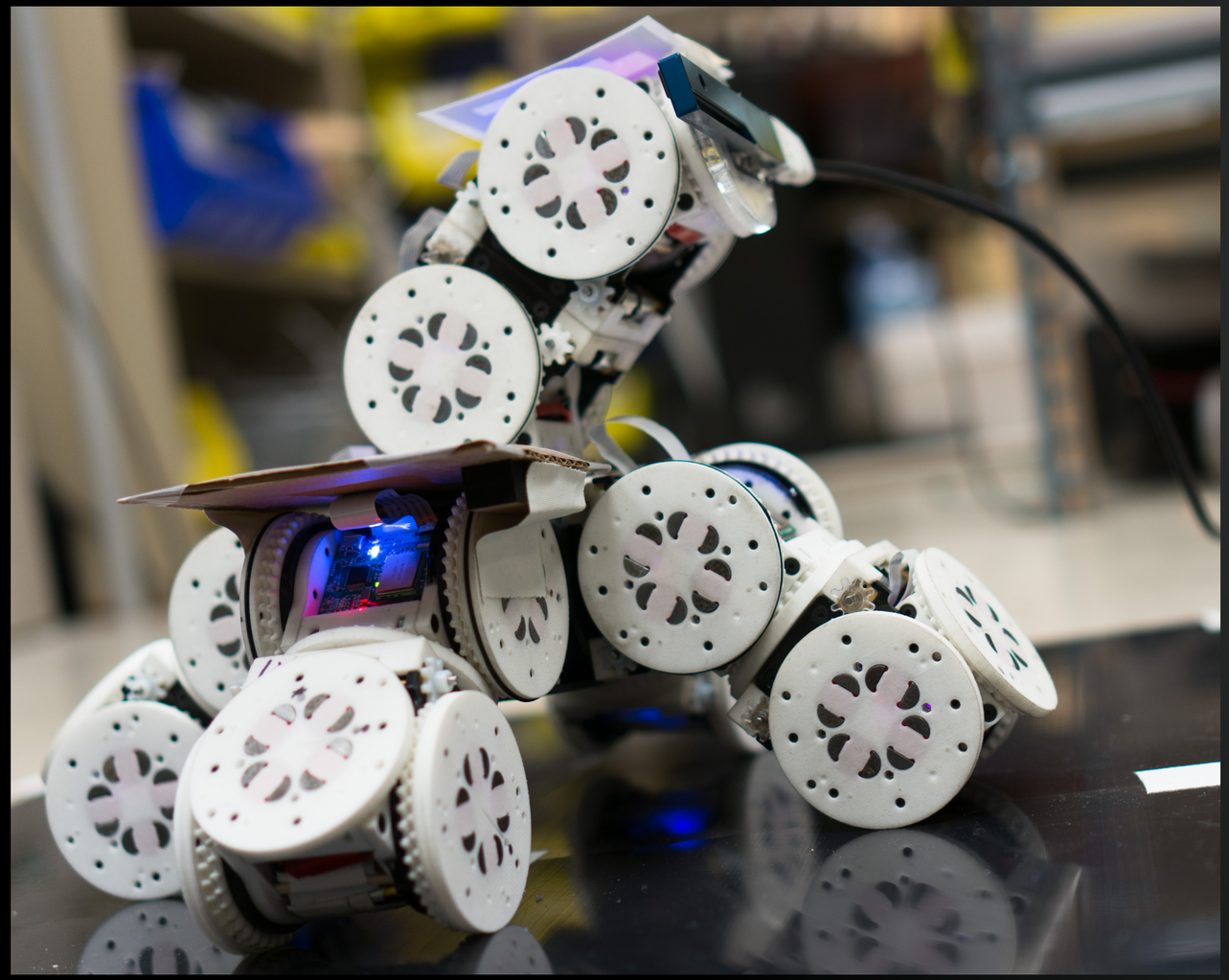
Tarik Tosun

Design Portfolio

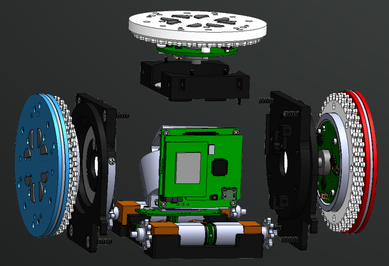


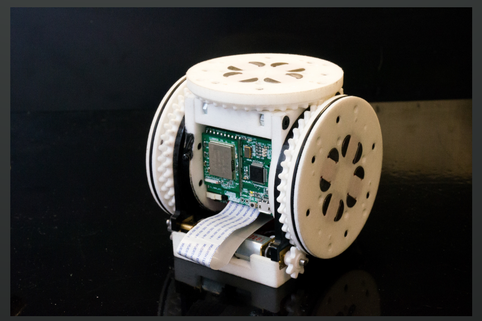
SMORES-EP

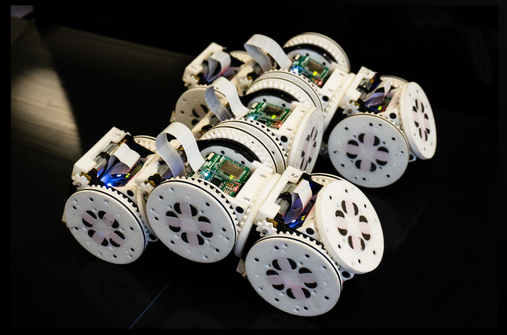
The SMORES-EP modular robot is the core hardware platform of my research. Each module has four actuated joints, its own battery, microcontroller, and radio, and can drive like a car, allowing them to operate independently or as part of a cluster. The