

BME Design-Spring 2021 - Brittany Glaeser Complete Notebook

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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

Brittany Glaeser - Feb 11, 2021, 11:16 PM CST

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.



Client Meeting 3/25

Brittany Glaeser - Mar 25, 2021, 8:31 PM CDT

Title: Discuss Testing Survey and Final Design

Date: 3/25

Content by: Britt

Present: Britt, Kaitlin, Zoe

Goals: Determine changes needed for survey and final design

Content:

- Email list for med students
 - He will reach out to supervisor to see if he can get a class list
 - Will be done ASAP so ready for when we wanna test
- Survey said will take 30 minutes
 - Thinks people will not take it if it says it'll take this long
 - Took him only about 10 minutes
 - Thinks it is reasonable to say 15 minutes to take survey
- Liked the new diffuser
- Counted the cycles of ventilation/perfusion to determine the ratio
 - This was not what we had intended the device to do but may implement for better understanding
 - 2:1 ratio, 2 cycles of ventilation vs. 1 cycle of perfusion
- Our design helps students think about the concepts more than those in a book that they may skim over
- Maybe the survey questions could be apart of the final package that could also help students learn
- For survey, it may be best to indicated that when the lights are off that it indicates shunt or dead space ventilation
 - Also for the design it should indicate this
 - Probably in the display
 - Maybe instead of completely off, just have the lights be a dim, solid, white light
- THOUGHT: When there is no ventilation, there is no perfusion therefore the lights should not change to red, they should stay blue
- Oxygenation occurs 1/3 of the way through the capillary at rest
 - Should change the design so that the 'purple' diffusing part begins later
 - This is more realistic this way

Conclusions/action items:

- He gave a few small changes to change for the survey so this will be added as soon as possible so the application can be approved
- He mentioned a few small changes to the overall model so those will need to be changed over time



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 it 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 acrylic 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



Advisor Meeting 3/5

Brittany Glaeser - Mar 05, 2021, 7:10 PM CST

Title: Advisor Meeting

Date: 3/5/21

Content by: Britt

Present: All

Goals: Determine IRB protocols and printing plans

Content:

- IRB by next Friday
- Testing Question
 - Example videos - test these
 - Test with old sample
 - Need design for detailed question
 - What is the optimal number of questions?
 - Looping videos
 - Don't need to watch the whole thing
 - Need to state is a loop
 - Best and worst case scenarios expected for results
- Verification: do we need med students?
- Validation: On med school population
 - A standard in which itll get compared to
 - A base line
- Run a pilot testing survey with friends
- Use a standard that everyone sees, with a correct answer
 - How does population respond to the control
- Laser Cutting
 - Find someone who can cut it for us

Conclusions/action items:

Finish main prototype by next week so it can be submitted for IRB approval.



Advisor Meeting 3/12

Brittany Glaeser - Mar 14, 2021, 10:00 PM CDT

Title: Advisor Meeting

Date: 3/12

Content by: Britt

Present: All

Goals: Discuss testing protocols and design progress

Content:

- Plan to submit IRB application by Monday
 - Need to send link out ASAP
- Should send survey to friends for feedback
 - Send to advisor
 - Send to client
 - Get his thoughts on how he wants to distribute survey
- We need to plan a final design meeting with the client
- Can always make changes to survey and send those updates via email
- Next week plan to review paper

Conclusions/action items:

The plan is to submit the survey ASAP and hopefully make as many changes as possible before then.

We will also work on cleaning up the circuit so that it works better and looks nicer.

A new solidworks print will also need to be created to fit the buttons, add display, and potentially clean up any edges.



Advisor Meeting 3/19

Brittany Glaeser - Mar 23, 2021, 6:32 PM CDT

Title: Discuss Survey

Date: 3/19

Content by: Britt

Present: All

Goals: Discuss what to do about testing

Content:

- Biggest goal is to finish IRB
- IRB application was submitted this past week
- We added to the survey specific known values for some videos as a reference point
- Update videos?
- Last video played different videos when it ended
 - No way to loop the videos?
 - No way to do videos side by side?
- Meet with client next week
 - Send survey to him ASAP
- Continue background testing before approval gets back
 - Friends and Family
- 4 WEEKS!
- Should create closure with the design so all are working on testing and results on testing
- Makerspace may have microcontrollers to buy
- Try and finish design in about a week and a half
- Outreach on the 30th (4:30 - 5:30)
 - Zoom link
- Client discussed submitting to a journal
 - He can help with some of the writing
 - We have our own parts to write so it is okay if he contributes as well
 - Have him work on it closer to the end when we have some final result for design and testing

Conclusions/action items:

The first thing to do is to get feedback on the survey so we can send this out asap to get results.

Kaitlin and I will work on finalizing the design a bit more. This includes a new print, the display, and cleaning up the wires.



Advisor Meeting 3/26

Brittany Glaeser - Mar 28, 2021, 6:13 PM CDT

Title: Discuss IRB and client changes

Date: 3/26/21

Content by: Britt

Present: All

Goals: Discuss changes to design and testing protocols

Content:

- IRB Approval
 - We were exempt from the IRB since we aren't testing the subjects in anyway
 - We will need to update the consent form
 - We can begin testing as soon as the survey is ready
- Client Meeting Updates
 - Slight modifications to the survey - nothing major
 - Discussed with him how he wants to distribute the survey - he is going to reach out to supervisor for class list
- Survey Changes from feedback
 - It is hard to distinguish between the ratios
 - The client was counting the lights to determine this
 - Should define terms so anyone (non medical students) can take the survey
 - Ventilation
 - Perfusion
 - Alveolus
 - Can add labels to the photo in the beginning to go along with the text explanation
- Testing Hypotheses
 - Should think of these for each questions - what do we expect to see?
 - How does our hypothesis help to prove or disprove things?
 - What stats do we expect to see?
 - How do we want to do the stats?
 - Make sure the data is leading to something
- Begin post processing, hypothesis, statistical test
 - Can use simulated data to test our methods

Conclusions/action items:

Begin testing soon! Kaitlin and I will continue to work on the design to get small things changed.

The sooner we can get the survey distributed will help to make sure we have plenty of data that analyzes what we want. We will also continue sending to friends for initial feedback.



Advisor Meeting 4/9

Brittany Glaeser - Apr 10, 2021, 8:35 PM CDT

Title: Finalizing survey and design

Date: 4/9/21

Content by: Britt

Present: All

Goals: Discuss what needs to be done for the next couple weeks

Content:

- Only two more weeks before poster presentation
- Edit executive summary
 - small changes - sent in email
 - Interactive dynamic model
- Send survey by monday
- send comments on prelim report
- Finish outreach
- Makerspace account issues
 - try to print by monday
- Finish up circuits
 - only small changes need to be made
- What happens if we don't get survey responses?
 - Send to family and friends
 - Do this right away so we aren't waiting until the last minute to get their "back up" responses
 - Send a different survey so that the stats don't mix
- Testing hypothesis
- How are we going to analyze data?
- Next meeting we plan to go through one set of data

Conclusions/action items:

With the poster presentation soon, the design will be printed and finalized by the end of next week and we hope to get survey data asap



Advisor Meeting 4/16

Brittany Glaeser - Apr 16, 2021, 6:06 PM CDT

Title: Discuss Report

Date: 4/16/21

Content by: Britt

Present: All

Goals: Discuss report and progress on testing

Content:

- Last advisor meeting
- We should do any analysis of testing before throwing away questions
 - This is why a pilot run is important
 - We could just consider the data as outliers
- Using gathertown for presentations
- Could combine the two surveys if can't get enough med school student data
 - Ask to resend the surveys monday to see if more students will do it
- Report comments
 - Format is good
 - State why it is important if the med schools don't understand V/Q ratios
 - Reference personal communication with Dr. Green
 - Change the order of the first two paragraphs
 - Start with physiology then explain the need and impact of the design
 - Context of the equations that were used in the background
 - How/why are they useful in determining V/Q ratios
 - Interactive/Dynamic Model
 - Hardware block diagram instead of schematic
 - Include schematic and code in the appendix
 - Also include software flow diagram
 - CAD can also go in the appendix
 - When label photos, try to have all the labels on one side and use shorter arrows, and get rid of the boxes around the labels
 - Test plans should go into the methods section

Conclusions/action items:

Finalize design, testing data, presentation and report. We will use the comments from the prelim report to modify the one we turned in.



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

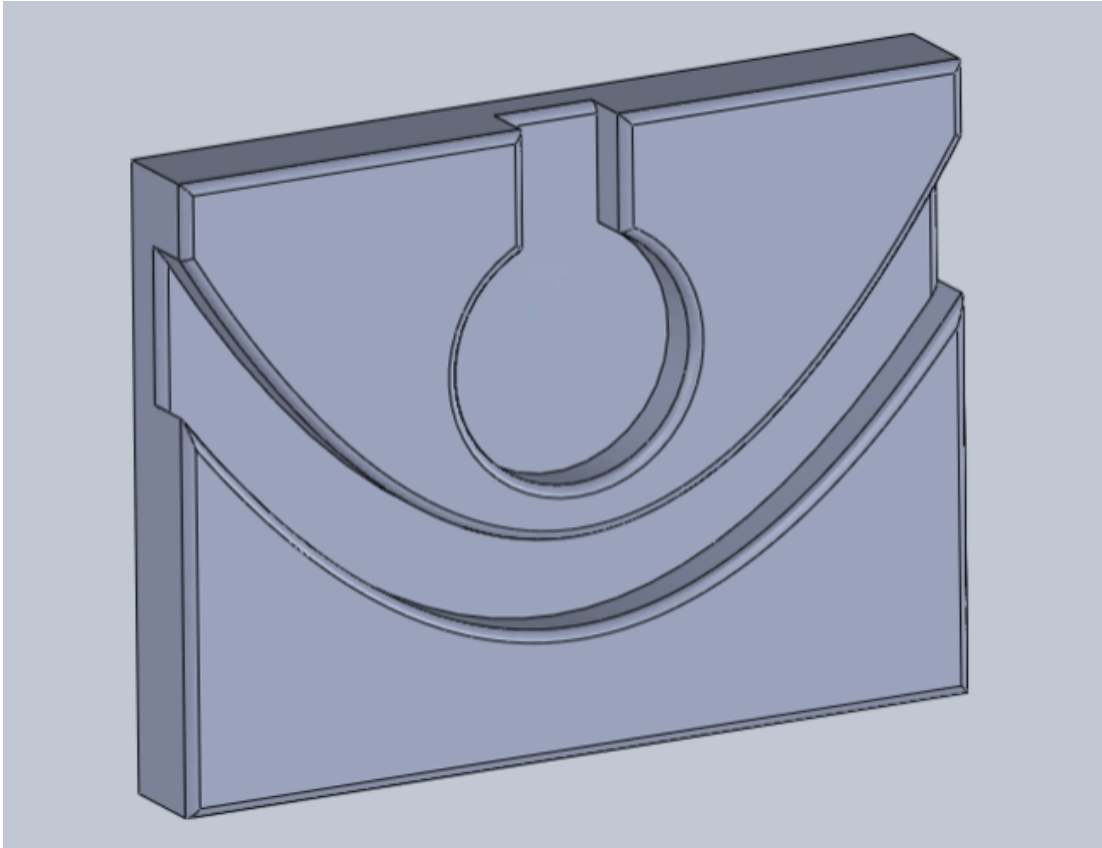
Title: Base Design from Last Semester

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

KAITLIN LACY - Mar 02, 2021, 10:07 PM CST

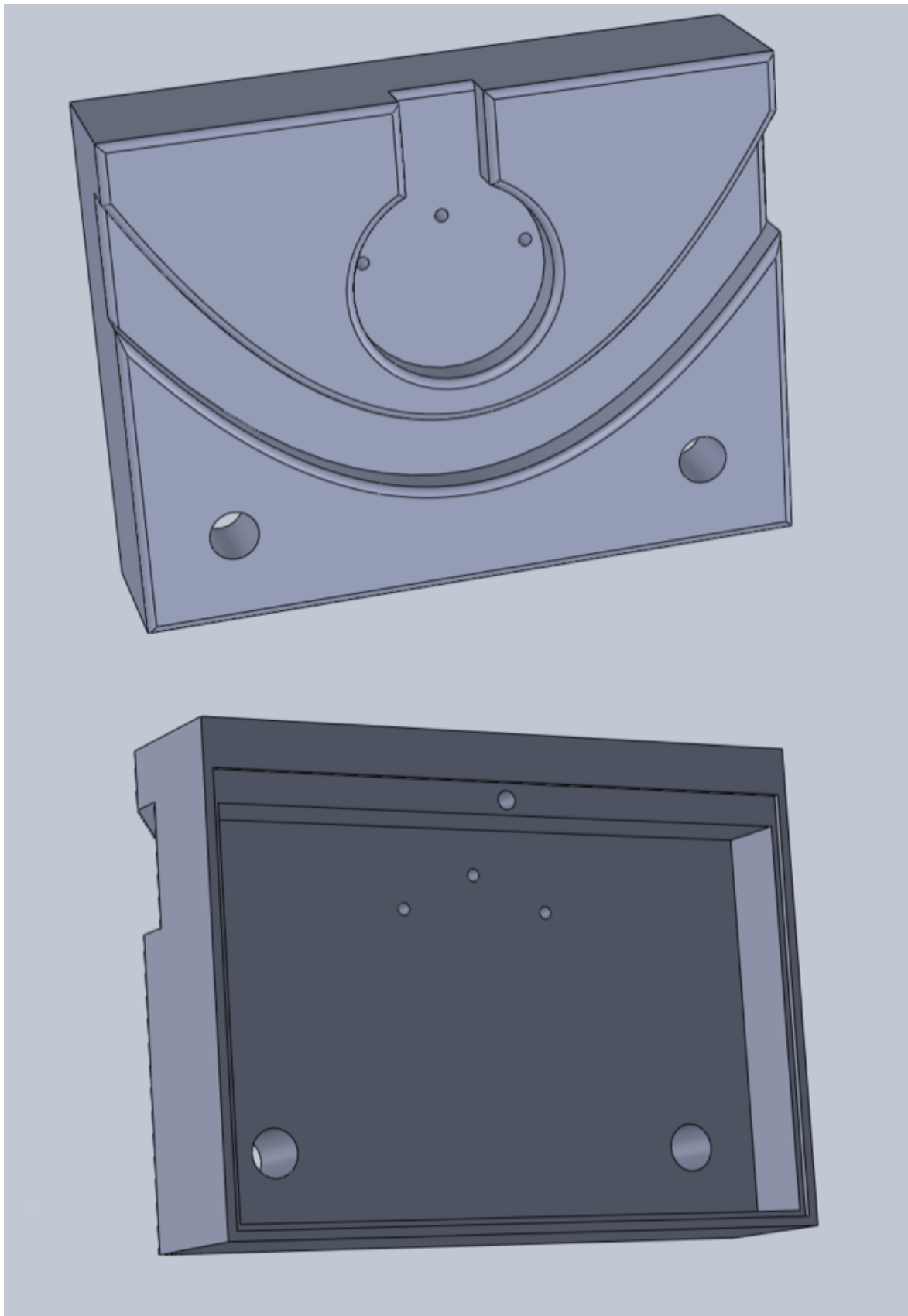
Title: Base Design with Hollow Back

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

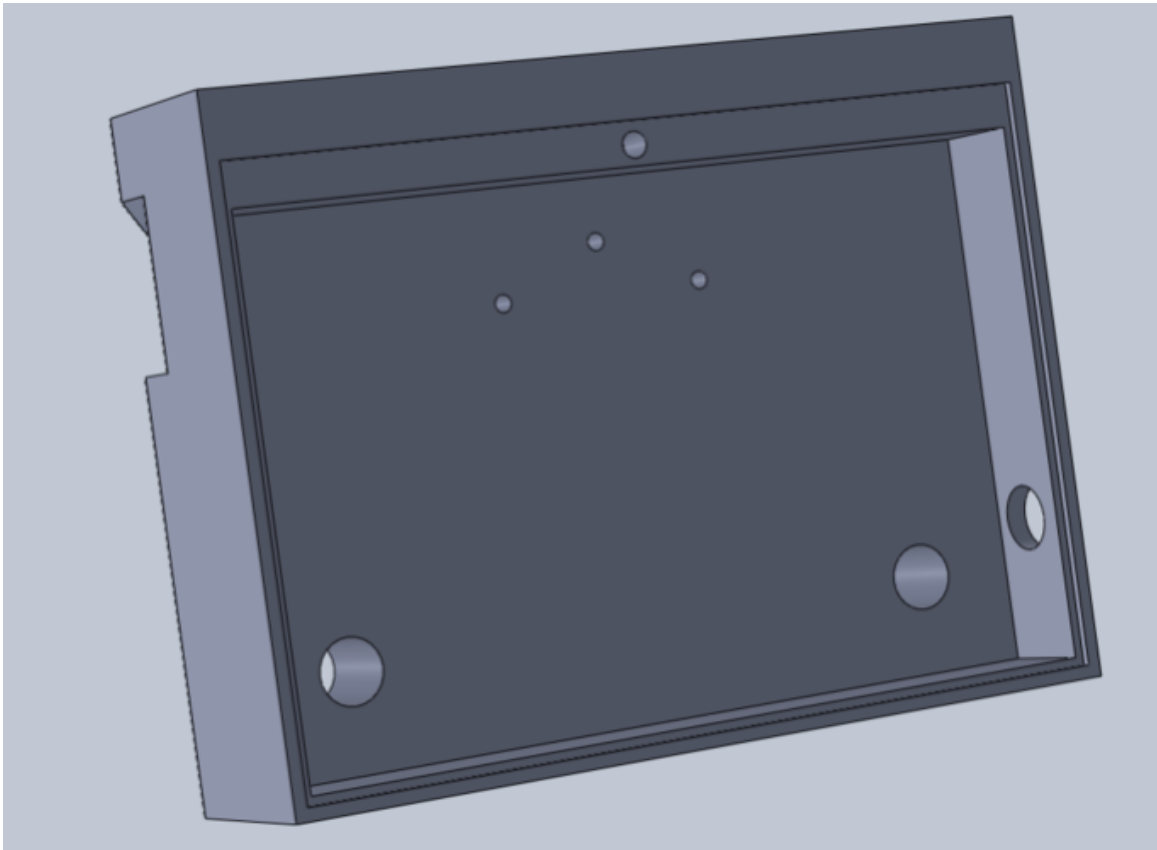
Title: Base Design with Hole for Power Cord

