AMATRIA

FEMALE SENTIENT ARCHITECTURE

SCHOOL OF
INFORMATICS, COMPUTING, AND ENGINEERING

CNS Cyberinfrastructure for Network Science Center
cns.iu.edu

"Amatria embodies the innovative spirit that drives the School of Informatics, Computing, and Engineering. It's not just a gorgeous piece of artwork. It also showcases the collaborative vision of SICE. As a sentient piece of architecture, it will learn from visitors as we learn how it interacts with those same visitors, and it mirrors the way students and faculty come together to create a thriving environment for discovery."

Raj Acharya,

Dean of the School of Informatics, Computing, and Engineering

"IU Bloomington is a leader in arts and humanities education, and the IU School of Informatics, Computing and Engineering is inventing, implementing and optimizing the next generation of intelligent systems, such as smart cars, health devices and brain interfaces. We hope the magnificent architecture of Luddy Hall, in combination with 'Amatria,' will inspire arts and humanities scholars from campus and beyond to visit our school, and fully engage with its faculty, staff and students."

Katy Börner,

Victor H. Yngve Distinguished Professor of Engineering and Information Science

News at IU Bloomington, April 17, 2018

"Amatria has exceeded our expectations as the embodiment of humanity's highest aesthetic ideal – Art. It imaginatively bridges the possibilities of science and technology in their most innovative forms. The fact that it is also interactive, will evolve through AI, and creates a living, learning laboratory for continuous innovation is its great promise. We are proud to have been part of bringing it to Indiana University."

Jane Martin,

Retired Venture Capitalist

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Amatria is ...

A luminous, forest-inspired landscape of soaring clouds and tangled thickets of 3D-printed formations alive with artificial intelligence that invites visitors into an interactive, ethereal space. 'She' is a delicate canopy of mesh- and frond-like organic structures suspended from the ceiling in Indiana University's Luddy Hall atrium, she reacts to her environment using light and motion sensors, responding with atmospheric sounds, undulating movements, and changing colors. Amatria is a 'living sculpture'. She is aware of the people who enter her sphere to gaze upon her visual story of abiogenesis: the emergence of life during the earliest stages of development of the universe.

Amatria senses her surroundings through 18 infrared sensors (arranged in triples on six 'sensor scouts' and several microphones). Through these she is able to track visitors. In response to visitor movement and sound she emits light from dozens of high-voltage lamps, plays sounds from several speakers, and vibrates through the use of dozens of small dedicated motors. Amatria currently has a total of 18 custom sound tracks that she can play.

Training the next generation of cutting-edge engineers ...

Amatria converts the 4th floor of Luddy Hall into an Internet of Things (IoT). Students will be able to access, process, and visualize data by Amatria and there are plans to add additional light, motion, and sound sensors as well as loudspeakers and motor actuators from other wireless-enabled devices. By working on these projects, students will gain hands-on experience writing code that utilizes data from wireless-enabled devices—a highly applicable skill in today's Internet-connected world.

Amatria is a physical manifestation of ISE's mission to create the next generation of "renaissance engineers," fluent in art, science and technology.

More information …

To learn more about Amatria and upcoming tours and workshops, please visit us at **http://amatria.cns.iu.edu**.

Take courses that analyze and visualize Amatria's rich data streams:

- ENGR-E484/E584 | Scientific Visualization (Fall 2018)
- ENGR-E484/583/Z637 | Information Visualization, **http://ivmooc.cns.iu.edu** (Spring 2019)

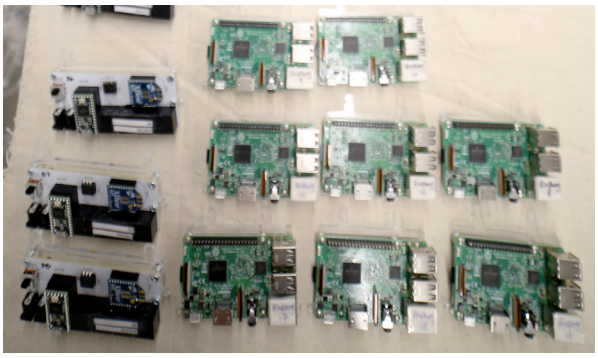
Or email Amatria at **amatria@indiana.edu**.

