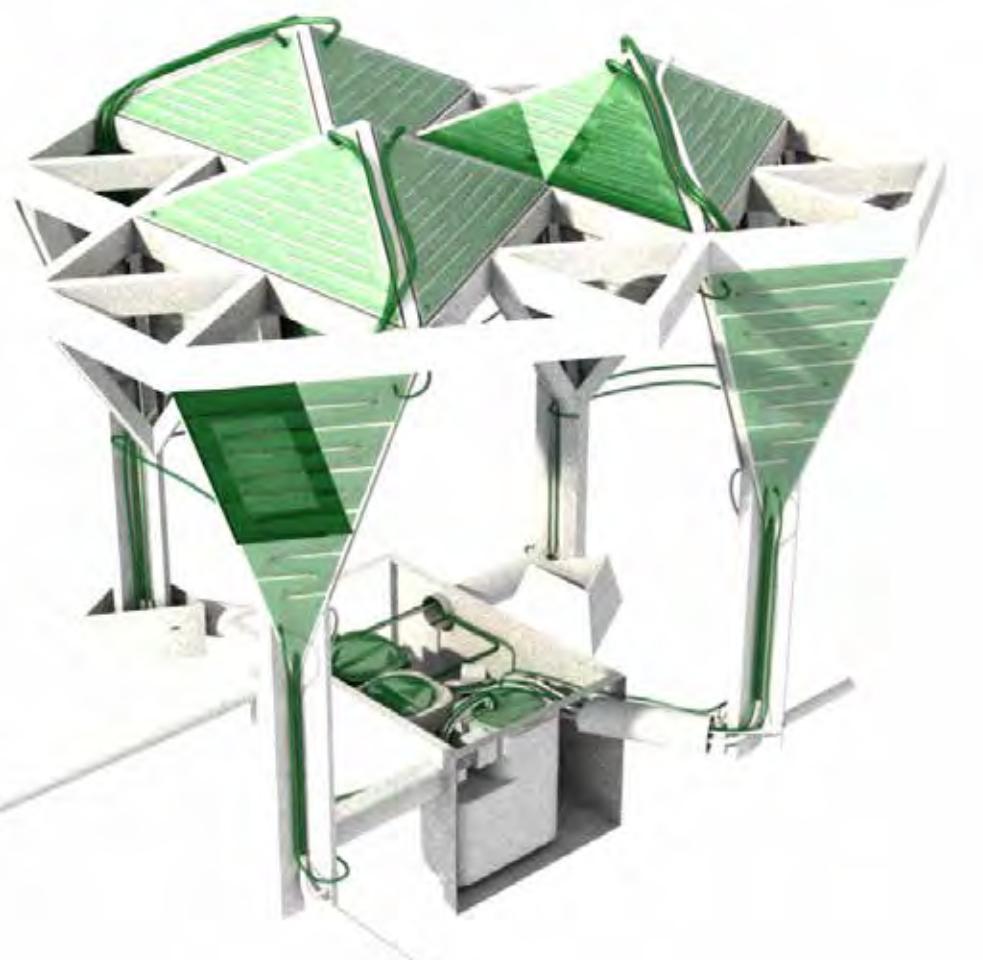
STEMcloud v2

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)

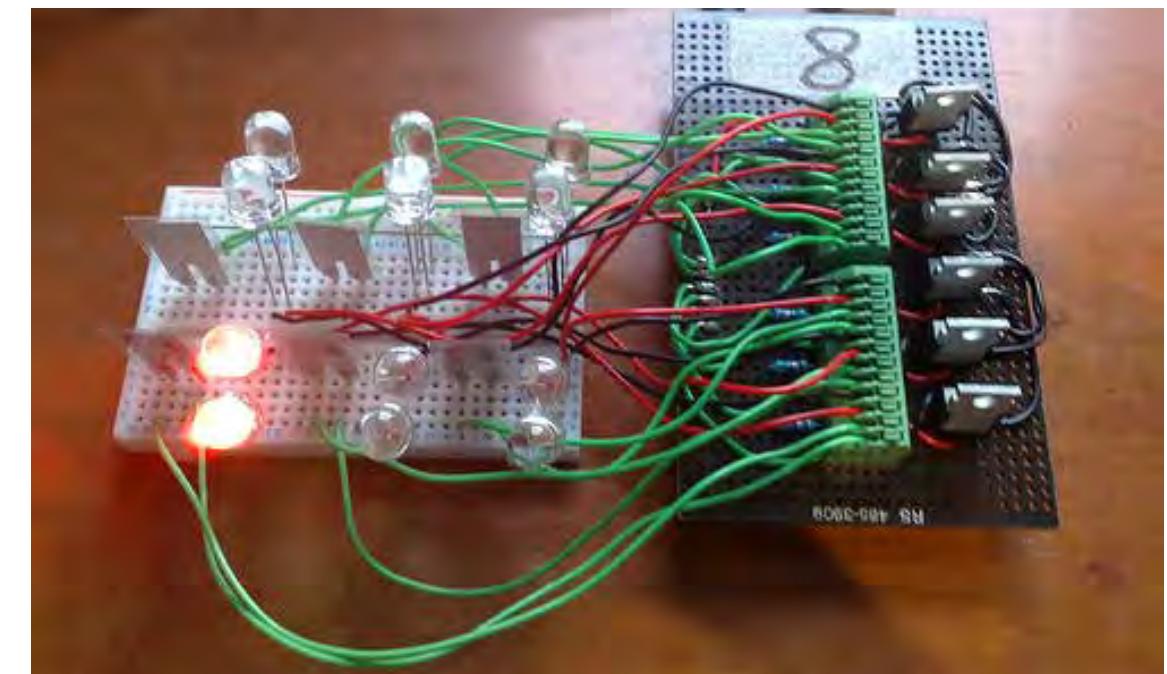
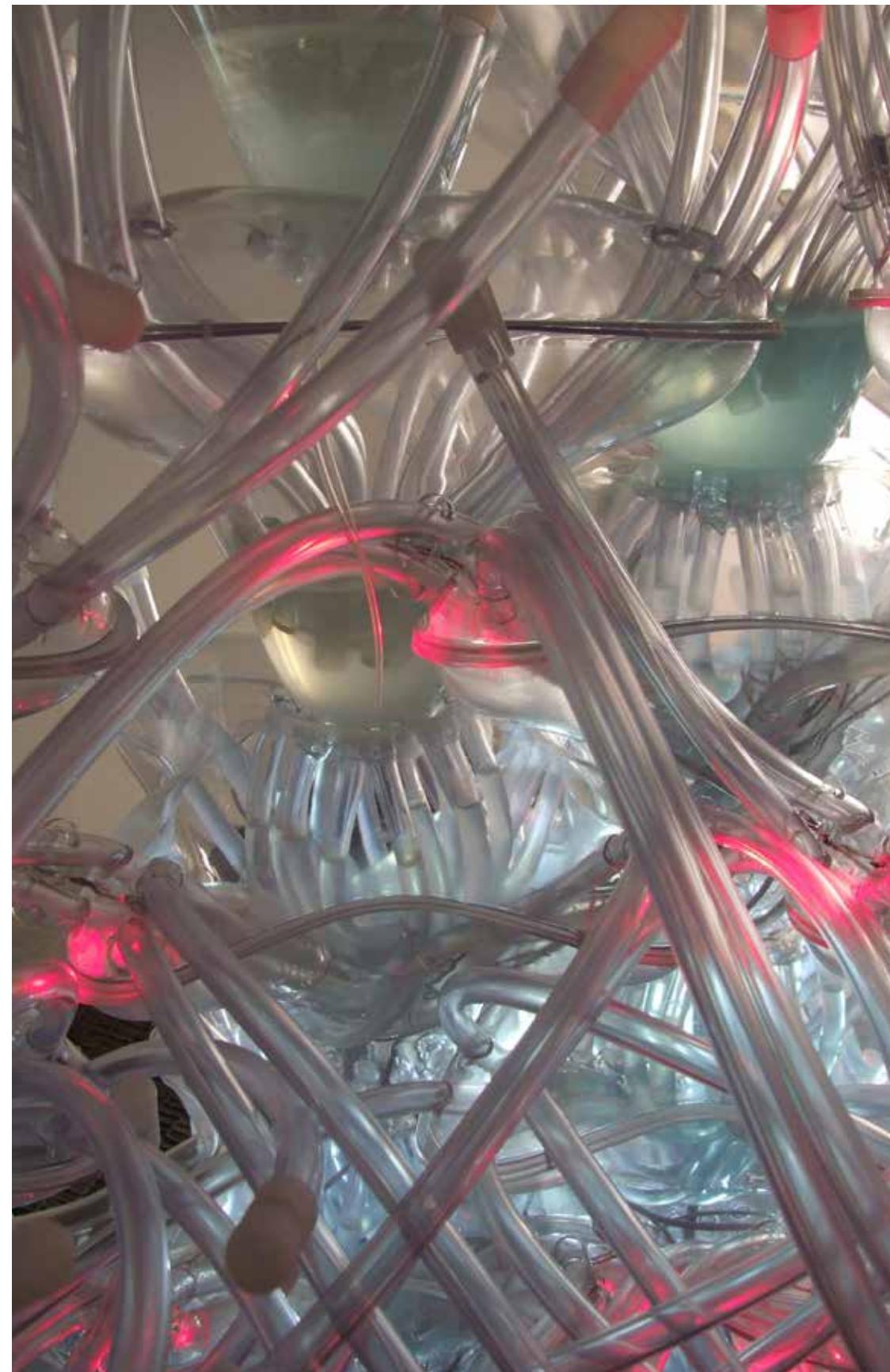
**Collaborator:**  
EcoLogic Studio

**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<sub>2</sub>. The CO<sub>2</sub> 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<sub>2</sub>) 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<sub>2</sub> glow brighter to attract attention from visitors to gain their CO<sub>2</sub>. 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<sub>2</sub> 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

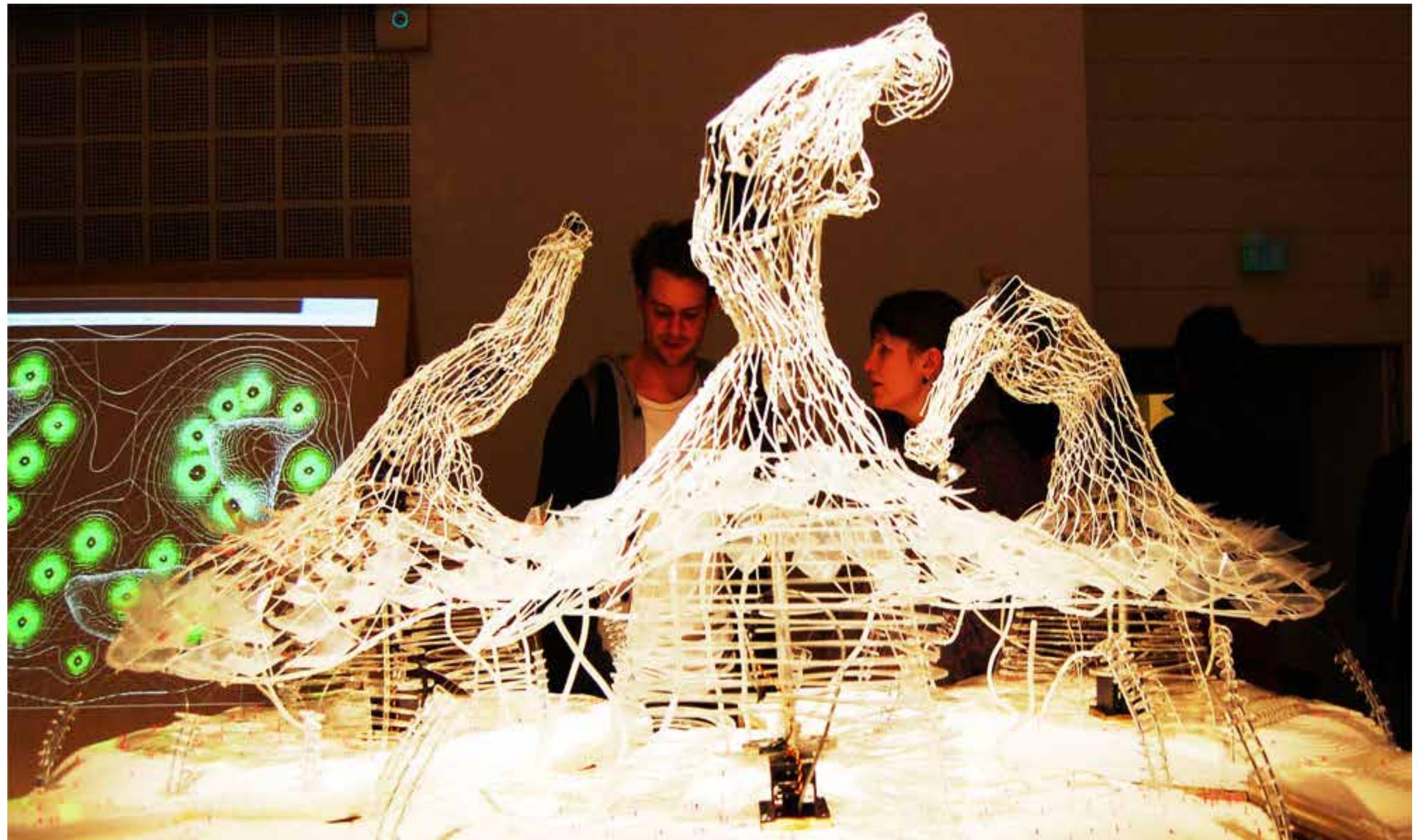
2011 ACADIA Conference,  
Banff, Canada

**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

**Collaborators:**  
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 Taflin, Inhabitat.com

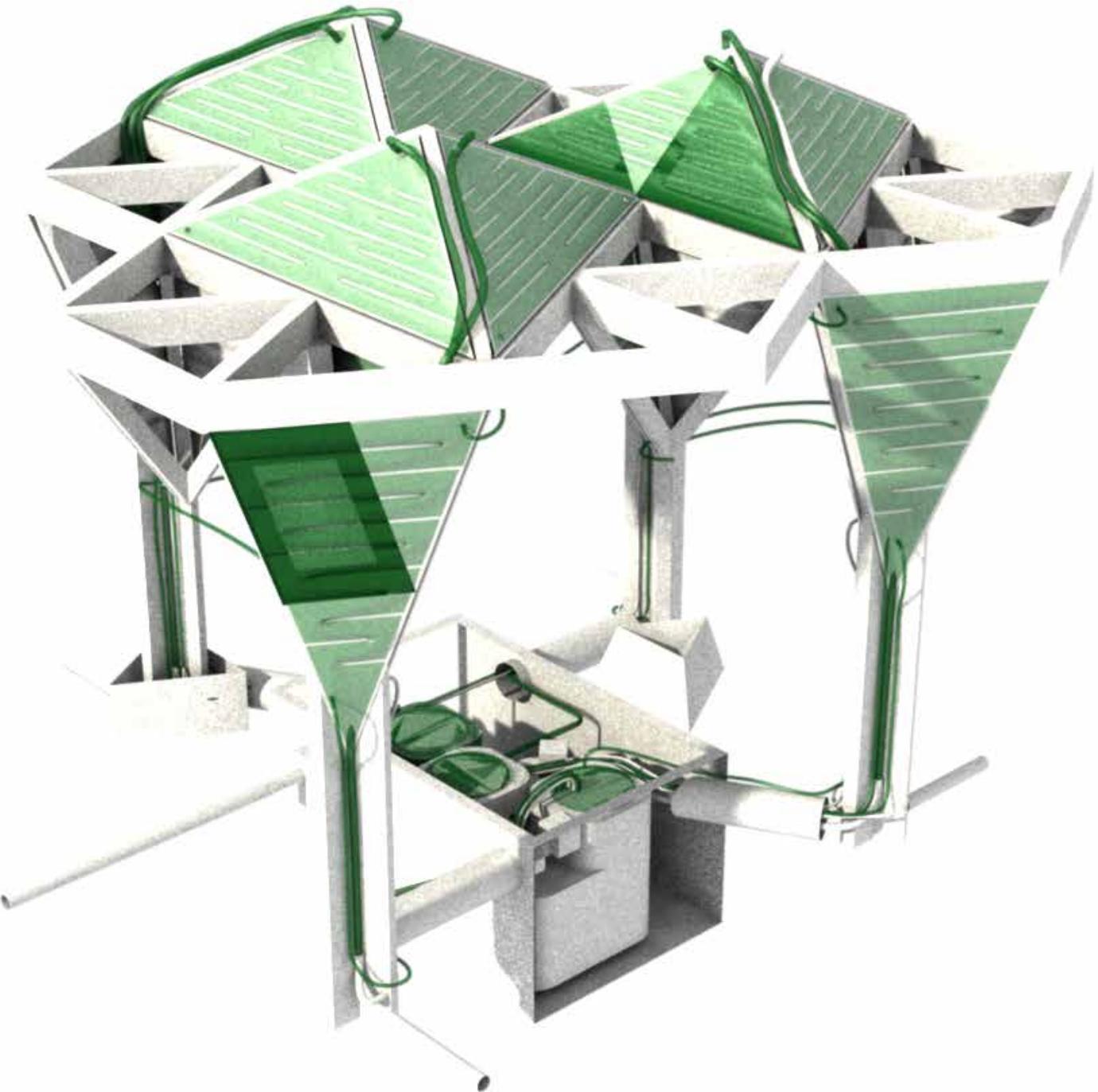
Urban Algae Folly  
Marcos Cruz, syndebio.com

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

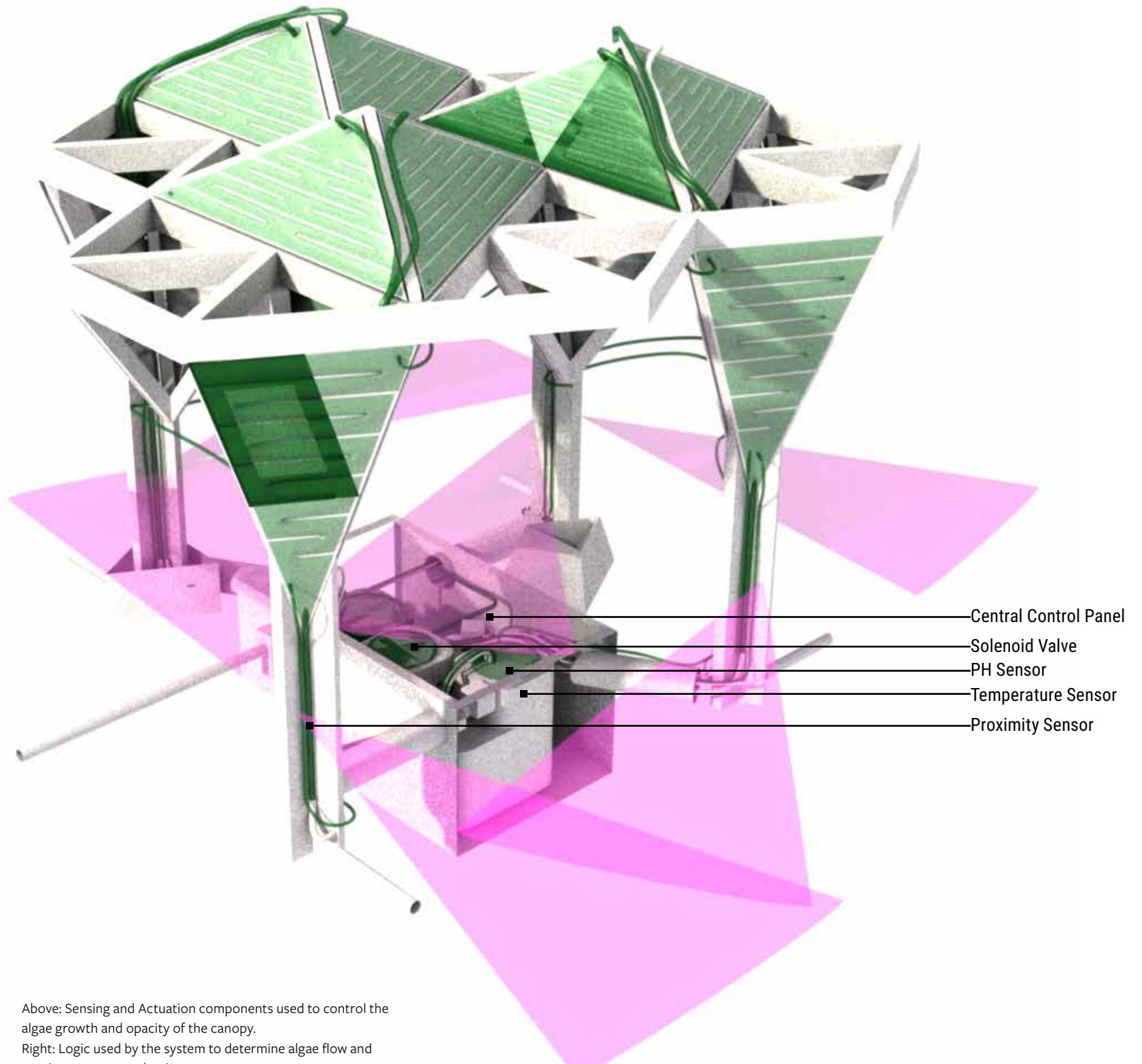
## [\*Urban Algae Folly videos\*](#)

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<sub>2</sub> 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 photosynthesis 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.

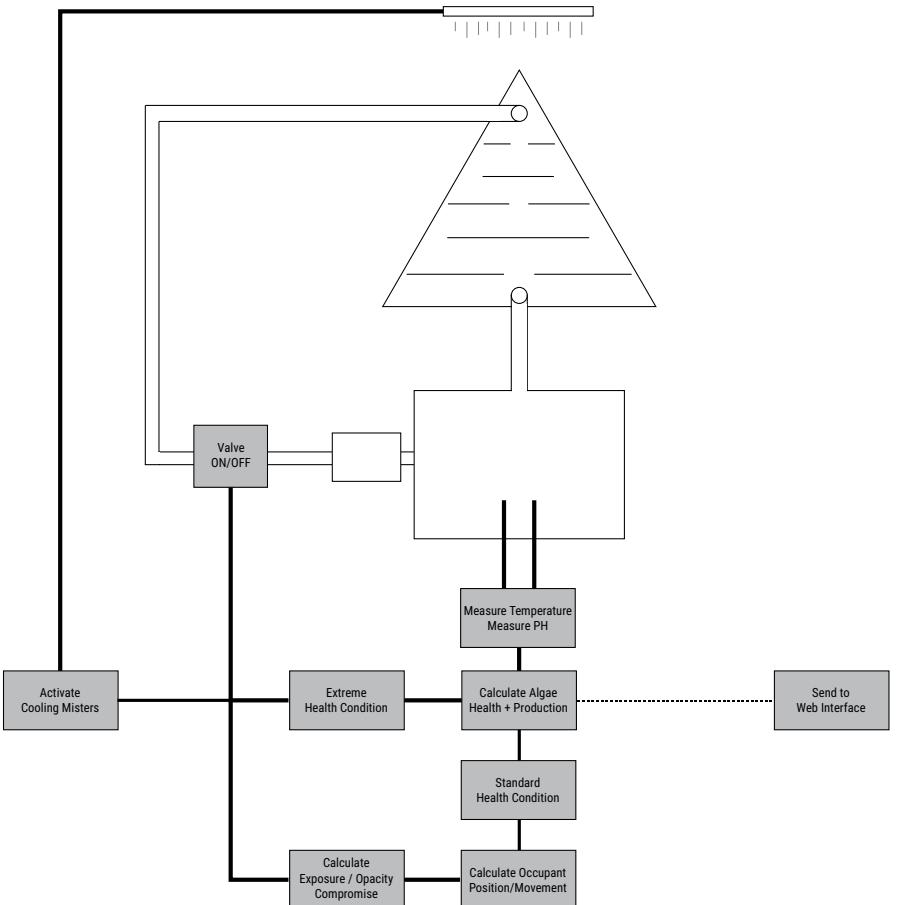


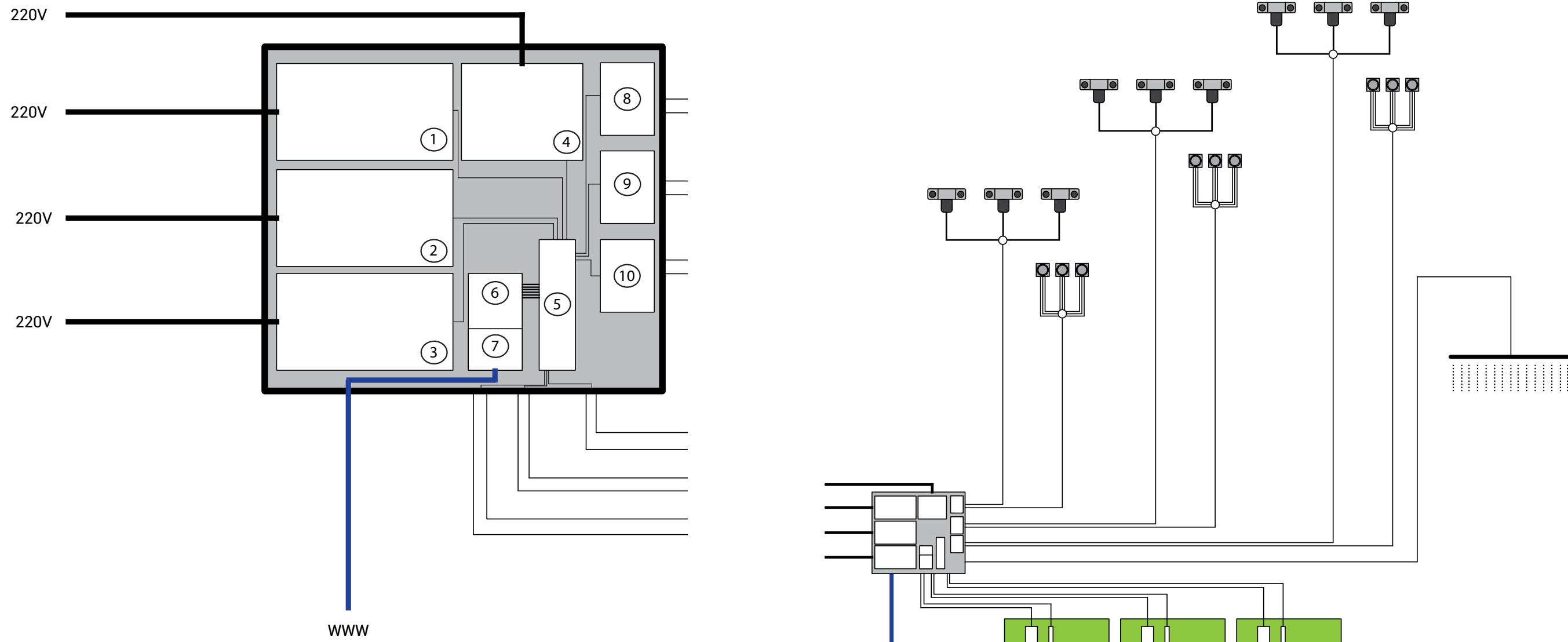
Right: Rendering of the Urban Algae Folly structure and underground mechanical system.



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.





#### 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 Controller

- Solenoid Valve
- Distance Sensor
- Temperature Sensor
- PH Sensor
- Mister



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.

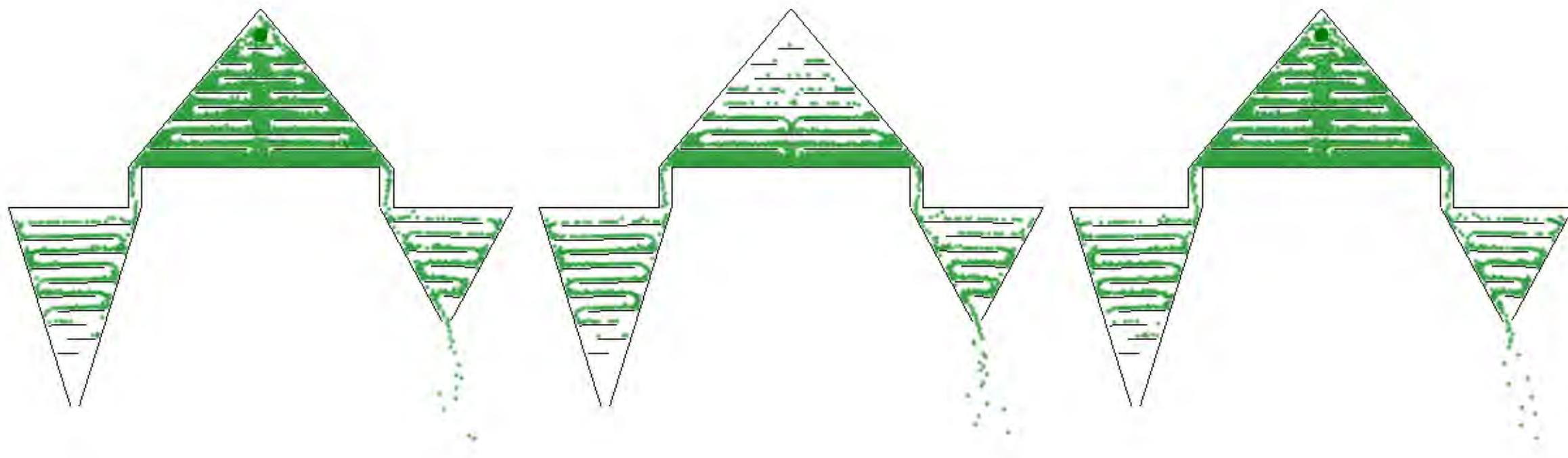
Bottom Right: Custom distance sensors and housings created to monitor the position and activity of visitors.



Flow Rate1: 120

Flow Rate2:0

Flow Rate3:120



Tests

Interactive Canopy

---

Vel Iter 8

Pos Iter 3

Pcl Iter 3

Hertz 60.0

---

Sleep

Warm Starting

Time of Impact

Sub-Stepping

Strict Particle/Body Contacts

---

Draw

Shapes

Particles

Joints

AABBs

Contact Points

Contact Normals

Contact Impulses

Friction Impulses

Center of Masses

Statistics

Profile

---

Pause

Single Step

Restart

Quit

---

Interactive Canopy

---

Key Shortcuts

(n) open/close

(+) increase flow

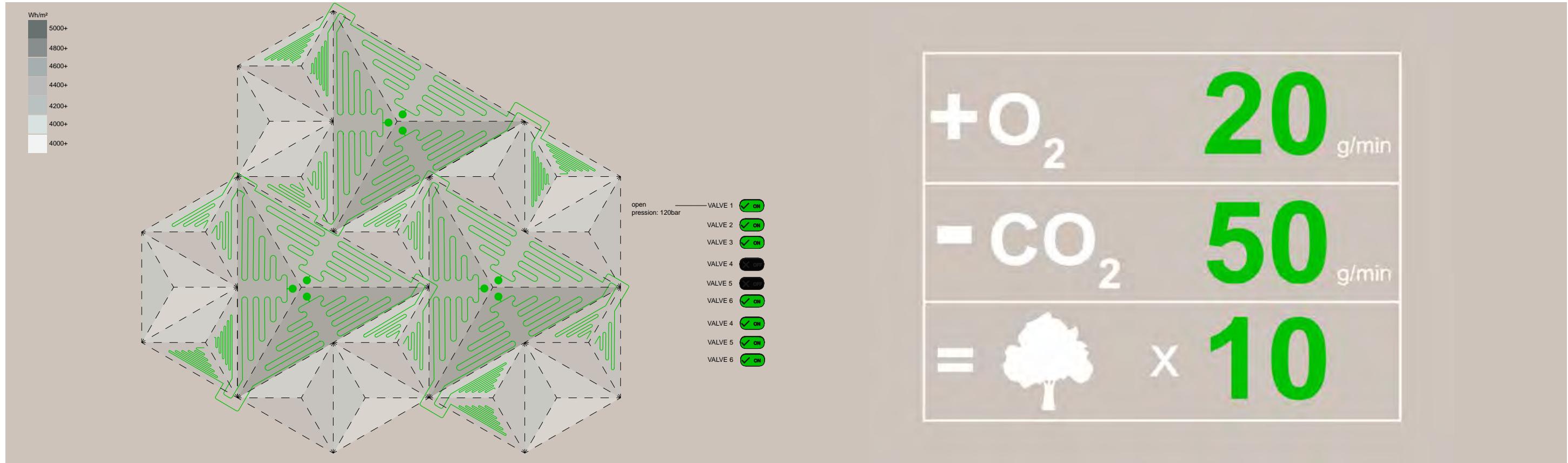
(-) reduce flos

(arrows) move simulation

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.