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

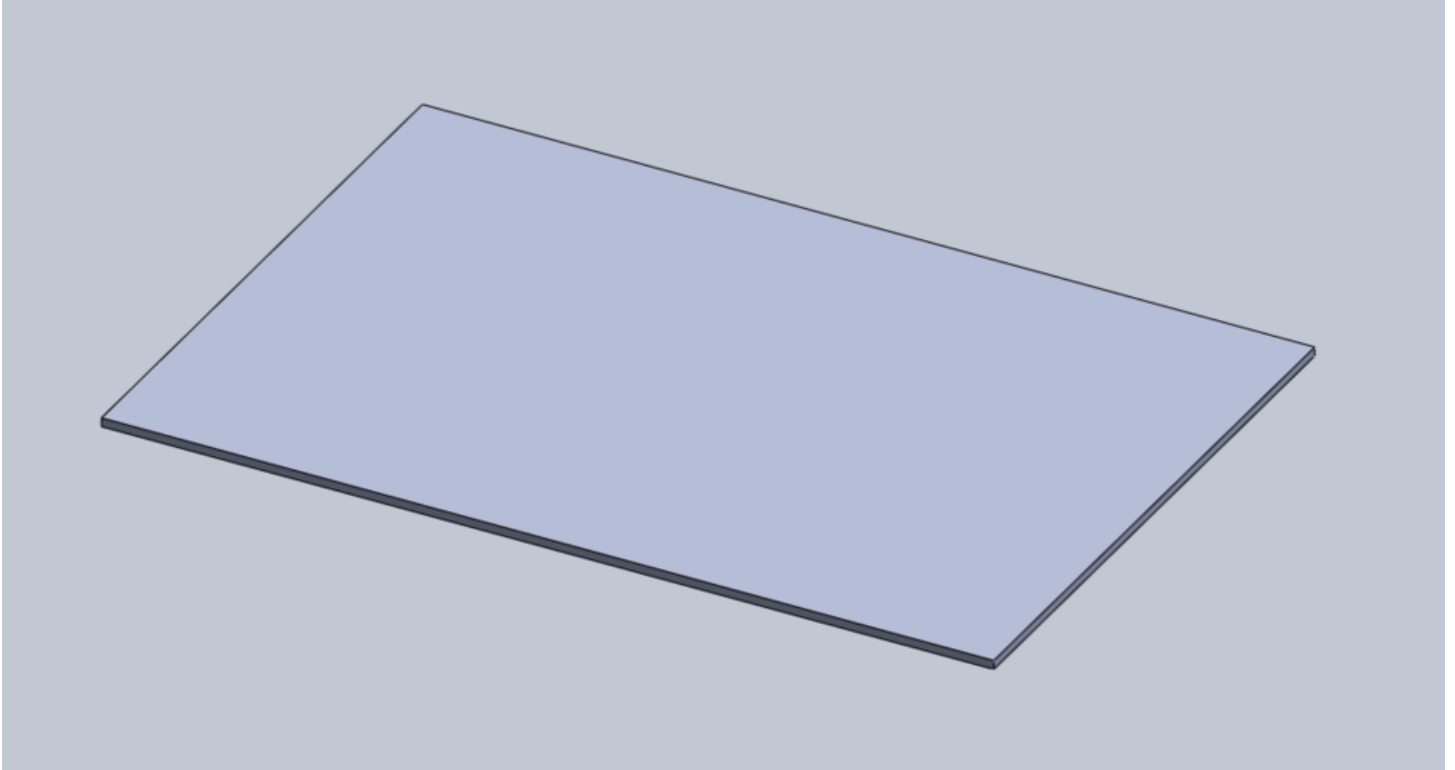
Title: Back Piece

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

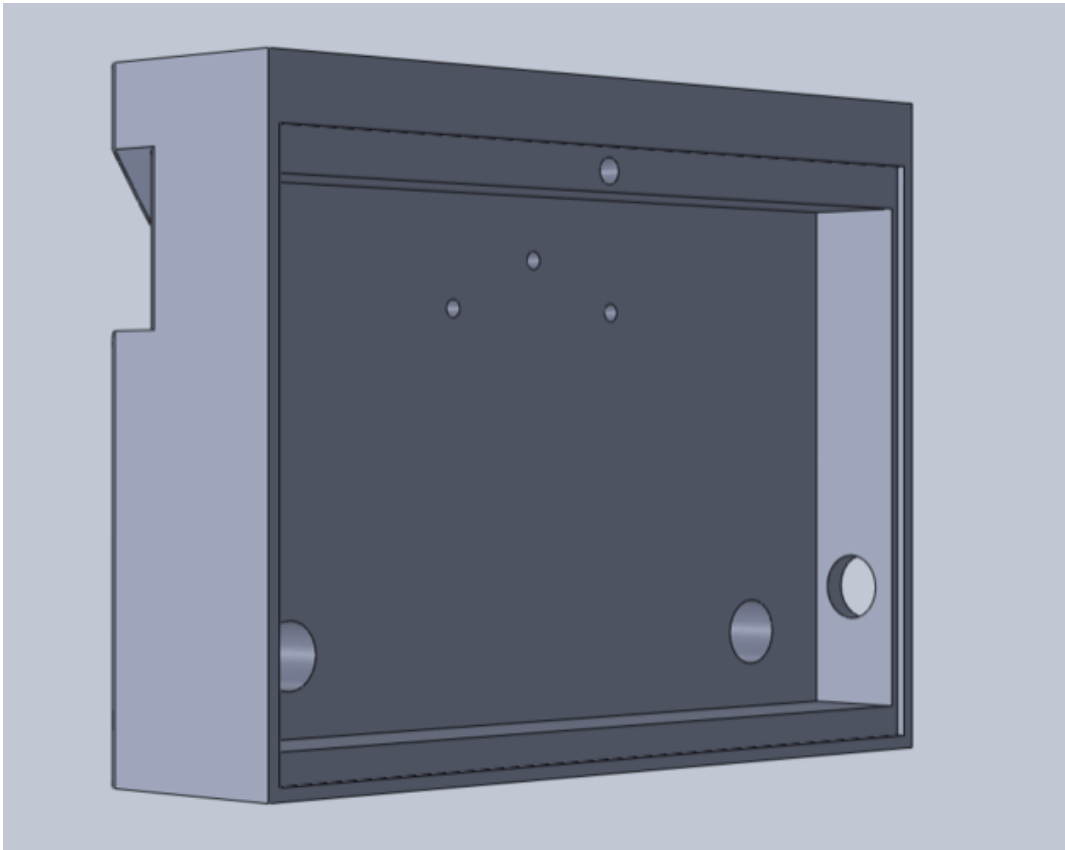
Title: Base Piece with Modified Rest for Back Piece

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.



2021/03/07 - Base Design with Space for Alveolus Diffuser

KAITLIN LACY - Apr 28, 2021, 12:14 PM CDT

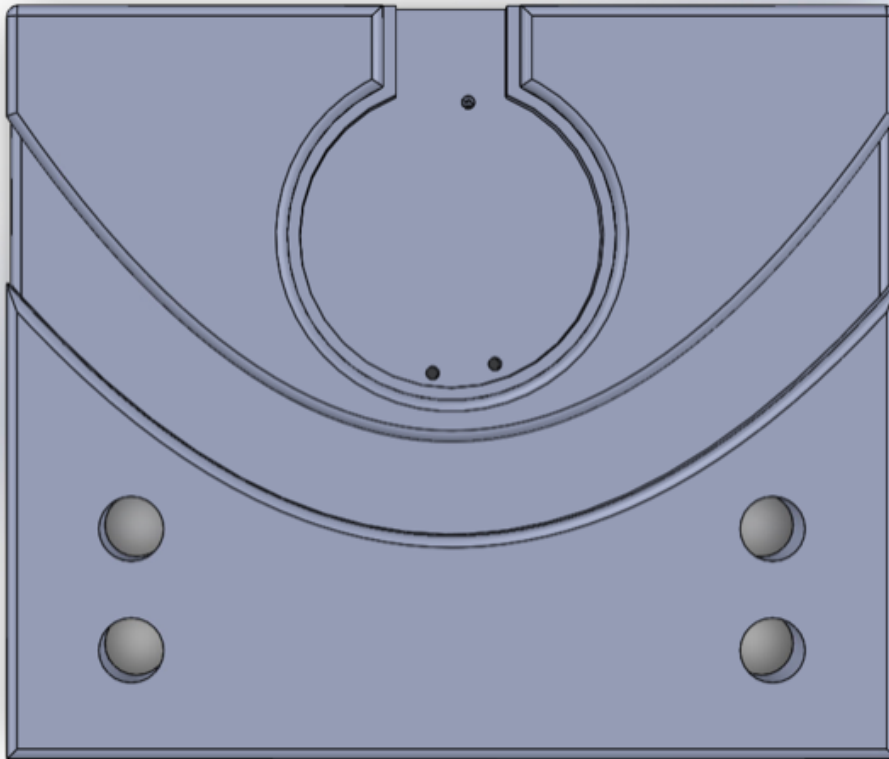
Title: Base Design with Space for Alveolus Diffuser

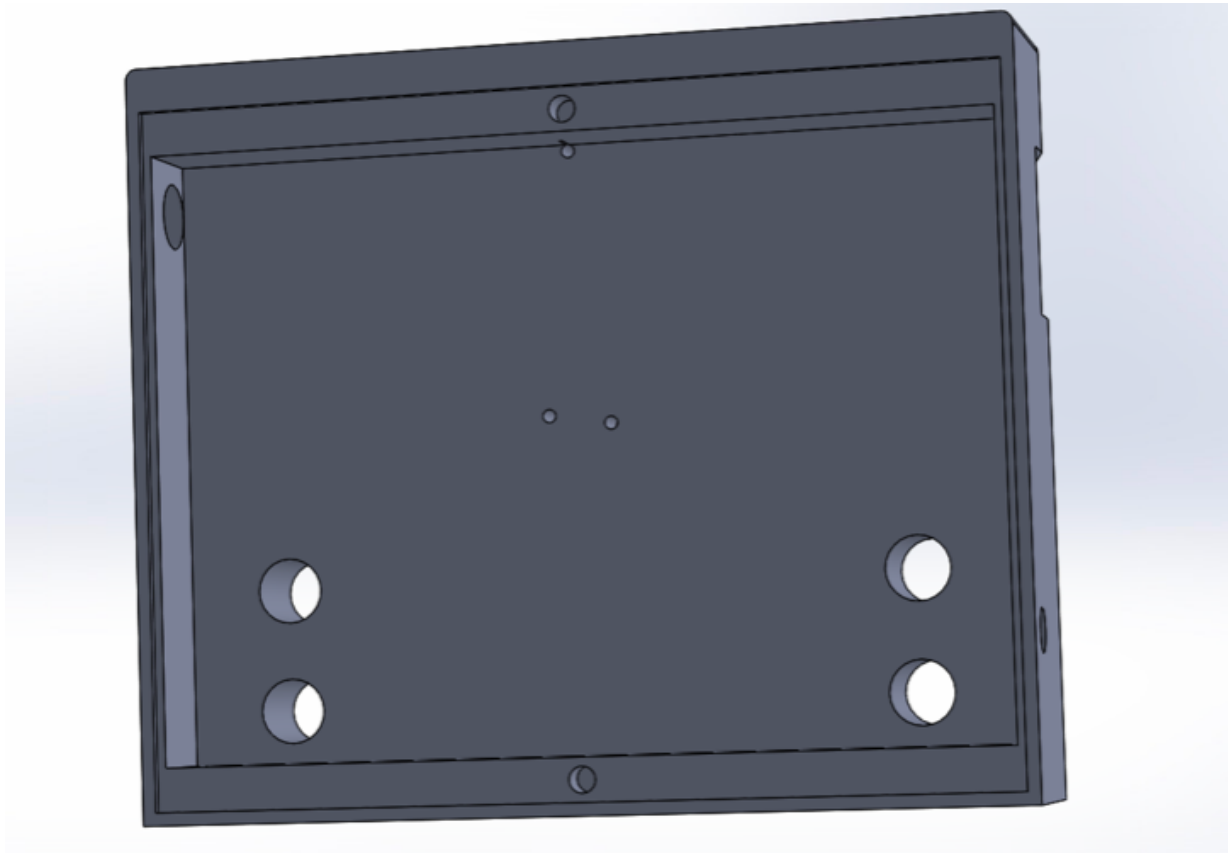
Date: 3/7/2021

Content by: Kaitlin Lacy

Goals: Add area for alveolus diffuser to rest on and be attached to.

Content:





Conclusions/action items:

Add space for the display, alter sizes of button holes, and change location and size of holes for cords. Reprint.



2021/04/09 - Base Design with Cutout for Display

KAITLIN LACY - Apr 28, 2021, 12:18 PM CDT

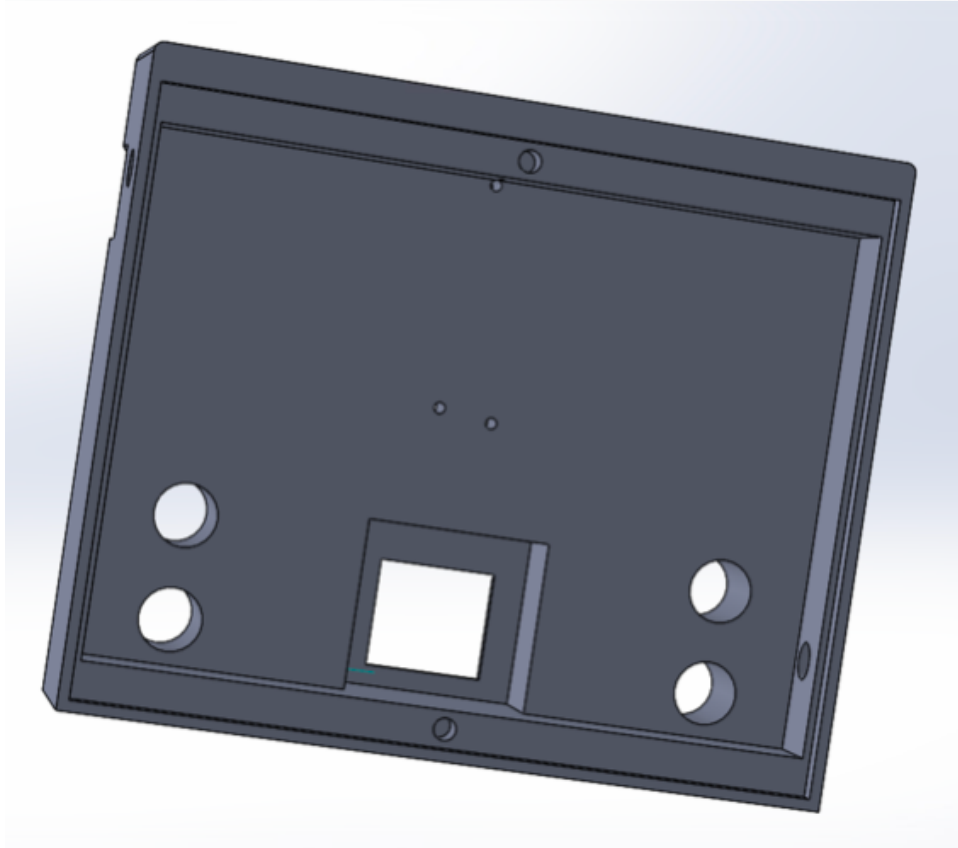
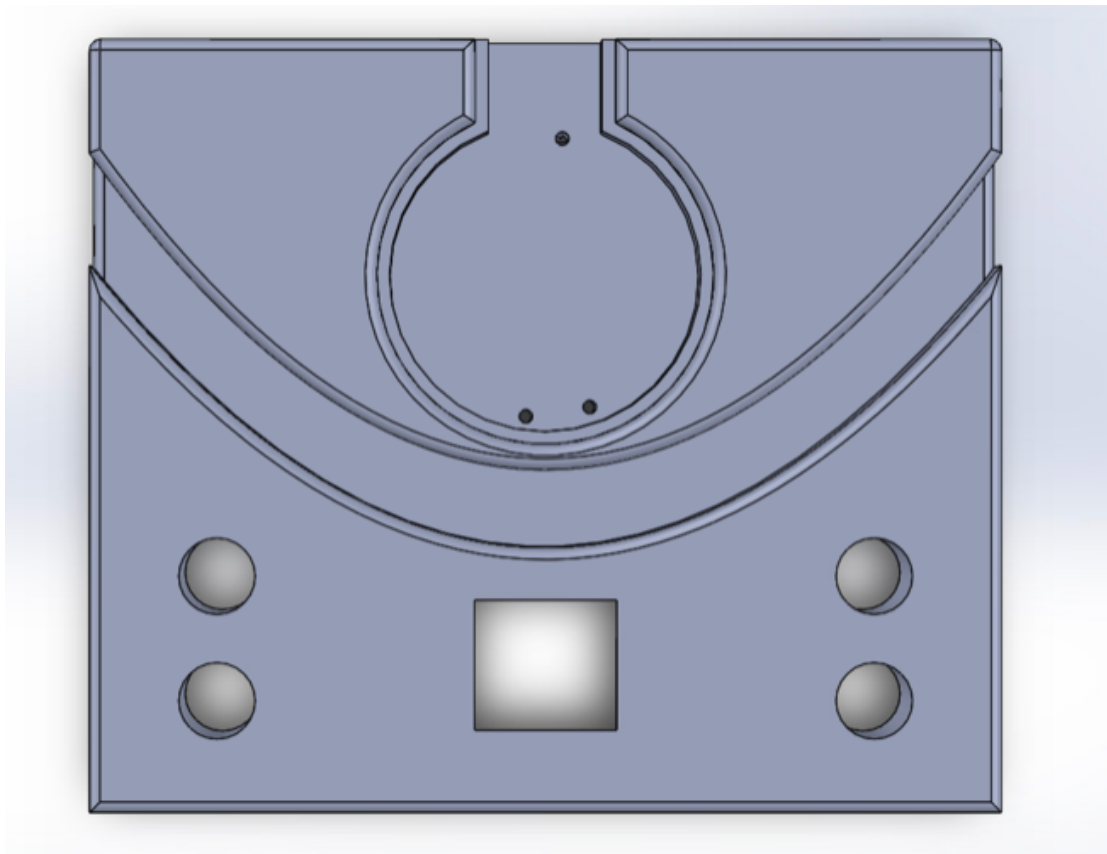
Title: Base Design with Cutout for Display

Date: 4/9/2021

Content by: Kaitlin Lacy

Goals: Insert an opening for the display to show through the front from its position in the back compartment.

