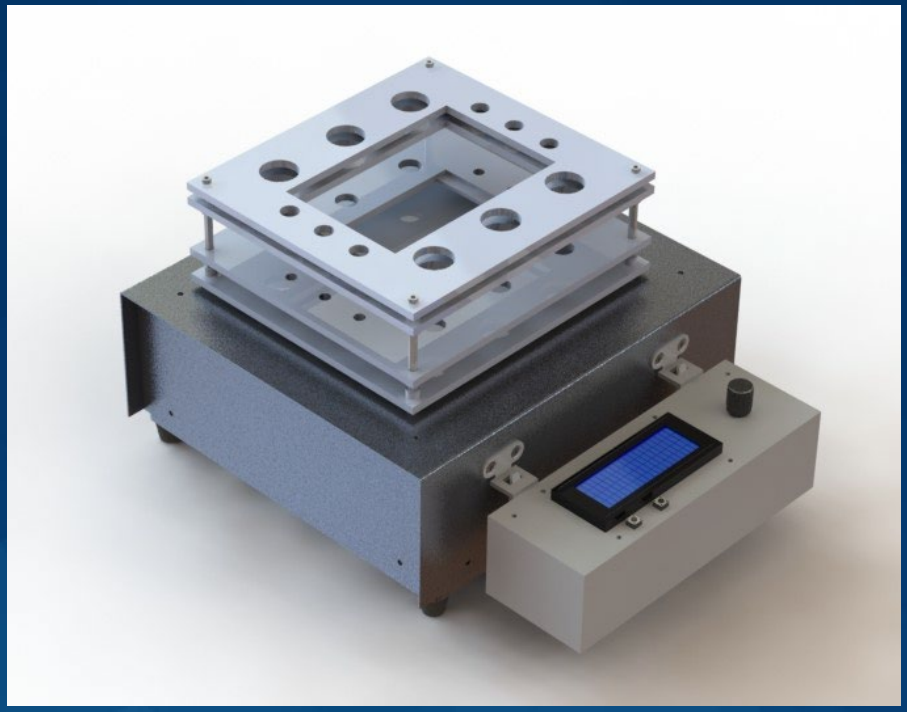
UF Herbert Wertheim College of Engineering
UNIVERSITY of FLORIDA

Final Presentation

4/25/2023
MAE-C



JAMS Devices 448L
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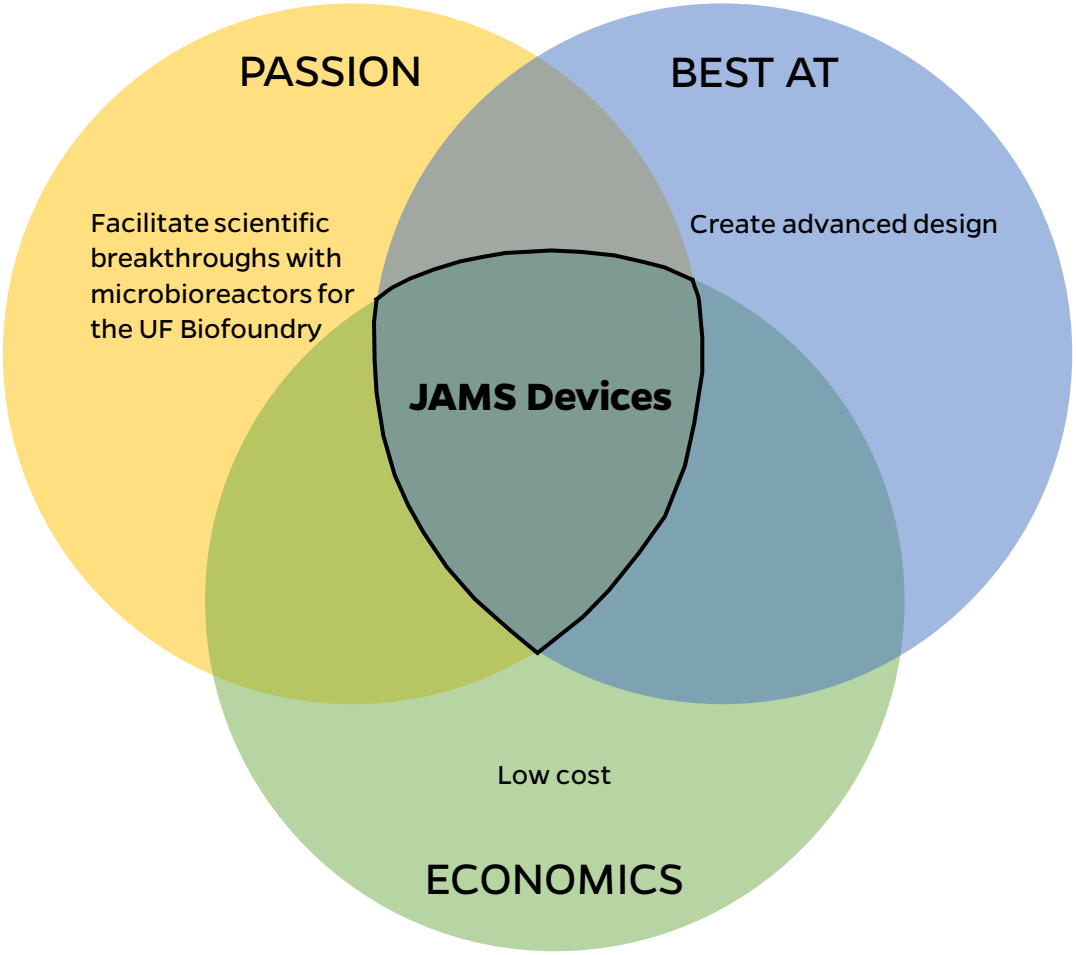
Presentation Outline

