NAU Fume Hood

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Project Description

- Lab fume hood for NAU Biomechatronics lab
- Exoskeletons to improve mobility for walking impairments
- Provide safety measures against carbon fiber hazards
- Compatible with existing exhauster
- Workspace must be completely safe to fabricate carbon fiber components by neutralizing epoxy fumes and filtering fine carbon fiber particles during sanding operations

Figure 1: Exhauster Fan

Functional Decomposition

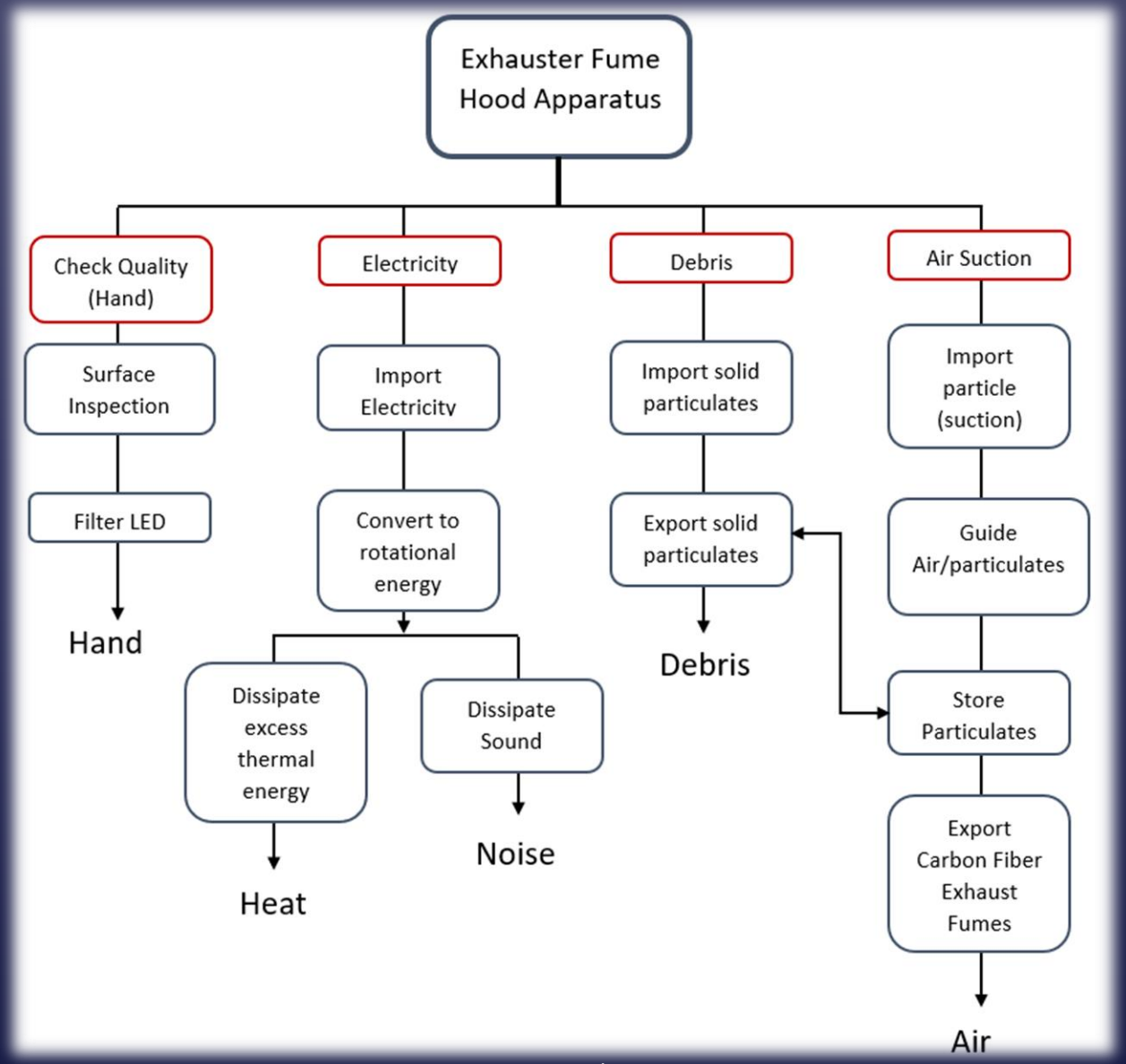

Figure 2: Functional Decomposition

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Concept Generation

- Client and Staff Meetings led to ideas for concept generation
- Dr. Zachary Lerner and Dr. Alexander Trevas
- Fume Hood with safety features