Amatria is made of …

Amartria has polymer and metal scaffold structures through which run electronic low-voltage light emitting diodes (LEDs) and miniature kinetic mechanisms that breathe life into her. She has a variety of glass bulbs with colored liquids that add splashes of color. Some bulbs contain vinegar and function as low level batteries to power the emulated birthing process, growing weaker over time. Her movements are accentuated by the subtle accompaniment of 18 evolutionary soundtracks.

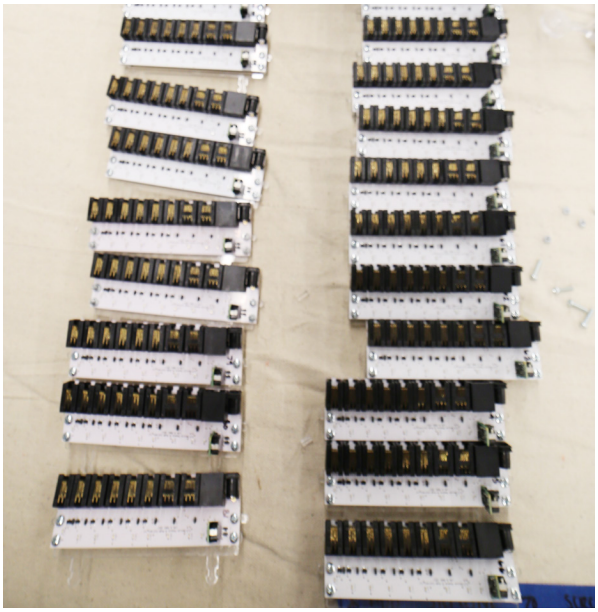
Amatria's key body parts (detailed on pages 6-13):

- 3 laptops
- 13 Raspberry Pi's
- 36 Teensy Microcontroller Node Controllers
- 6 Teensy Microcontroller Sound Modules
- 77 custom Device Module boards
- 10 audio amplifiers
- 6 pitch reading microphones
- 6 proprioceptive microphones
- 15 current sensors
- 144 DC vibration motors
- 162 high-current LEDs.



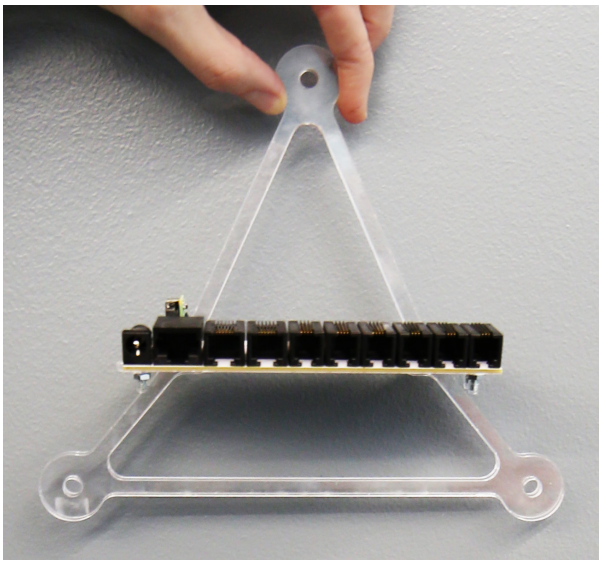
Raspberry Pi and Node Controllers

Control the behavior of sculpture.



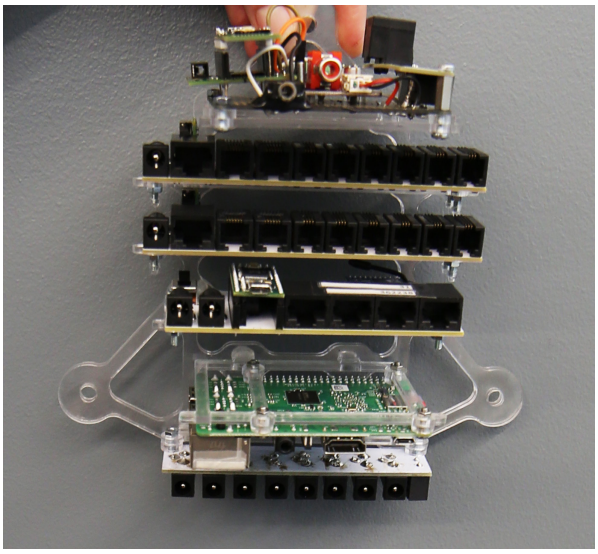
Device Modules

These components are the hardware that directly interacts with and controls the sensors and actuated components.



