UF Herbert Wertheim College of Engineering
UNIVERSITY of FLORIDA

BiAxis Solar

Simple, Modular, and Powerful

Section 30309, Group 473P

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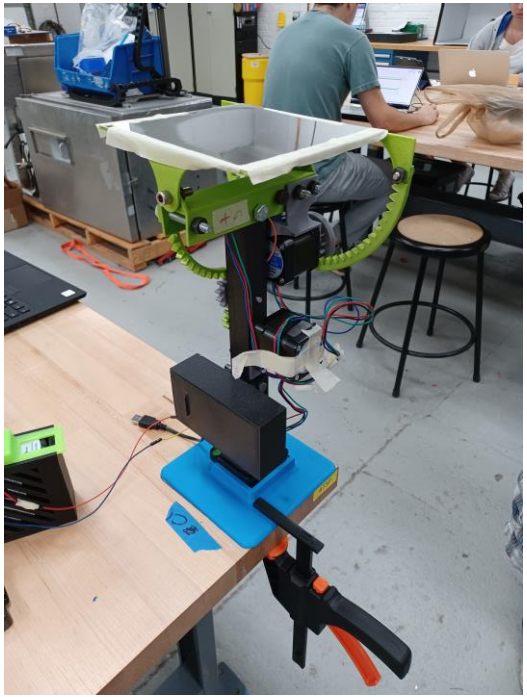
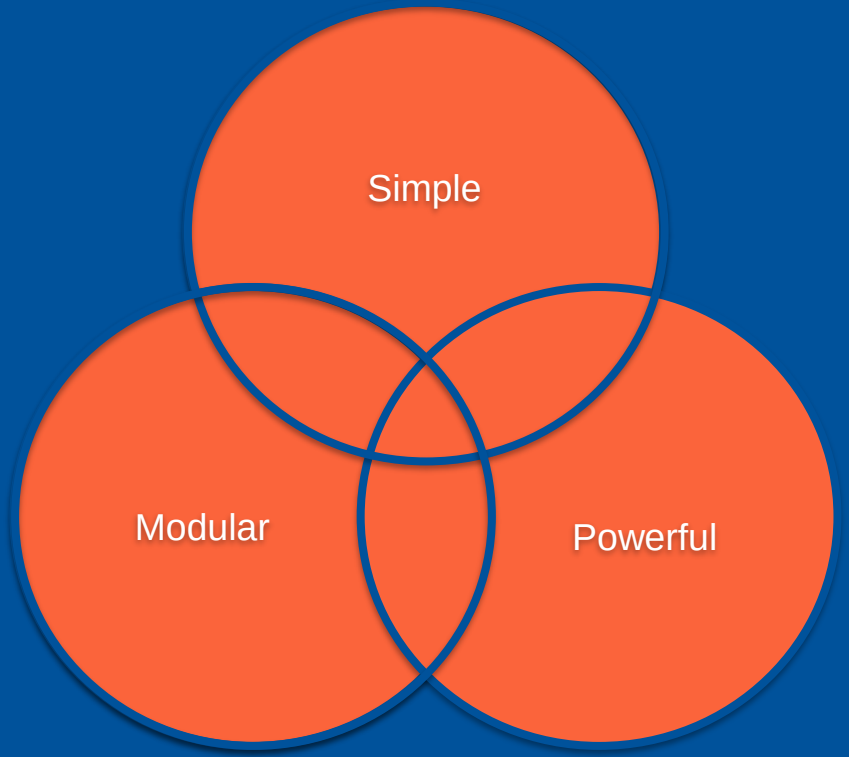
Our design focuses on **simplicity** with two motors that individually control the axes of motion. Exposed gears and motors allow for easy maintenance and problem recognition.