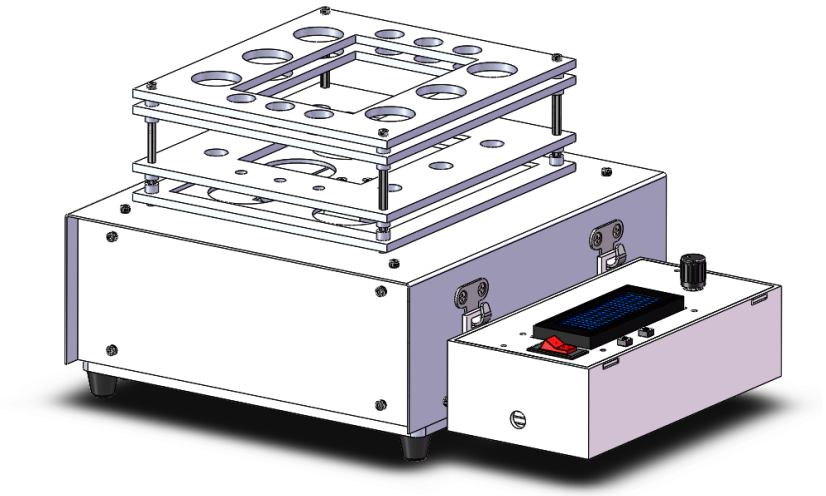
- Hedgehog Concept
- Key Product Specifications
- Testing Deliverables
- Design Highlights
- Design Evolution
- Exploded CAD
- Cost Table
- Summary Slide

Hedgehog Concept



Key Product Specifications

- Drive System:
  - 2 stepper motors (x and y motion)
  - Belt driven system on linear bearings
  - 4 limit switches for alignment
- Test Tube Tray
  - Holds 6x15 mL tubes and 6x50 mL tubes
- Controls
  - Removable tethered control box
- User Interface
  - Two buttons and rotary encoder
  - Sets speed, radius, duration, and pattern
- OD/FI
  - Optical Density (525 nm LEDs)
  - Fluorescent Intensity (250 nm LEDs)



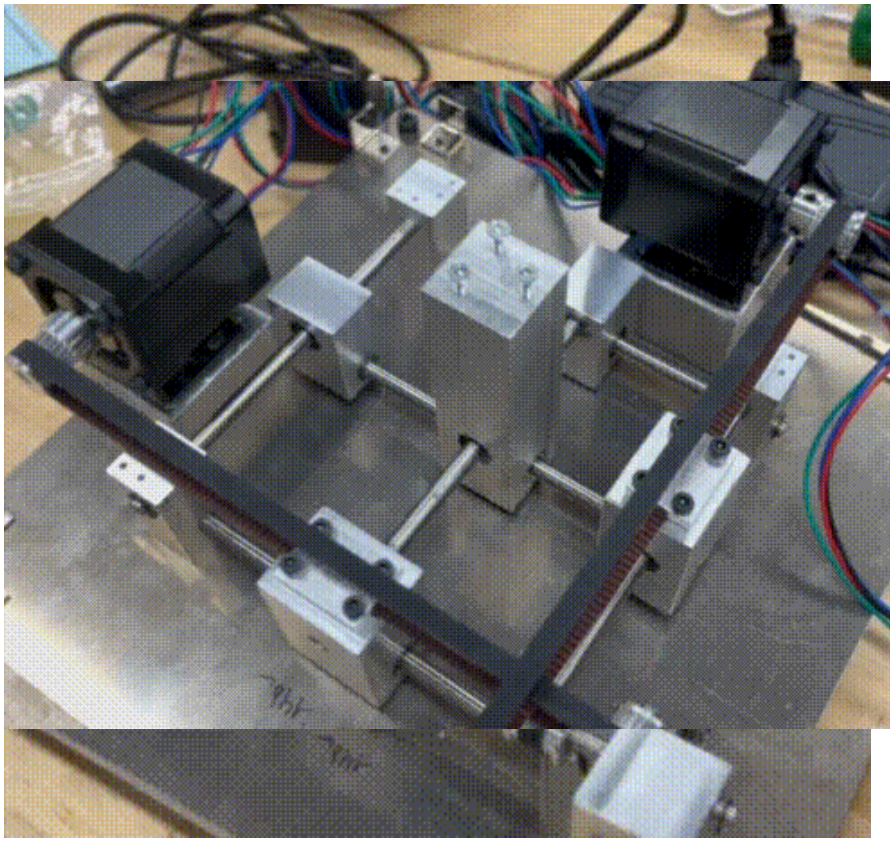
Testing Deliverables

- Full Machine Demonstration
- IP-X5 Performance Evaluation
- OD/FI Integration Performance Evaluation
- Extreme Capability Performance Evaluation
- Drop Test Performance Evaluation

