BME Design-Spring 2021 - Brittany Glaeser
Complete Notebook

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KAITLIN LACY

on

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Team contact Information

John Puccinelli - Dec 19, 2013, 11:28 AM CST

Last Name	First Name	Role	E-mail	Phone	Office Room/Building
		Advisor			
		Client			
		Leader			
		Communicator			
		BSAC			
		BWIG			
		BPAG			

Project description

John Puccinelli - Aug 14, 2013, 12:01 PM CDT

Course Number:

Project Name:

Short Name:

Project description/problem statement:

About the client:

Client Meeting 2/10

Title: Discuss semester work

Date: 2/10/21

Content by: Britt

Present: Team + Client

Goals: Determine the goals for this semester

Content:

- Used the word lumped parameter model
  - Lump all perfusion into 1 capillary
  - Is an oversimplified design but the hopes are that it is good for teaching and understanding V/Q ratios within an alveolus
- Can look at the journals he sent us from awhile ago (last semester) to get ideas for a journal this year
  - Zoe has some
- Arbitrary Scale
  - For both brightness and speed
  - Somehow mimic reality
    - Maybe use with factors/ratios
    - Minute Ventilation
      - Speed by and by changing the frequency of which the lights turn on
    - Normal 1:1 ratio, Shunt (no alveolus), Dead Space (No blood)
- pO2 doesn't change much in an alveolus despite how much perfusion or ventilation is occurring
  - For the alveolus, he said not to worry about changing the color and the partial pressure don't change much
  - Diffusion is what is most important for the V/Q ratios, doesn't have much to do with partial pressures
- He doesn't like the idea of how the air in the alveolus move in a circular fashion as this is not what happens in real life
  - Could somehow have random lights turn on one at a time to show the alveolus filling up
  - Talked about having multiple concentric LED rings where the lights can move in and out to show the filling and expelling of air
    - Can use the blink here to simulate minute ventilation
    - The speed of the blink can increase
- Human Subject Testing
  - Can send out a group email to many med student with the video and survey and hope they will respond
  - Also mentioned how faculty have meetings weekly and could potentially take away some time in their meetings to look at our design
    - We would most likely want med students as they would be the ones learning from the design

Conclusions/action items:

Ideally would like to meet once a month, but will be in contact soon as we develop testing plans.

The team is going to work on altering the hardware for the design, especially the alveolus to mimic more of reality.

Advisor Meeting 1/29

Brittany Glaeser - Jan 29, 2021, 3:31 PM CST

Title: First Advisor Meeting

Date: 1/29

Content by: Britt

Present: All

Goals: To determine the goals for the semester

Content:

- First thing the team would like to start out with is adding buttons to the circuit so that the V and Q values in the ratio can be altered
  - The buttons will be read into a digital input pin on the arduino microcontroller so it can read the changes in voltages
  - The code will determine how many times the voltage values from the button have a low setting to activate the counter
    - To eliminate the bouncing of the button the team can either create a debouncing circuit or can use a timer within the code to not allow the counter to count again until a certain amount of time has passed
  - The first thing to do is add the button to the circuit and then alter the code
  - Later the buttons will likely need to be updated and the base design will need to be altered to house the buttons
- The team needs to create a roadmap for what we would like our accomplishments to be each week
  - Accomplishments for design
  - Testing protocols/days
    - More light testing
    - Test with other individuals
    - Discuss with client
  - Determine tasks for each individual
- Materials that will need to be ordered
  - Diffuser for the circular LEDs
  - Connectors for the silicone LEDs so that the circuit is stronger
  - Potentially more buttons for each team member to work on the code
- The team will set up a client meeting for this coming week to discuss what he would like us to accomplish this semester
- The team needs to look for journal style templates for the report this semester
- TEAM GOAL: Design something that our client will come out with a prototype that can be used in a classroom that will be beneficial to the students learning

Conclusions/action items:

The team will begin a roadmap for the semester to determine everything we want to accomplish this semester. This roadmap will be fluid throughout the semester and likely after our meeting with our client. We would like to order materials as soon as possible so everyone can work on the design.

Advisor Meeting 2/5

Brittany Glaeser - Feb 05, 2021, 3:28 PM CST

Title: Discuss semester plan and weekly accomplishments

Date: 2/5/20

Content by: Britt

Present: All

Goals: Determine the next steps for the next week

Content:

- Discussed some ideas for testing
  - Zoe brought up doing a test for the button to determine a decent time interval that we prevent debouncing
  - Have to discuss human subject testing
  - Create a detailed plan for Friday and present to
    - Can likely be done in a word doc unless we hear anything else
  - How many trials is enough to prove its correct
    - Kaitlin brought this up as last semester we only did one trial and our results were inconclusive
- Did some research into journals
  - Can talk to client about this to discuss further
- Button circuit was discussed
  - Test the button for debouncing
  - Look into ordering bigger buttons to add to the circuit that will be easy for a variety of people to use (many colors too!)
  - The circuit currently is messy and unstable, using a different microcontroller that can be soldered and potentially placed on a board would be ideal
    - I (britt) have used KiCad before to do this. Can potentially take about a week and will print multiple boards
  - Also need to look into a display to show what values the V/Q ratios are at for the user to understand
    - Need to represent when MAX values occur
    - 7-Segment display would probably not be enough
- To finish everything this semester it would likely be best to split up the work (Potential groups)
  - Hardware/Software: Britt and Kaitlin
  - Testing: Jenna and Zoe

Conclusions/action items:

The first step would be to come up with a testing plan to present on Friday. This is important as much of the semester will be spent testing.

It would also be ideal to order any final circuit items, so when testing comes around, we have a completed design (or mostly completed) design to use.

Advisor Meeting 2/12

Brittany Glaeser - Feb 12, 2021, 2:59 PM CST

Title: Prelim Testing Presentation

Date: 2/12/21

Content by: Britt

Present: All

Goals: Discuss testing and hardware plans for the semester

Content:

- Discussed client meeting
    - Biggest change was how the doc cam adjust brightness so we want to eliminate changes in brightness and focus on color gradients and blinking rates
- Button Testing
    - Need to order one more set of buttons (the ones we ordered are LARGE)
- Flow/Blinking Rate Testing
    - Length of video?
        - Need to determine what is enough time to see the video
            - Likely not a loop
            - Should be no back and forth as this is also not realistic
            - Maybe 5 seconds
    - Have the video change flow rates automatically as if it were real time and the professor is changing the buttons
    - Should research how people visually and cognitively depict differences in changing rates and colors
    - Can use google forms or survey monkey where a video can be directly implemented to the test taker
- One test is verification of the system (buttons) and another is validation that is teaches what it should
- Should consider a pilot testing period with a small group of people to enough that the testing goes well
- Discussed how the device will be powered through a port in the design
    - Can use a voltage regulator for 12V access and 5V USB area to power microcontroller and LEDs
- Consider a front plate to cover the design to hold LEDs in place

Conclusions/action items:

The next steps would be to fix any hardware concerns and wait for shipments to come in. We should also begin a more detailed testing plans so it can be executed rather quickly.

Advisor Meeting 2/29

Brittany Glaeser - Feb 20, 2021, 3:26 PM CST

Title: Advisor Meeting

Date: 2/19/21

Content by: Britt

Present: All

Goals: Discuss weekly accomplishments and future plans

Content:

- Human Subject Testing
    - UW IRB
        - IRB through education
            - do right away so ready when device is ready
            - Best to schedule a meeting
            - Generally pretty quick
        - Would still need an application even if we don't think we need it
        - Will need some form of consent on the first page
- Diffusing acylic sheets
    - Order multiple thickness because we don't really know what we need
    - Transparent front panel?
        - Could also order from same place
        - Would need to be more transparent than the diffuser
- Time is important!
    - Order different circular LEDs since the one's we want are not in stock
    - Finish software/hardware by the end of march
- Make some test videos with the current design
    - Voice over? text?
    - length of video?
- Prelim report needs to be in journal style
- Need to decide when we want to print a new base to test out
- ORDER
    - Circular LEDs
    - Wall plug
    - Diffuser
    - Buttons

Conclusions/action items:

The next steps would be to figure out the IRB so that is ready to go for testing. Software will continue to be worked on so it is ready for testing

Advisor Meeting 2/26

Brittany Glaeser - Feb 26, 2021, 2:55 PM CST

Title: Advisor Meeting

Date: 2/26/21

Content by: Britt

Present: All

Goals: Discuss team progress

Content:

- IRB Drop in on Wednesday
- Google Forms Testing
    - State how long the test will take
    - Figure out if ads will show on the youtube videos - this can be annoying
    - The titles on the videos kind of interfere with the video itself
        - Can the video be made larger?
- Stats from the google forms?
    - What tests can we run from the data from google forms?
- Arduino Nano not working
    - Return and order new ones ASAP
- Ideally would like to finish basic design in the next couple weeks

Conclusions/action items:

Continue to wait for materials to arrive and create more detailed testing questions

Testing Protocols 2/10/21

Brittany Glaeser - Feb 11, 2021, 11:04 PM CST

Title: Testing Protocols

Date: 2/10/21

Content by: Britt

Present: All

Goals: Discuss what types of test we could run this semester

Content:

- Last semester testing
    - Could use more trials
    - Kind of concluded that brightness was not the best option as cameras/doc cams correct for this
        - Varying shades of color could be better
- Client discussed having a blinking of the alveolus to represent minute ventilation
    - This can be a bit much
    - Maybe find an optimal blinking factor
- Human Subject Testing
    - Since it is hard to meet in person right now, we could create a video that we send out to people along with a google form to receive feedback
- Debouncing Button Test
    - Test 3 different buttons and which one has less of a bounce effect to use so there is less error when someone presses the button
    - Could have different trials where each time we press the button a certain amount of times and see how many register
- Flow Rate Test
    - Have different flow rate videos played one after another and see if the user could tell the difference
    - Can be multiple choice
    - See if the rates between the two videos are significant enough
        - The user can easily tell the difference in flow rates and therefore can learn from the design that ventilation/perfusion was increasing or decreasing
- Overall understanding of Test
    - Can test the understanding of V/Q ratios before and after using the device
    - Would need some form of a baseline test
    - Use difference of means to analyze
        - Could have one group use the model and one group without
        - Could run two different tests - one with med students and one without

Conclusions/action items:

We have concluded on 3 possible tests for this semester - a debouncing button test, flow rate differences, and overall understanding of the design.

We still would like to brainstorm if there are any ways to receive quantifiable data.

Hardware/Software Timeline

Brittany Glaeser - Mar 02, 2021, 10:00 PM CST

Title: Hardware/Software Timeline

Date: 3/2/21

Content by: Britt/Kaitlin

Present: Britt/Kaitlin

Goals: Determine what aspect of the design to focus on over the next couple weeks

Content:

- Solder Concentric circles together - **3/5**
  - Half completed
- Work on alveolus minute ventilation code **- 3/5**
- Print first run of base design - **3/5**
- Add new buttons to LED circuit - **3/10**
- Update capillary code - **3/12**
- Cut acrylic sheets for alveolus diffuser - **?**
  - 3/2/21 - sheets have yet to arrive
- Work on display for V/Q ratios - **3/17**
  - Determine how to add to base design
- Finalize base design - **3/24**
- Make a more cleaner/concise circuit - **3/30**

Conclusions/action items:

Follow timeline for hardware/software

Ideally we would like to try and complete most of the hardware software by april 1st so testing can be completed and there is plenty of time for small changes for the rest of the semester. This timeline is not set in stone as we are still waiting for parts and possibly run into problems coding.

2021/01/21 - Base Design from Last Semester

KAITLIN LACY - Mar 02, 2021, 9:51 PM CST

Title: Base Design from Last Semester

Date: 1/21/2021

Content by: Kaitlin Lacy

Goals: Analyze base design from last semester to determine necessary changes that need to be made.

Content:
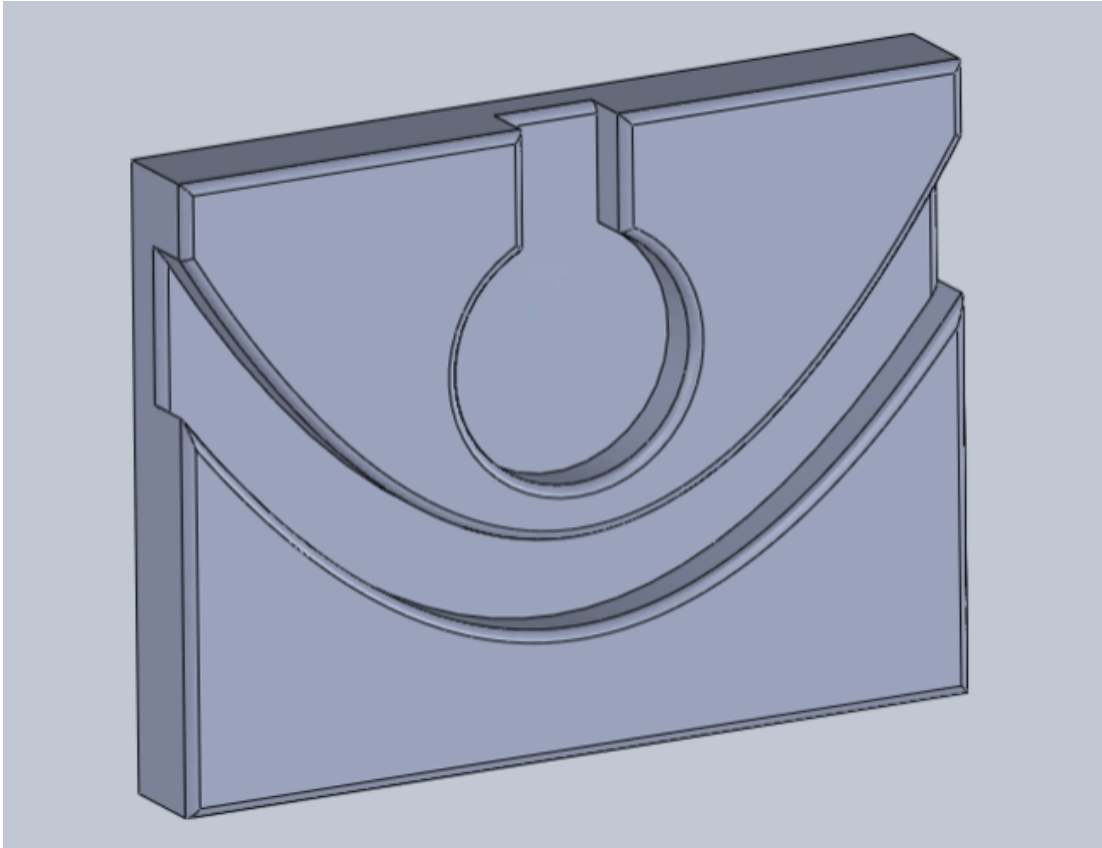
Conclusions/action items: Add a hollowed out portion to the back that can house the electronic components, as this would make the design much more visually appealing and help to protect these pieces. Add holes for buttons and add holes for the wires of the alveolus to thread through.