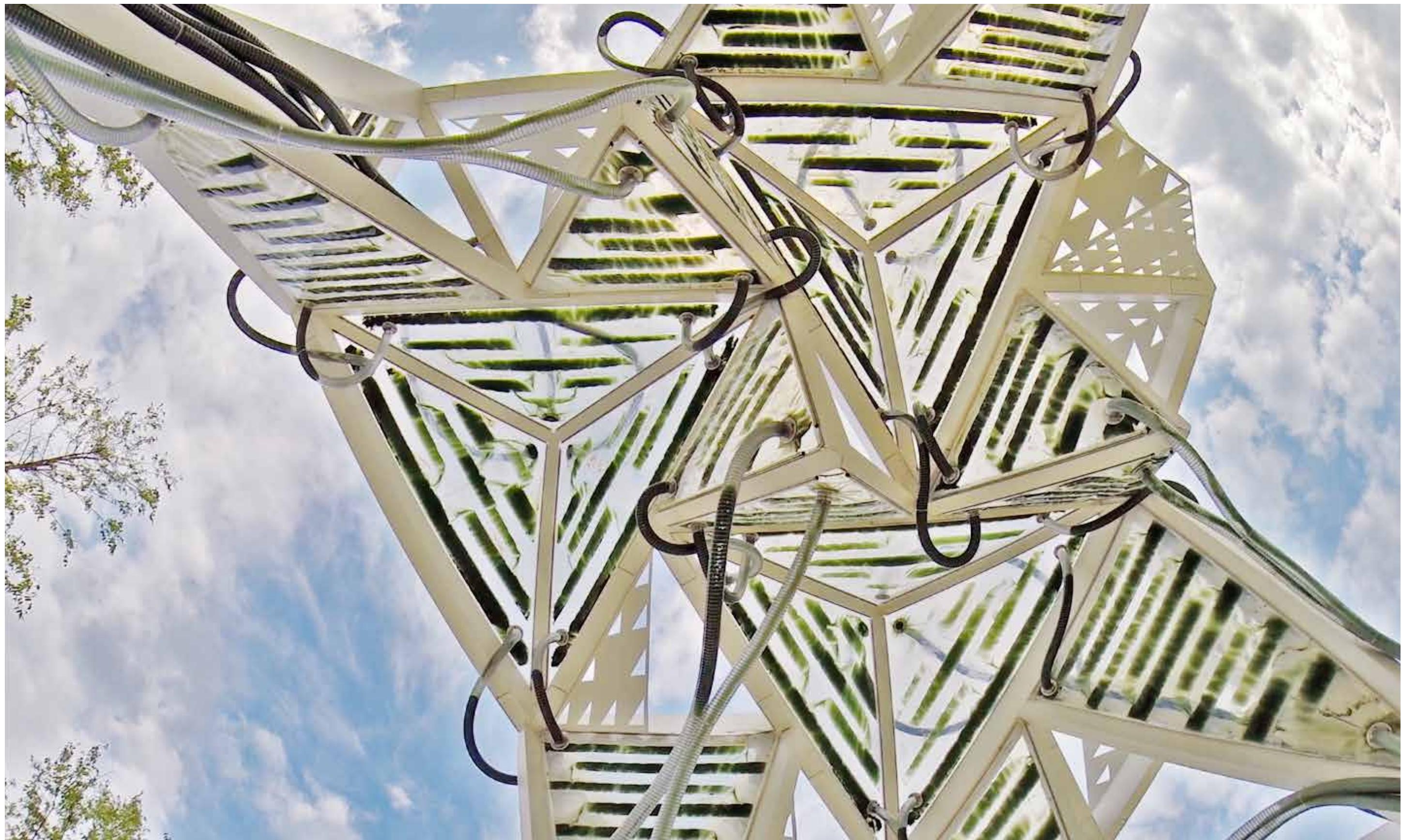


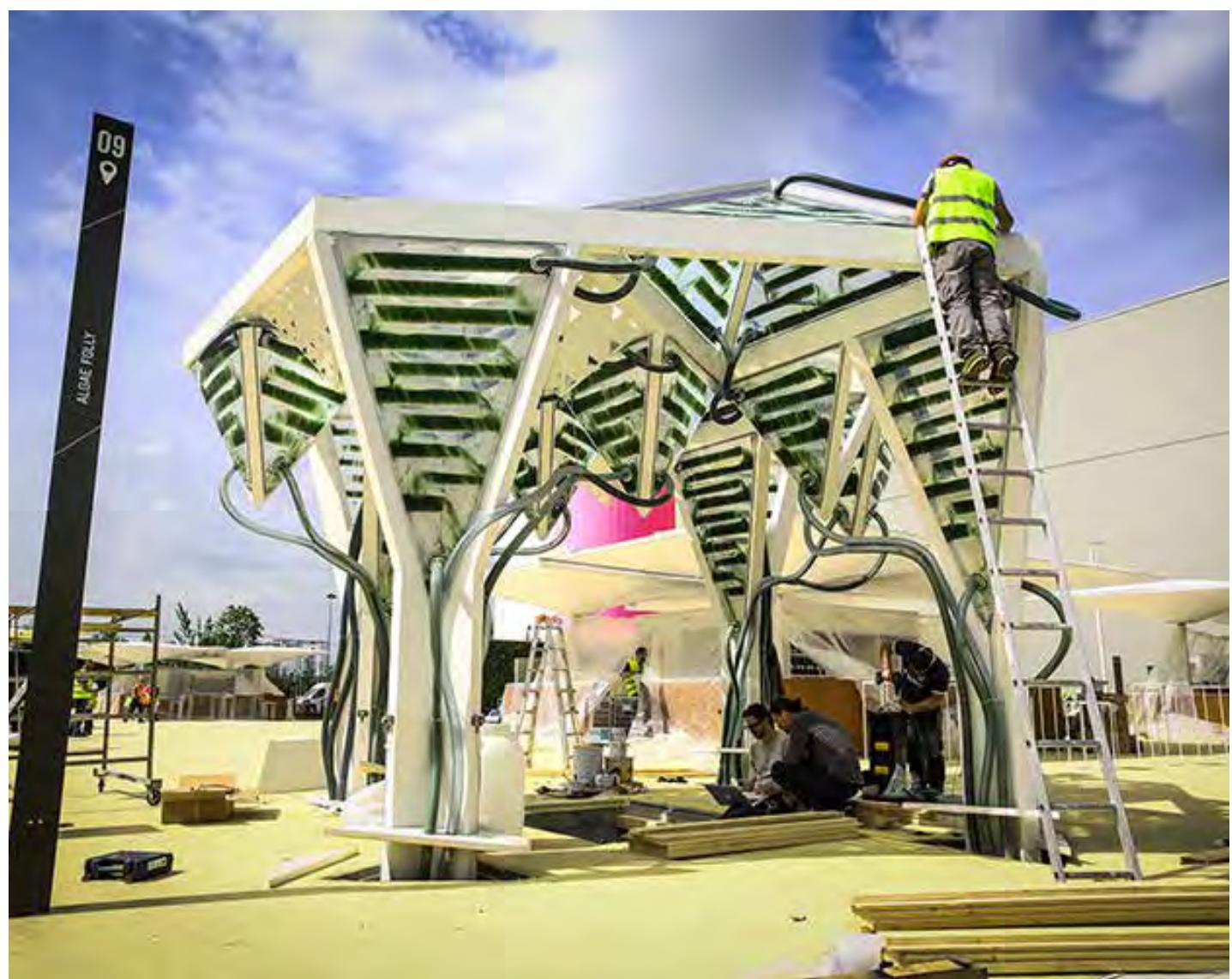
Variable opacities created through the regulation of the algae flows.



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<sub>2</sub> 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

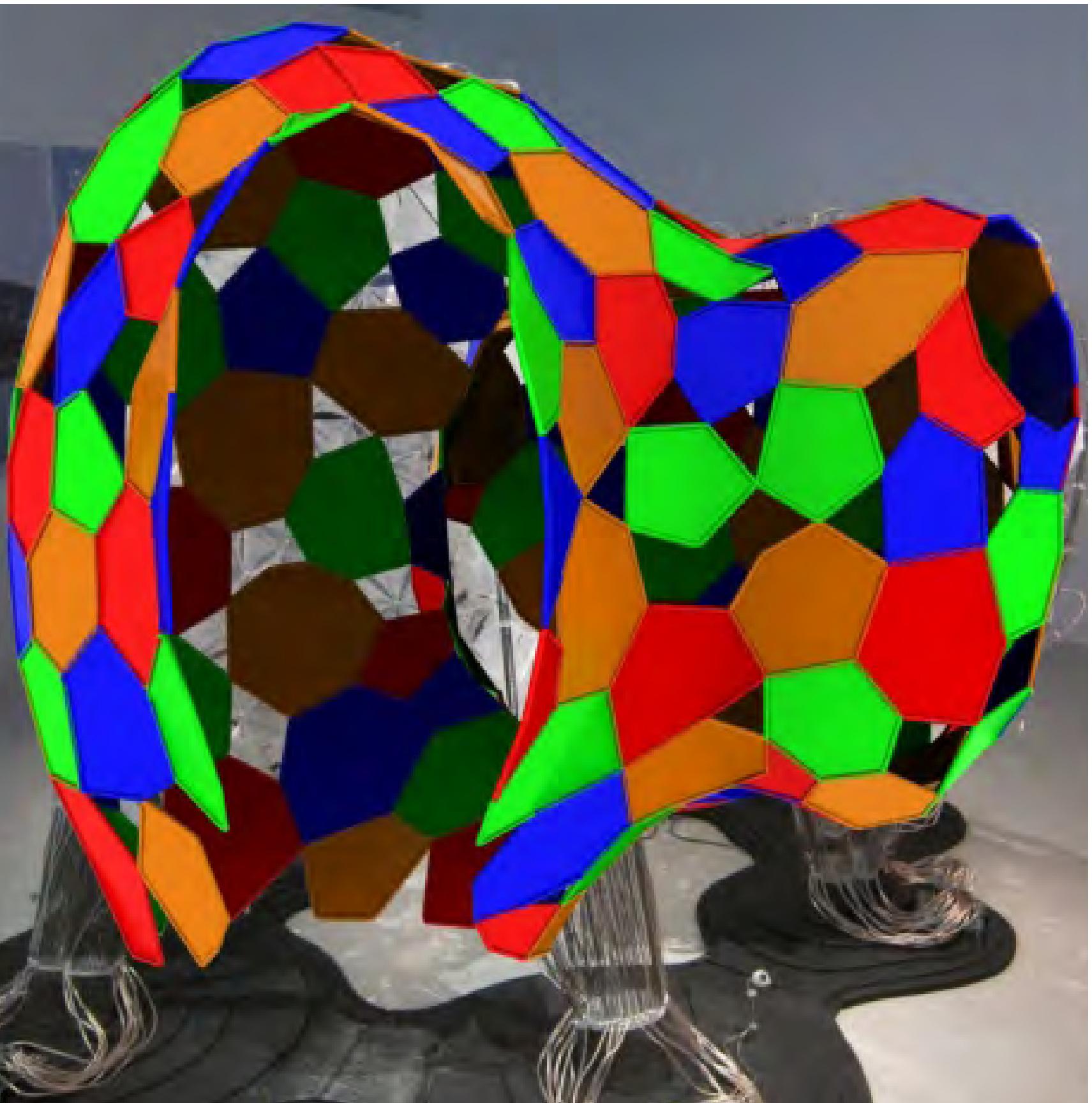
**Exhibitions:**  
ArchiLab 2013: Naturalizing Architecture,  
FRAC Centre, Orleans, France

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

**1000m<sup>2</sup> 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.

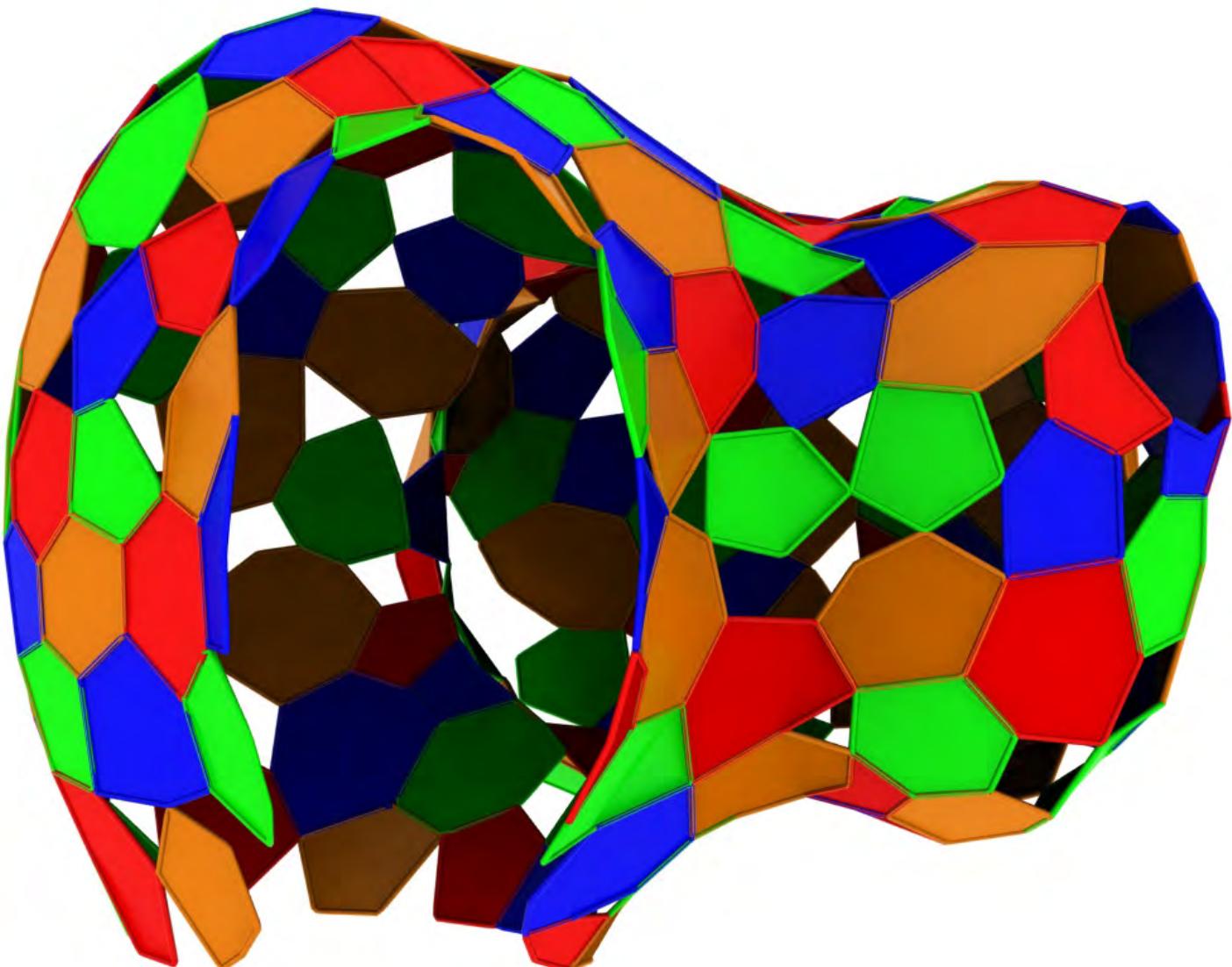


Right: The physical structure of METAfolly is overlaid with the digital control structure of the software.

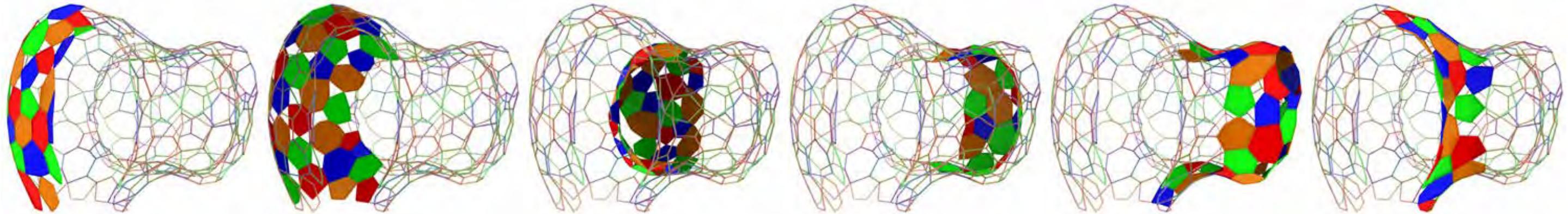
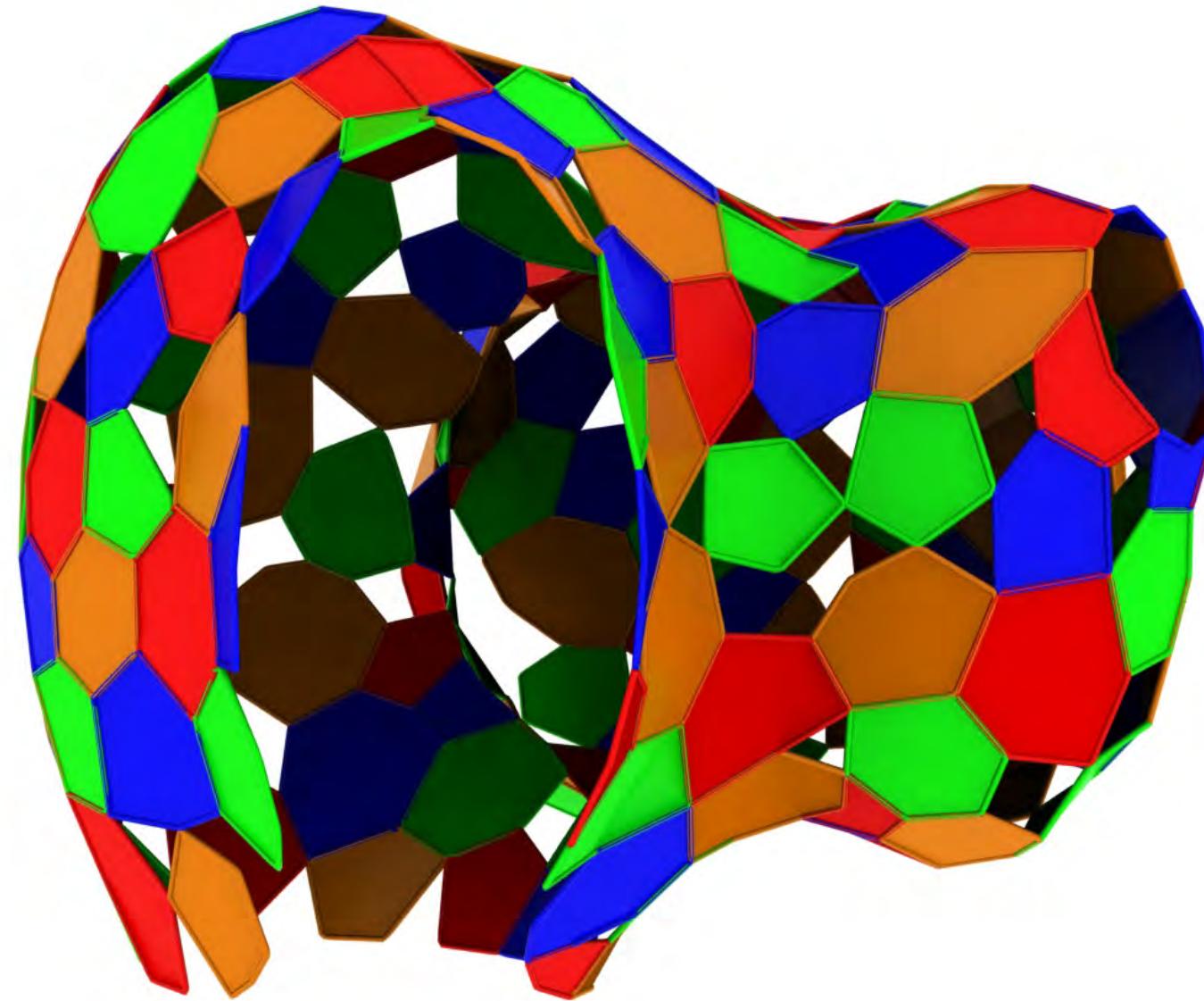


Above Left: View of METAfolly struture

Above Right: View of Software control model



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

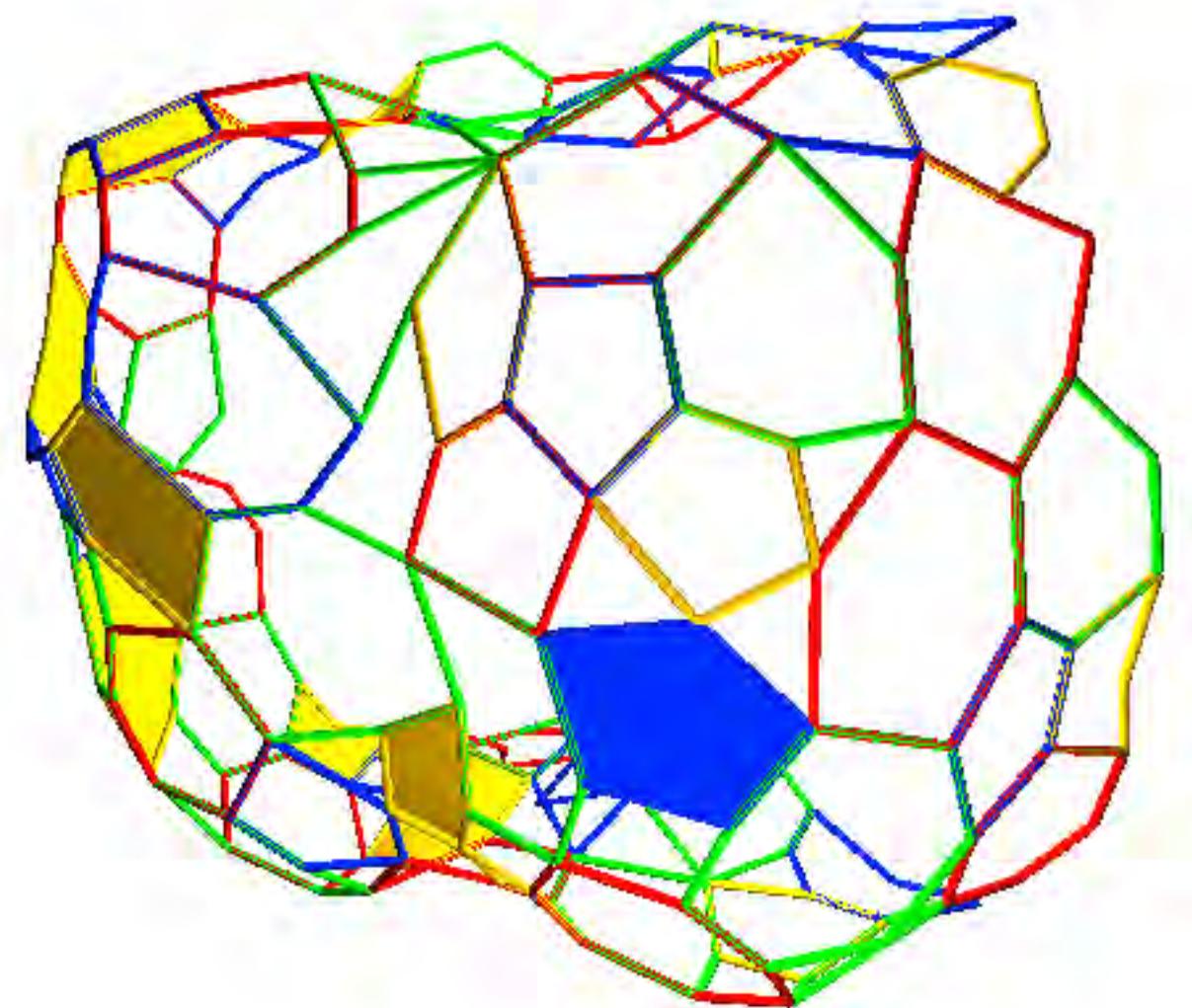


ModC Current Tone: C

 Delay: 2.288136

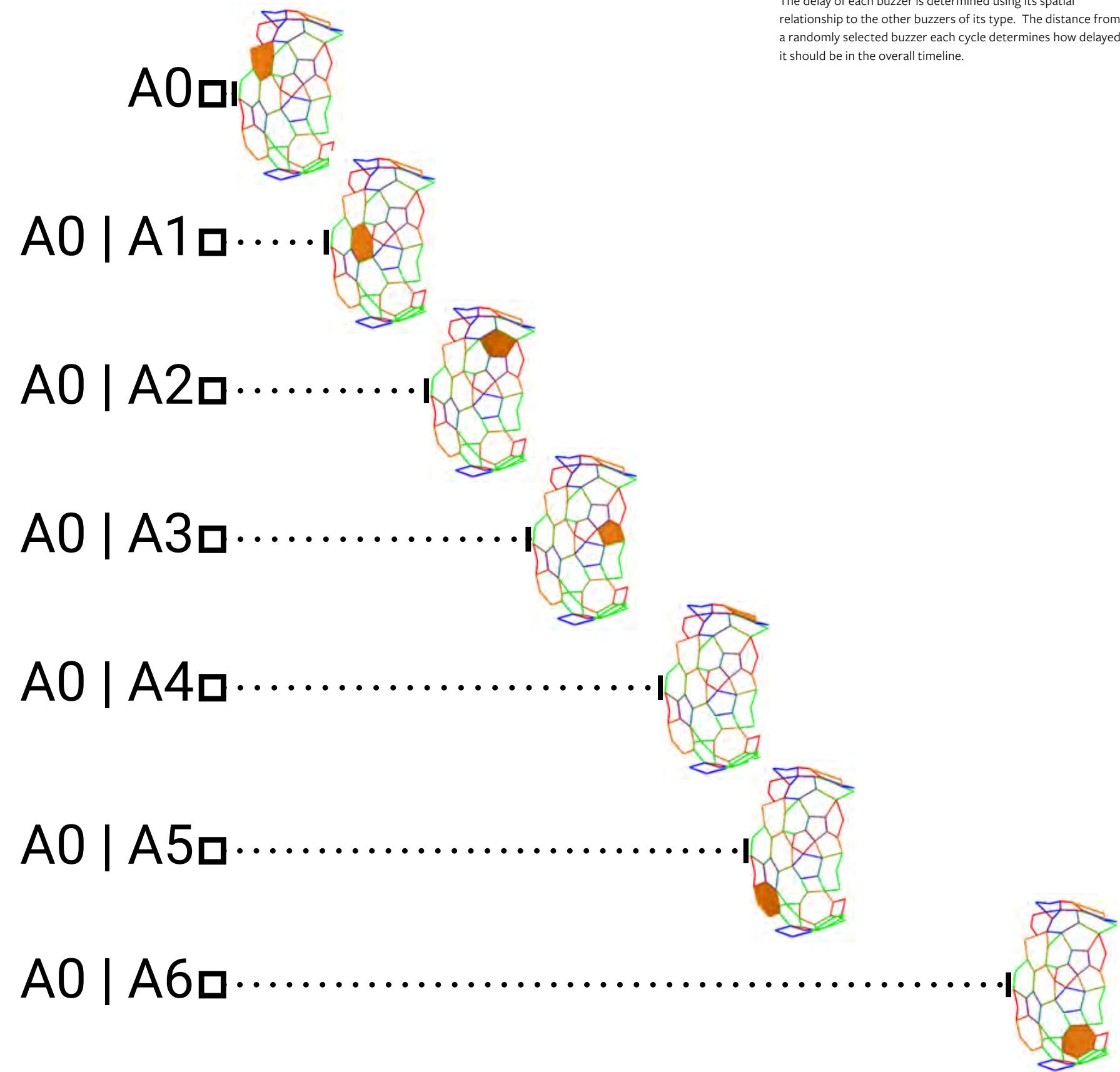
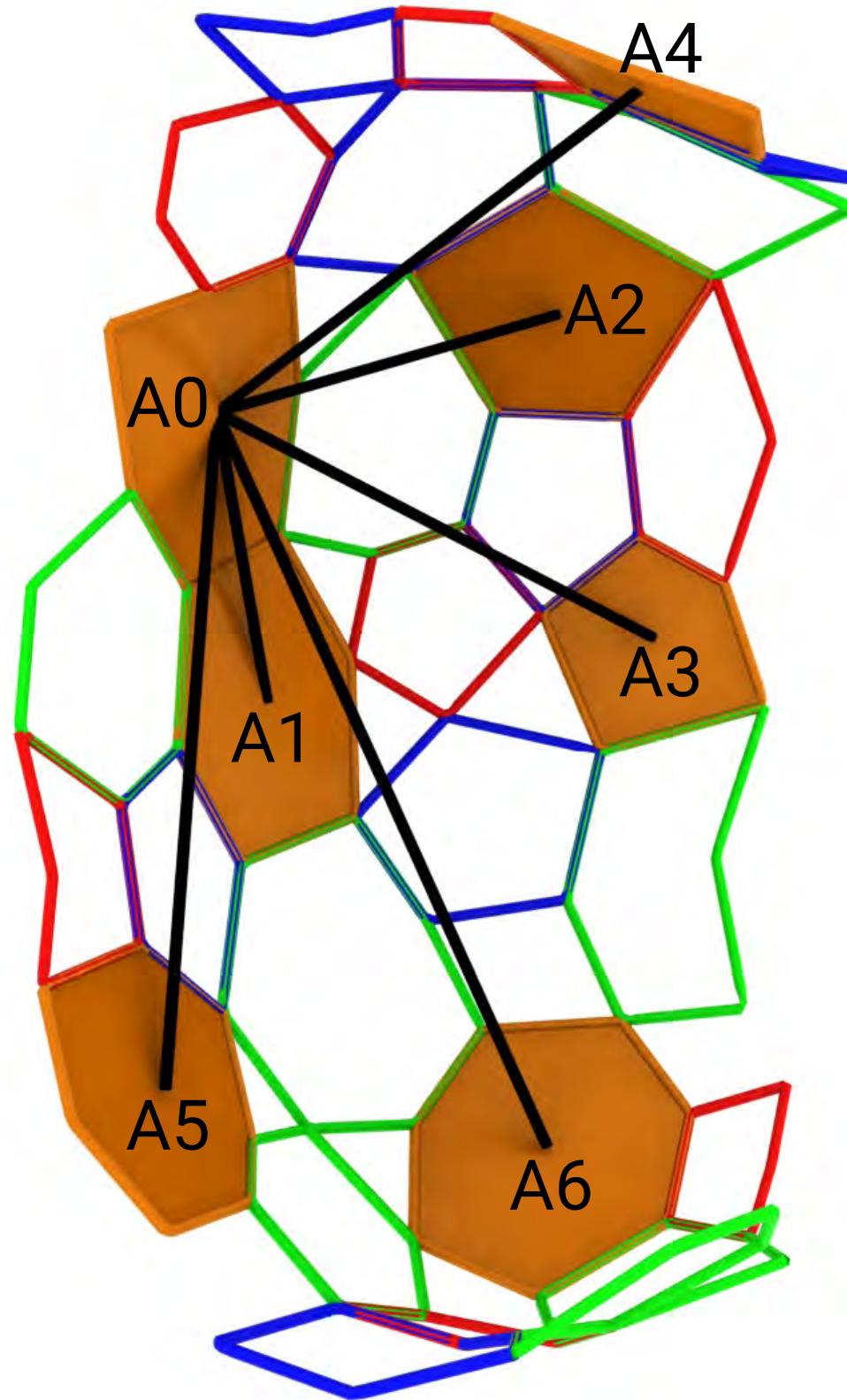
ModB Current Tone: D