full system consists of 25 identical modules that can be assembled into many different configurations, and self-reconfigure between different morphologies to meet the needs of a task.

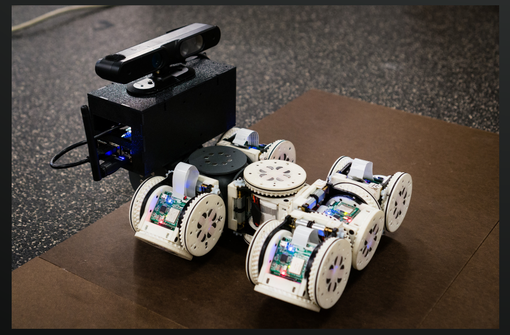
Videos: https://youtu.be/0rtXv4Z1E-o and https://youtu.be/eJsnG9DZjgM

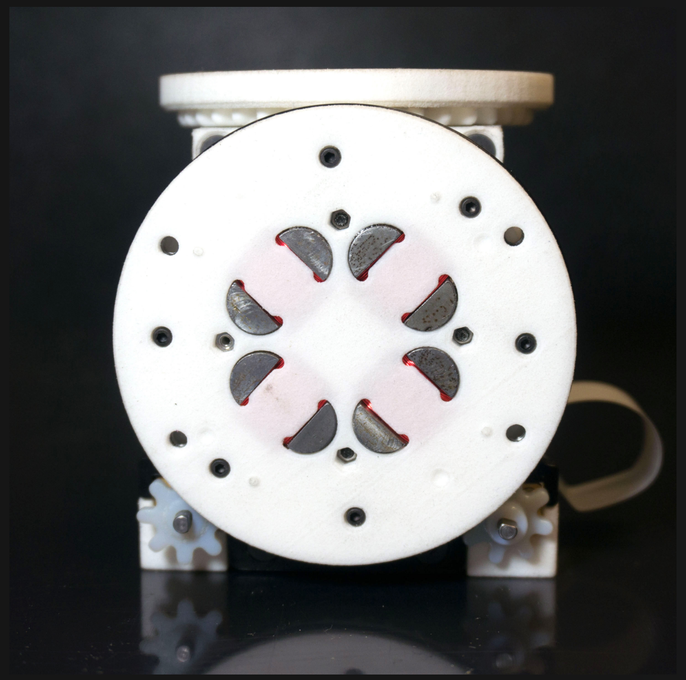
Design Lead: Tarik Tosun
Mechanical, Electrical, and Software Team Leaders:
Jay Davey, Chao Liu, and Gabrielle Merritt