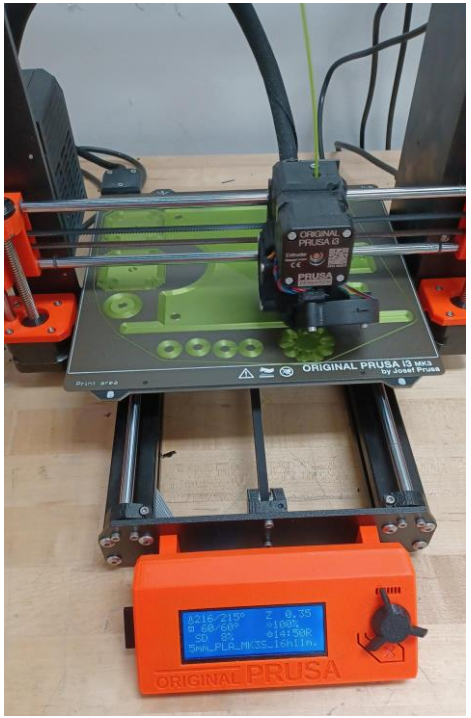



Simple
Modular
Powerful

Key Product Specifications

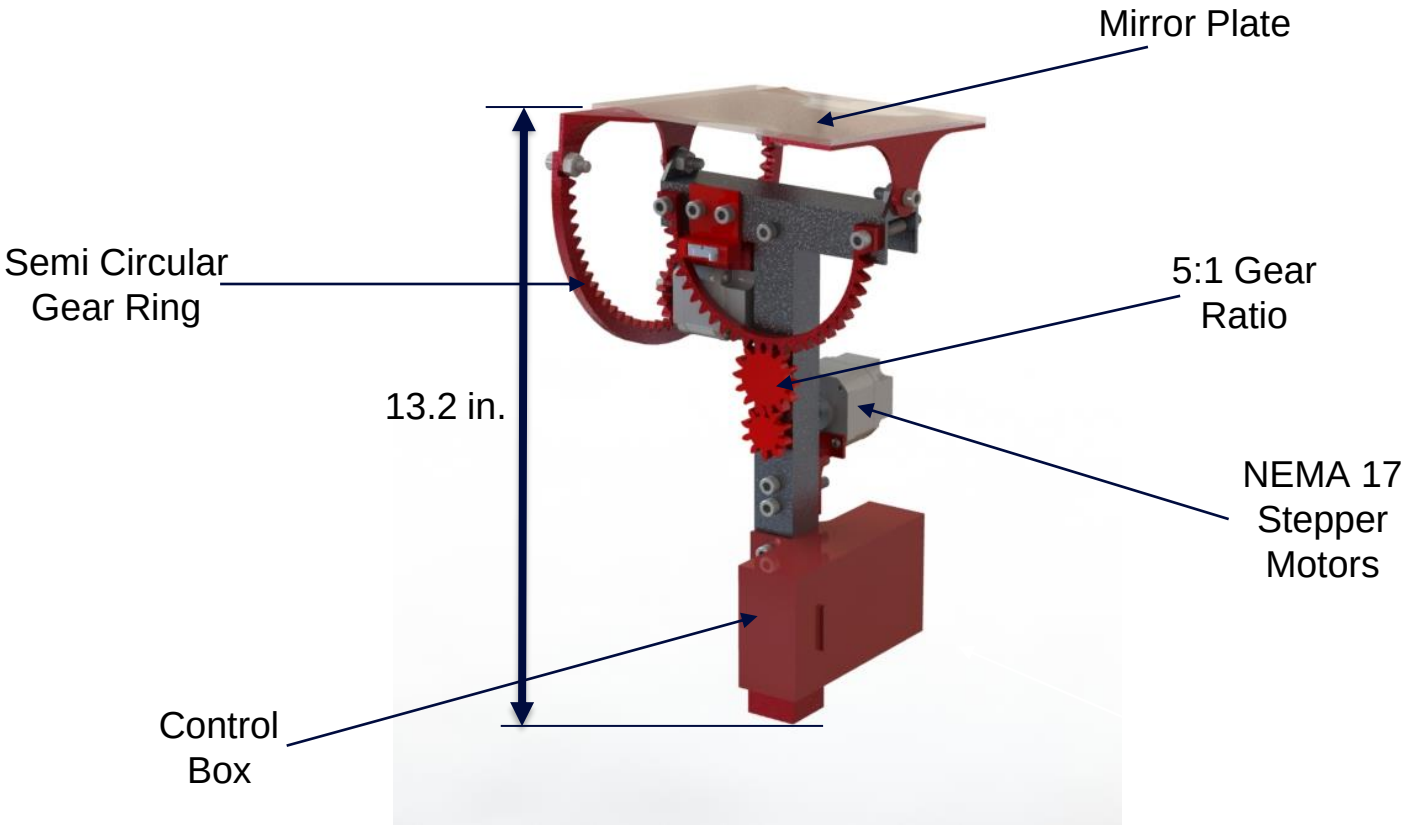
- Cost < $\$100/m^2$
- Parts cost ≤ OTS part cost
- FOS > 2
- Works in Las Vegas Environment
- Small non-reflecting area
- Washable reflecting surface
- Operational lifetime > 20 years

3D Printed Parts used in Prototyping



Wind Tunnel Testing

Laser Targeting Testing

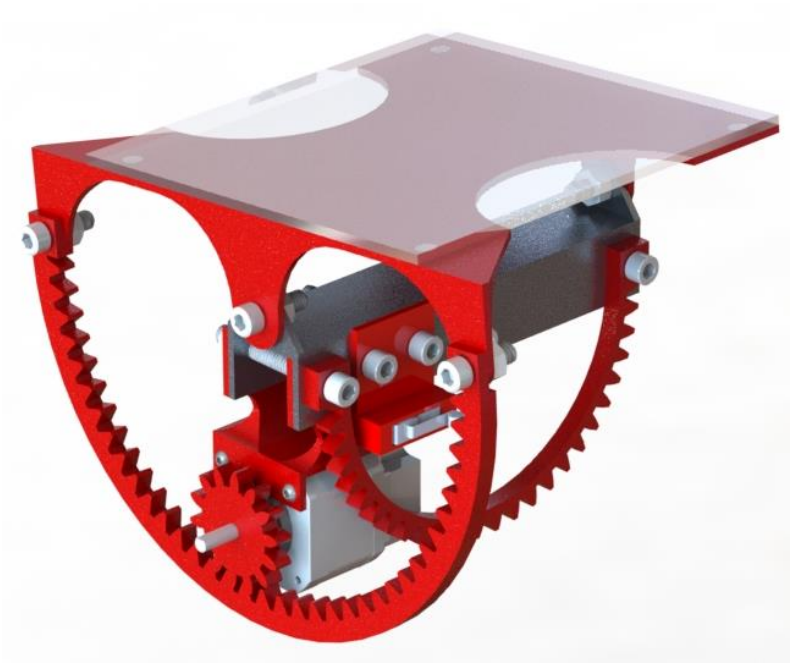

Mirror Plate
Semi Circular Gear Ring
5:1 Gear Ratio
13.2 in.
NEMA 17 Stepper Motors
Control Box

Main structure

- 11″ height, 1″ aluminum square tubing with 0.125″ wall thickness
- Aluminum was selected for its resistance to weather-based corrosion
- Short height, stiffer material and cross section all contribute to stability in the wind

Drive Train Assembly

- 2 axes of rotation to track azimuth and elevation
- Calculated 3.6 gear ratio for angular resolution of 0.5 degrees (1.8 degrees per step of stepper motor)
- Actual gear ratio of 5 to account for slipping



Drive Train Assembly

- Max Torque Calculation:

$$T_{hold} = 3.17\ kg \cdot cm$$

$$T_{out} = T_{hold} \times G = T_{hold} \times 5$$

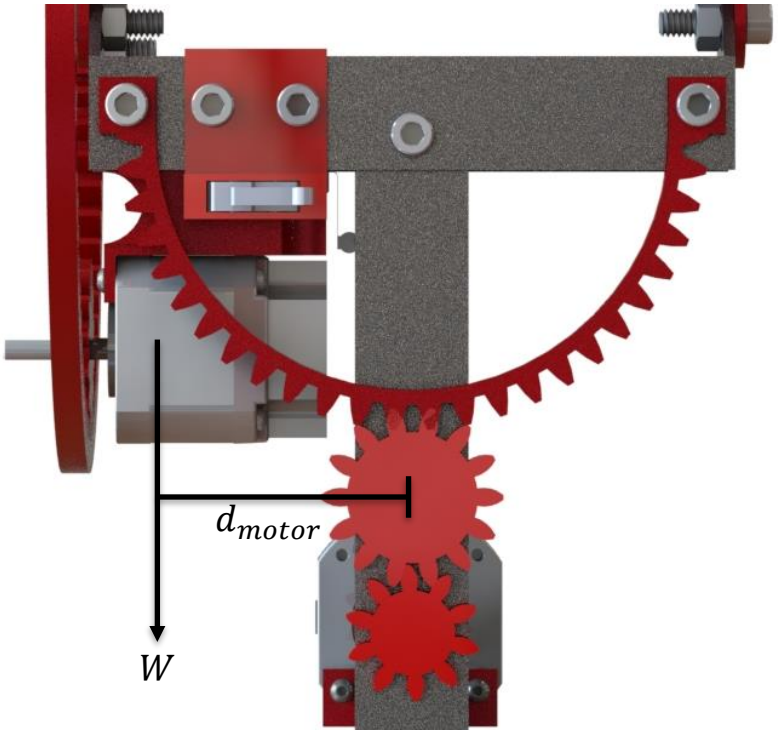
$$T_{out} = 15.85\ kg \cdot cm$$

$$T_{in} = W_{motor} \times d_{motor}$$

$$T_{in} = 0.365\ kg\ \times 4.2\ cm$$

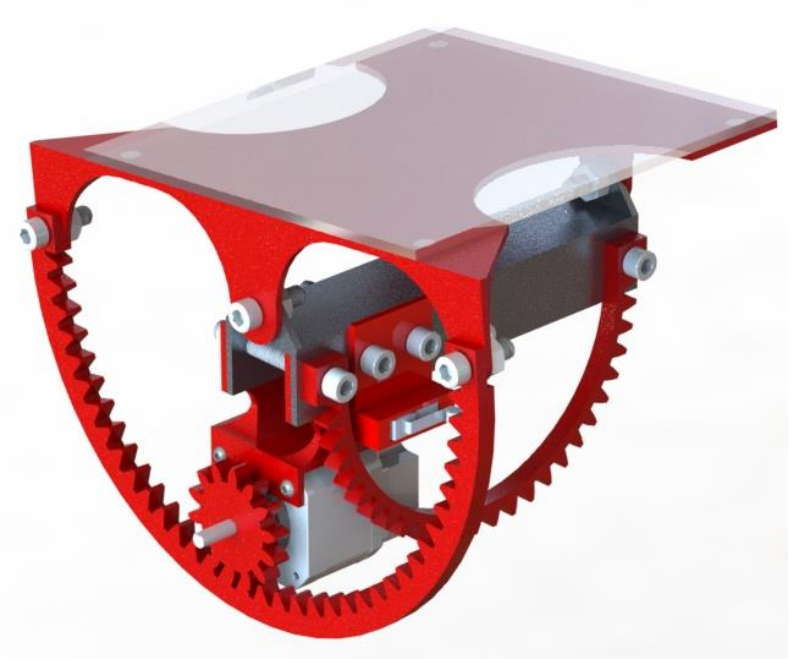
$$T_{in} = 1.533\ kg \cdot cm$$

$$T_{in} < T_{out}$$



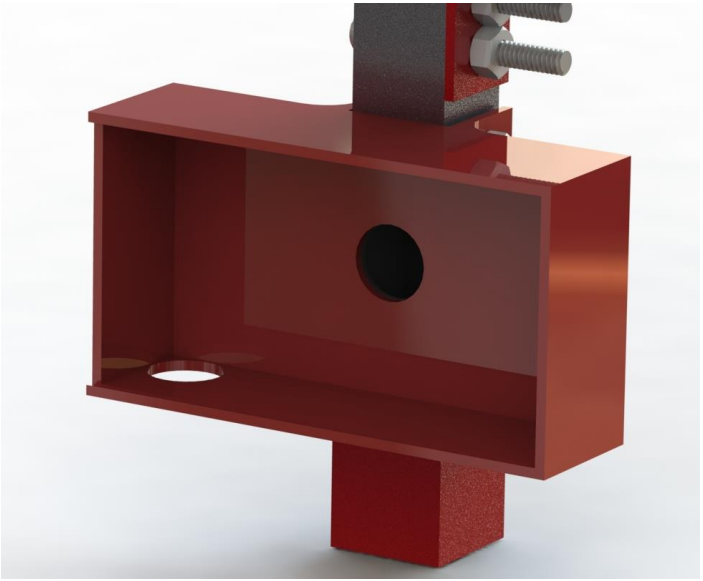
Drive Train Assembly

- Sleeve bearings in pivot points to allow for smooth rotation
- Limit switches to allow for homing
- Standard size fasteners for ease of assembly
  - All ¼”-20 thread with 3 different lengths



Control Box

- Contains breadboard with motor controllers, microcontroller board, and SHTC3 temperature sensor
- Box was added late in development once required electronics and wiring was finalized
- Hole in bottom allows for passage of USB connection and 12 V power supply wires



Controls

- Motor control was done with C++ code in Arduino environment
- SparkFun Thing Plus ESP32 board and NEMA 17 stepper motors
- The NEMA motors have a step size of 1.8°, with 5:1 gear reduction allowing for a step size of 0.36°, meeting the required 0.5° angle accuracy of the product

Dynamics

- The two NEMA motors can move a maximum of 68 (South) and 161 (East-West) degrees respectively due to physical obstacles in the limit switches and supporting pillar, but full solar tracking is still possible in the given angle regions
- On startup, the motors home to 0° (straight up) for South motor and -90° (West) for East-West motor to track motor position
- The Arduino code can be given target angle or Cartesian position and rotate the motors to reflect to the desired point

Manufacturing Considerations

- External service friendly
- Standard fastener selection
- Number of fasteners limited where possible using overlapping parts such as limit switch holder
- 3D printed rapid prototyping -> commonly available aluminum tubing

Cost Summary

- Total cost of one unit: $47.77
  - Including *: $154.02
- Total cost of 3000 units: $143,310
  - Including *: $462,060

Item	Cost
Given OTS Parts*	$106.25
3D Printed Parts	$11.60
OTS Parts	$6.47
Raw Materials	$13.20
Manufacturing Costs	$9.59
Energy Consumption	$0.29
Assembly Labor	$6.62
	TOTAL: $47.77

* Not accounted for in total cost

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Why Choose BiAxis Solar?

POWERING THE NEW ENGINEER TO TRANSFORM THE FUTURE

Design Simplicity

Efficiency

Ease of Control

Cost and Time

Modularity