 Delay: 0

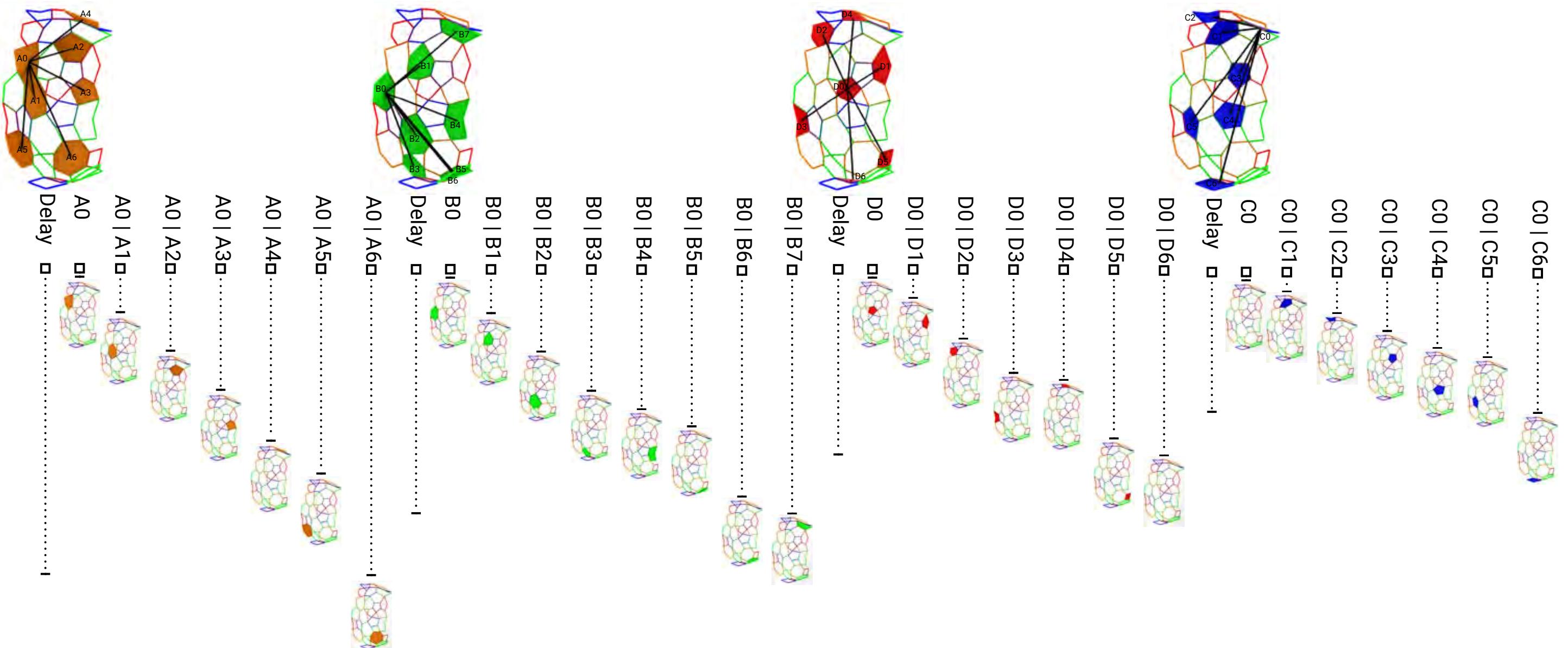


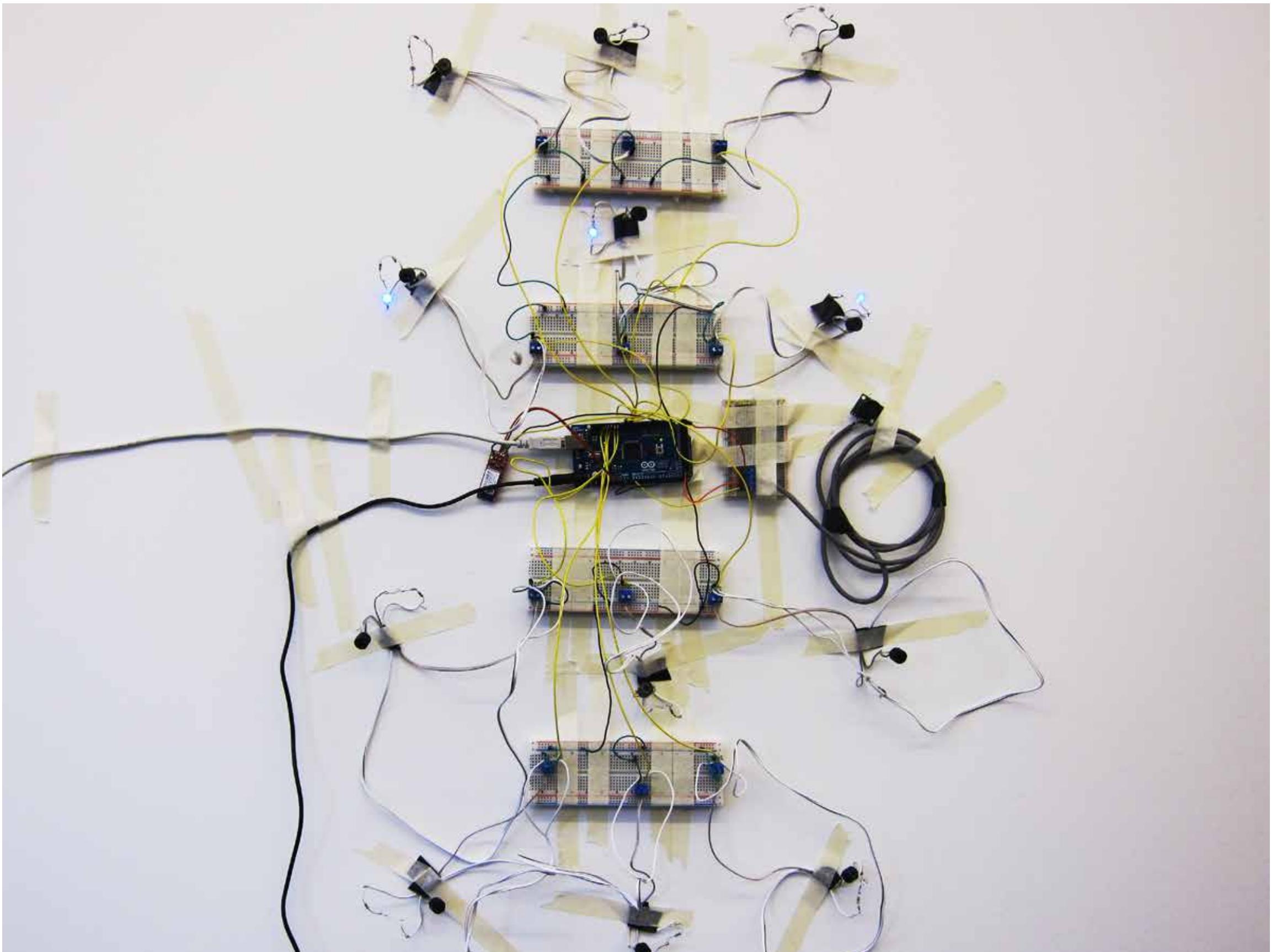
Interactive Simulation of the METAfolly software that shows the movement and delay of the sound based on spatial relationships.

“ created with [Unity](#) ”

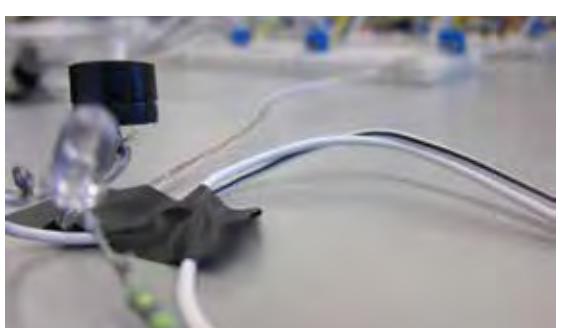
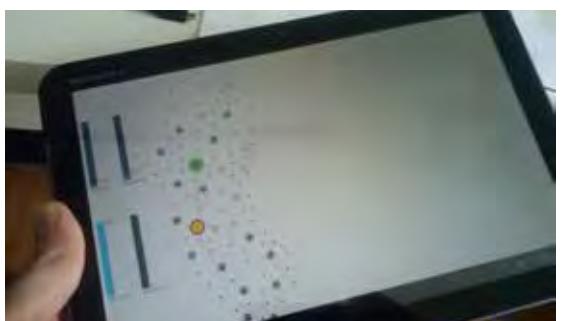


The spatial delay system plays out over all 4 tone typologies in repetition and in response to what the maximum delay is at any given moment. The folly attempts to bring that delay value to 0, but movement around the structure increases the delay.

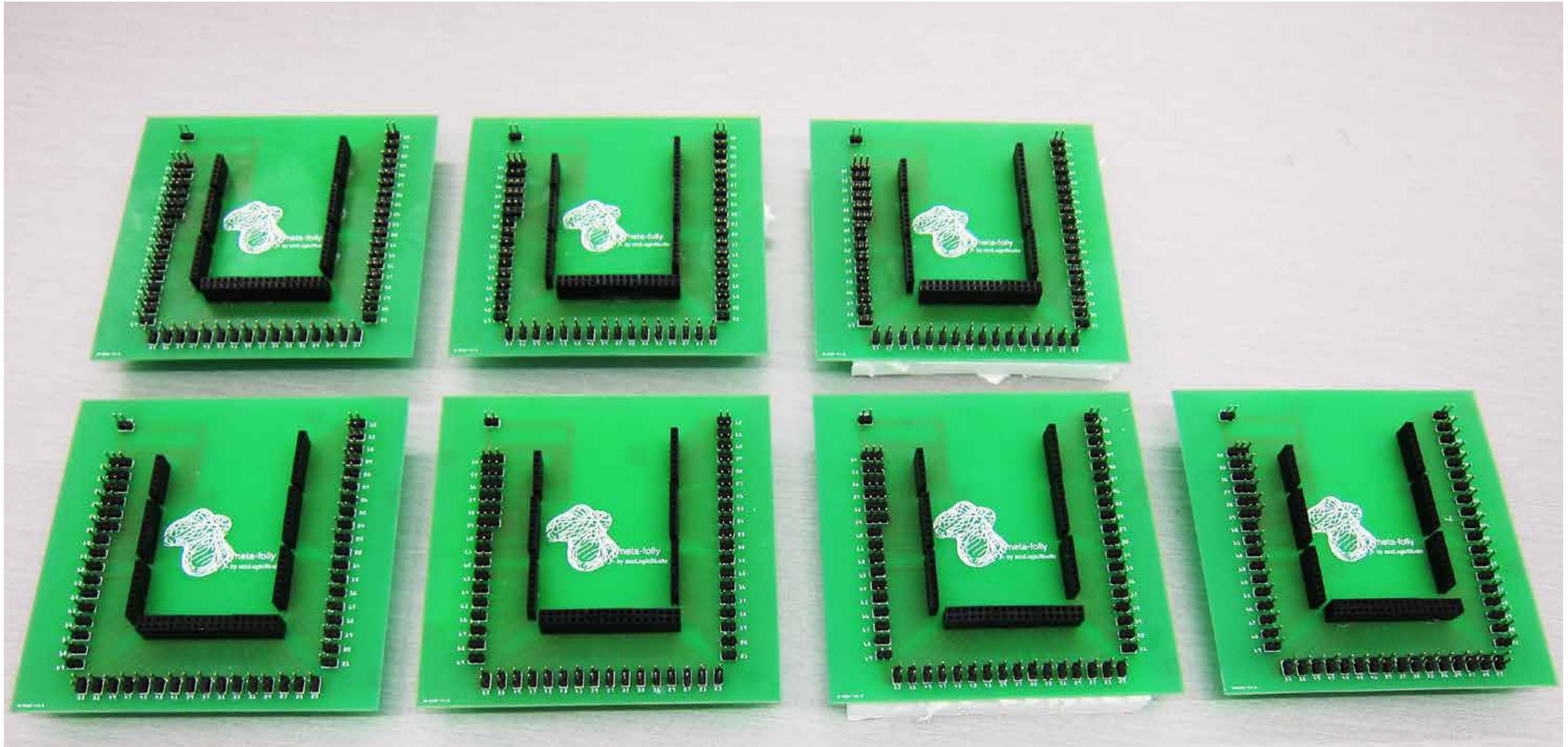




The prototyping strategy for METAfolly had 2 key components.  
1 twin prototypes in Toronto and London, 2, a wireless interface  
for tuning the system. Pictured is the Toronto twin and we  
worked in real-time over video chat using the twins to make  
adaptations to the software.



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.

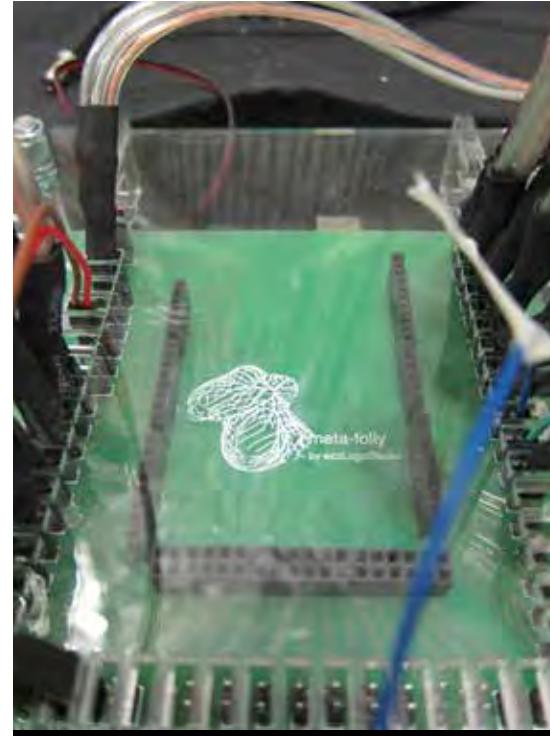




Peizo buzzer module embedded in the structure.



One of six distance sensors that monitored the amount of movement occurring 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 polypropylene units and the controllers.



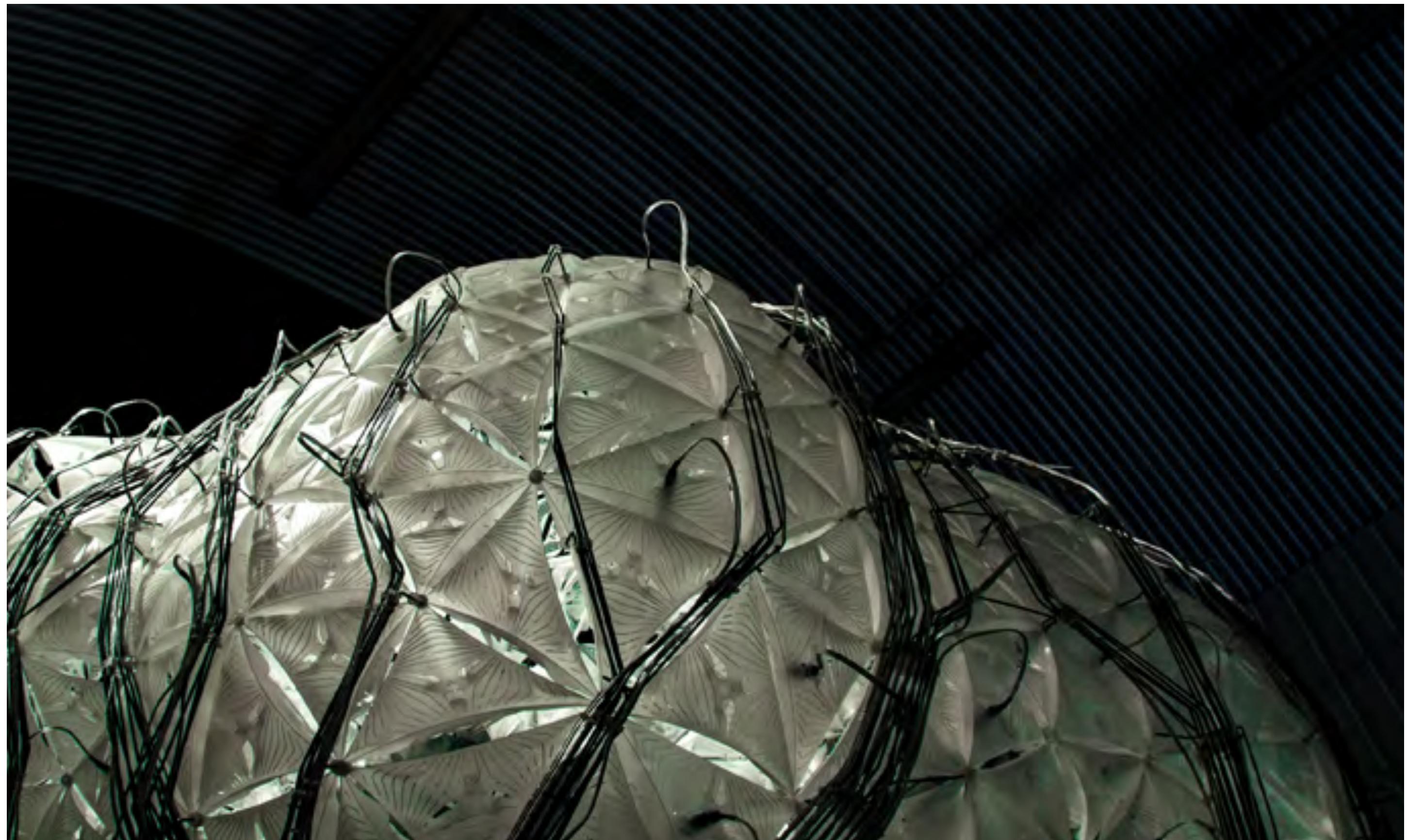
Left: METAfolly as exhibited at Archilab 2013.  
Right: Interior of the soundscape.



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



METAfolly exhibited at 1000m<sup>2</sup> of Desire, Centre de Cultura Contemporània de Barcelona



## Custom Fabrication Systems

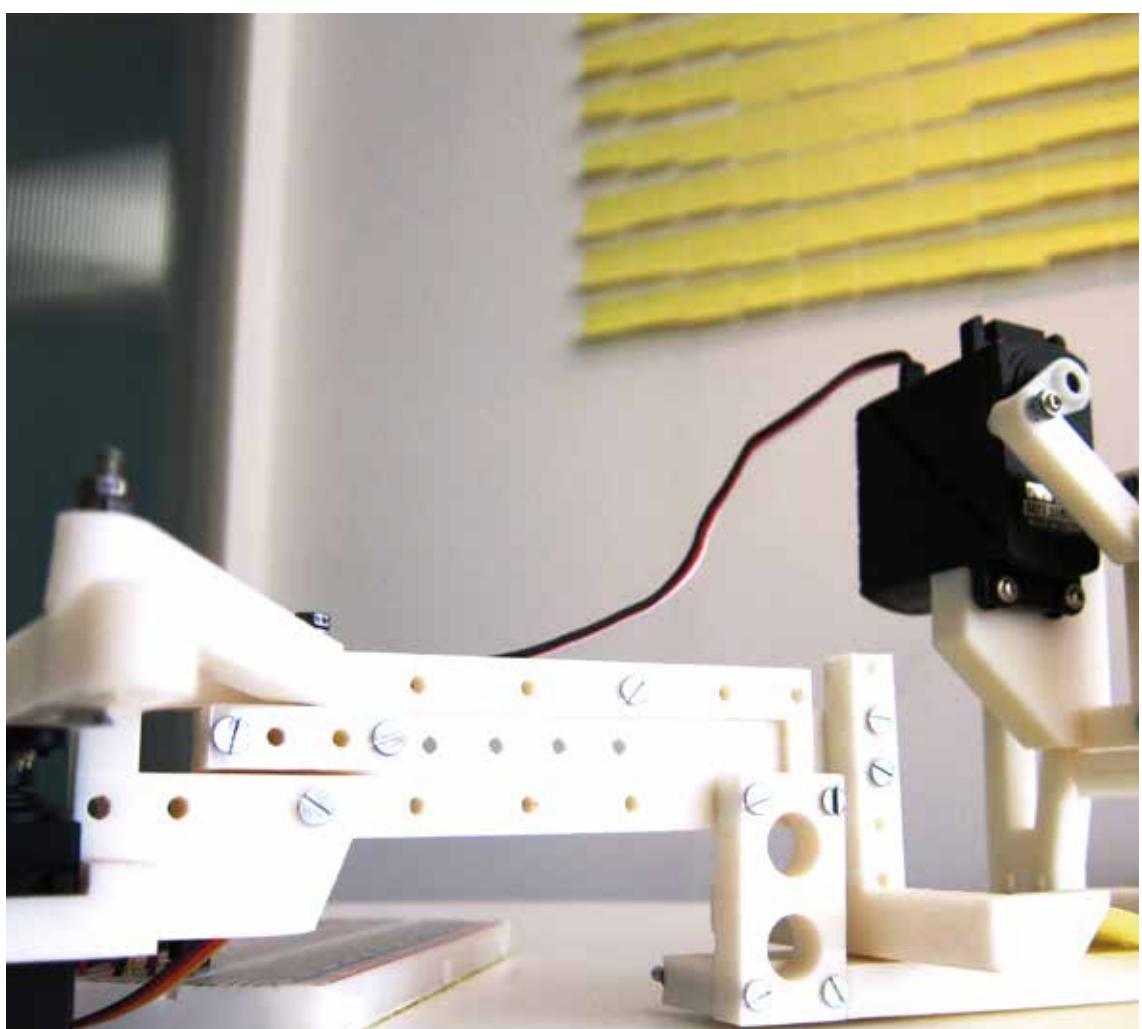
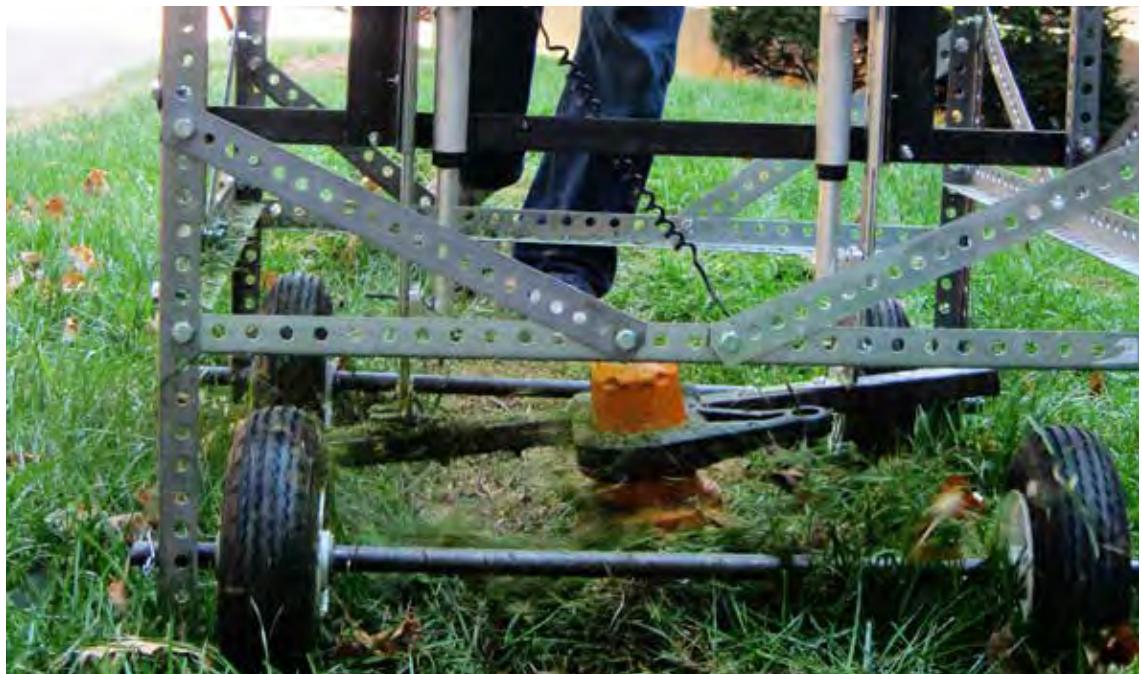
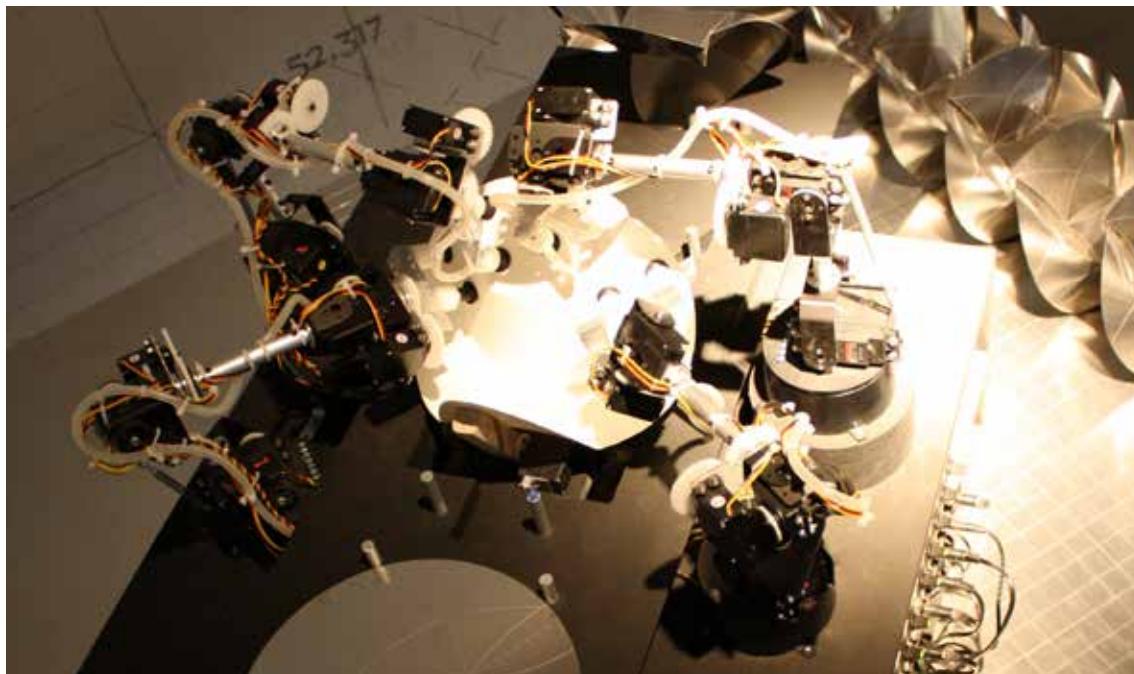
[RoboFold](#)

[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

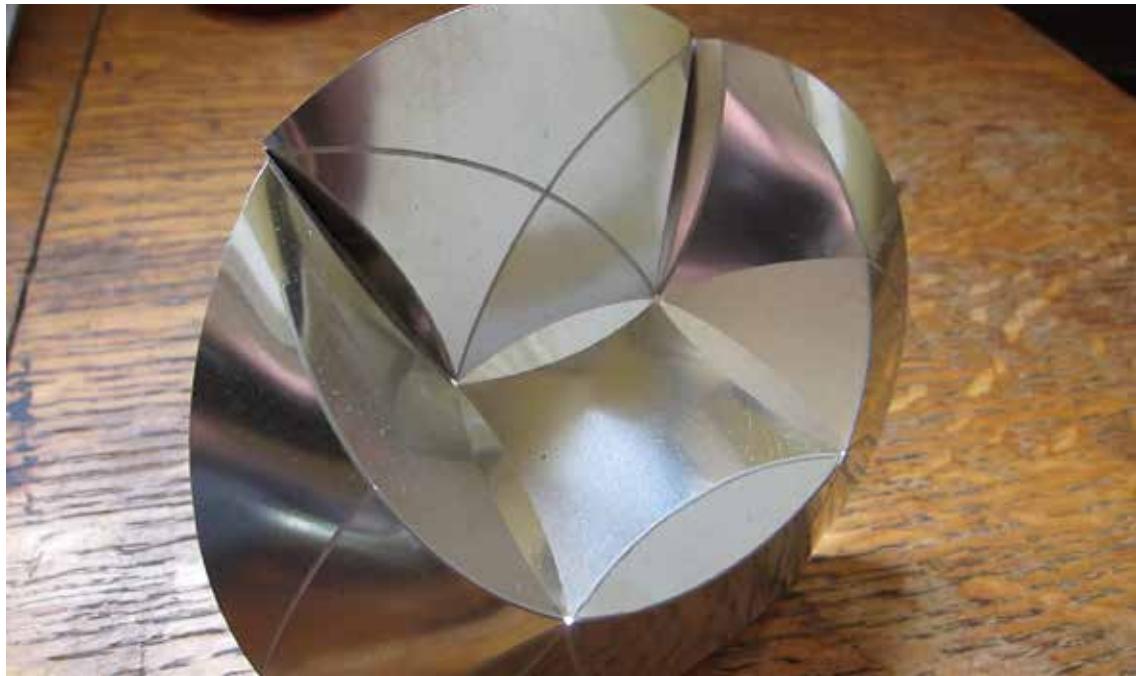
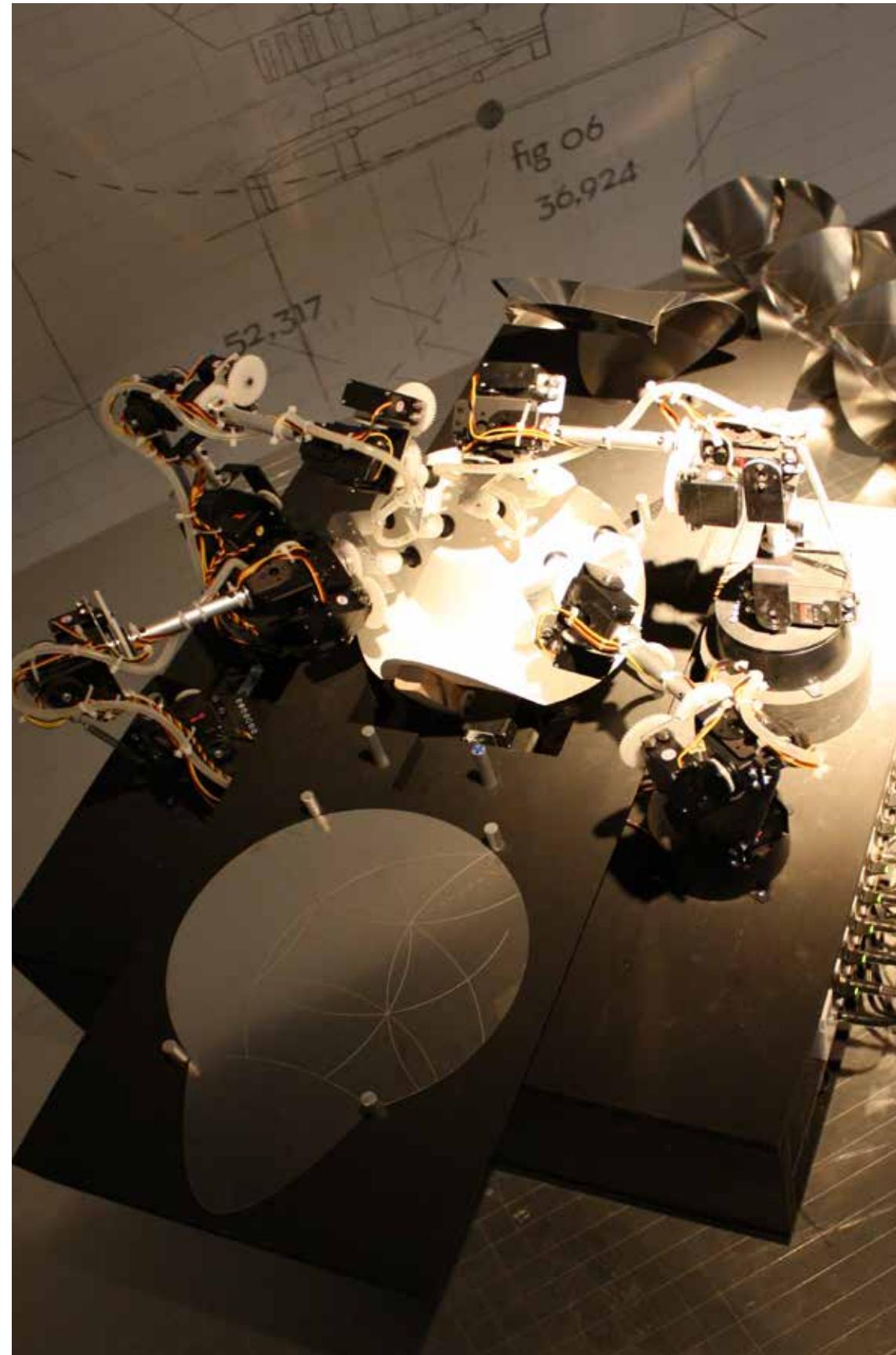
Laarman Lab  
Friedman Benda Gallery, New York, USA