Content:



Conclusions/action items:

Fillet the edges of the display hole and confirm dimensions. Reprint.



2021/04/16 - Base Design with Final Display Dimensions and Fillet

KAITLIN LACY - Apr 28, 2021, 12:23 PM CDT

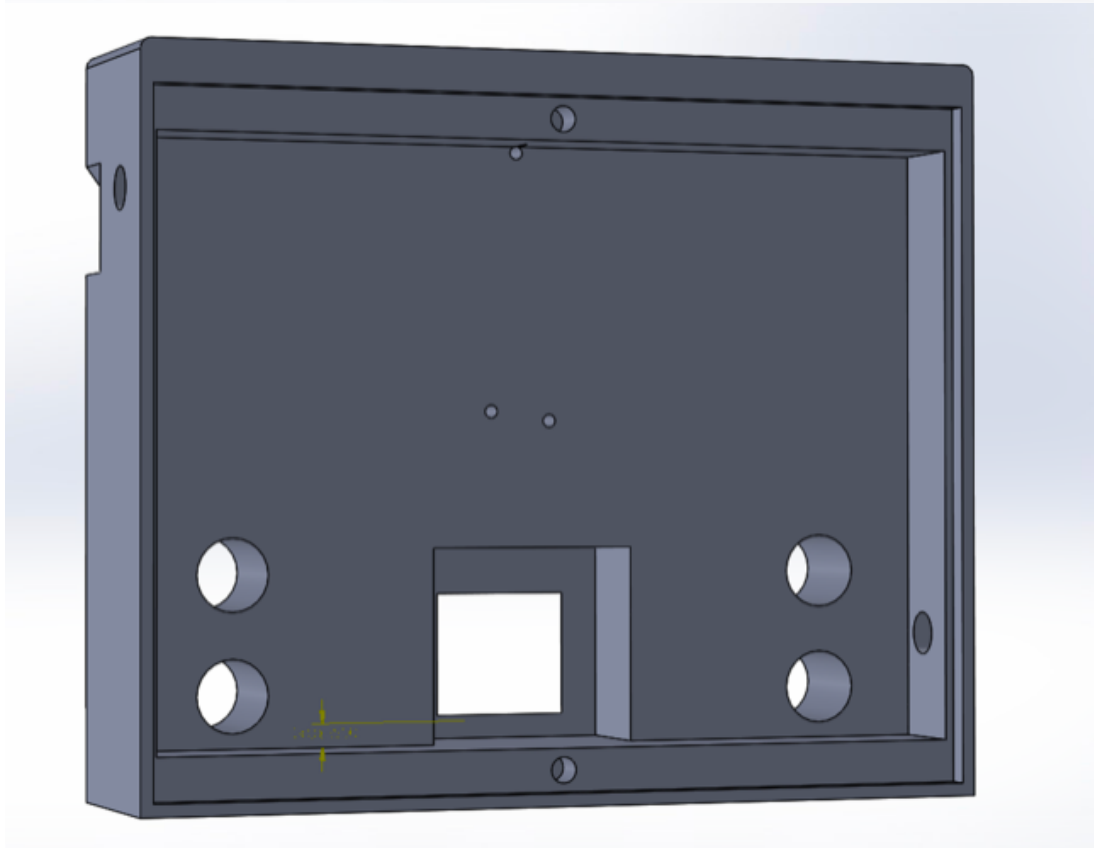
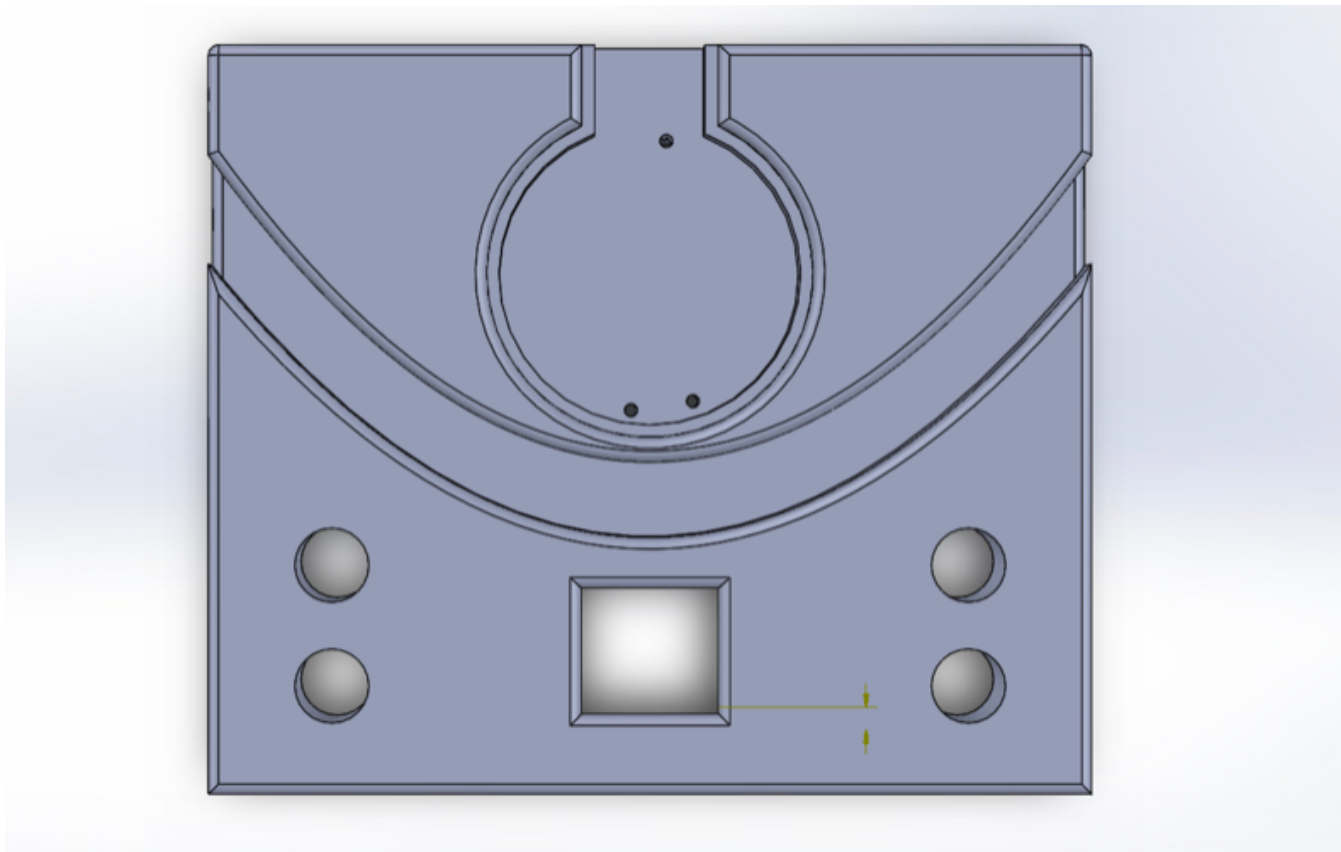
Title: Base Design with Final Display Dimensions and Fillet

Date: 4/16/2021

Content by: Kaitlin Lacy

Goals: Add a fillet to the display hole to make it look more aesthetically pleasing, as well as confirm all dimensions before a reprint.

Content:

**Conclusions/action items:**

After printing, there is an imperfection between the capillary channel and the cavity for the display. Increase the distance between these and reprint. Move the hole for the power cord, and make big enough for both the Arduino cord and the capillary LED cords. Make the base thicker to accommodate for the display wires.



2021/04/24 - Base Design with Modified Thickness and Power Cord Hole

KAITLIN LACY - Apr 28, 2021, 1:12 PM CDT

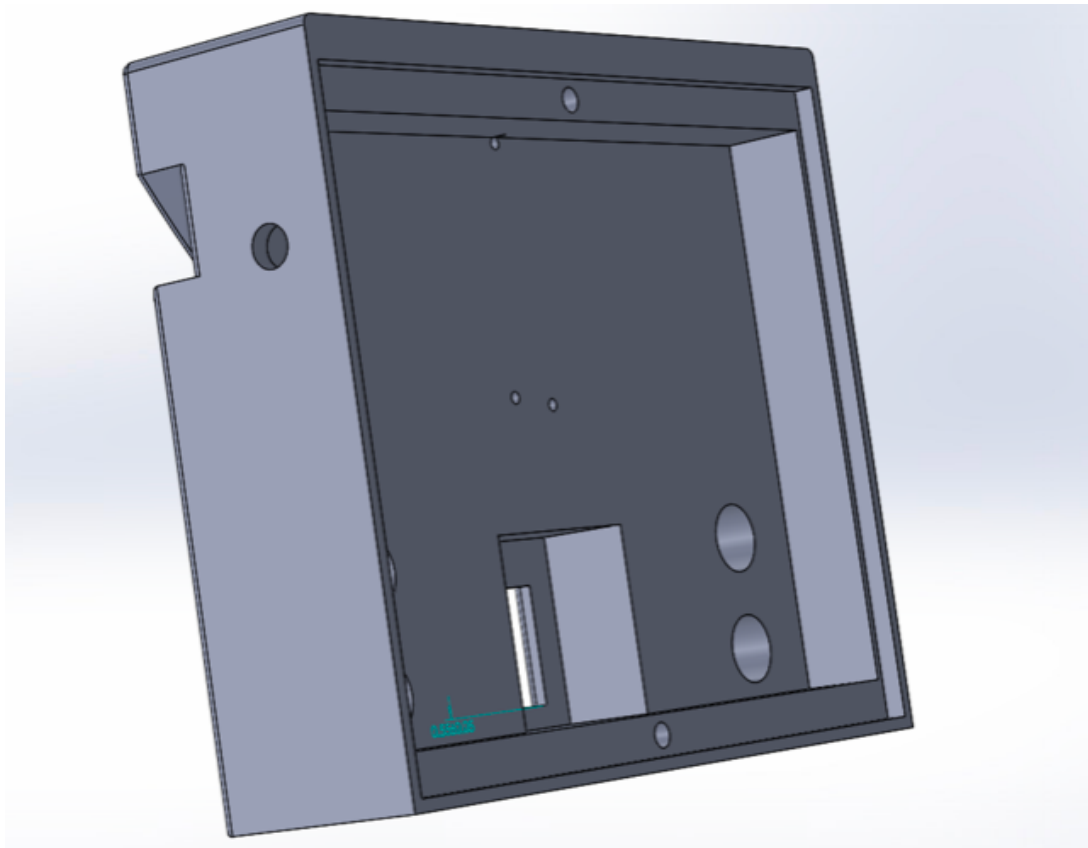
Title: Base Design with Modified Thickness and Power Cord Hole

Date: 4/24/2021

Content by: Kaitlin Lacy

Goals: Move the hole for the power cord down slightly and adjust the thickness to fit the display wires.

Content:



Conclusions/action items:

Complete one final print!



2021/03/02 - Expense Table

KAITLIN LACY - Mar 03, 2021.

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	B01EVLJ7G	2/10/2021	1	\$9.99	\$9.99	https://www.amazon.com/EL-CP-003-Breadboard-Solderless-Distribution-Connectivity/dp/B01EVLJ7G/ref=sr_1_5?hbid=1&keywords=breadboard&qid=1612919041&sr=8-5
Component 2	Nano	Amazon	B00NLAM69G	2/10/2021	2	\$9.99	\$19.98	https://www.amazon.com/ATmega328P-Microcontroller-Board-Cable-Arduino/dp/B00NLAM69G/ref=sr_1_1?hbid=1&keywords=arduino+nano+atmega328p&qid=1612919041&sr=8-5
Component 3	1.44" color LCD	Adafruit	2008	2/10/2021	1	\$14.95	\$14.95	https://www.adafruit.com/product/2088?ackd=C6KCOAqomBBhCXARisAFNVJqNVz_ZY5bdeQweckVUJoMEziOei_mG9W9xGzKYYVggnN3MENC29kaAIMEELw_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	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	4686	2/16/2021	2	\$46.96	\$93.92	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?ackd=C6KCOAqomBBhCXARisAFNVJqNVz_ZY5bdeQweckVUJoMEziOei_mG9W9xGzKYYVggnN3MENC29kaAIMEELw_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?ackd=C6KCOAqomBBhCXARisAFNVJqNVz_ZY5bdeQweckVUJoMEziOei_mG9W9xGzKYYVggnN3MENC29kaAIMEELw_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-Adapters/dp/B07GRZ8Y93/ref=sr_1_1?hbid=1&keywords=12v+dc+2a+power+supply+adapter+with+2.1+mm&qid=16039838
Component 16	LED Strip with Si	Adafruit	3869	2/22/2021	1	\$34.95	\$34.95	https://www.adafruit.com/product/3869?ackd=C6KCAe5e_BB8UEwAPu_I0E-wkV+QGTEwEw-UJUYAAeoXBLrh974c0ATu0AmfwZzCH4LRc3n8QAvD_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.



4/28/21 - Unit Cost Expenses

Brittany Glaeser - Apr 28, 2021, 1:11 PM CDT

Title: Expenses to replicate 1 design

Date: 4/28/21

Content by: Britt

Present:

Goals: List all the items that were used in the design

Content:

Item	Part Number	Link	Description	Vendor	Cost	Quantity	Subtotal
Adafruit Neopixel 7x5050 RGB LED	2226	https://www.adafruit.com/product/2226	Ring with 6 outer LEDs and 1 inner LED for address	Adafruit	5.95	1	5.95
Adafruit Neopixel 16x5050 RGB LED	1463	https://www.adafruit.com/product/1463	Ring with 16 LEDs for address	Adafruit	9.95	1	9.95
Adafruit Neopixel 24x5050 RGB LED	1586	https://www.adafruit.com/product/1586	Ring with 24 LEDs for address	Adafruit	16.96	1	16.96
Adafruit Neopixel LED strip	3919	https://www.adafruit.com/product/3919	A flexible strip with 30 LEDs powered with 5V	Adafruit	12.50	1	12.50
Adafruit 1.44" TFT LCD Display	2008	https://www.adafruit.com/product/2008	Small LCD display with color for output V/Q ratios	Adafruit	14.95	1	14.95
Adafruit 16 mm Blue Momentary Push Button	1447	https://www.adafruit.com/product/1447	Glowing blue button that reads HIGH when pressed	Adafruit	1.95	1	1.95
Adafruit 16 mm Green Momentary Push Button	1440	https://www.adafruit.com/product/1440	Glowing green button that reads HIGH when pressed	Adafruit	1.5	1	1.5
Adafruit 16 mm White Momentary Push Button	1479	https://www.adafruit.com/product/1479	Glowing white button that reads HIGH when pressed	Adafruit	1.95	2	3.90
Arduino Nano	A000005	https://www.adafruit.com/product/A000005	Microcontroller with no pins	Arduino	20.70	1	20.70
Shrink Plastic Sheets	AS067	https://www.amazon.com/dp/B000000000	25Pcs Shrink Plastic Sheets for Crafts Heat Shrink Paper for Crafts Kids DIY Jewelry Making	Amazon	10.54	1	10.54

Total Cost: \$98.9

This table list all the expenses with information on the product and were it was bought from. This table does not include the cost of the 3D printed part which is around \$20-\$25 bringing the total cost close to \$120 which is well under the budget that our client had initially given us.

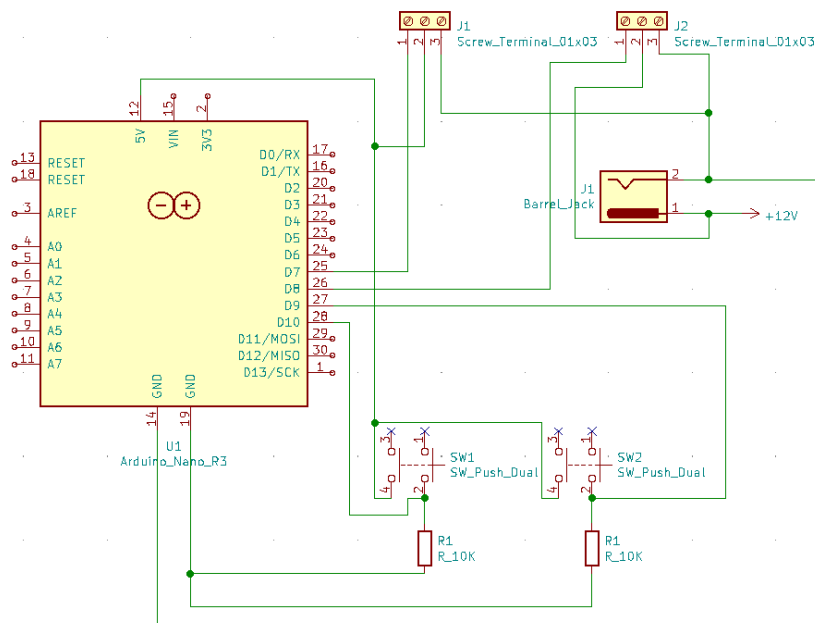
Many other items have also been purchased this semester but were decided not to be used in the final design. A full list of semester expenses can be found in 2021/03/02 - Expense Table in the Materials and Expenses folder.

