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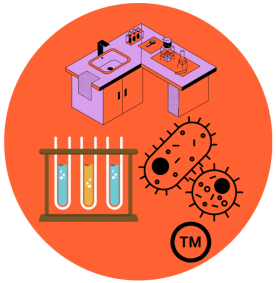
Cell Service Providers



Shaker Table with Integrated OD/FI System

Group 473P – Kailey Carpenter, Itan Gross, Dante Macean, Stefano Marconi, Carlos Rios, Rachel Wrobel

Presentation Overview

Meet the 473P Cell Service Providers Team


Rachel Wrobel

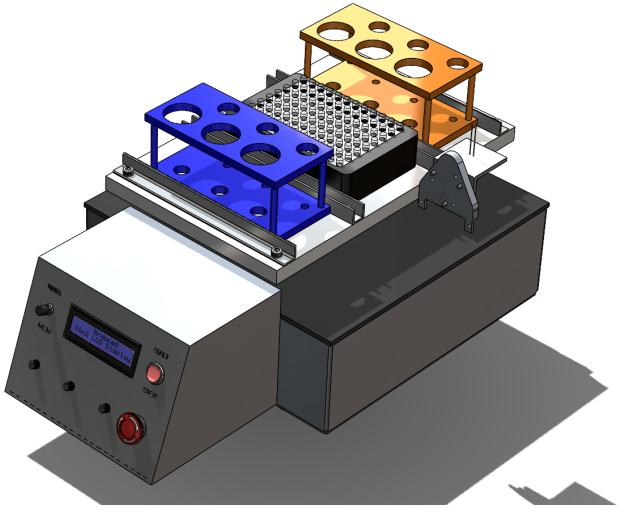

Dante Macean


Kailey Carpenter

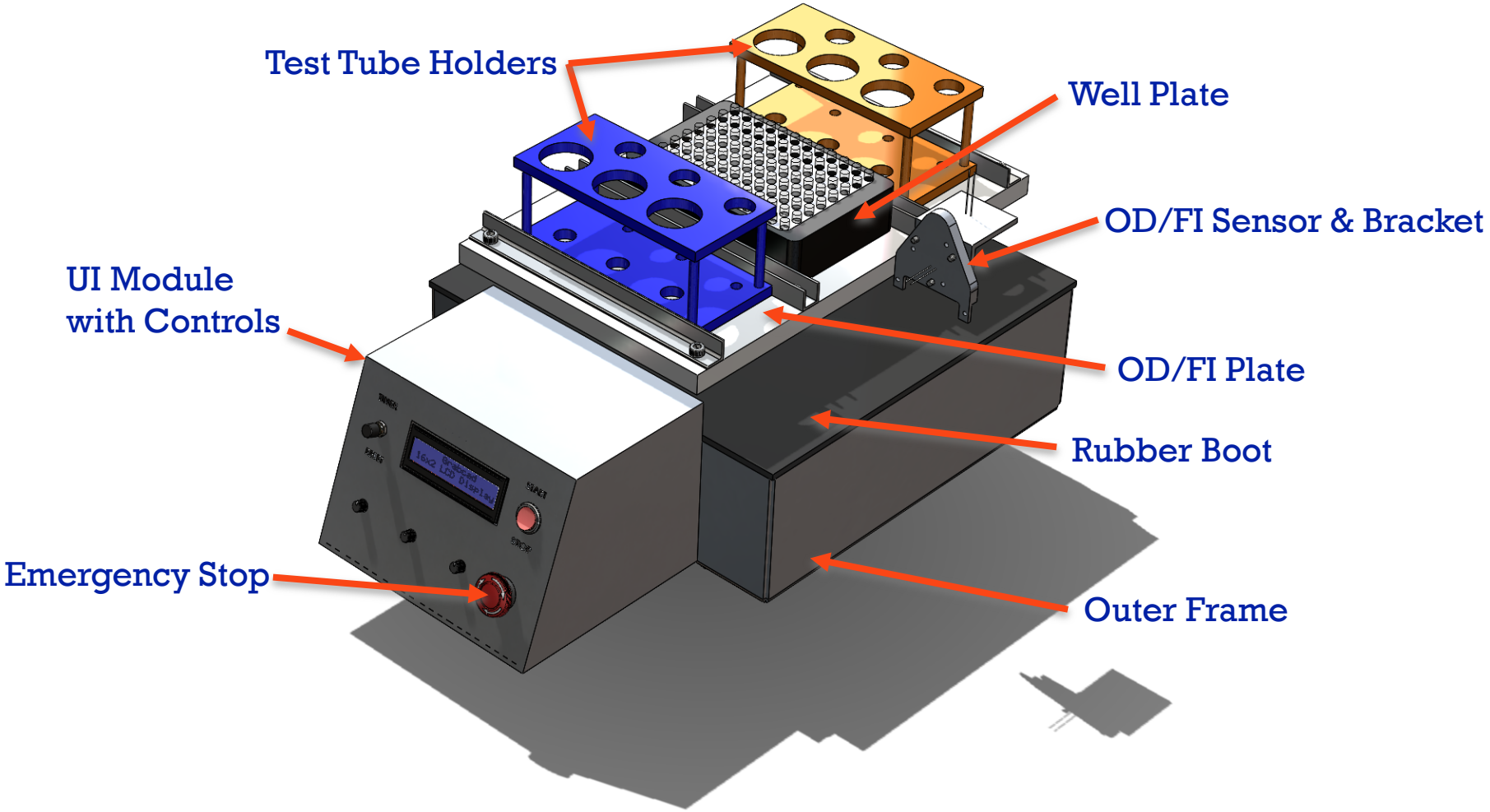

Stefano Marconi


Carlos Rios


Itan Gross

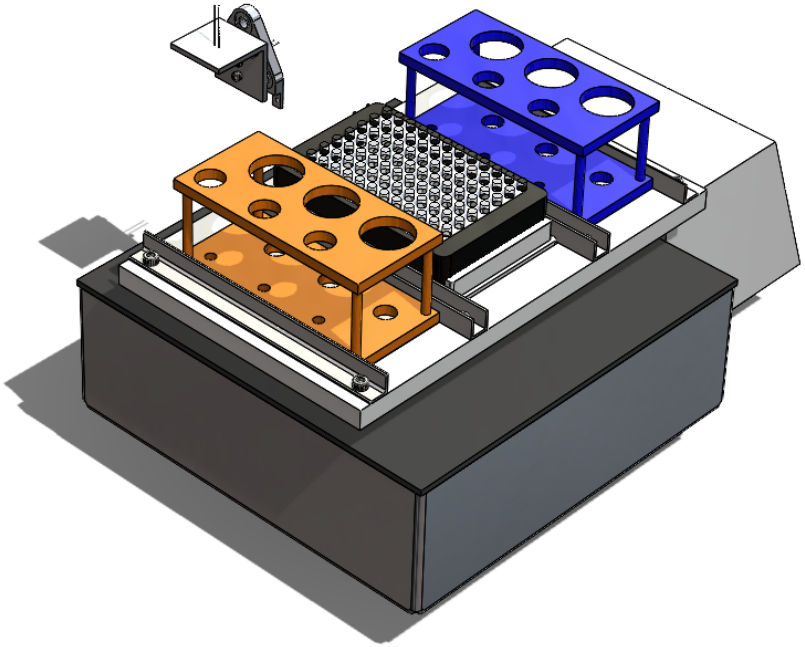

CAD rendering of the Cell Service Provider's team shaker table design

Product Overview

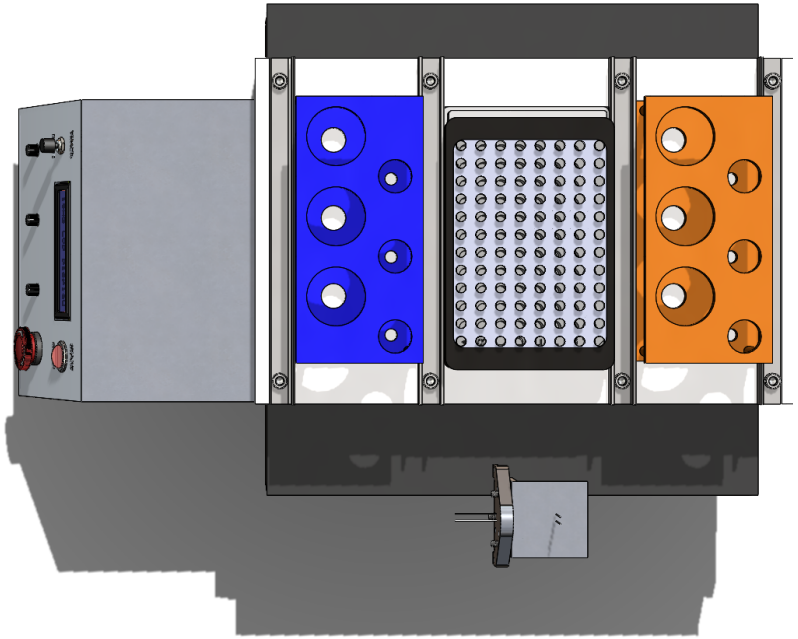


Front isometric view of shaker table

Product Overview



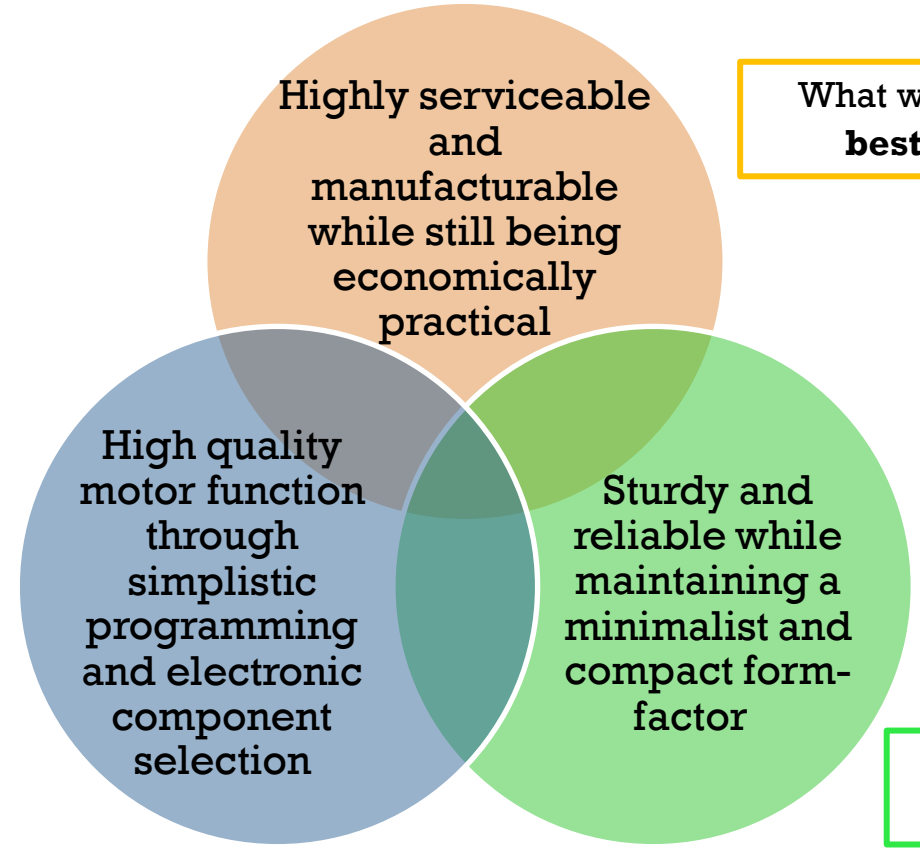
Back isometric view of shaker table



Top view of shaker table

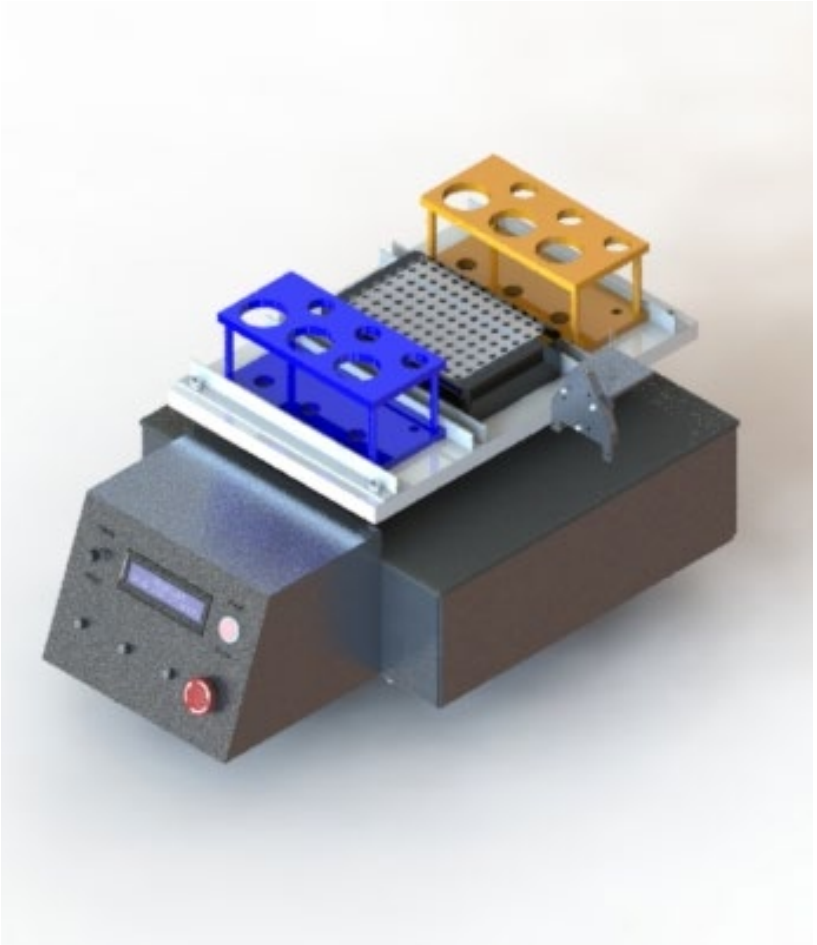
Hedgehog Concept

- Our main goal while designing was to create a well made, easy-to-use product at a reasonable cost.



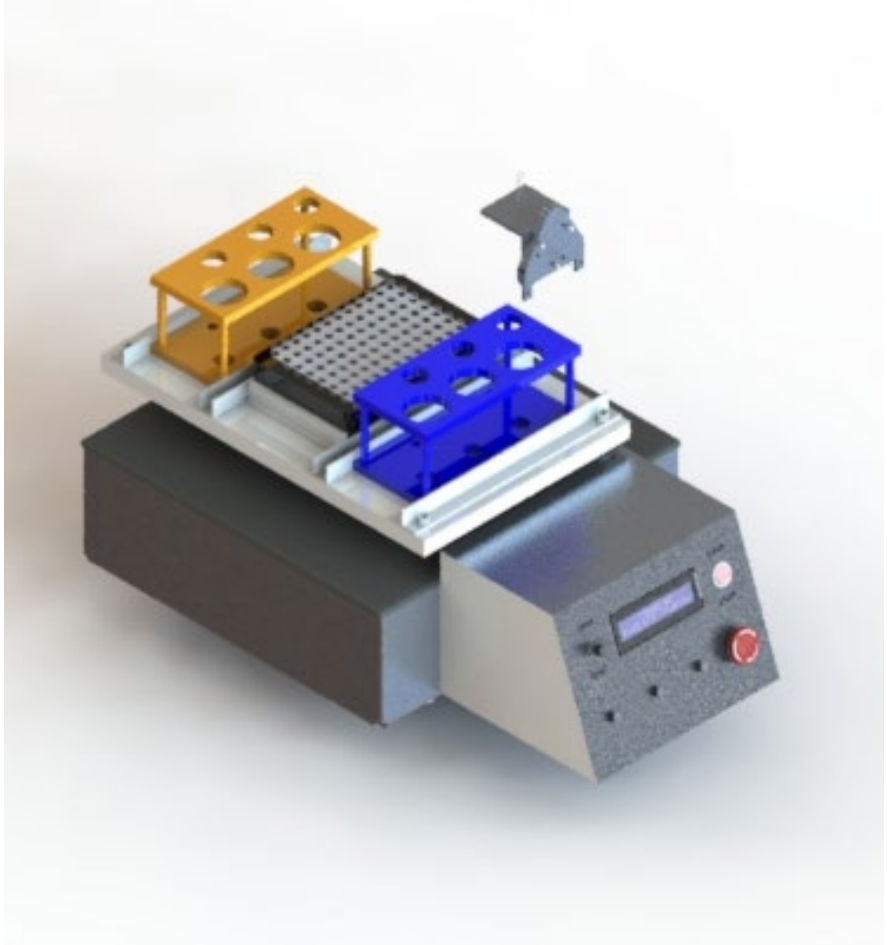
Key Product Specifications

- Detachable User Interface (UI) module that disconnects from shaker table while maintaining shaking operations
- Manufactured for <$500
- IP-X5 Certified Waterproof rating for working electronics (except UI module)