*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 calculate 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

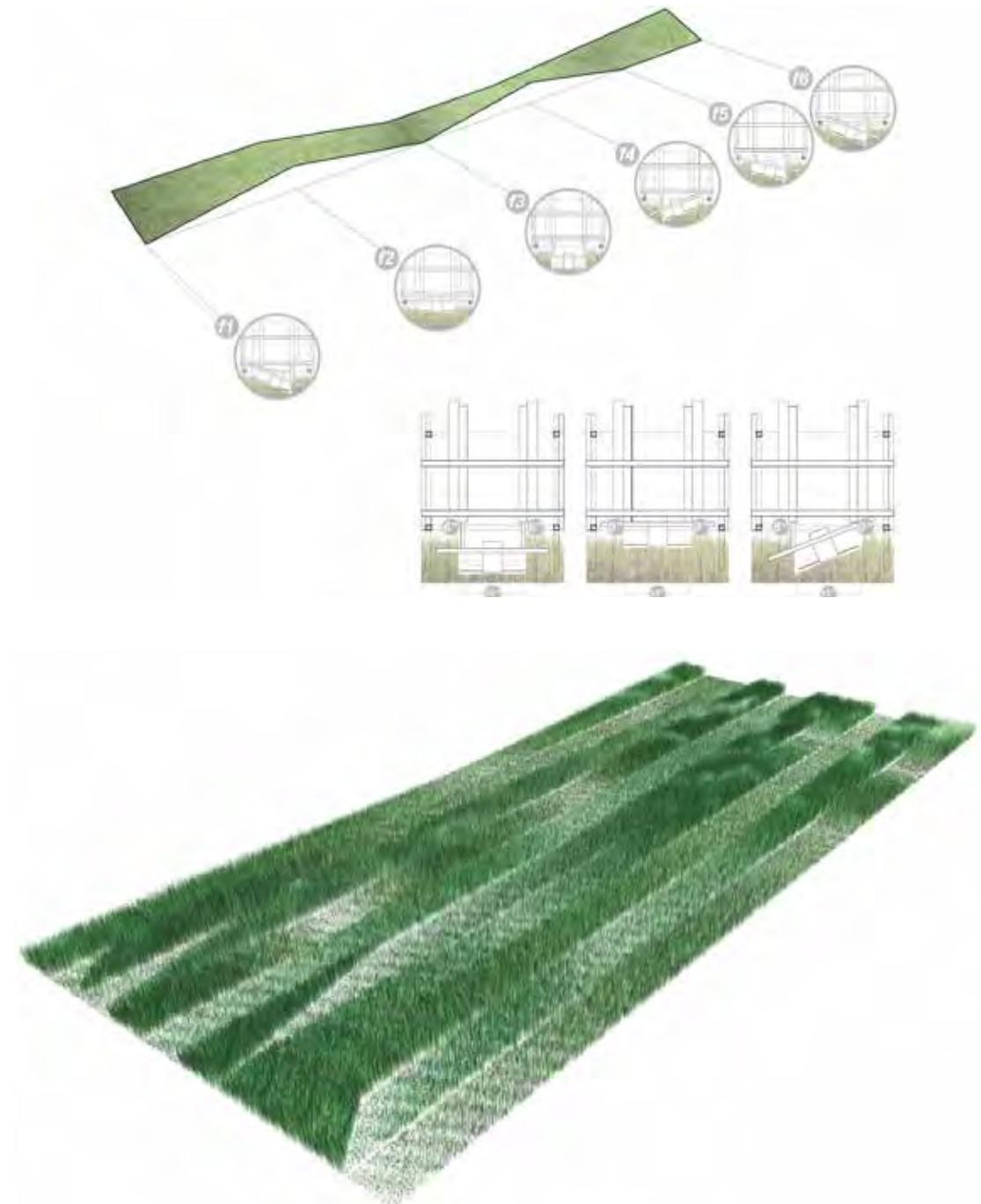
**Exhibition:**  
New Faculty Show, Land of Tomorrow,  
Lexington, USA

**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.

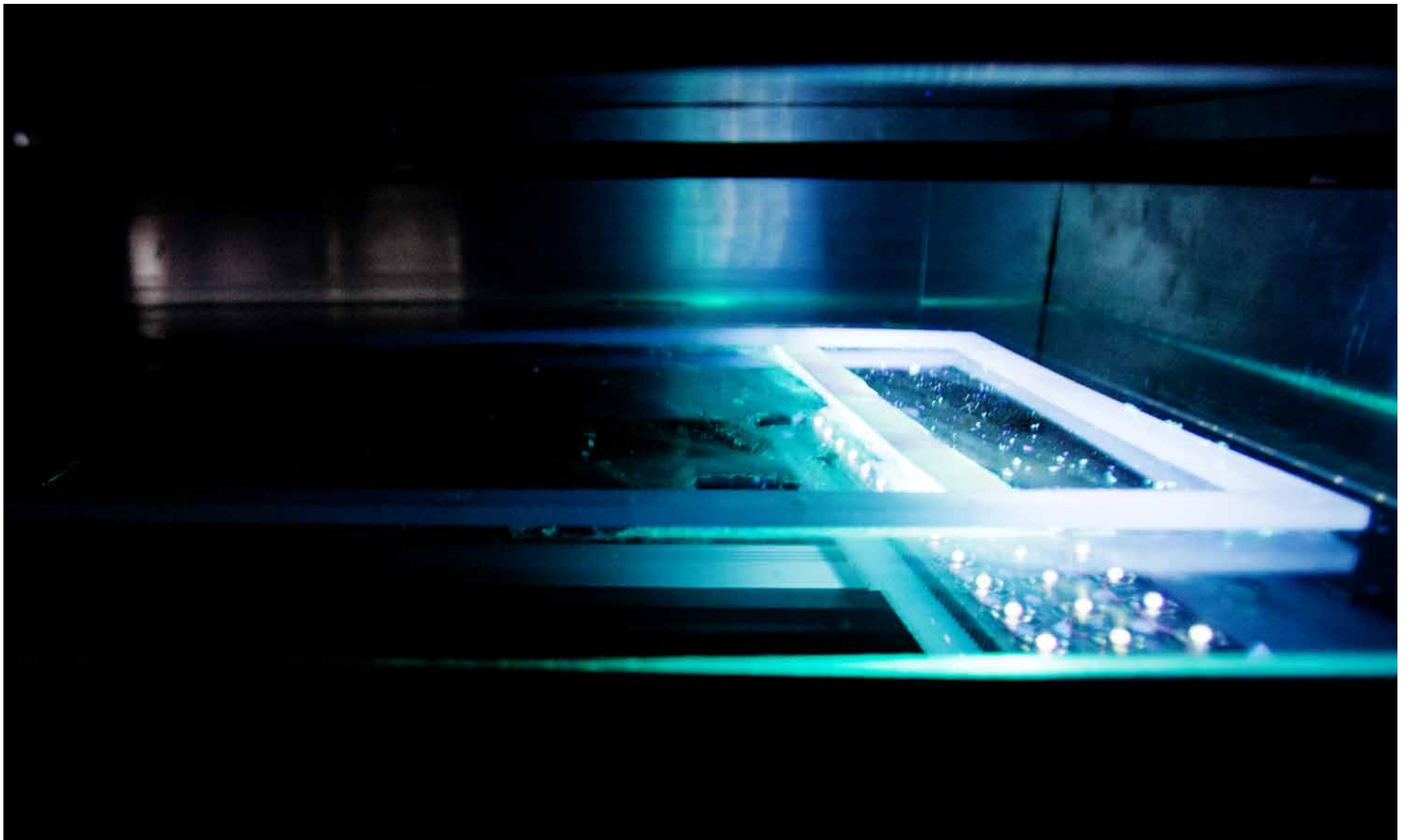
The system created uses high intensity UV lights mounted to a linear actuator to cure larger sheets of material within a lab setting.



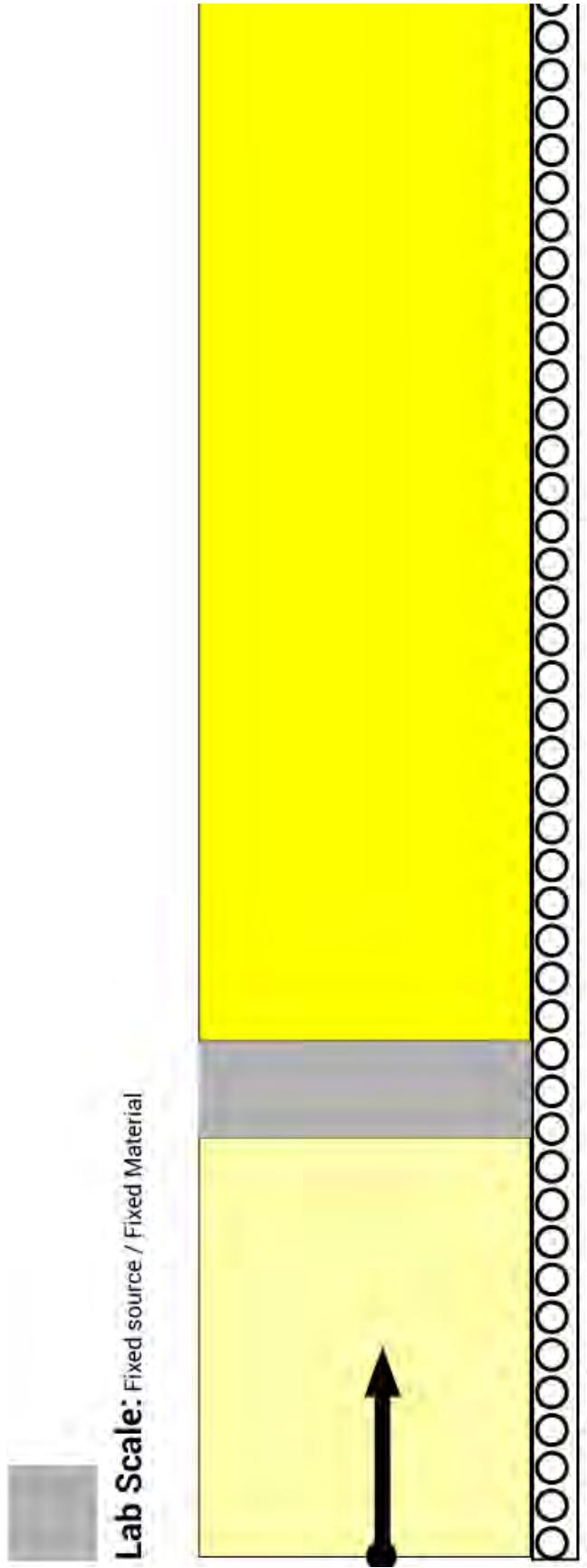
Above: Shape Memory Polymer sheet created using BlackBox. The material is programmed to respond to 35°C and has been laser cut to allow movement.

Next Page: BlackBox curing system

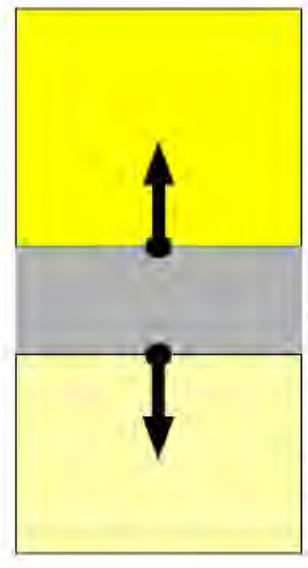




**Lab Scale:** Fixed source / Fixed Material



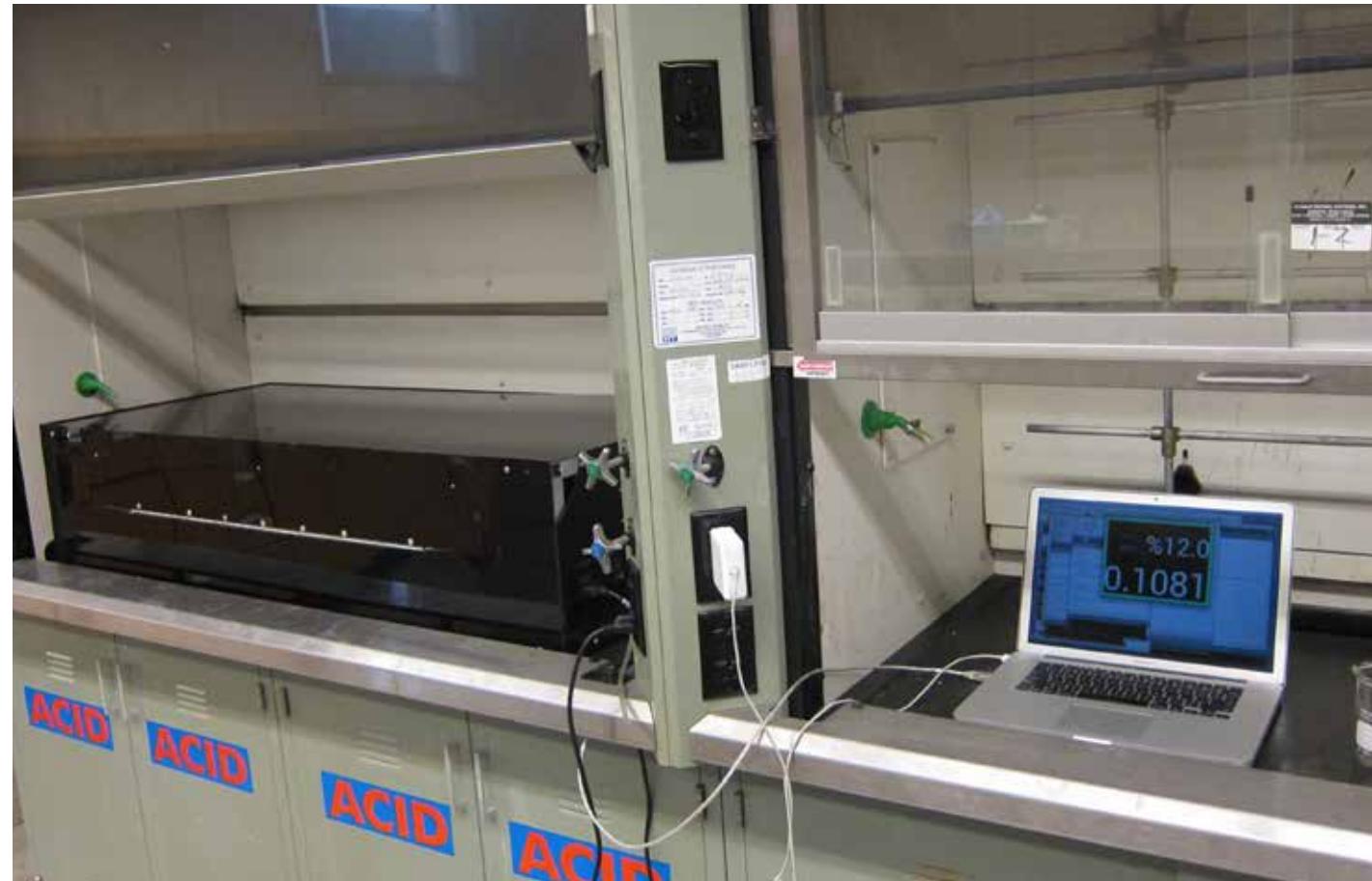
**Factory Scale:** Fixed source / Moving Material



**Prototype Scale:** Moving source / Fixed Material



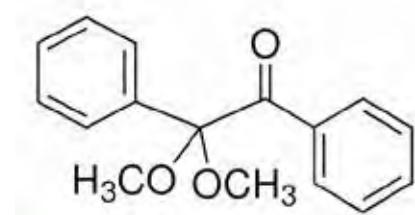
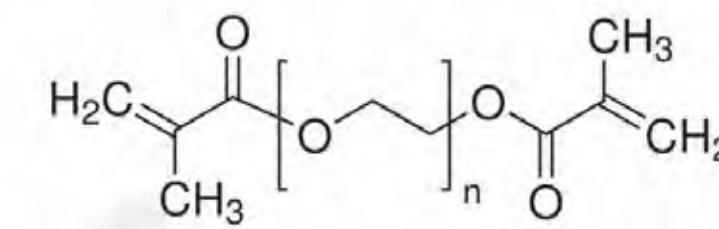
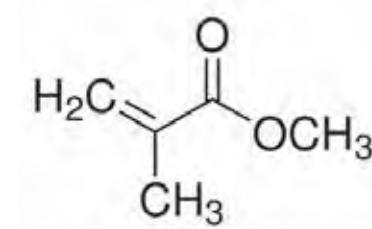
Left: After a study of existing curing equipment, a prototype was designed that uses high intensity UV LEDs mounted to a linear actuator to cure larger pieces of material within a confined space.



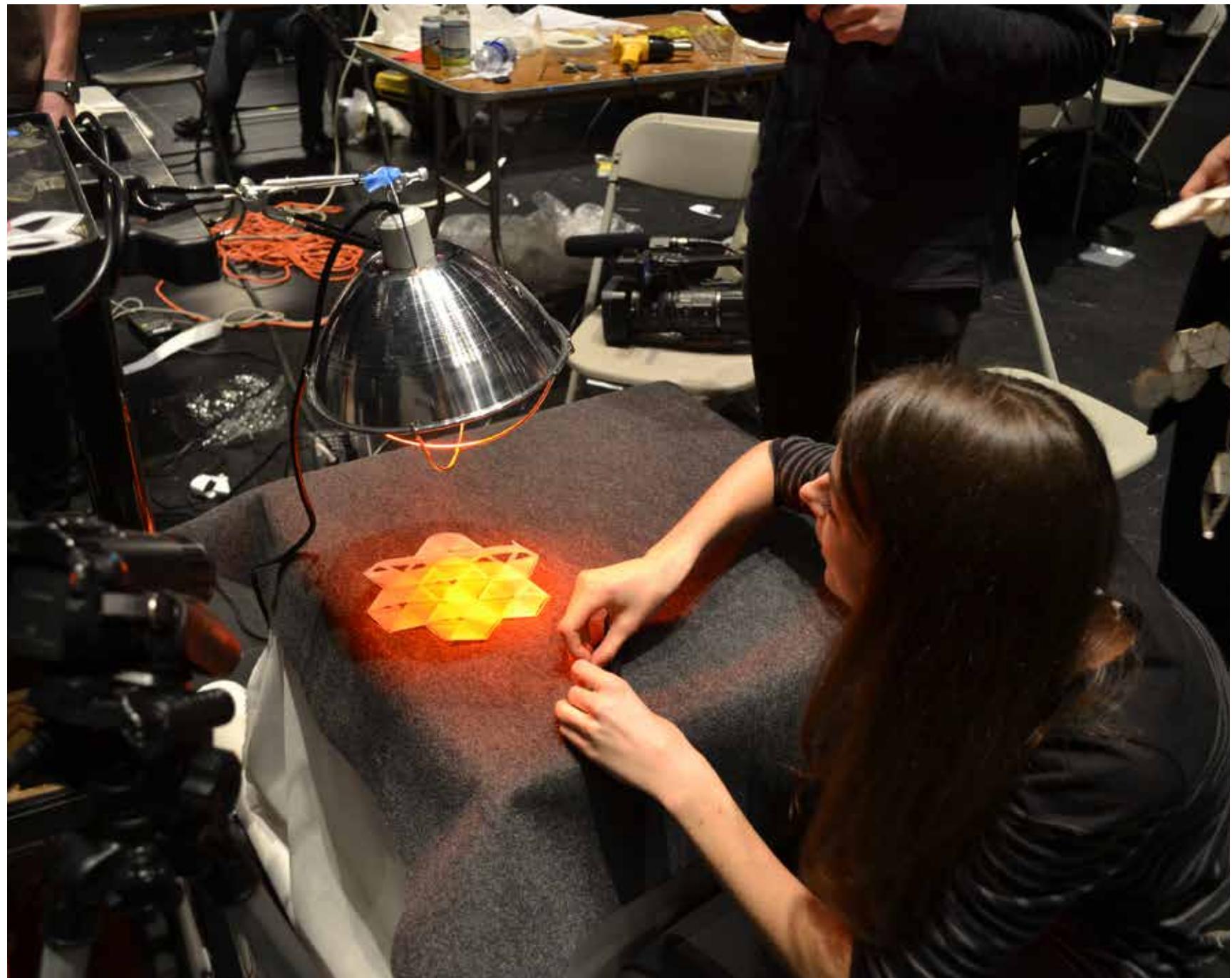
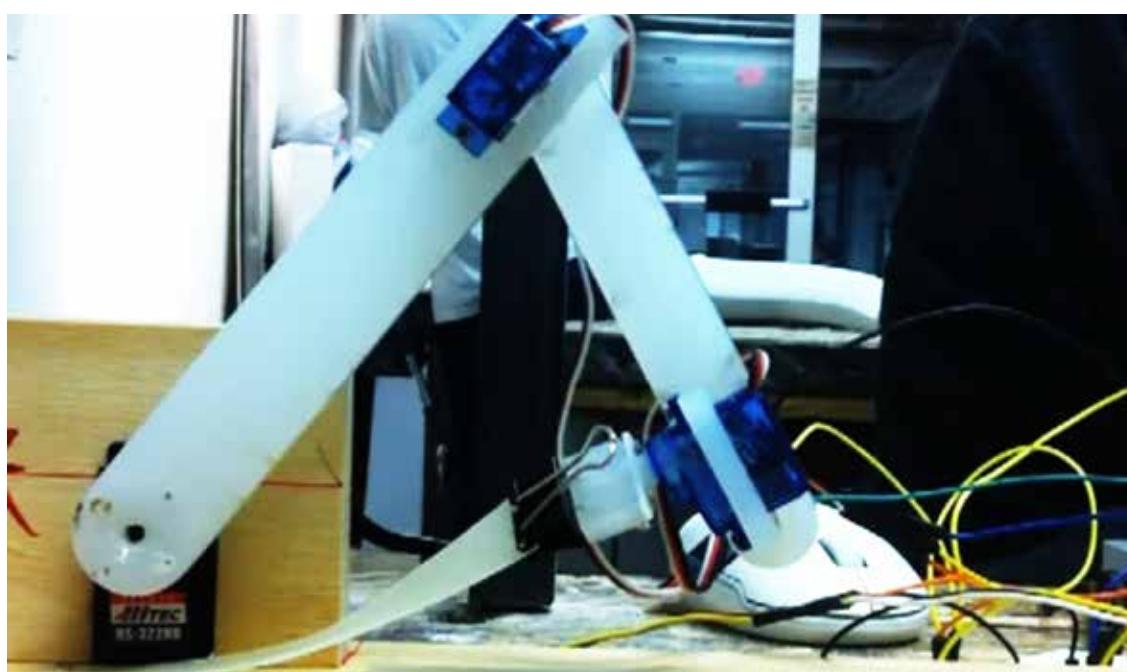
Testing the BlackBox system within a material science lab. The goal is to create a system that can interface with typical lab equipment, but produce usable material prototypes.



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



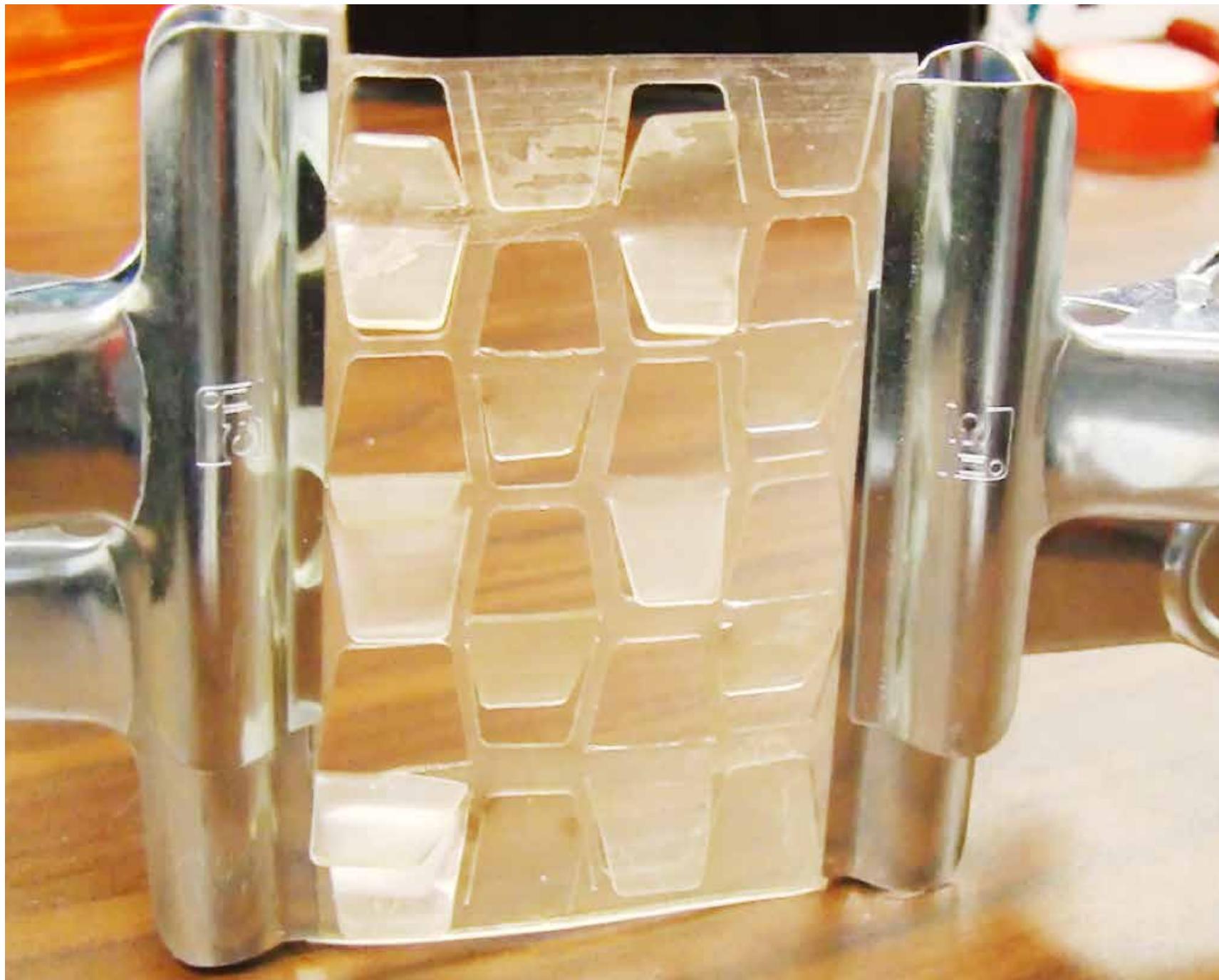
The process and chemicals required for producing Shape Memory Polymer using Blackbox.



Top Left: First Shape Memory Polymer Sample created using BlackBox.

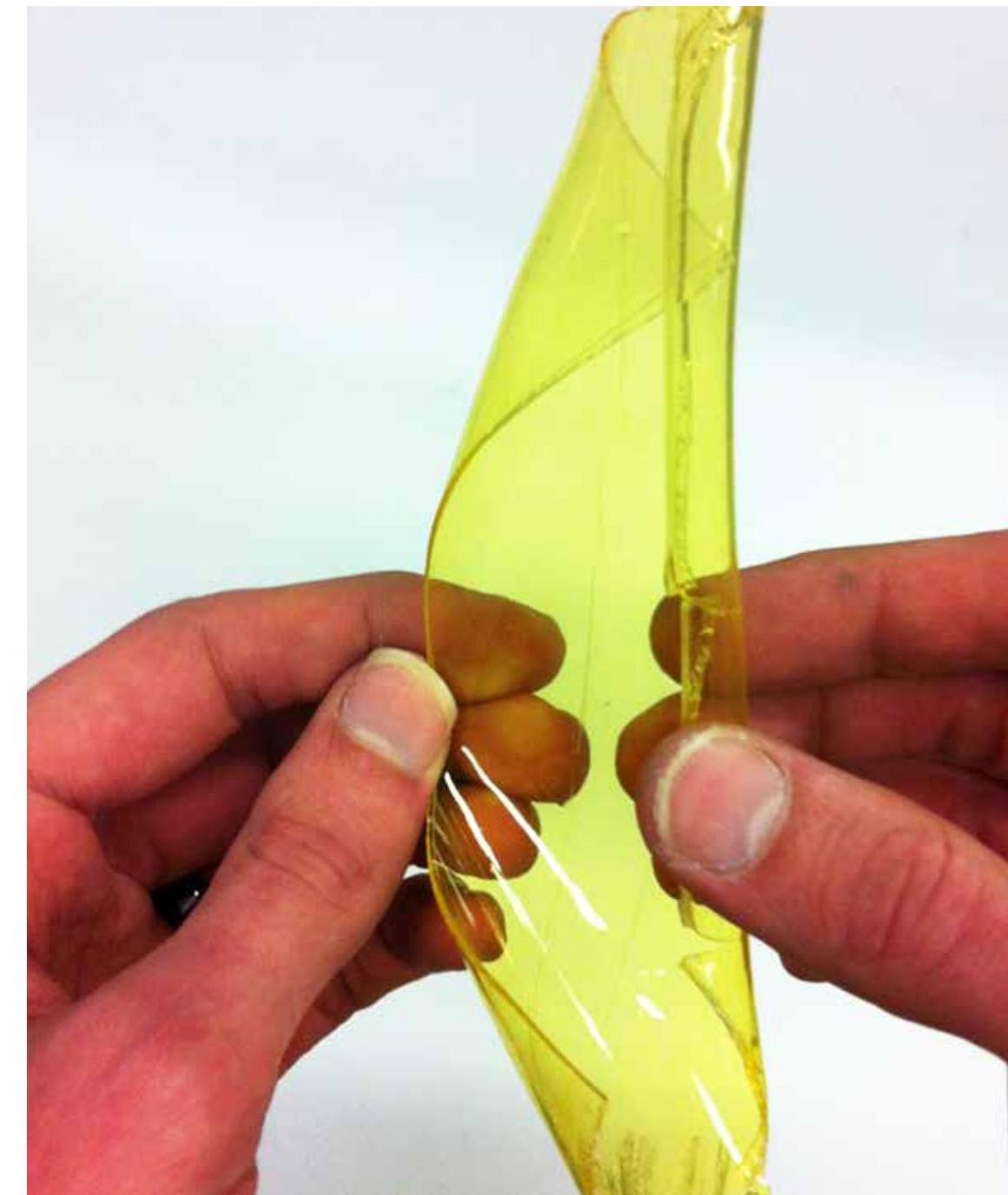
Bottom Left: Training the target shape of a Shape Memory Polymer sheet using a custom “grooming robot”.

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.