Testing Deliverables

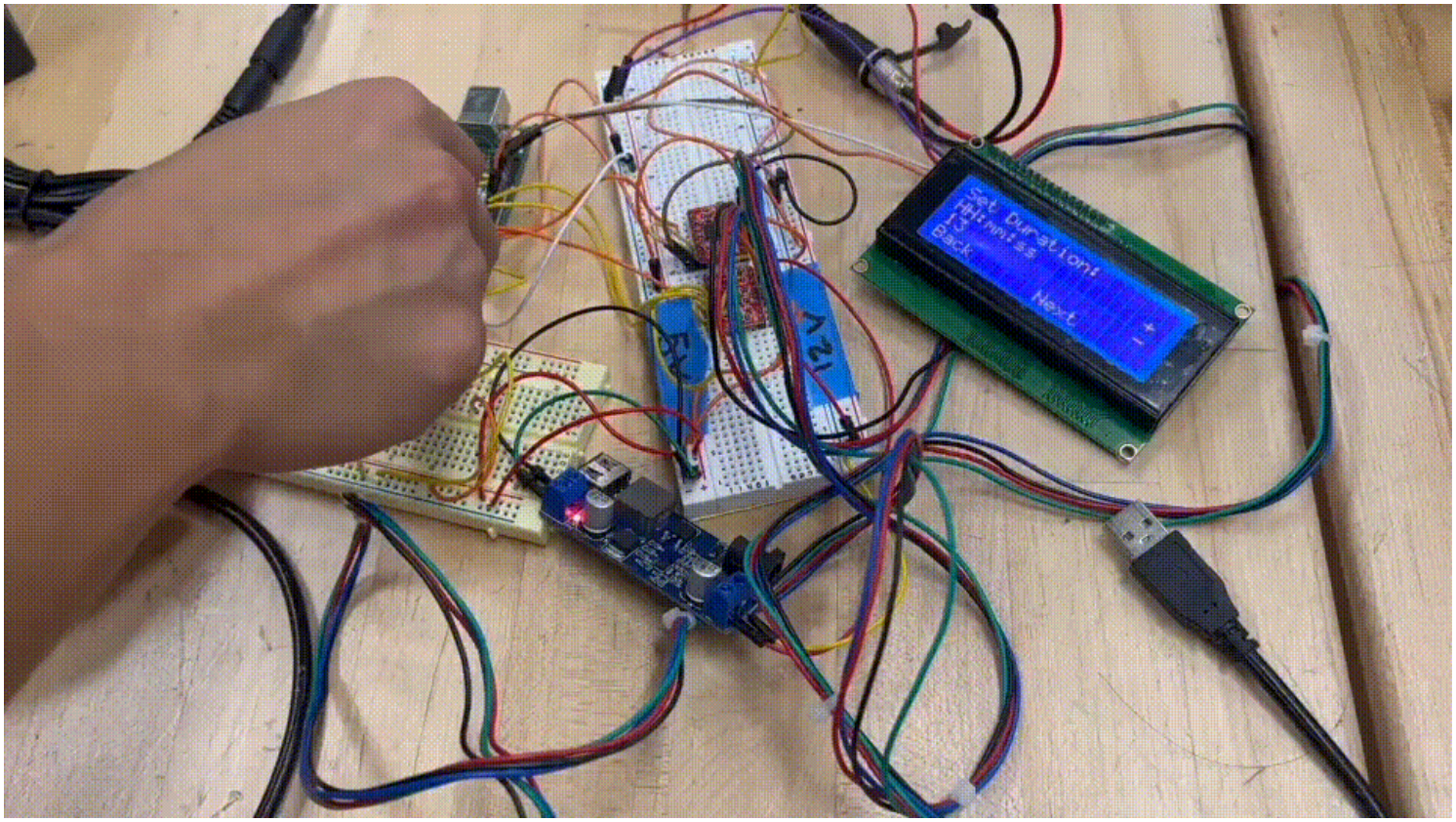
In-class functional demonstration:

- Orbit Types: Linear, Orbital, Double Orbital
- Radius: 5-25 mm
- RPM: 50-350 RPM