- Generates multiple motion patterns (linear, orbital, double orbital) at variable speeds defined by user
- Accommodates two test tube holders and one well plate



Key Product Specifications

- Integrated Optical Density/Fluorescent Intensity (OD/FI) light sources emitting ~365nm of light
- Includes OD/FI photoresistor sensor unit for solution measuring purposes
- Can withstand environments with temperatures ranging from 0°C (32°F) to 70°C (158°F)



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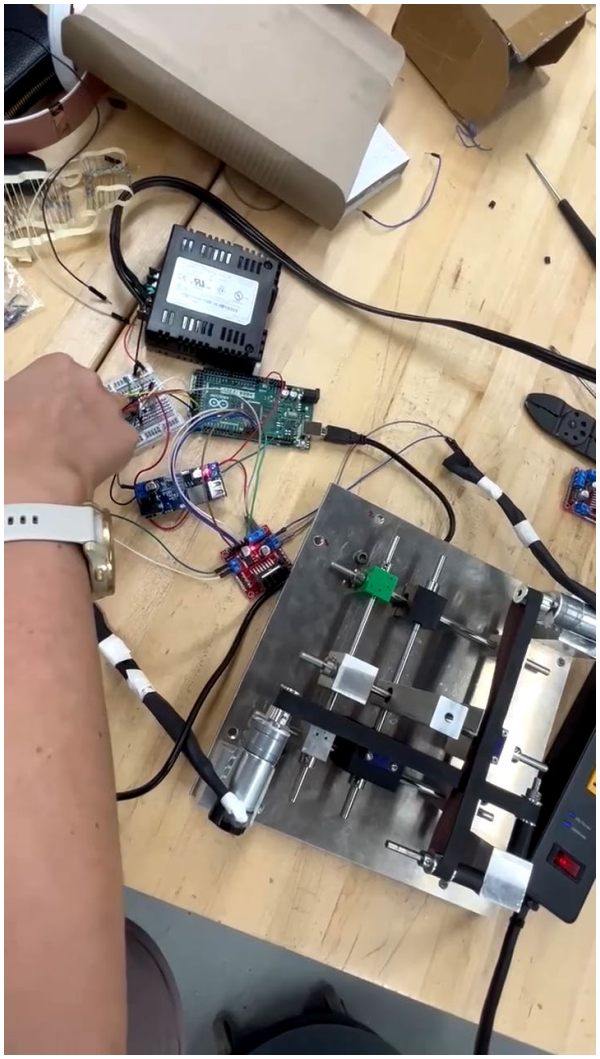
Prototype Demonstrations

Prototype Demos – Motion Patterns

- Three motions:
  - Linear
  - Orbital
  - Double Orbital
- Average RPM = 390
- 1st step

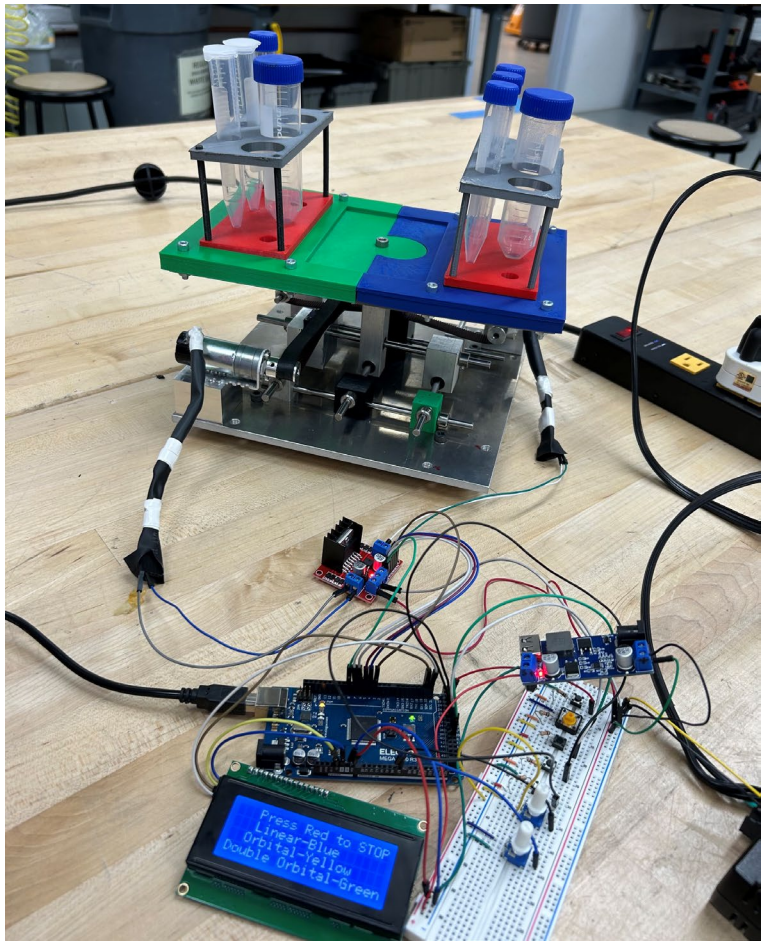


Prototype Demos – IP-X5 Test

- Water test
- Heat shrink, electrical tape, waterproof Loctite used
- 4 minutes of water spray with commercial hose

Prototype Demos – Full Machine Test

- Collision of finished electrical, code, mechanical assembly
- Functions tested include self sustained operation (linear test), adjustable parameters, and safety features



Prototype Demos – Temperature Test

- Withstand as low as 0°C and up to 70°C
- Fridge and mini oven used
- Still to be conducted
- PETG melting point = 220 °C
- Perf board assembled