2021/02/11 - Base Design with Hollow Back

Title: Base Design with Hollow Back

Date: 2/11/2021

Content by: Kaitlin Lacy

Goals: Add a hollow portion to the back of the base to house the electronic components.

Content:
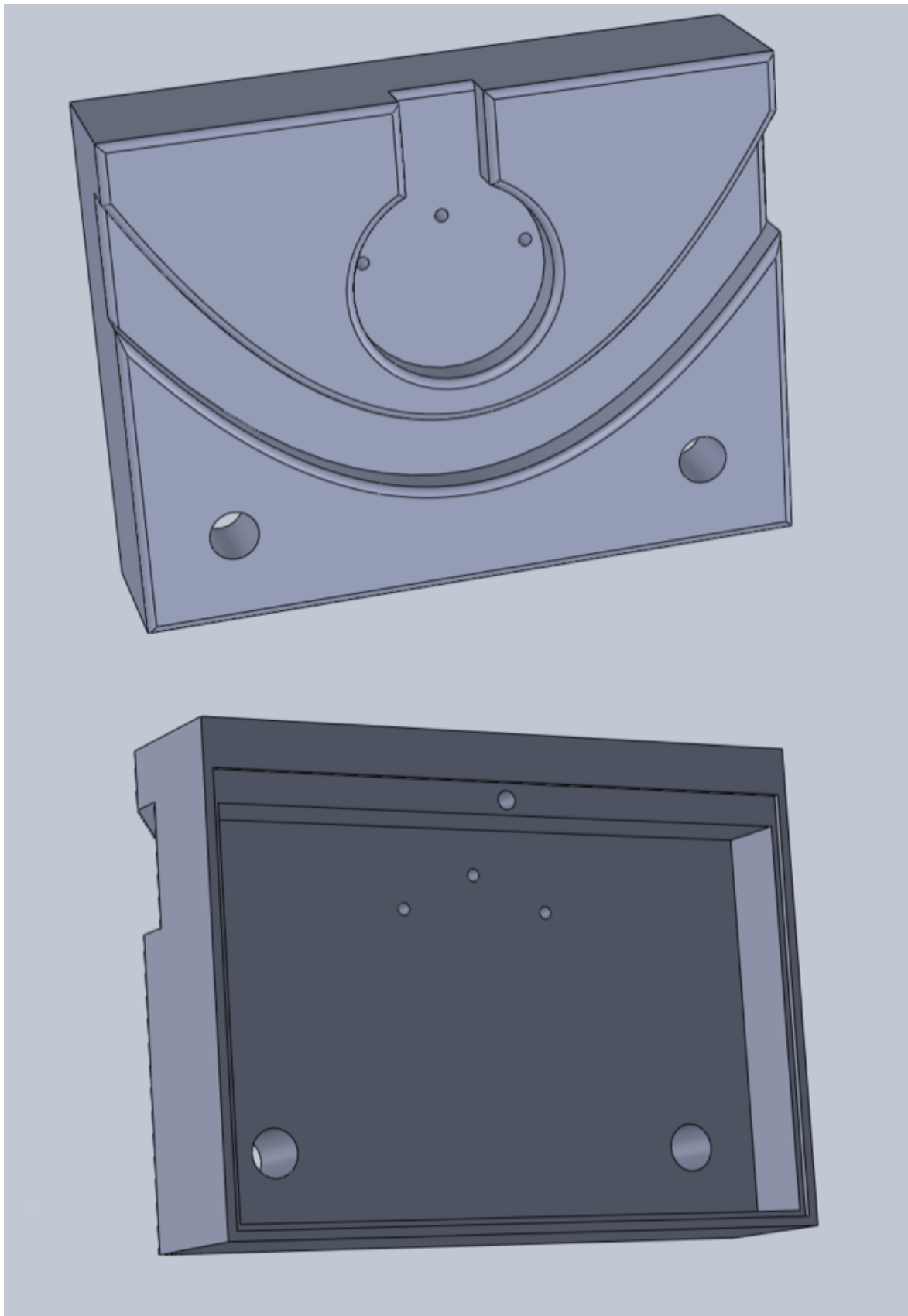
While creating the back compartment, it seemed necessary to add lip for a back cover to rest on that would be held in place by screws (similar to the way batteries are often held in many different electronics). Here, one screw hold is depicted, as well as an indentation of 2 mm for this back panel. The thickness of the entire base was increased in order to allow for adequate room in the compartment. Two holes were added for buttons to pass through in order to attach to the breadboard housed in the back. Holes for the alveolus ring wires were also incorporated here.

Conclusions/action items:

Finalize the buttons, so that the dimensions of the button holes can be determined. Add two more button holes and adjust their location as necessary. Add a hole in the side for a power cord to pass through, as well as another screw hole at the bottom to help further secure the back panel.

2021/02/19 - Base Design with Hole for Power Cord

KAITLIN LACY - Mar 02, 2021, 10:12 PM CST

Title: Base Design with Hole for Power Cord

Date: 2/19/2021

Content by: Kaitlin Lacy

Goals: Add hole for power cord.

Content:
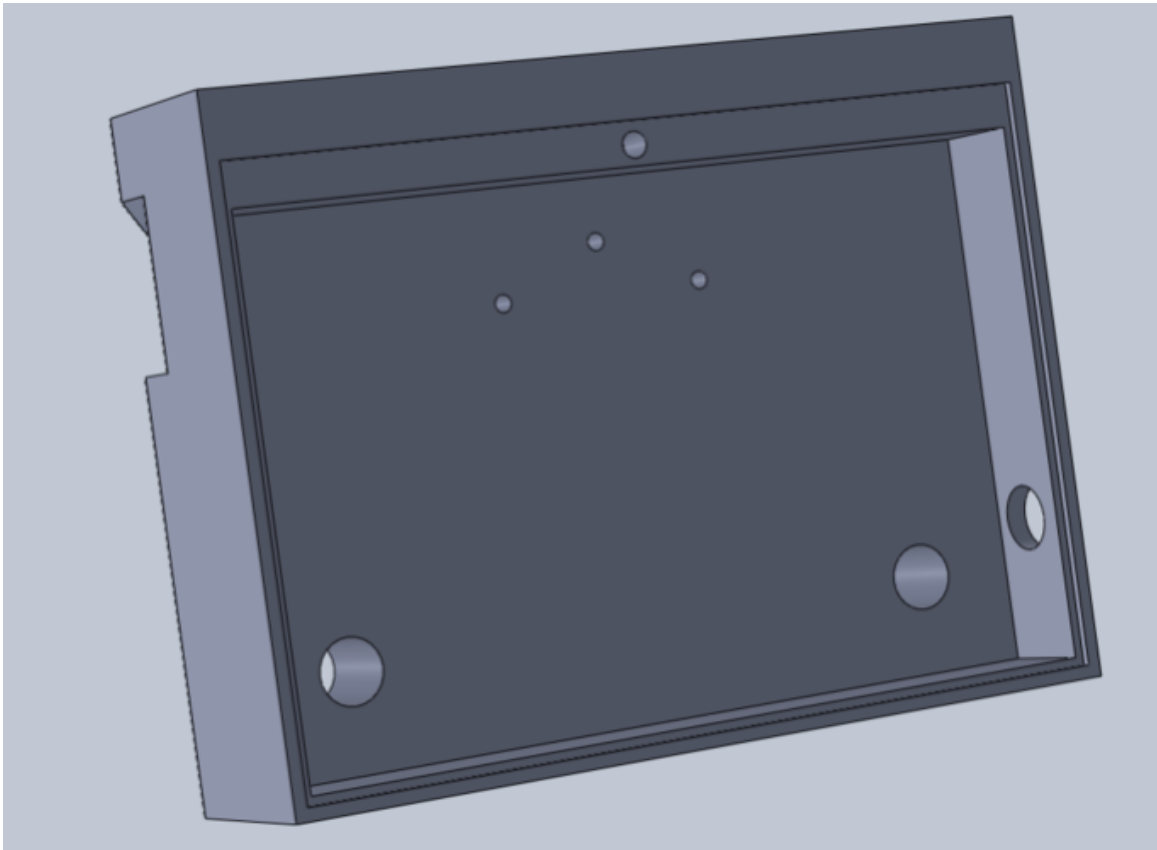
Conclusions/action items: Select buttons, so the button holes on this drawing can be finalized.

2021/02/19 - Back Piece

KAITLIN LACY - Mar 03, 2021, 10:55 AM CST

Title: Back Piece

Date: 2/19/2021

Content by: Kaitlin Lacy

Goals: Create a simple back cover with the proper dimensions corresponding to the hollow back of the base.

Content:
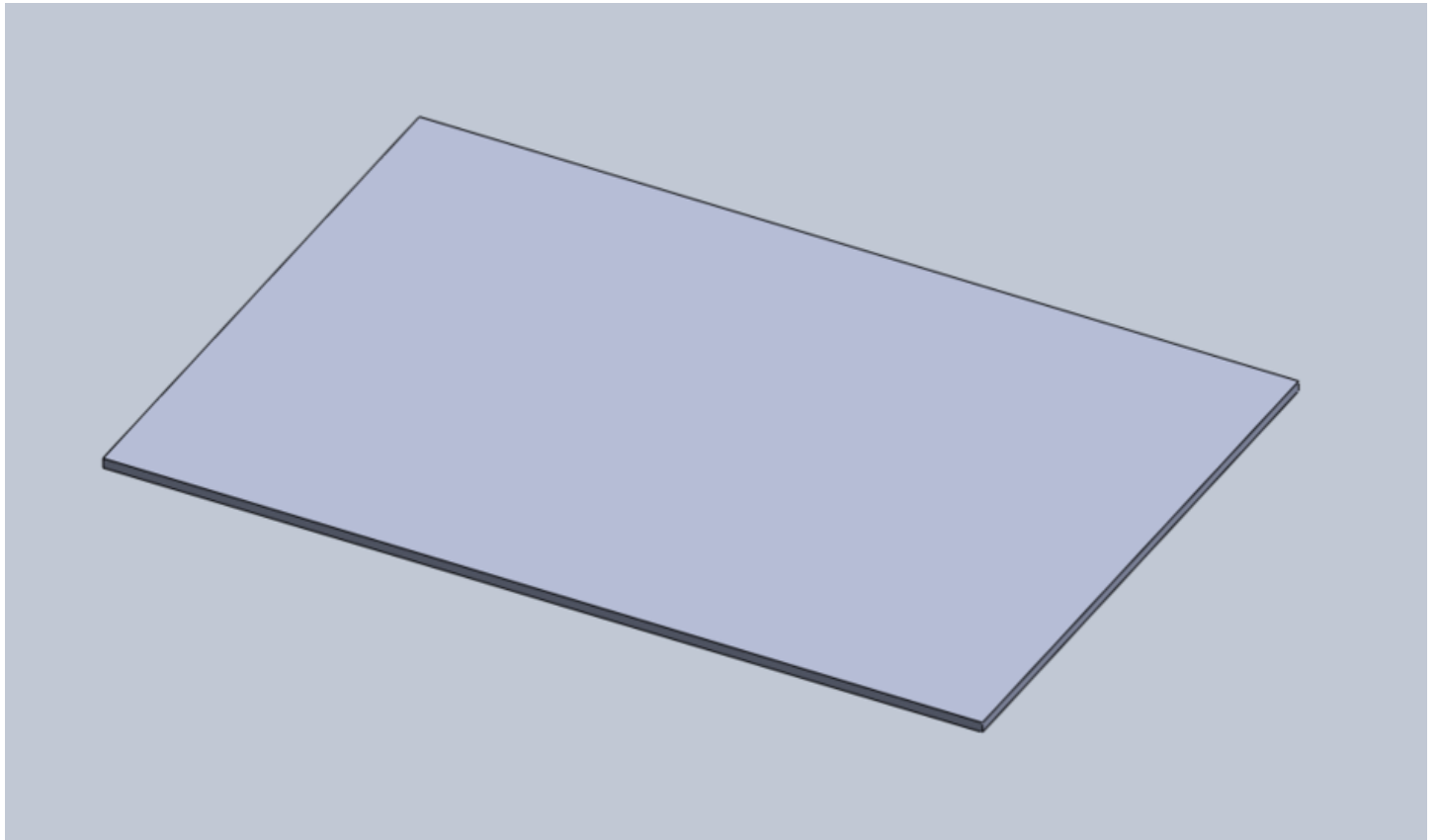
Conclusions/action items: Screw holes will need to be added once their location and size is finalized on the base.

2021/02/26 - Base Piece with Modified Rest for Back Piece

KAITLIN LACY - Mar 03, 2021, 11:00 AM CST

Title: Base Piece with Modified Rest for Back Piece

Date: 2/26/2021

Content by: Kaitlin Lacy

Goals: Adjust the dimensions and location of the hollow back to allow for a more secure attachment of the back piece.

Content:

Conclusions/action items: Once the screw/insert sizes are finalized, adjust the size of the top screw and add in the hole for the second screw.

2021/03/02 - Expense Table

KAITLIN LACY - Mar 03, 2021, 11:28 AM CST

Title: Expense Table

Date: 3/2/2021

Content by: Jenna Eizadi, Brittany Glaeser, and Kaitlin Lacy

Goals: Record materials and purchases.