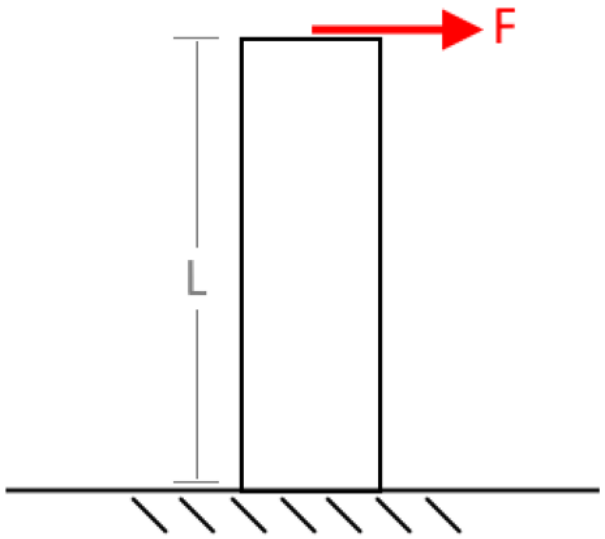
Testing Deliverables

Prototype Demonstration



Design Highlights

- Center block
  - Minimal deflection under expected load

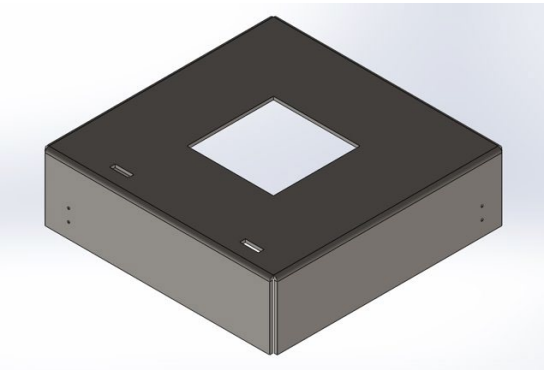


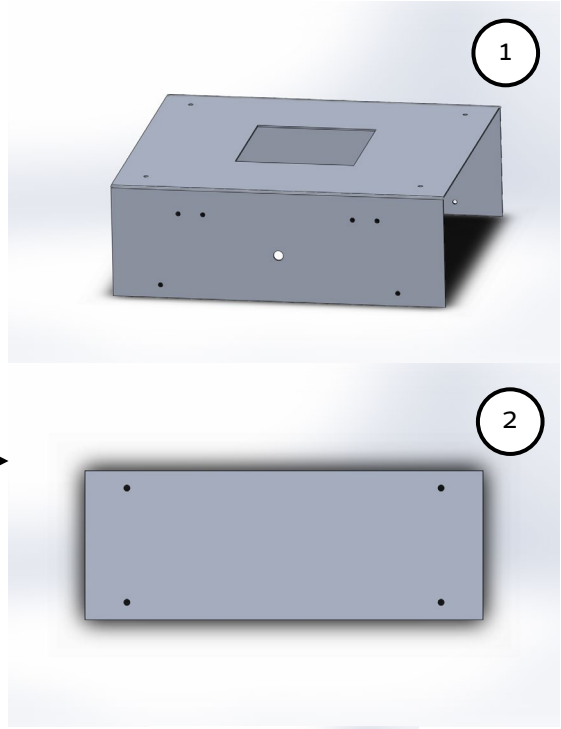
$$\delta_{max} = \frac{FL^3}{3EI}$$

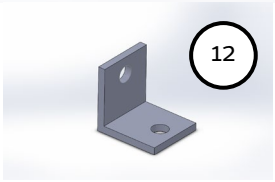
$$d_{max} = \frac{7.75 \cdot 10^{-3} kips \cdot (2.53\ in)^3}{3 \cdot 10{,}000\ ksi \cdot\ 0.0833\ in^4} = 5 \cdot 10^{-5} in$$

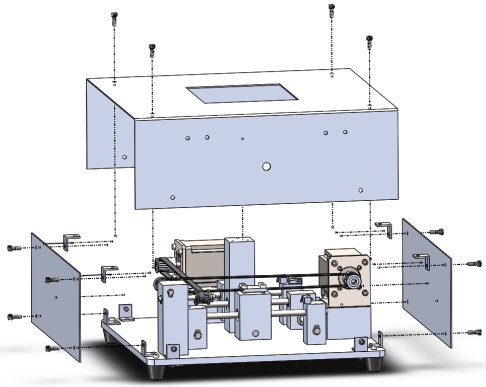
Design Highlights

- Two-piece Enclosure



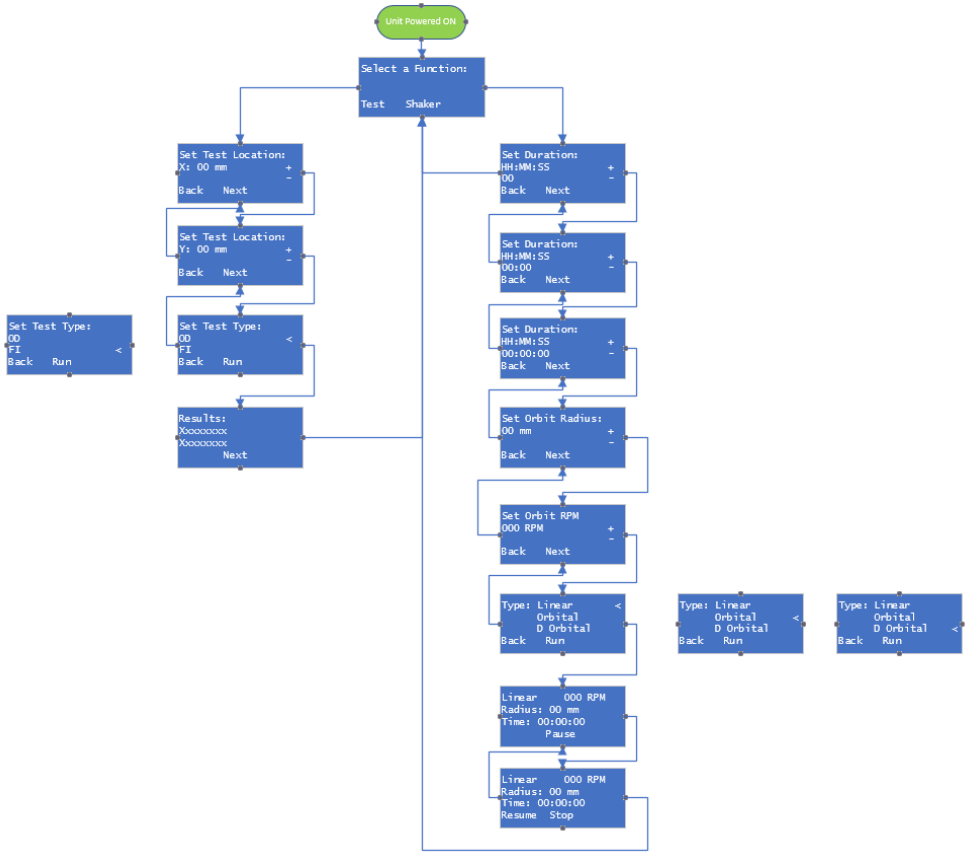






Design Highlight

- User Interface
  - Two buttons and rotary encoder
  - Sets speed, radius, duration, and pattern