Figure 3: PVC Fume Hood

Concept Generation- Features

- Pressure Sensor- Arduino circuit board
- LED Sensor
- Portability within lab
- Temperature kill switch
- Motorized front panel
- Possible hose replacement
- Carbon fiber specific filter

Figure 4: Pressure Transducers

Figure 5: Arduino Coding

Concept Generation- Performance Curves

- Exhauster's model used is EBR-50. Which is designed with 10 ft hose.
- Maximum pressure drop = 5.3"
- Maximum flow rate = 395 CFM (Cubic feet per minute).
- Equation that relates Flow rate & Pressure drop:

$$Flow\ Rate = Nozzle\ Area * \sqrt{\frac{\Delta p}{\rho_{Air}}} \quad \text{(Eqn 1)}$$

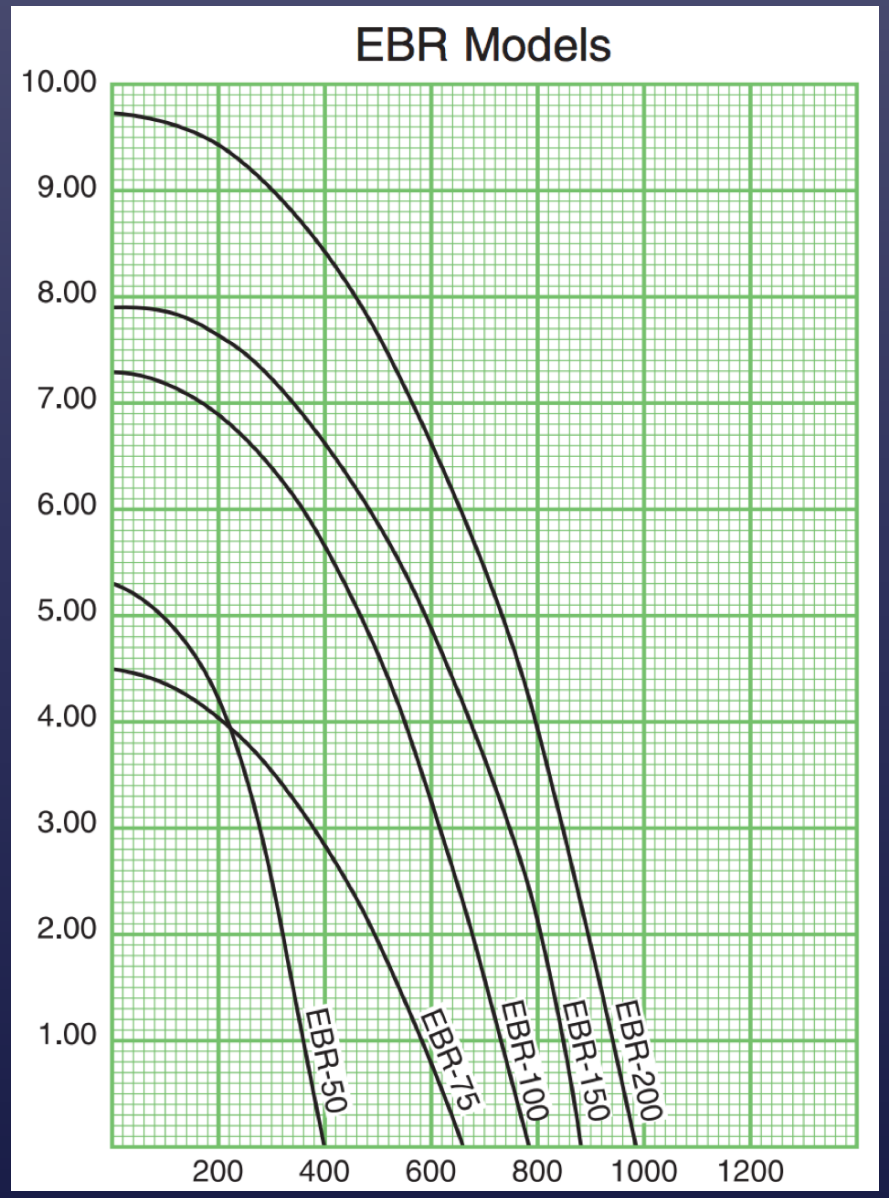

Figure 6: Performance Curve EBR model 50 [1]