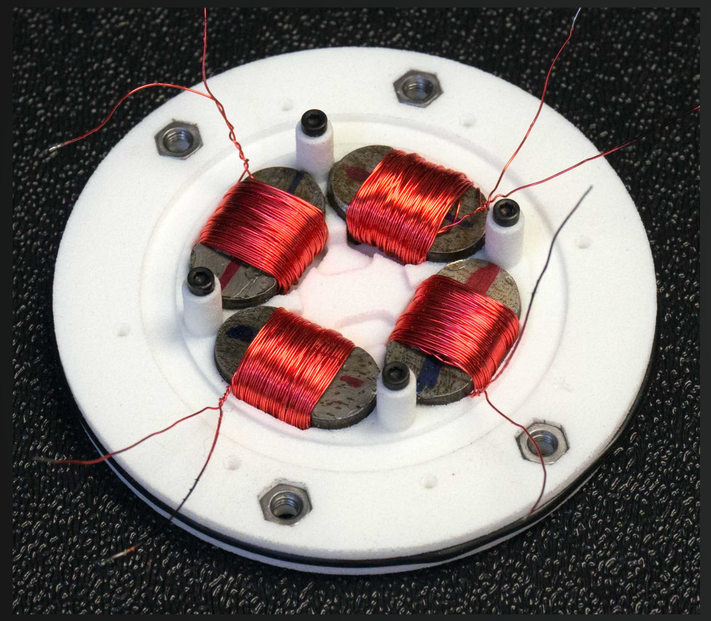


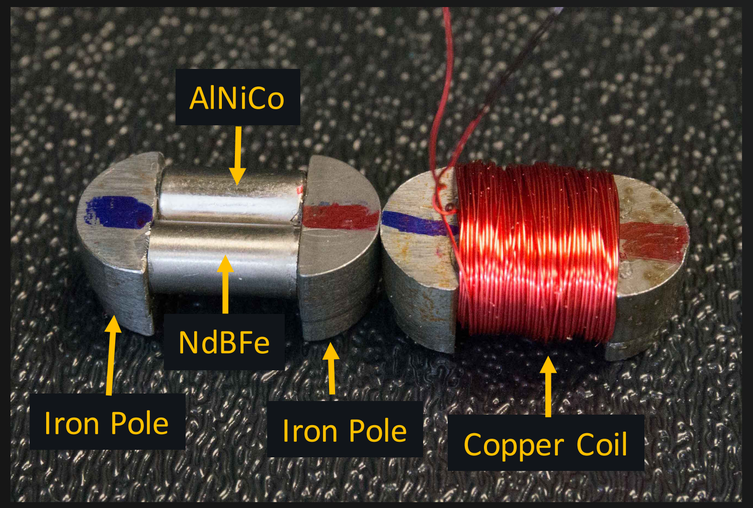












The EP-Face

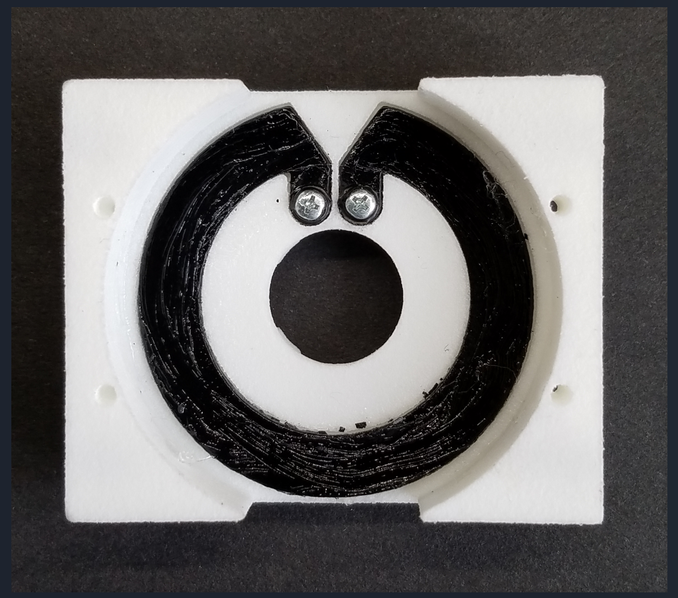
The EP-Face connector consists of an array of electro-permanent magnets (EP magnets) embedded in a planar face. EP magnets are solid-state magnetic devices that can be turned on (attractive) and off (no force) and require power only when changing state.

