

Project KISS

Kinetic Interactive Solar Sculpture



Department of Electrical Engineering and Computer Science
University of Central Florida

Dr. Lei Wei

Sponsored by: OUC

Group 5

Robert Perkins	tahteperkins@gmail.com	EE
Connor Heckman	connorheckman@knights.ucf.edu	CE
Ben King	ben0king@knights.ucf.edu	EE
Jack Gray	Jack.Gray@knights.ucf.edu	EE

Project Narrative Description

While conducting solar sculpture research online, our team was surprised to find that the vast majority of analogous projects consisted of stationary constructs that failed to make actual use of the solar energy being collected. Based on this observation, we came up with the idea for an interactive kinetic solar sculpture, which will utilize its solar power to entertain observers and demonstrate the practicality of solar energy in real-time.

Our solar sculpture will utilize motion sensors in concert with gesture detection software to allow for immediate interaction between the installation and the observer. Actuators built into the framework of the solar sculpture will allow the installation to move in response to stimulus from observers. Water effects along with decorative LEDs will be employed to add to the aesthetics of the display. All of these will be powered through the use of solar panels, thus demonstrating to observers the capability of solar energy in real-time.

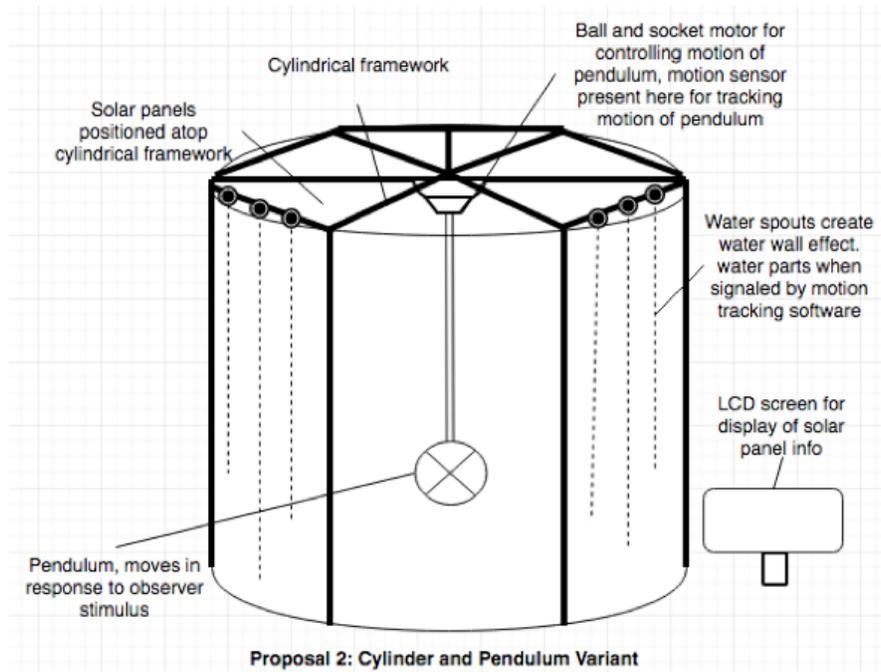
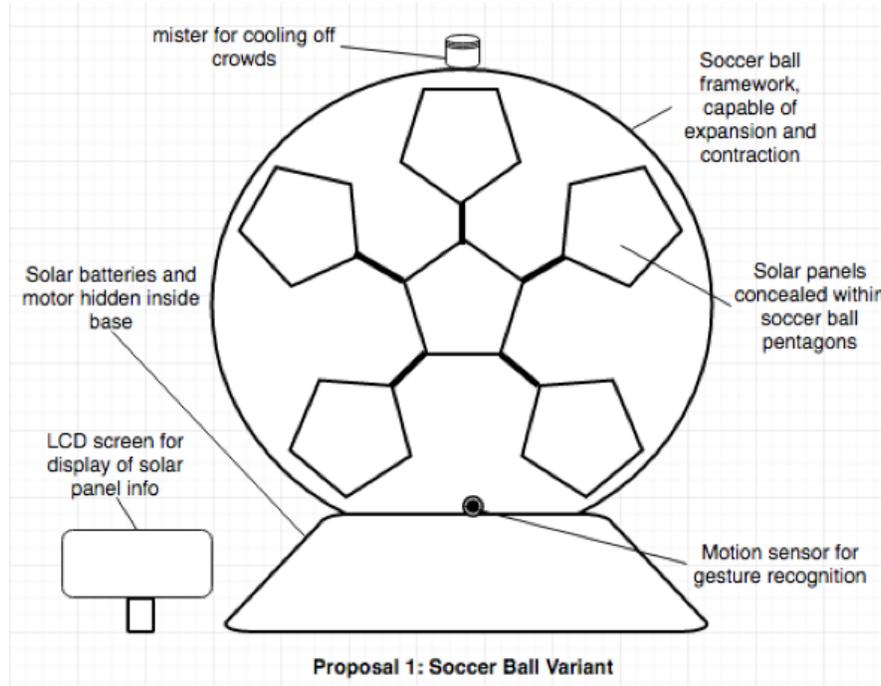
This project has a variety of possible approaches. Our team has narrowed the design down to two possible variants. The first is a soccer ball structure, which is designed to pay homage to the project's connections to the Orlando City soccer team. This variant is designed to entertain a larger crowd of observers, and would ideally be placed outside of the Orlando City stadium. The second variant is a cylindrical structure with a center pendulum. This cylinder and pendulum variant is better suited as an installation in a park with a smaller concentration of observers. The specifics of both variants will be discussed next.