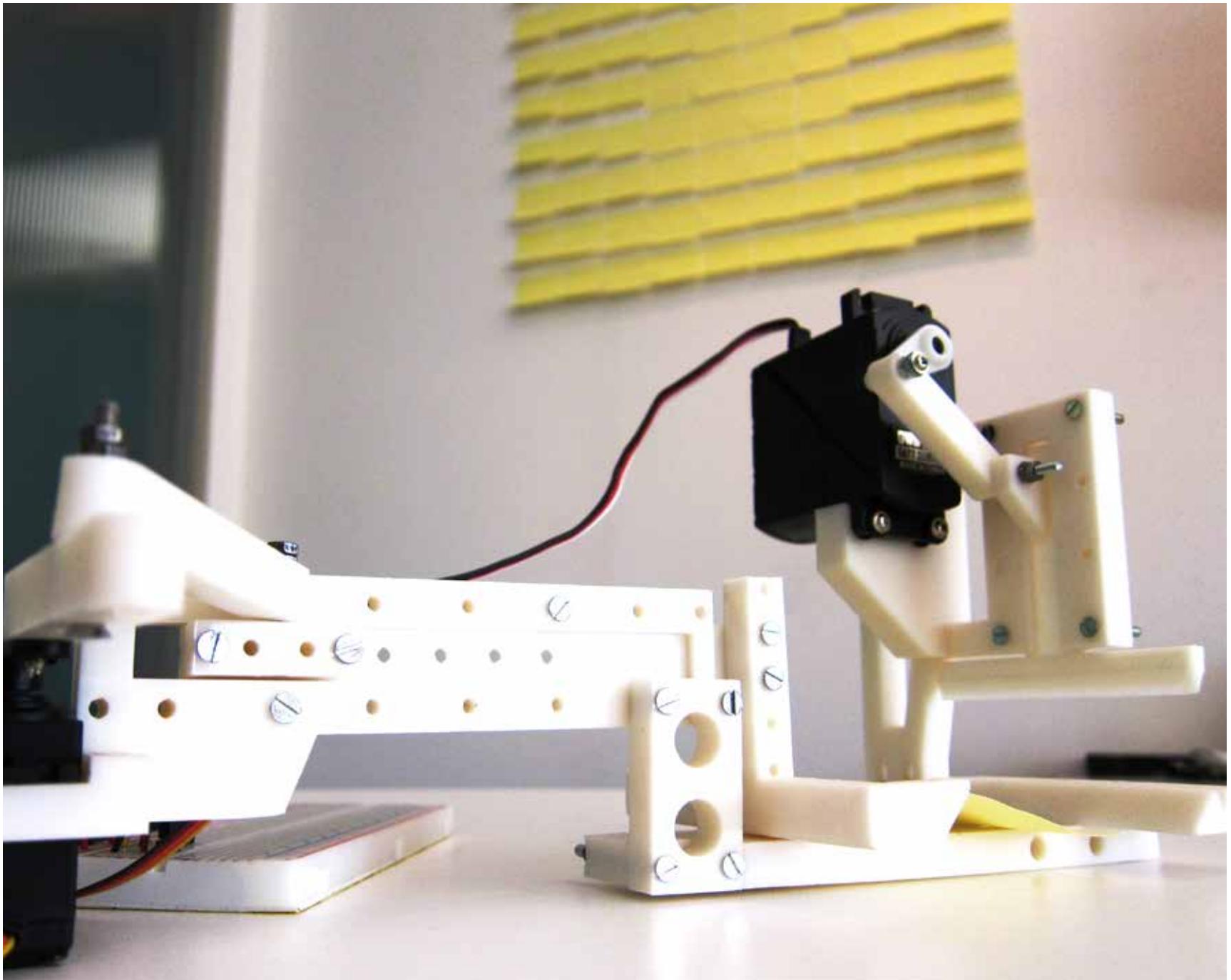
## FabNodes

Research Funded by GRAND NCE, AD Node

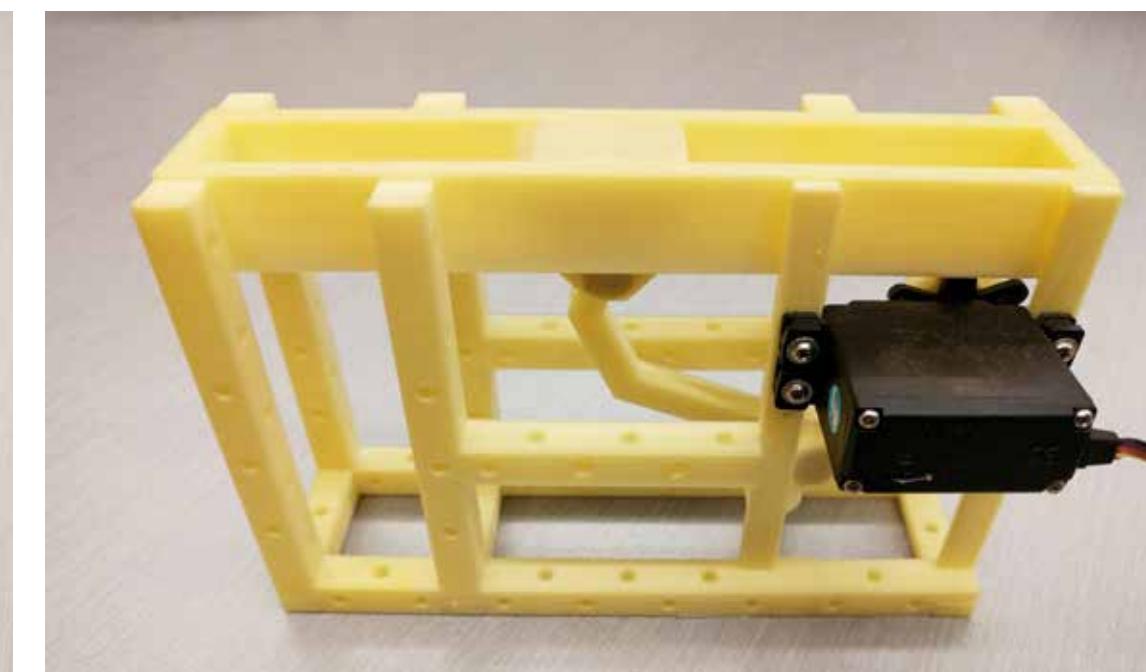
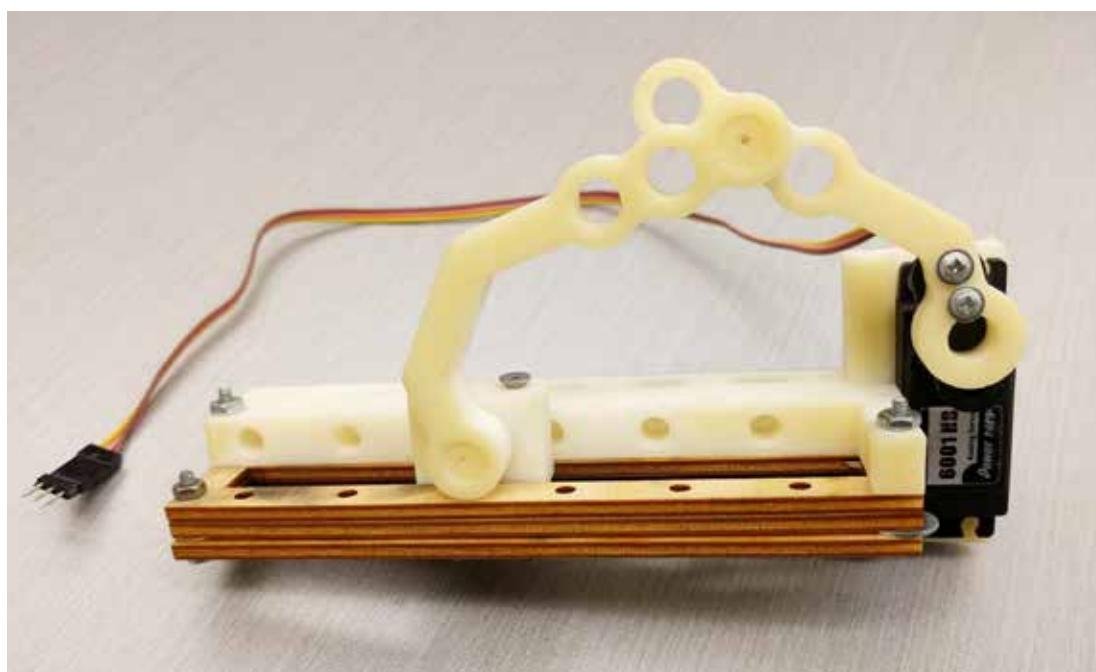
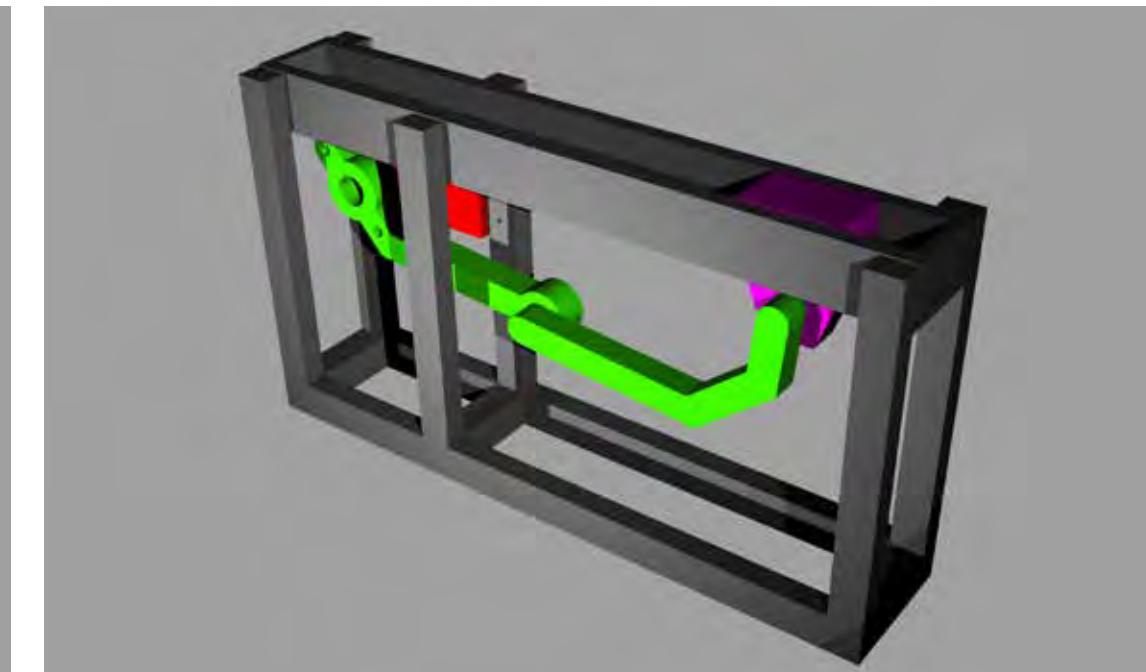
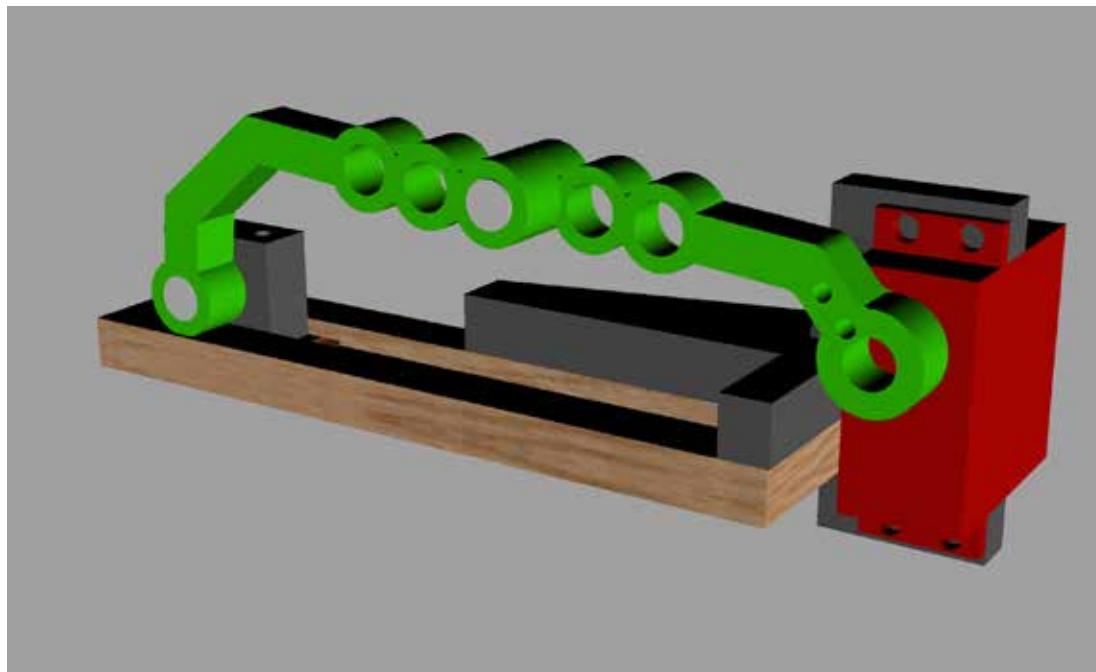
[\*FabNodes videos\*](#)

*Conference Presentation:*  
TechNarte 2014, BilBao Spain

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.

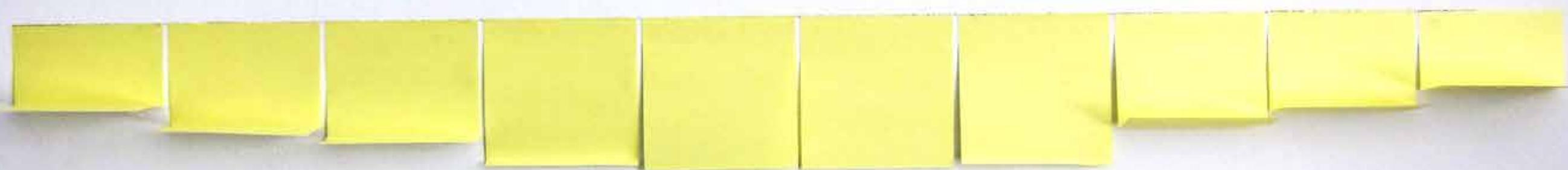


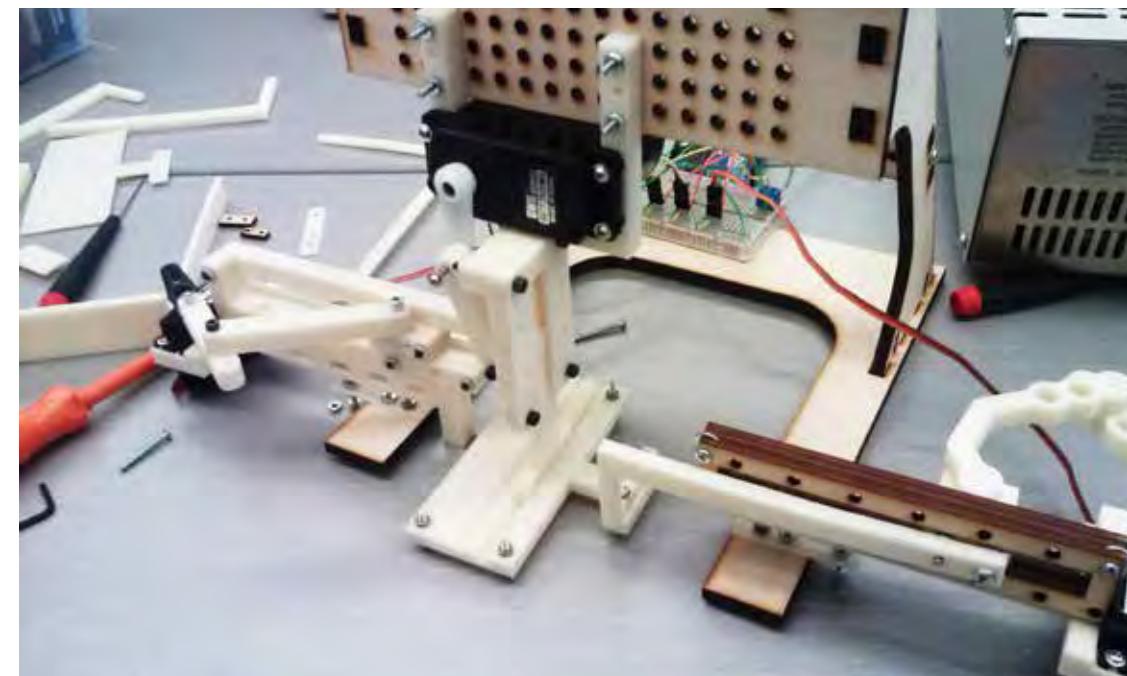
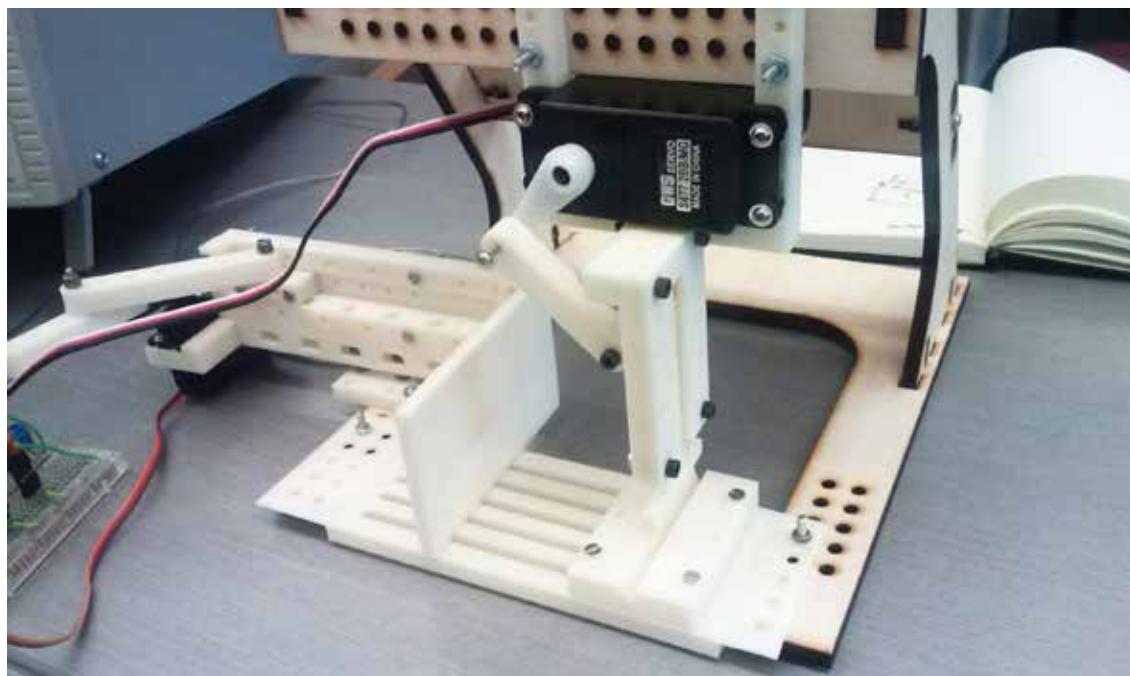
Final FabNode machine created and the resulting installation.



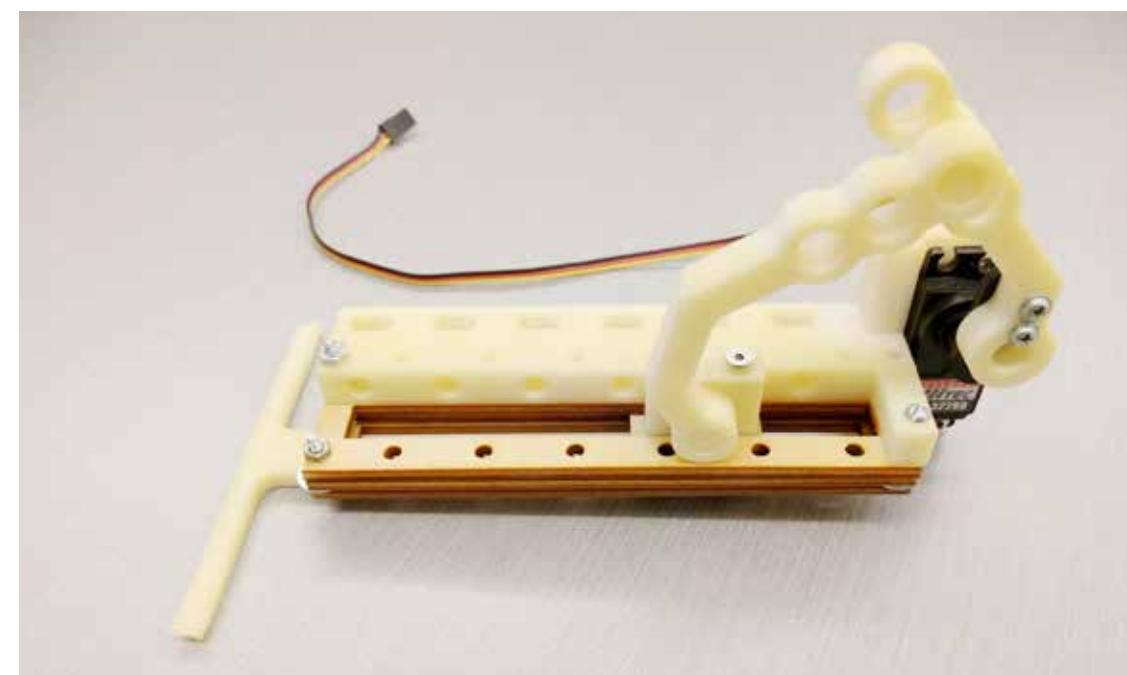
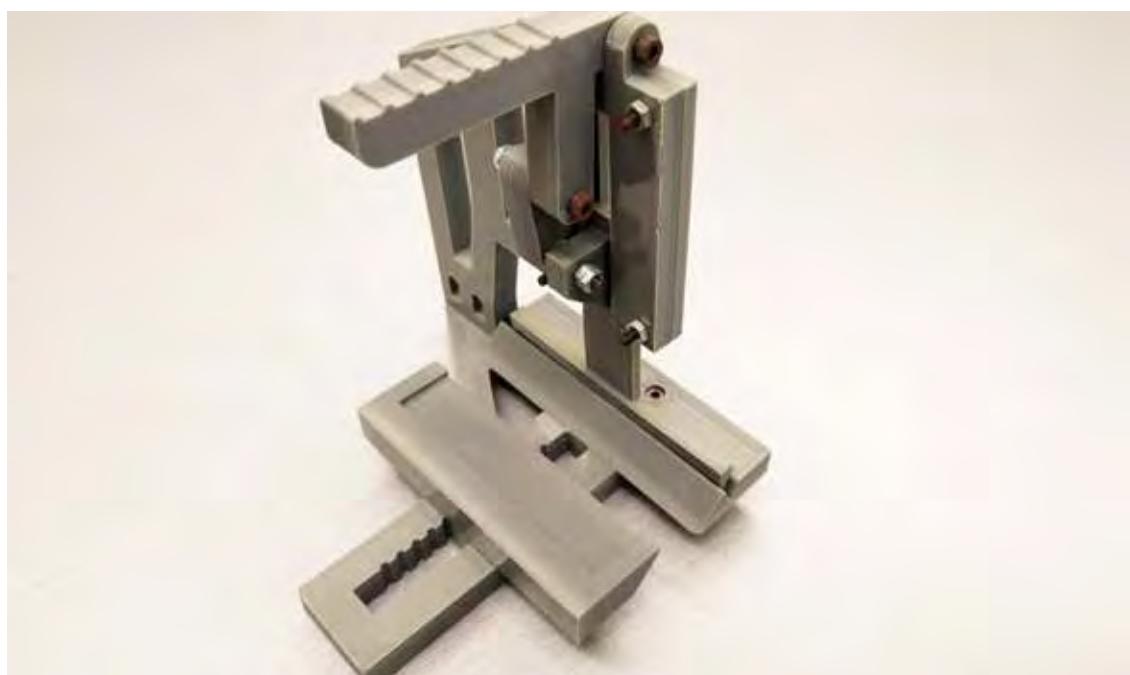
Left: Initial phase of the research. Actuators were digitally designed and then printed to transform simple hobby servos into linear actuators.

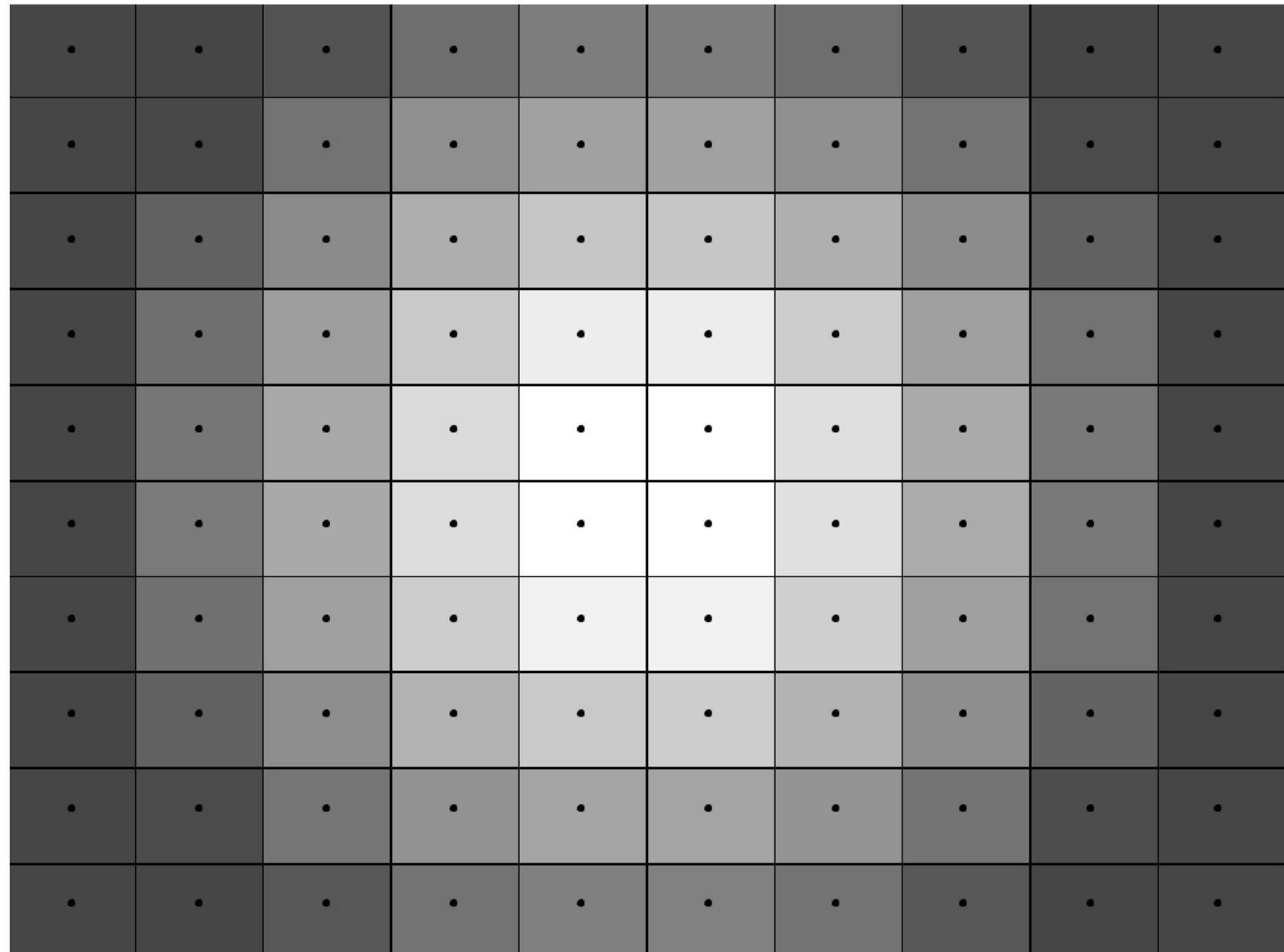
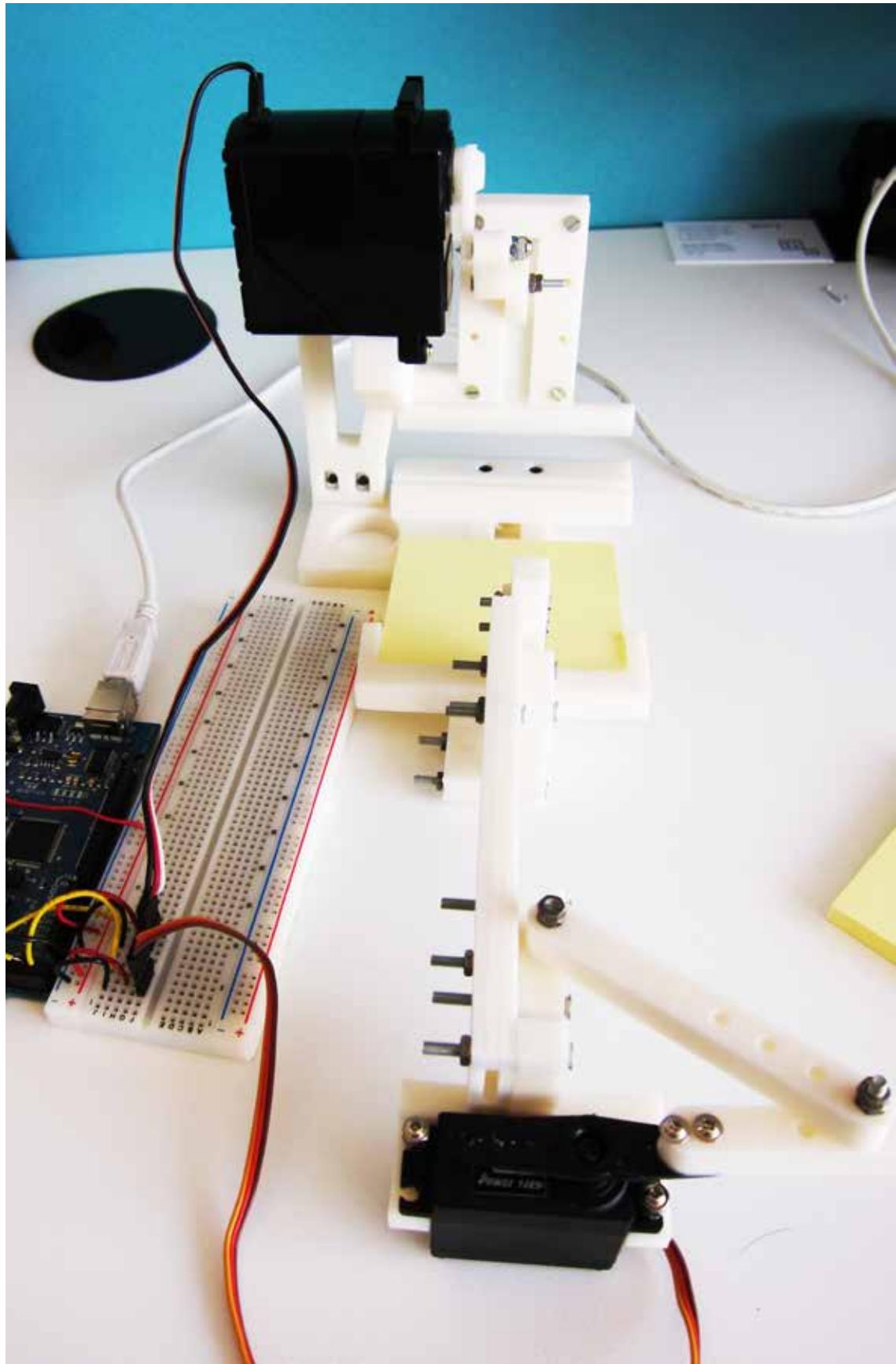
Next Page: First Pattern test for transforming gray scale values into folding points.