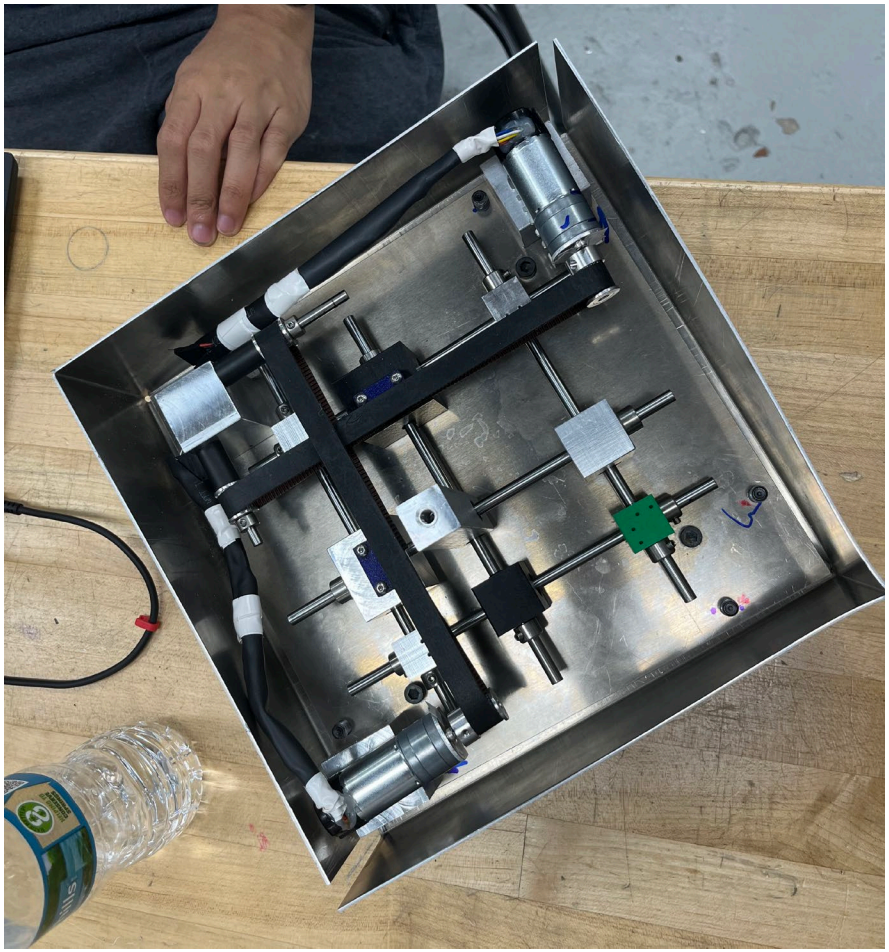
Properties	Typical value		Standard	
	PLA	PETG	PLA	PETG
Heat deflection temperature (0.45 MPa)	55°C	68°C	ISO 75	ISO 75
Modulus of elasticity	2.3 GPa*	2.1 GPa	ASTM D638	ASTM D638
Maximum melting temperature	145-160°C	220-245°C	ISO 11357	ISO 11357
Glass transition temperature	55-60°C	80-82°C	ISO 11357	ASTM E1356
Elongation at flow	2%	14%	ASTM D638	ASTM D638
Final traction force	26.4 MPa**	45.8 MPa	ASTM D638	ASTM D638

*GPa-gigapascals, ** MPa-megapascals

PETG [Polyethylene Terephthalate Glycol-Modified], one of the most widely used filamen

Prototype Demos – Drop Test

- Dropped from 75 cm height
- Sheet metal walls added to protect internal components
- Designed with strong motor mounts in mind



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Design Analysis and Highlights

Design Highlights

- Major Changes from Fall 2022 Design
  - Fall 2022: Nema 17 Stepper Motors → Spring 2023: 12V DC Polulu 25D Gearmotors
    - The original design utilized stepper motors, however in order to achieve variable speed capabilities and be able to withstand a wide temperature range, DC motors were chosen. Analysis as to how these motors were completed and can be seen in the proceeding slides.
- Fall 2022: No Integrated OD/FI system → Spring 2023: Designed Integrated OD/FI system
  - The original design only focused on the shaking aspect of the table design, but to make the product more appealing to a variety of potential customers, an integrated OD/FI system was designed.

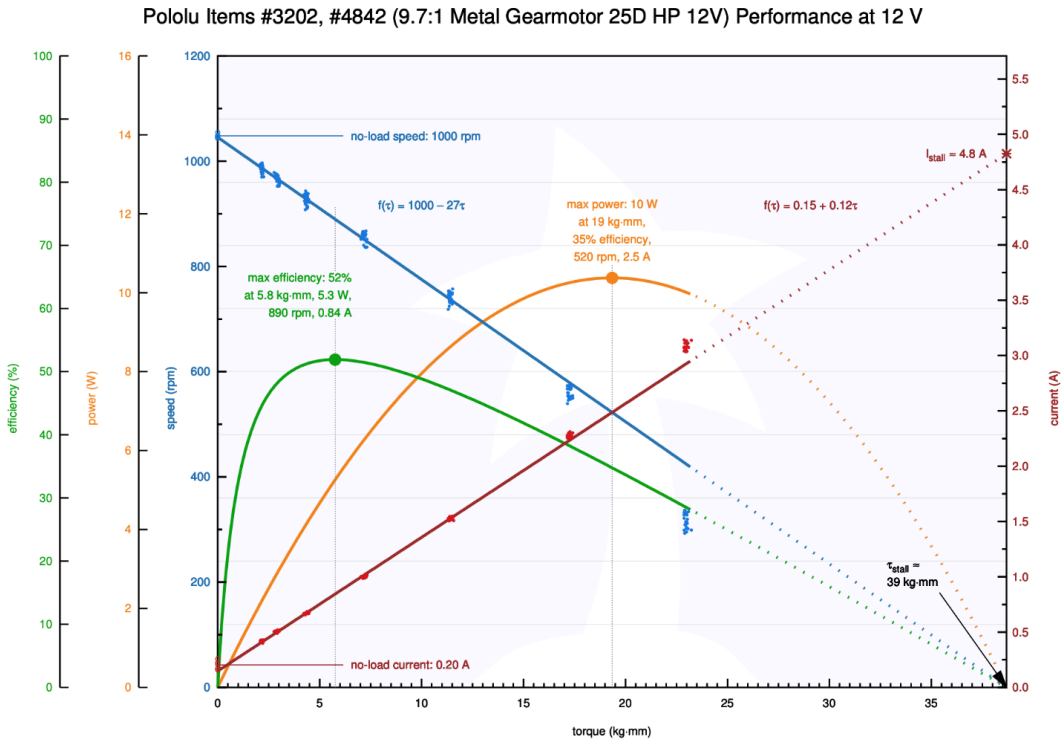
Motor Selection Analysis – Torque

- Torque analysis begins with finding the axial force experienced by the motor shaft.
  - $F_a = mg\mu = (2.27\ kg)\left(9.81\frac{m}{s^2}\right)(0.51) = 11.4\ N$
  - Motor experiences an axial force of 11.4 N

- Next, the torque required from the motor could be determined using the following equation:
  - $T = \frac{F_a r}{1000\eta} = 0.11\ \text{Nm}$
  - From the above, it was found that the motors would need to supply a minimum torque of 0.11 Nm.

Motor Selection Analysis – Speed vs. Torque Plot

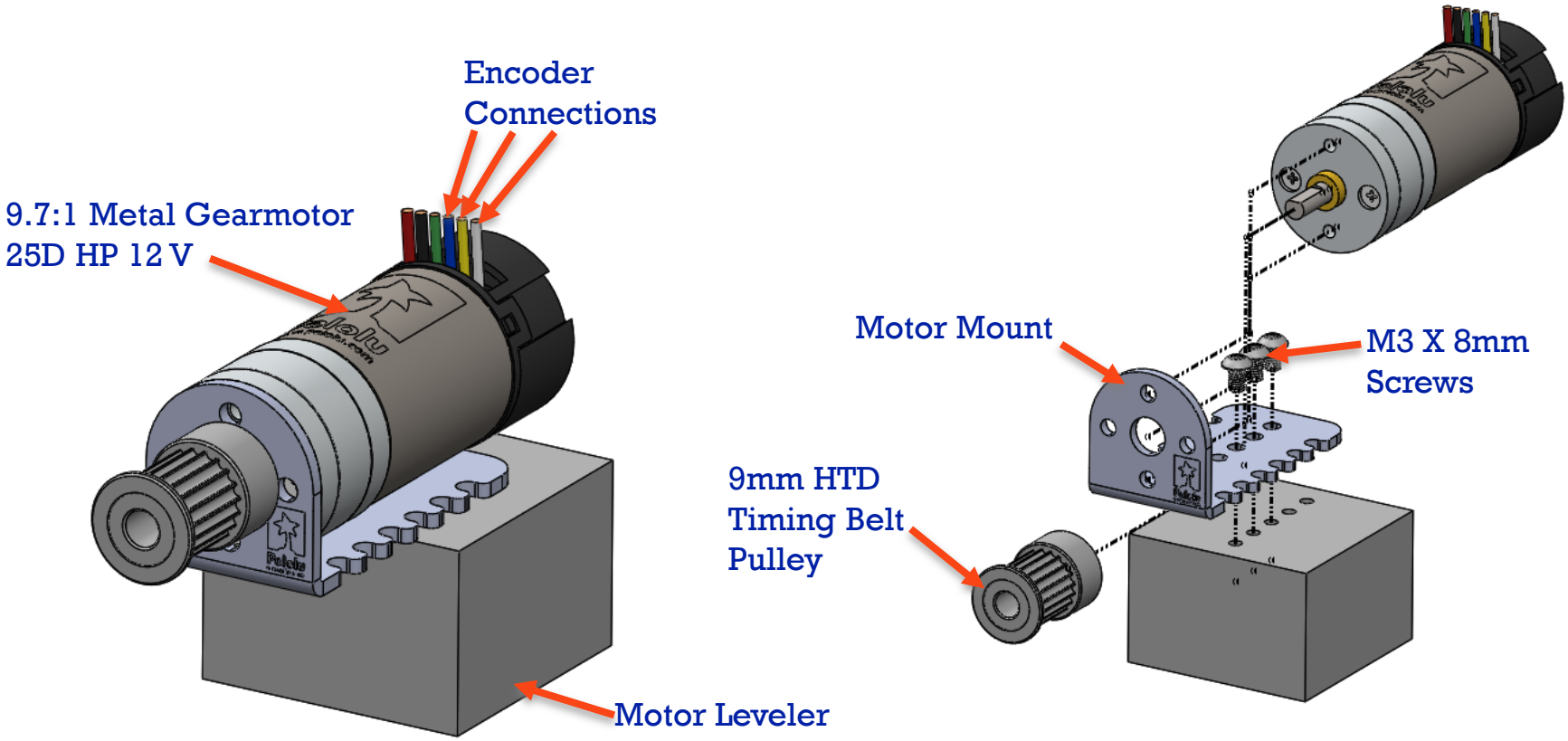
- Polulu Robotics and Electronics manufactures 12V DC motors with encoders
- After looking at speed vs. torque plots, a **9.7:1 Metal Gearmotor 25D HP 12 V** was selected



- At 350 rpm, the selected motor can provide 0.27 Nm of torque, which is over two times the required torque. Additionally, it can run up to 1000 rpm and can still supply more than enough torque