Content:

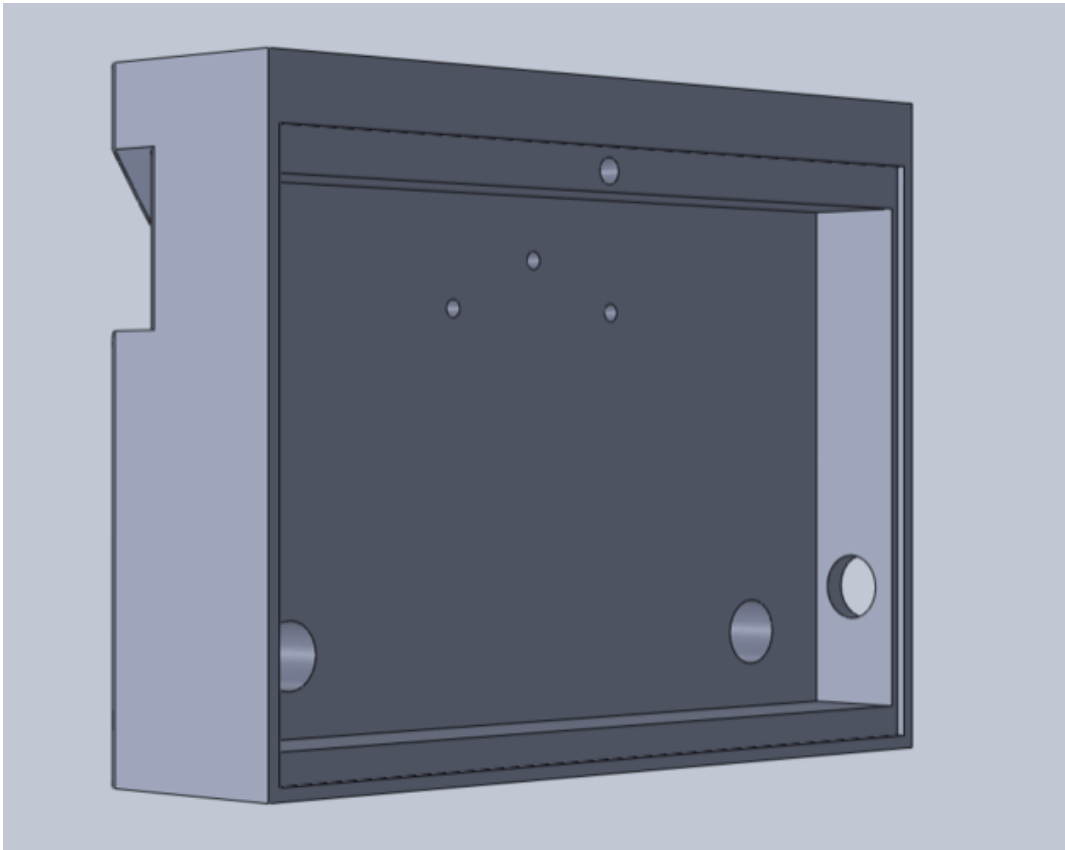| Item	Description	Manufacturer	Part Number	Date	Quantity	Cost Each	Total Cost	Link
Component 1								
	Long breadboard	Amazon	B01EV6LJ7G	2/10/2021	1	$9.99	$9.99	https://www.amazon.com/EL-CP-003-Breadboard-Solderless-Distribution-Connecting/dp/B01EV6LJ7G/ref=sr_1_5?dchild=1&keywords=breadboard&qid=1612919041&sr=8-5
~~Component 2~~								
	~~Nano~~	~~Amazon~~	~~B00NLAMS9C~~	~~2/10/2021~~	~~2~~	~~$9.99~~	~~$19.98~~	https://www.amazon.com/ATmega328P-Microcontroller-Board-Cable-Arduino/dp/B00NLAMS9C/ref=asc_df_B00NLAMS9C/?tag=hyprod-20&linkCode=df0&hvadid=309776868400&hvpos=&hvnetw=g&hvrand=1704368616930
Component 3								
	1.44" color LCD	Adafruit	2088	2/10/2021	1	$14.95	$14.95	https://www.adafruit.com/product/2088?gclid=Cj0KCQiAgomBBhDXARIsAFNyUqNVz_2Y6bdeOxecKVJgMEzjOet_mG9W9ixiGz0KYxVGgmN3bENCZ9kkaAjMEEALw_wcB
Component 4								
	Quad Alphanumeric	Adafruit	1912	2/10/2021	1	$13.95	$13.95	https://www.adafruit.com/product/1912
Component 5								
	Green Triangular	Adafruit	4188	2/10/2021	2	$3.95	$7.90	LED Illuminated Triangle Pushbutton A.K.A 1960s Sci-Fi Buttons
Component 6								
	Blue Triangular B	Adafruit	4187	2/10/2021	2	$3.95	$7.90	LED Illuminated Triangle Pushbutton A.K.A 1960s Sci-Fi Buttons
Component 7								
	7 Circular LEDs	Adafruit	2226	2/16/2021	2	$5.95	$11.90	https://www.adafruit.com/product/2226
~~Component 8~~								
	~~24 Circular LEDs~~	~~Adafruit~~	~~1586~~	~~2/16/2021~~	~~2~~	~~$16.95~~	~~$33.92~~	https://www.adafruit.com/product/2226
Component 9								
	24 Circular Neop	Adafruit	2863	2/22/2021	2	$19.95	$39.90	https://www.adafruit.com/product/2863?gclid=Cj0KCQiApsiBBhCXARIsAN8o_4i5chh_WB5ZCrYPQ9H0LAN8X5oE7eHv92yUXL5EHtrtWe-mOA2oLGEaAuv-EALw_wcB
Component 10								
	Red Momentary	Adafruit	1439	2/22/2021	2	$1.50 $3.00		https://www.adafruit.com/product/1439
Component 11								
	Blue Momentary	Adafruit	1477	2/22/2021	2	$1.95	$3.90	https://www.adafruit.com/product/1477?gclid=Cj0KCQiApsiBBhCXARIsAN8o_4irRf_DqUKndbWPvUnLyiTu6oPf3cAu-MDItWIVg2bAMA7dpFhfuggaAgf7EALw_wcB
Component 12								
	Green Momentar	Adafruit	1440	2/22/2021	2	$1.50	$3.00	https://www.adafruit.com/product/1440
Component 13								
	Yellow Momentar	Adafruit	1441	2/22/2021	2	$1.50	$3.00	https://www.adafruit.com/product/1441
Component 14								
	White Momentar	Adafruit	1479	2/22/2021	2	$1.95	$3.90	https://www.adafruit.com/product/1479
Component 15								
	12V Wall Plug Ac	Amazon	12V2A0823	2/22/2021	1	$9.99	$9.99	https://www.amazon.com/Adapter-100-240V-Transformers-Switching-Adaptor/dp/B07GRZB5Y9/ref=sr_1_17?dchild=1&keywords=12V+DC+2A+power+supply+adapter+with+2.1+mm&qid=1603983837&sr=8-1
Component 16								
	LED Strip with Si	Adafruit	3869	2/22/2021	1	$34.95	$34.95	https://www.adafruit.com/product/3869?gclid=CjwKCAjw5p_8BRBUEiwAPpJO6-iskV-hGQTETEw9-UiGUYAAeoXBLnH974c0ATku9Am6wkZcOHl-LRoC3n8QAvD_BwE
Component 17								
	12 in. x 36 in. x 1	Home Depot	308669197	2/22/2021	1	$20.48	$20.48	https://www.homedepot.com/p/Falken-Design-12-in-x-36-in-x-1-8-in-Thick-Acrylic-White-Translucent-50-2447-Sheet-Falken-Design-ACRYLIC-WT-2447-1-8-1236/308669197
Component 18								
	12 in. x 24 in. x 3	Home Depot	308669138	2/22/2021	1	$20.51	$20.51	https://www.homedepot.com/p/Falken-Design-12-in-x-24-in-x-3-16-in-Thick-Acrylic-White-Translucent-50-2447-Sheet-Falken-Design-ACRYLIC-WT-2447-3-16-1224/308669138
Component 19								
	Arduino Nano	Arduino	7630049200173	3/1/2021	2	$20.70 $41.40		https://store.arduino.cc/usa/arduino-nano
							$284.54	

Conclusions/action items: Continue to update as more items are purchased.

3/2/21 - Schematic

Brittany Glaeser - Mar 02, 2021, 8:51 PM CST

Title: Circuit Schematic

Date: 3/2/21

Content by: Britt

Present: Britt

Goals: To create a schematic to represent circuit connections

Content:
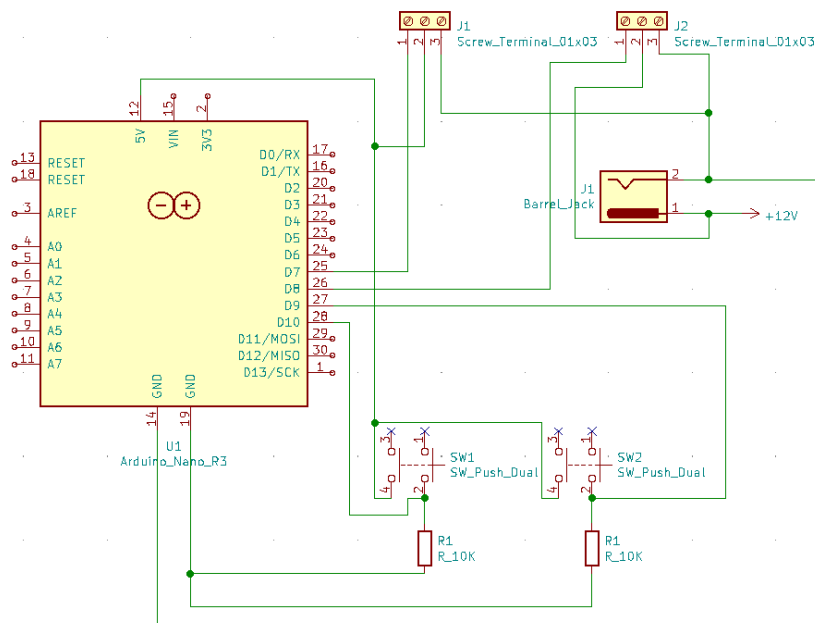
The schematic was changed to with arduino nano rather than the arduino Uno. Also, two tactile buttons were added to change the values of the V/Q ratios. Each has a resistor in series with the GND and digital input pin. Also, the LEDs were changed so that they are attached to a screw terminal on the breadboard for a more solid design.

Conclusions/action items:

This will be updated later as connections will change, a display will be added, as well as two extra buttons.

Notebook from Last Semester

Hypoxemia_Teaching_Model-Final_Notebook.pdf(23 MB) - download

Minute Ventilation

Brittany Glaeser - Mar 02, 2021, 10:12 PM CST

Title: Minute Ventilation Rates

Date: 2/25/21

Content by: Britt

Present: Britt

Goals: Determine normal ventilation rates to control alveolus rate

Content:

- Minute Ventilation: Amount of volume inhaled or exhaled in a minute
    - Tidal Volume x Respiratory Rate
- Tidal Volume: Volume of air delivered to lungs with each breath
    - Generally about 500-600 mL
    - Corresponds to about 12-14 breathes per minute
- Normal Ventilation is between 5-8 L per minute
- This can double to light exercise
- Up to 40 L per minute during heavy exercise
- Main method of boosting oxygenation is increased inspired air concentration (Not necessarily important for our design)
- V/Q = Volume of air entering lungs / Volume of blood research capillaries

Ex idea for code - 12 breaths per minute = LEDs (all rings) turn on 12 times in a minute or once every 5 seconds - simulate breathing

Conclusions/action items:

The next steps would be to determine what minute ventilations are the extremes and how it is used to calculate V/Q ratios.

CITATION: Richard M. Levitan, F., 2021. *Avoid Airway Catastrophes on the Extremes of Minute Ventilation*. [online] ACEP Now. Available at: <https://www.acepnow.com/article/avoid-airway-catastrophes-extremes-minute-ventilation/#:~:text=Normal%20minute%20ventilation%20is%20between,40%20Lpm%20with%20heavy%20exercise.> [Accessed 26 February 2021].

V and Q Values

Brittany Glaeser - Mar 02, 2021, 10:44 PM CST

Title: Values for ventilation and perfusion

Date: 3/2/21

Content by: Britt

Present:

Goals: Determine values of V and Q to mimic flow and to be displayed on the display

Content:

- This shows a few graphs with great explanation of V/Q ratios
  - 1 = Well matched gas and blood flows
    - Every unit of blood flow there is a unit of gas flow received
  - < 1 = Good blood flow but not sufficient ventilation
  - > 1 = Great ventilation but not great blood flow
  - infinite = lung receives no blood
  - 0 = no ventilation
- In a normal young person, a V/Q scatter (spectrum of V/Q ratios) can vary bw 0.6 and 3
- V/Q ratios vary within in a lung depending on which alveolus is being observed
  - In a healthy person, there is less scatter in the plot and the bulk of the lung has a V/Q ratio close to 1
- A pretty normal V/Q ratio is 0.8 because generally 5L/min of blood and 4L/min of air
- Figure 1 represents a scatter of a 44 year old male while Figure 2 represents a 22 year old male

-
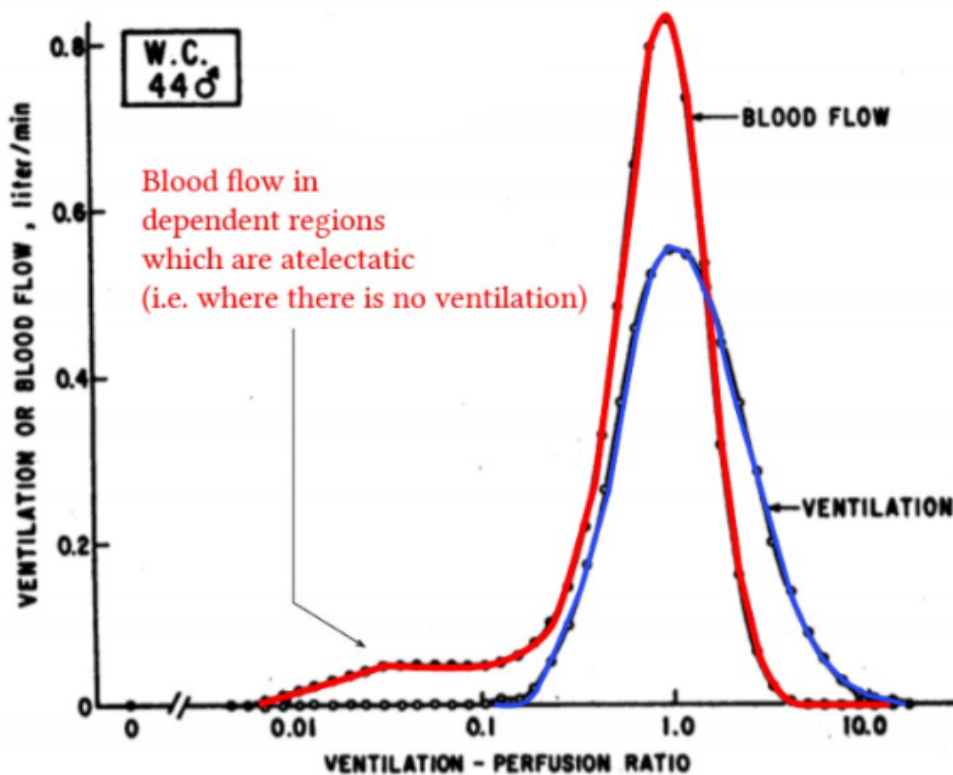
Figure 1. A graph of ventilation and perfusion values over a single lung
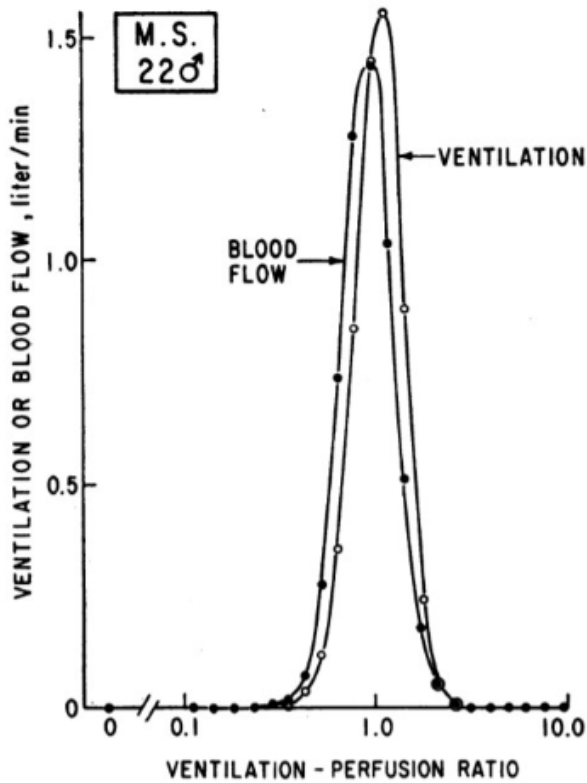
Figure 2. Ventilation and blood flow graphs over V/Q ratios

In figure 2, the two graphs almost over lap whereas figure 1, the graphs are clearly different - this is mismatching!

