Herbert Wertheim College of Engineering
UNIVERSITY of FLORIDA

H3LIOSTAT

H3LIO Gators

Section 30310, Group 486Q

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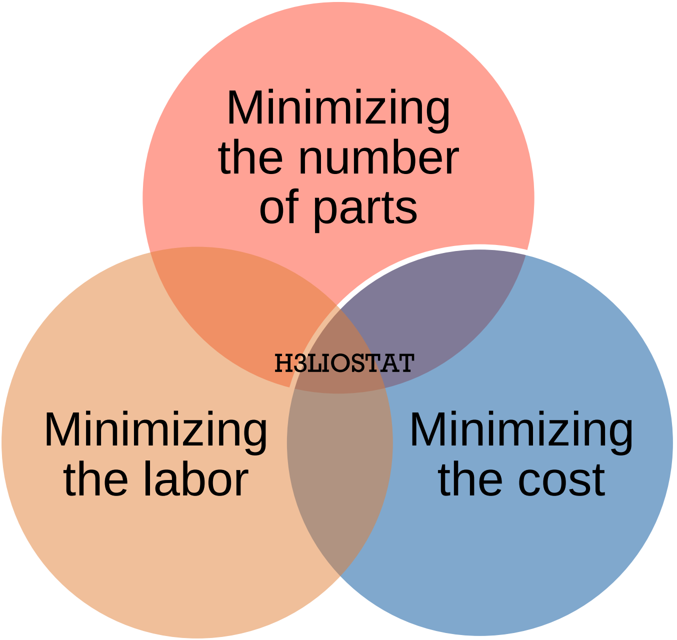
Presentation Outline

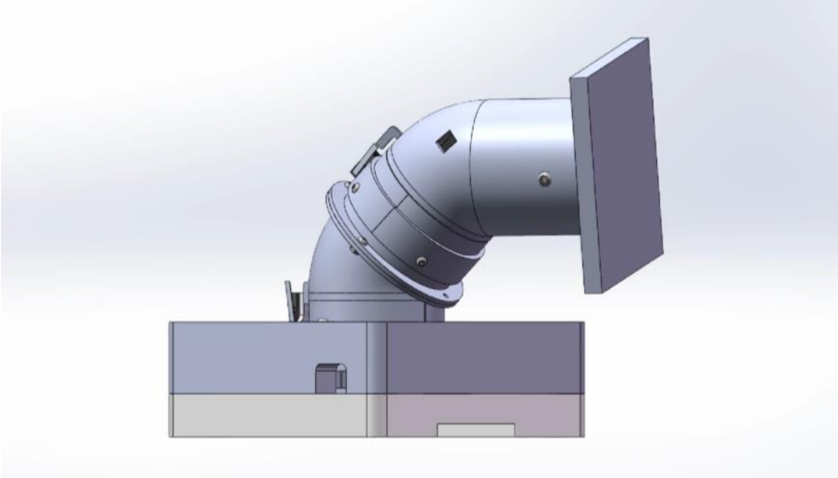
- Hedgehog Concept
- Key Product Specifications
- Videos and images of successful completion of major testing
- Design highlights
- Exploded CAD views
- Cost summary
- Why us?

Hedgehog Concept



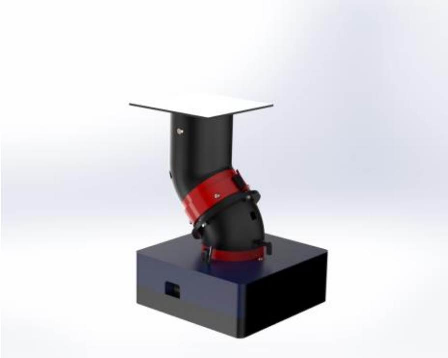
Key Product Specifications

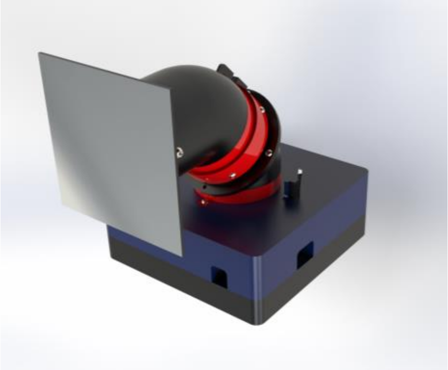
- Innovative heliostat module using minimal number of parts
- Designed to manipulate mirror, track the sun's movements, and reflect light
- Desired angles of the mirror achieved using two independently rotating elbows
- Cost effective design using 3D printing for prototyping
- Designed to withstand environmental conditions