The soccer ball variant will consist of a raised platform for a base and a large framework soccer ball structure. For our senior prototype we will construct a miniature version of the fully realized sculpture. The soccer ball structure will be able to rotate via a motor placed in the base, as well as contract and expand via actuators hidden within in the soccer ball's structure. Misters will be present in the sculpture, to help observers cool off in the heat of the day. At night, a preprogrammed light display will illuminate the sculpture and enhance the overall visual presentation. An observer standing in front of the sculpture will be able to control all the kinetic elements of the sculpture, by performing specific gestures in view of the sculpture's motion sensors.

The cylinder and pendulum variant will expand upon the idea of a 'waterfall swing', in which the person swinging travels through openings created in a falling water display. Our design will consist of a cylindrical framework surrounded by a water wall effect, and a pendulum suspended in the center of the cylindrical frame. The water wall effect will be achieved through the use of spouts installed in the top of the structure, giving the illusion that the pendulum is encased in a cylinder of flowing water. A ball joint motor installed at the top of the structure will allow the ball to swing in any direction, with the microcontroller controlling the swinging motion of the pendulum. The pendulum will be capable of swinging in any direction. A motion sensor installed at the top of the sculpture will track the motion of the pendulum. An observer standing in front of the sculpture will be able to move the pendulum by gesturing in view of the sculpture's frontal motion sensor. When the pendulum is swung towards the water wall, the spouts will be signaled to disengage by the sculpture's motion tracking software and the water will part as the pendulum passes through it.