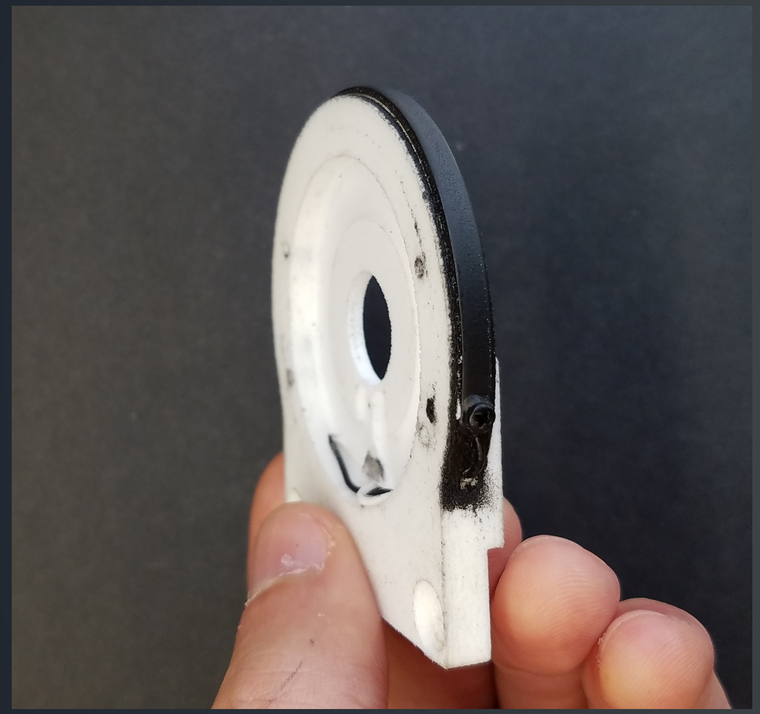
Each SMORES-EP modules is equipped with four EP-Faces. Any face of one module can connect to any face of another, allowing a cluster of modules to reconfigure.

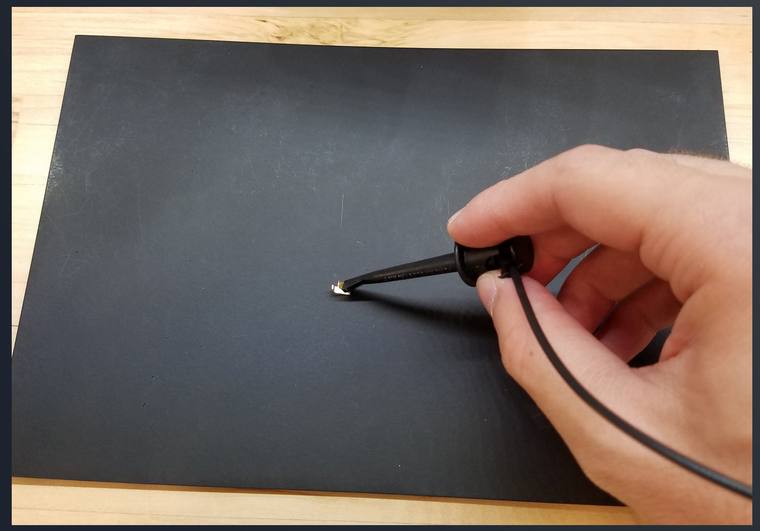
To build the SMORES-EP robot system, over 100 EP-Faces (and over 400 EP magnets) were designed and manufactured in-house at UPenn.

Video: https://www.youtube.com/watch?v=6IAfVOLRHLo

Design Leads: Tarik Tosun and Jay Davey
Electronics Team Lead: Chao Liu







PaintPots

The PaintPot manufacturing process creates low-cost, low-profile, highly customizable potentiometers for position sensing in robotic applications. It uses widely accessible materials, requires no special expertise, and creates custom potentiometers in a variety of shapes and sizes, including curved surfaces. PaintPots offer accuracy and precision performance comparable with commercial (non-customizable) options through a calibration process that trades small computation for cost.

Three Wheel PaintPots (top left) and one Tilt PaintPot (top right) are used for position encoding in each SMORES-EP module.

The ability to create arbitrary resistive surfaces also opens up the possibility of tracking position in 2D on the surface of a sphere (bottom left) or a plane (bottom right).