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





Grayscale patterns are broken down into 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

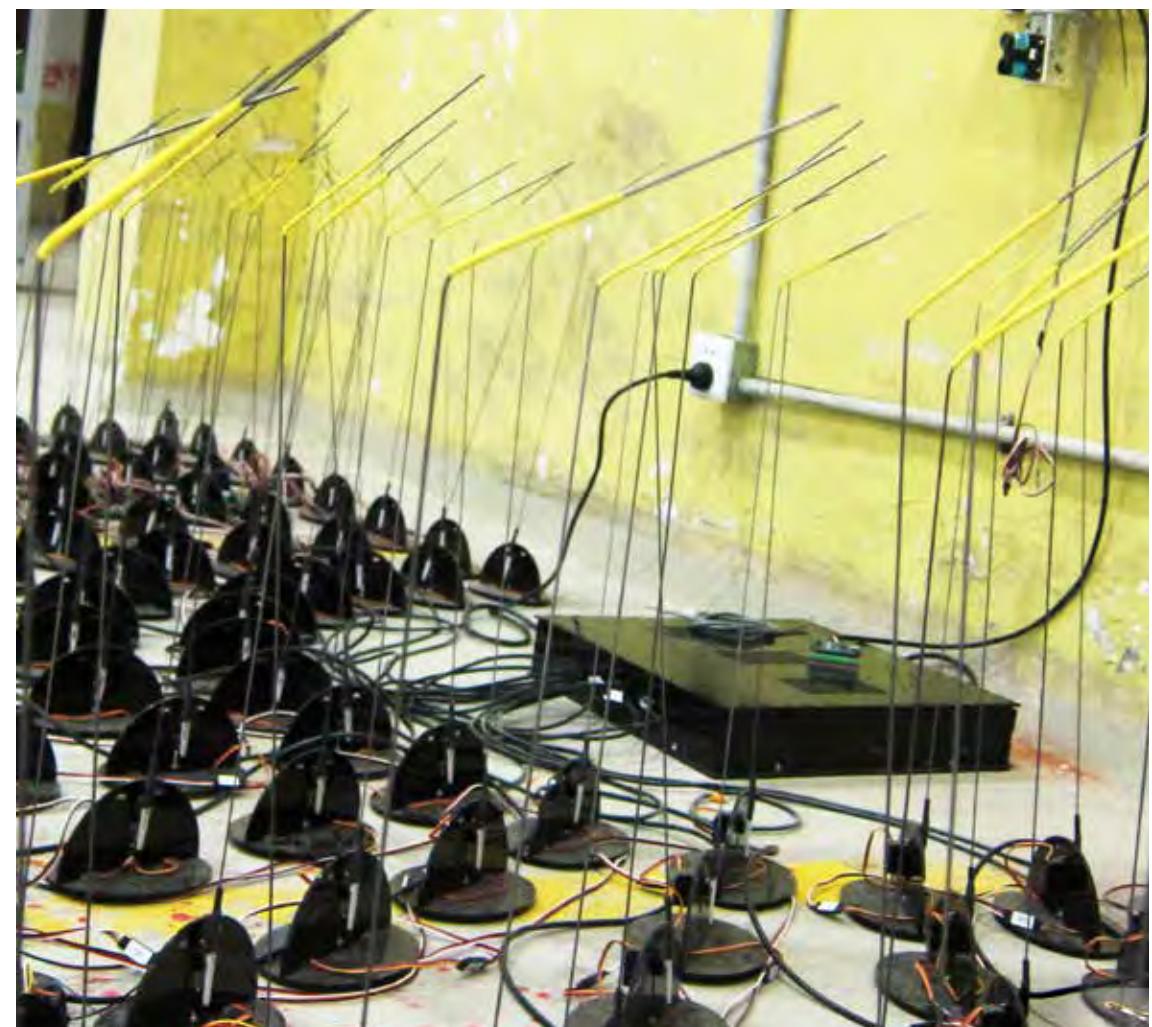
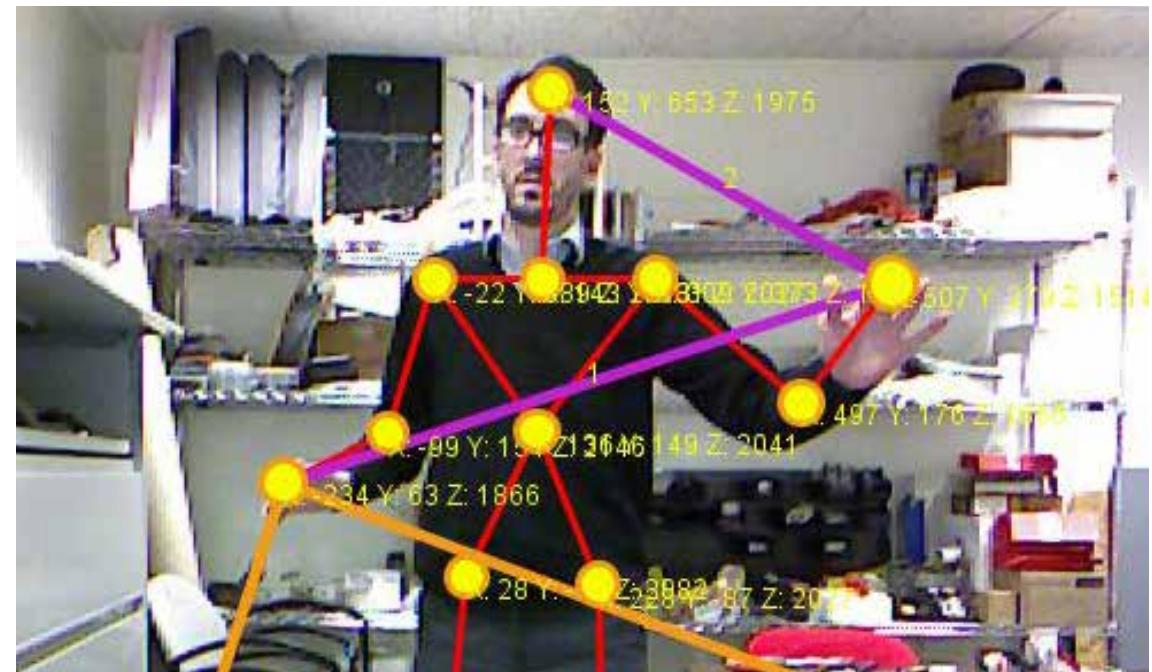
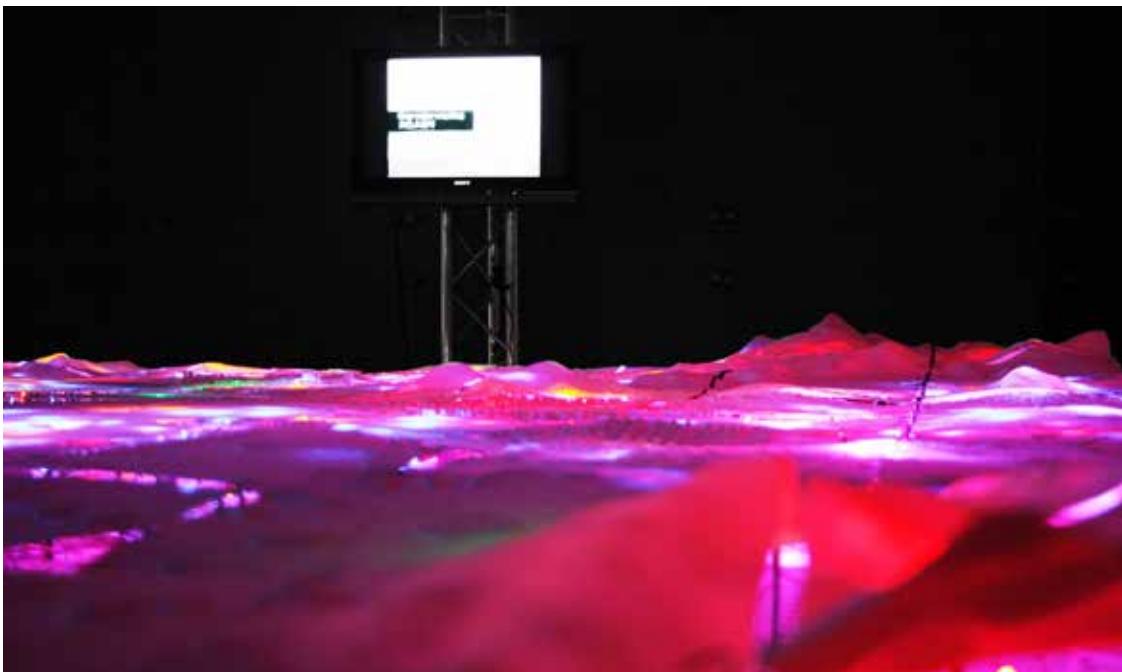
Xiamen Energy Masterplan

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

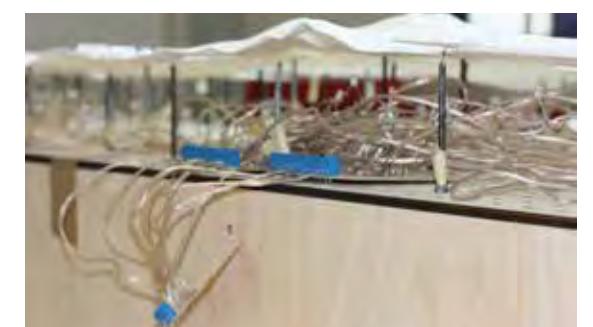
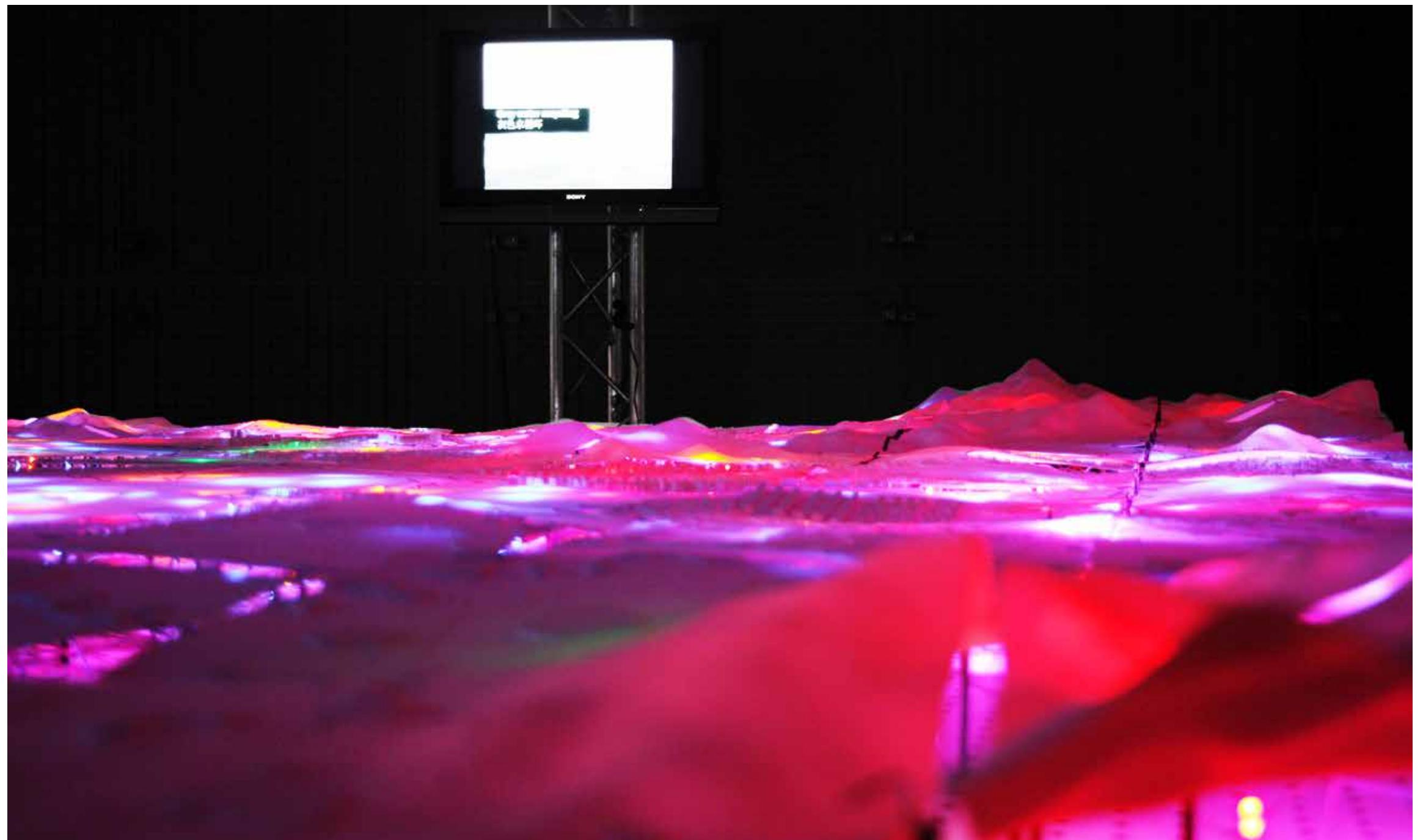
International Energy Expo  
Xiamen, China

*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.

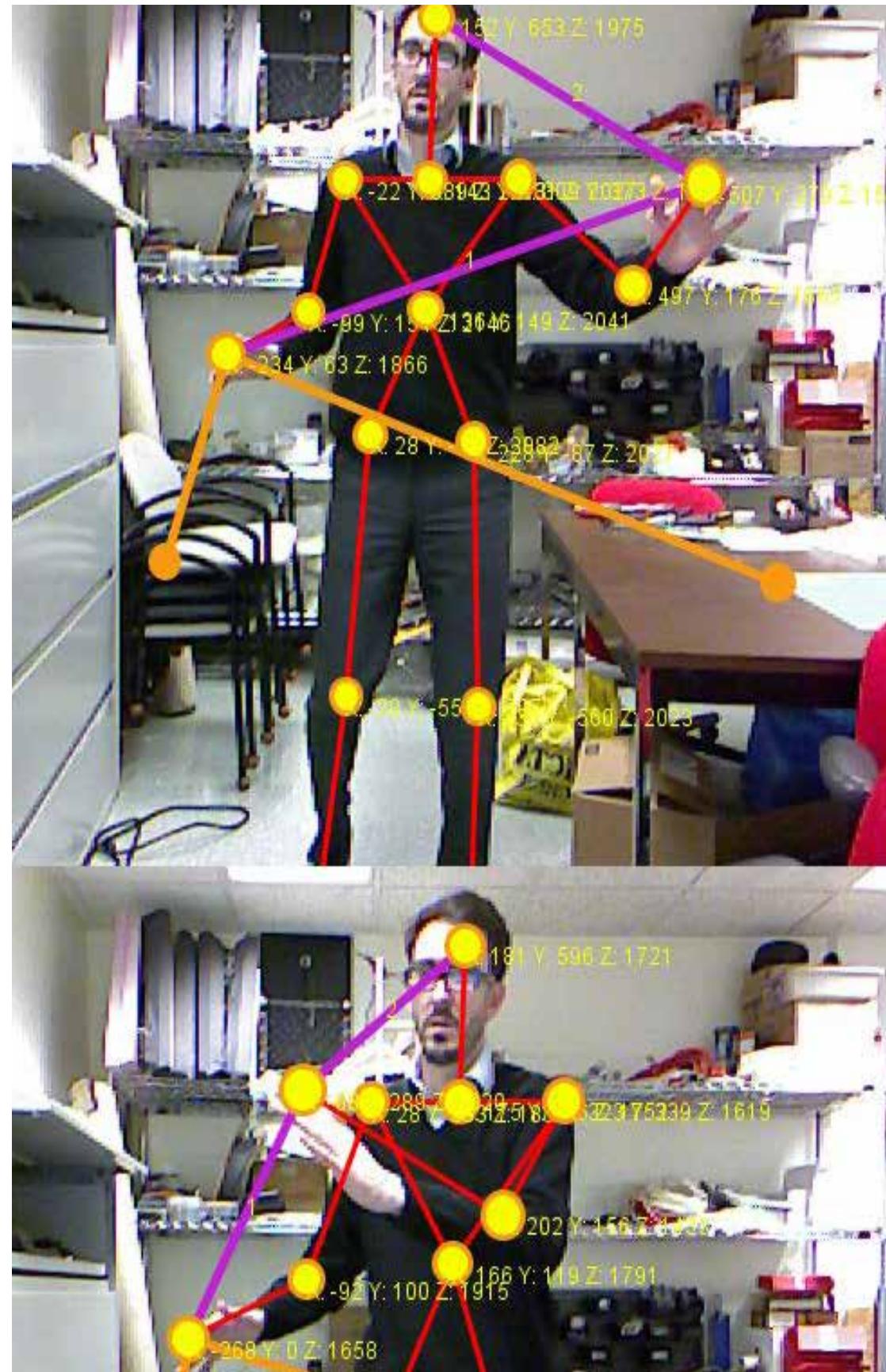
## Kinect Research Framework

**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

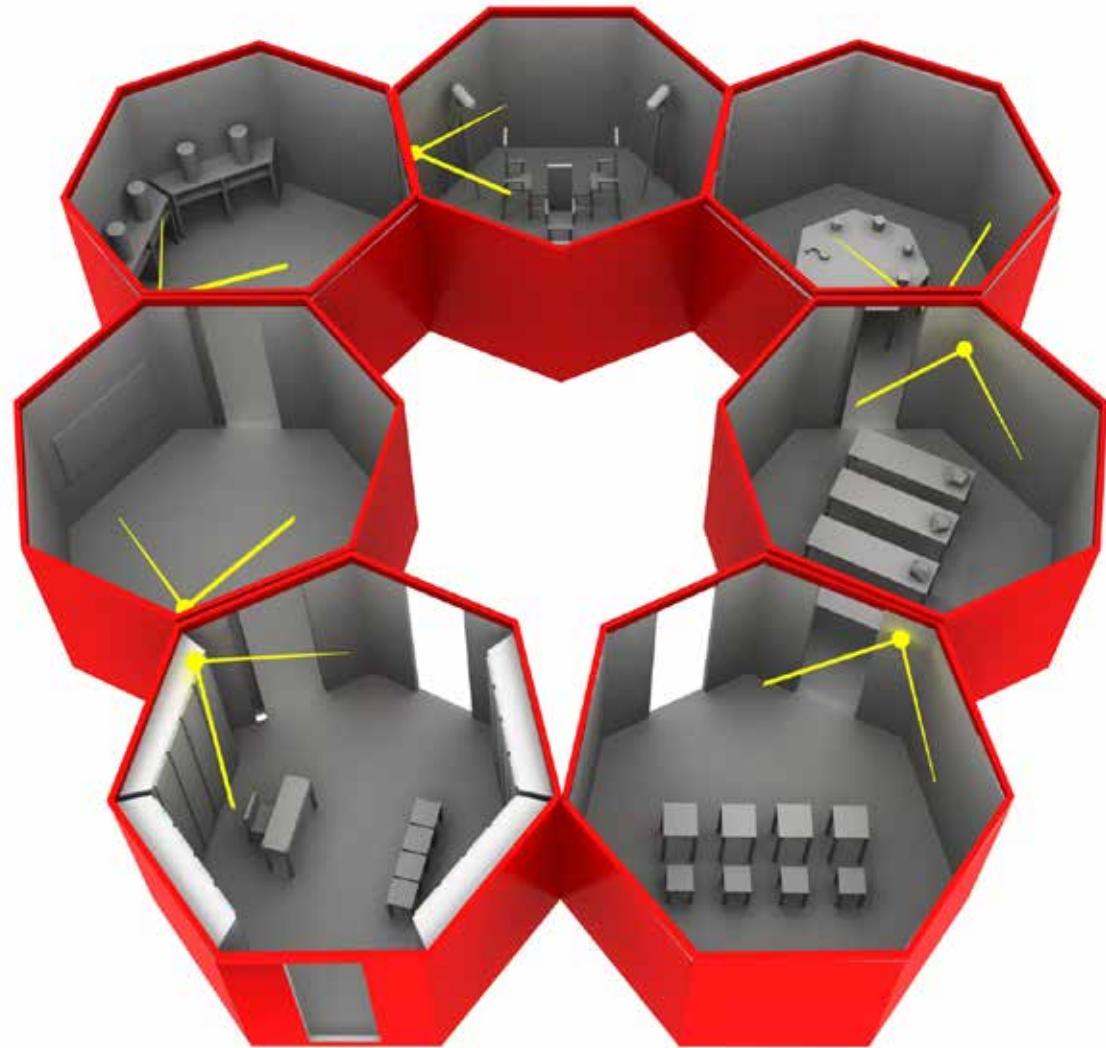
MAI Prototype, Luminato Festival  
Toronto, Canada

*Publication:*  
Metamatic Reloaded, Kehrer, 2013

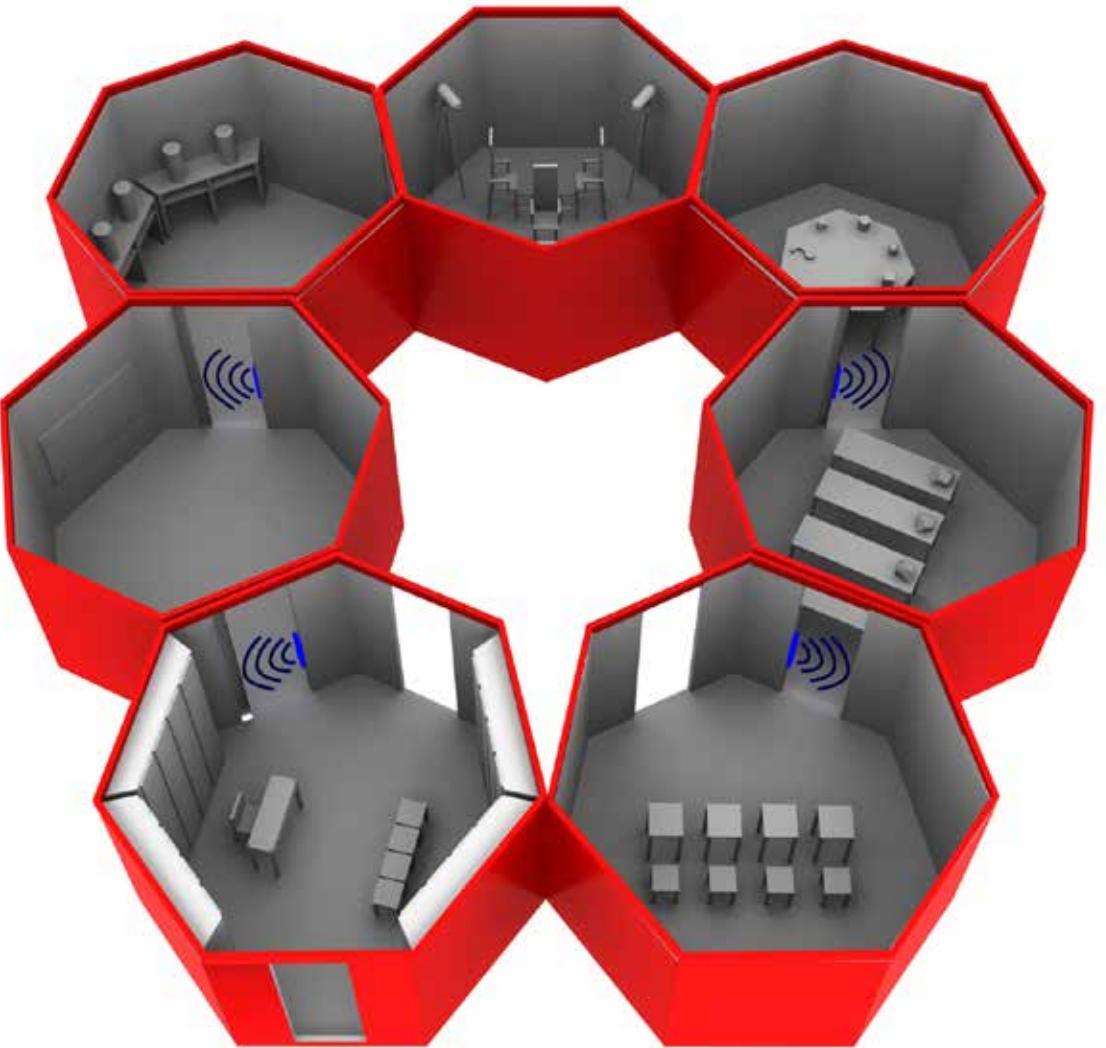
Marina Abramovic's MAI prototype represents a first test in the artist's initiative to develop an institute where visitors can learn the techniques and ideas she has developed in the field of performance art. This mobile prototype consists of 7 connected chambers and an interior courtyard that visitors 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

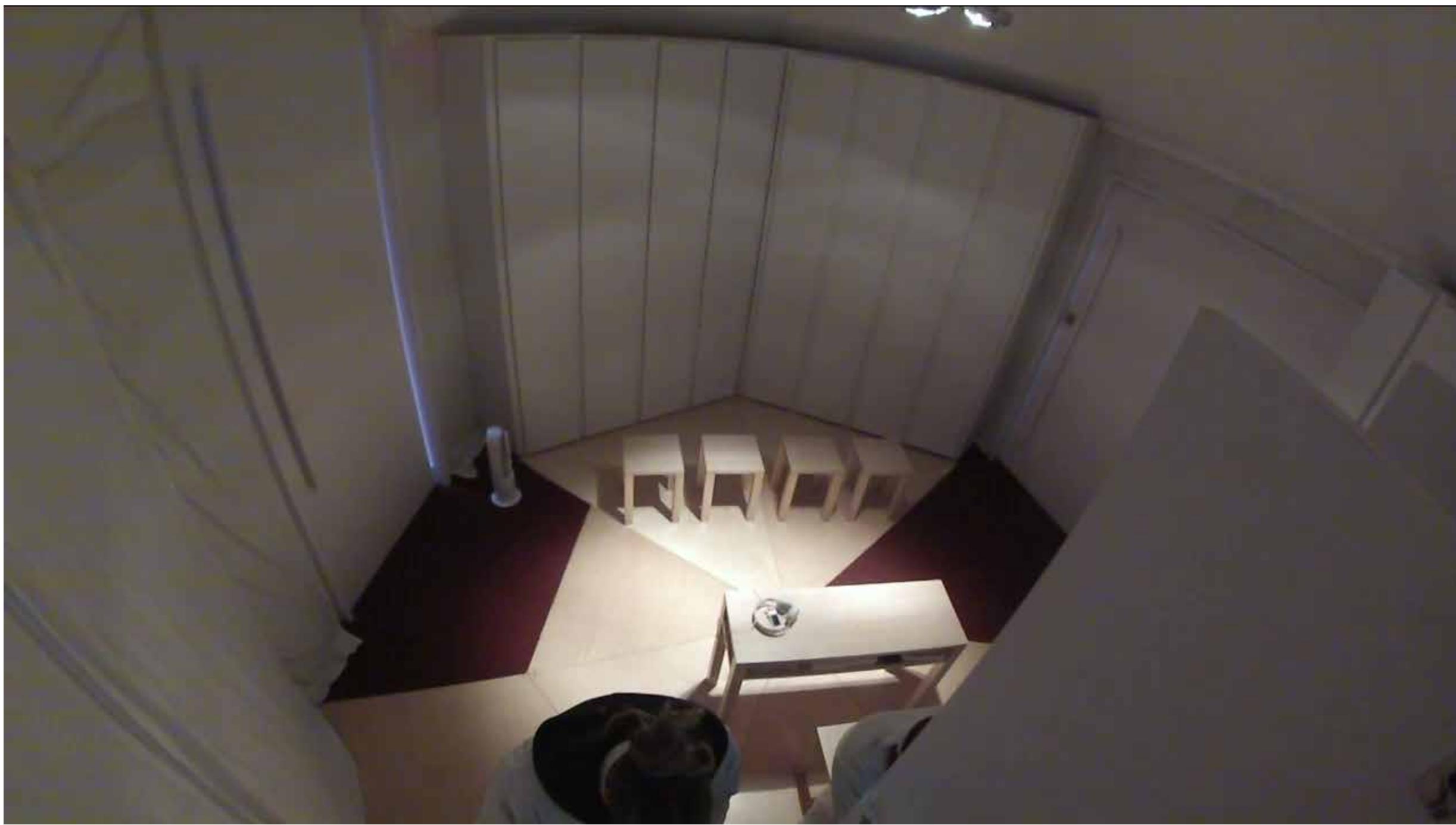


Placement of the cameras.

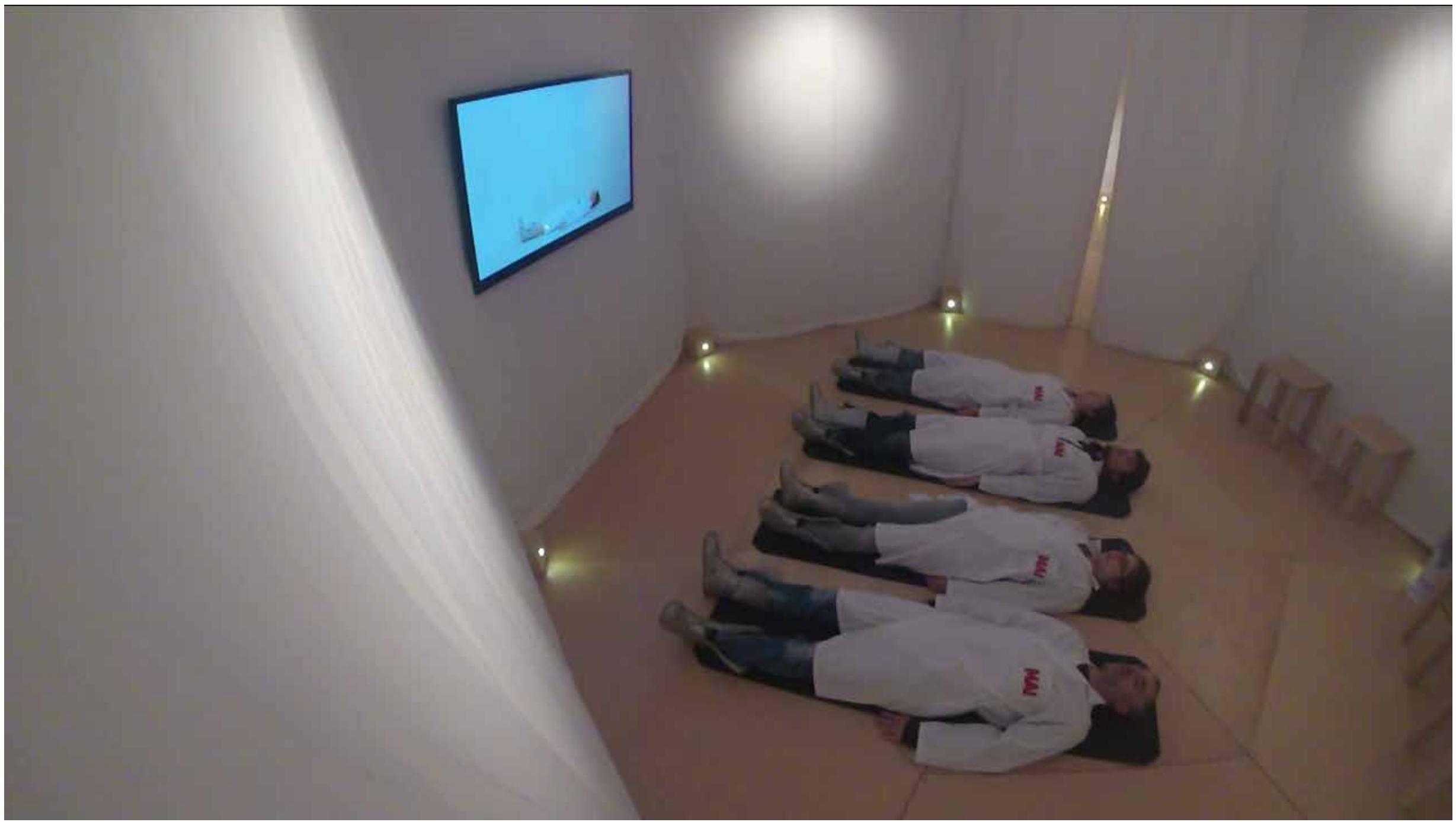


Placement of the RFID readers.