Conclusions/action items:

Due to the semester being over, this table will not likely be updated again.

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.

4/26/21 - Schematic

Brittany Glaeser - Apr 26, 2021, 12:44 AM CDT

Title: Updated Schematic

Date: 4/26/21

Content by: Britt

Present:

Goals: To state the changes made to the circuit

Content:

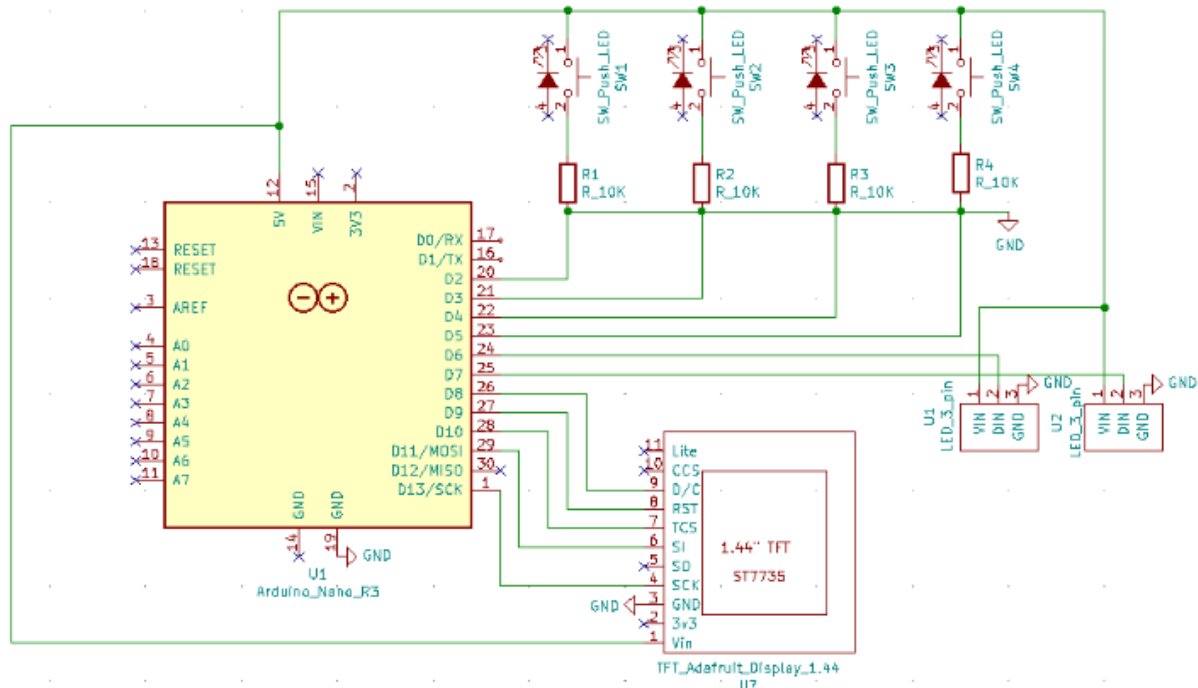


Figure 1. Updated Schematic

Features:

- Arduino Nano Microcontroller
- 4 momentary push buttons
 - Each of these buttons will either increase or decrease ventilation or perfusion rates
 - Each consists of an LED, but for the purpose of this design, the LEDs were not utilized
 - GND, digital pin, and GND of the button are in series
- Two 3 pin LEDs
 - These represent the neopixel rings and neopixel strip utilized in the design
 - They are both powered by 5V and connected to a digital pin on the microcontroller
- 1.44" TFT display
 - LCD display powered by 5V from arduino nano

Conclusions/action items:

This was the final circuit design for this semester. It included changes such as adding buttons and including a display. This circuit also did not require an external 12V as those LEDs caused many complications. A schematic was created in hopes that eventually a PCB can be made for future projects to better secure the circuit components.



4/27/21 - Final Circuit

Brittany Glaeser - Apr 26, 2021, 12:19 PM CDT

Title: Final Circuit

Date: 2/27/21

Content by: Britt

Present:

Goals: To add a photo of the final circuit for reference

Content:

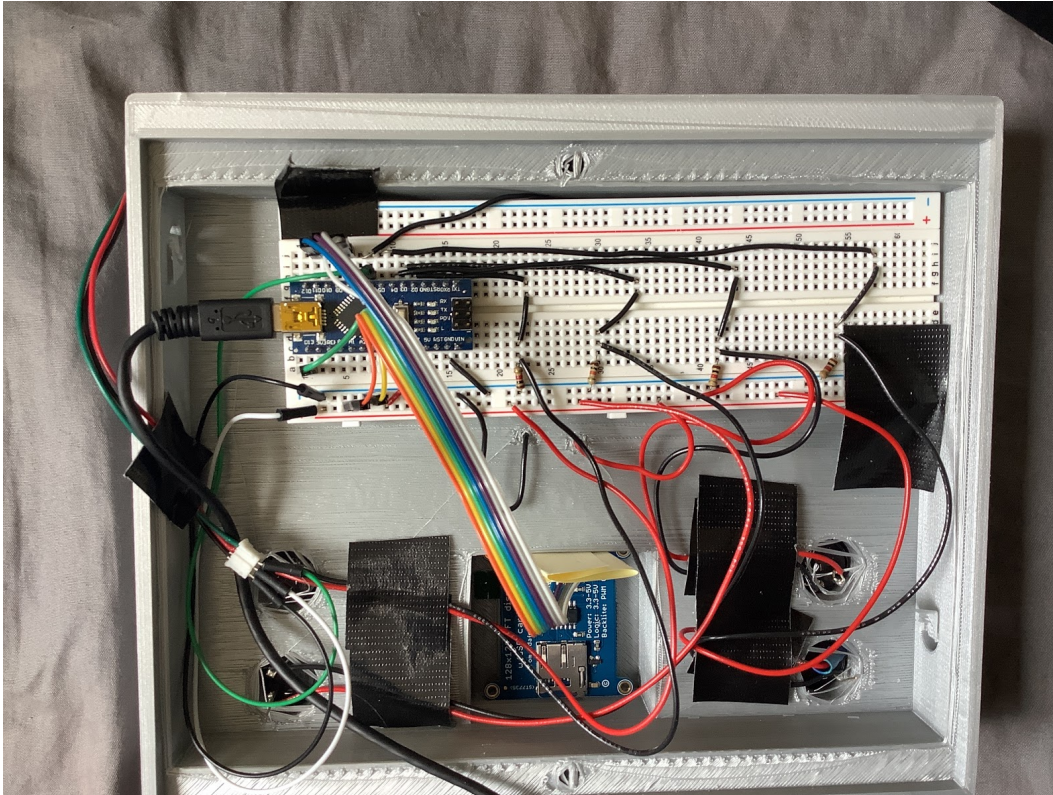



Figure 1. Final circuit with buttons, display, LEDs, and microcontroller

Conclusions/action items:

This circuit design is not very secure, even with some of the tape, the wires tend to fall out and the design does not work as it is suppose to. This photo is just meant to be used as a reference to see how all the connections are made.

 4/27/21 - Final Design

Title: Final Design

Date: 4/27/21

Content by: Britt

Present:

Goals: Add a photo and explanation of the final design



Figure 1. Final design

The design consists of concentric adafruit neopixel LED rings in a circle cutout of the base. These LEDs are used to represent the air flow through a single alveolus in the lungs. The lights are The rings lights first turn on in the center and turn on sequentially outward before turning off. The LEDs turning off represents the diffusion of gases into the capillary. As the rate of ventilation i

A single strip of adafruit neopixels is placed in a curve piece below the alveolus. This is to represent blood flow through a capillary surrounding an alveolus. These lights fade from blue to purple deoxygenated to oxygenated blood. A single LED is off and moves from left to right to indicate the direction of flow.

Four buttons are used to allow the user to change the rates of ventilation and perfusion. The blue button on the top left will increase the rate of perfusion while the white button just beneath it w user to understand that the top will most likely increase while the bottom will decrease. The buttons are also color coded to match the colors of the LEDs. The green button on the top right will decrease the rate of ventilation.

In the center of the design, there is an 1.44" TFT LCD display that will have outputted values based on the settings the user indicates. The green represents the alveolus values/settings while therefore the setting values are placed on the design out of 5 to tell the user what setting it is on and whether they can continue to increase or decrease the rates. Following the settings, the re to visually understand how the ratio changes with respect to the different rates. These values where decided based off of research. The final V/Q ratio is then displayed in white at the bottom a

Conclusions/action items:



4/28/21 - Existing Code

Brittany Glaeser - Apr 27, 2021, 3:54 PM CDT

Title: Existing Code

Date: 4/28/21

Content by: Britt/Kaitlin

Present:

Goals: Place code in lab archives for further reference

Content:

```
#include <Adafruit_NeoPixel.h>
#include <elapsedMillis.h>
#include <Adafruit_GFX.h> // Core graphics library
#include <Adafruit_ST7735.h> // Hardware-specific library for ST7735
#include <Adafruit_ST7789.h> // Hardware-specific library for ST7789
#include <SPI.h>

// These variables are set specifically for the display
#define TFT_CS 10
#define TFT_RST 9 // Or set to -1 and connect to Arduino RESET pin
#define TFT_DC 8

// Alveolus Variables
int ALV_LED_NUMBER = 64; // Number of LEDs connected in the ring LEDs
elapsedMillis minuteVent = 0; // This counts the time between time the LED rings turn on and off
int alvSpeed = 2000; // Starting speed for the LEDs to turn on
int alvBrightness = 2; // Brightness used for the alveolus LEDs
bool ALV_ON = true; // When true, this turns on the LEDs, when false it will turn them all off to start over
bool SHUNT = false; // When true, all alveolus LEDs are white
String respirationRate = "2 L/min"; // String is updated as the settings change and it is the rates that are outputted to the display

// Capillary Variables
int CAP_LED_NUMBER = 15; // Number of LEDs in the LED strip
int blue = CAP_LED_NUMBER; // Used for the colors of the LED strip
int red = (CAP_LED_NUMBER - 1) * 3; // Used for the colors of LED strip
int pixelNumber = CAP_LED_NUMBER - 1; // PixelNumber is the LED that is off for each cycle
bool capON = true; // when true, capillary LEDs are blue-red and flow, when false LEDs are turned to white
int cap_4_5 = CAP_LED_NUMBER * 0.8; // Used to determine when the LEDs should change color
elapsedMillis capillaryTime = 0; // Time between each off LED in the flow pattern
int capSpeed = 400; // Initial capillary speed
String perfusionRate = "2 L/min"; // String is updated as the settings change and it is the rates that are outputted to the display

// Button values
int alvSetting = 2; // Initial alveolus setting
int capSetting = 2; // Initial capillary setting
int alvIncreaseButton = 2; // digital pin for alveolus increase rate button
int alvDecreaseButton = 3; // digital pin for alveolus decrease rate button
int capIncreaseButton = 4; // digital pin for capillary increase rate button
int capDecreaseButton = 5; // digital pin for capillary decrease rate button
elapsedMillis buttonWait = 0; // used to create debouncing circuit

// Initializes neopixel LEDs and LCD display
Adafruit_NeoPixel alveolusLED(ALV_LED_NUMBER, 7, NEO_GRB + NEO_KHZ800);
Adafruit_NeoPixel capillaryLED(CAP_LED_NUMBER, 6, NEO_GRB + NEO_KHZ800);
Adafruit_ST7735 tft = Adafruit_ST7735(TFT_CS, TFT_DC, TFT_RST);

void setup() {
  // Sets up serial and neopixel LEDs
  Serial.begin(9600);
  alveolusLED.begin();
  capillaryLED.begin();

  // pinMode for all 4 buttons
  pinMode(alvIncreaseButton, INPUT);
  pinMode(alvDecreaseButton, INPUT);
  pinMode(capIncreaseButton, INPUT);
  pinMode(capDecreaseButton, INPUT);
  // Initializes display
  tft.initR(INITR_144GREENTAB);
  // Setup display for initial start variables
  tftPrint();
}

void loop() {
  // This section only counts how many times the button has been pressed
  // The button wait is used to create a debouncing circuit - 300ms allows for it to count on 1 press each time
  if(buttonWait > 300){
    // When the button is pressed, the digital pin will read 1 and it will increase or decrease settings and resets button timer
```



```

// capON is used so that if no perfusion is occurring, it is set to false and the capillary LEDs turn white
if(capON){
// LEDs wait a given time before flowing, this speed is manipulated by the buttons
if (capillaryTime > capSpeed){
// pixelNumber ensures that the LEDs don't continue counting down for non-existent LEDs, if so it will restart at the top of the LEDs
if(pixelNumber > -1){
// if a shunt occurs in the alveolus, no diffusion occurs and capillary lights remain blue (done in else statement)
if(!SHUNT){
// This originally turns on all the leds to flow from blue to red to show deoxygenated to oxygenated
for(int i = 0; i < CAP_LED_NUMBER; i++){
// LEDs , "oxygen", diffuse early on so this makes sure that the color changes happens at a certain time
if(i<CAP_LED_NUMBER/2 +1){
capillaryLED.setPixelColor(i,red,0,blue);
}
else if(i<(CAP_LED_NUMBER)*0.8){
capillaryLED.setPixelColor(i,red,0,blue);
red = red - 14;
blue = blue + 14;
}
}
else{
capillaryLED.setPixelColor(i,0,0,blue);
}
}
}
}
}
}

// This sets one LED off in the LED strip so they have a pattern of flow
capillaryLED.setPixelColor(pixelNumber, 0, 0, 0);
capillaryLED.show();
// PixelNumber states which LED is off in a given time to create the illusion of flow
pixelNumber--;
// capillaryTime is reset so they rate is the same and lights don't flash through
capillaryTime = 0;
// Color variables need to be reset each time and LED is turned off so when they turn back on it creates flow
red = (CAP_LED_NUMBER - 1) *3;
blue = 0;
}
else{
pixelNumber = CAP_LED_NUMBER - 1;
}
}
}
}
}
}

// Function for the display
void tftPrint(){

// Sets up back ground color
tft.setTextWrap(false);
tft.fillScreen(ST77XX_BLACK);

// Sets cursor position, size, and color for ventilation settings
tft.setCursor(0, 0);
tft.setTextColor(ST77XX_GREEN);
tft.setTextSize(1);
tft.print("V Setting: ");
tft.println(alvSetting + 1);
tft.println("/5");

// Sets cursor position, size, and color for perfusion settings
tft.setCursor(0, 10);
tft.setTextColor(ST77XX_RED);
tft.setTextSize(1.5);
tft.print("Q Setting: ");
tft.println(capSetting + 1);
tft.println("/5");

// Sets cursor position, size, and color for ventilation flow rates
tft.setCursor(0,40);
tft.setTextColor(ST77XX_GREEN);
tft.println("Minute Ventilation: ");
tft.setCursor(40,50);
tft.println(respirationRate);

//Sets cursor position, size, and color for perfusion flow rates
tft.setCursor(0,60);
tft.setTextColor(ST77XX_RED);
tft.println("Perfusion Rate: ");
tft.setCursor(40, 70);
tft.println(perfusionRate);

// Sets cursor position, size, and color to output overall V/Q ratio
tft.setCursor(0, 90);
tft.setTextColor(ST77XX_WHITE);
tft.setTextSize(2);
tft.println("V/Q Ratio: ");
// This will calculate the V/Q ratio based off of the setting values which correspond to the ventiation and perfusion rates
tft.setCursor(40,110);
tft.println((double)alvSetting/capSetting);

```

```

}
void settingValues(){
// This is taking the value of the capillary/alveolus setting and assigning values
// Cap settings are 0 through 4 and increases in perfusion rate with increase in cap setting values
if(capSetting == 0){
// capSpeed doesn't matter because LEDs will be solid white
capON = false;
// This changes the values of flow outputted to the display
perfusionRate = "0 L/min";
// This calls the display function to change the values on display corresponding to the new settings
tftPrint();
}
else if(capSetting == 1){
capON = true;
// capSpeed changes for values 1-4 of settings and changes the rate the LEDs flash/flow
capSpeed = 600;
perfusionRate = "1 L/min";
tftPrint();
}
else if(capSetting == 2){
capON = true;
capSpeed = 400;
perfusionRate = "2 L/min";
tftPrint();
}
else if(capSetting == 3){
capON = true;
capSpeed = 200;
perfusionRate = "3 L/min";
tftPrint();
}
else if(capSetting == 4){
capON = true;
perfusionRate = "4 L/min";
tftPrint();
capSpeed = 50;
}
}
// This is specific to the alveolus settings
if(alvSetting == 0){
SHUNT = true;
// respirationRate sets the string value for flow rate for the display
respirationRate = "0 L/min";
// this calls the display function
tftPrint();
}
else if(alvSetting == 1){
// This changes the rate at which the LEDs turn on and changes for every setting manipulated by the user
alvSpeed = 3000;
SHUNT = false;
respirationRate = "1 L/min";
tftPrint();
}
else if(alvSetting == 2){
alvSpeed = 2000;
SHUNT = false;
respirationRate = "2 L/min";
tftPrint();
}
else if(alvSetting == 3){
alvSpeed = 1400;
SHUNT = false;
respirationRate = "3 L/min";
tftPrint();
}
else if(alvSetting == 4){
alvSpeed = 900;
SHUNT = false;
respirationRate = "4 L/min";
tftPrint();
}
}
}

```

Conclusions/action items:



4/28/21 - Block Diagrams

Brittany Glaeser - Apr 28, 2021, 11:31 AM CDT

Title: Block Diagrams

Date: 4/28/21

Content by: Britt

Present:

Goals: To describe the hardware and software flow diagrams

Content:

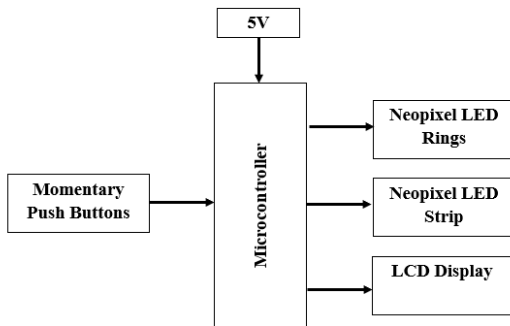


Figure 1. Hardware block diagram

This hardware block diagram was created to show how some of the main components of the design work together. The microcontroller is powered by a 5V supply and the microcontroller also receives data from the momentary push buttons. Data from the momentary push buttons will be used to control the lights of the neopixel rings and strip as well as the LCD display.