Video: https://www.youtube.com/watch?v=3Kg5WvFV02M

Design Lead: Tarik Tosun
Team Members: Daniel Edgar, Chao Liu, Thulani Tsabedze

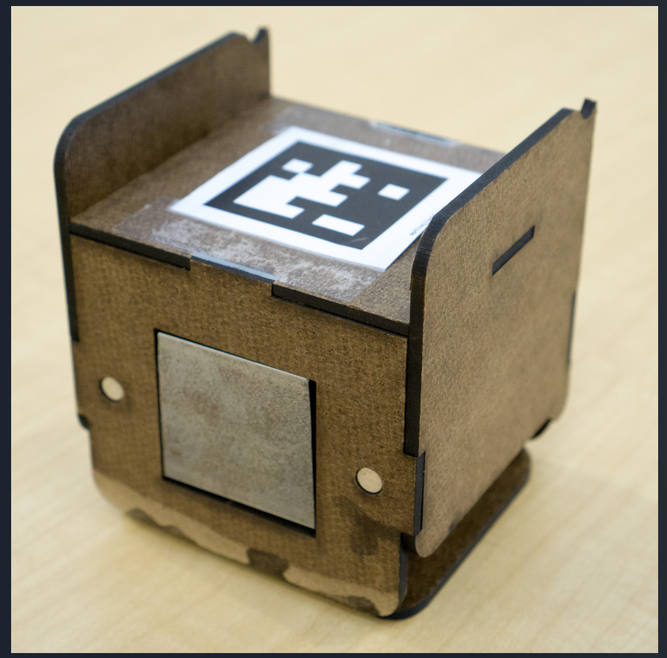
Sensor Module

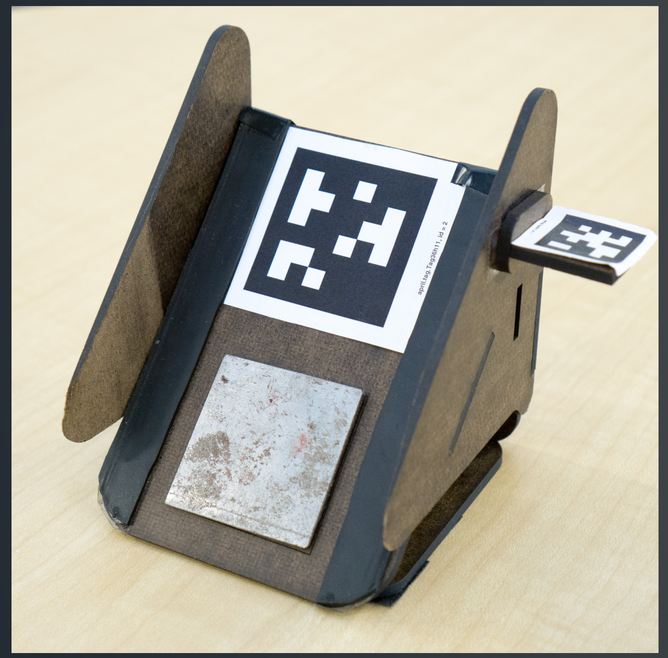
The Sensor Module provides sensing and computation capabilities that enable a cluster of SMORES-EP modules to operate autonomously. The body contains a battery, computer, and WiFi module. Steel plates on the front and back of the body allow SMORES-EP modules to connect magnetically.

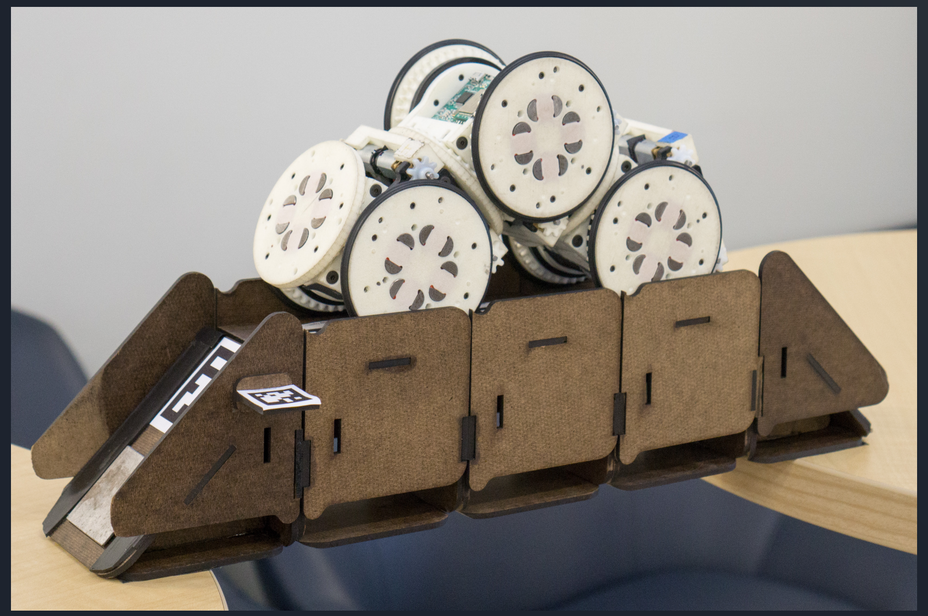
Two cameras are mounted to the stem, which extends 40 centimeters above the body. The larger Orbecc Astra Mini RGB-D camera is the primary sensor, providing a view of the world in front of the cluster. Using color and depth data from this sensor, the onboard computer can to map the environment and identify objects.