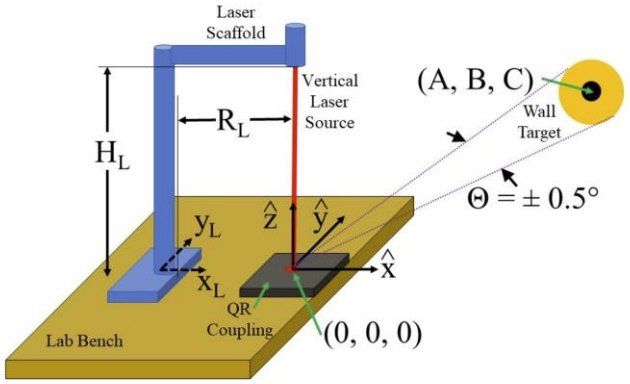
Wind Survivability Test

- Wind Survivability Test
  (https://uflorida.sharepoint.com/:f:/r/teams/EML4502Spring2022995/Class%20Materials/Test%20Milestone%20-%20Wind%20Survivability%20Test%20(Due%202022-02-25)/Pictures%20%26%20Videos/Team%20Q?csf=1&web=1&e=MPztZV)
- Two tests were conducted to test for aerodynamic failure:
  - Low speed: the heliostat was subjected to a fan while in “normal operations” configuration
  - High speed: The heliostat was subjected to a leaf blower while in a “safety mode” configuration

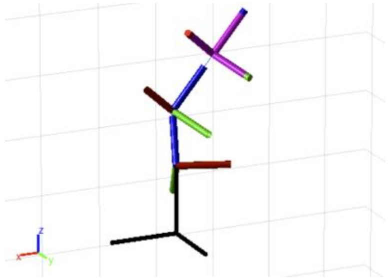




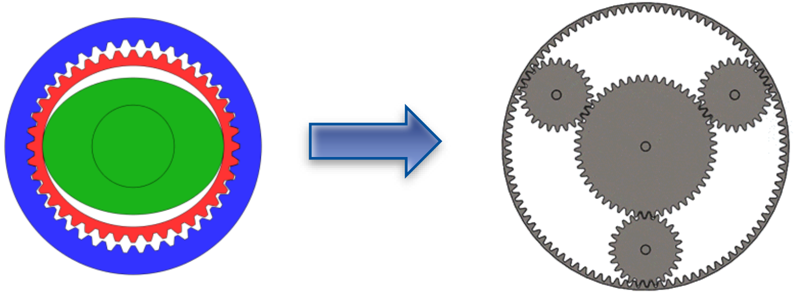
Laser Reflection Targeting Test



- Separated into 5 tests:
  - Two human commanded closed loop tests
  - One open loop test with the target coordinates provided
  - Two open loop tests with no coordinates given
- Angle of rotation calculated in MATLAB
  - Denavit-Hartenberg parameters used to formulate transformation matrices
  - Approximate heliostat as a rigid body in 3D space
  - Determine position of vector normal to mirror and match it to a desired position
  - Iterate with a set of angles for both motors until an error of ±0.5 degrees is obtained



Evolution of Design



Gear System

- Simplified design by going from harmonic drive system to planetary gear system with 2 planetary gears
- Planetary gear system was easier achieve through 3D printed gears and still allowed for better torque

$$Gear\ Ratio = \frac{Ring\ Gear\ \#\ of\ teeth}{Sun\ Gear\ \#\ of\ teeth}$$

$$Gear\ Ratio = \frac{60}{20} = 3$$

$$\tau = Motor\ Torque\ * Gear\ Ratio$$

$$\tau = 59\ Ncm\ * 3 = 177\ Ncm$$

Evolution of Design

Planetary gear attachment method

- Started with hex standoffs inserted within gears and attached to elbow via fastener.
- Issue: Gears would travel up and down by threading and unthreading along fastener
- Changed by testing sleeve bearings and ball bearings, and press fitting shaft of 3D printed gear into bearing
- Either would work, but to allow for less friction went with ball bearing design