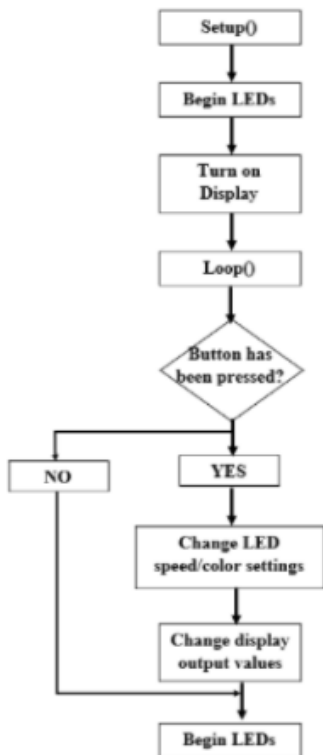


Figure 2. Software flow diagram

To begin the software, setup occurs. This includes starting the LEDs and turning on the display. Here is also where all the variables will be initialized. Then the loop function begins which loops based on whether or not the buttons have been pressed. If a button has not been pressed, the LEDs will begin as normal. If a button has been pressed, the LED speed/color settings will change and the output of the display will be changed before beginning the LEDs again with the new settings.

Conclusions/action items:

These will be put in the final report as a reference. They will also be updated if anything is changed.



2021/04/20 - Testing Plan

ZOE SCHMANSKI - Apr 28, 2021, 1:32 PM CDT

Title: Testing Plan

Date: 4/20/2021

Content by: Zoe

Present: Team

Goals: Document testing strategy

Content:

Fabrication Testing Protocol

Buttons

- Protocol: Delimitate 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).

Human Subjects Testing Protocol

1. Flow rate / Blinking rate
2. 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.
3. 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.

1. Model validation
2. 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.

3. 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:

Created questionnaire for testing.



2021/04/10-Statistical Testing Ideas

JENNA EIZADI (eizadi@wisc.edu) - Apr 28, 2021, 1:51 PM CDT

Title: Statistical Testing from Google Form Data

Date: 04/10/2021

Content by: Jenna

Present:

Goals: To determine appropriate tests to run on data from Google Form.

Content:

- analyze model's capability to improve a subject's understanding of V/Q ratios
- data from Google Form sent to two populations: medical students and others
- Test #1: T-Test on data from a population of medical students
 - expect that they will be able to achieve 100% given aid from the teaching model
 - null hypothesis: mean will be 1 corresponding to a score of 100%
 - alternative: mean is less than the expected outcome
 - if alternative is true, teaching model does not do a sufficient job of improving the understanding of medical students
- Test #2: T-Test on data from a population of people without prior knowledge
 - expect that the baseline score is 33.33% or answering at random
 - null: mean will be equal to that of the baseline score of 33.33%
 - alternative: mean will be greater than the expected outcome
 - if the alternative is true, the teaching model improves on the understanding of subjects
- Test #3: Two-Sample T-Test on means of both populations
 - null: two means are equal
 - alternative: mean from the other's population is less than that of the medical students

Conclusions/action items:

Collect data and perform statistical tests to draw conclusions.



2021/04/01-Google Form Final

JENNA EIZADI (eizadi@wisc.edu) - Apr 28, 2021, 1:48 PM CDT

Title: Google Form Final Copy

Date: 04/01/2021

Content by:

Present:

Goals: To provide a final copy of the Google Form to be sent out for testing.

Content:

- Google Form will be sent to 2 populations: medical students and others

Conclusions/action items:

Will need to outline and perform testing once Google Form has enough ~50 responses.

JENNA EIZADI (eizadi@wisc.edu) - Apr 28, 2021, 1:48 PM CDT



Teaching_V_P_Mismatching_Model_-_Others_-_Google_Forms.pdf(524.5 KB) - [download](#)



2021/04/21 - Testing analysis

ZOE SCHMANSKI - Apr 21, 2021, 2:54 PM CDT

Title: Statistical Analysis

Date: 4/21/2021

Content by: Zoe

Present: Jenna

Goals: Document the statistic done on the data from the questionnaire

Content:

Flow and Blinking Rate Test

- (1) When comparing the V/Q ratios in Video 1 and 2 above by specifically looking at the ventilation rates (alveolus), it can be concluded that...
 - 0.9387755102
- (2) When comparing the V/Q ratios in Video 1 and 2 above by specifically looking at the perfusion rates (capillary), it can be concluded that...
 - 0.8571428571
- (3 and 4) When comparing the V/Q ratios in Video 1 and 2 above by specifically looking at the ventilation rates (alveolus), it can be concluded that...
 - 0.8163265306
 - 0.8367346939
- (3 and 4) When comparing the V/Q ratios in Video 1 and 2 above by specifically looking at the perfusion rates (capillary), it can be concluded that...
 - 0.8163265306
 - 0.8367346939
- VENTILATION TOTAL: 0.8639455782
 - $s=0.0656030664$
- PERFUSION TOTAL: 0.8367346939
 - $s=0.02040816327$
- One-sample T-test for Ventilation Rates
 - $p\text{-value}=0.0025283581$
 - $t=-14.0092$
 - Mean is greater than 0.3333
- One-sample T-test for Perfusion Rates
 - $p\text{-value}=2.73697e-4$
 - $t=-42.7239$
 - Mean is greater than 0.3333

Conclusions/action items:

Add to final report and poster



2021/04/21 - Testing analysis continued

ZOE SCHMANSKI - Apr 28, 2021, 1:33 PM CDT

Title: Statistical Analysis

Date: 4/21/2021

Content by: Zoe

Present: Jenna

Goals: Further documentation of statistics done on the data from the questionnaire

Content:

Teaching Model Validation

- (1) When comparing the V/Q ratios in Video 1 and 2 above by specifically looking at the ventilation rates (alveolus), it can be observed that...
- (1) The V/Q ratio depicted in Videos 1 and 2 most accurately represents which physiological state...
- (2) When comparing the V/Q ratios in Video 1 and 2 above by specifically looking at the perfusion rates (capillary), it can be observed that...
- (2) The V/Q ratio depicted in Videos 1 and 2 most accurately represents which physiological state...
- (3 and 4) When observing the V/Q ratio in Video 2 above, what is the most accurate estimate of the corresponding values for ventilation and perfusion given that the V/Q ratio in Video 1 above is 1:1...
- (3 and 4) When comparing the V/Q ratios in Video 1 and 2 above, it can be observed that...

OTHERS

- Average score: 0.7934782609
- Standard deviation: 0.07264470165
- Expected average score with guessing: 0.33333...
- P-value: 4.479e-9 with a hypothesis test that the mean is greater than expected

MEDICAL STUDENTS

- Average score: 0.98
- Standard deviation: 0.0632455532
- Expected average score: 1
- P-value: 0.171718 with a hypothesis test that the mean is less than expected

OTHERS & MEDICAL STUDENTS

- 2 sample T-Test
- $M_1 = M_2$ with alternative $M_1 < M_2$
- $p = 7.2514e-4$
- (1) is others and (2) is medical students

Conclusions/action items:

Add to final report and poster



2021/04/21 - Results

JENNA EIZADI (eizadi@wisc.edu) - Apr 28, 2021, 1:47 PM CDT

Title: Results from the Google Form

Date: 04/21/2021

Content by:

Present:

Goals: To detail the results from the Google Form.

Content:

Population #1: 46 Subjects without previous exposure or knowledge of V/P

- Average score: 0.7935 or 79.35%
- Standard deviation: 0.073 or 7.3%

Population #2: 5 Medical Students with prior knowledge of V/P

- Average score: 0.98 or 98%
- Standard deviation: 0.06 or 6%

T-Test on Population #1

- P-value: 4.479e-9
- Accept alternative hypothesis at an alpha of 0.05
- Conclude that the average score is above the expected result of randomly answering questions
- Suggests that the device can improve a subject's understanding of V/P

T-Test on Population #2

- P-value: 0.17
- Reject alternative hypothesis at an alpha of 0.05
- Conclude that the average score is close to the expected of 100%
- Suggests that the device improves upon existing knowledge of medical students

Two-Sample T-Test on Population Means from #1 and #2

- P-value: 7.25e-4
- Accept alternative hypothesis that the mean from 1 is less than that from 2
- Conclude that prior knowledge of V/P is important for effectiveness of teaching mode

Conclusions/action items:

Discussion of the results needs to be performed and a complete write-up of testing for the Journal.



Notebook from Last Semester

KAITLIN LACY - Mar 03, 2021, 11:32 AM CST

BME Design-Fall 2020 - Britany Glasser
 Complete Notebook
 PDF Version generated by
 KAITLIN LACY
 on
 Dec 08, 2020 @ 12:04 PM CST

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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)
- $V/Q = \text{Volume of air entering lungs} / \text{Volume of blood research capillaries}$

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

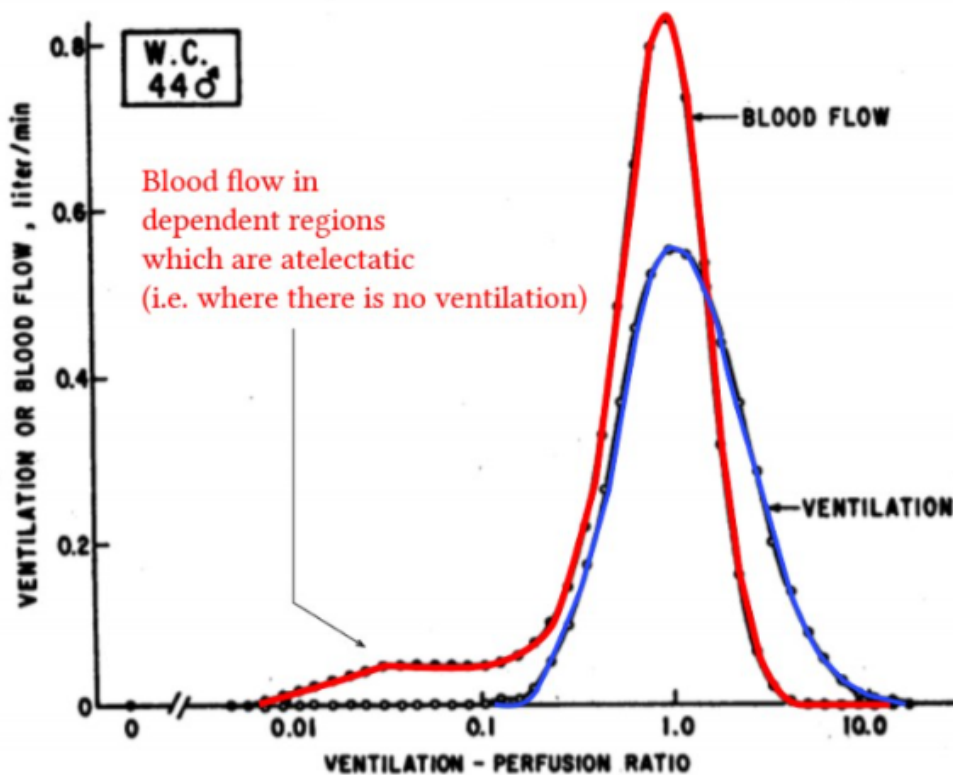


Figure 1. A graph of ventilation and perfusion values over a single lung

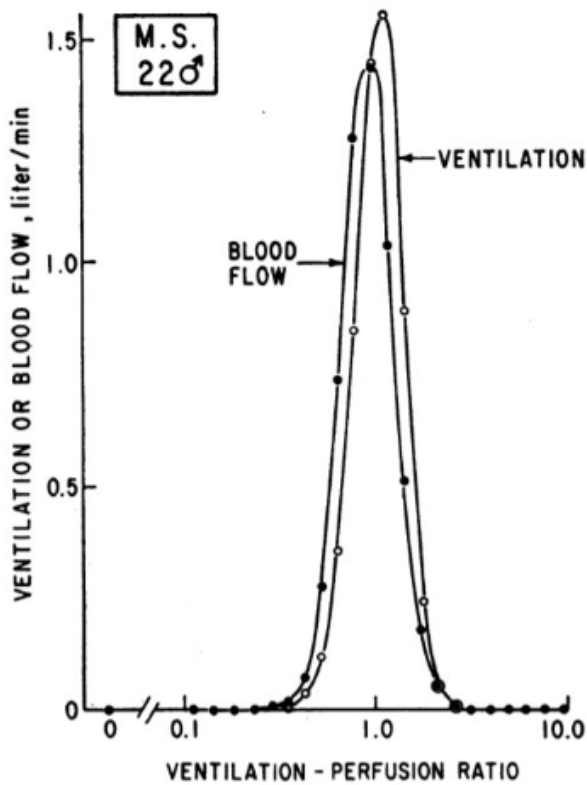


Figure 2. Ventilation and blood flow graphs over V/Q ratios

In figure 2, the two graphs almost overlap 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].

Title: V/Q Ratios

Date: 4/17/21

Content by: Britt

Present: Britt

Goals: Further understand V/Q Ratios and look for helpful diagrams and V or Q values

Content:

- The main purpose for looking through these articles was to find specific V and Q values that can be outputted to the display to help the students understand. This was difficult to find extremes in values and this article in particular focused on the partial pressures.
- Overall a very interesting article and provided many interesting facts
- The figure below is a good representation of V/Q mismatch extremes vs. normal

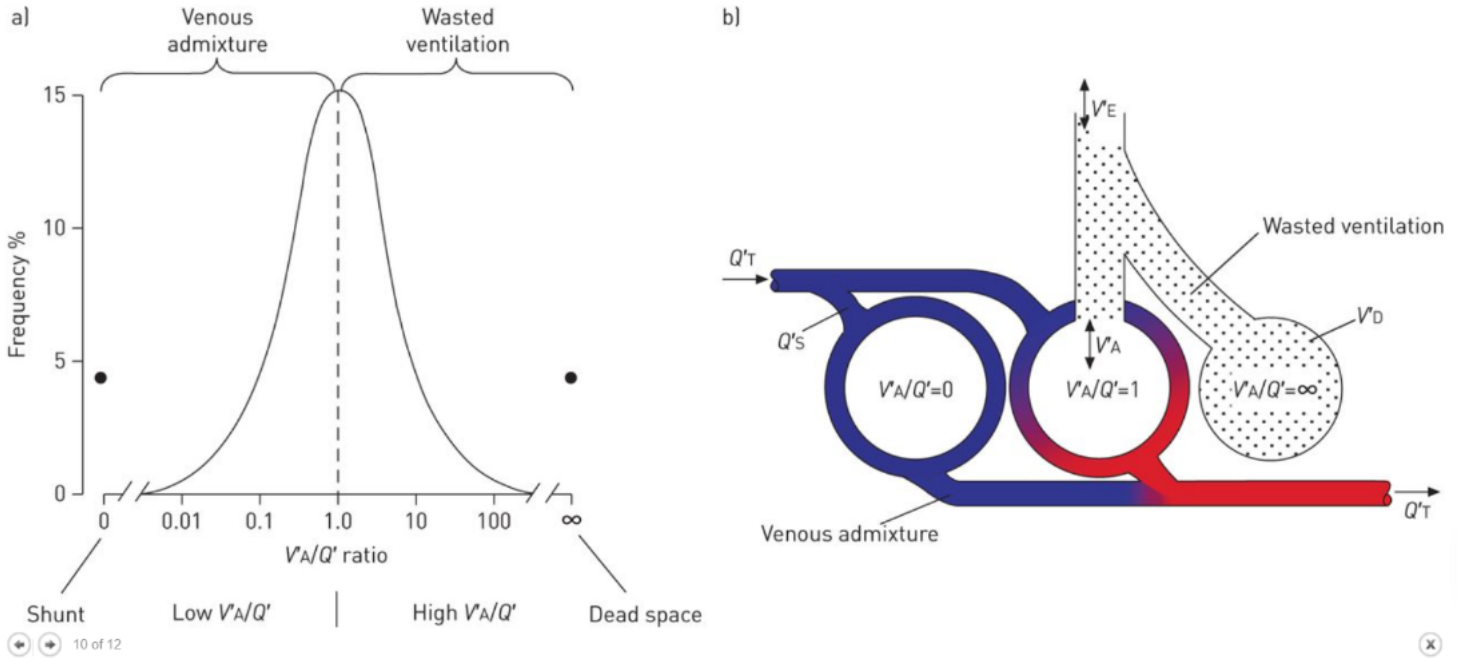


Figure 1. V/Q ratio graph with extremes along with a diagram showing what is occurring during those extremes

- Normal alveolus ventilation is about 5L/min
 - For Chronic lung disease they would need a respiration rate of 25L/min or greater to achieve an alveolar ventilation of 5L/min
- When wasted ventilation increases, minute ventilation also need to increase to maintain alveolar ventilation

Conclusions/action items:

Although the article had good information, a lot was necessary for our design. The photo found is a great way to represent the extremes of V/Q ratios and will likely be incorporated into the report

CITATION:

J. Petersson and R. W. Glenny, "Gas exchange and ventilation–perfusion relationships in the lung," *European Respiratory Journal*, vol. 44, no. 4, pp. 1023–1041, 2014.