I think the most important take away from this article is that V/Q ratios vary greatly in a single lung in a single person, but the scatter can change more with age or health.

Conclusions/action items:

The values given in the graph can be values that can be displayed in our design. The volumes are flow for both air and lung will be helpful for students to identify how V/Q is affected as flow rates change.

CITATION: A. Yartsev, "Ventilation-perfusion matching and mismatching," *Deranged Physiology*. [Online]. Available: https://derangedphysiology.com/main/cicm-primary-exam/required-reading/respiratory-system/Chapter%20073/ventilation-perfusion-matching-and-mismatching. [Accessed: 03-Mar-2021].

Debouncing Circuit

Brittany Glaeser - Feb 05, 2021, 4:21 PM CST

Title: Debouncing Circuit

Date: 2/5

Content by: Britt

Present: Britt

Goals: Prevent debouncing in our button circuit

Content:

- Debouncing means that the circuit or code is prevent the button from be read multiple times after a single press
- Most buttons have springs and springs can bounce causing multiple contacts that send signals through the microcontroller
- One way to account for the bounce is in the code using a timer
    - By only allowing it to be read one time in a given time
- Another way to account for the bounce is within the circuit itself
    - One circuit i found is for a switch debounce, but i would assume a similar circuit can be used for a button
        - A capacitor is used to filter out any quick changes[1]
- Things to consider in a debouncing circuit
    - System clock frequency
    - Shortest expected press
    - Longest bounce time
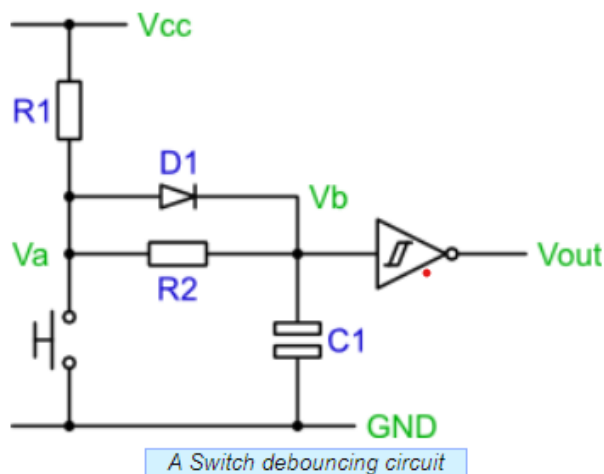
Figure 1. Debouncing Circuit

- Another circuit I found used a filter with a capacitor and a resistor
    - Pick R and C so tht they are in the ballpark of the time you'd like to debounce for [2]
    - Ex. 10K ohms and 100 nF gives 1 ms
    - May not work as well, especially for longer presses as the capacitor becomes full (reaches 2.5 V)
    - Another way to do it is with hysteresis (this seems complicated and more research would need to be conducted), but bascially states that there are three thresholds and when the button is in a LOW state, it will only count when the HIGH state is presented (MID states are ignored) and vis versa [2]
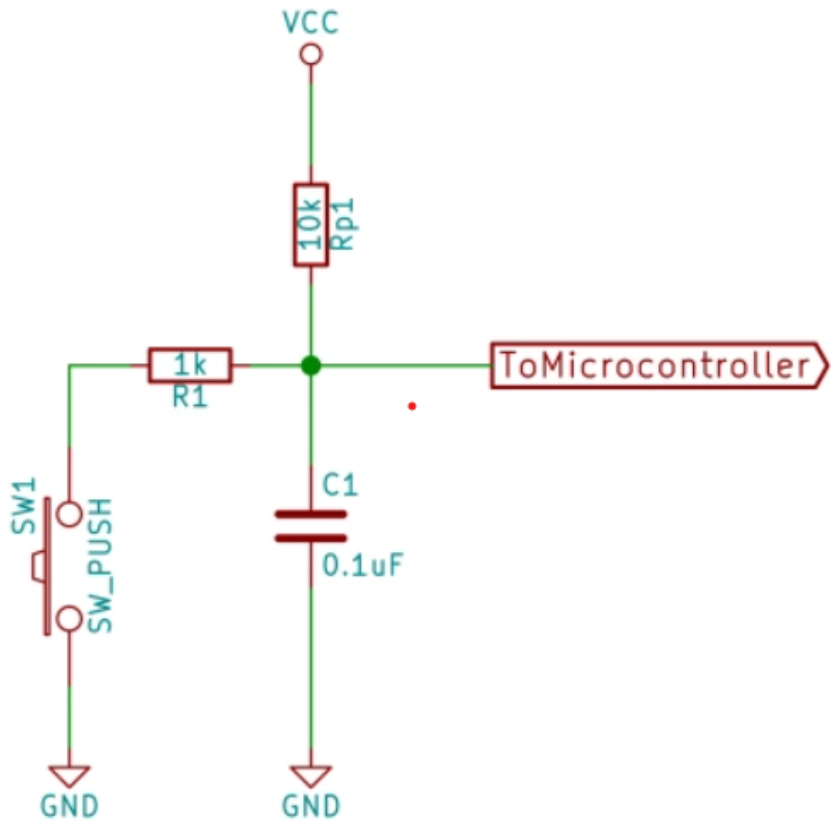
Figure 2. Debouncing Circuit w/o diode
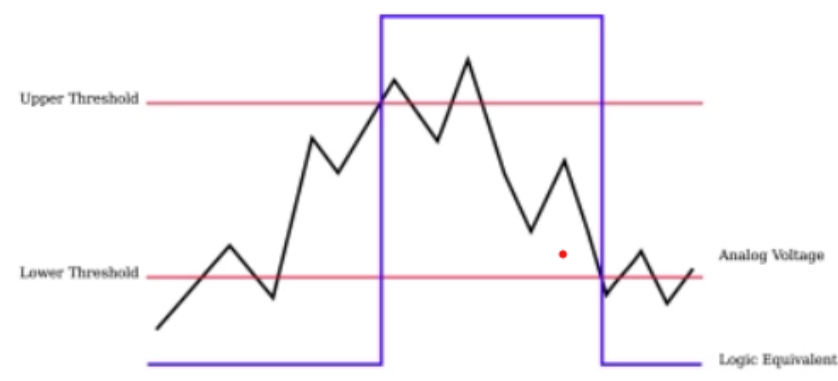
Figure 3. Example of hysteresis HIGH, LOW, and MID ranges

- One way to test is also plotting the voltage inputs on a graph to see the bouncing of the button and find approximate times and voltages
    - Can an analog pin be used rather than a digital pin that only accounts for HIGH and LOW voltages??

Conclusions/action items:

Currently, the design uses a timer to account for the bounce. This works relatively well and allows for a simpler circuit. It would be ideal to create a circuit with a filter to determine if that would filter out any noise better. Testing can easily be conducted on the buttons to find the amount of bounce that occurs and if there are other ways we can prevent that from occurring (I have the thought of maybe using analog instead of digital pins so it only counts once voltage is over a given threshold).

CITATIONS:

[1] Greensted, A., 2010. *Switch Debouncing*. [online] The Lab Book Pages. Available at: <http://www.labbookpages.co.uk/electronics/debounce.html> [Accessed 3 February 2021].

[2] E. Williams. "Embed With Elliot: Debounce Your Noisy Buttons, Part I," *Hackaday*, 05-Dec-2015. [Online]. Available: https://hackaday.com/2015/12/09/embed-with-elliot-debounce-your-noisy-buttons-part-i/. [Accessed: 05-Feb-2021].

Test Triangle Buttons

Brittany Glaeser - Feb 26, 2021, 1:31 PM CST

Title: Triangle Buttons

Date: 2/25/21

Content by: Britt

Present: Britt

Goals: Test triangle buttons - these are similar to the round ones we bought

Content:

These buttons did not have a datasheet to follow on adafruit's website, but they did give some guidelines to follow.

The LED was connected in series with a 330 Ohm resistor and the 5V power supply (as this is was is mainly used in our system). These wires are connected to the sides of the rectangular block on the behind the triangle button. The red side corresponds to the power and the black corresponds to the GND. This was only to power the LED. This can be seen in figure 1.

The button aspect was set up use the remaining two hooks on the button. One was connected to the 5V supply and the other was connected to the GND in series with a 1k Ohm resistor and the digital input pin. This allows the arduino to read the high and low signals passing through the button. The button is normally remained open so no power passes through and a digital input is read as 0.

The button was tested using the testButton_2221 code (found below) along with the serial monitor to see when the button was pushed. ElaspsedMillis and/or a debouncing circuit was not used, it was only to test the setup of the circuit.

```
int buttonCounter = 0;
int button = 8;

void setup() {
  // put your setup code here, to run once:
  pinMode(button, INPUT);
  Serial.begin(9600);
}

void loop() {
  // put your main code here, to run repeatedly:
  if(digitalRead(button) == 1){
    buttonCounter++;
    Serial.println(buttonCounter);
    Serial.print("voltage ");
    Serial.println(digitalRead(button));
    delay(500);
  }
  else{
    Serial.println("Volatge: ");
    Serial.println(digitalRead(button));
    delay(500);
  }
}
```

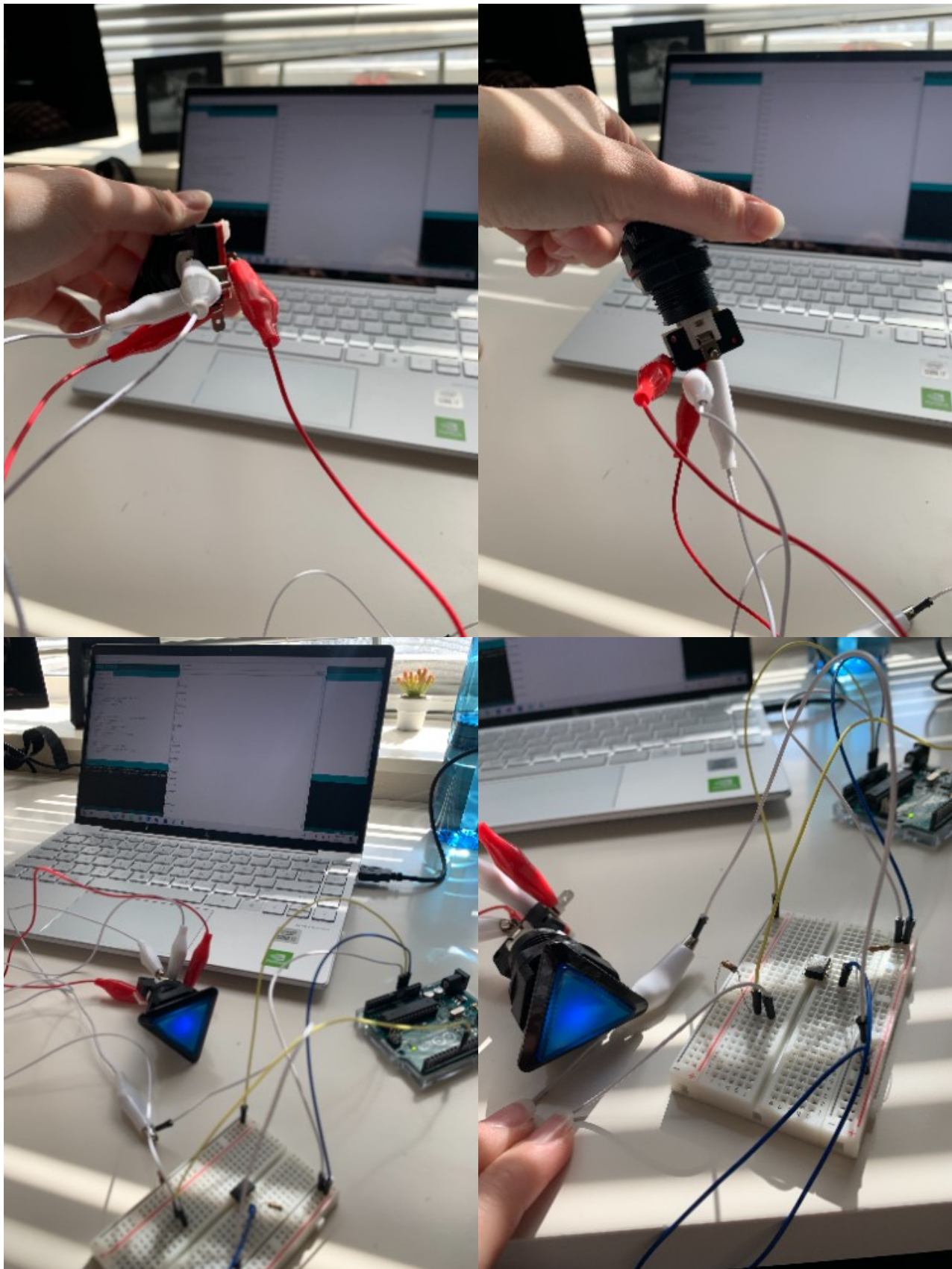Figure 1. Wire connections on the button and the breadboard connections for arduino uno

Conclusions/action items:

This circuit will eventually be applied to the new buttons when they arrive and implemented into the overall code. ElapsedMillis is already being used in the code to act as a debouncing circuit, but more testing can be done on the buttons to see the time frame in which the "bounce" occurs.