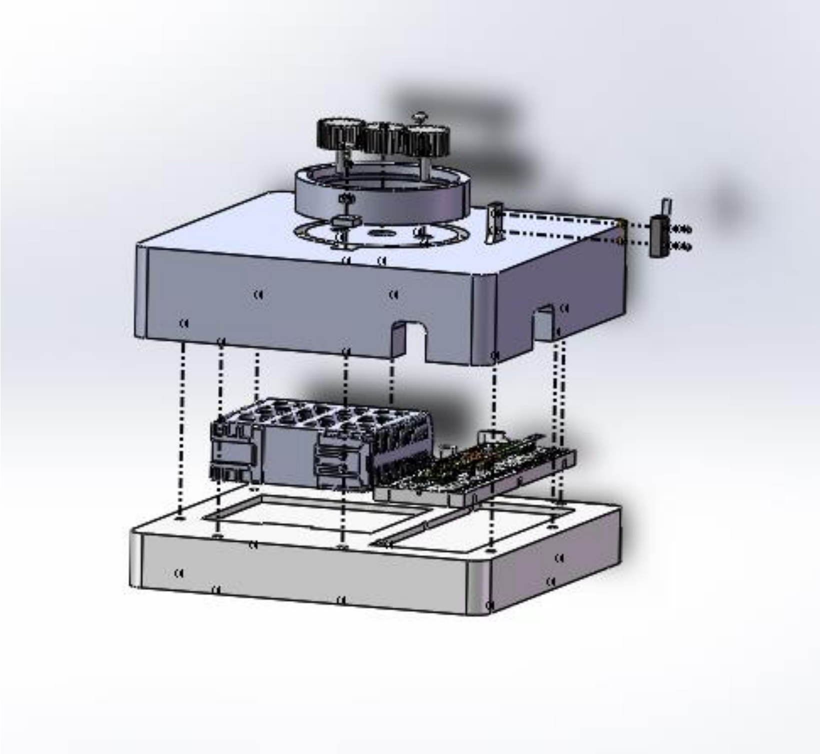
Evolution of Design

Ring and pin

- Started with 2 pin and 1 slot design to attach elbows and still allow for rotation
- It limited movement since pin could line up with slot and get stuck
- Converted to two flanges that both run 360 degrees, but one is split into two to allow for assembly

Base Assembly

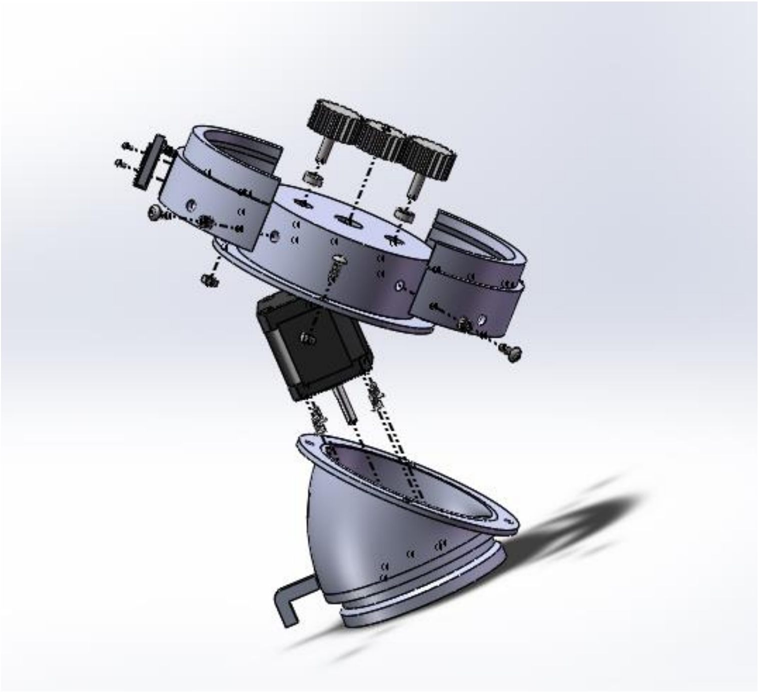
- Base is split in two parts
- Inside base is electronic components
- On base is planetary gear system that corresponds with Elbow 1
- Limit Switch for Elbow 1