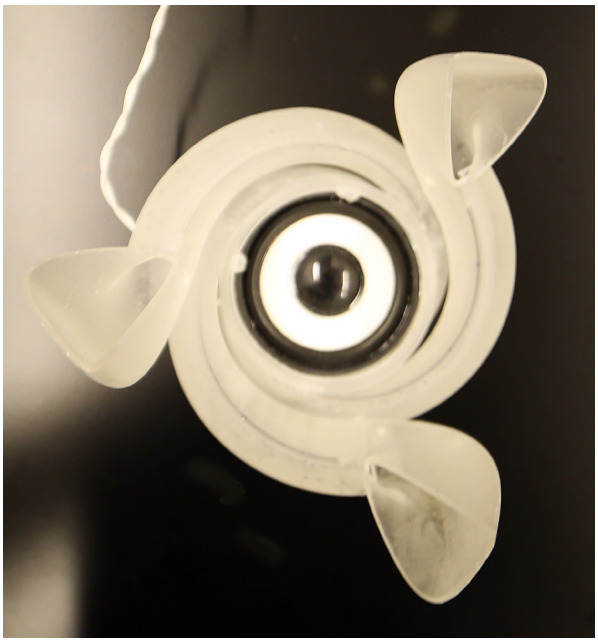
Device Mount

High Current Device Mount on a single device mount and matching tray.



Devices in Tray

All of the devices in the sculpture are designed to mount to desktop kit sleds, a standardized part. These sleds are then fit into device trays, which are custom made to fit various areas of the sculpture.

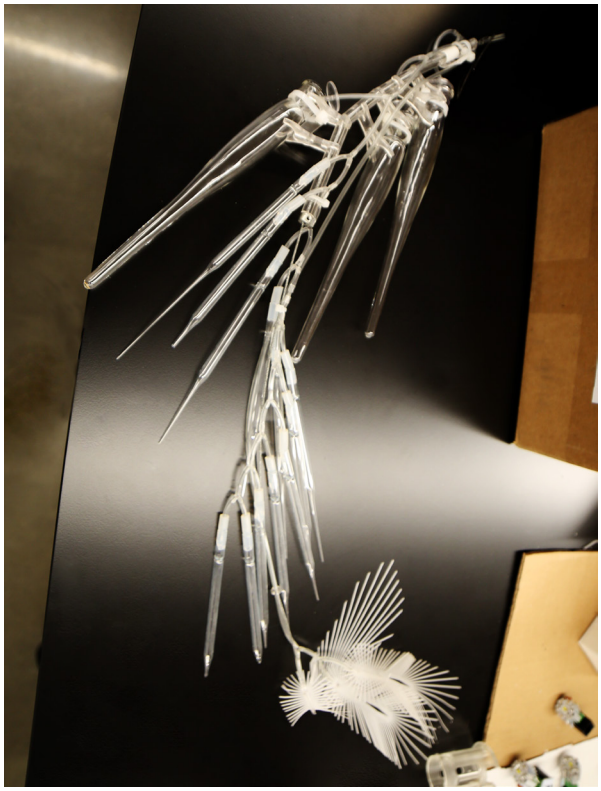


Bass Extended Speaker

The horns on the speaker units are designed to boost the bass frequency response of the unit. These are located in Sensor Scouts and the spheres.

Organic Battery Cell

These cells are located around the Sensor Scouts. They are used to trigger various behaviour.



Glass Chain

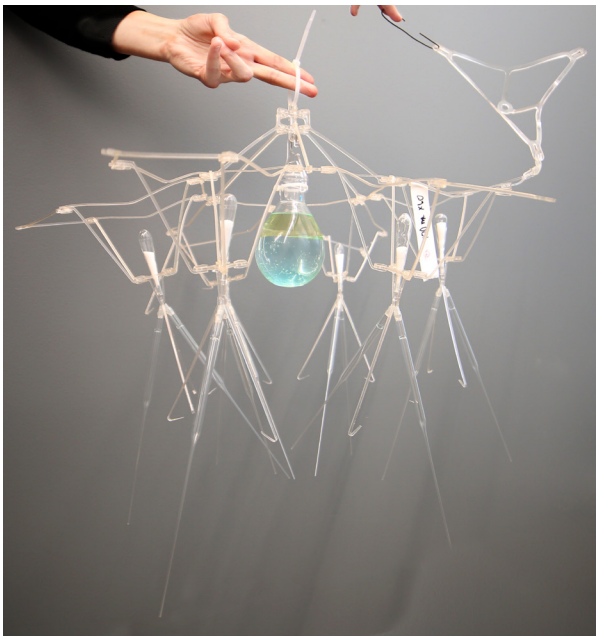
This particular glass chain supports mainly tapered glass, and it gradually tapers down to pipets and is finished with a small frond.