Diffuser for Circular LED

Brittany Glaeser - Feb 05, 2021, 4:40 PM CST

Title: Diffuser for circular LED

Date: 2/4

Content by: Britt

Present: Britt

Goals: Find a way to diffuse circular LED similar to that of silicone LEDs

Content:

- One way to diffuse the LEDs is using a privacy glass film (the website i found used a flexible vinyl
  - Once finding the sheet, it should be easy to incorporate by creating slits around the circle part of the 3D print to allow the sheet to slide in. This would also make it easy for removal
  - Needs to be attached to a structure
  - The film itself seems relatively cheap, but would need something to be placed on top of
  -
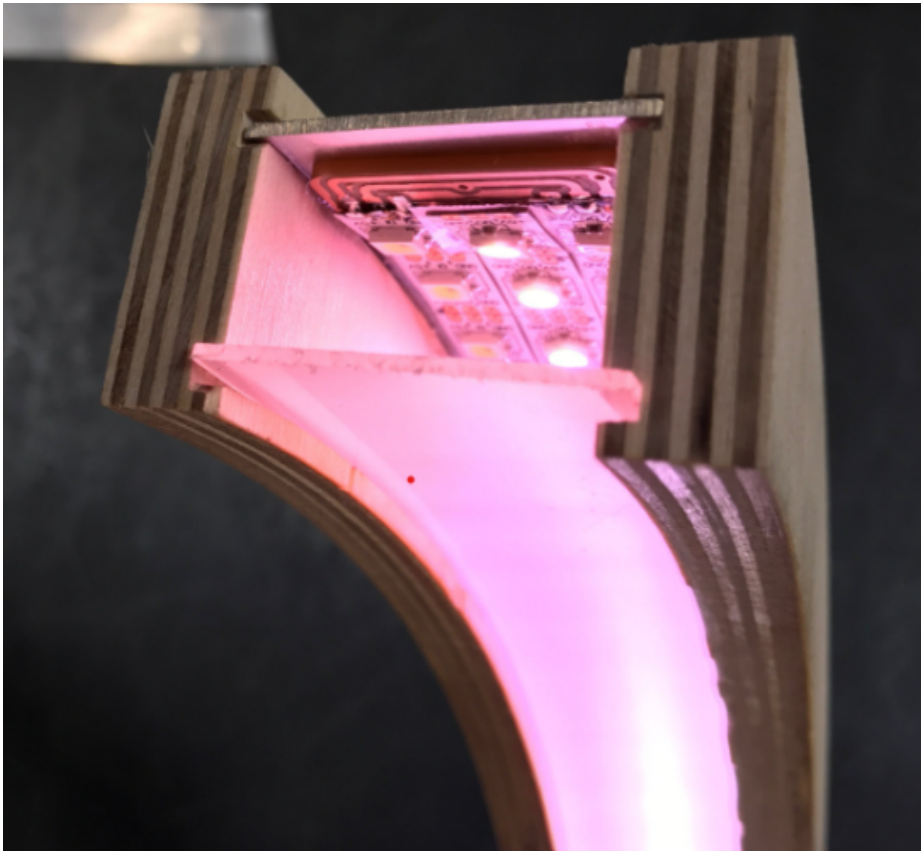
Figure 1. Privacy sheet

- Another way is using a silicone cast
  - This would allow the two sets of LEDs to have a similar appearance
  - This is likely more expensive and more work as it would require a fitted mold
- Frosted Acrylic sheets could also work
  - They would have to be added similar to the privacy screen
  - Works well for flat surfaces
  - These are pretty cheap but would need to be cut to size (laser cutter would likely be best)
  - The translucence may vary so it could be hard to find the right one
- The last one that seemed as it could work is 3D printed covers
  - The website used white PLA (which we could use in the makerspace)
  - This is inexpensive
  - Could be hard to find the right thickness
  - Could be incorporated right into our design somehow if we chose to print in white (maybe not ideal tho)
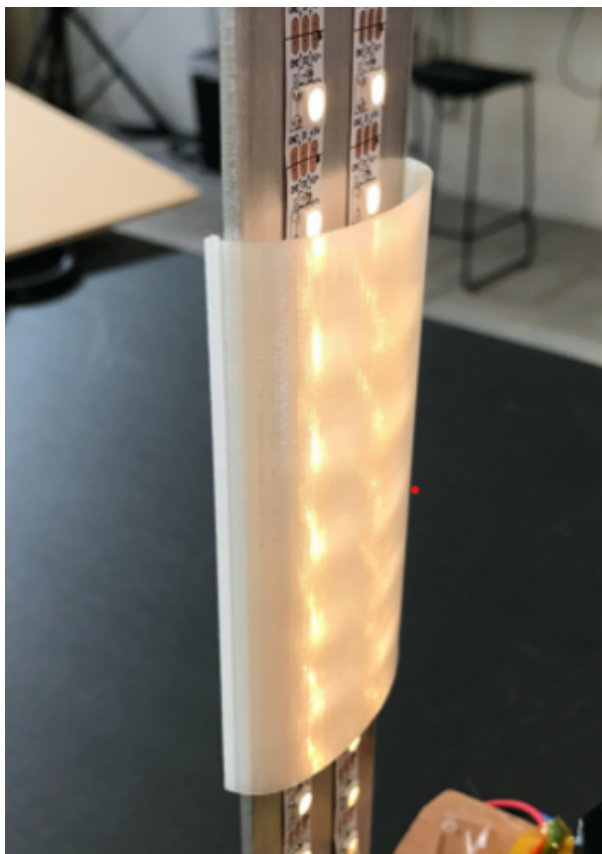
Figure 2. 3D printed LED diffuser clips

This could also all depend on if we only cover the LEDs or if we cover the entire alveolus because there are silicone tubes that are suppose to cover LEDs by sliding the LEDs into them. I do not know the size of these or how well they would be able to be placed on a circular LED. More research would need to be done.

Conclusions/action items:

This would be important to order soon as we will need them for testing because it will change the way the light is perceived.

Display for Ratios

Brittany Glaeser - Feb 08, 2021, 8:47 PM CST

Title: Monochrome Display for Ratios

Date: 2/8/21

Content by: Britt

Present: Britt

Goals:

Content:

https://www.adafruit.com/product/2719?gclid=Cj0KCQiA34OBBhCcARIsAG32uvNrMk6UYNPtSJQfGQSGY-48QWlQrAEnXM35oQT9ekwBcHILBnhQPCYaAucfEALw_wcB

- More expensive

https://www.adafruit.com/product/3502?gclid=Cj0KCQiA34OBBhCcARIsAG32uvMbTb9tuZG3y7wqTvbDzLN0ZNPmAoKSDngqI27o5Ak11CRMlkX7sjwaAr4wEALw_wcB

- Less expensive

https://www.adafruit.com/product/326?gclid=Cj0KCQiA34OBBhCcARIsAG32uvNJtz-ogTPQkvdji2RU86Lrkr1P1cD7jCGbYCQdHLmU0wCOzqOfv6kaAsI4EALw_wcB

- Even cheaper
- Comes ready to use (i think), expect would need to also buy QT connector (very cheap)
    - not sure yet if anything else would be needed(i think can be run on uno?)
    - Looks like if you use the QT it only needs the Vin, GND, Din, and CLK on the uno

https://www.adafruit.com/product/4313

- The cheapest
- Has color!
- Examples on website!

Conclusions/action items:

Button Circuit

Brittany Glaeser - Feb 04, 2021, 11:46 AM CST

Title: Initial Button Circuit

Date: 2/2/20

Content by: Britt

Present: Britt

Goals: To design a circuit in which the button can be included to control V/Q ratios

Content:
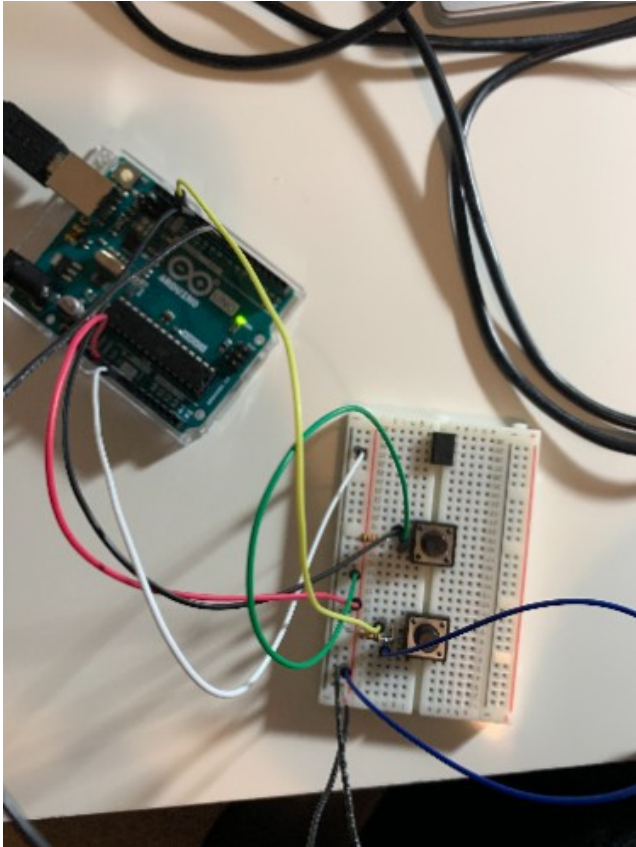
Figure 1. Breadboard with two buttons, one controls increased ventilation and the other decreases ventilation.

The buttons used were a tactile push button that were used in our BME 201 lab. The circuit was connected using the pins on one side of the button. One pin was connected to a 5V pin on the arduino and the pin on the other side was connected to a 10k ohm resistor, GND, and a digital pin (pins 12 and 13 were utilized).

When the button is pressed, a HIGH signal is transmitted to the digital pins and can be read via the arduino code. When the button is not pressed, a LOW signal is read. Because these buttons work as a spring, the spring bounces and can transmit multiple signals for one push so this needs to be accounted for so that the user gets the desired results when pushed.

The number of pulses it sends is dependent on how hard the button is pressed and how fast which is hard to manage as a user. To account for this, a debouncing circuit can be used (see notebook folder "Research Notes" and page "Debouncing Circuit". This required a lot more circuitry and was not utilized for the time being. Instead, within the arduino code, it was done by only counting one push within a given time (assuming that in that given time multiple pulses are read by the digital pins). Therefore, no matter how many times pulses are read, within the set time it will only count as one push.

The button that increases the circuit will only allow the ventilation to be changed 4 times and then resets at the lowest level. The decreasing button will only allow the counter to go to 0 and once at 0 it will stay at 0 until increased.

```
////////////***************************************************
if(buttonWait > 150){
  if(digitalRead(alvIncrease) == 1){
    buttonCounter++;
    buttonWait = 0;
    if(buttonCounter > 4){
      buttonCounter = 1;
    }
  }else if(digitalRead(alvDecrease) == 1){
    buttonCounter--;
    buttonWait = 0;
    if(buttonCounter < 1){
      buttonCounter = 1;
    }
  }
}
```

Figure 2. Code used to count the number of times the button was pushed using variable buttonCounter.

Conclusions/action items:

More buttons are needed so that there can be buttons that can increase and decrease perfusion as well and this will also need to be added to the code. It would also be best to later find better buttons that might limit the amount of bounce and can be integrated into the 3D print rather than the breadboard.

The photo shows a mess of wires and are not secure. A circuit that is more secure and smaller will be ideal for implementing into the design.

A debouncing circuit should also be created to determine which is a better option/more accurate for our design.

Jumper Wires

Brittany Glaeser - Feb 23, 2021, 12:58 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

https://www.youtube.com/watch?v=ver-Av8vr1Q

https://learn.adafruit.com/breadboards-for-beginners/diy-jumper-wires?view=all

Conclusions/action items:

Concentric Circle Alveolus LEDs

Brittany Glaeser - Feb 11, 2021, 11:30 PM CST

Title: Concentric Circle LEDs

Date: 2/11/21

Content by: Britt

Present: Britt

Goals: Find LEDs to fill alveolus

Content:

We already are using the Adafruit Neopixel 5050 RGB LEDs so it would be best to stick with a similar design and incorporate our existing rings. I have found other websites with neopixel rings, but the connections are different and may make a bulkier design for the circuit whereas I know the Adafruit designs have an easy DOUT pin that can be connected to the next rings DIN pin. Plus the code already incorporates Adafruit's neopixel library on Arduino.

Adafruit has 7, 12, 16, 24, and 60 neopixel rings. To fit together within the alveolus the 24, 16, and 7 would be best to create 4 rings (24, 16, 6, 1) with easy connections.

The dimensions of the rings [1]:

24: Outer = 65.5 mm, inner = 52.3 mm

16: Outer = 44.5 mm, inner = 31.7 mm

7: Outer = 23 mm

The diameter of the alveolus may need to be changed ever so slightly to fit the 24 neopixel rings. This can be seen in figure 1.
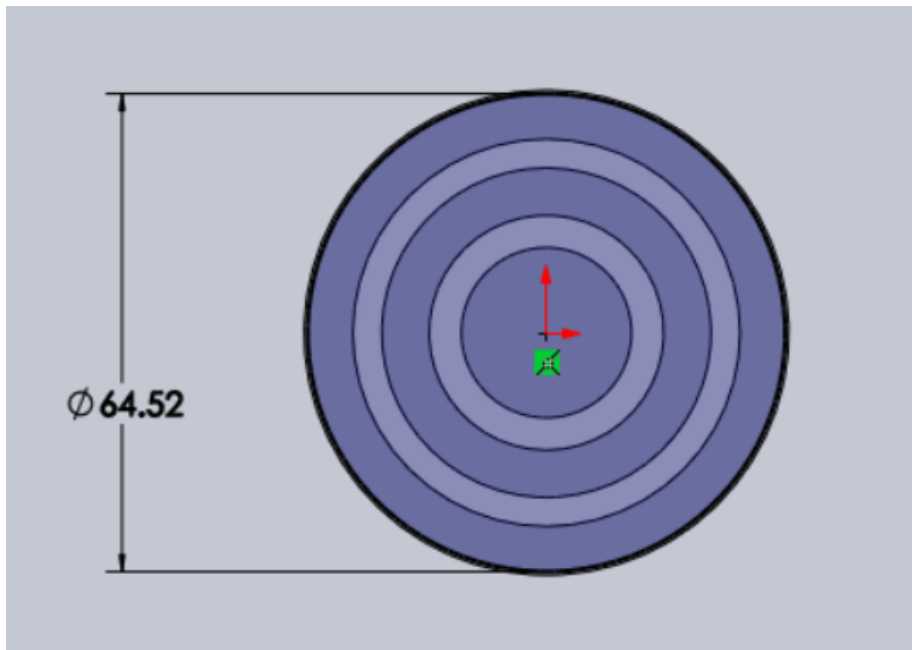
Figure 1: The sizing of the concentric circles with the LED dimensions for 24, 16, and 7 Neopixel boards

Conclusions/action items:

The next steps would be to order these LEDs and begin coding so they no longer 'flow' in a circular direction but more in and out as the alveolus fills (I think of a balloon for some reason). We would also need to find a way to secure the LEDs in place so they wouldn't shift within in the alveolus.