Exploded View

Elbow 1 Assembly

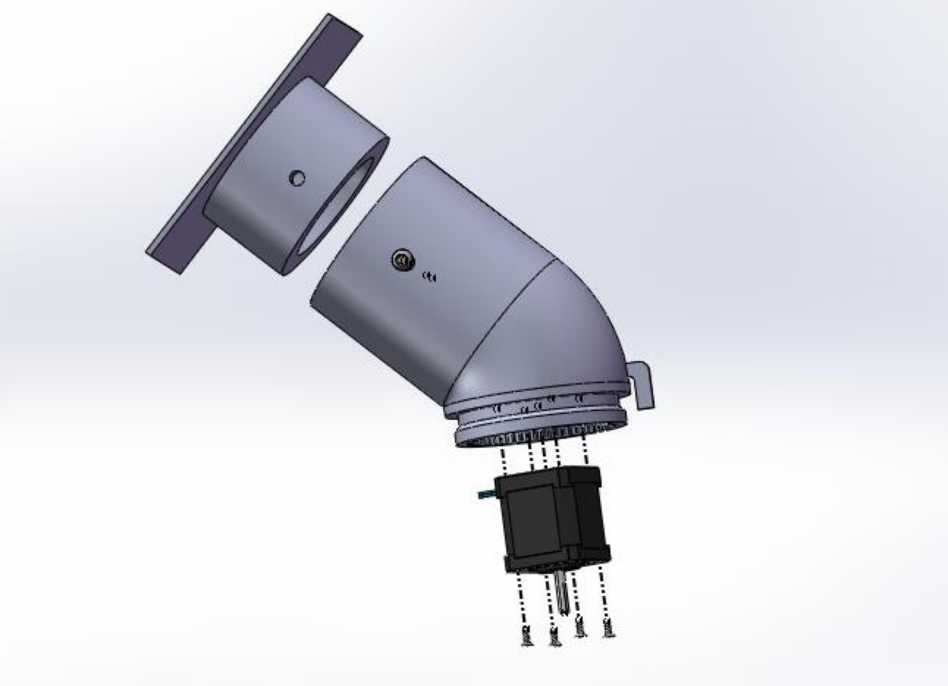
- Contains motor that controls the angle of Elbow 1
- Contains planetary gears that control Elbow 2
- Limit Switch for Elbow 2



Exploded View

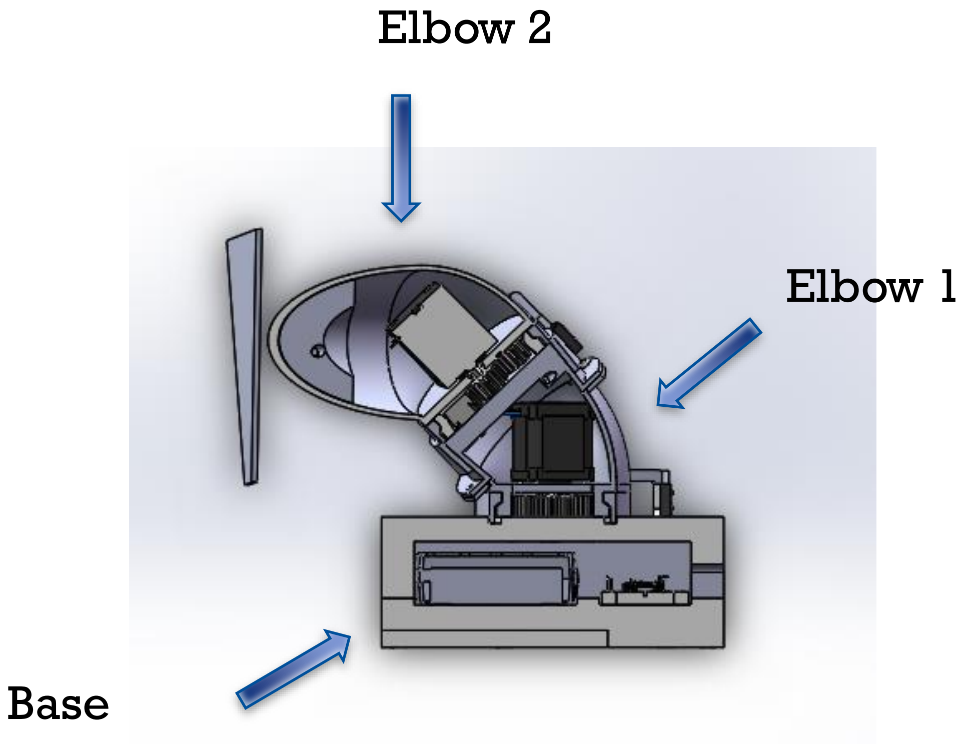
Elbow 2 Assembly

- Contains motor that controls the angle of Elbow 2
- Mirror attached with adhesive to attachment inside elbow