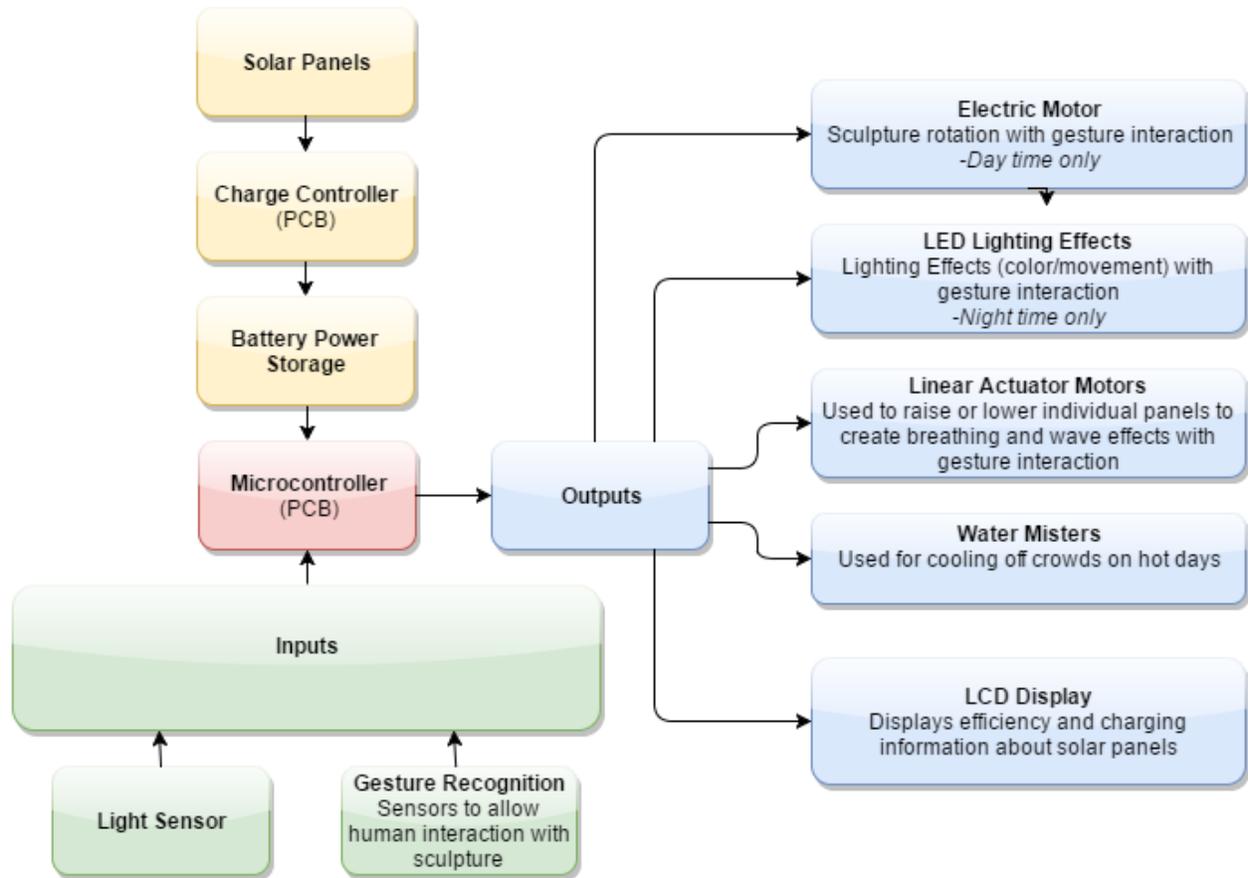
While these two variants represent two very different designs and their own individual development challenges, the primary goals of the project remains the same: to produce a solar

sculpture which educates on the practicality of solar power through its entertainment. In both variants a framework will be constructed for the majority of the sculpture's structure, saving cost on building materials for the full-scale realization of the sculpture. Interactivity is stressed in the design of both variants, in the hopes of engaging passerby and thus drawing more attention to the installation.



BLOCK DIAGRAM

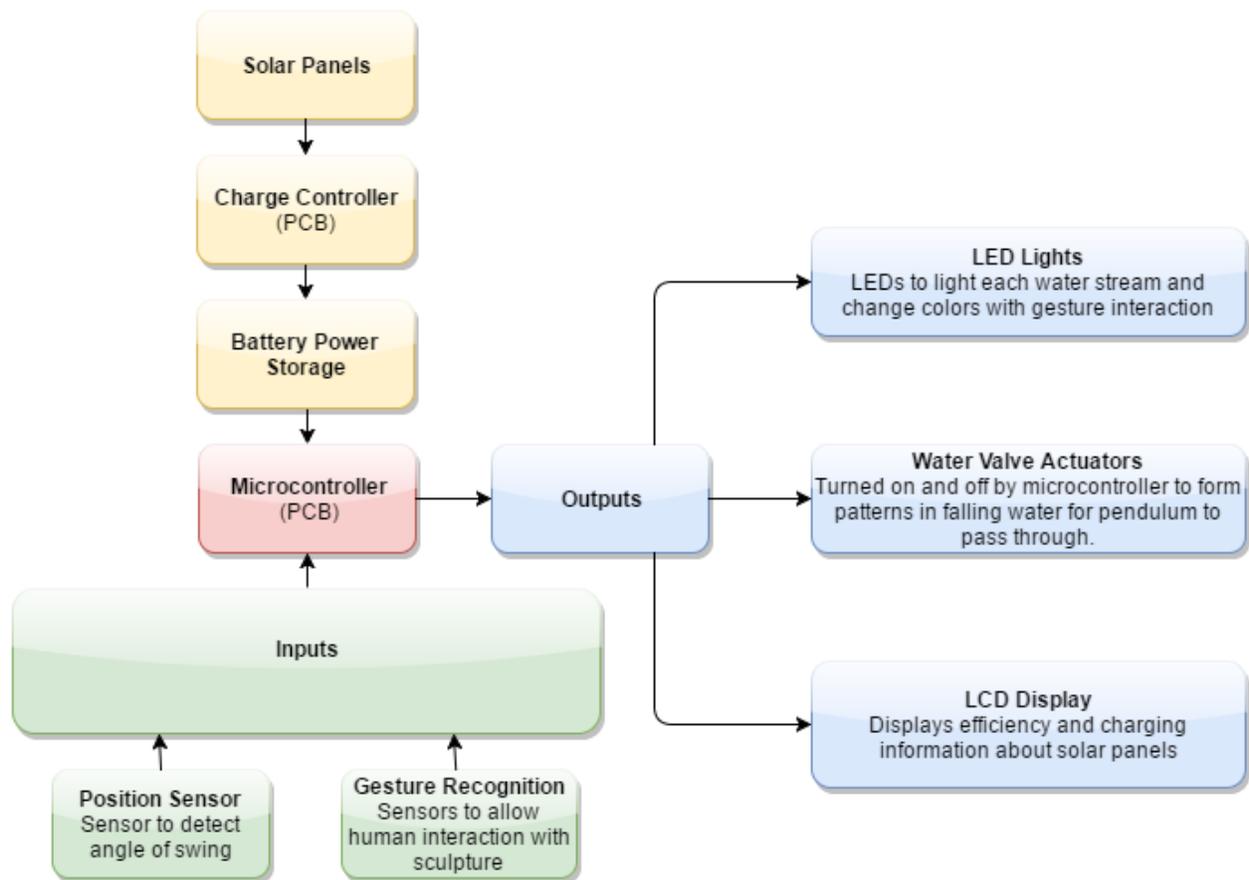
Hardware Block Diagram - Soccer Ball Variant



Block Description	Group Member Assigned	Block Status
Solar Panels	Robert Perkins	Research / Not Acquired
Charge Controller	Jack Gray	Research / Not Acquired
Battery Power Storage	Robert Perkins	Research / Not Acquired
PCB Design	Jack Gray	Research / Not Acquired
Microcontroller (including software)	Connor Heckman	Research / Not Acquired
Light Sensor	Connor Heckman	Research / Not Acquired
Gesture Recognition	Connor Heckman	Research / Not Acquired
Electric Motor (Rotation)	Ben King	Research / Not Acquired
LED Lighting	Ben King	Research / Not Acquired
Linear Actuators	Ben King	Research / Not Acquired
Water Mister	Ben King	Research / Not Acquired
LCD Display	Connor Heckman/Jack Gray	Research / Not Acquired

BLOCK DIAGRAM

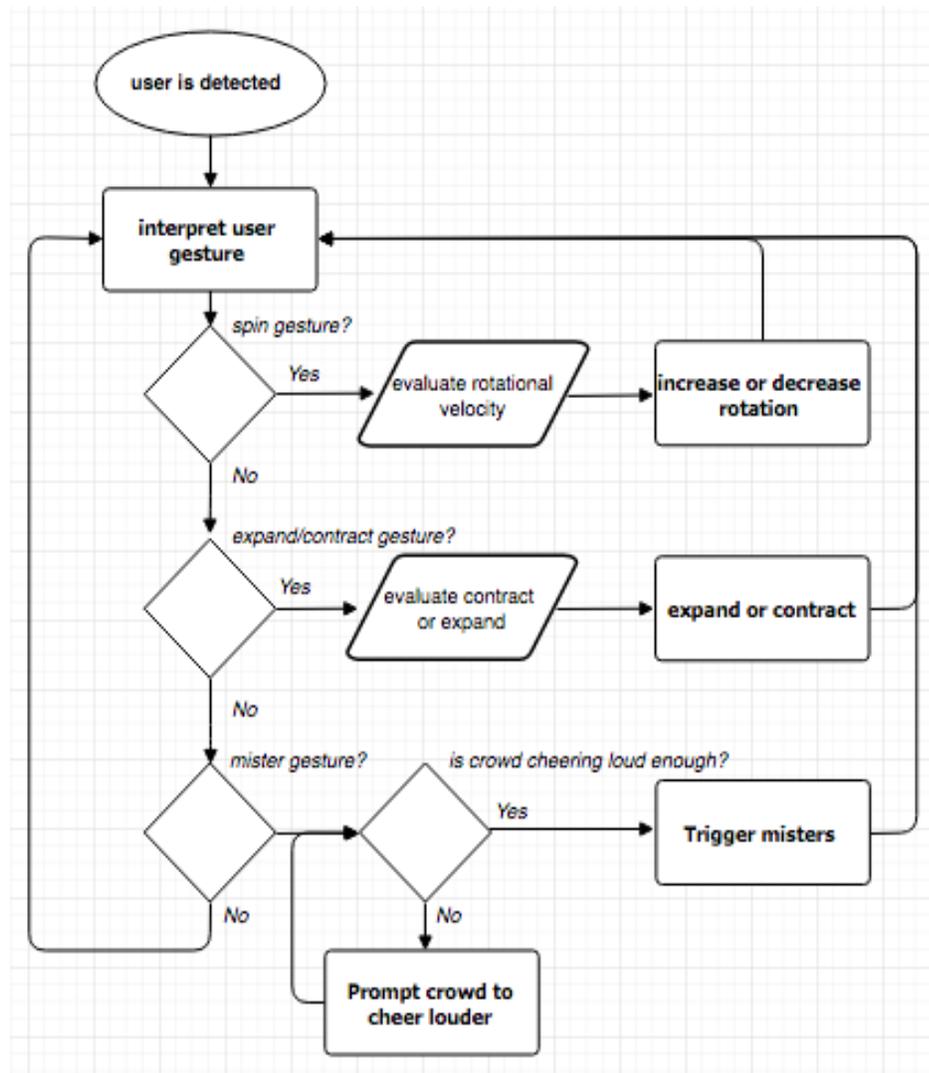
Hardware Block Diagram - Cylinder & Pendulum Waterfall Variant



Block Description	Group Member Assigned	Block Status
Solar Panels	Robert Perkins	Research / Not Acquired
Charge Controller	Jack Gray	Research / Not Acquired
Battery Power Storage	Robert Perkins	Research / Not Acquired
PCB Design	Jack Gray	Research / Not Acquired
Microcontroller (including programming)	Connor Heckman	Research / Not Acquired
Position Sensor	Connor Heckman	Research / Not Acquired
Gesture Recognition Sensor	Connor Heckman	Research / Not Acquired
LED Lighting	Ben King	Research / Not Acquired
Water Valve Actuators (Water Pump and System)	Ben King	Research / Not Acquired
LCD Display	Connor Heckman/Jack Gray	Research / Not Acquired

Software Logic Diagram

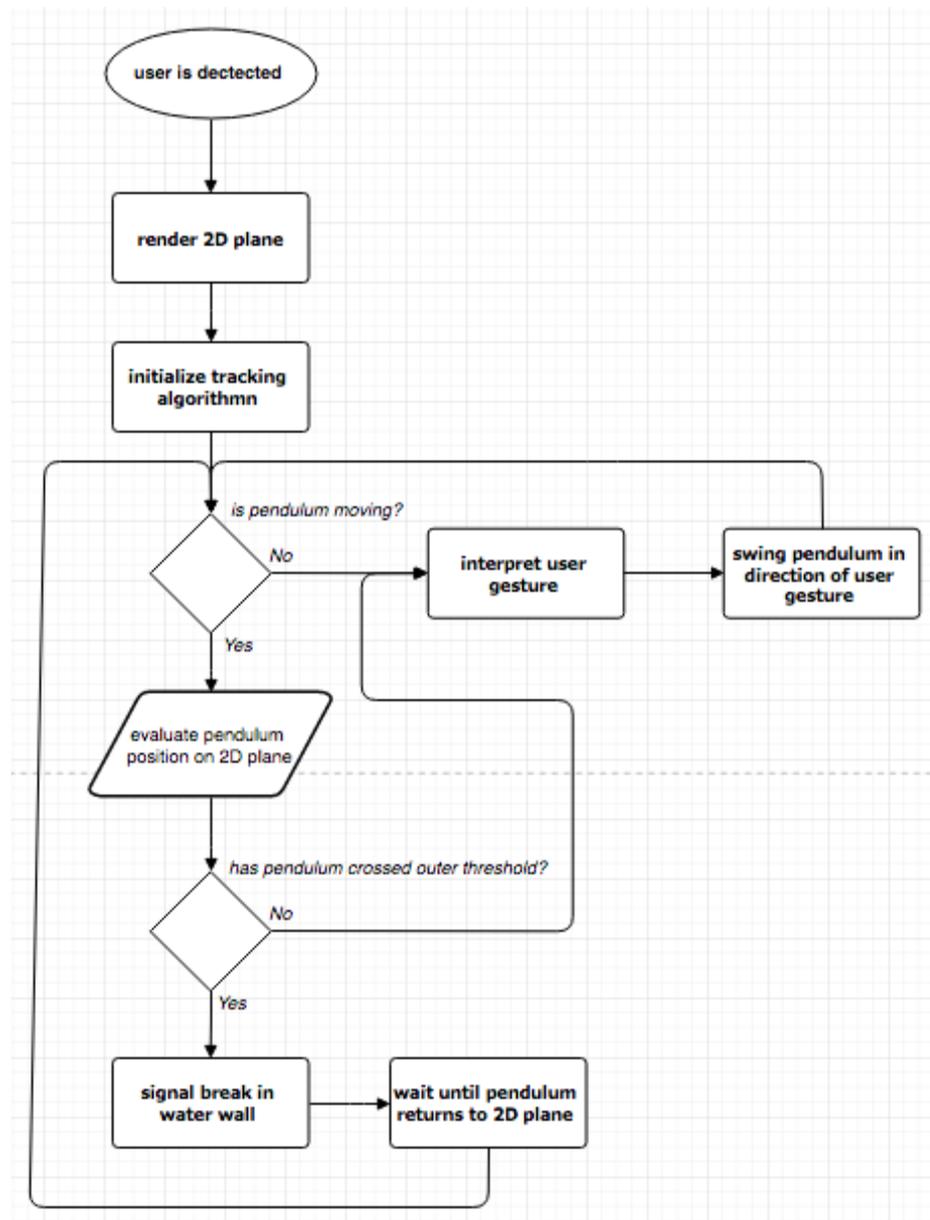
Gesture Recognition - Soccer Ball Variant



For the soccer ball variant of our project, the gesture recognition software will analyze the movements of a single observer and determine which action to perform. A loop with a conditional evaluation will lead to one of the three possible routines. If the observer gestures to increase or decrease the rotation of the sculpture, the software will evaluate the rotational velocity of the sculpture and determine if it has reached its max allowable value, if not it will increment or decrement the sculpture's rotational velocity. If the observer gestures for the sculpture to contract or expand, the software will evaluate the angle of the framework's interlocking joints and determine if the sculpture has reached its maximum allowable expansion angle or minimum allowable contraction angle. If not, the sculpture will signal the framework's actuators to contract or expand the sculpture. In the case of the observer gesturing to trigger the misters, the sculpture will prompt the assembled crowd to cheer louder until an audio sensor determines the audio threshold has been reached and will trigger the misters.

Software Logic Diagram

Gesture Recognition - Cylinder & Pendulum Waterfall Variant



In the cylinder and pendulum variant, the software will track the motion of the pendulum on a 2-dimensional plane using a motion sensor that looks down on the pendulum from the top of the cylindrical framework. Signals are then sent which control the water spouts appropriately. While the pendulum is swinging outside the 2 dimensional plane (i.e. outside the cylinder), the software cycles and waits for the pendulum to return into view of the motion sensor. Each time an observer gesture is recognized, the software checks the position of the pendulum before signaling the ball and socket motor to swing the pendulum in the direction of the user's gesture.

Project Specifications

- Location
 - Entrance to Orlando City Soccer Stadium
 - 17 S Parramore Ave, Orlando, FL 32805
- Dimensions
 - Full Scale- Maximum 15' tall x 8' wide, Minimum 5' x 2'
 - Model- 1/8th scale
- Cost
 - Full Scale- \$25k-30k
 - Model- Maximum \$1,000
- Solar Panels
 - Quantity-12
 - Size- 2' Pentagon
 - Output: Minimum 850 kWh/year
- Sensors
 - Quantity- 4
 - Size- Approx 6 cubic inches
 - Output: 180 degree gesture recognition
- Displays
 - Quantity-1
 - Size- 16" screen
 - Output: Live output of solar efficiency
- Effects
 - Quantity- 100+ LEDs,
 - Size- Individual 10mm bulb
 - Output: Variable color and power manipulation
- Batteries
 - Quantity-12
 - Size- 6 Volt -8 Amp Lead Acid Battery
 - Output: Maximum 72 V

Project Constraints

- Ability to properly charge batteries on overcast days
- Interaction with the installation is limited to one observer at a time
- Observer safety concerns regarding a rotating framework with sharp panel edges
- Observer safety concerns regarding the swinging pendulum
- Concerns regarding weather conditions, including waterproof operation of electronics for cylinder and pendulum variant
- Concerns regarding maintenance costs to prevent rusting and erosion of structural components

Project Budget

Solar Sculpture Water Swing Part List (full scale)

Part	Price Per Unit	Amount	
Microcontroller	\$50	1	\$50.00
Batteries	\$380	1	\$380.00
Solar Panels (100W)	\$150	4	\$600.00
Computer Vision Sensor	\$50	1	\$50.00
LED's	\$200	1	\$200.00
Water Pump	\$100	1	\$100.00
Misc. Circuit Components	\$50	1	\$50.00
PCB	\$100	1	\$100.00
LCD Display	\$100	1	\$100.00
TOTAL			\$1,630.00

Solar Sculpture Part Soccer Ball List (1/8 scale)

Part	Price Per Unit	Amount	
Microcontroller	\$50	1	\$50.00
Batteries	\$50	1	\$50.00
Solar Panels (4W)	\$20	8	\$160.00
Computer Vision Sensor	\$50	1	\$50.00
LED's	\$200	1	\$200.00
Electric Motor	\$50	1	\$50.00
Misc. Circuit Components	\$50	1	\$50.00
PCB	\$100	1	\$100.00
LCD Display	\$100	1	\$100.00
TOTAL			\$810.00

The majority of the cost for the full-scale electrical components comes from the solar panels and the batteries to store solar energy. Priced above for our Water Swing Part List are the minimum panels to fulfill the power production specified by our sponsor and enough battery storage for one day's worth of production. More panels might be needed based on power consumption. Although we have two working ideas many components are shared by both projects. The only component that changes between the two projects are the motor and the water pump. Some components on our parts list are hopefully over budgeted in order to account for errors such as the PCB board.

OUC, our sponsor, is providing us with \$1000 of funding. Our team will be covering the difference if our project exceeds that budget. Also our parts list does not include non-electrical hardware. Hopefully we will get more information on that once we have added mechanical engineers to our team.

Project Timeline and Milestones

Milestone	Date
Initial Meeting	May 23, 2016
Group Formation	August 25, 2016
Initial Project Design Submission	August 26, 2016
Design and Specifications Documentation	September 9, 2016
Meeting with Sponsors	September 16, 2016
Research and Resource Identification	September 23, 2016
Updated Design and Specifications	September 30, 2016
Table of Contents Submission	November 4, 2016
Updated Design Documentation	November 11, 2016
Finalized Design Documentation	December 6, 2016
Begin Senior Design 2	January 9, 2017
Design Hardware and Software Elements	January 23, 2017
Order Equipment and Materials	January 30, 2017
Test Equipment and Materials	February 13, 2017
Construct Final Project	February 27, 2017
Test Final Project	March 27, 2017
Present Final Project	April 24, 2017
Implement Full Size Solar Sculpture	February 27, 2018

House of Quality

		Output Efficiency	Solar Panel Coverage	Implementation Time	Durability	Size	Cost
		+	+	-	+	+	-
Engagement	+	↓		↓↓		↑↑	↓
Power Usage	-	↑				↓↓	↑
Aesthetics	+		↓	↓		↑	↓
Structural Complexity	-		↓↓	↑	↓	↓	↑↑
Cost	-	↓	↓↓	↑	↓	↓↓	