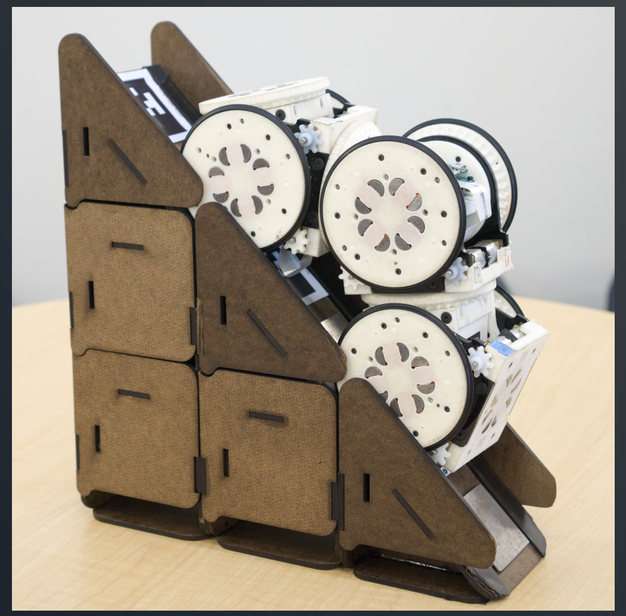
A smaller camera is mounted at the top of the stem, and faces downward to view a 1m x 0.75m region on the ground. Within this region, the sensor module can track the position of SMORES-EP modules equipped with visual markers, allowing them to disconnect from the cluster and drive freely during reconfiguration.