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

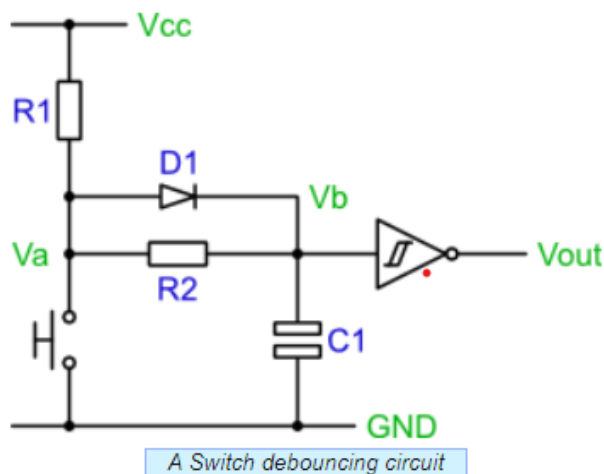


Figure 1. Debouncing Circuit

- 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]

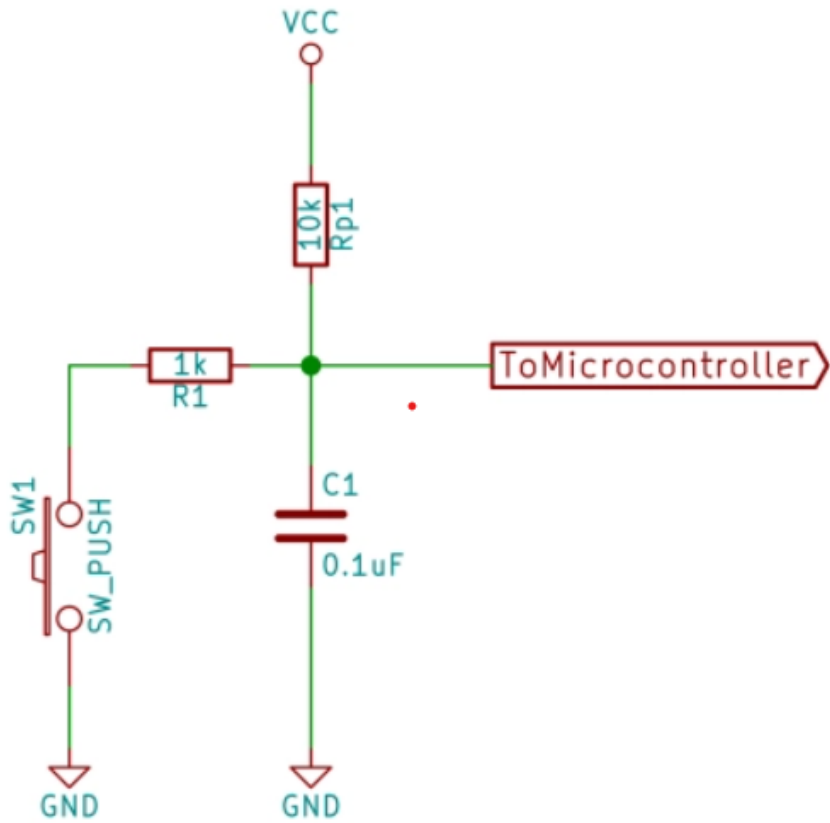


Figure 2. Debouncing Circuit w/o diode

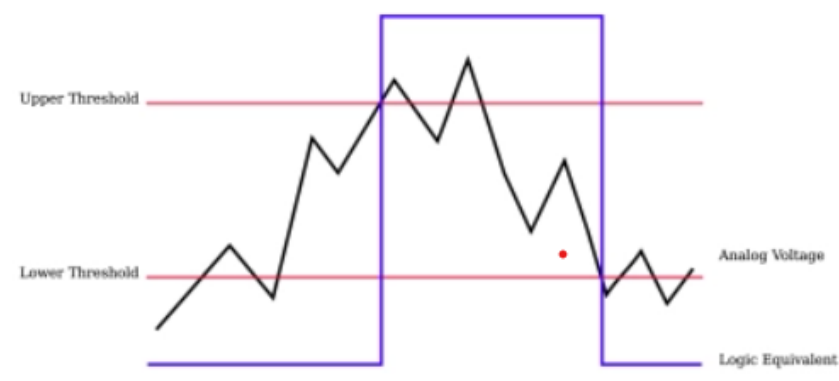


Figure 3. Example of hysteresis HIGH, LOW, and MID ranges

- 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-elliott-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 what is mainly used in our system). These wires are connected to the sides of the rectangular block on the back of 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 using 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 held 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. ElapsedMillis 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("Voltage: ");
    Serial.println(digitalRead(button));
    delay(500);
  }
}
```

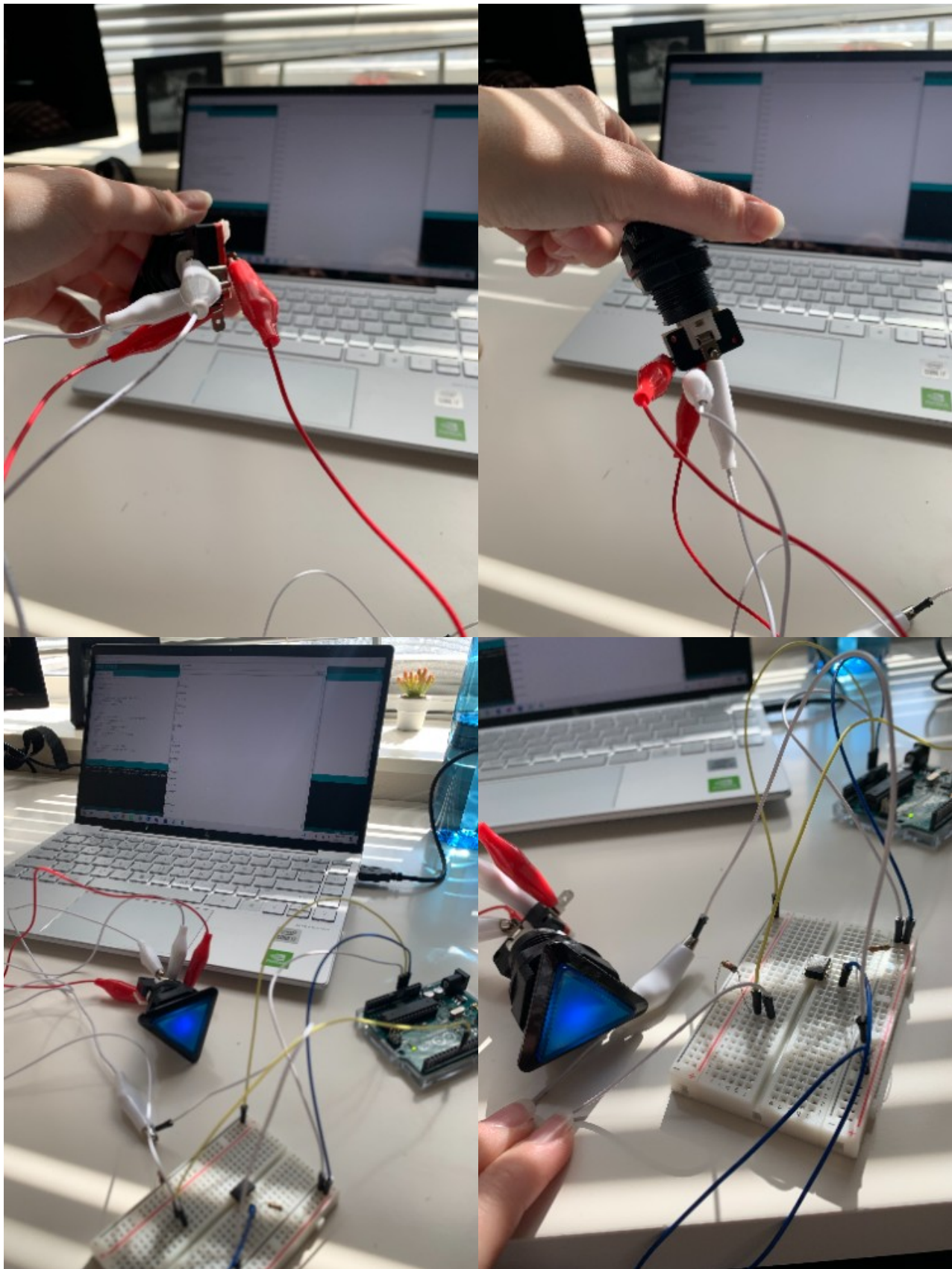


Figure 1. Wire connections on the button and the breadboard connections for arduino uno

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.



Test Display Code

Brittany Glaeser - Apr 06, 2021, 10:21 PM CDT

Title: Test Display

Date: 4/6/21

Content by: Britt

Present: Britt

Goals: To test displaying different values on the display

Content:

Below is the code used to print to the display. It displays the capillary and alveolus settings, capillary and perfusion rates, as well as the overall ratio for the design. The capillary and alveolus values are also color coded with red and green respectively.

```
#include <Adafruit_GFX.h> // Core graphics library
#include <Adafruit_ST7735.h> // Hardware-specific library for ST7735
#include <Adafruit_ST7789.h> // Hardware-specific library for ST7789
#include <SPI.h>

#define TFT_CS 10
#define TFT_RST 9 // Or set to -1 and connect to Arduino RESET pin
#define TFT_DC 8

// For 1.44" and 1.8" TFT with ST7735 use:
Adafruit_ST7735 tft = Adafruit_ST7735(TFT_CS, TFT_DC, TFT_RST);

float p = 3.1415926;

int ventSetting = 5;
int capSetting = 1;

void setup() {
  // put your setup code here, to run once:
  Serial.begin(9600);
  // Serial.print(F("Hello! ST77xx TFT Test"));

  // OR use this initializer (uncomment) if using a 1.44" TFT:
  tft.initR(INITR_144GREENTAB); // Init ST7735R chip, green tab
}

void loop() {
  // put your main code here, to run repeatedly:
  tftPrint();
  delay(10000);
}

void tftPrint(){
  tft.setTextWrap(false);
  tft.fillScreen(ST77XX_BLACK);
  tft.setCursor(0, 0);
  tft.setTextColor(ST77XX_GREEN);
  tft.setTextSize(1);
  tft.print("V Setting: ");
  tft.print(ventSetting);
  tft.println("/5");
  tft.setCursor(0, 10);
  tft.setTextColor(ST77XX_RED);
```



```
tft.setTextSize(1.5);
tft.print("Q Setting: ");
tft.print(capSetting);
tft.println("/5");

tft.setCursor(0,40);
tft.setTextColor(ST77XX_GREEN);
tft.println("Minute Ventilation: ");
tft.setCursor(40, 50);
tft.println("5 L/min");

tft.setCursor(0,60);
tft.setTextColor(ST77XX_RED);
tft.println("Perfusion Rate: ");
tft.setCursor(40, 70);
tft.println("1 L/min");

tft.setCursor(0, 90);
tft.setTextColor(ST77XX_WHITE);
tft.setTextSize(2);
tft.println("V/Q Ratio: ");
tft.setCursor(55,110);
tft.println(ventSetting/capSetting);
}
```

Conclusions/action items:

Use this code as starter code to be implemented into the overall design code. I think the best way to do it is everytime the buttons are pressed, the display will change its values by altering string values and calling a function that set the display.

A delay is used in the code above because otherwise it would flash everytime the functions for text are called. I assume this would go away once implemented into overall code as the function would only be called when the values are changed via the buttons.



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

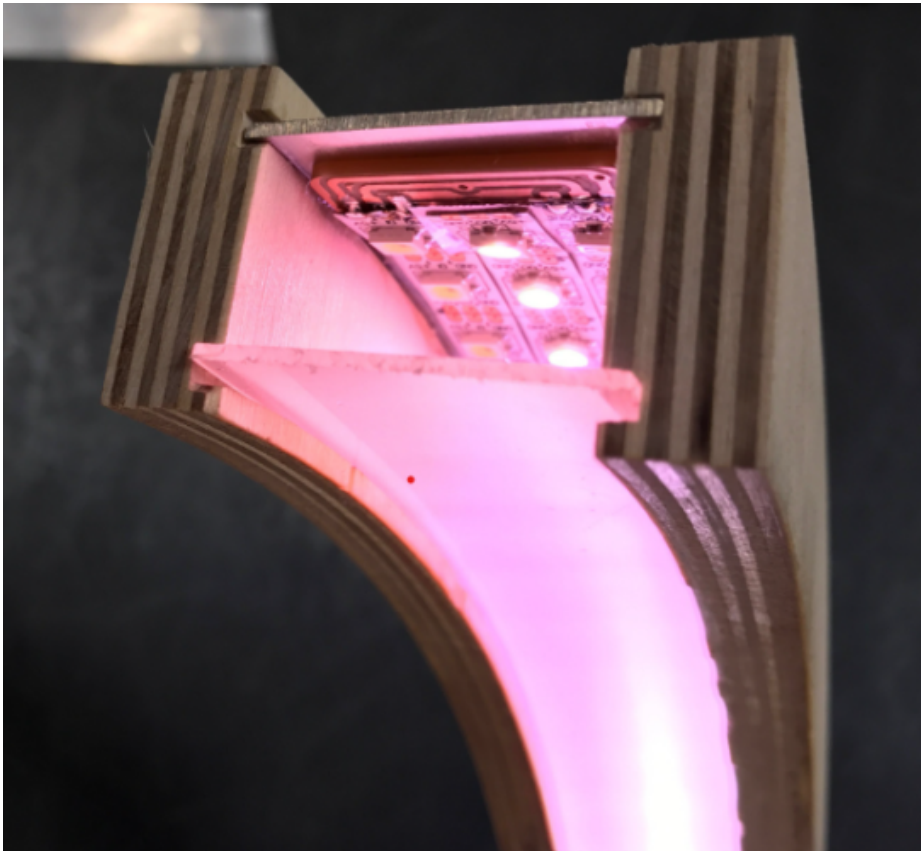


Figure 1. Privacy sheet

- 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.



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-48QWIQRaEnXM35oQT9ekwBcHILBnhQPCYaAucfEALw_wcB

- More expensive

https://www.adafruit.com/product/3502?gclid=Cj0KCQiA34OBBhCcARIsAG32uvMbTb9tuZG3y7wqTvbDzLN0ZNPmAoKSDngqI27o5Ak11CRMIkX7sjwaAr4wEALw_wcB

- Less expensive

https://www.adafruit.com/product/326?gclid=Cj0KCQiA34OBBhCcARIsAG32uvNJtz-ogTPQkvdj2RU86Lrkr1P1cD7jCGbYcQdHLMU0wCOzqOfv6kaAsI4EALw_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:



Speed and Ratio Ratios

Brittany Glaeser - Apr 06, 2021, 10:16 PM CDT

Title: Ratios for speed and V/Q ratio

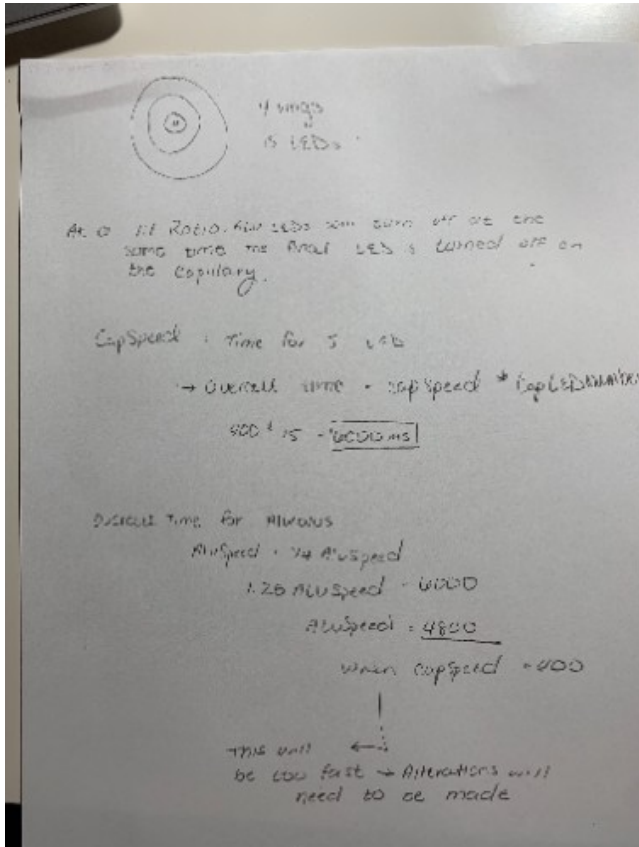
Date: 4/6/21

Content by: Britt

Present: Britt

Goals: To model V/Q ratios by the speeds of the lights

Content:



I attached a photo of some of the handwritten work I did. Basically, how the code is set up, for the lights of the capillary to go through 1 cycle, the alveolus speed should equal 1.25 times the capillary speed. This will ensure that the lights will finish at the same time for a 1:1 ratio. For how it is set up with the speed values now, this might make the speeds too fast and hard to watch so we may not be able to go with this unless further alterations are made.

Another thing to consider is if we would want a 1:1 ratio to be achieved different ways. For example, if we increase the capillary by 1 and decrease the alveolus by 1 a 1:1 ratio can still be achieved so would this also need to be reflected in the lights?

The client at one point discussed having the LEDs correspond to ventilation and perfusion rates. Would we want the LEDs to go through a certain amount of cycles or could we display changes in these rates on the display with values that seem accurate.

Conclusions/action items:

The first step will be to test the math on the actual LEDs themselves and further change can then be made.



Title: Circuit improvements

Date: 4/17/21

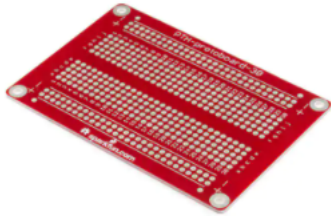
Content by: Britt

Present: Britt

Goals: Determine ways that could increase the longevity of the circuit

Content:

- Currently the circuit is placed on a breadboard and some of the components are not as secure
 - The worry is if the design is moved around too much pieces may come loose
- Solderable Breadboard
 - This would allow use to solder parts directly to the board to make them more secure
 - A concern would be whether or not they open solder wires would cause any problems or if there is anything that could accidentally ground the circuit
 - It is also not know if the rails are connected in a particular direction
 - It seems as if it may depend on the board bought
 - This would be easy to determine if this was decided
 - The downside would also be that the circuit would need to be absolutely finalized as it could be difficult to de-solder some of the parts



PRT-12070



Digi-Key Part Number	1568-1082-ND
Manufacturer	SparkFun Electronics
Manufacturer Product Number	PRT-12070
Supplier	SparkFun Electronics 
Description	BREADBOARD GENERAL PURPOSE PTH
Manufacturer Standard Lead Time	2 Weeks
Customer Reference	<input type="text" value="Customer Reference"/>
Datasheet	 Datasheet

Figure 1. Example of a solderable breadboard from digikey [1]

- Another possible option would be to create a PCB
 - This would give a much cleaner and more concise circuit
 - Would need to be exact dimensions or another board would need to be made or ordered
 - It could take awhile to receive and will cost more
 - I have ordered PCB through digikey before and they always turned out nice
 - There are likely many other companies that can also be used

Conclusions/action items:

We will not have time to complete a new board this semester, but if we want to continue it for the client these are some potential options to consider.

CITATION: [https://www.digikey.com/en/products/detail/sparkfun-electronics/PRT-12070/5230951?](https://www.digikey.com/en/products/detail/sparkfun-electronics/PRT-12070/5230951?utm_adgroup=Prototype%20Boards%20Perforated&utm_source=google&utm_medium=cpc&utm_campaign=Shopping_Product_Prototyping%2C%20Fabrication%20Products_NEW&utm_term=02T2xXicpRE8r18LWV4FbKxhEic9VD7Yhd2G7PmibO2bxoCLSUAvD_BwE)

utm_adgroup=Prototype%20Boards%20Perforated&utm_source=google&utm_medium=cpc&utm_campaign=Shopping_Product_Prototyping%2C%20Fabrication%20Products_NEW&utm_term=02T2xXicpRE8r18LWV4FbKxhEic9VD7Yhd2G7PmibO2bxoCLSUAvD_BwE

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:

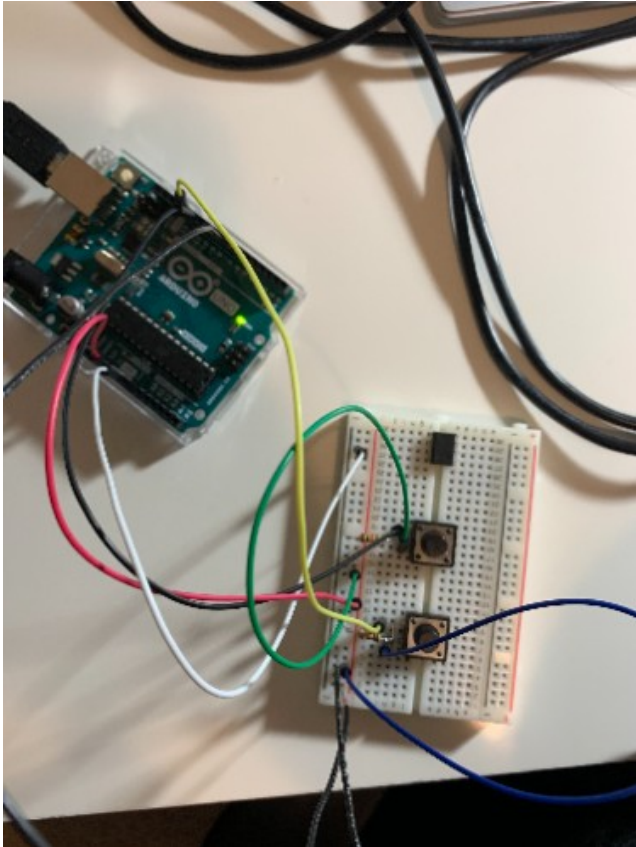


Figure 1. Breadboard with two buttons, one controls increased ventilation and the other decreases ventilation.

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.



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.

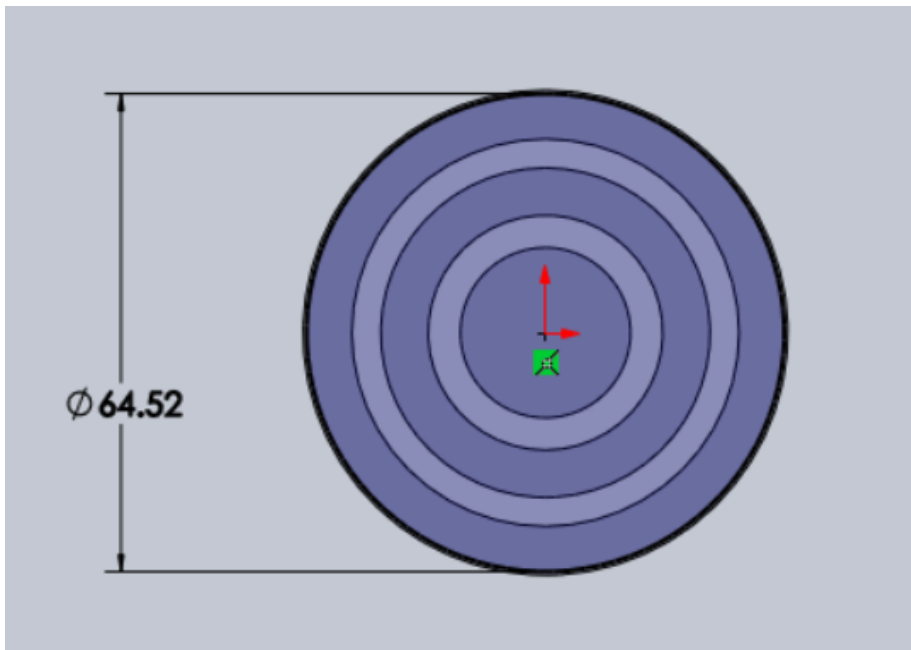


Figure 1: The sizing of the concentric circles with the LED dimensions for 24, 16, and 7 Neopixel boards

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 V/Q ratio setting and values above 25 could be used in the high V/Q 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 the 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=c&hvdvcmdl=&hvlocint=&hvlocphy=9018948&hvtargid=453470548504&psc=1



Adhesives that can be used on PLA

KAITLIN LACY - Apr 27, 2021, 7:31 PM CDT

Title: Adhesives that can be used on PLA

Date: 4/20/2021

Content by: Kaitlin Lacy

Goals: Determine the best way to attach the LED lights and alveolus diffuser to the 3D print.

Content:

-Prior to glueing any plastic together, it is important to sand out any bumps.

-The surface should be cleaned with something like alcohol and dried before the glueing process.

Possible bonding agents:

-cyanoacrylate glues work well for rigid 3D prints made out of PLA, and a common type of cyanoacrylate glue is Superglue.

-Plumbers ABS Cement and Epoxy can both be used when bonding two 3D printed pieces together.

-Polyurethane glues and Silicone glues can be used (these leave a seam due to requiring a thickness of a few millimeters).

-Hot glue: has similar issue of leaving a seam

Conclusions/action items:

Discuss these ideas with the team, and choose an adhesive to use/order

"Gluing 3D Printed Parts: Best Glues for PLA, ABS & PETG," *All3DP*, 18-Apr-2021. [Online]. Available: <https://all3dp.com/2/gluing-3d-printed-best-ways-bond-3d-prints/>. [Accessed: 20-Apr-2021].



How to Use Advanced Hole Feature in SolidWorks

KAITLIN LACY - Apr 27, 2021, 7:40 PM CDT

Title: How to Use Advanced Hole Feature in SolidWorks

Date: 4/21/2021

Content by: Kaitlin Lacy

Goals: Learn how to use the advanced hole feature of SolidWorks to countersink the holes on the back panel.

Content:

This makes it possible to stack different features of a hole along the same axis, which makes it easier than having to implement each of these features separately. This makes it easier to create countersunk holes with a variety of features.

1. Visit the top menu bar on the upper right-hand side of your screen
2. Select Insert > Features > Advanced Hole
3. Select Near Side
4. Dimension the position of the hole in the Position tab of the Property Manager
5. Choose the first hole feature you want on your customized hole
6. Select the Insert Element buttons to insert the rest of your desired custom features for the near side.

Conclusions/action items:

Use this to customize the holes on the back panel to those that would allow the device to lay flat on a table, with no screw heads in the way.

"How to Use the Advanced Hole Tool in SOLIDWORKS," *SolidProfessor*, 07-Nov-2018. [Online]. Available: <https://www.solidprofessor.com/blog/how-to-use-the-advanced-hole-tool-in-solidworks/>. [Accessed: 21-Apr-2021].



Smoothing 3D Prints of PLA Material

KAITLIN LACY - Apr 28, 2021, 12:40 PM CDT

Title: Smoothing 3D Prints of PLA Material

Date: 4/25/2021

Content by: Kaitlin Lacy

Goals: Find a way to reduce the appearance of the grooves on the front of the print, which is not aesthetically appealing.

Content:

-PLA prints with a rough finish, which can be make the finish look less professional and have imperfections.

-One obvious alternative is to apply fillers/primers and sand it down, but this would be very time consuming.

-Alternative is using low-viscosity epoxy resin. This source says many people thin it out with isopropyl alcohol, but getting the correct ratio for the specific case at hand is tricky. This source using Z-Poxy.

Conclusions/action items:

With not much time remaining, the print may not be able to be smoothed down without risking needing to reprint. Future work could involve experimenting with different methods to correct the slashed lines that are on the front of every 3D print so far.

Debouncing Circuit and Code Ideas

KAITLIN LACY - Feb 05, 2021, 10:14 AM CST

Title: Debouncing Circuit and Code Ideas

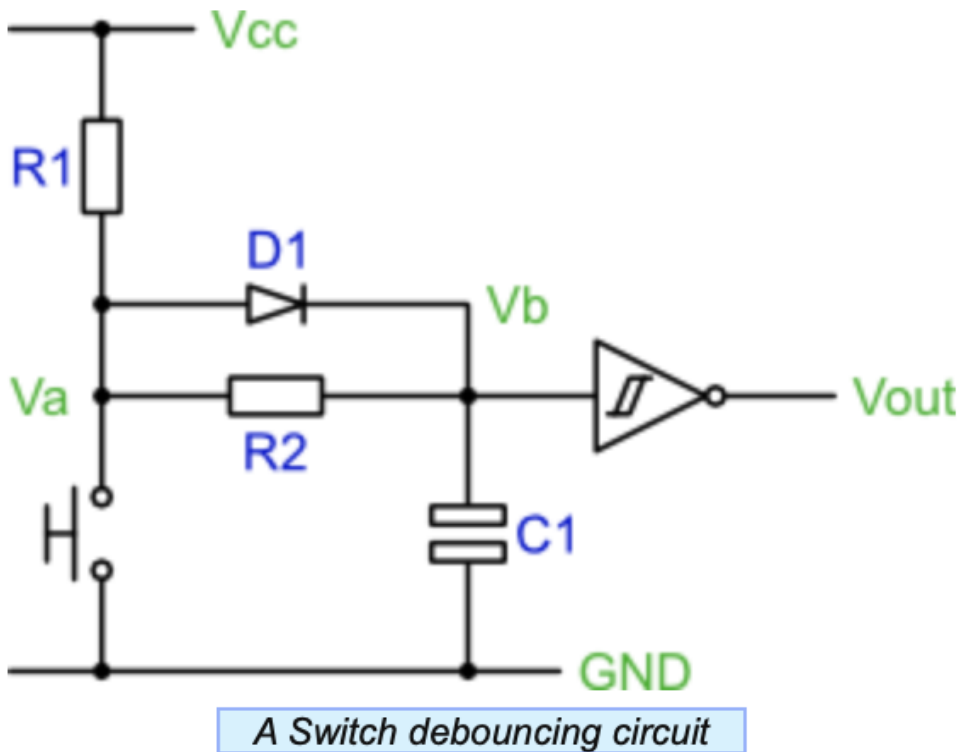
Date: 2/4/2021

Content by: Kaitlin Lacy

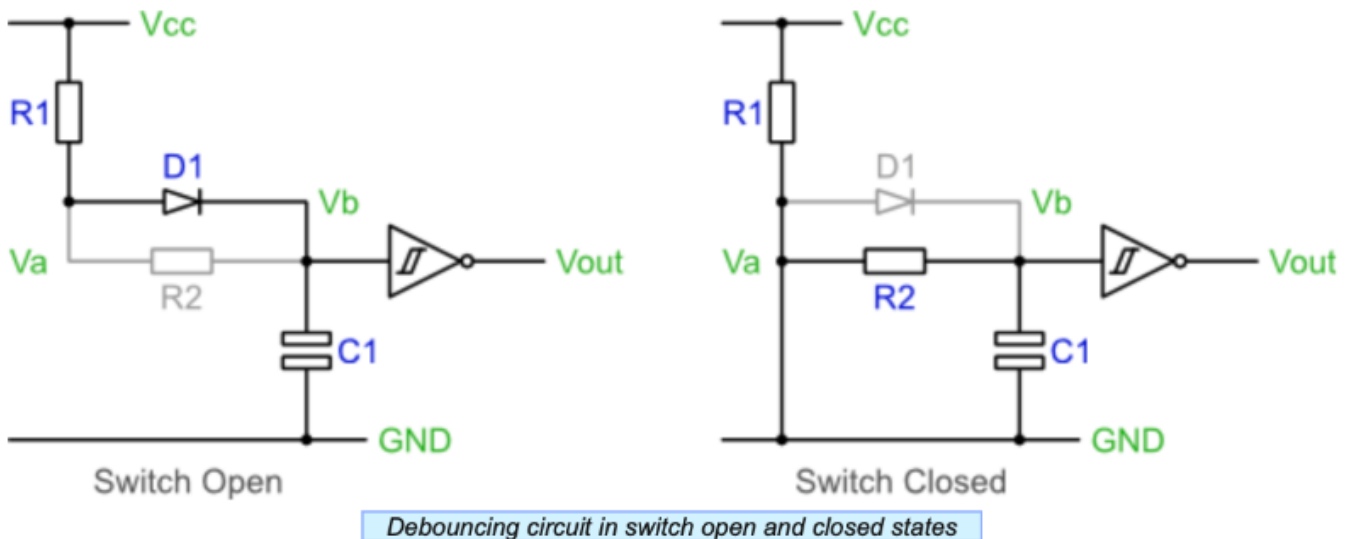
Goals: Learn more about correcting the problem of switch debouncing in a circuit

Content:

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



An example switch debouncing circuit is pictured above.



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 variable 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].



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.

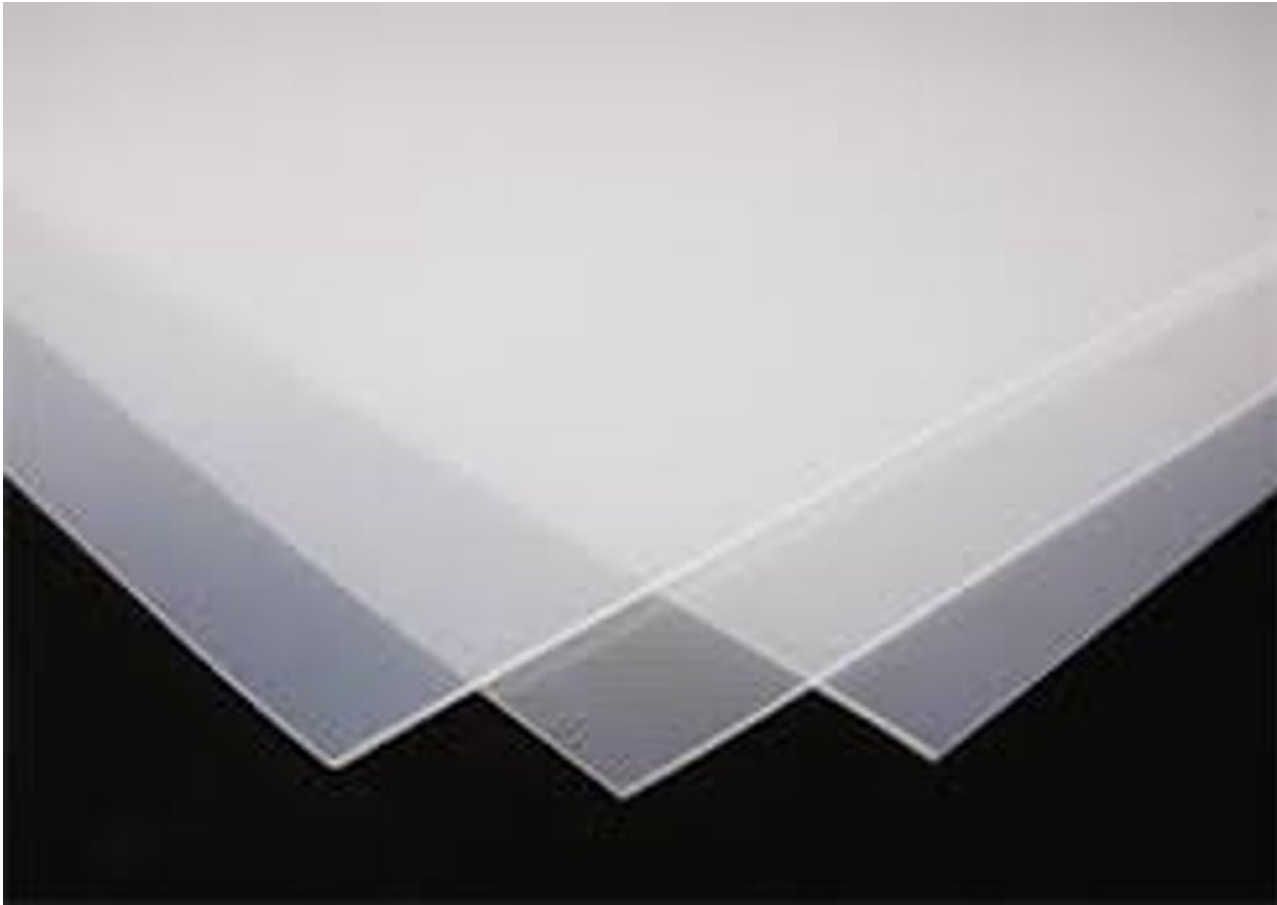


Fig. 1: HDPE sheet for sale on Etsy.



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 remotes) 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.



KAITLIN LACY - Apr 27, 2021, 7:13 PM CDT

Title: Back Container for Base

Date: 4/19/2021

Content by: Kaitlin Lacy

Goals: Create an alternative method to cover the open compartment on the back to protect the electronic components.

Content:

-The back panel has a possibility of failure/ screw heads may stick out if not countersunk very precisely / may require multiple prints. An alternative printed at the same time would be nice to print concurrently with the back panel as an alternative.

-Currently, the device is being housed in an Adafruit cardboard box that it fits snugly around. It's actually a great way to secure the back pieces, because the device can be pulled out to have access to the back pieces. However, we obviously can't give it to the client with it being contained by a cardboard box. However, we could 3D print a box with a similar idea, and attach the device to it through velcro or some other form of adhesive.

Pros: Would be secure, protect the electronic components, not require screwdrivers to open (which would be easier for the client), and be aesthetically appealing

Cons: If not secured well, it is possible the device could easily slide out

Conclusions/action items:

Sketch up a first draft of a CAD model, and see whether this would be a possibility.



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>



2021/03/07 - CITI human subject research training

ZOE SCHMANSKI - Mar 10, 2021, 6:40 PM CST

Title: CITI Human Subjects Training

Date: 3/7/2021

Content by: Zoe

Present: n/a

Goals: Document human subjects research training completion

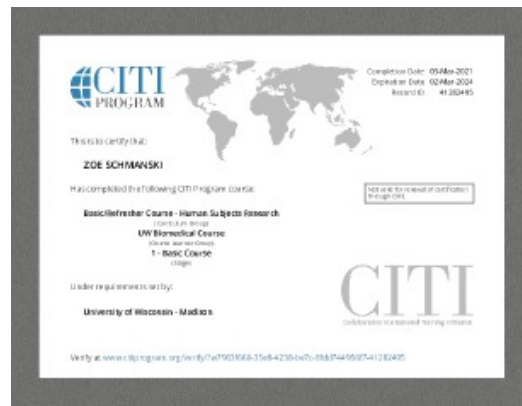
Content:

Every team member must complete the CITI human subjects research training requirement for the IRB in order to complete the survey testing and analysis.

Conclusions/action items:

Report to the IRB

ZOE SCHMANSKI - Mar 10, 2021, 6:40 PM CST



CITI.pdf(410.3 KB) - [download](#)



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: Delimitate 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



2021/03/09 - Validation Testing Questions

ZOE SCHMANSKI - Mar 10, 2021, 6:48 PM CST

Title: Possible Survey Questions**Date:** 3/9/2021**Content by:** Zoe**Present:** n/a**Goals:** List survey questions for the validation of the V/Q model**Content:**

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.

Questions

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

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