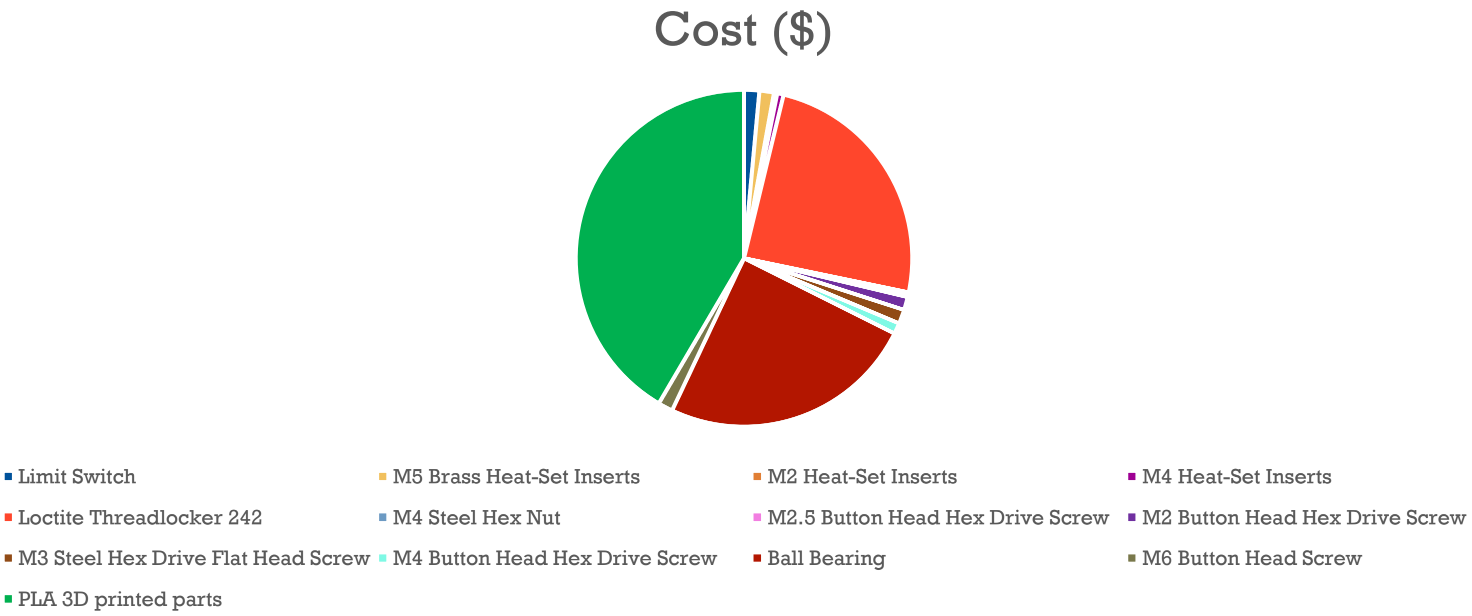


Exploded View

Section View



Cost Table Summary

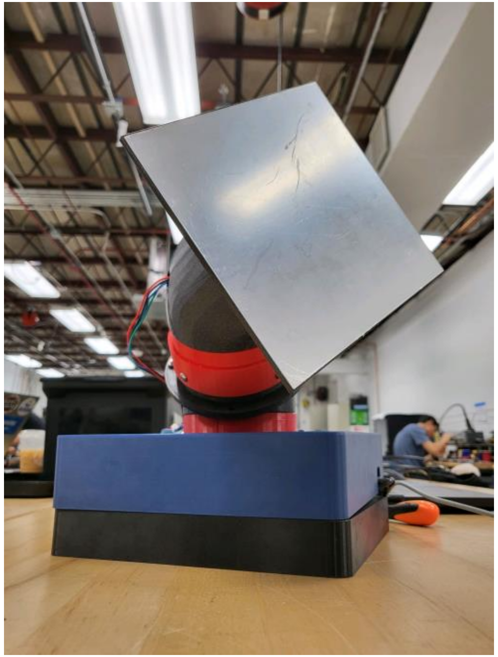


Summary

- Minimal parts – 3 Assemblies
- Compact design- all components are housed within elbows and base
- Greater range of motion- nontraditional two axes design

Thank you!

- Any questions?



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