Downward-facing camera tracks reconfiguring modules







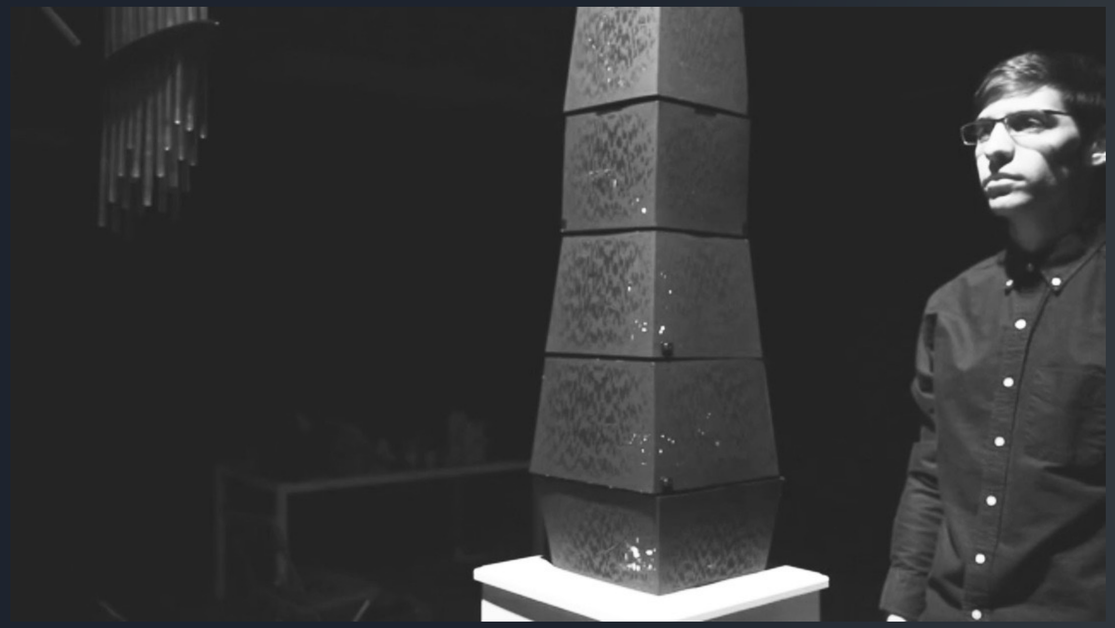


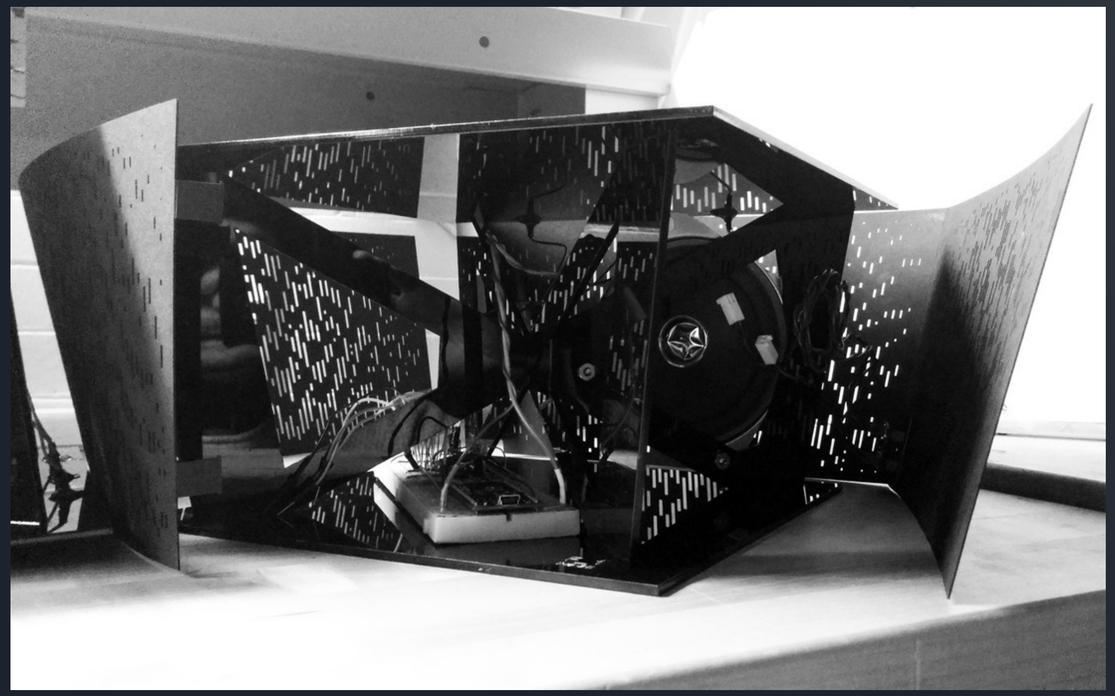
Environment Augmentation Modules

Wedge and Block modules are passive elements that allow SMORES-EP robots to augment their environment by autonomously building structures that make problematic obstacles traversable.

Wedges and blocks are designed to work synergistically with SMORES-EP. Steel plates allow easy magnetic manipulation. Interlocking features and neodymium magnets allow them to snap together to form bridges and ramps. Side walls and a high-friction rubber surface allow SMORES-EP robots to drive over these structures without falling off.

Video: https://youtu.be/NKj-xulsxco





The Furies

Orpheus and Eurydice: Electromechanical Redux

A collaboration between PennEngineering, PennDesign, and members of the Philadelphia Opera and Curtis Institute of Music, **Orpheus and Euridice: Electromechanical Redux** is a modern, mechatronic retelling of the classic opera.

The Furies are the vengeful guardians of the underworld. When Orpheus first encounters them, the five electromechanical Furies each scream a random tone, resulting in a dissonant cacophony. When furies come in contact with one other, their tones converge and settle at their average frequency. As Orpheus sings, the Furies are assembled into a tower. Their sounds slowly converge to a single, pure tone, harmonizing with Orpheus and the musicians. The Furies, now tame, allow Orpheus to pass into the underworld to find his lover.

Video: https://vimeo.com/117354199#t=1165s
(headphones recommended)

Concept: Tarik Tosun
Electronic Design: Tarik Tosun and Seethu Christopher (PennEngineering)
Housing Design: John Luke Prifogle (PennDesign)