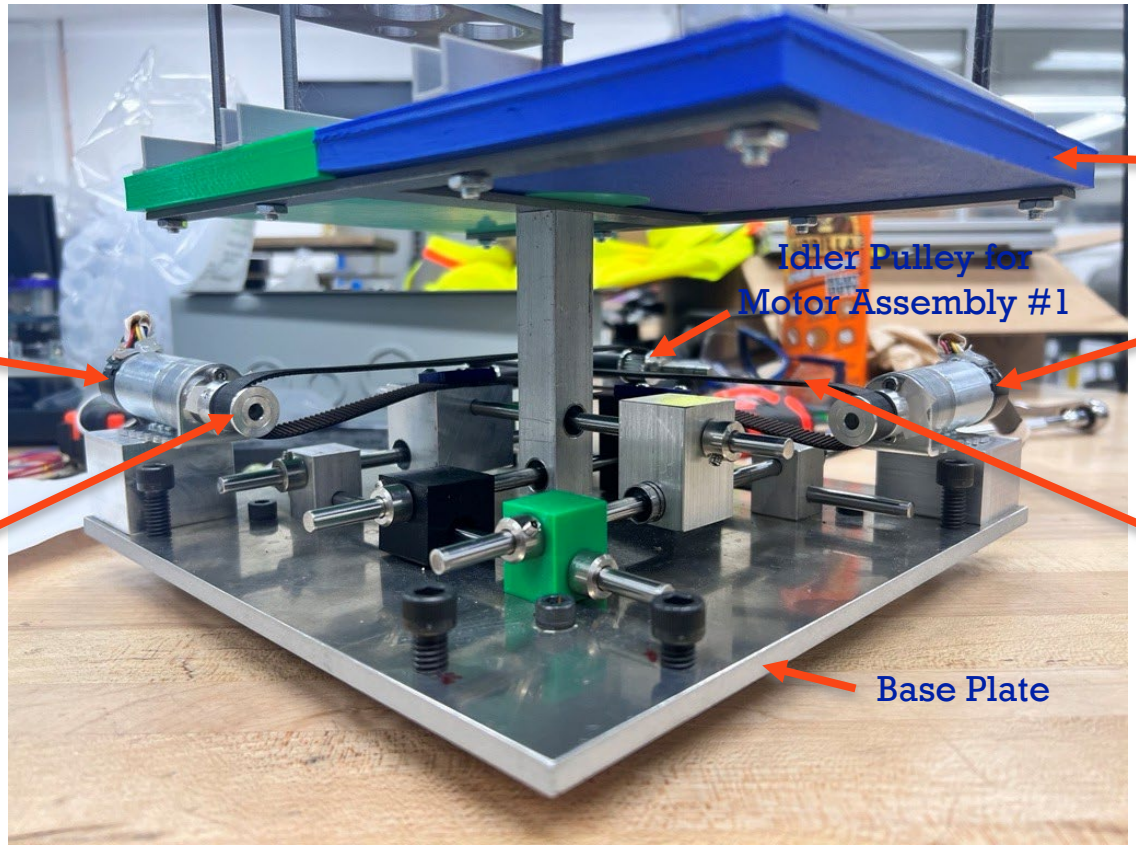
Motor Selection Analysis

- Below is an image of one of the motor assemblies.



Motor Selection Analysis

- Below is an image of the physical implementation of the motors into our design.



Drop Test Analysis – Outer Frame

Analysis Proving Resilience to 75 cm Drop

$$V_f^2 = V_i^2 + 2a\Delta y \rightarrow$$

$$V_f = \sqrt{2\left(9.8\ \frac{m}{s^2}\right)(0.75m)} = 0.4\ \text{m/s} = \text{Velocity on impact}$$

$$F = \frac{mv^2}{2d} \rightarrow$$

$$\frac{(1.135\ kg)(0.4m)^2}{2(0.142m)} = 0.64\ \text{N Force on impact}$$

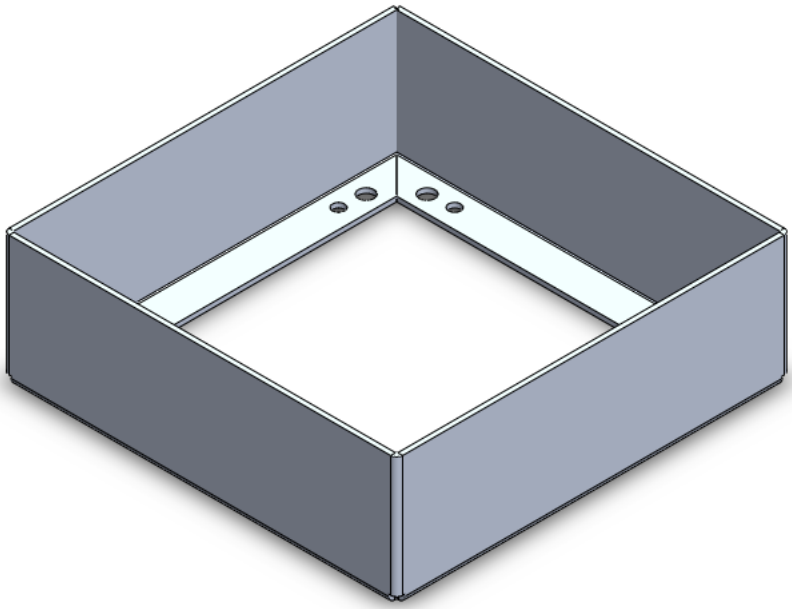
$$\sigma = \frac{F}{A} \rightarrow$$

$$\frac{0.64\ N}{6.4\ m^2} = 10\ \text{Pa} = \text{Stress on impact}$$

Aluminum Yield Strength is 270 MPa >> 10Pa

Drop Test Analysis – Outer Frame

- From the analysis completed on the previous slide, the outer frame was designed using 6061 T6 Aluminum sheet metal as it assists in the structural rigidity of the shaker table and assists in keeping the noise level down while operating. The image below is a CAD screenshot of the outer frame.



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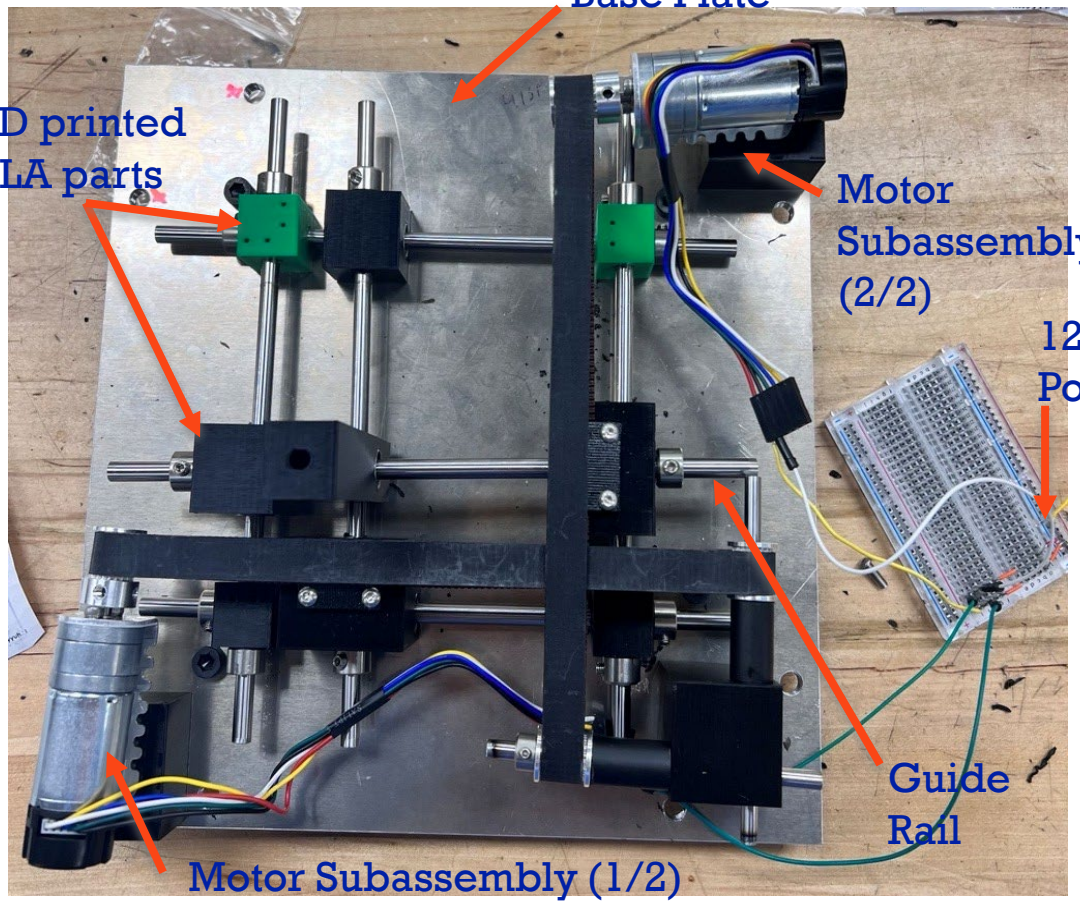
Design Evolution

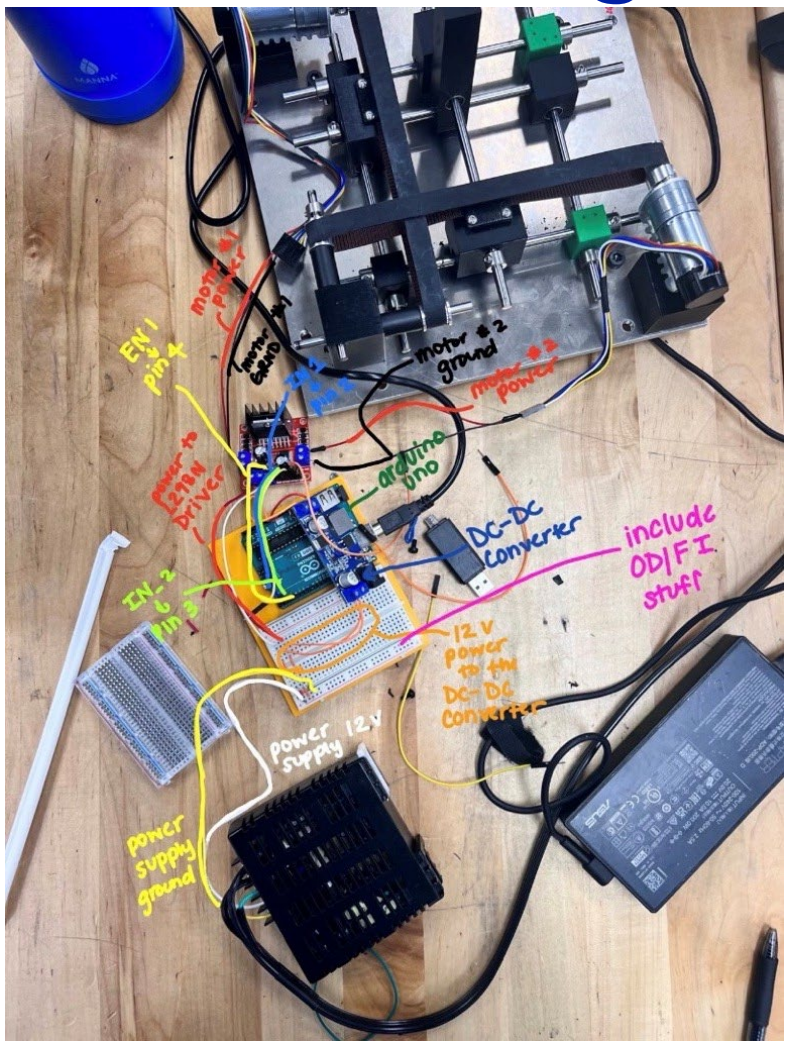
Design Evolution – Initial Build

- Mechanical Structure:
  - Machined base plate & rails
  - PLA 3D printed parts
- Electrical Structure:
  - 12V sent to motors