Design Alternative 1

- Mix use of water and air filter
- Arduino + Pressure Transducer mechanism

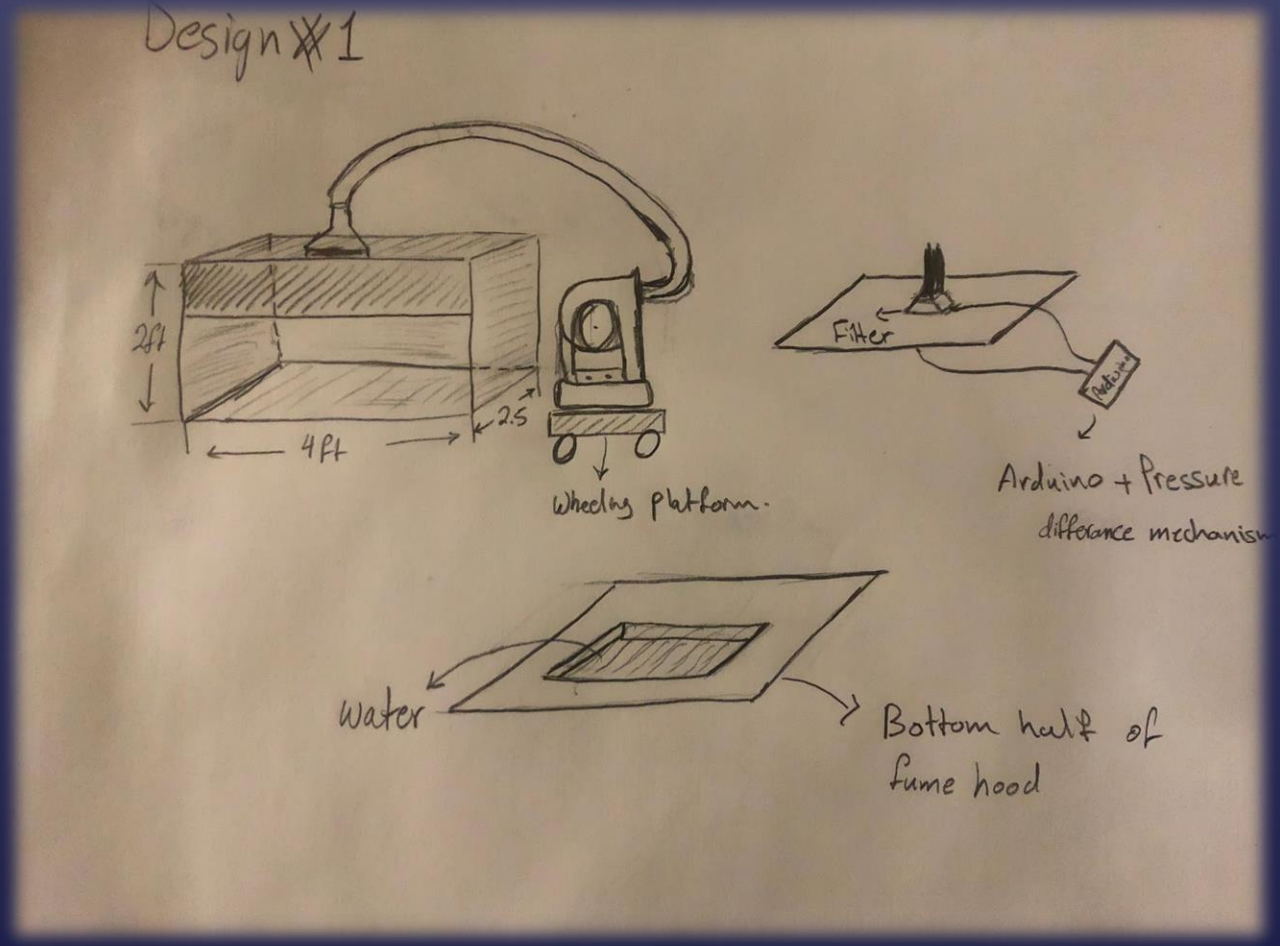

Figure 7: Design alternative #1

Design Alternative 2

- Removeable air filter
- Enclosed along 3 walls

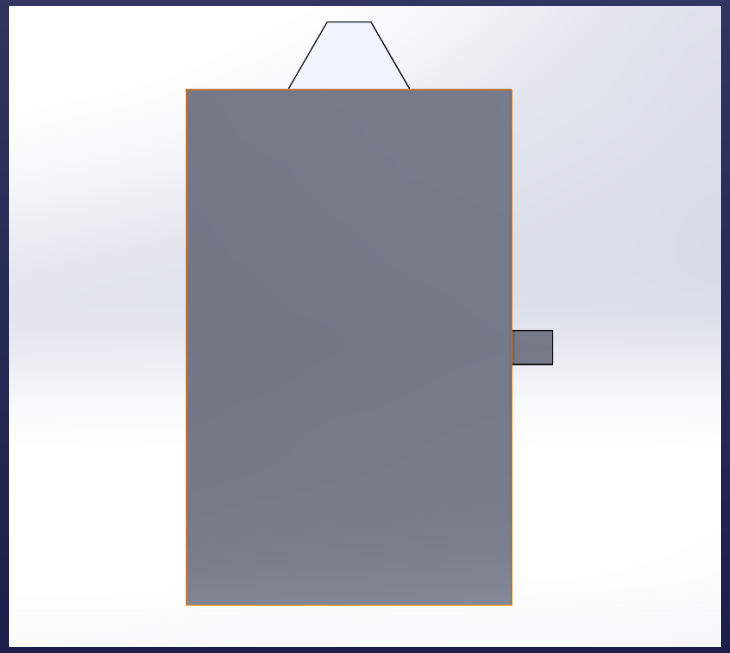