Empty Glass Chains

Additional dressing and density for the Grotto section of the sculpture. These will receive glass elements filled with various liquids.

Spar

Spars are the thermoformed components that make up the main scaffold of the sculpture. They are made of laser cut acrylic plastic and pulled into shape after being heated. They form the spar field and are also placed in arrays to make up the sphere units. Made of thermoformed acrylic.



Meagre Ghost

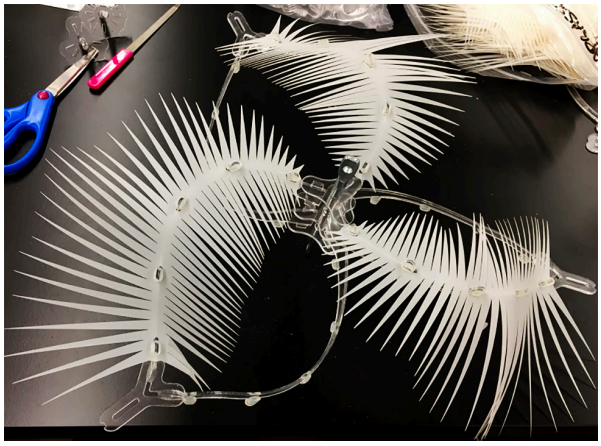
The Meagre Ghosts are located on the outer perimeter of the spar field. They are dressed with pipettes, and they carry a liquid vessel and several small salt vessels.

Large Sargasso

Large Sargassos are the outer components of the spar field. They have dense fronds and receive a pear glass vessel underneath.

They are comprised of:

- 1 threaded rod
- 2 female end pieces
- 12 long copolyester arms
- 60 rubber stoppers
- 6 double-frosted mylar frawns
- 6 acrylic ends
- 2 acrylic 6-holed flower ends
- 1 acrylic
- 12-holed center piece



Sargasso Spider

The smaller Sargasso Spiders serve to connect the larger Sargasso in the outer portion of the spar field.

They are comprised of:

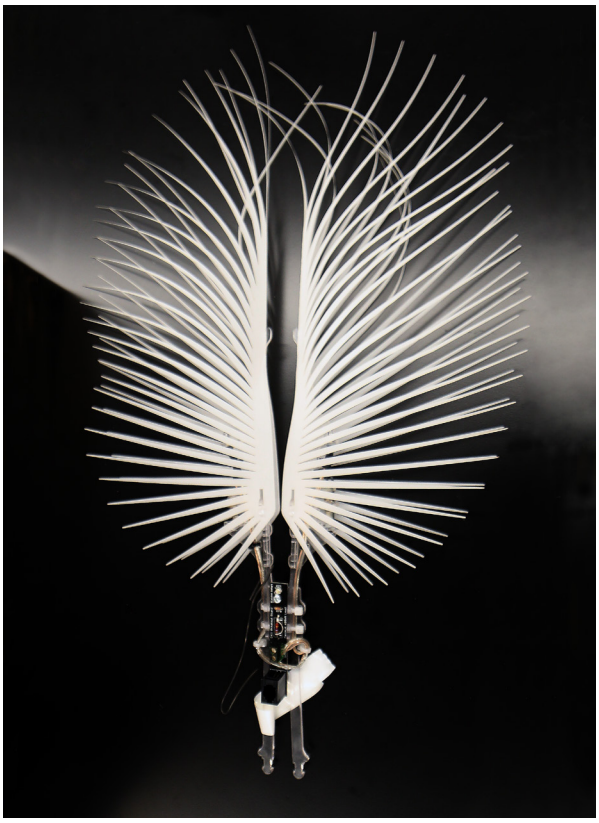
- 1 threaded rod
- 6 copolyester small arms
- 3 double-frosted mylar frawns
- 3 acrylic ends
- 30 rubber stoppers
- 2 female end pieces
- 2 acrylic 3-holed pyramid ends
- 1 acrylic 6-holed cloverleaf center piece

Tear Weed

Additional version of a tear weed with feathered frond on the end.