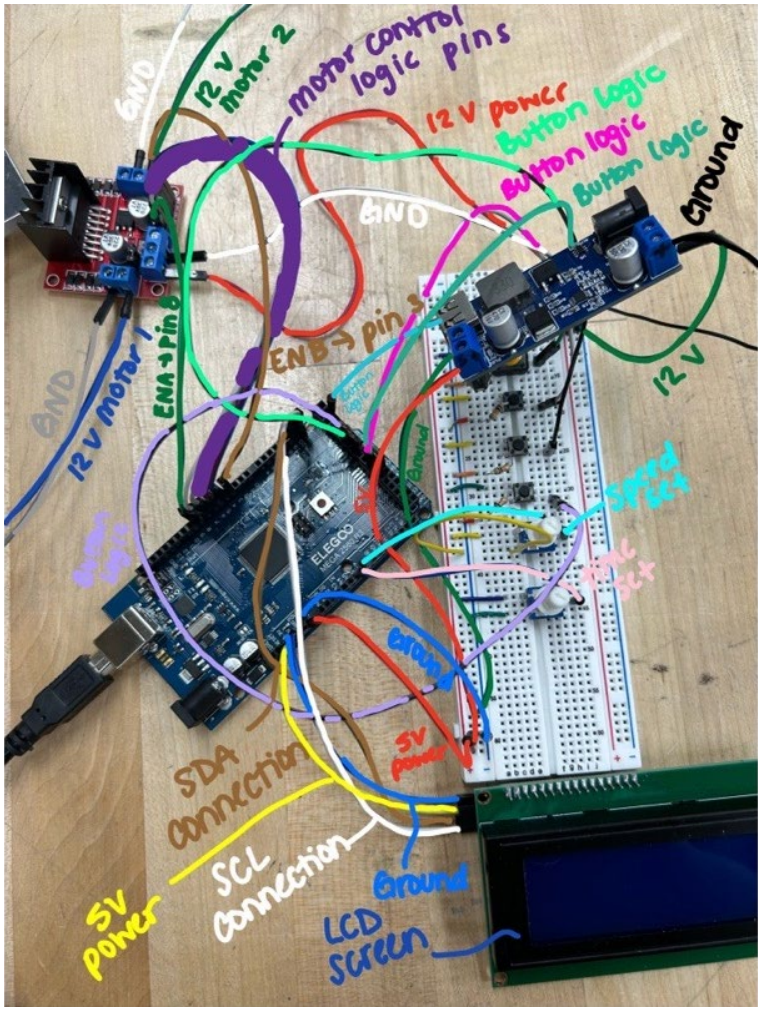
Design Evolution – Initial Wiring

- Electrical Components:
  - Breadboard
  - Arduino
  - L298 Motor controller
  - DC-DC converter
  - AC-DC converter
  - Motors
- Initially tested that the motors could perform the three patterns



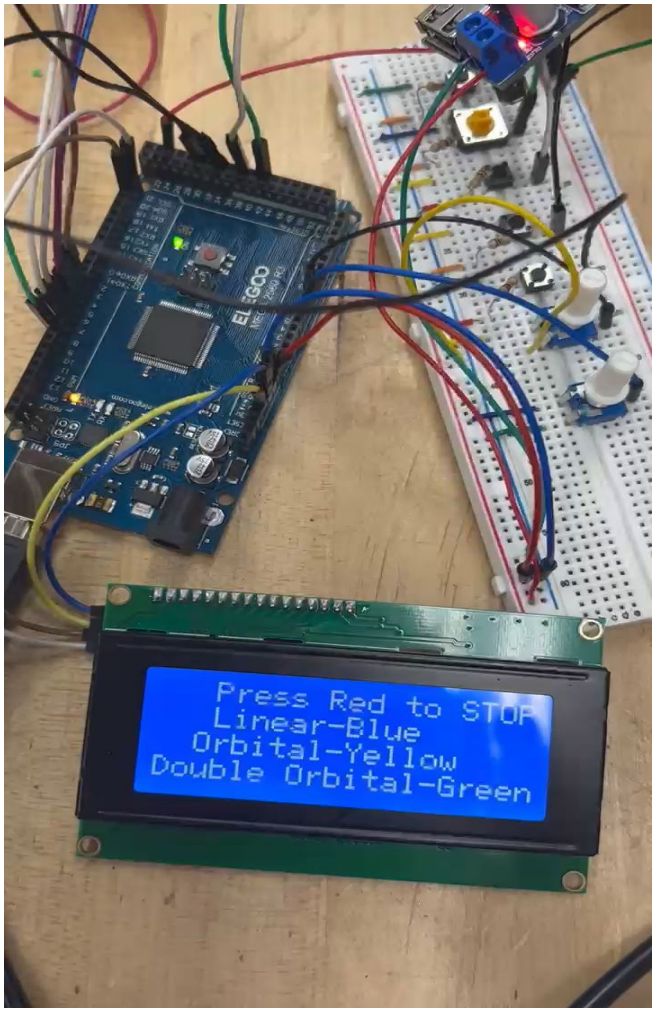
Design Evolution – Current Wiring

- Electrical Components:
  - Breadboard
  - Arduino Mega
  - L298 Motor controller
  - DC-DC converter
  - AC-DC converter
  - Motors
  - Buttons
  - Potentiometers
  - LCD 2004
- Capable of full machine demonstration



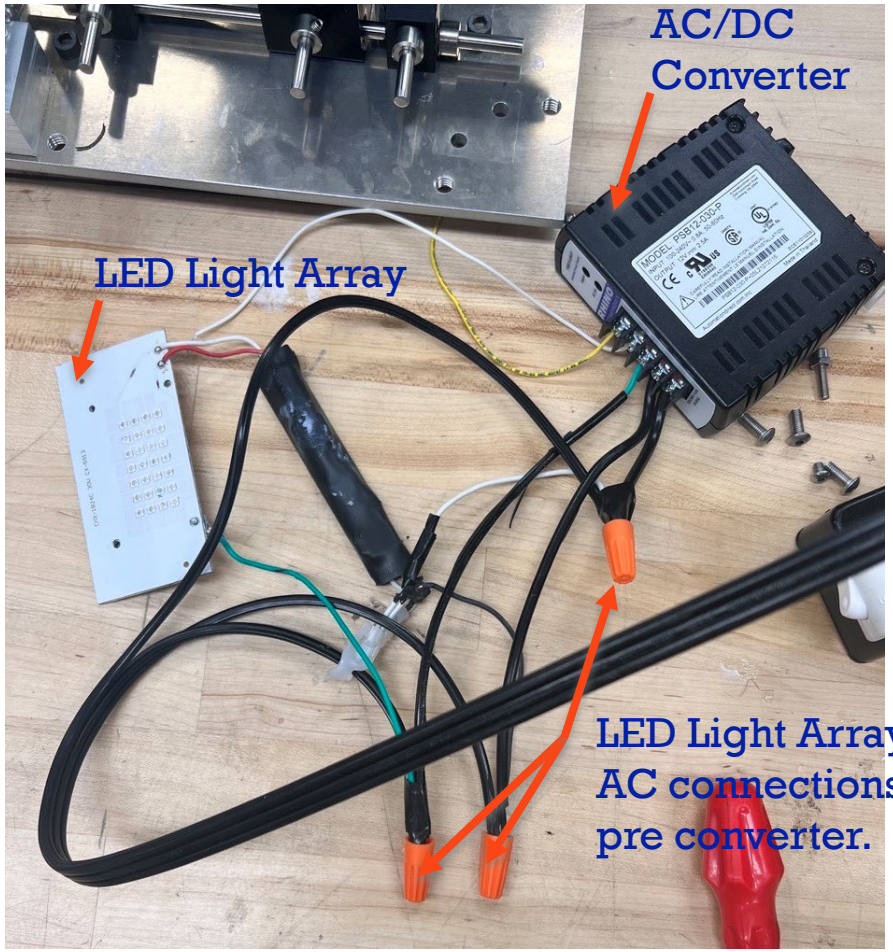
Design Evolution – Programming

- Void loop{
  - While (black == low) {
    - //code for main menu displays}
  - If (yellow==high & red==low) {
    - //code for orbital pattern}
  - Else If (blue==high & red==low){
    - //code for linear pattern}
  - Else If (green==high & red==low){
    - //code for double orbital pattern)
  - Else if (red == high) {
    - //code to turn off machine and display message to LCD screen}
  - }



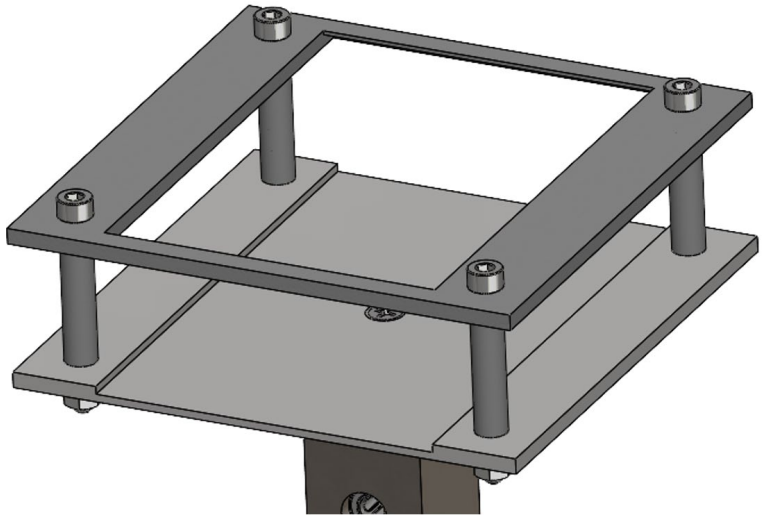
Design Evolution – Initial OD/FI Wiring

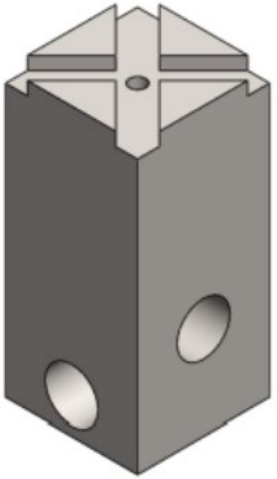
- LED light array emits ~365 nm wavelength
  - Operates on AC power
  - Power supply was spliced to power both the LED and shaker table
- LED circuit shorted and progress has been halted due to shipping delays

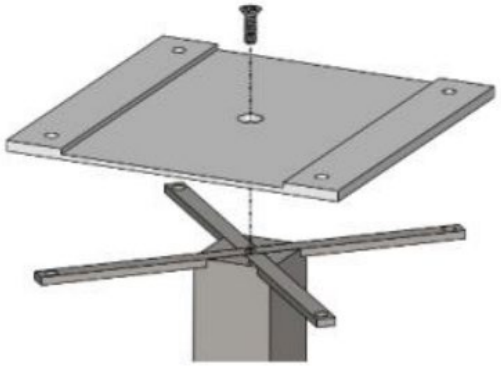


OD/FI Plate Evolution

- From the Fall 2022 design, the OD/FI plate looked as so:

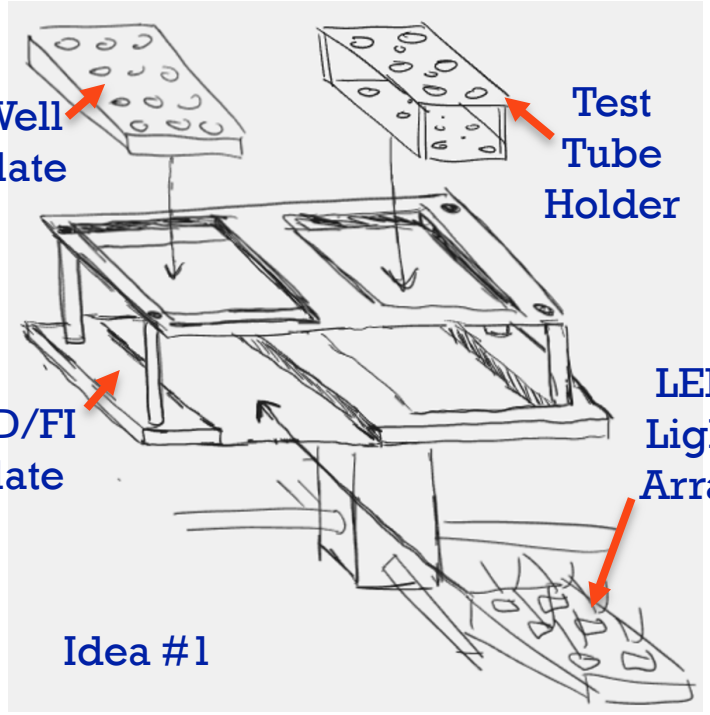






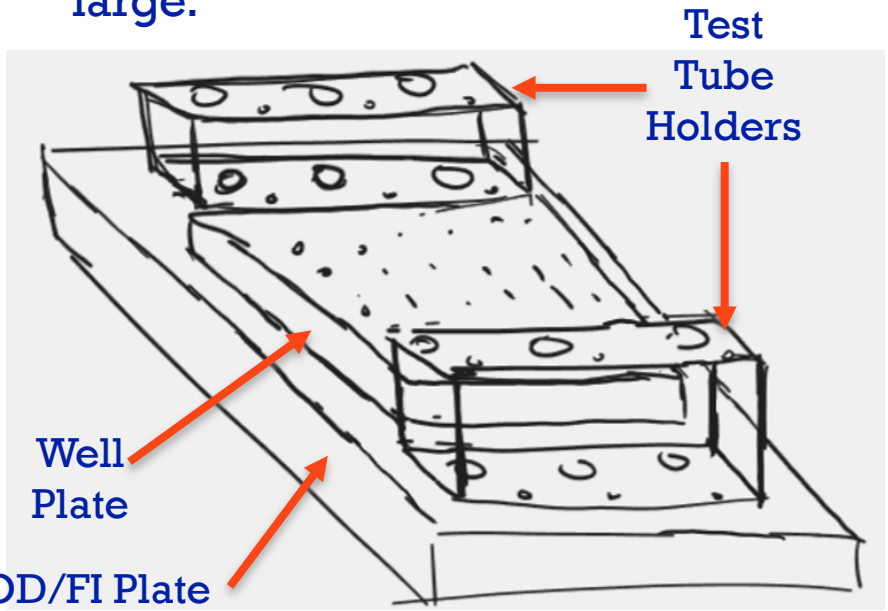
OD/FI Plate Evolution

- In order to incorporate the more test tubes and a well plate, the following design was sketched:



Idea #1

- Main issue was that the distance between the light array and the test tube holder/well plate was too large.

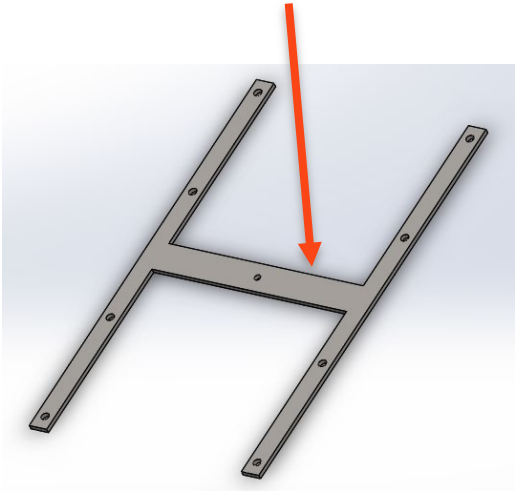


Idea #2

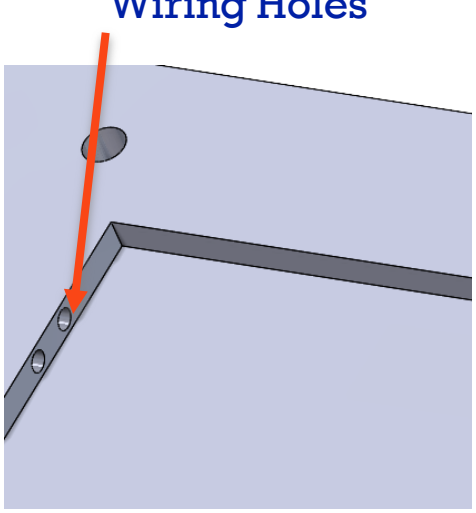
OD/FI Plate Evolution

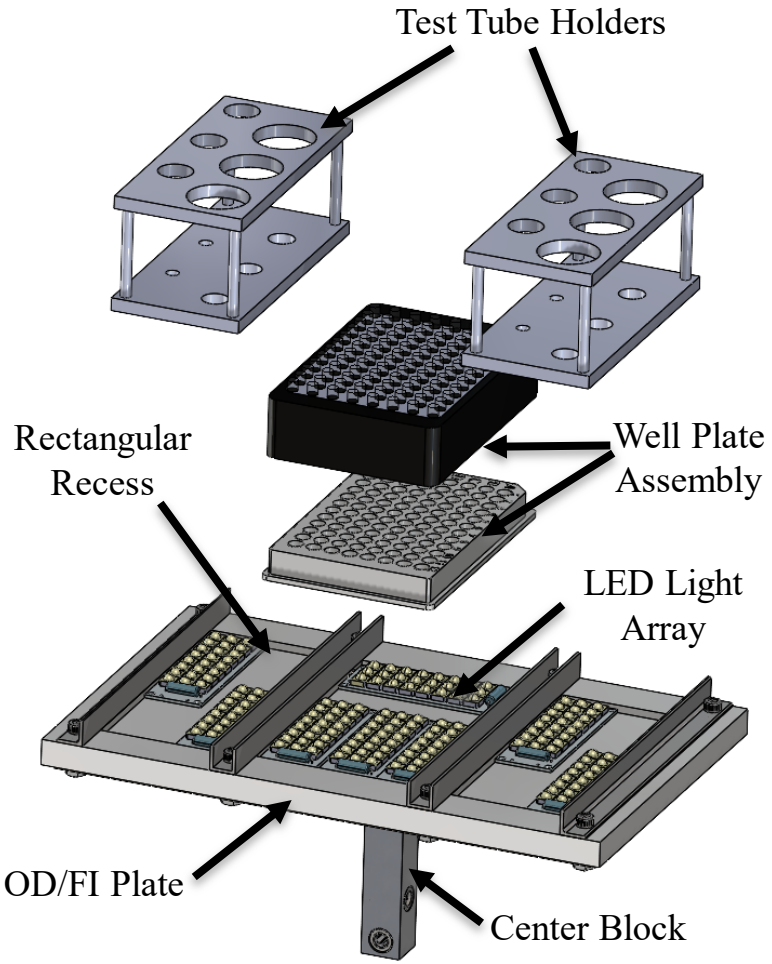
- Using idea #2 as the guideline, the OD/FI Plate to the right was developed.
- Place-holder LED PCB arrays were used
- Support rods modified to "H-bracket" configuration

Support Bracket



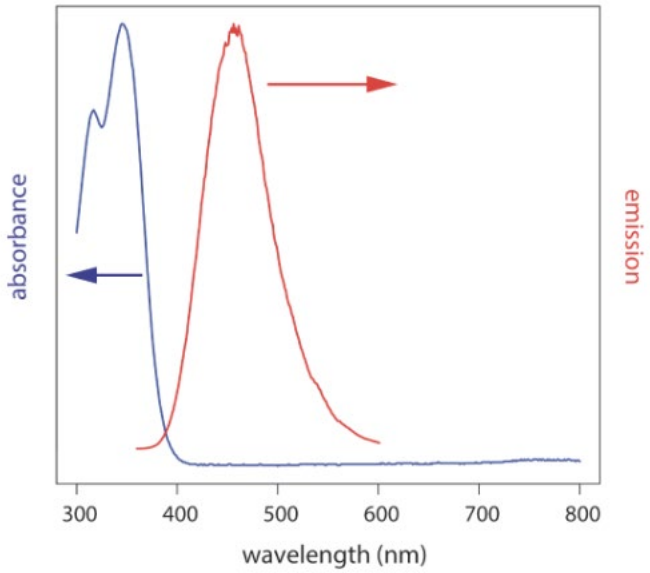
OD/FI LED Array Wiring Holes





Photoresistor/LDR Sensor Design

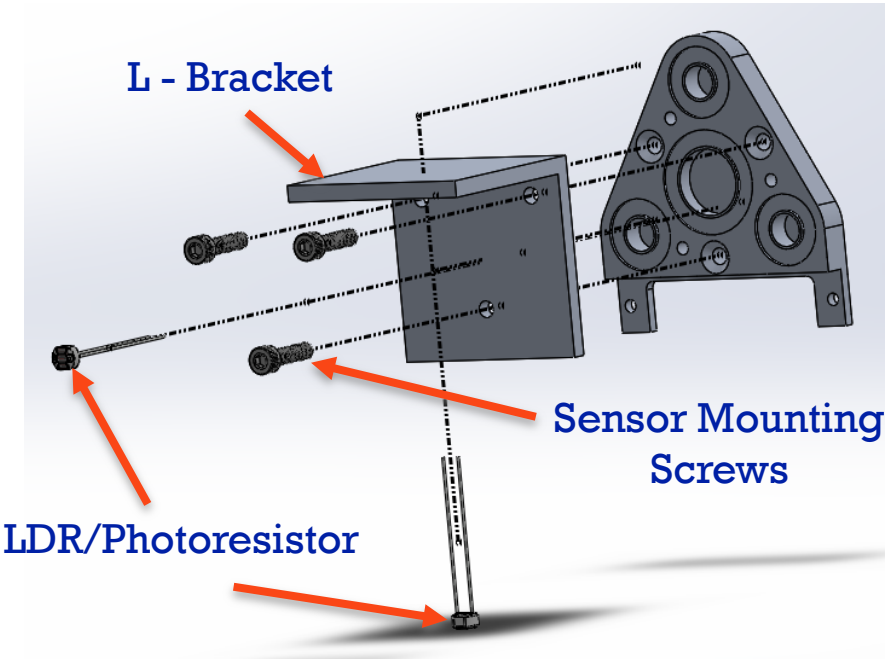
- LED light arrays emit light at wavelength of ~365 nm
- Use Quinine as test solution, has absorbance peaks at 250 nm and 350 nm
- Use photoresistor/LDR to detect light emitted in spectral range
  - For Quinine, emits at a wavelength of ~450 nm