Reception Chamber



Exercise Chamber



Water-Drinking Chamber



Looking Eyes Chamber



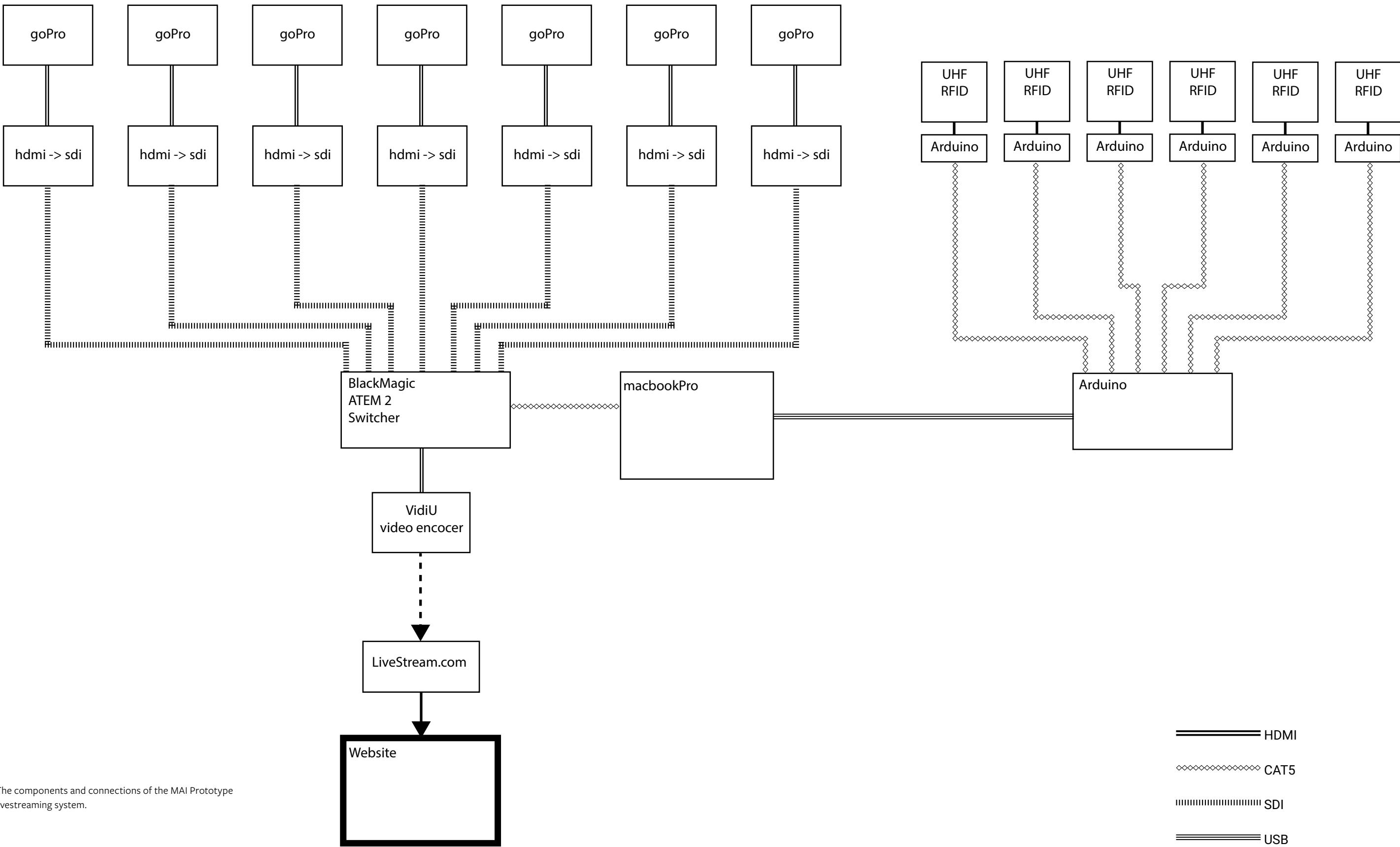
Electricity Chamber



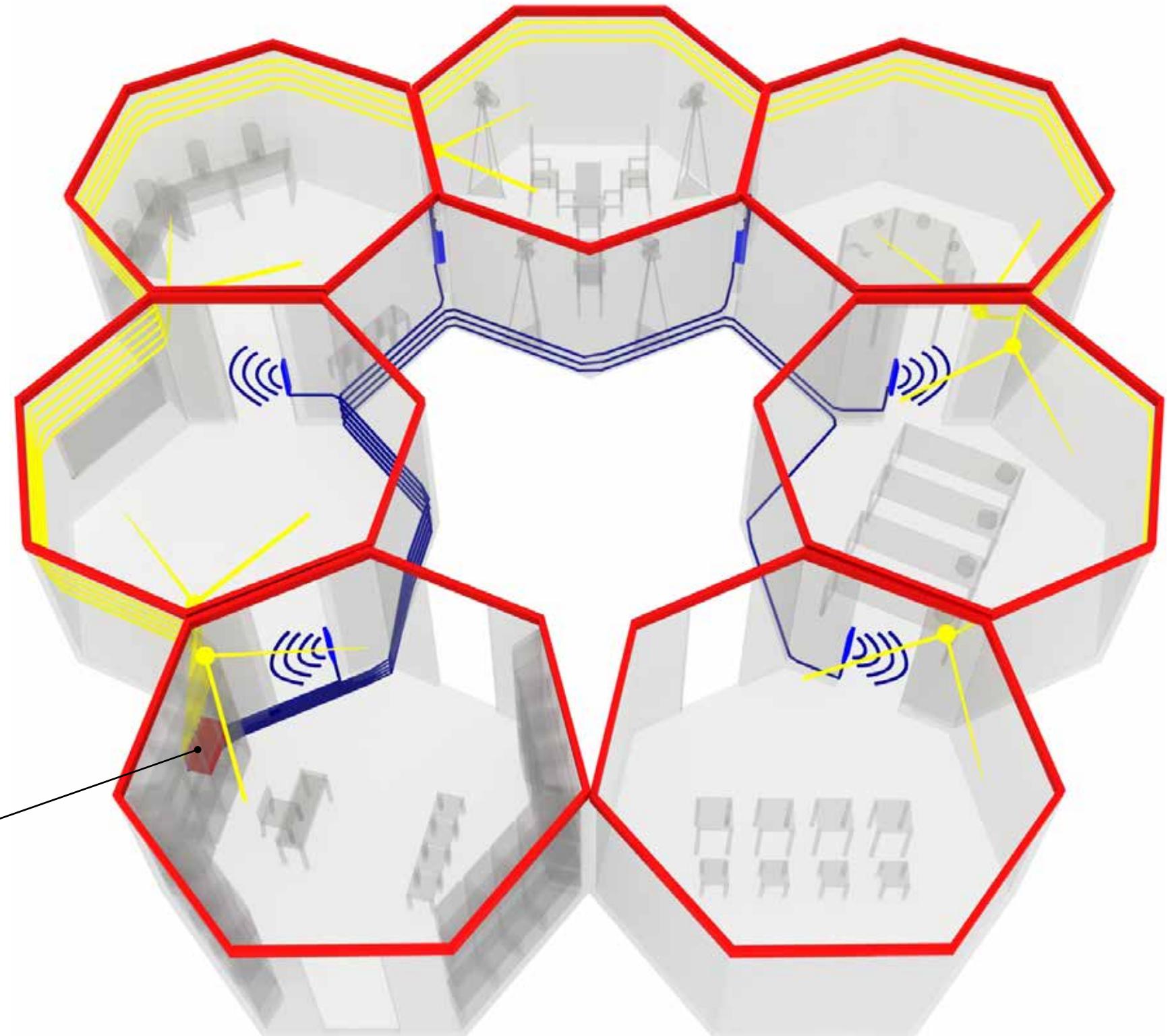
Luminosity Chamber



Writing Chamber



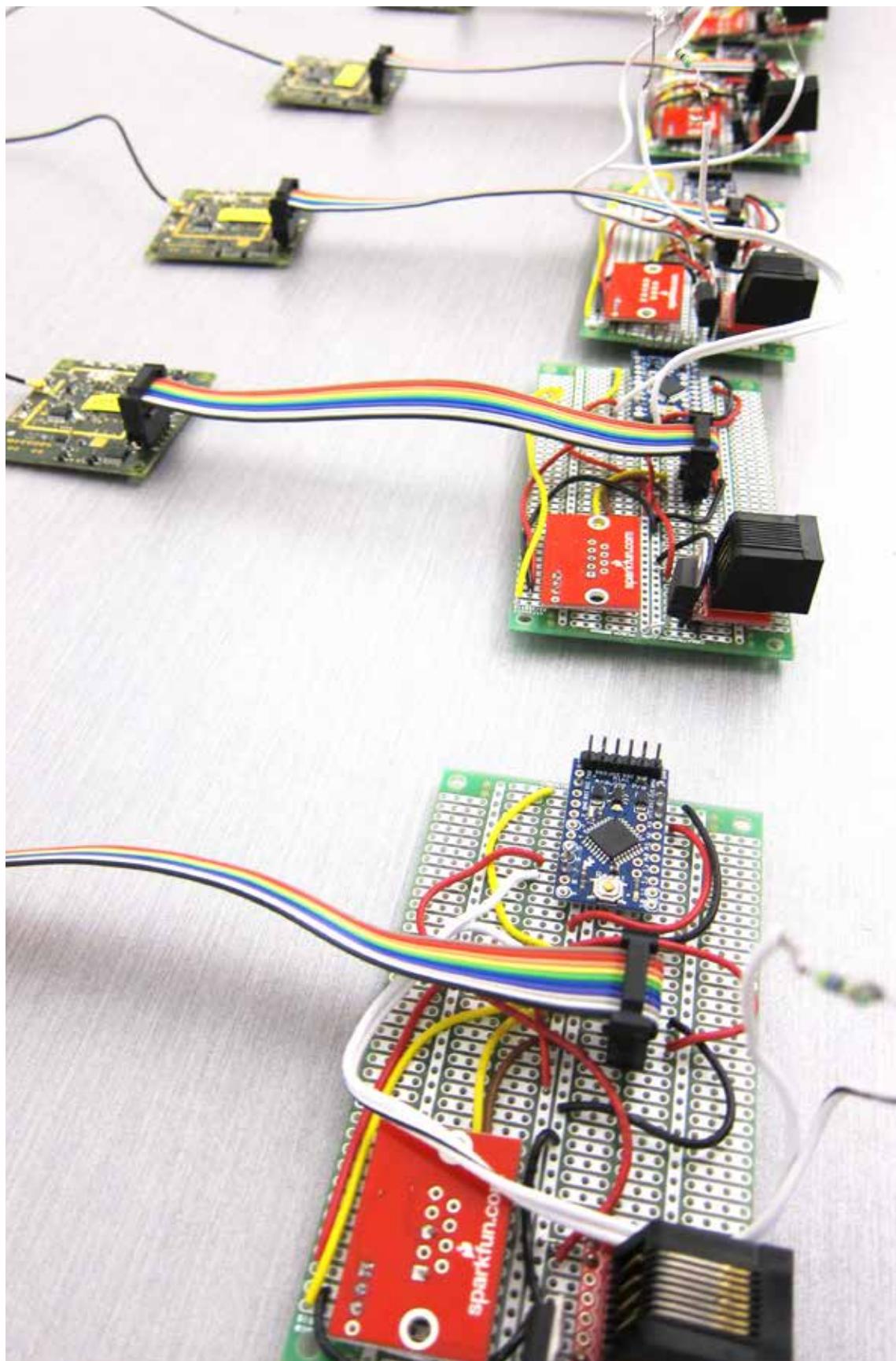
The components and connections of the MAI Prototype  
livestreaming system.



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

Next Page: Cameras and video encoder prototyping.

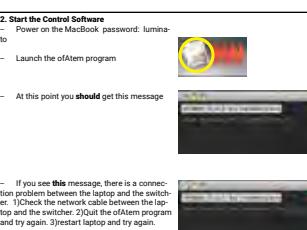
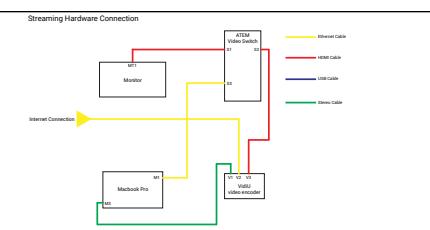
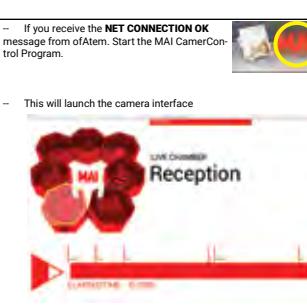
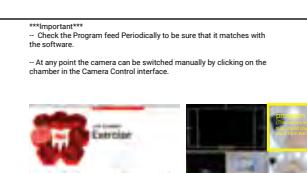
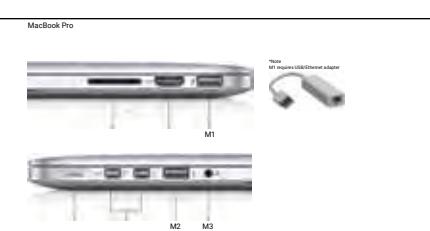
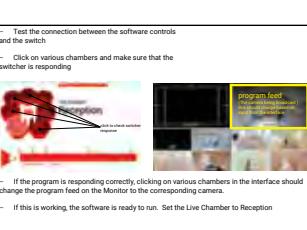
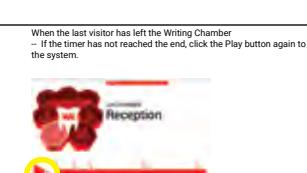




Left: Custom built RFID readers.  
Right: RFID tag attached to a visitor's boot.



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.

|  |   |  |
|--|---|--|
|  <p>Live Streaming User Manual</p>  | <p><b>2. Start the Live Stream</b></p> <ul style="list-style-type: none"> <li>- Press the Red Button on the front of the video encoder to start the stream.</li> <li>- When asked to notify followers choose "YES"</li> <li>- At this point the encoder should show that it is LIVE</li> </ul>  <p>The live stream is now ready to run</p> | <p><b>System Shutdown</b></p> <p>The Livestreaming system should be switched off at the end of each day.</p> <ol style="list-style-type: none"> <li>1. Press the Red button on the Video encoder to turn off the live stream.</li> <li>- When asked, select "Post the Video"</li> <li>2. Turn off each camera by holding down the silver button on the front of the camera</li> <li>3. Close the MAI Camera Control Software</li> <li>4. Close the oAtem Software</li> <li>5. Shut down the laptop.</li> </ol>   |
| <p><b>Daily Startup Method</b></p> <p><b>1. Turn on All Cameras</b></p> <ul style="list-style-type: none"> <li>- Start by turning on the multiview monitor</li> <li>- Red LED should be blinking</li> <li>- Hold down button on the front of the camera, until the camera beeps and the display lcd comes on.</li> </ul> <p>At this point all of the camera feeds should be visible in the monitor</p>    | <p><b>System Operation</b></p> <p>To start the livestream system for a group, click the Play button in the interface.</p> <p>This should be clicked at the same time as pressing Play on the DVD player</p>    | <p><b>System Connection Diagrams</b></p>   |
| <p><b>2. Start the Control Software</b></p> <ul style="list-style-type: none"> <li>- Power on the MacBook password: lumina-</li> <li>- Launch the oAtem program</li> <li>- At this point you should get this message</li> </ul> <p>If you see this message, there is a connection problem between the laptop and the switcher. 1)Check the network cable between the laptop and the switcher. 2)Quit the oAtem program and try again. 3)restart laptop and try again.</p>  | <p>Once clicked</p> <ul style="list-style-type: none"> <li>- The Live Chamber should switch to Exercise</li> <li>- The Elapsed Time should be counting up</li> <li>- The Program feed on the Monitor should be on the Exercise Room</li> </ul>   | <p><b>Streaming Hardware Connection</b></p>    |
| <p>-- If you receive the NET CONNECTION OK message from oAtem. Start the MAI Camera Control Program.</p> <p>-- This will launch the camera interface</p>    | <p><b>**Important**</b></p> <ul style="list-style-type: none"> <li>- Check the Program feed Periodically to be sure that it matches with the software.</li> <li>- At any point the camera can be switched manually by clicking on the chamber in the Camera Control interface.</li> </ul>    | <p><b>MacBook Pro</b></p>   |
| <p>-- Test the connection between the software controls and the switch</p> <p>-- Click on various chambers and make sure that the switcher is responding</p> <p>-- If the program is responding correctly, clicking on various chambers in the interface should change the program feed on the Monitor to the corresponding camera</p> <p>-- If this is working, the software is ready to run. Set the Live Chamber to Reception</p>                                      | <p>When the last visitor has left the Writing Chamber</p> <ul style="list-style-type: none"> <li>- If the timer has not reached the end, click the Play button again to reset the system.</li> </ul>   | <p><b>ATEM Video Switch</b></p> <img alt="Diagram of the ATEM Video Switch showing its internal structure with three inputs (S1, S2, S3) and three outputs (O1, O2, O3). Labels include 'Input 1', 'Input 2', 'Input 3', 'Output 1', 'Output 2', 'Output 3', 'Program Feed', 'Preview Feed', 'Monitor Feed', 'Ch 1', 'Ch 2', 'Ch 3', 'Ch 4', 'Ch 5', 'Ch 6', 'Ch 7', 'Ch 8', 'Ch 9', 'Ch 10', 'Ch 11', 'Ch 12', 'Ch 13', 'Ch 14', 'Ch 15', 'Ch 16', 'Ch 17', 'Ch 18', 'Ch 19', 'Ch 20', 'Ch 21', 'Ch 22', 'Ch 23', 'Ch 24', 'Ch 25', 'Ch 26', 'Ch 27', 'Ch 28', 'Ch 29', 'Ch 30', 'Ch 31', 'Ch 32', 'Ch 33', 'Ch 34', 'Ch 35', 'Ch 36', 'Ch 37', 'Ch 38', 'Ch 39', 'Ch 40', 'Ch 41', 'Ch 42', 'Ch 43', 'Ch 44', 'Ch 45', 'Ch 46', 'Ch 47', 'Ch 48', 'Ch 49', 'Ch 50', 'Ch 51', 'Ch 52', 'Ch 53', 'Ch 54', 'Ch 55', 'Ch 56', 'Ch 57', 'Ch 58', 'Ch 59', 'Ch 60', 'Ch 61', 'Ch 62', 'Ch 63', 'Ch 64', 'Ch 65', 'Ch 66', 'Ch 67', 'Ch 68', 'Ch 69', 'Ch 70', 'Ch 71', 'Ch 72', 'Ch 73', 'Ch 74', 'Ch 75', 'Ch 76', 'Ch 77', 'Ch 78', 'Ch 79', 'Ch 80', 'Ch 81', 'Ch 82', 'Ch 83', 'Ch 84', 'Ch 85', 'Ch 86', 'Ch 87', 'Ch 88', 'Ch 89', 'Ch 90', 'Ch 91', 'Ch 92', 'Ch 93', 'Ch 94', 'Ch 95', 'Ch 96', 'Ch 97', 'Ch 98', 'Ch 99', 'Ch 100', 'Ch 101', 'Ch 102', 'Ch 103', 'Ch 104', 'Ch 105', 'Ch 106', 'Ch 107', 'Ch 108', 'Ch 109', 'Ch 110', 'Ch 111', 'Ch 112', 'Ch 113', 'Ch 114', 'Ch 115', 'Ch 116', 'Ch 117', 'Ch 118', 'Ch 119', 'Ch 120', 'Ch 121', 'Ch 122', 'Ch 123', 'Ch 124', 'Ch 125', 'Ch 126', 'Ch 127', 'Ch 128', 'Ch 129', 'Ch 130', 'Ch 131', 'Ch 132', 'Ch 133', 'Ch 134', 'Ch 135', 'Ch 136', 'Ch 137', 'Ch 138', 'Ch 139', 'Ch 140', 'Ch 141', 'Ch 142', 'Ch 143', 'Ch 144', 'Ch 145', 'Ch 146', 'Ch 147', 'Ch 148', 'Ch 149', 'Ch 150', 'Ch 151', 'Ch 152', 'Ch 153', 'Ch 154', 'Ch 155', 'Ch 156', 'Ch 157', 'Ch 158', 'Ch 159', 'Ch 160', 'Ch 161', 'Ch 162', 'Ch 163', 'Ch 164', 'Ch 165', 'Ch 166', 'Ch 167', 'Ch 168', 'Ch 169', 'Ch 170', 'Ch 171', 'Ch 172', 'Ch 173', 'Ch 174', 'Ch 175', 'Ch 176', 'Ch 177', 'Ch 178', 'Ch 179', 'Ch 180', 'Ch 181', 'Ch 182', 'Ch 183', 'Ch 184', 'Ch 185', 'Ch 186', 'Ch 187', 'Ch 188', 'Ch 189', 'Ch 190', 'Ch 191', 'Ch 192', 'Ch 193', 'Ch 194', 'Ch 195', 'Ch 196', 'Ch 197', 'Ch 198', 'Ch 199', 'Ch 200', 'Ch 201', 'Ch 202', 'Ch 203', 'Ch 204', 'Ch 205', 'Ch 206', 'Ch 207', 'Ch 208', 'Ch 209', 'Ch 210', 'Ch 211', 'Ch 212', 'Ch 213', 'Ch 214', 'Ch 215', 'Ch 216', 'Ch 217', 'Ch 218', 'Ch 219', 'Ch 220', 'Ch 221', 'Ch 222', 'Ch 223', 'Ch 224', 'Ch 225', 'Ch 226', 'Ch 227', 'Ch 228', 'Ch 229', 'Ch 230', 'Ch 231', 'Ch 232', 'Ch 233', 'Ch 234', 'Ch 235', 'Ch 236', 'Ch 237', 'Ch 238', 'Ch 239', 'Ch 240', 'Ch 241', 'Ch 242', 'Ch 243', 'Ch 244', 'Ch 245', 'Ch 246', 'Ch 247', 'Ch 248', 'Ch 249', 'Ch 250', 'Ch 251', 'Ch 252', 'Ch 253', 'Ch 254', 'Ch 255', 'Ch 256', 'Ch 257', 'Ch 258', 'Ch 259', 'Ch 260', 'Ch 261', 'Ch 262', 'Ch 263', 'Ch 264', 'Ch 265', 'Ch 266', 'Ch 267', 'Ch 268', 'Ch 269', 'Ch 270', 'Ch 271', 'Ch 272', 'Ch 273', 'Ch 274', 'Ch 275', 'Ch 276', 'Ch 277', 'Ch 278', 'Ch 279', 'Ch 280', 'Ch 281', 'Ch 282', 'Ch 283', 'Ch 284', 'Ch 285', 'Ch 286', 'Ch 287', 'Ch 288', 'Ch 289', 'Ch 290', 'Ch 291', 'Ch 292', 'Ch 293', 'Ch 294', 'Ch 295', 'Ch 296', 'Ch 297', 'Ch 298', 'Ch 299', 'Ch 300', 'Ch 301', 'Ch 302', 'Ch 303', 'Ch 304', 'Ch 305', 'Ch 306', 'Ch 307', 'Ch 308', 'Ch 309', 'Ch 310', 'Ch 311', 'Ch 312', 'Ch 313', 'Ch 314', 'Ch 315', 'Ch 316', 'Ch 317', 'Ch 318', 'Ch 319', 'Ch 320', 'Ch 321', 'Ch 322', 'Ch 323', 'Ch 324', 'Ch 325', 'Ch 326', 'Ch 327', 'Ch 328', 'Ch 329', 'Ch 330', 'Ch 331', 'Ch 332', 'Ch 333', 'Ch 334', 'Ch 335', 'Ch 336', 'Ch 337', 'Ch 338', 'Ch 339', 'Ch 340', 'Ch 341', 'Ch 342', 'Ch 343', 'Ch 344', 'Ch 345', 'Ch 346', 'Ch 347', 'Ch 348', 'Ch 349', 'Ch 350', 'Ch 351', 'Ch 352', 'Ch 353', 'Ch 354', 'Ch 355', 'Ch 356', 'Ch 357', 'Ch 358', 'Ch 359', 'Ch 360', 'Ch 361', 'Ch 362', 'Ch 363', 'Ch 364', 'Ch 365', 'Ch 366', 'Ch 367', 'Ch 368', 'Ch 369', 'Ch 370', 'Ch 371', 'Ch 372', 'Ch 373', 'Ch 374', 'Ch 375', 'Ch 376', 'Ch 377', 'Ch 378', 'Ch 379', 'Ch 380', 'Ch 381', 'Ch 382', 'Ch 383', 'Ch 384', 'Ch 385', 'Ch 386', 'Ch 387', 'Ch 388', 'Ch 389', 'Ch 390', 'Ch 391', 'Ch 392', 'Ch 393', 'Ch 394', 'Ch 395', 'Ch 396', 'Ch 397', 'Ch 398', 'Ch 399', 'Ch 400', 'Ch 401', 'Ch 402', 'Ch 403', 'Ch 404', 'Ch 405', 'Ch 406', 'Ch 407', 'Ch 408', 'Ch 409', 'Ch 410', 'Ch 411', 'Ch 412', 'Ch 413', 'Ch 414', 'Ch 415', 'Ch 416', 'Ch 417', 'Ch 418', 'Ch 419', 'Ch 420', 'Ch 421', 'Ch 422', 'Ch 423', 'Ch 424', 'Ch 425', 'Ch 426', 'Ch 427', 'Ch 428', 'Ch 429', 'Ch 430', 'Ch 431', 'Ch 432', 'Ch 433', 'Ch 434', 'Ch 435', 'Ch 436', 'Ch 437', 'Ch 438', 'Ch 439', 'Ch 440', 'Ch 441', 'Ch 442', 'Ch 443', 'Ch 444', 'Ch 445', 'Ch 446', 'Ch 447', 'Ch 448', 'Ch 449', 'Ch 450', 'Ch 451', 'Ch 452', 'Ch 453', 'Ch 454', 'Ch 455', 'Ch 456', 'Ch 457', 'Ch 458', 'Ch 459', 'Ch 460', 'Ch 461', 'Ch 462', 'Ch 463', 'Ch 464', 'Ch 465', 'Ch 466', 'Ch 467', 'Ch 468', 'Ch 469', 'Ch 470', 'Ch 471', 'Ch 472', 'Ch 473', 'Ch 474', 'Ch 475', 'Ch 476', 'Ch 477', 'Ch 478', 'Ch 479', 'Ch 480', 'Ch 481', 'Ch 482', 'Ch 483', 'Ch 484', 'Ch 485', 'Ch 486', 'Ch 487', 'Ch 488', 'Ch 489', 'Ch 490', 'Ch 491', 'Ch 492', 'Ch 493', 'Ch 494', 'Ch 495', 'Ch 496', 'Ch 497', 'Ch 498', 'Ch 499', 'Ch 500', 'Ch 501', 'Ch 502', 'Ch 503', 'Ch 504', 'Ch 505', 'Ch 506', 'Ch 507', 'Ch 508', 'Ch 509', 'Ch 510', 'Ch 511', 'Ch 512', 'Ch 513', 'Ch 514', 'Ch 515', 'Ch 516', 'Ch 517', 'Ch 518', 'Ch 519', 'Ch 520', 'Ch 521', 'Ch 522', 'Ch 523', 'Ch 524', 'Ch 525', 'Ch 526', 'Ch 527', 'Ch 528', 'Ch 529', 'Ch 530', 'Ch 531', 'Ch 532', 'Ch 533', 'Ch 534', 'Ch 535', 'Ch 536', 'Ch 537', 'Ch 538', 'Ch 539', 'Ch 540', 'Ch 541', 'Ch 542', 'Ch 543', 'Ch 544', 'Ch 545', 'Ch 546', 'Ch 547', 'Ch 548', 'Ch 549', 'Ch 550', 'Ch 551', 'Ch 552', 'Ch 553', 'Ch 554', 'Ch 555', 'Ch 556', 'Ch 557', 'Ch 558', 'Ch 559', 'Ch 560', 'Ch 561', 'Ch 562', 'Ch 563', 'Ch 564', 'Ch 565', 'Ch 566', 'Ch 567', 'Ch 568', 'Ch 569', 'Ch 570', 'Ch 571', 'Ch 572', 'Ch 573', 'Ch 574', 'Ch 575', 'Ch 576', 'Ch 577', 'Ch 578', 'Ch 579', 'Ch 580', 'Ch 581', 'Ch 582', 'Ch 583', 'Ch 584', 'Ch 585', 'Ch 586', 'Ch 587', 'Ch 588', 'Ch 589', 'Ch 590', 'Ch 591', 'Ch 592', 'Ch 593', 'Ch 594', 'Ch 595', 'Ch 596', 'Ch 597', 'Ch 598', 'Ch 599', 'Ch 600', 'Ch 601', 'Ch 602', 'Ch 603', 'Ch 604', 'Ch 605', 'Ch 606', 'Ch 607', 'Ch 608', 'Ch 609', 'Ch 610', 'Ch 611', 'Ch 612', 'Ch 613', 'Ch 614', 'Ch 615', 'Ch 616', 'Ch 617', 'Ch 618', 'Ch 619', 'Ch 620', 'Ch 621', 'Ch 622', 'Ch 623', 'Ch 624', 'Ch 625', 'Ch 626', 'Ch 627', 'Ch 628', 'Ch 629', 'Ch 630', 'Ch 631', 'Ch 632', 'Ch 633', 'Ch 634', 'Ch 635', 'Ch 636', 'Ch 637', 'Ch 638', 'Ch 639', 'Ch 640', 'Ch 641', 'Ch 642', 'Ch 643', 'Ch 644', 'Ch 645', 'Ch 646', 'Ch 647', 'Ch 648', 'Ch 649', 'Ch 650', 'Ch 651', 'Ch 652', 'Ch 653', 'Ch 654', 'Ch 655', 'Ch 656', 'Ch 657', 'Ch 658', 'Ch 659', 'Ch 660', 'Ch 661', 'Ch 662', 'Ch 663', 'Ch 664', 'Ch 665', 'Ch 666', 'Ch 667', 'Ch 668', 'Ch 669', 'Ch 670', 'Ch 671', 'Ch 672', 'Ch 673', 'Ch 674', 'Ch 675', 'Ch 676', 'Ch 677', 'Ch 678', 'Ch 679', 'Ch 680', 'Ch 681', 'Ch 682', 'Ch 683', 'Ch 684', 'Ch 685', 'Ch 686', 'Ch 687', 'Ch 688', 'Ch 689', 'Ch 690', 'Ch 691', 'Ch 692', 'Ch 693', 'Ch 694', 'Ch 695', 'Ch 696', 'Ch 697', 'Ch 698', 'Ch 699', 'Ch 700', 'Ch 701', 'Ch 702', 'Ch 703', 'Ch 704', 'Ch 705', 'Ch 706', 'Ch 707', 'Ch 708', 'Ch 709', 'Ch 710', 'Ch 711', 'Ch 712', 'Ch 713', 'Ch 714', 'Ch 715', 'Ch 716', 'Ch 717', 'Ch 718', 'Ch 719', 'Ch 720', 'Ch 721', 'Ch 722', 'Ch 723', 'Ch 724', 'Ch 725', 'Ch 726', 'Ch 727', 'Ch 728', 'Ch 729', 'Ch 730', 'Ch 731', 'Ch 732', 'Ch 733', 'Ch 734', 'Ch 735', 'Ch 736', 'Ch 737', 'Ch 738', 'Ch 739', 'Ch 740', 'Ch 741', 'Ch 742', 'Ch 743', 'Ch 744', 'Ch 745', 'Ch 746', 'Ch 747', 'Ch 748', 'Ch 749', 'Ch 750', 'Ch 751', 'Ch 752', 'Ch 753', 'Ch 754', 'Ch 755', 'Ch 756', 'Ch 757', 'Ch 758', 'Ch 759', 'Ch 760', 'Ch 761', 'Ch 762', 'Ch 763', 'Ch 764', 'Ch 765', 'Ch 766', 'Ch 767', 'Ch 768', 'Ch 769', 'Ch 770', 'Ch 771', 'Ch 772', 'Ch 773', 'Ch 774', 'Ch 775', 'Ch 776', 'Ch 777', 'Ch 778', 'Ch 779', 'Ch 780', 'Ch 781', 'Ch 782', 'Ch 783', 'Ch 784', 'Ch 785', 'Ch 786', 'Ch 787', 'Ch 788', 'Ch 789', 'Ch 790', 'Ch 791', 'Ch 792', 'Ch 793', 'Ch 794', 'Ch 795', 'Ch 796', 'Ch 797', 'Ch 798', 'Ch 799', 'Ch 800', 'Ch 801', 'Ch 802', 'Ch 803', 'Ch 804', 'Ch 805', 'Ch 806', 'Ch 807', 'Ch 808', 'Ch 809', 'Ch 810', 'Ch 811', 'Ch 812', 'Ch 813', 'Ch 814', 'Ch 815', 'Ch 816', 'Ch 817', 'Ch 818', 'Ch 819', 'Ch 820', 'Ch 821', 'Ch 822', 'Ch 823', 'Ch 824', 'Ch 825', 'Ch 826', 'Ch 827', 'Ch 828', 'Ch 829', 'Ch 830', 'Ch 831', 'Ch 832', 'Ch 833', 'Ch 834', 'Ch 835', 'Ch 836', 'Ch 837', 'Ch 838', 'Ch 839', 'Ch 840', 'Ch 841', 'Ch 842', 'Ch 843', 'Ch 844', 'Ch 845', 'Ch 846', 'Ch 847', 'Ch 848', 'Ch 849', 'Ch 850', 'Ch 851', 'Ch 852', 'Ch 853', 'Ch 854', 'Ch 855', 'Ch 856', 'Ch 857', 'Ch 858', 'Ch 859', 'Ch 860', 'Ch 861', 'Ch 862', 'Ch 863', 'Ch 864', 'Ch 865', 'Ch 866', 'Ch 867', 'Ch 868', 'Ch 869', 'Ch 870', 'Ch 871', 'Ch 872', 'Ch 873', 'Ch 874', 'Ch 875', 'Ch 876', 'Ch 877', 'Ch 878', 'Ch 879', 'Ch 880', 'Ch 881', 'Ch 882', 'Ch 883', 'Ch 884', 'Ch 885', 'Ch 886', 'Ch 887', 'Ch 888', 'Ch 889', 'Ch 890', 'Ch 891', 'Ch 892', 'Ch 893', 'Ch 894', 'Ch 895', 'Ch 896', 'Ch 897', 'Ch 898', 'Ch 899', 'Ch 900', 'Ch 901', 'Ch 902', 'Ch 903', 'Ch 904', 'Ch 905', 'Ch 906', 'Ch 907', 'Ch 908', 'Ch 909', 'Ch 910', 'Ch 911', 'Ch 912', 'Ch 913', 'Ch 914', 'Ch 915', 'Ch 916', 'Ch 917', 'Ch 918', 'Ch 919', 'Ch 920', 'Ch 921', 'Ch 922', 'Ch 923', 'Ch 924', 'Ch 925', 'Ch 926', 'Ch 927', 'Ch 928', 'Ch 929', 'Ch 930', 'Ch 931', 'Ch 932', 'Ch 933', 'Ch 934', 'Ch 935', 'Ch 936', 'Ch 937', 'Ch 938', 'Ch 939', 'Ch 940', 'Ch 941', 'Ch 942', 'Ch 943', 'Ch 944', 'Ch 945', 'Ch 946', 'Ch 947', 'Ch 948', 'Ch 949 |



MAI prototype at the Luminato Festival

## Pulse v1

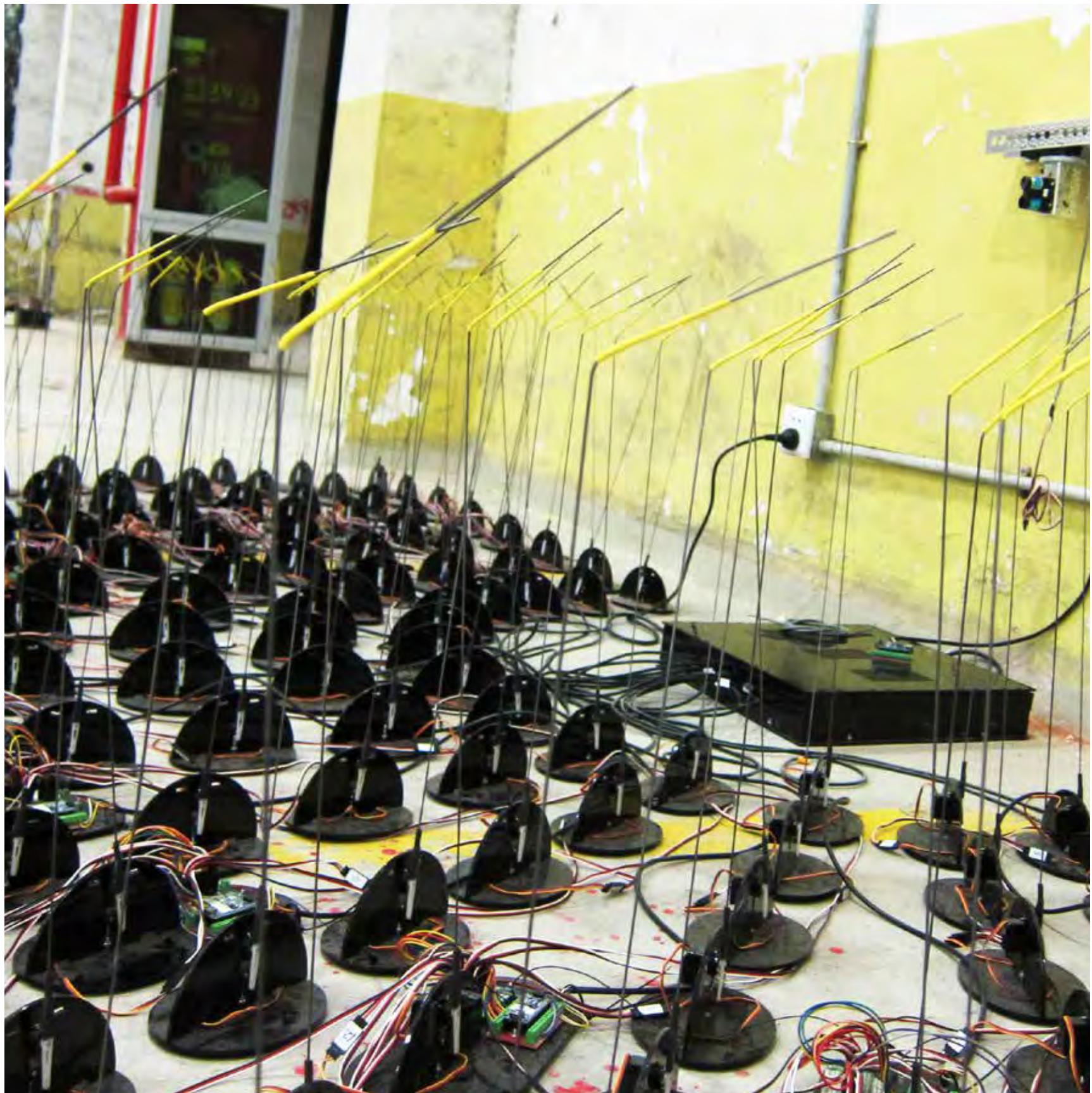
Commissioned by The Bi City Biennale Of Urbanism & Architecture (UABB)

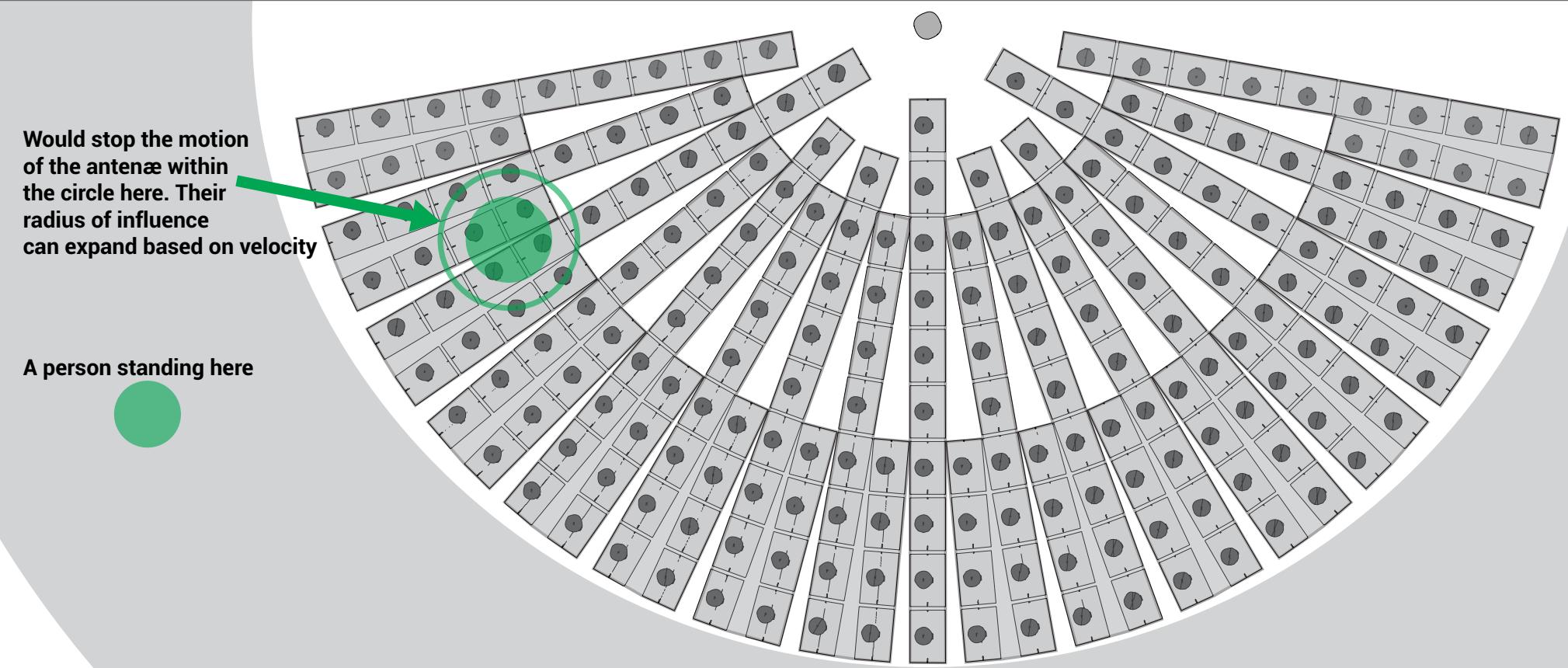
**Exhibition:**  
Re-Living the City, 2015 Bi City Biennale Of Urbanism & Architecture.  
Shenzhen, China

### *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.

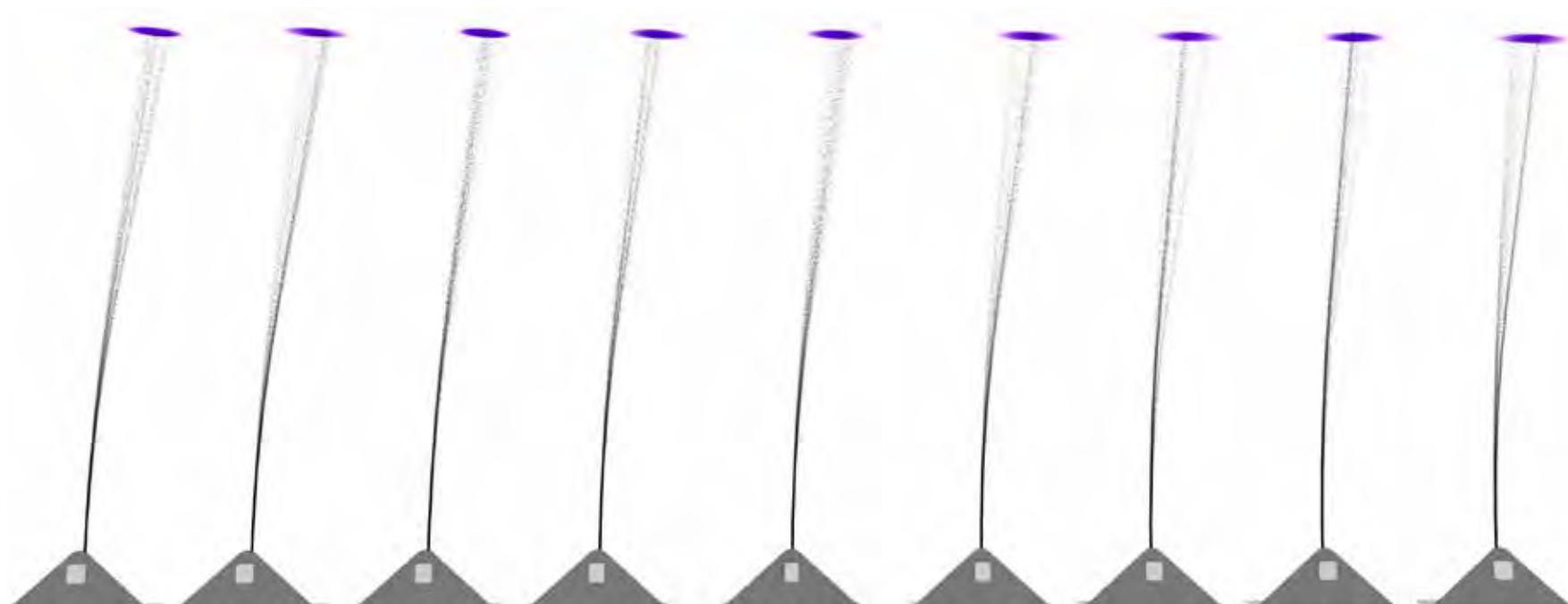
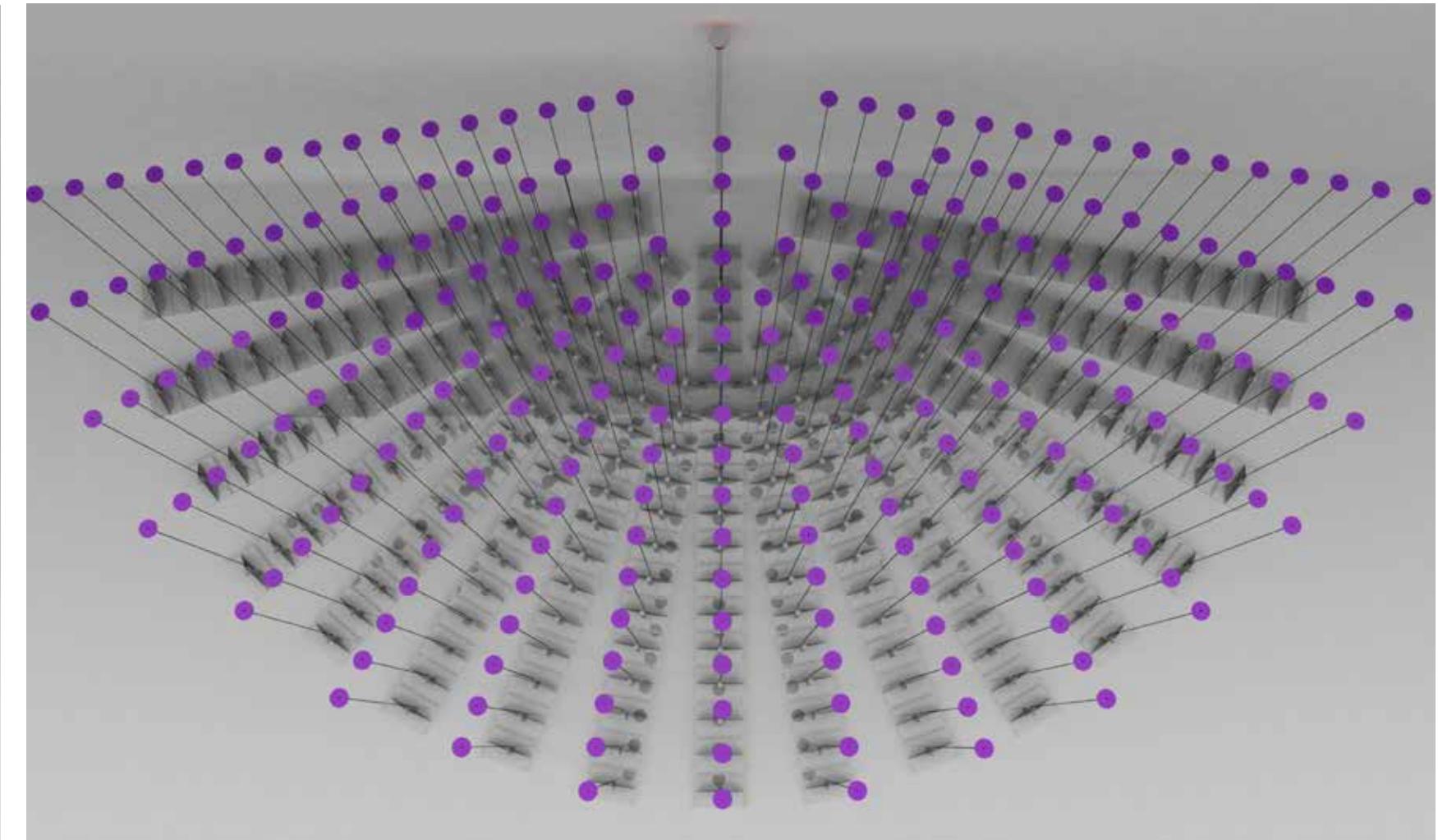
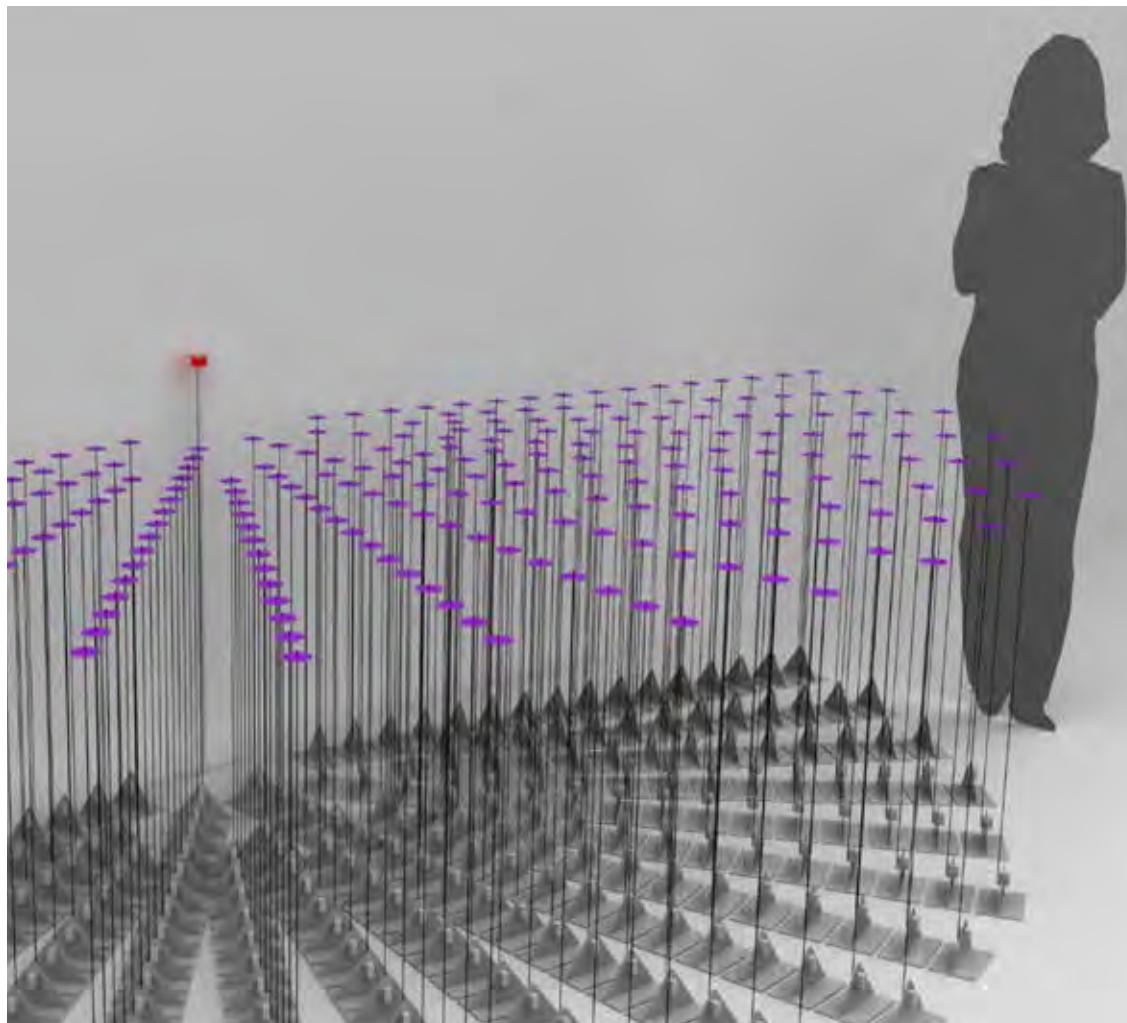
Resistor v1 installed at the 2015 Bi City Biennale Of Urbanism Architecture in Shenzhen.





**The overall behaviour:**

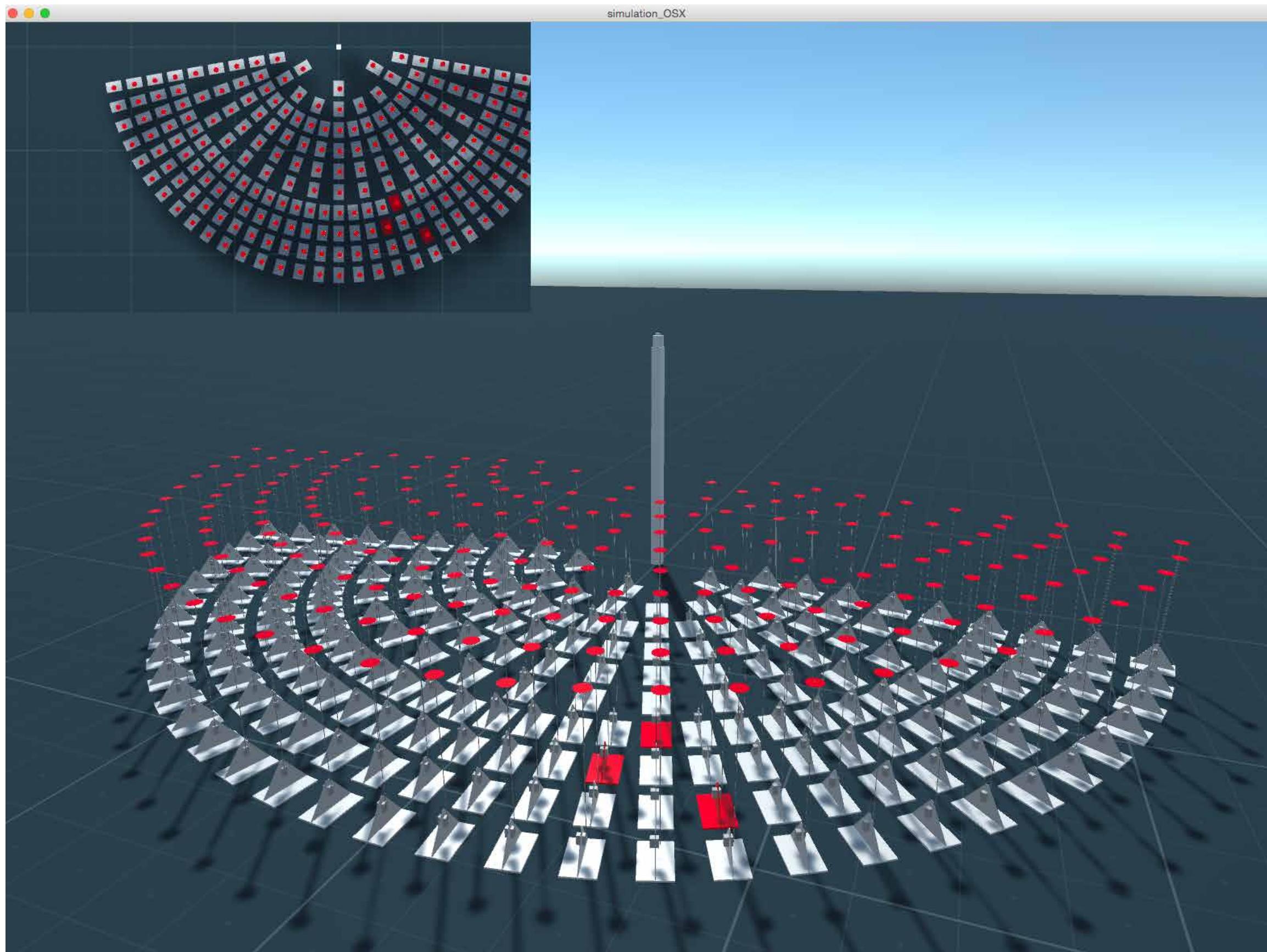
As the Lidar rotates, it creates a radial wave that passes back and forth in a constant loop. If no-one is within the sensing zone/angle when the Lidar passes over it all of them pulse. People interrupt that wave with their presence. Only 1 column is sensed pulsed at a time, but people will generally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



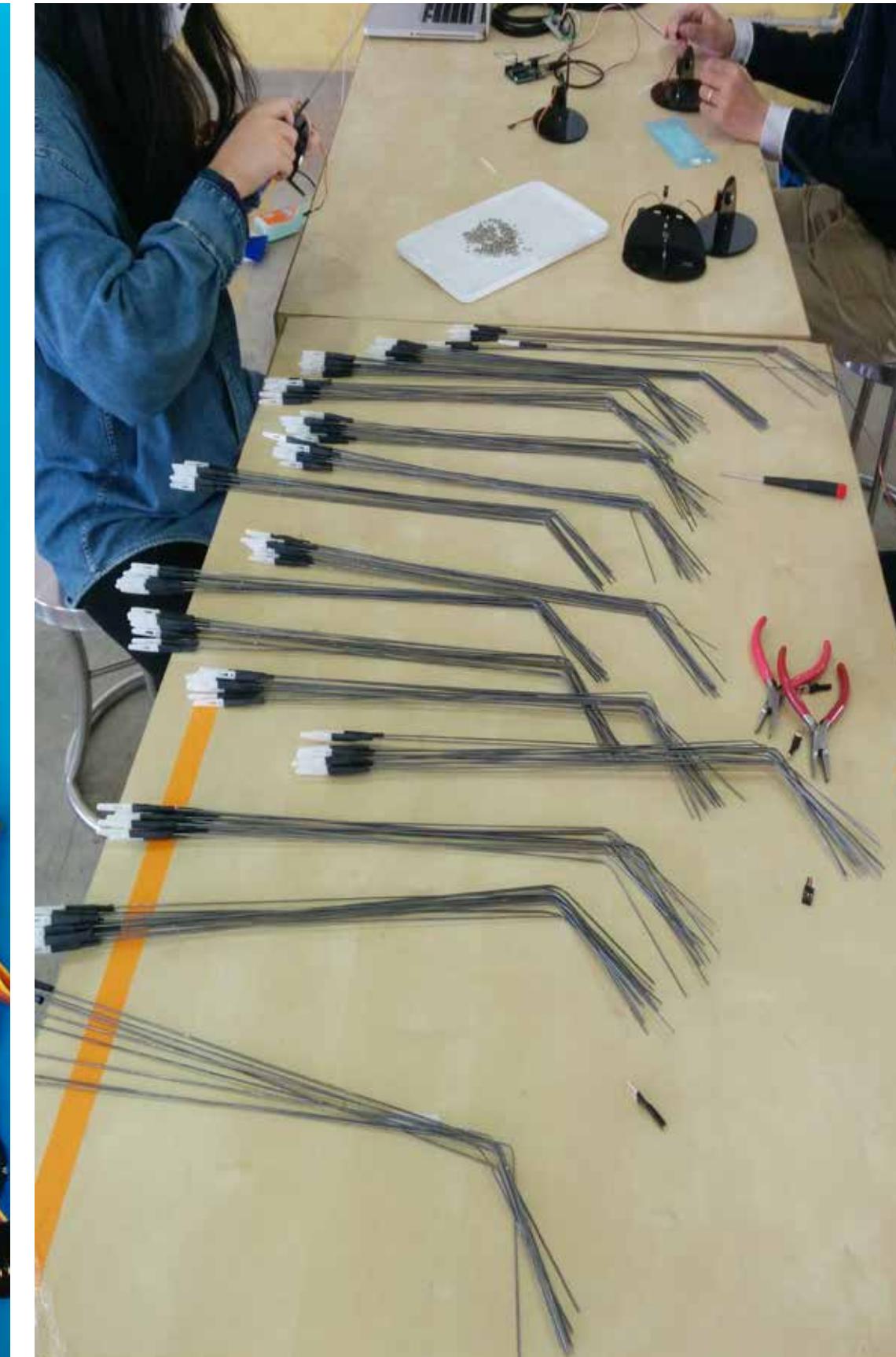
Above: Initial design concepts for the overall layout and behaviour.

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



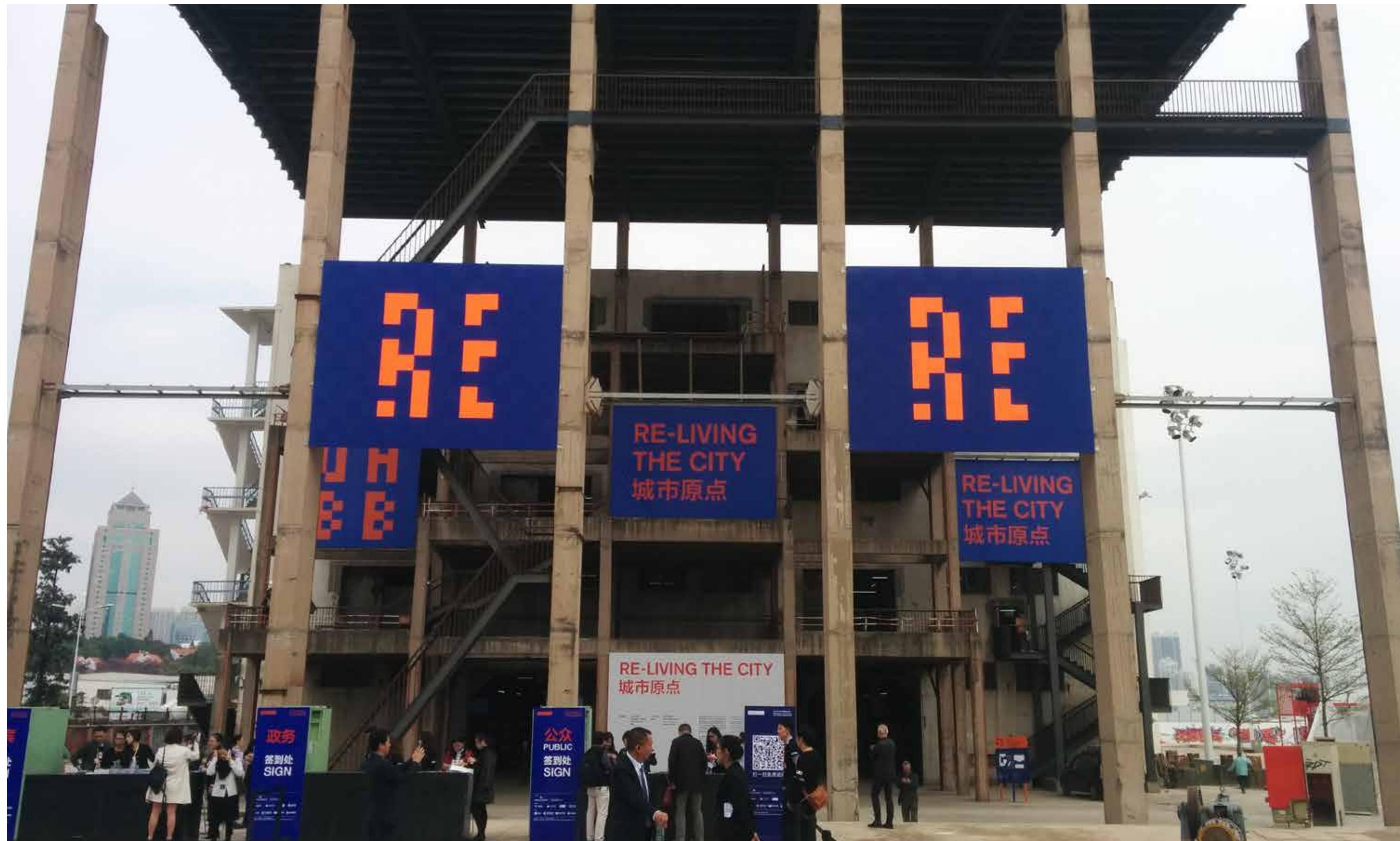


An interactive digital simulation of Resistor was created as a way to prototype the material, behaviour, and interaction systems.



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.





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.