Round Tear Weed

These are another dressing that is located in the grotto. They consist of tygon and silicone tubing, and support tear glass vessels.

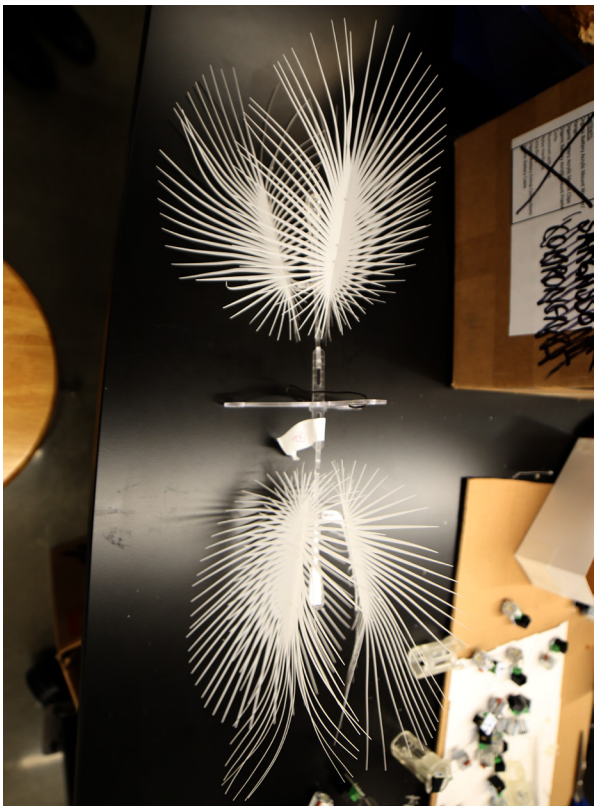


Moth

Moths are one of the main actuators in the sculpture. They have two vibrating motors and two LEDs to interact with people.

They are comprised of:

- 1 node controller
- 1 acrylic sled for node controller
- 2 acrylic arms
- 2 double-frosted mylar frawns
- 2 LEDs
- 2 motors



Double Frond

The double fronds fill out the centre of the spar field, creating the spar river. They are positioned between the sensor scout layer and the double rebel star layer. They carry a salt vessel on top and an oil vessel underneath.

Amatria Unveiled: Visualizing her inner life

Katy Börner, Andreas Bueckle, CNS, SICE, Indiana University Bloomington

Amatria Unveiled is a data visualization project aiming to enhance visitors' understanding of Amatria. It is part of ongoing research into data visualization using 3D environments with immersive technologies, specifically augmented and virtual reality. In its current stage, it is a software prototype that locates the sensors and actuators that make up the sculpture and visualizes sensor values from 2 infrared sensors in real-time. In the future, it might also give visitors a way to see big-picture data flow patterns within the sculpture, and even to playfully interact with Amatria. *Amatria Unveiled* is an evolution of a similar app created for Beesley's *Sentient Veil* sculpture displayed at the Isabella Stewart Gardner Museum in Boston, MA, in 2017.

FEATURES

Currently, the app offers two views, called "stories". Story 1 ("What can I sense and do?") is a rotatable, zoomable 3D model of Amatria that shows where infrared sensors, microphone sensors, speakers, vibration motors, and lights are located on the sculpture (see Fig. 1). This gives the user an idea of the structure of Amatria, and outlines its hardware backbone. Users can also choose preset camera angles as well as reset the camera position. Story 2 (Make me feel!") provides a high-detail 3D model of a sound sensor scout (SSS), a node consisting of several electronic elements: three(3) infrared sensors, one(1) microphone sensor, six(6) lights, several Moths (vibration motors), and a speaker. The current level of two(2) infrared sensors in SSS1 (which is located to the right of the staircase when facing down) is visualized using a particle stream (see Fig. 2).

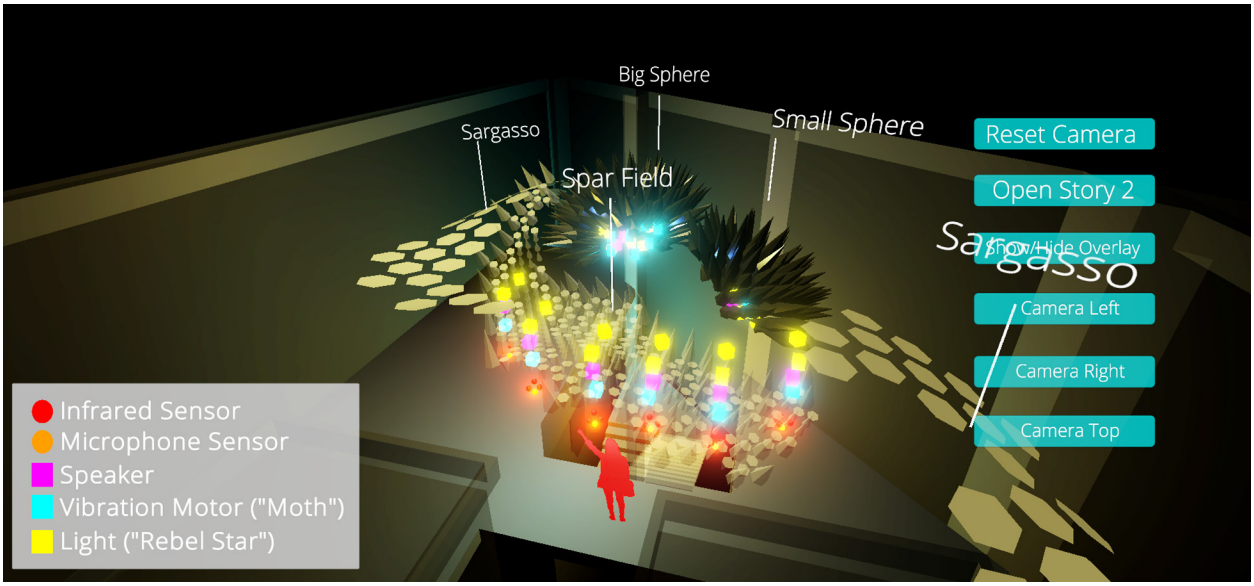


Fig. 1: Story 1 ("What can I sense and do?"), explores the structure of Amatria.

The sensor value is visualized with 4 variables. The higher the value:

- The redder the particles
- The higher their speed
- The higher their spawn rate per second
- The wider the cone in which they spawn.

This allows users to see the effects of their own actions visualized and gives them an idea of how their behavior affects Amatria. It is also a way of emotionalizing data to a certain extent.

BEHIND THE SCENES

Amatria Unveiled uses the Unity game engine for graphics and animation, such as particle effects. The choice to use simple graphics to represent the various elements of the sculpture maintains application responsiveness. Tracking all input in a fully detailed model would be too much data for any tablet, or even most desktop computers. Amatria is as complex as she is unique, and the same is true for the 3D model originally developed by Philip Beesley's team. This is why the model of the full sculpture used in Story 1 has such a low count of polygons while the SSS model in Story 2 is highly detailed.

FUTURE PLANS

Like Amatria, the *Amatria Unveiled* app will grow and change over time. Two future enhancements are:

1. Allowing users to tap certain points in the 3D model, and to see an actuation wave traveling through the 3D model, and
2. Giving the designers refined tools to debug their creation.

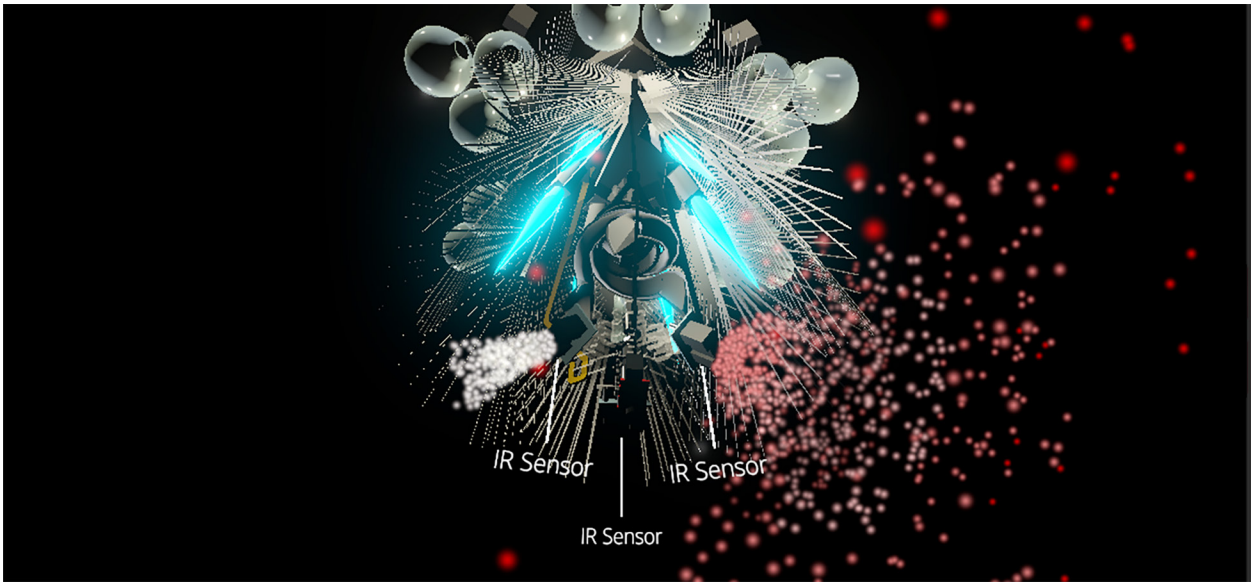


Fig. 2: Story 2 ("Make me feel!"), presents real-time data visualization of infrared sensor values.

Who gave life to Amatria?

Amatria is a testament to the constructive power of people uniting to collaborate on a shared vision to produce something beautiful, possessed of deep meaning and purpose.

DESIGN
Architect and artist Philip Beesley, in concert with the Living Architecture Systems Group/Philip Beesley Architect, Toronto, Canada (www.philipbeesley.com | www.lasg.ca).

SOFTWARE
Robert Gorbet, PhD, Associate Professor & Chair, University of Waterloo, Canada and Adam Francey, Toronto, CA.

SOUND
Salvador Breed, Co-founder and Creative Developer of 4DSOUND (www.4dsound.net) and Poul Hollemen, Amsterdam, The Netherlands.

"AMATRIA UNVEILED" DATA VISUALIZATION
Andreas Bueckle, Lead Developer and Katy Börner, Faculty Supervisor from the School of Informatics, Computing, and Engineering, Indiana University - Bloomington. Victoria Fard and Timothy Boll, 3D Model, Rob Gorbet and Adam Francey, Data Pipeline from LASG.

VOLUNTEERS
Over 200 volunteers helped bring Amatria to life, coming from Indiana University, the city of Bloomington, and beyond.

LEAD GIFT
The installation was generously funded by a lead gift from Pat and Jane Martin of Bloomington, IN.

Jane Martin speaking at Amtria's unveiling.

Volunteers assemble components of Amatria.

AMATRIA

4TH FLOOR LUDDY HALL
INDIANA UNIVERISTY - BLOOMINGTON

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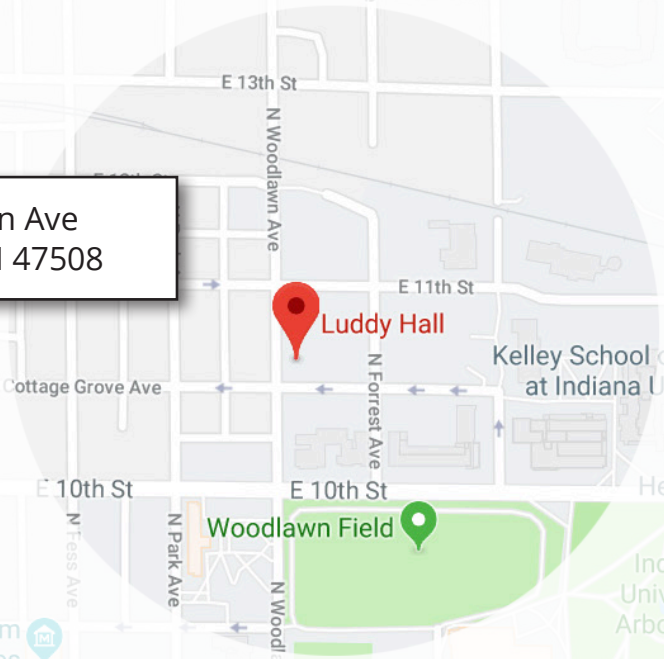

IMAGE CREDITS: Cover Ann Schertz; page 4 Steven Cox; page 5 Tracey Theriault; pages 6 - 13 Andreas Bueckle; page 16 Ann Schertz, picture of Jane Martin, and Andreas Bueckle, picture of volunteers; back cover Tracey Theriault. Map by Google Maps.


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