CITATION:

[1] Industries, A., 2020. *NeoPixel Ring - 24 x 5050 RGB LED with Integrate Drivers*. [online] Adafruit.com. Available at: <https://www.adafruit.com/product/1586> [Accessed 11 February 2021].

Breathing Rates to Compare Alveolar Ventilation Rate To

KAITLIN LACY - Mar 03, 2021, 11:10 AM CST

Title: Breathing Rates for Adults

Date: 2/25/21

Content by: Kaitlin Lacy

Goals: Research breathing rates of adults to establish a set of values that can be used to model the alveolar ventilation in the model.

Content:

A breathing rate of 12-16 seems to be the average resting rate. However, the Cleveland Clinic defines a respiration rate of 12-20 breaths per minute as normal. Anything below 12 and above 25 is considered abnormal. Values below 12 could be used for the low VQ ratio setting and values above 25 could be used in the high VQ ratio. A value somewhere in the 12-16 could be used for the 1:1 ratio as this is supposed to be the "normal" setting.

0 breaths per minute ; shunt (lights dark)

Breaths per minute < 12 ; low V/Q ratio

12< breaths per minute < 20; 1:1 ratio

25 < breaths per minute ; High V/Q ratio

Continuously lit ; Dead space ventilation (not sure if we should still have the lights blink to show movement, but this would be difficult to make them look faster than the High V/Q state but not be distracting.)

Conclusions/action items: Discuss these values with Dr. Green once the prototype of the model is set up to confirm that this or something similar would make sense to him and his students.

"Vital Signs," *Cleveland Clinic*. [Online]. Available: https://my.clevelandclinic.org/health/articles/10881-vital-signs. [Accessed: 03-Mar-2021].

Minute Ventilation and Alveolar Ventilation Research

KAITLIN LACY - Mar 03, 2021, 11:09 AM CST

Title: Minute Ventilation and Alveolar Ventilation

Date: 2/25/2021

Content by: Kaitlin Lacy

Goals: The alveolus blinking could also be based off of the minute ventilation or alveolar ventilation, which is itself based off of the respiratory rate.

Content:

Minute ventilation = tidal volume * respiratory rate ~ 500 mL * RR

Tidal volume can change as well as respiratory rate, so this could be used to manipulate the blinking of the LEDs as well.

- Speed could be related to the respiratory rate and tidal volume could be related to the number of lights lit in the circular LEDs

Alveolar ventilation = (Tidal volume - Dead space) * RR ~ (500 - 150 mL) * RR

(Tidal volume is typically estimated at 500mL and dead space is estimated at 150 mL)

- Tidal volume or dead space could be modified in order to change the lights as well

Conclusions/action items: It would be helpful to have another conversation with Dr. Green and see what exactly he would like us to base the lights off and display to the students.

R. G. Carroll, "Pulmonary System," in *Elselvier's Integrated Physiology*, .

Different Methods of Cutting Acrylic Sheets

KAITLIN LACY - Mar 03, 2021, 11:21 AM C

Title: Different Methods of Cutting Acrylic Sheets

Date: 3/2/2021

Content by: Kaitlin Lacy

Goals: Research ways to cut acrylic sheets that don't rely on laser cutting.

Content:

If improperly cut, acrylic sheets have the possibility of cracking

-Amazon sells an acrylic cutting knife - It is used to score the sheet four to eight times and then the sheet is broken along that line.This implies that cutting rounded pieces may not be possible

-Table saws can be used as well - there are sometimes special blades to cut acrylic with, but it is not absolutely necessary to have specialized blades

-Routers can be used for straight or curved cuts - typically a table saw is used for the bigger cuts and then a router cleans up afterwards. It is also emphasized to have a secure attachment to sheet to get clean cuts

It is possible to use a combination of these methods to get a rough shape and then sand it down to the precise size we need.

Conclusions/action items: Look into laser cutting options on campus as this may end up being easier than trying to cut it with a saw. I have access to a few saws at home, so I could do some cuts there if it difficult to use the tools on campus.

https://www.amazon.com/Supreme-Tech-Acrylic-Cutting-Knife/dp/B07D4RNMNX/ref=asc_df_B07D4RNMNX/?tag=hyprod-20&linkCode=df0&hvadid=242163315092&hvpos=&hvnetw=g&hvrand=14369726158442761583&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9018948&hvtargid=453470548504&psc=1

Debouncing Circuit and Code Ideas

Title: Debouncing Circuit and Code Ideas

Date: 2/4/2021

Content by: Kaitlin Lacy

Goals: Learn more about correcting the problem of switch debouncing in a circuit

Content:

A capacitor is utilized to filter out any rapid changes in the circuit that are a result of a switch bounce.

A Switch debouncing circuit
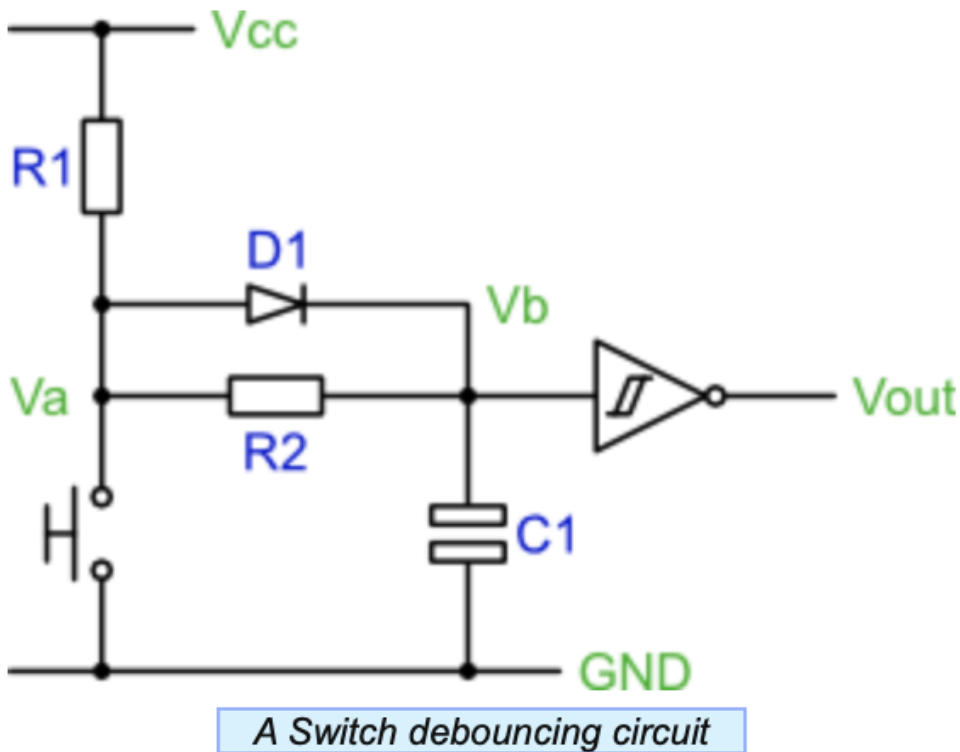
An example switch debouncing circuit is pictured above.

Debouncing circuit in switch open and closed states
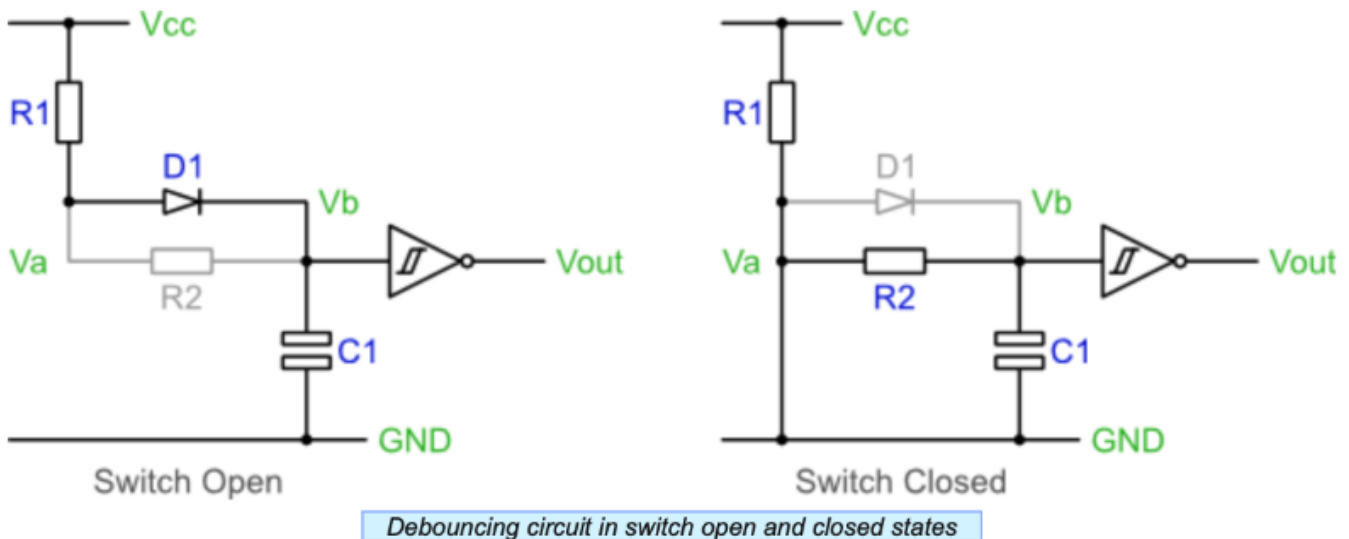
When the switch is open, C1 will charge through R1 and D1. When C1 is charged, Vb will be within 0.7V of Vcc giving an output of a logic 0.

When the switch is closed, the capacitor discharges via R2, Vb reaches 0V. The output is then a logic 1.

Code ideas:

-Use a counter to time how long signal is low. If low for a long time, then the switch is pressed and stable.

```
 1 Setup a counter variable, initialise to zero.
 2 Setup a regular sampling event, perhaps using a timer. Use a period of about 1ms.

 3 On a sample event:
 4   if switch signal is high then
 5     Reset the counter varaible to zero
 6     Set internal switch state to released
 7   else
 8     Increment the counter variable to a maximum of 10
 9   end if
10   if counter=10 then
11     Set internal switch state to pressed
12   end if
```

-Use a shift register instead of a counter.

```
 1 Setup a variable to act as a shift register, initialise it to xFF.
 2 Setup a regular sampling event, perhaps using a timer. Use a period of about 1ms.

 3 On a sample event:
 4   Shift the variable towards the most significant bit
 5   Set the least significant bit to the current switch value
 6   if shift register val=0 then
 7     Set internal switch state to pressed
 8   else
 9     Set internal switch state to released
10   end if
```

Conclusions/action items: There are several options for how to debounce a switch. Decide whether to use a switch debouncing circuit or code in order to remedy the problem of switch bouncing in the model.

A. Greensted, "The Lab Book Pages," *Sitewide RSS*. [Online]. Available: http://www.labbookpages.co.uk/electronics/debounce.html. [Accessed: 04-Feb-2021].

![Alveolus logo] **Alveolus Diffuser Ideas**

KAITLIN LACY - Feb 19, 2021, 12:48 PM CST

Title: Alveolus Diffuser Ideas

Date: 2/18/2021

Content by: Kaitlin Lacy

Goals: Identify some possible options for a diffuser for the alveolus LEDs.

Content:

-There is a shop on Etsy that is advertising a 1/16 inch thick 24x24 inch HDPE sheet that looks like it would be able to diffuse the light. In fact, many people in the comments said that they used it for that purpose, with examples and photos of light fixtures utilizing this material. It most likely could be purchased from a different source if we went forward with that idea.
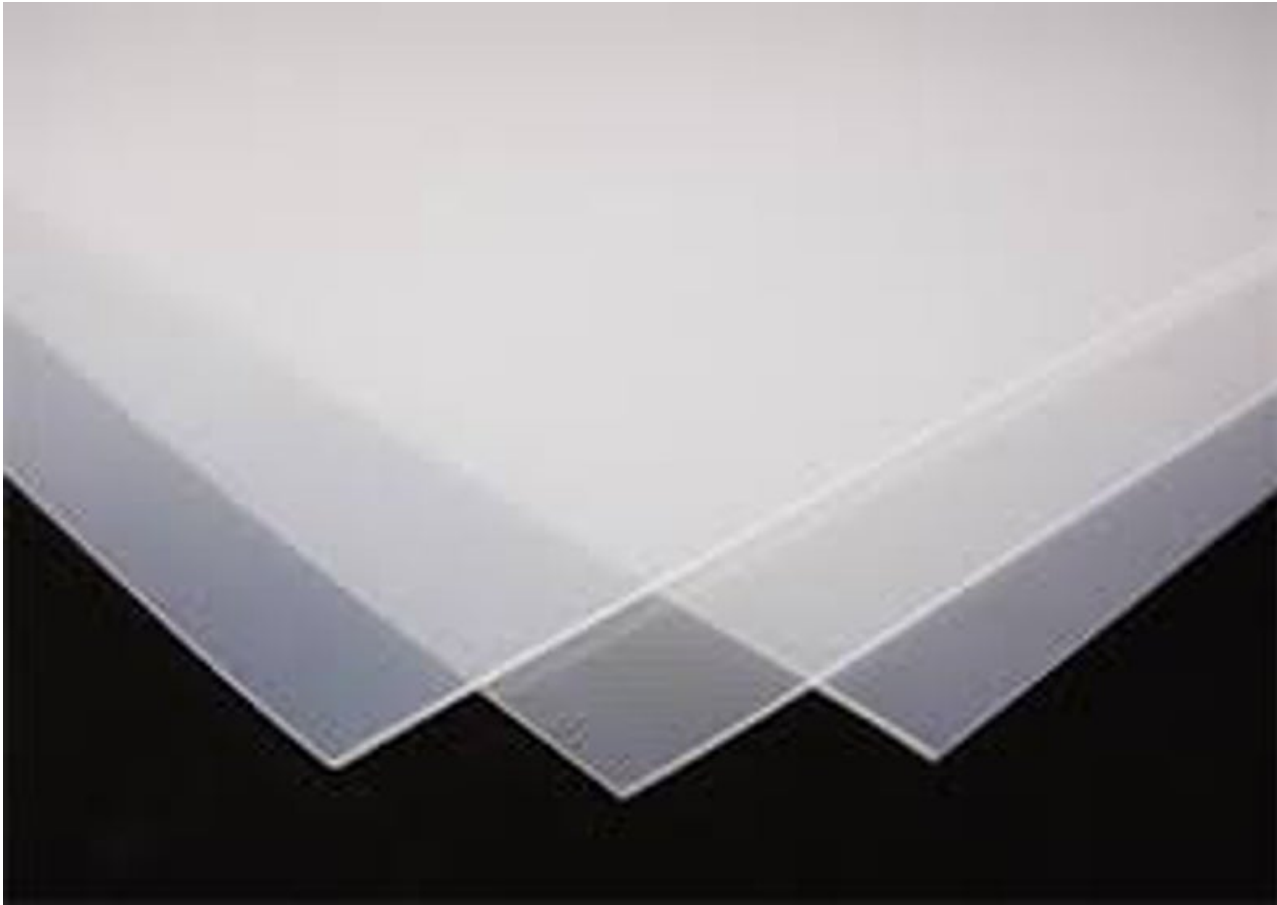
Fig. 1: HDPE sheet for sale on Etsy.