Figure 8: Design alternative #2 Cad model-side

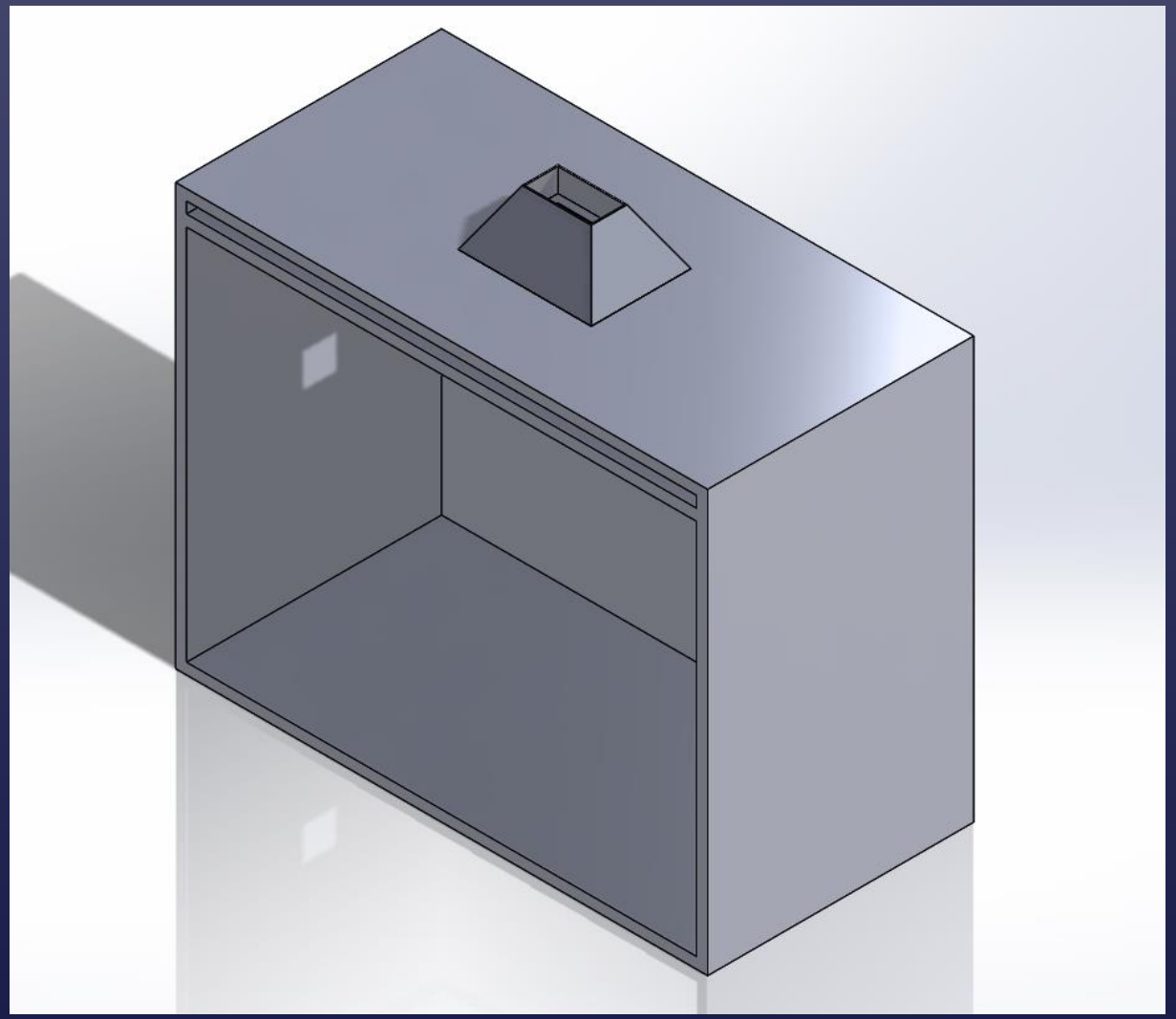

Figure 9: Design alternative #2 Cad model-ISO

Design Alternative 3

- Air Filter with emergency filtration system
- Back panel fans for additional filtration