Design Highlight

- Code Organization
  - All necessary operations are neatly packaged in 9 functions, allowing for easy modification / updates
  - Minimal dependency on external libraries (just AccelStepper.h and LiquidCrystal_I2C.h)

```
 62 > void setup() {···
 96   }
 97
 98 > void alignment() {···
104   }
105
106 > void refreshScreen(int state) {···
287   }
288
289 > bool menuNav() {···
339   }
340
341 > bool paramChange() {···
383   }
384
385 > void runlinear(){···
393   }
394
395 > void runOrbital(){···
405   }
406
407 > void runDoubleOrbital(){···
416   }
417
418 > void runTimer(){···
451   }
452
453 > void updateEncoder() {···
469   }
```

Design Highlights

- Slipping Analysis
  - Rubber pegs interfacing with table
  - 0.9 friction coefficient

$$F_C = m\omega^2 r$$

$$F_C = (2.06\ kg)\left(26.18\frac{rad}{s}\right)^2 (0.0125\ m)$$

$$F_C = 34.5\ N = 7.76\ lbf$$

$$F_G = (5.7\ kg)\left(9.81\frac{m}{s^2}\right) = 56.35\ N$$

$$F_f = (56.35\ N)(0.9) = 50.72\ N$$

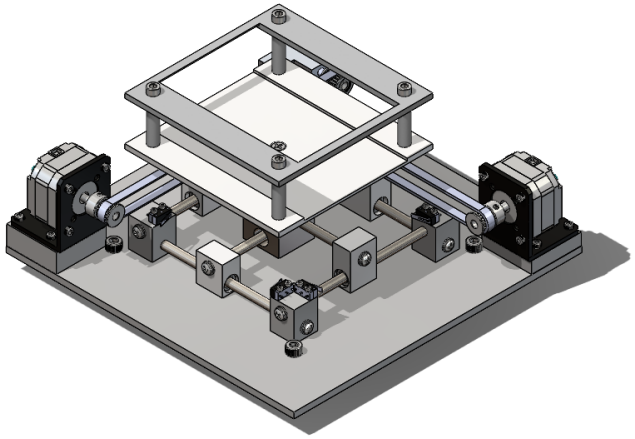
$$F.O.S. = \frac{F_f}{F_C} = \frac{50.72}{34.5} = 1.47$$

Design Highlights

- ODFI System
  - Consists of an array of LED's mounted onto the shaker table below the samples and a photoresistor mounted above
- Optical Density Testing
  - Any wavelength of light could be used for source light
  - 12 525 nm LED's mounted on a PCB
  - LDR has its peak response at 520 nm wavelength
- Fluorescence Intensity Testing
  - Testing sample has absorbance peaks at 250 and 350 nm and an emission peak at 450 nm
  - 12 350 nm LED's mounted on a PCB
  - LDR has a range of 400 – 700 nm so no source light interference is possible

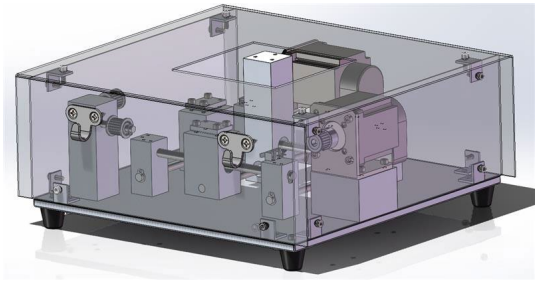
Design Evolution: Base Design - > Milestone 1

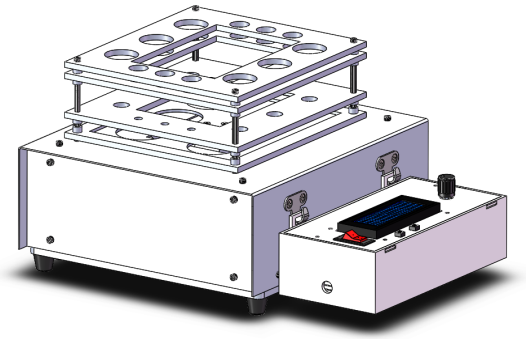
Base Design



- Driven by stepper motors
- Impossible to manufacture parts
- Missing enclosure + control box