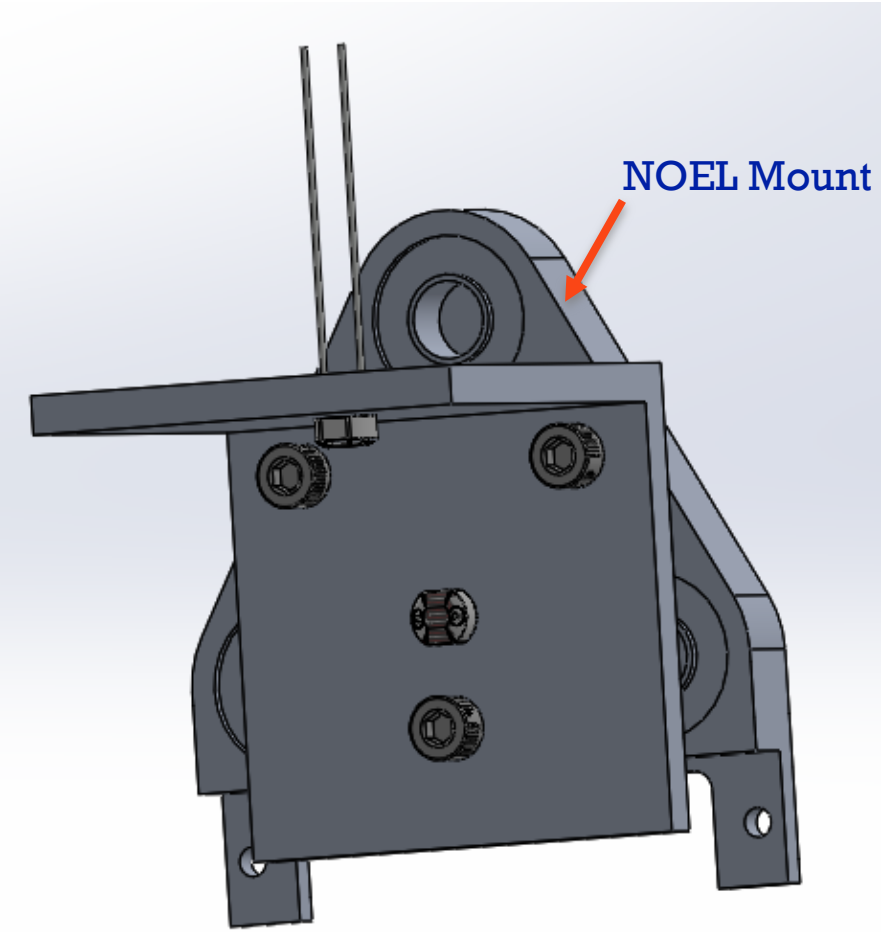


Absorbance spectrum and fluorescence emission spectrum for Quinine [3]

Photoresistor/LDR Sensor Design

- Design approach: design a sensor that measures the excitation wavelengths of Quinine that is perpendicular to the light source to not contaminate the measurement





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Cost Analysis

Cost Summary – One Prototype Build

	1 Prototype Build	Production Scale of 100
Mechanical Components	$462.25	$346.69
Electrical Components	$150.02	$112.52
Total	$612.27	$459.20

- For more information, purchase orders are available at the end of the presentation.

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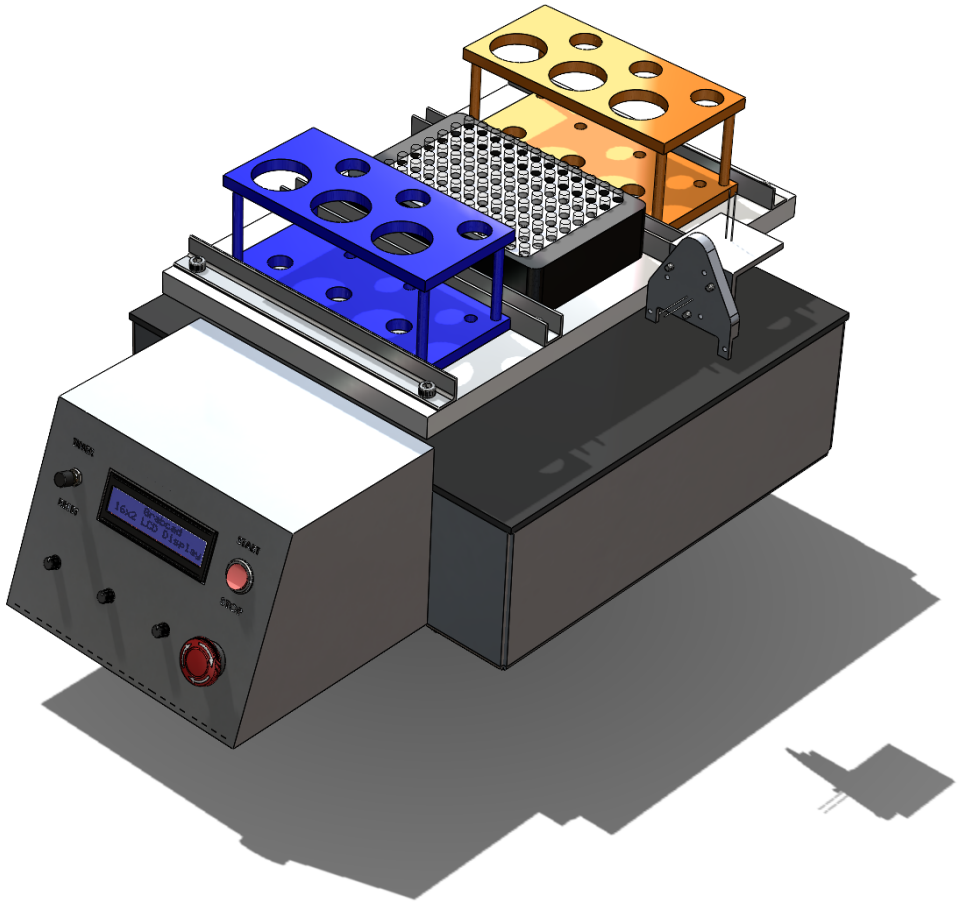
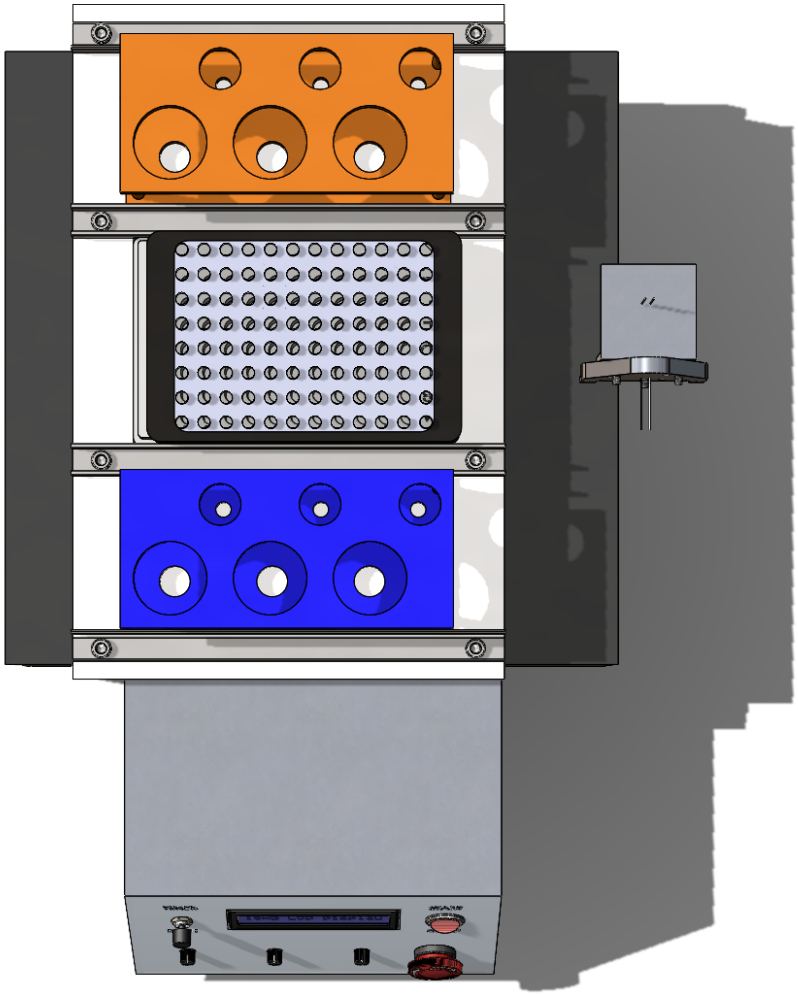
Total Overview

Final Product Overview





Thank you!

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Backup Slides

Mechanical Purchase Order

REQUEST FOR ITEMS TO BE PURCHASED

Date Requested: 2/20/2023

1. Purchase Order Number: 1
2. Group requesting item(s): Cell Service Providers (473P)
3. Account to be charged: MAE Mechanical Design 3
4. Group member issuing PO: Stefano marconi

BOM Part Name	Description of item to be purchased:	Part Number	Qty.	Unit	Price	Shipping	Sub Total	Vendor Name	Vendor Address	Vendor City/State/Zip	Vendor Phone Number
Screw Shaft Collar	303 Stainless steel set screw shaft collar, hex socket, OD 10mm, Width 6mm	6058N13	8	Single	$ 34.56	$ 9.69	$ 44.25	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/6058N13/								
Screw Shaft Collar	303 Stainless steel set screw shaft collar, hex socket, OD 12 mm, Width 8 mm	6058N14	4	Single	$ 17.28	$ 9.69	$ 26.97	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/6058N14/								
12mm Belt Pulleys	Corrosion resistant HTD Timing Belt Pulley, press fit mount, finished bore type, MATL: Aluminum	3684N14	2	Single	$ 16.92	$ 9.69	$ 26.61	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/3684N14/								
12mm Belt Idler Pulleys	High-strength HTD timing Belt Idler Pulley, finished bore type, MAT: Aluminum	3693N13	2	Single	$ 19.34	$ 9.69	$ 29.03	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/3693N13/								
Pulley Rod Shims	18-8 Stainless Steel Round Shim, 0.1mm thick, 5mm ID	98089A205	1	Pack	$ 7.75	$ 9.69	$ 17.44	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/98089a205/								
Unthreaded Spacer Stocks	Unthreaded spacer shock, polypropylene spacer stock, 1/2" OD	92377A620	1	Single	$ 5.41	$ 9.69	$ 15.10	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/92377A620-92377A120/								
12V DC Motor	12V, 1000 RPM, 300mA, metal gearmotor with 48C CPR Encoder	Pololu #: 4842	2	Single	$ 97.90	$ 7.95	$ 105.85	Pololu	920 Pilot Road, Las Vegas NV	Las Vegas, Nevada 89119	702-262-6648
		Web Site:	https://www.pololu.com/product/4842								
Guide Rail Shafts	6mm linear motion shafts, 200mm long, raw stock material	6112K52	6	Single	$ 95.58	$ 10.12	$ 105.70	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/6459K1/								
Sheet Metal frame	6" by 48" sheet metal to provide for 4.25" by 40" dimensions	89015K17	1	Single	$ 22.58	$ 25.00	$ 47.58	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/89015K17/								
Sheet Metal frame Hex Head Screws	alloy steel socket head screws, thread size 5.6" - 18, UNC thread type.	91251A581	1	Pack	$ 11.41	$ 10.12	$ 21.53	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/91251a581/								
Shaker Plate Assembly Socket Screws	Black Oxide Alloy Steel Socket Head Screw, 10-32, 7/8" Long	91251A346	1	Pack	$ 9.64	$ 9.69	$ 19.33	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/91251A346/								
Steel Hex Nuts	Low Strength, Steel Hex Nut, Zinc-plated, 10-32 thread size	90480A195	1	Pack	$ 2.20	$ 9.69	$ 11.89	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/90480A195/								
L-channel Aluminunm extrusion	Multipurpose 6061 aluminum 90 degree angle, 2ft long, 1/16" thickness	8982K65	1	Single	$ 2.60	$ 9.67	$ 12.27	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/8982K54/								
Pulley Shafts/Rods	Pulley shafts and rods for directional movements	6112K37	1	Single	$ 10.98	$ 8.87	$ 19.85	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/6112K37/								
Button Head Cap Screws for Drive Rails	button head cap screws for drive rails	92095A160	1	Pack	$ 5.96	$ 8.87	$ 14.83	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/92095A160/								
Bearings	bearings for motor levelers	3766N13	6	Single	$ 10.62	$ 8.87	$ 19.49	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.amazon.com/gp/product/B07K71FWMG								
M6 Alloy Steel Socket Head Screw	M6 Alloy steel socket head screw	91290A316	1	Pack	$ 14.57	$ 9.27	$ 23.84	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/91290A316/								
Medium-Strength Steel Hex Nuts - Grade 5 Black Corrosion-Resistant Coated, 5/16"-18	medium high strength steel hex nuts	98797A030	1	Pack	$ 9.14	$ 9.27	$ 18.41	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/98797A030/								
Support Blade Screw	support blade screw	92210A199	1	Single	$ 13.97	$ 9.27	$ 23.24	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/92210A199/								
Silicone for Boot	Silicone material to wrap around the boot	1460N32	1	Single	$ 89.93	$ 18.24	$ 108.17	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/1460N32/								
Belt	Drive belt to attach to motor shafts	3682N3	2	Single	$ 48.44	$ 18.54	$ 66.98	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/3682N3/								
Sensor Bracket Screws	Sensor Bracket screws	91251A128	1	Pack	$ 12.14	$ 18.92	$ 31.06	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/91251A128/								
Neoprene Rubber Feet	Neopere rubber material for water resistance purposes	9546K212	4	Single	$ 16.36	$ 18.92	$ 35.28	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/9546K212/								
ODFI L bracket screws	ODFI L shaped brackets for fastening purposes	8982K945	1	Single	$ 40.16	$ 18.92	$ 59.08	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/8982K94-8982K945/								
ODFI U bracket screws	ODFI U shaped brackets for fastening purposes	9001K6	1	Single	$ 9.68	$ 18.92	$ 28.60	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/9001K6-9001K224/								
Screws for ODFI Plate	Scres used on ODFI Plate	90128A946	1	Single	$ 4.57	$ -	$ 4.57	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/90128A946/								
Nuts for ODFI Plate	Nuts for ODFI Plate	90480A195	1	Pack	$ 2.20	$ -	$ 2.20	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/90480A195/								
M3X0.5 Screws	M3X0.5 screws for fastening purposes	92095A179	6	Pack	$ 5.83	$ 18.92	$ 24.75	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
		Web Site:	https://www.mcmaster.com/92095A179/								

TOTAL $ 649.40

Deliver to whom: Sean R. Niemi
Delivery location: Dept of Mech and Aero Eng.
Building B, Room 305

Electrical Purchase Order

REQUEST FOR ITEMS TO BE PURCHASED

Date Requested: 3/20/2023

1. Purchase Order Number: 1
2. Group requesting item(s): Cell Service Providers (473P)
3. Account to be charged: MAE Mechanical Design 3
4. Group member issuing PO: Stefano Marconi

BOM Part Number	BOM Part Name	Description of item to be purchased:	Part Number	Qty.	Unit	Price	Shipping	Sub Total	Vendor Name	Vendor Address	Vendor City/State/Zip	Vendor Phone Number
EML4502-E1	Arduino Mega	Electrical control board, USB connection, reset buttons, containing digital and analog inputs.	A000067	1	1	$ 48.20	$ -	$ 48.20	Amazon	410 Terry Ave N	Seattle, WA 98109	1-888-280-4331
				https://www.amazon.com/ARDUINO-MEGA-2560-REV3-A000067/dp/B0046AMGW0/ref=sr_1_3?crid=132N6J8D1261L&keywords=arduino+mega&qid=1679626414&sprefix=arduino+mega%2Caps%2C95&							
EML4502-E2	LDR Photoresistor	Photoresistors for ODFI Electrical components and sensors.	H-4716	1	1	$ 14.99	$ -	$ 14.99	Hiltchi	No. 85 Building, Fuxuan New Village, Dalang Street	Shenzen, Guangdong, 518109	
				https://www.amazon.com/Hiltchi-Dependent-Photoresistor-Photoconductive-Resistance/dp/B08L6HGNTP/ref=sr_1_3?crid=4URUHFVFNSDY&keywords=ldr+photoresistor&qid=1679675796&s=industrial&sp							
EML4502-E3	Bread Board	Bread board for wiring between arduino and motors	32110000	1	1	$ 9.99	$ -	$ 9.99	EML4502 Lab	571 Gale Lemerand Drive	Gainesville, Florida, 32603	
				https://www.amazon.com/DEYUE-breadboard-Set-Prototype-Board/dp/B07LFD4LT6/ref=sr_1_3?keywords=Breadboard+Arduino&qid=1681748652&sr=8-3							
EML4502-E4	Liquid Crystal Display (LCD)	Glass plate, Liquid crystal material with polarizing filter.	43211900	1	1	$ 11.99	$ -	$ 11.99	EML4502 Lab	571 Gale Lemerand Drive	Gainesville, Florida, 32603	
				https://www.amazon.com/AZDelivery-Character-Backlight-Converter-Compatible/dp/B07JH6GHPR/ref=sr_1_2_sspa?keywords=liquid+crystal+display+arduino&qid=1681748701&sprefix=liquid+crystal+displa							
EML4502-E5	LED Light Array	White Individually Addressable LED Chips 5050SMD LED Module Pixels Light DC 5V.	SK6812RGBWW-W-100P	3	1	$20.99	$ -	$ 62.97	Amazon	410 Terry Ave N	Seattle, WA 98109	1-888-280-4331
				https://www.amazon.com/BTF-LIGHTING-SK6812RGBW-WS2812B-Individually-Addressable/dp/B07C1XGD1X/ref=sr_1_1_sspa?keywords=LED+Array&qid=1679681653&sr=8-1-spons&psc=1&spLa=ZW5							
EML4502-E6	Push Button	Push button to control moving patterns (orbital, double orbital)	JF0022	3	1	$ 5.99	$ -	$ 5.99	EML4502 Lab	571 Gale Lemerand Drive	Gainesville, Florida, 32603	
				https://www.amazon.com/Momentary-Tactile-Through-Breadboard-Friendly/dp/B07WJF76VH7/ref=sr_1_1_sspa?crid=1FBLXXAMR9JR8&keywords=push%2Bbutton%2Bfor%2Bbread%2Bboard&qid=168174							
EML4502-E7	220 Ohm Resistor	Carbon resistors of 21 gauge lead.	B07QK9ZBVZ	1	1	$ 5.99	$ -	$ 5.99	EML4502 Lab	571 Gale Lemerand Drive	Gainesville, Florida, 32603	
				https://www.amazon.com/EDGELEC-Resistor-Tolerance-Multiple-Resistance/dp/B07QK9ZBVZ/ref=sr_1_1_sspa?crid=2IBYRROL45YJ0&keywords=220%2Bohm%2Bresistor&qid=1681748524&sprefix=220%							
EML4502-E8	Heat Shrink	Heat-Shrink Tubing 1 Foot Long, 0.06" ID Before Shrinking	7496K411	1	1	$ 8.45	$ -	$ 8.45	McMaster-Carr	P.O. Box 5370	Princeton, NJ 08543-5370	(609) 689-3000
				https://www.mcmaster.com/7496K41-7496K411/								
EML4502-E9	Loctite Clear Silicone Water proof Sealant	Silicone waterproof sealant	908570	1	1	$ 12.56	$ -	$ 12.56	Amazon	410 Terry Ave N	Seattle, WA 98109	1-888-280-4331
				https://www.amazon.com/Loctite-Silicone-Waterproof-2-7-Ounce-908570/dp/B0002BBX3U/ref=sr_1_3?crid=2SGB3UG57YFQN&keywords=waterproof+silicone+sealant&qid=1679619553&sprefix=waterproo							
EML4502-E10	DC-DC Converter	12V DC to 5V voltage drop converter	LM2596	1	1	$ 8.99	$ -	$ 8.99	EML4502 Lab	571 Gale Lemerand Drive	Gainesville, Florida, 32603	
				https://www.amazon.com/LM2596-Converter-3-0-40V-1-5-35V-Supply/dp/B08NV3JCBC/ref=sr_1_5?crid=2PNK2CWHOPWY5&keywords=DC-DC+converter&qid=1681748295&sprefix=dc-dc+converte%2Ca							
EML4502-E11	L298N Driver	L298N DC Motor Driver Module	B07BK1QL5T	1	1	$ 11.49	$ -	$ 11.49	EML4502 Lab	571 Gale Lemerand Drive	Gainesville, Florida, 32603	
				https://www.amazon.com/HiLetgo-Controller-Stepper-H-Bridge-Mega2560/dp/B07BK1QL5T/ref=sr_1_1_sspa?crid=3MBJ70EYC5JI3&keywords=L298N+driver&qid=1681748214&sprefix=l298n+driver%2Cap							
EML4502-E12	Potentiometer	10 kOhm potentiometer	B07S69443J	1	1	$ 7.99	$ -	$ 7.99	Amazon	16C5 Zhongang Beiyuan, Futioan District	Guangdong, 518105, China	
				https://www.amazon.com/MCIGICM-Breadboard-Trim-Potentiometer-Arduino/dp/B07S69443J/ref=sr_1_3?keywords=arduino+potentiometer+10k&qid=1682003513&sprefix=arduino+potenti%2Caps%2C932&							
EML4502-E13	20 Gauge Wiring	20 Gauge wiring for wiring purposes.	B089CFST2X	1	1	$ 9.99	$ 4.99	$ 14.98	Amazon	A3 Building Zhongyuanguomao techology park	Guangdong, 518105, China	n/a
				https://www.amazon.com/Fermerry-Stranded-Electronic-Electrical-Automotive/dp/B089CFST2X/ref=sr_1_6?crid=1VYTCC991ITKL&keywords=20%2Bgauge%2Bwiring&qid=1681747625&sprefix=20%2Bgauc							
EML4502-E14	Sound Deadening Material	Sound Deadening material used to lower sound emitting from motors.	SLL36	1	1	$ 49.95	$ -	$ 49.95	Amazon	223 Avenue U	Brooklyn, New York, 11223	1-905-237-8384
				https://www.amazon.com/Sound-Deadening-Foam-157mil-Insulation/dp/B07B75PD8B/ref=sr_1_2_sspa?keywords=dynamat&qid=1680722437&sprefix=dynam%2Caps%2C249&sr=8-2-spons&spLa=ZW5jr							

TOTAL: $ 274.53

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Building B, Room 305

References

[1] "Pololu 25d metal gearmotors." [Online]. Available: https://www.pololu.com/file/0J1829/pololu-25d-metal-gearmotors.pdf. [Accessed: 20-Feb-2023].

[2] "OD/FI Lecture", Mechanical Design 3, University of Florida Spring 2023

[3] Libretexts, "1.2: Photoluminescent Spectroscopy," Chemistry LibreTexts, 11-Aug-2020. [Online]. Available: https://chem.libretexts.org/Courses/British_Columbia_Institute_of_Technology/Chem_2305/01%3A_Spectroscopy/1.02%3A_Photoluminescent_Spectroscopy#:~:text=Quinine's%20excitation%20spectrum%20has%20absorption,extraction%20from%20the%20urine%20sample. [Accessed: 21-Apr-2023].