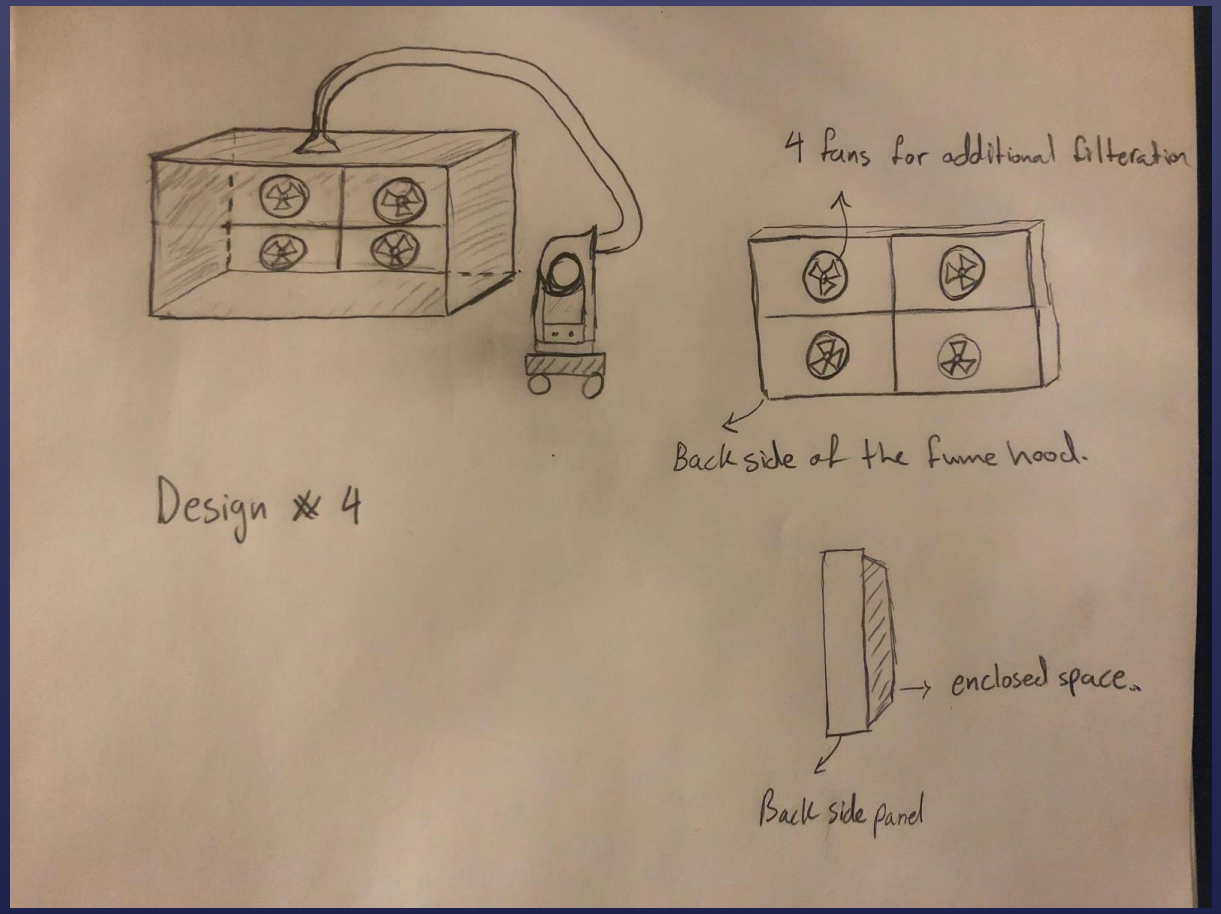

Figure 10: Design alternative #3

Concept Generation-Decision Matrix

- **Purpose & Procedure:** Evaluate three design alternatives (DA) based on fulfillment of ER's. Scored each DA for all ER's.
- **Results:** Our decision matrix shows numerically that design 2 is the most viable option in conjunction with our engineering requirements

Table 1: Decision Matrix

		Designs							
		Design #1		Design #2		Design #3		Design #4	
Criteria	Weighting	Score	Total	Score	Total	Score	Total	Score	Total
		1-10		1-10		1-10		1-10	
Filtering System	30%	8	24	8	24	7	21	9	27
Portability	15%	4	6	6	9	6	9	5	7.5
Safety	25%	8	20	9	22.5	7	17.5	9	22.5
Durability	15%	6	9	8	12	8	12	7	10.5
Cost	15%	9	13.5	7	10.5	8	12	6	9
Total	100%		72.5		78		71.5		76.5

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Budget Analysis- Bill of Materials

Table 2: Preliminary Bill of Materials

Component	Cost Per Unit ($/unit)	Amount Per Unit	Total Material Cost	Purchase
Spectre tapered air filter	$ 20.63	1	$20.63	Amazon
Arduino Uno Rev 3	$22.00	1	$22	Store.Arduino.cc
0.187x24x96” PVC sheet	$72.48	1	$72.48	eplastics
Buffalo tools dolly 1000lb rating	$18.32	1	$18.32	Home Depot
0.187x48x48 PVC Sheet	$72.48	1	$72.48	Eplastics
Pressure Transducer	Donated			Dr. Trevas
LED Arduino light	$0.26	3	$0.78	Store.arduino.cc