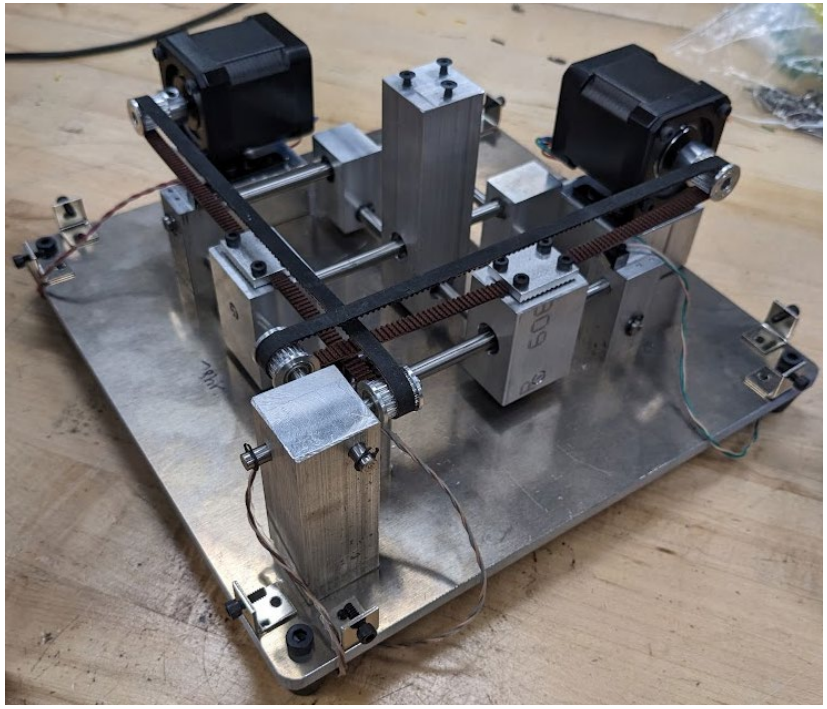
Milestone 1 Revisions

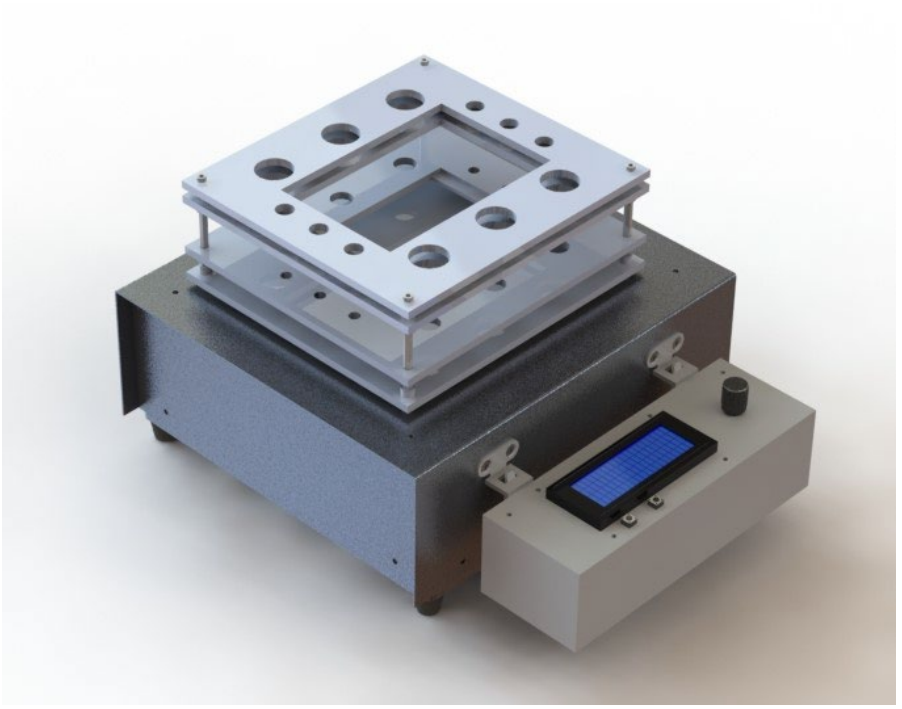




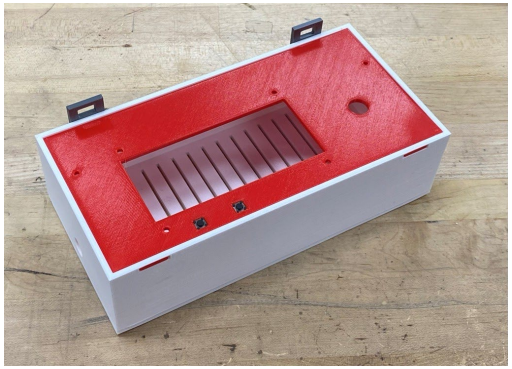
- Designed for BLDC motors
- All manufactured parts redesigned:
  - Increase hole clearances
  - Use nominal stock
  - Simplify parts
- 2-piece sheet metal enclosure
- Detachable control box
- Test tube tray redesigned for greater capacity