Figure 2: Example of how one customer utilized the sheet as a diffuser for this light fixture.

- Home Depot has several options for acrylic plastic sheets that could diffuse the light, and these come in a variety of sizes and thicknesses. An example is cited below.

Conclusions/action items:

There are many possible options for light diffusion in the alveolus. With our budget, we could order a few different thicknesses from Home Depot, and compare them in order to find the best option. Ideally, we want something that diffuses the light to prevent seeing the definition of the individual LEDs while still displaying as much brightness as possible.

"HDPE Flexible Translucent Plastic Sheet 1/16," *Etsy*. [Online]. Available: https://www.etsy.com/listing/690624162/hdpe-flexible-translucent-plastic-sheet?gpla=1&gao=1&&utm_source=google&utm_medium=cpc&utm_campaign=shopping_us_ps-b-craft_supplies_and_tools-raw_materials-plastic&utm_custom1=_k_Cj0KCQiA4L2BBhCvARIsAO0SBdZ3RRrLDeBi88V6MF7y2UyNikoF-H0jKx0wNUxoe4DwFXC1idRGCrkaAjoiEALw_wcB_k_&utm_content=go_11505663052_117861172008_476160638578_pla-322726484098_c__690624162_160848359&utm_custom2=11505663052&gclid=Cj0KCQiA4L2BBhCvARIsAO0SBdZ3RRrLDeBi88V6MF7y2UyNikoF-H0jKx0wNUxoe4DwFXC1idRGCrkaAjoiEALw_wcB. [Accessed: 18-Feb-2021].

"Falken Design 12 in. x 36 in. x 1/8 in. Thick Acrylic White Translucent 50%, 2447 Sheet-Falken Design ACRYLIC-WT-2447-1-8/1236," *The Home Depot*. [Online]. Available: https://www.homedepot.com/p/Falken-Design-12-in-x-36-in-x-1-8-in-Thick-Acrylic-White-Translucent-50-2447-Sheet-Falken-Design-ACRYLIC-WT-2447-1-8-1236/308669197?source=shoppingads&locale=en-US. [Accessed: 18-Feb-2021].

Back Panel for Base

KAITLIN LACY - Mar 02, 2021, 10:28 PM CST

Title: Back Panel for Base

Date: 2/11/2021

Content by: Kaitlin Lacy

Goals: Find a way to hold the electronic components in place in the back while the device is being used or transported.

Content:

While the device is being used or transported, the electronic pieces housed in the back are at risk of falling out or being accidentally manipulated due to contact with these elements. They could also get damaged through unnecessary exposure.

-The pieces could be glued in place to prevent them from falling out or jostling each other in the back compartment. However, this does not alleviate the problem of something coming in contact with the electronics and potentially disconnecting or breaking them.

-A cover similar to those that cover batteries in items such as tv remotes could be used to provide protection for these back pieces. It would need to be a few millimeters thick, and rest on a lip around the outside edge of the back compartment. A screw would then be inserted to hold this into place. While it would be nice to have it pop in and out without screws (like the back of some TV removes) that would be difficult to achieve, and the user should not need to access the components for a majority of the time. Only if something needed to be replaced or fixed would they need to gain access.

Conclusions/action items:

Implement this idea into the device and select inserts and screws of the proper size.

2021/02/14 - UW Madison Human Subject Policies

ZOE SCHMANSKI - Feb 19, 2021, 2:35 PM CST

Title: UW Madison Human Subject Testing

Date: 2/14/2021

Content by: Zoe

Present: n/a

Goals: Document policies from UW Madison that we must follow for our human subject testing

Content:

Contact

Stephanie Wilson
Senior IRB Analyst
(608) 890-0244
316 Lathrop Hall
stephanie.wilson@wisc.edu

HRPP maintains the human subjects research protection policies utilized by UW Madison Institutional Review Boards (IRBs)

IRB Authorization Agreement (IAA)

Accepting or Ceding IRB oversight

Whether the research is federally funded.
Whether the research involves a vulnerable population (e.g. children, prisoners, individuals lacking capacity to consent).
Whether the research poses more than minimal risk.
Whether the research will involve procedures or activities that raise significant regulatory or ethical issues.
Whether the project likely qualifies for exemption.
Whether the research will be conducted as part of an existing IRB reliance partnership.
Whether a UW IRB or the proposed IRB of record has sufficient knowledge of the local context to assume IRB oversight for the research.
Whether a UW IRB/UW HRPP or proposed IRB of record/HRPP has sufficient resources to adequately oversee the research in a manner that will ensure the protection of human participants.
Whether UW or non-UW investigators are in good standing with no recent history of noncompliance or misconduct and are qualified to conduct the research as proposed.

Accepting IRB Oversight

Whether the non-UW investigators are unaffiliated with an institution with an HRPP Program because this:

Prevents UW-Madison from being able to rely on the other institution to inform it of the local research context;
Poses challenges for monitoring the conduct of the research;
Poses challenges for ensuring other investigators have appropriate training and expertise to conduct the research;

Whether some or all of the research will take place outside of Wisconsin, putting at issue other states' or countries' laws.
Whether the non-UW site is the coordinating center for a clinical trial (regardless of phase).
Whether any of the non-UW investigators have a conflict of interest, particularly if not managed by their home institution.
Whether the non-UW investigators are affiliated with a commercial, for-profit entity.

Ceding IRB Oversight

Whether the institution accepting IRB oversight does not maintain a Federalwide Assurance and, thus, is not subject to the Terms of Assurance requiring compliance with the Common Rule and the Belmont Report.
Whether the institution accepting IRB oversight does not have an accredited human research protection program.
Whether the study qualifies as a Veterans Administration (VA) study (e.g., veterans will be enrolled, the PI conducts the research under a VA appointment, VA facilities will be used).
Whether the research is funded via a SBIR or STTR award.

Whether the proposed IRB of record will accept IRB oversight of all study activities conducted by UW investigators.

Whether previous experience with the proposed IRB of record indicates the IRB reliance process will be protracted or if concerns arise during the reliance process (e.g., extensive negotiations regarding the IAA are required, the proposed IRB of record is not responsive to queries from the UW).

Conclusions/action items:

https://research.wisc.edu/kb-article/?id=56620

2021/02/15 - Possible Forms

ZOE SCHMANSKI - Feb 19, 2021, 11:33 AM CST

Title: Forms for testing

Date: 2/15/2021

Content by: Zoe

Present: n/a

Goals: Possible forms needed to be submitted for testing

Content:

FORMS:

Consent Form Wizard
Declaration to Researchers
HIPAA Authorization Wizard
HIPAA Authorization and Consent Form Wizard (Combined)
A Minor's Right to Consent to Treatment and Authorize Disclosure of PHI
Parent/Guardian Authorization Form Wizard
Power of Attorney for Research
Request for PI Status Form
Request for Personally Identifiable Information from Student Education Records for Research Purposes
Statement to Activate Power of Attorney for Research

Conclusions/action items:

https://research.wisc.edu/kb-article/?id=34102

2021/2/1 - Spring Button Testing

ZOE SCHMANSKI - Feb 01, 2021, 1:41 PM CST

Title: Spring Button testing

Date: 2/1/2021

Content by: Zoe

Present: n/a

Goals: Brainstorm ways to test the problem of a button clicking multiple times

Content:

Click the button in a series with different time intervals to determine the lowest possible interval for waiting to click the button

1. Display the code and output on a computer

2. Press the button for a series of 5 times

3. For the first round, wait 5 seconds between each click

4. Conduct multiple rounds, each decreasing the time interval by half a second

5. Observe how many clicks are registered after each push of the button

Conclusions/action items:

Include in the design specs of the device

2021/02/12 - Validation Test

ZOE SCHMANSKI - Feb 19, 2021, 12:01 PM CST

Title: Design Validation Testing

Date: 2/12/2021

Content by: Zoe and Jenna

Present: n/a

Goals: Brainstorm survey questions for design validation

Content:

A test to determine if the device is able to improve upon a human subject's understanding of ventilation/perfusion ratios by graphically displaying what occurs when the rates are modulated.

Hypothesis: The model improves a human subjects's understanding of ventilation/perfusion ratios.

Brief protocol: The human subjects used for this testing will be medical students with prior knowledge of ventilation/perfusion mismatching. This test will feature a series of two multiple choice tests; one administered before viewing the model and one administered after. The questions will be similar in nature to assess whether the model increased understanding.

Statistical Tests/Analysis: Difference of Means Hypothesis Test to compare the initial test score to the final test score for each subject. If our model did not show improvement in understanding, we would expect to find a difference of 0 when initial and final scores are compared. Therefore, we will be observing whether the final test scores increased significantly compared to the initial.

The results from this testing will verify that our model achieves the goal of being able to help medical students understand ventilation/perfusion mismatching.

**Ask the client for possible assessment questions he may use in his class

Conclusions/action items:

Refer back during client meeting

2021/02/13 - Blink/Flow Rate Verification Testing

ZOE SCHMANSKI - Feb 19, 2021, 11:58 AM CST

Title: Verification Testing for the Blink/Flow rates

Date: 2/13/2021

Content by: Zoe and Jenna

Present: n/a

Goals: Verify that the blinking rates in the alveolus and flow rates in the capillary represent V/Q ratios

Content:

The rate of change in flow/blinking in the capillary/alveolus will be tested to determine if a notable difference can be observed by the user of the model. A human subjects test will be administered.

Hypothesis: Human subjects will be able to distinguish between differences in flow and blinking rates in the model in order to understand V/Q ratios.

Brief protocol: First, two videos showing different levels of flow/blinking rates on the model will be provided. Then, the subject will answer whether or not they see a noticeable difference between the two videos. This will be repeated with all of the chosen values for flow/blinking rates to determine if a noticeable difference exists. The sample size will be at least 10 human subjects to generate meaningful results.

Statistical Tests/Analysis: To analyze the data, we will perform a One-Sample T-Test of Proportions to compare the difference in means of questions answered correctly for the observed group to 0.5 or the probability of answering questions correctly at random.

The results from this testing will determine if the rate of change in flow and blinking rate generates a noticeable difference for the human eye.

Conclusions/action items:

Take the videos once the device is fully assembled

2021/02/10 - Button Fabrication Testing

ZOE SCHMANSKI - Feb 19, 2021, 12:01 PM CST

Title: Button Testing

Date: 2/10/2021

Content by: Zoe and Jenna

Present: n/a

Goals: Test 3 buttons for possible use in the final design

Content:

A test will be conducted on the three buttons shown above in Figure 5 to determine which will be used to increase and decrease ventilation and perfusion rates.

The testing will verify that they can be incorporated into the existing circuitry without debouncing problems.

Hypothesis: The buttons should be capable of increasing or decreasing a set value by the corresponding amount of times they are pressed.

Brief protocol: Deliminate a few numbers of presses given to each button; 1, 3, 5, and 7. Run multiple trials for each number and record the amount of presses each button captured. Compare this to the actual number of presses performed and select a button based on the results.

Statistical Tests/Analysis: Linear Regression T-Test to determine if the number of times a button is pressed(independent) correlates to how many times it records being pressed(dependent).

The results from this testing will verify that the buttons can increase and decrease a set value by the amount of times pressed without introducing debouncing or other errors.

Conclusions/action items:

Conduct testing once the buttons ordered are delivered

2021/02/02-Testing

JENNA EIZADI (eizadi@wisc.edu) - Mar 02, 2021, 9:50 PM CST

Title: Testing

Date: 02/02/2021

Content by: Jenna

Present:

Goals: To brainstorm testing of our model to verify the components necessary.

Content:

Testing with various subjects:

- Subjects: we would want a variety of people of different backgrounds i.e. medical students, students in Dr. Green's class, inexperienced people such as parents/family members
- Mode: could record a video of our device switching through different V and Q ratios and either ask people to rate them from lowest to highest based on brightness or something of that sort of qualitative test
- Pretest/Posttest: our device is supposed to be capable of teaching students and improving their knowledge of V/Q ratios
    - pretest: to be administered before we show our model could attempt to determine the amount of knowledge medical students have before seeing our model
    - post-test: to be administered after viewing our model to determine if our design is successful in aiding their learning of V/Q
    - Most likely would not be administered to the inexperienced population as they do not have previous exposure to V/Q ratios, but we could create some sort of test similar to this one to figure out if they are able to discern certain things about our model such as what the alveolus represents, which way things are flowing, etc?
- We would want at least 5 people for each different category but ideally would have many test subjects so that our statistics are more meaningful

Testing with button changing LED colors and brightness

Conclusions/action items:

Finalize testing plans with Zoe to begin formulating a complete plan for what needs to be done to test our model.