Photo Resistor	$0.95	6	$5.70	Store.arduino.cc
10 Kohm resistor	$0.036	10	$0.36	Store.arduino.cc
221-ohm resistor	$0.27	1	$0.27	Store.arduino.cc
4” worm drive clamps	$1.71	2	$3.42	Home Depot
36” wide polypropylene fume hood	$356.76	1	$356.76	US plastic
Total Cost			$573.40	

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Budget Analysis-Monetary Distribution

- From the Bill of Materials we determined that 100% of cost would be considered for building/manufacture of the fume hood system
- If necessary, replacement parts would be a simple fraction of the total cost as we expect minimal replacement.
  - Tapered Air Filter - $20.63 (completely washable and reusable)
  - Worm Drive Clamps - $3.42 (may lose tension over time)
  - Arduino boards - $22.00 (life span of boards are 10-15 years)
  - Sensors and lights - ~$7 (assuming each sensor/ resistor were replaced simultaneously)
- Our initial total budget was $400 provided by the Biomechatronics lab, however if necessary we will be able to acquire more funding from the lab.

Questions??

References

- [1] Cincinnati Fan, "Portable Fume Exhauster-Blower," [Online]. Available: https://www.cincinnatifan.com/catalogs/FumeExhausters-1207.pdf.
- [2] Fantech, "Learning the fan performance curve," [Online]. Available: https://www.youtube.com/watch?v=HgVmA6_fKw8.