Design Evolution: Current Design

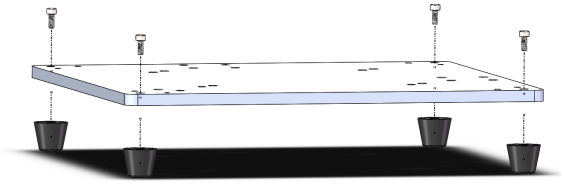


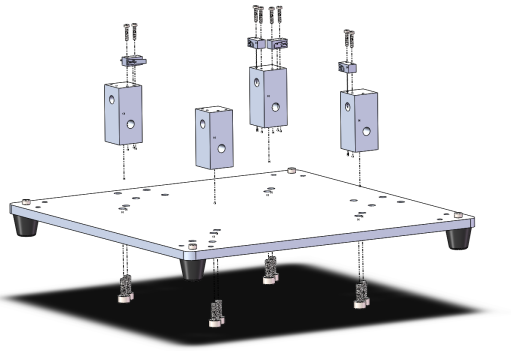


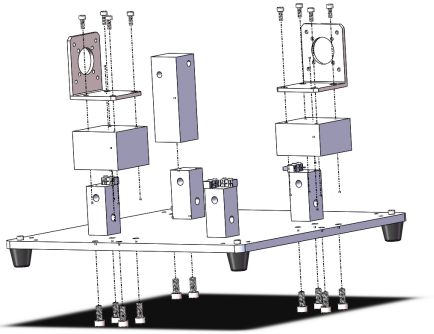
- BLDC Motors -> Stepper Motors (easier control / driving)
- Revisions to control box dimensions and mounting
- Revisions to enclosure for ease of manufacturing
- Currently working on circuit integration and testing
- Working on OD/FI

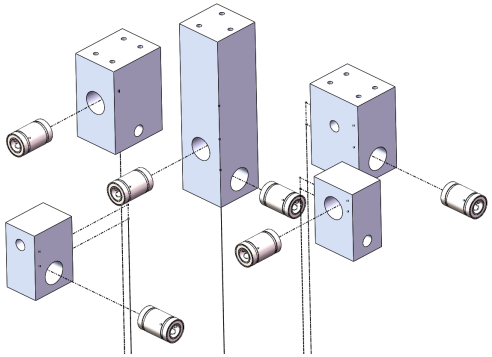


Exploded CAD









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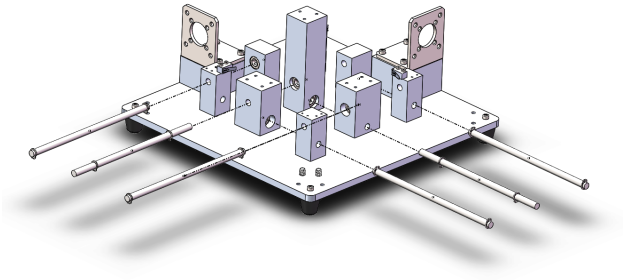

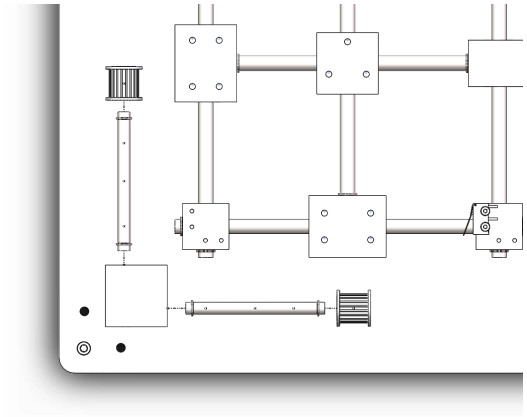

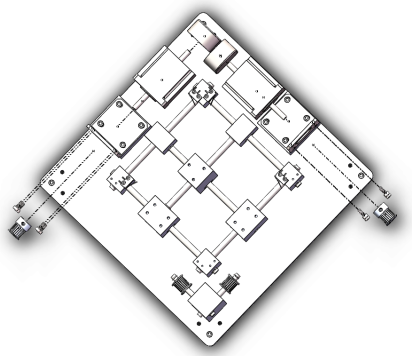

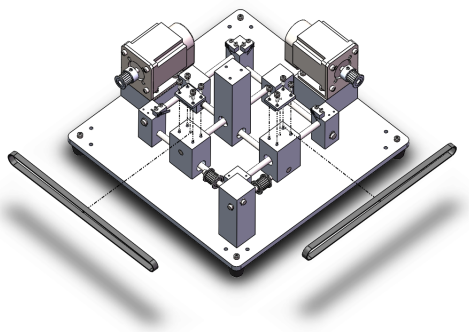

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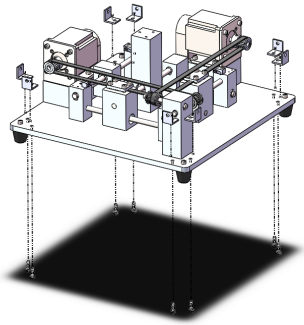
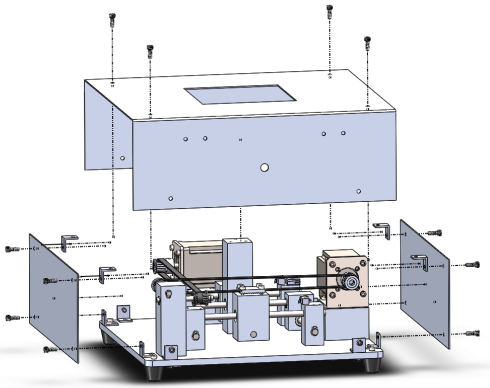
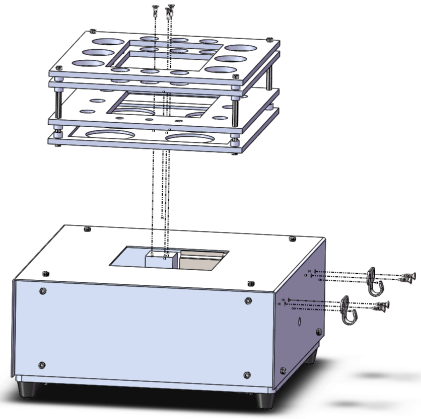
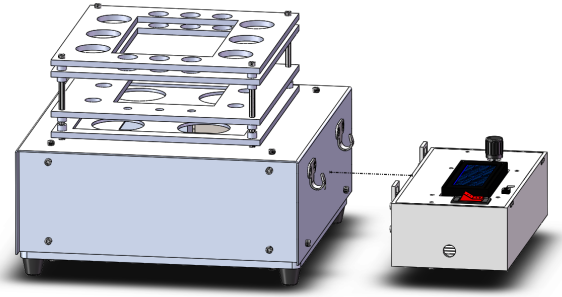