2021/02/14-Human Subject Regulations

JENNA EIZADI (eizadi@wisc.edu) - Mar 03, 2021, 8:41 AM CST

Title: Human Subject Regulations for Testing

Date: 02/14/2021

Content by: Jenna

Present:

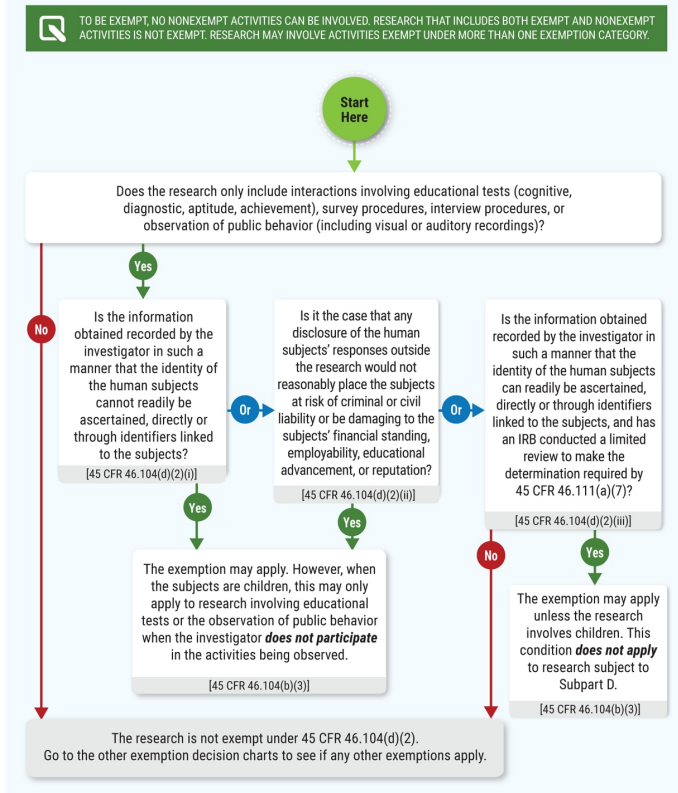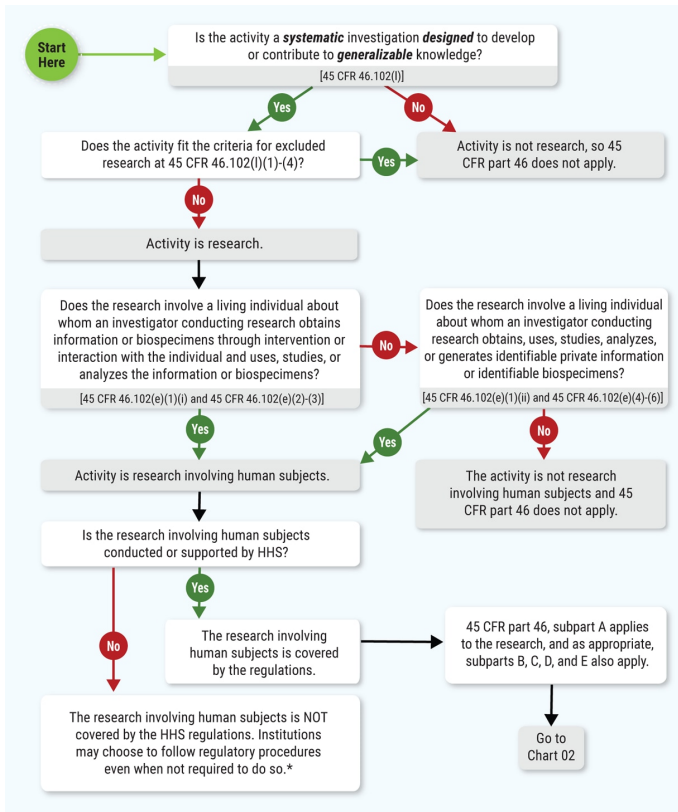**Goals:** To investigate the necessary protocols to be followed when conducting human subject testing.

Content:

UW Madison Human Subject Research Page: https://research.wisc.edu/compliance-policy/human-research-protection-program/

- https://www.hhs.gov/ohrp/regulations-and-policy/decision-charts-2018/index.html#c4
  - our research with human subjects seems to be exempt

Chart 01

Start Here → Is the activity a *systematic* investigation *designed* to develop or contribute to *generalizable* knowledge? [45 CFR 46.102(l)]

- Yes → Does the activity fit the criteria for excluded research at 45 CFR 46.102(l)(1)-(4)?
  - Yes → Activity is not research, so 45 CFR part 46 does not apply.
  - No → Activity is research.
- No → Activity is not research, so 45 CFR part 46 does not apply.

Activity is research. → Does the research involve a living individual about whom an investigator conducting research obtains information or biospecimens through intervention or interaction with the individual and uses, studies, or analyzes the information or biospecimens? [45 CFR 46.102(e)(1)(i) and 45 CFR 46.102(e)(2)-(3)]

- Yes → Activity is research involving human subjects.
- No → Does the research involve a living individual about whom an investigator conducting research obtains, uses, studies, analyzes, or generates identifiable private information or identifiable biospecimens? [45 CFR 46.102(e)(1)(ii) and 45 CFR 46.102(e)(4)-(6)]
  - Yes → Activity is research involving human subjects.
  - No → The activity is not research involving human subjects and 45 CFR part 46 does not apply.

Activity is research involving human subjects. → Is the research involving human subjects conducted or supported by HHS?

- Yes → The research involving human subjects is covered by the regulations. → 45 CFR part 46, subpart A applies to the research, and as appropriate, subparts B, C, D, and E also apply. → Go to Chart 02
- No → The research involving human subjects is NOT covered by the HHS regulations. Institutions may choose to follow regulatory procedures even when not required to do so.*

Chart 02

TO BE EXEMPT, NO NONEXEMPT ACTIVITIES CAN BE INVOLVED. RESEARCH THAT INCLUDES BOTH EXEMPT AND NONEXEMPT ACTIVITIES IS NOT EXEMPT. RESEARCH MAY INVOLVE ACTIVITIES EXEMPT UNDER MORE THAN ONE EXEMPTION CATEGORY.

Start Here → Does the research only include interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recordings)?

- No → The research is not exempt under 45 CFR 46.104(d)(2). Go to the other exemption decision charts to see if any other exemptions apply.
- Yes →
  - Is the information obtained recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects? [45 CFR 46.104(d)(2)(i)]
    - Yes → The exemption may apply. However, when the subjects are children, this may only apply to research involving educational tests or the observation of public behavior when the investigator *does not participate* in the activities being observed. [45 CFR 46.104(b)(3)]
  - Or — Is it the case that any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation? [45 CFR 46.104(d)(2)(ii)]
    - Yes → The exemption may apply. However, when the subjects are children, this may only apply to research involving educational tests or the observation of public behavior when the investigator *does not participate* in the activities being observed. [45 CFR 46.104(b)(3)]
  - Or — Is the information obtained recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and has an IRB conducted a limited review to make the determination required by 45 CFR 46.111(a)(7)? [45 CFR 46.104(d)(2)(iii)]
    - No → The research is not exempt under 45 CFR 46.104(d)(2).
    - Yes → The exemption may apply unless the research involves children. This condition *does not apply* to research subject to Subpart D. [45 CFR 46.104(b)(3)]

https://kb.wisc.edu/hsirbs/33386#Not_Research_Tool

https://kb.wisc.edu/hsirbs/88896#nhsr

- Our testing/research would fit under the exemptions from category 1 and 2 as listed on this page
- This means that we are exempt from submitting an IRB but might still need to submit an application to guarantee that we are exempt(?)
  - need to look into the application piece

https://kb.wisc.edu/hsirbs/page.php?id=41769

- We will need to provide some form of informed consent in our survey
- as suggested in this link, it can be in the form of a first page to the survey with information that addresses all of the informed consent elements
    - provide an option for printing should subjects choose it
- subjects cannot be minors!
- look here for the informed consent guidelines: https://kb.wisc.edu/hsirbs/page.php?id=18665

Conclusions/action items:

We should reach out to someone from the department at UW Madison to verify that we will not need any certification to conduct our testing studies. Additionally, we should ensure that we create a consent form for our survey that can be printed and that we do not use minors for our research.

2021/02/15-Testing Protocols

JENNA EIZADI (eizadi@wisc.edu) - Mar 03, 2021, 8:41 AM CST

Title: Button Verification Testing

Date: 02/15/2021

Content by: Jenna

Present:

Goals: To create a detailed plan to demonstrate that the buttons selected are capable of increasing or decreasing a set value by the number of times pressed, without debouncing or other errors.

Content:

A test will be conducted on the three buttons to determine which will be used to increase and decrease ventilation and perfusion rates.

- The testing will verify that they can be incorporated into the existing circuitry without debouncing problems.
- Hypothesis: The buttons should be capable of increasing or decreasing a set value by the corresponding amount of times they are pressed.
- Brief protocol: Deliminate a few numbers of presses given to each button; 1, 3, 5, and 7. Press the button a certain number of times and compare this value to the number recorded on a microcontroller. Compare this to the actual number of presses performed and select a button based on the results.
- Statistical Tests/Analysis: Linear Regression T-Test to determine if the number of times a button is pressed(independent) correlates to how many times it records being pressed(dependent).
- The results from this testing will verify that the buttons can increase and decrease a set value by the number of times pressed without introducing debouncing or other errors.

Conclusions/action items:

Narrow down the protocol for this testing and integrate buttons into the circuit so we can begin testing.

2021/02/15-Flow rate/Blinking rate Testing

JENNA EIZADI (eizadi@wisc.edu) - Mar 02, 2021, 9:45 PM CST

Title: Flow Rate/Blinking Rate Testing

Date: 02/15/2021

Content by: Jenna

Present:

Goals: To test whether a human subject can distinguish between a change in flow/blinking rate on the model.

Content:

The rate of change in flow/blinking in the capillary/alveolus will be tested to determine if a notable difference can be observed by the user of the model. A human subjects test will be administered.

- Hypothesis: Human subjects will be able to distinguish between differences in flow and blinking rates in the model in order to understand V/Q ratios.
- Brief protocol: The test will consist of a video showing the same or changing rates of flow or blinking on the model and a human subject will determine if they observe a noticeable change in the rates. This will be repeated with all of the chosen values for flow/blinking rates to determine if a noticeable difference exists. The sample size will be at least 50 human subjects to generate meaningful results.
- Statistical Tests/Analysis: To analyze the data, we will perform a One-Sample T-Test of Proportions to compare the difference in means of questions answered correctly for the observed group to 0.5 or the probability of answering questions correctly at random.
- The results from this testing will determine if the rate of change in flow and blinking rate generates a noticeable difference for the human eye.

Conclusions/action items:

Determine what needs to be done to perform this type of test. Look into possible IRB forms necessary for human subject testing. Record the model displaying different rates of flow and blinking for the test. Formulate questions for a multiple-choice test and find a forum that can pair videos with corresponding questions.

2021/02/15-Model Validation Testing

JENNA EIZADI (eizadi@wisc.edu) - Mar 02, 2021, 9:41 PM CST

Title: Model Validation Testing

Date: 02/15/2021

Content by: Jenna

Present:

Goals: To develop a test to validate our model's ability to improve a human subject's understanding of V/P ratios.

Content:

A test to determine if the device is able to improve upon a human subject's understanding of ventilation/perfusion ratios by graphically displaying what occurs when the rates are modulated.

- Hypothesis: The model improves human subjects' understanding of ventilation/perfusion ratios.
- Brief protocol: The human subjects used for this testing will be medical students with prior knowledge of ventilation/perfusion mismatching. This test will feature a series of two multiple-choice tests; one administered before viewing the model and one administered after. The questions will be similar in nature to assess whether the model increased understanding.
- Statistical Tests/Analysis: Difference of Means Hypothesis Test to compare the initial test score to the final test score for each subject. If our model did not show improvement in understanding, we would expect to find a difference of 0 when initial and final scores are compared. Therefore, we will be observing whether the final test scores increased significantly compared to the initial.
- The results from this testing will verify that our model achieves the goal of being able to help medical students understand ventilation/perfusion mismatching

Conclusions/action items:

Determine what needs to be done to perform this type of test. Look into possible IRB forms necessary for human subject testing. Formulate questions for a multiple-choice test.

2021/02/25-Google Form Test

JENNA EIZADI (eizadi@wisc.edu) - Mar 02, 2021, 9:59 PM CST

Title: Google Form Multiple-Choice Test

Date: 02/25/2021

Content by: Jenna

Present: Zoe

Goals: To investigate a method for a multiple-choice test to be sent as a survey to medical students.

Content:

- Google Form can pair video content with corresponding multiple-choice questions
- We could be able to pair videos of our device in various states with questions testing if human subjects understand certain aspects of these videos
- In the case of our flow/blinking rate testing, we could insert videos with the same or different rates and ask questions to determine if human subjects perceive the differences
- In the case of our model validation testing, we could administer a pre-test on knowledge about V/P mismatching, then insert a video with our device and a brief explanation of the various components, and then administer a post-test

Teaching V/P Mismatching Model

This is a research project being conducted for BME 402 at the University of Wisconsin-Madison. You are invited to participate in this research project because you are a medical student with knowledge of pulmonary physiology. Your participation in this research study is voluntary. You may choose not to participate. If you decide to participate in this research survey, you may withdraw at any time. If you decide not to participate in this study or if you withdraw from participating at any time, you will not be penalized. The procedure involves filling an online survey that will take approximately 30 minutes. Your responses will be confidential and we do not collect identifying information such as your name, email address or IP address. The survey questions will be about identifying and distinguishing various characteristics on a teaching model. We will do our best to keep your information confidential. All data is stored in a password protected electronic format. To help protect your confidentiality, the surveys will not contain information that will personally identify you. The results of this study will be used for scholarly purposes only and may be shared with University of Wisconsin-Madison representatives in a published journal.

* Required

ELECTRONIC CONSENT: Please select your choice below. Clicking on the "agree" button below indicates that: you have ready the above information, you voluntarily agree to participate, and you are at least 18 years of age. If you do not wish to participate in the research study, please decline participation by clicking on the "disagree" button. *

Model Validation

This section will determine if the device is able to improve upon a human subject's understanding of ventilation/perfusion ratios by graphically displaying what occurs when the rates are modulated.

LED video

The circular LED represents the alveolus and the curved LED represents a capillary bed. Which direction is blood flowing through the capillary bed? *

◯ Left to right

◯ Right to left

◯ Upward

◯ Downward

- The figures above demonstrate a sample of what the google form could look like: the picture on the left allows us to insert the proper consent necessary via IRB guidelines for human subject testing and the figure on the right demonstrates the capability to insert a video and ask corresponding questions based off of it
- We are also able to make the survey anonymous, keeping with IRB protocol
- Google Form also enables the creator of the survey to control the order the questions are viewed in, which could be important in our second test for the pre and post-test

Conclusions/action items:

We need to record videos of our model for both tests once the fabrication is complete and finalize the questions we want to include in the surveys.

In addition, we need to follow through with the IRB form to enable us to perform human subject testing.

2021/03/03-IRB Application

JENNA EIZADI (eizadi@wisc.edu) - Mar 03, 2021, 10:07 AM CST

Title: New IRB Application

Date: 03/03/2021

Content by: Jenna

Present:

Goals: To initialize a new IRB application to prepare for a meeting with IRB personnel to discuss what needs to be submitted.

Content:

- All members of the study need to be listed in ARROW-currently I am the only one who is listed
- CITI training: all members of the study need to complete the human subjects research training listed in CITI and I may have to take a refresher course if mine has expired
- I created a new IRB application listing Amit Nimunkar as the PI for the research attached to this page
- I created a consent document attached to this page for the IRB application that outline consent for our study
- Checklist via: https://kb.wisc.edu/sbsedirbs/41849

Conclusions/action items:

The next steps are to meet with IRB personnel to discuss the submission and ensure that the application is filled out correctly and submit the application for review.

JENNA EIZADI (eizadi@wisc.edu) - Mar 03, 2021, 10:04 AM CST

Consent_Form.docx(43.9 KB) - download

Teaching_Model_V_P_IRB_Application.pdf(498.6 KB) - download

2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 9/5/2016

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2014/11/03-Template

John Puccinelli - Nov 03, 2014, 3:20 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items: