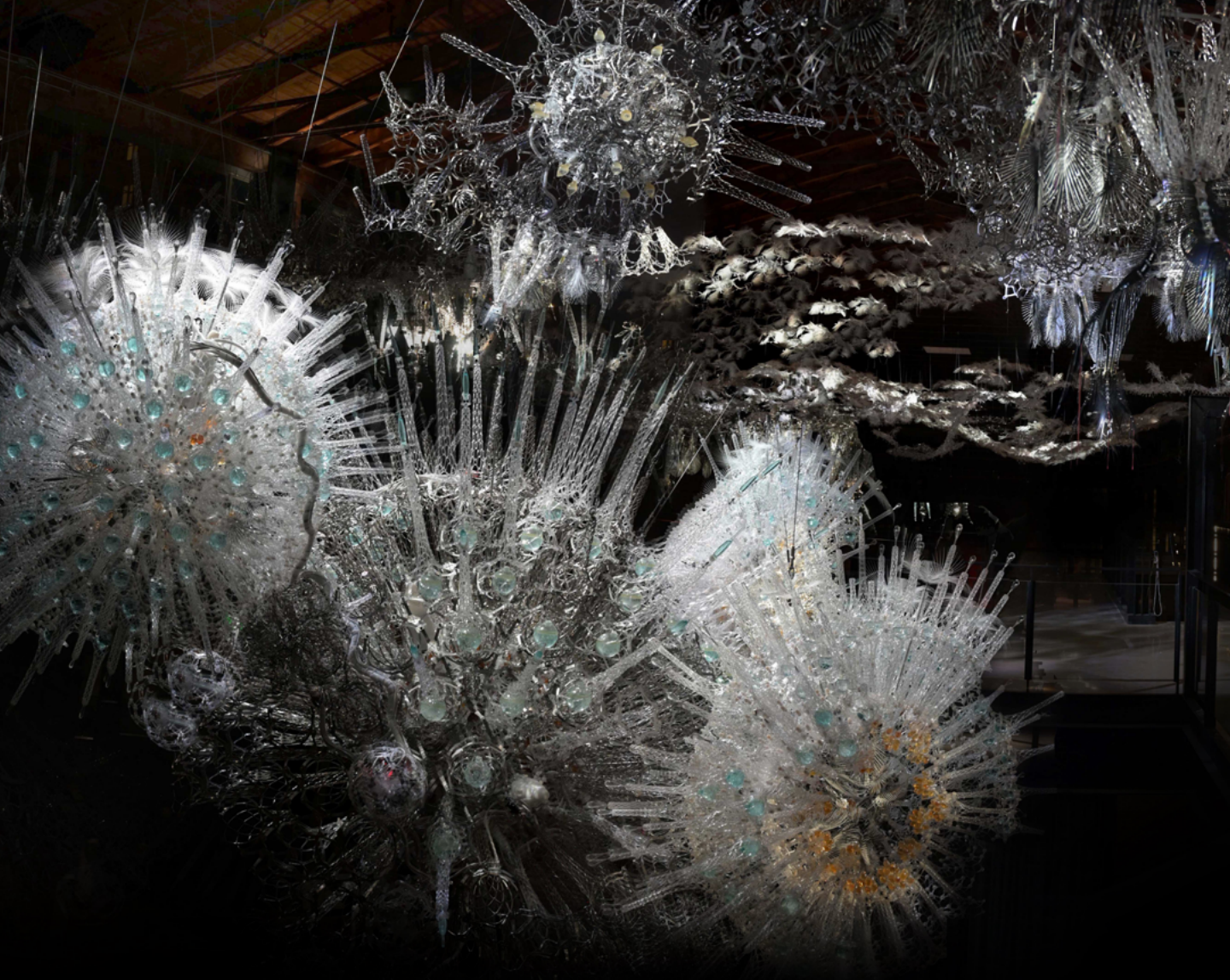
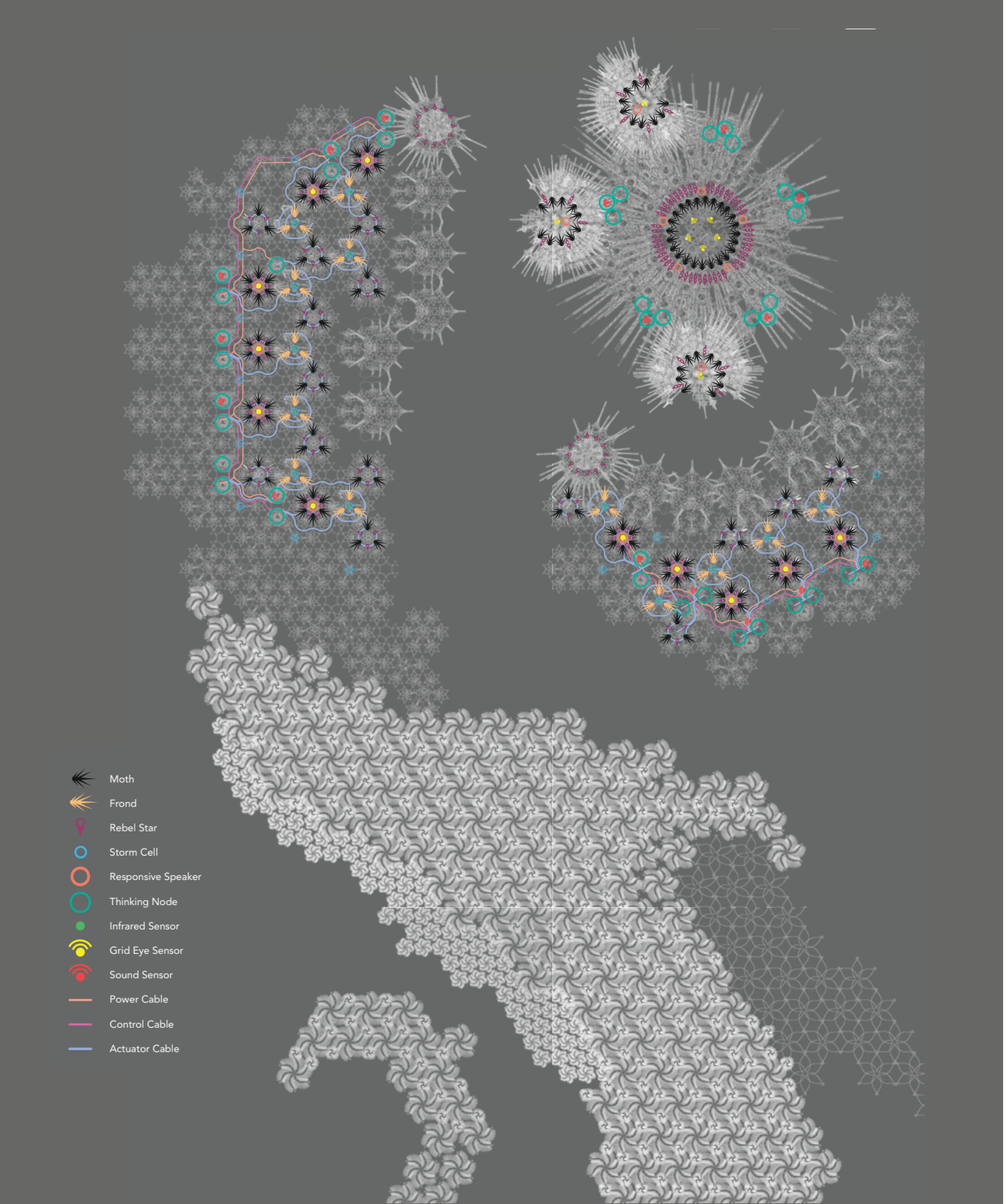


MEANDER

LIVING ARCHITECTURE SYSTEMS GROUP

R LASG UNIVERSITY OF WATERLOO HIP

Contents



Meander

Meander is an artificial ecosystem, gently flexing and responding to the movement of viewers. The innovations in Meander suggest ways of making adaptive, sensitive buildings of the future.

Meander was created by Canadian sculptor Philip Beesley working with a large group of researchers and creators within the Living Architecture Systems Group, hosted by the University of Waterloo.

Flexible custom geometric tiles make up the undulating surfaces of the sculpture. Live data from the environment feeds directly into the interactive sculpture network, stimulating swells of light, vibration and sound. Early studies for Meander included trips down the Grand River, studying its water flows and diverse wildlife. Like the scouring and depositing forces that create the Grand's oxbow shape, Meander's form is the result of accumulations of many small elements that work together in networks.

Panoramic view of central shell cluster and flanking canopies

Detailed view of central hemispherical shell cluster

Elevation view of central shell structures

Living Architecture

This sculpture is a ‘test bed’ that supports ongoing research about future architecture.

Meander’s lightweight meshwork scaffolds are interwoven with miniature computers, arrays of sensors and interlinked mechanisms. These systems can sense, react, and learn from viewers. The interactive control systems that have been used within Meander are being used for research about artificial intelligence and interactive behaviour.

The lightweight, flexible scaffolds that support Meander are being used for research about sustainable and adaptive construction. Responsive systems in the sculpture include liquid chemistry, lights, movement and sound. Glass cells contain crystal formations that react to changes in the environment. Future buildings could integrate these innovative responsive systems.

Learning from Nature

By studying patterns from nature we can think about buildings in new ways.

Meander takes inspiration from the Grand River, a complex ecosystem weaving its way through the centre of Cambridge, spanning geological time scale periods in its gradual formation. The Grand River tells stories of constant transformation. Like the scouring and depositing forces that created the Grand River's oxbow shape, many cycles combining and exchanging groups of layered components have created Meander. Live data feeds into the interactive environment, creating swells of light, movement and sound.

By interlinking many resilient parts, these robust structures can handle intense amounts of force. The structures demonstrate how future buildings could be designed for the increasing storms and turbulence of our changing climate.

Our insecure world often creates isolation

Classical design methods tend to encourage closed walls and boundaries

New buildings could reach out with responsive, open thresholds

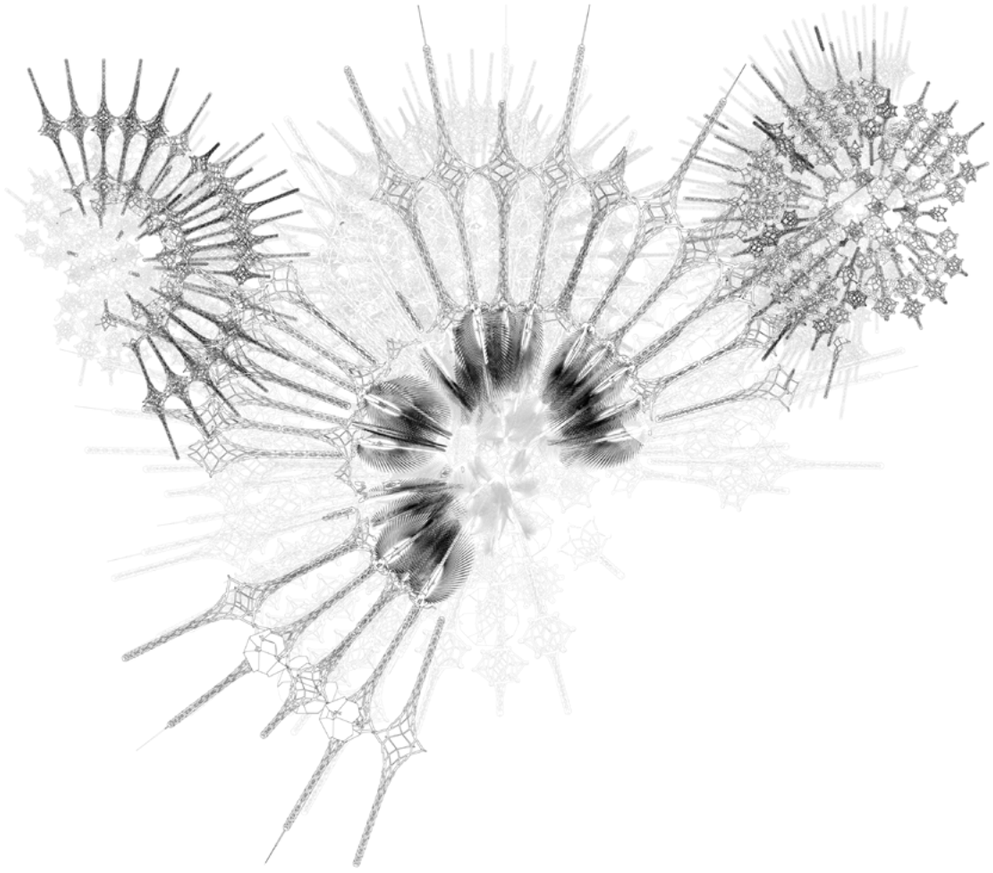
We could connect to wide environments

How Meander is Organized

Meander has three main parts: a central Geode Cluster, canopy Reefs that curve around the edges of the central foyer, and a billowing Cloud that extends out over high levels within the main Event Space of the building. Parts of the Reefs can be viewed up close from mezzanine levels.

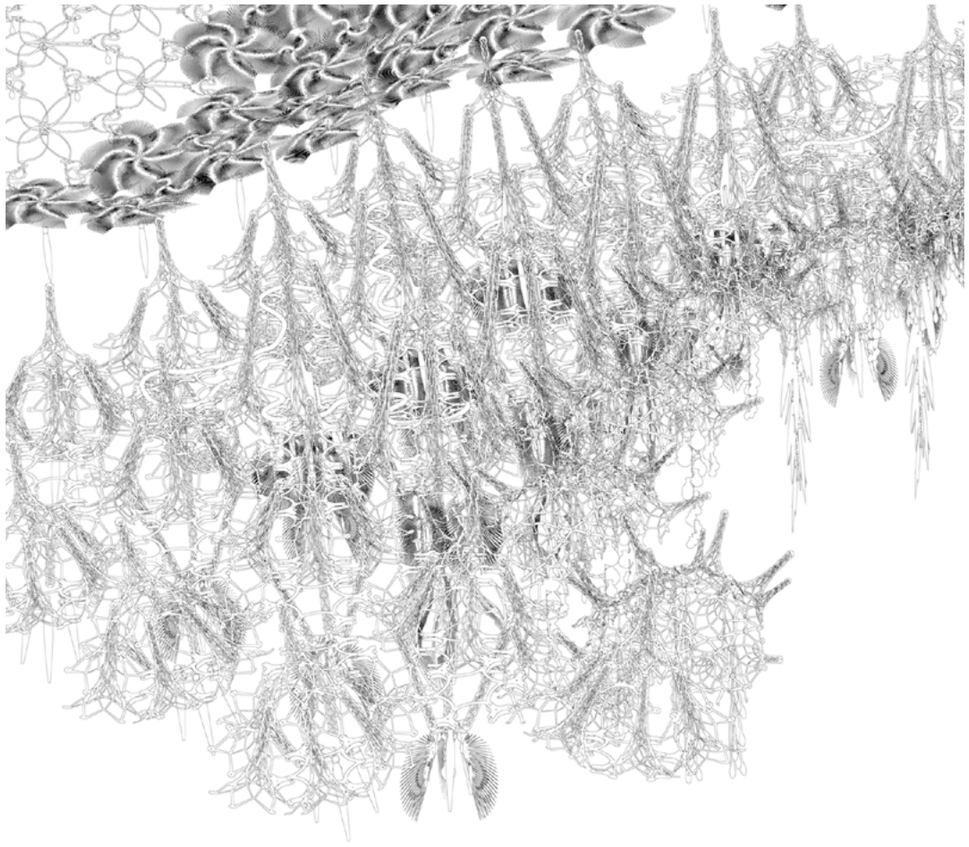
The organization of these parts is similar to a nervous network connected with muscles and voice within a living organism. Networks of sensors (the ‘eyes’) and devices (the vibrating-frond ‘muscles’, glowing lights and ‘voice’ sounds) linked to distributed microprocessor control systems give the Reefs and central Geode Cluster areas their behaviour.

Spherical Nest control clusters like miniature brains can be seen mounted along the lower edges of the central sphere and also along the surfaces of the Reef canopies. Gesture-sensing sensors that invite open-ended exploration are located along the edges of the mezzanine level.



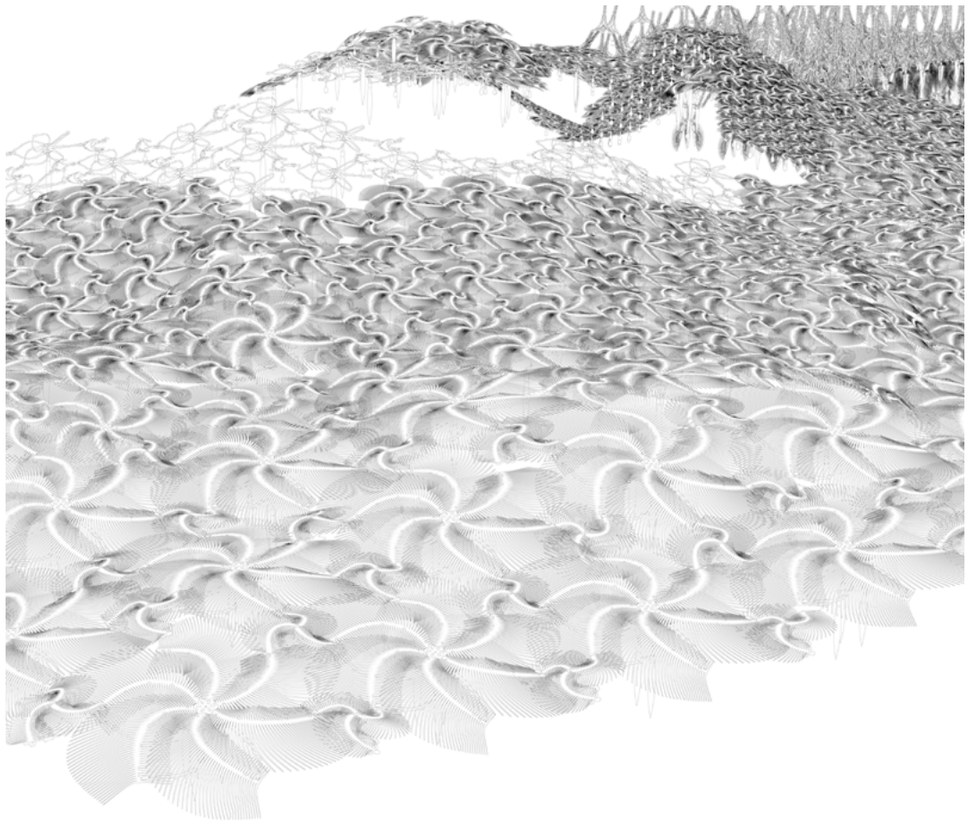
Geode Cluster

A cluster of curved shell forms making up the centre of the sculpture, constructed from lightweight expanded meshwork elements. The geode cluster’s weight is distributed over multiple suspension points. Within the cluster are illuminated glass vessels, vibrating motors with mylar fronds, and custom responsive speakers.



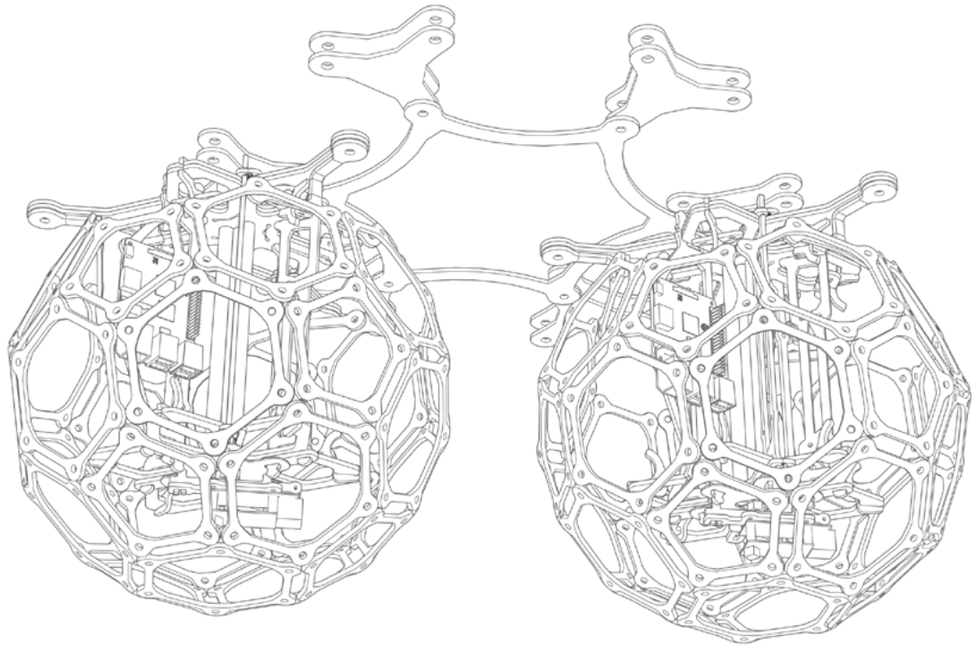
Reef Canopies

Two suspended lattices of interlinking skeletal forms are composed of metal and polymer structural components. Mylar fronds and fluid-containing glass vessels are embedded within this scaffold.



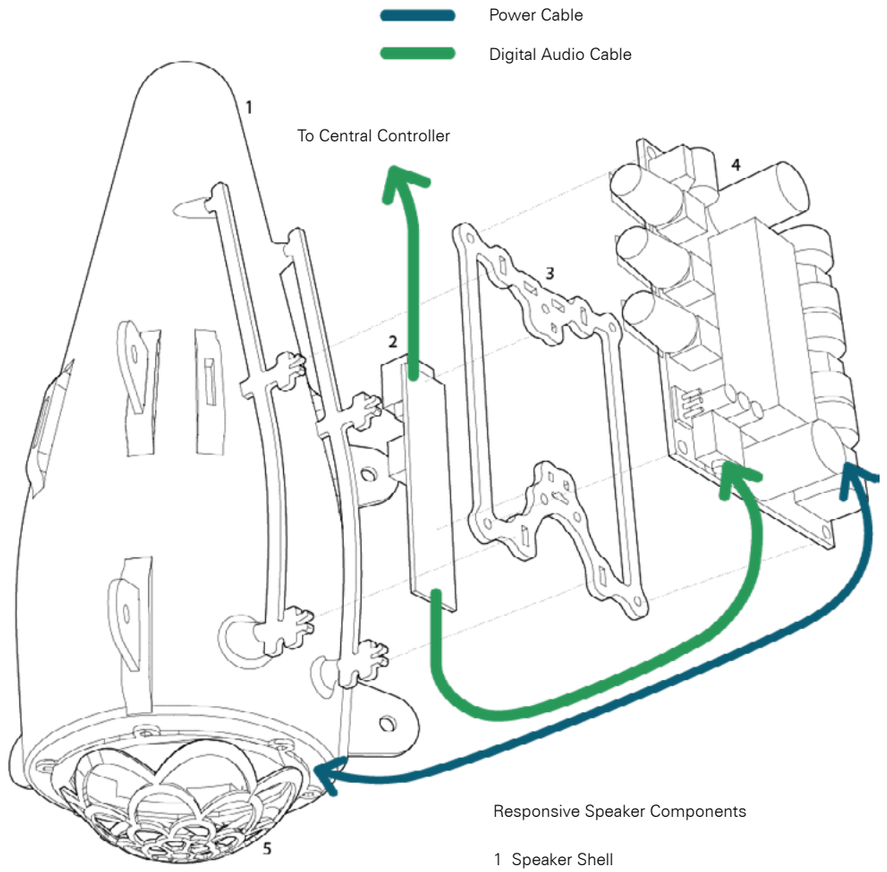
Cloud

The sculpture includes passive suspended membranes made up of interlinking, lace-like skeletal frames with Mylar frond and glass vessel dressing.



Thinking Node

Small computers are connected all through the sculpture. They work together, constantly passing signals back and forth.

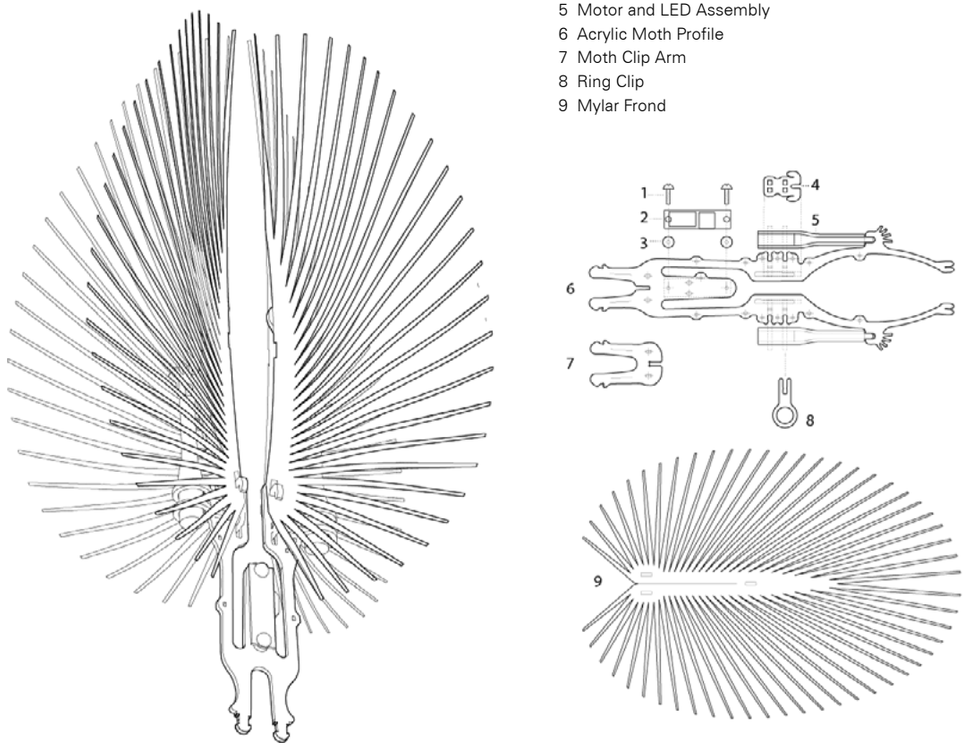


Responsive Speaker Components

1 Speaker Shell
2 Amplifier Circuit Board
3 Acrylic Electronics Sled
4 Digital Audio Board
5 Metal Speaker Grill

Responsive Speaker

Layers of individual sounds are stored within the sculpture's electronics. If you listen carefully you may be able to hear how sounds move all around you. Can you tell what happens when you move close to the sensor mounted on a speaker?

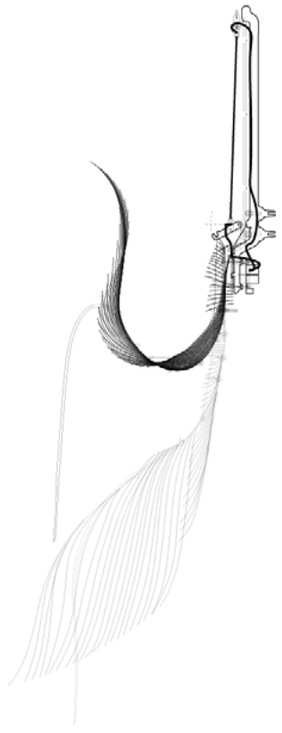


Moth Components

1 Screw
2 Electronic Board
3 Acrylic Washer
4 Ring Clip Fastener
5 Motor and LED Assembly
6 Acrylic Moth Profile
7 Moth Clip Arm
8 Ring Clip
9 Mylar Frond

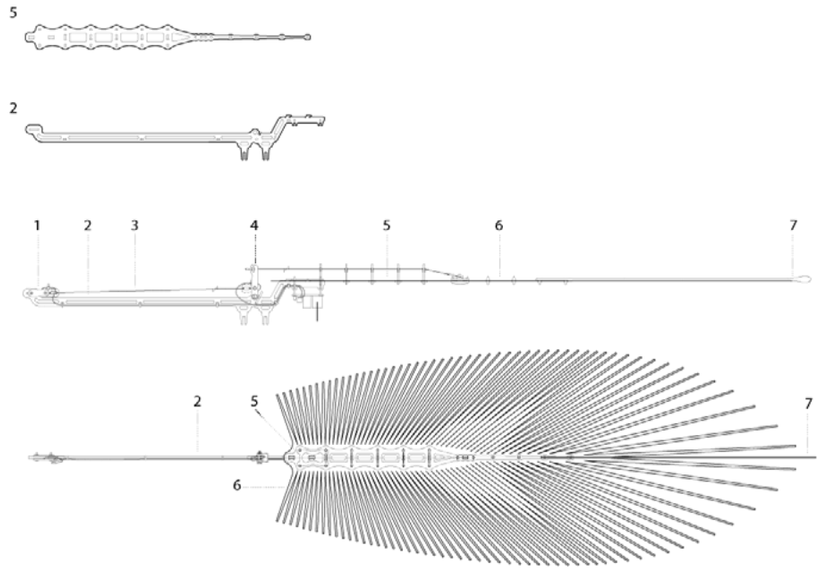
Moth Cluster

Tiny motors make these moths vibrate. Each moth is gentle but when large groups of moths vibrate together they can be very strong. Do you hear the rustling from vibrations passing you?



Kinetic Frond Components

1 Adjustable Clip
2 Metal Spine
3 Shape Memory Alloy (SMA) Wire
4 Acrylic Lever
5 Stainless Steel Tongue
6 Mylar Frond
7 Silicone Lash



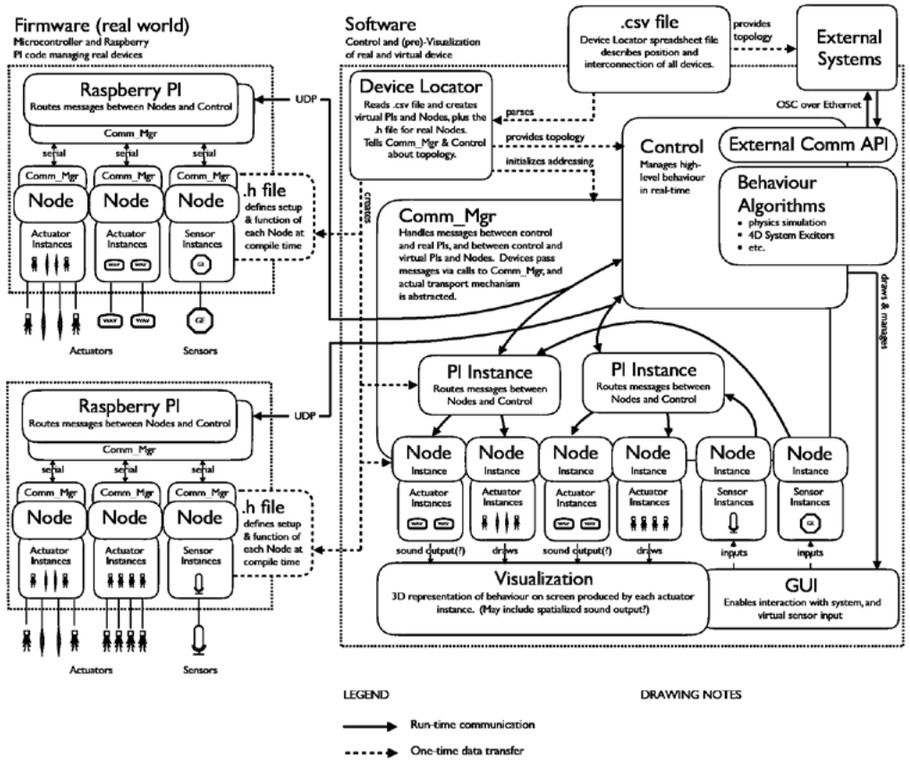
Frond

A special kind of wire called Shape Memory Alloy makes these fronds curl and wave. When an electrical current runs through the wire it shortens and pulls on the flexible tongue.

Meander's Behaviour

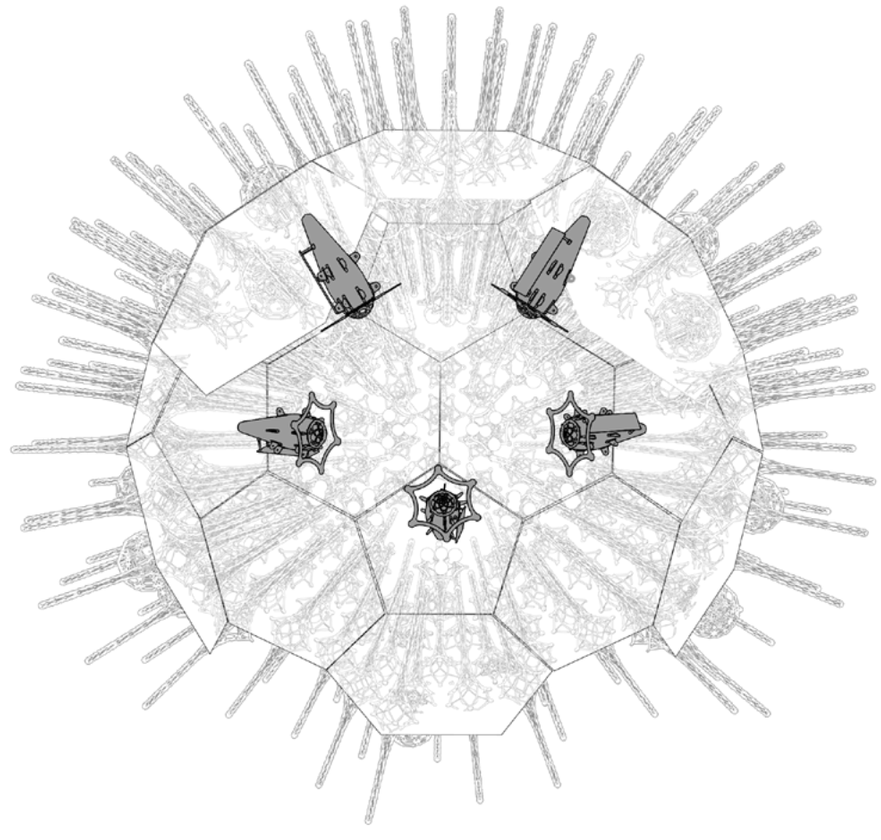
Software is organized in clusters of interconnected groups that can communicate with each other. Meander's sensors can detect closeness, movement, and sound.

Sensors are Meander's tools for observing visitors and the environment. Actuators are devices that generate light, movement, and sound allowing the sculpture to respond and display its own internal activity. A custom software system contains decision-making modules that control Meander's behaviour.



Immersive Sound

Meander incorporates layers of sculpted sound, created in collaboration with composer Salvador Breed and lead software developer Poul Holleman of 4DSOUND. The composition is played through arrays of custom speakers throughout the environment, making constantly-shifting sound that responds to visitors. The sound composition is inspired by the concept of complex forms of life emerging from inorganic material.

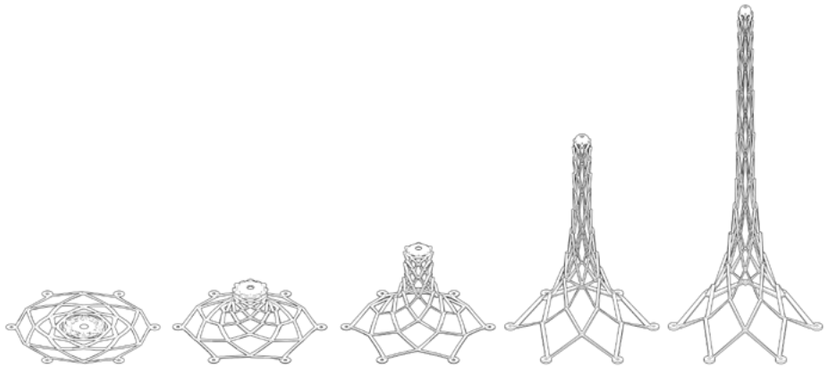


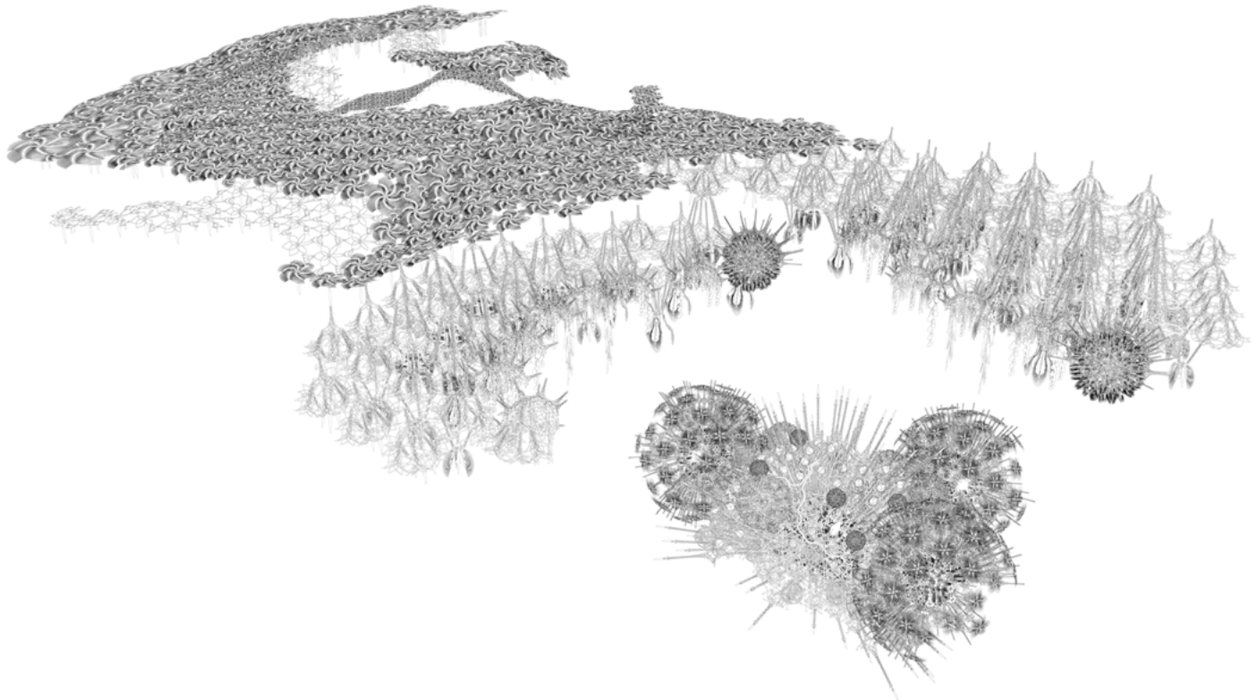
Making Meander

The sculpture is 100 feet long and 45 feet wide, and 30 feet high. Approximately 500 component patterns have been used to create over 400,000 parts. Meander weighs 500+ pounds, a fraction of the weight of traditional canopy and tent structures of this size. The forms that are used in these constructions reflect new research pursuing sustainable construction that uses a minimum of material. These forms acquire their strength by cutting, folding and stretching sheets into thin skeleton structures.

A small team of designers developed the original patterns creating this work. Many community members assisted them, organized in a series of workshops and assembly teams. Assembly took approximately 4,000 hours and lasted four months.

Materials include impact-resilient polymer sheets, filaments and resins, combined with custom-fabricated aluminium and stainless steel components, and custom-printed circuit boards. Moving parts use electronic ‘muscle wires’ that pull and stretch like natural muscle fibres. The open mesh grid-like construction is composed of thin sheets of materials.





The geometric structures seen in Meander use interlinking, flexible lattices that behave like natural plant forms. Overlapping strands of materials balance each other within doubly-curved conical stem-shaped forms. The skeletal forms create strong inner and outer shells much in the same way that bone structures are formed. Rather than static, closed boundaries, thresholds of new buildings could be deliberately fragile and delicate.

By interlinking many delicate parts, robust structures can handle intense amounts of force, accommodating the increasing storms and turbulence of our changing climate. Instead of the heavy masses of material used in traditional building, this kind of process uses extremely light, thin sheets of material, reducing material use and saving energy.

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