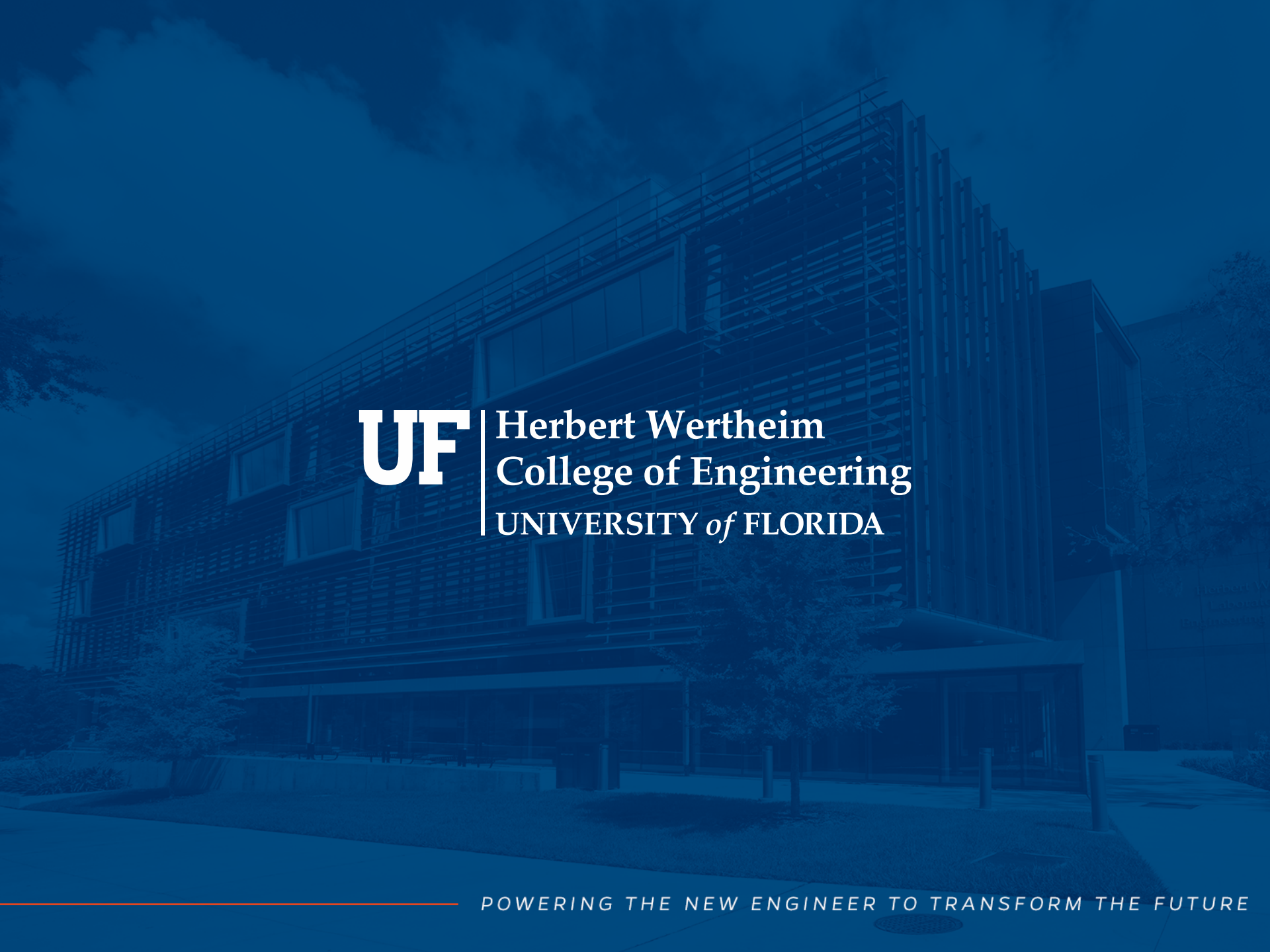


Cost Table

Type	Prototype Cost	Mass Production (1000 units) Cost
OTS Parts and Raw Materials	$1086.17	396.02
Energy	$12.24	$12.24
Manufacturing	$16.72	$8.36
Labor	$70.21	$35.11
Total:	**$1185.34**	**$451.73**

Summary

- Simple design
  - Straightforward user interface
  - Satisfies all the customer needs
- Low cost
  - Sturdy and low-cost materials
- Looks like other available shaker tables on the market but at a cheaper price point
- Easily manufactured and assembled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