The curved LED represents a capillary bed. Blue colored LEDs signify deoxygenated blood and red signify oxygenated blood. Where is the higher concentration of deoxygenated blood located on the model?

The curved LED represents a capillary bed. Blue colored LEDs signify deoxygenated blood and red signify oxygenated blood. Where is the higher concentration of oxygenated blood located on the model?

*Show two videos of different V/Q ratios

- Videos 1 and 2 represent two different V/Q ratios. Video 1 shows a

Decrease, increase, same...

- Comparing Videos 1 and 2...

Decrease, increase, same...

Conclusions/action items:

Possibly meet with the client to talk about assessment-like questions about V/Q ratios



2021/03/29 - Survey Questions

ZOE SCHMANSKI - Apr 12, 2021, 12:27 PM CDT

Title: Survey Questions

Date: 4/8/2021

Content by: Zoe

Present: n/a

Goals: Brainstorm survey questions for testing

Content:

Summary

The circular LED represents the alveolus and the curved LED represents a capillary bed. Green colored LEDs signify the oxygen in the alveolus, which stays constant throughout. Blue colored LEDs signify deoxygenated blood and red signify oxygenated blood. The blinking rates of the LEDs change to signify specific ventilation rates in the alveolus and perfusion rates in the capillary. The normal V/Q ratio is 1:1, with the mismatching occurring when either the ventilation or perfusion rate (or both) is increased or decreased. Dead space ventilation can occur in which there is air movement in the alveoli with ventilation that is unable to participate in gas exchange. Inversely, a shunt occurs when there is perfusion, but no ventilation of the corresponding alveoli.

Questions

*Show a video of the model followed by questions

Video - Capillary 1 Alveolus 1

Q: When looking at the video above, the model is representing

- An extreme high V/Q ratio
- An extreme low V/Q ratio
- A 1:1 ratio

Q: What physiological result is represented by this V/Q ratio?

- Shunt
- Dead space ventilation
- Normal

1 Video - Capillary 0 Alveolus 4

Q: When looking at the video above, the model is representing

- An extreme high V/Q ratio
- An extreme low V/Q ratio
- A 1:1 ratio

Q: What physiological result is represented by this V/Q ratio?

- Shunt
- Dead space ventilation
- Normal

1 Video - Capillary 4 Alveolus 0

Q: When looking at the video above, the model is representing

- An extreme high V/Q ratio
- An extreme low V/Q ratio
- A 1:1 ratio

Q: What physiological result is represented by this V/Q ratio?

- Shunt
- Dead space ventilation
- Normal

Conclusions/action items:

Create survey



2021/04/03 - Survey Questions (2 videos)

ZOE SCHMANSKI - Apr 12, 2021, 12:30 PM CDT

Title: Survey Questions

Date: 4/3/2021

Content by: Zoe

Present: n/a

Goals: Continued brainstorming questions comparing 2 videos

Content:

Summary

Ventilation is the exchange of air between the lungs and the atmosphere. During this process, oxygen is exchanged for carbon dioxide in the alveoli. Alveoli are tiny air sacs in the lungs. The singular form of alveoli is alveolus.

Perfusion is defined as the passage of fluid through the circulatory system or lymphatic system to an organ or tissue. The blood is delivered to capillary beds, which are tiny network of blood vessels in the tissue.

During gas exchange, oxygen moves from the lungs to the bloodstream. At the same time, carbon dioxide passes from the blood to the lungs. This exchange occurs between the alveoli and capillaries in the lung.

Ventilation perfusion (V/Q) ratio is the measurement of total oxygen that reaches the alveoli in the lungs (ventilation) versus the total oxygen that enters the blood (perfusion). A 1:1 ratio is desired for V/Q ratio in the body, meaning all of the oxygen entering the lung is being transferred to the bloodstream.

V/Q mismatching occurs when the ratio is not 1:1. Many ratio combinations can occur due to different ventilation or perfusion rates, including the lung receiving oxygen without blood flow or blood flow occurring without oxygen.

As seen in the image below, the model contains two components: a circular LED track representing the alveolus and a curved LED track representing a capillary bed.

Green colored LEDs signify the oxygen in the alveolus, which stays constant throughout. In the capillary, blue colored LEDs signify deoxygenated blood and red signify oxygenated blood.

If no LEDs are illuminated in the alveolus, it is assumed no ventilation is occurring.

Similarly, if no LEDs are illuminated in the capillary, it is assumed no perfusion is occurring in the bloodstream.

The blinking rates of the LEDs change to signify specific ventilation rates in the alveolus and perfusion rates in the capillary. The normal V/Q ratio is 1:1, with the mismatching occurring when either the ventilation or perfusion rate (or both) is increased or decreased.

The V/Q ratio is quantified in this study by dividing the rate of ventilation by the rate of perfusion.

A value greater than 1 signifies that the rate of ventilation is greater than the rate of perfusion. Conversely, a value less than 1 signifies that the rate of ventilation is less than the rate of perfusion. The normal V/Q ratio would be calculated as 1, as the rates of ventilation and perfusion are equal.

In the scenario where there is no perfusion occurring, we will consider the denominator to be a very small value close to 0.

Dead space ventilation is present when alveoli are ventilated but not perfused. These alveoli do not participate in gas exchange. Inversely, a shunt occurs when there is perfusion of alveolar capillaries but no ventilation of the adjacent alveoli, this is termed shunting. Again, no gas exchange occurs in areas of shunting.

Questions

2 Video Comparison - Video 1 (C1A1) and Video 2 (C1A4)

Q: When comparing the V/Q ratios in Video 1 and 2 above by specifically looking at the ventilation rates (alveolus), it can be observed that...

- The V/Q ratio is higher in Video 1
- The V/Q ratio is higher in Video 2
- The V/Q ratio is the same in both videos

2 Video Comparison - Video 1 (C1A1) and Video 2 (C4A1)

Q: When comparing the V/Q ratios in Video 1 and 2 above by specifically looking at the perfusion rates (capillary), it can be observed that...

- The V/Q ratio is lower in Video 1
- The V/Q ratio is lower in Video 2
- The V/Q ratio is the same in both videos

Conclusions/action items:

Complete survey to be sent out



2021/04/10 - Final Questionnaire

ZOE SCHMANSKI - Apr 12, 2021, 12:33 PM CDT

Title: Final Questionnaire

Date: 4/10/2021

Content by: Zoe

Present: n/a

Goals: Documentation of the final questionnaire

Content:

One copy was sent to the medical students

A second copy was sent our to a random population as a secondary testing in case no medical students are able to be tested.

Conclusions/action items:

Analyze results

ZOE SCHMANSKI - Apr 12, 2021, 12:33 PM CDT

©11/2021 The Ventilation/Perfusion Teaching Model

The Ventilation/Perfusion Teaching Model

You are invited to participate in a research study about a teaching model's ability to help medical students recognize different ventilation/perfusion ratios and their consequences. You have been asked to participate because you are a medical student with knowledge of pulmonary physiology.

The purpose of the research is to analyze a teaching model's ability to improve upon a human subject's understanding of ventilation/perfusion ratios by visually displaying what occurs when the ratios are miscalculated.

This study will include medical students from the University of Wisconsin-Madison. This research will be conducted through an online questionnaire.

If you decide to participate in this research, you will be asked to watch videos and answer corresponding questions pertaining to the teaching model.

Your participation will last approximately 15 minutes. We don't anticipate any risks to you from participation in this study. We don't expect any direct benefits to you from participation in this study. This study is confidential. Neither your name or any other identifiable information will be published. Only approved personnel will have access to the data.

You may ask any questions about the research at any time. If you have questions about the research after completing the study, you should contact Arni H. Mankar at 608-850-1016 or his email arni@wisc.edu.

If you decide not to participate or to withdraw from the study, you may do so without penalty.

Your signature indicates that you have read this consent form and voluntarily consent to participate.

* Required

1. ELECTRONIC CONSENT: Please select your choice below. Clicking on the "agree" button below indicates that you have read 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. *

Mark only one oval

Agree

Disagree

<https://www.google.com/forms/d/1FqgBw4SDc1v0KLLuL8h4n4p4vE9M4M0u4t>

Teaching_V_P_Mismatching_Model_-_Medical_Students_-_Google_Forms.pdf(652.2 KB) - [download](#)



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

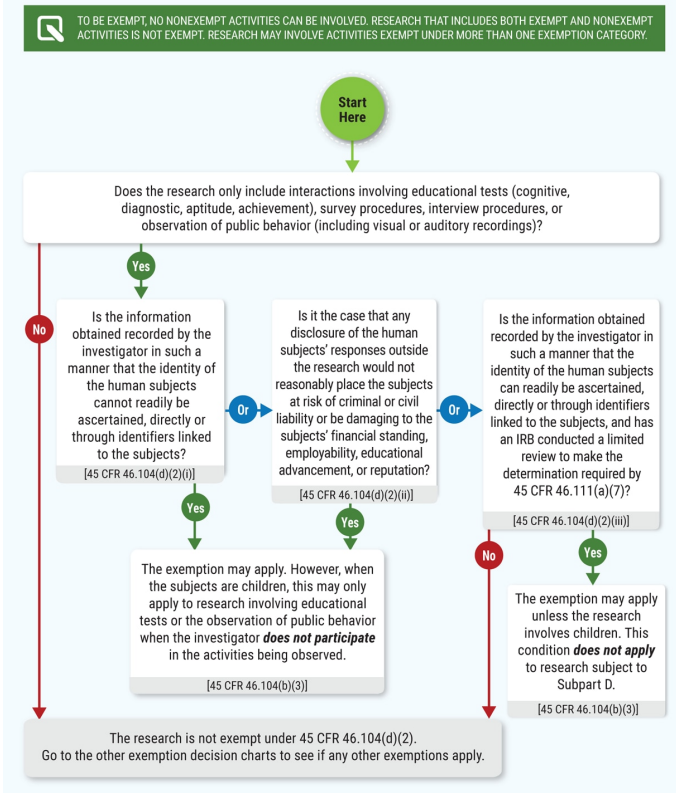
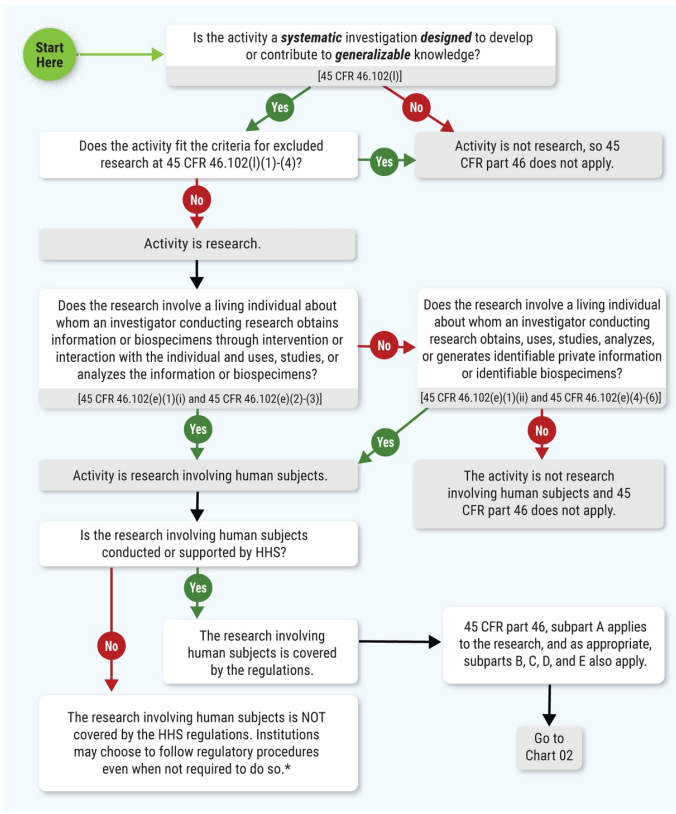
Present:

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



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: Delimitate 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.

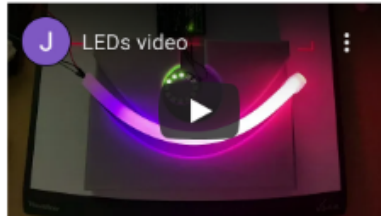
* Required

ELECTRONIC CONSENT: Please select your choice below. Clicking on the "agree" button below indicates that: you have read 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

University of Wisconsin - Madison
Research Participant Information and Consent Form

Study Title: Teaching Model for Ventilation and Perfusion Study
Principal Investigator: Amit Nimunkar (Phone: 609 974680) (Email: ajn@wisc.edu)
Student Researcher: Jenna Eizadi (609 974886)

Description of the research:
You are invited to participate in a research study about a model's ability to help medical students conceptualize different ventilation/perfusion ratios and their consequences. You have been asked to participate because you are a medical student with knowledge of pulmonary physiology. The purpose of the research is to analyze a model's capability to improve upon a human subject's understanding of ventilation or perfusion ratios by graphically displaying what occurs when the ratios are modulated. This study will include medical students from the University of Wisconsin-Madison. This research will be conducted through an online questionnaire.

What will my participation involve?
If you decide to participate in this research, you will be asked to watch videos and answer corresponding questions pertaining to the teaching model. Your participation will last approximately 45 minutes per session and will require 3 sessions which will require 45 minutes in total.

Are there any risks to me?
We don't anticipate any risks to you from participation in this study.

Are there any benefits to me?
We don't expect any direct benefits to you from participation in this study.

How will my confidentiality be protected?
This study is confidential. Neither your name or any other identifiable information will be published. Only approved personnel will have access to the data.

Whom should I contact if I have questions?
You may ask any questions about the research at any time. If you have questions about the research after you leave today you should contact the Principal Investigator Amit Nimunkar at 609 974680.

If you are not satisfied with response of research team, have more questions, or want to talk

Consent_Form.docx(43.9 KB) - download



2021/04/01-Google Form Final Copy

JENNA EIZADI (eizadi@wisc.edu) - Apr 27, 2021, 8:54 PM CDT

Title: Google Form Final Copy

Date: 04/01/2021

Content by: Jenna

Present:

Goals: To provide a final copy of the Google Form to be sent out for testing.

Content:

- Google Form will be sent to 2 populations: medical students and others

Conclusions/action items:

Will need to outline and perform testing once Google Form has enough ~50 responses.

JENNA EIZADI (eizadi@wisc.edu) - Apr 27, 2021, 8:54 PM CDT



Teaching_V_P_Mismatching_Model_-_Others_-_Google_Forms.pdf(524.5 KB) - download



2021/04/10-Statistical Testing

JENNA EIZADI (eizadi@wisc.edu) - Apr 27, 2021, 9:03 PM CDT

Title: Statistical Testing from Google Form Data

Date: 04/10/2021

Content by: Jenna

Present:

Goals: To determine appropriate tests to run on data from Google Form.

Content:

- analyze model's capability to improve a subject's understanding of V/Q ratios
- data from Google Form sent to two populations: medical students and others
- Test #1: T-Test on data from a population of medical students
 - expect that they will be able to achieve 100% given aid from the teaching model
 - null hypothesis: mean will be 1 corresponding to a score of 100%
 - alternative: mean is less than the expected outcome
 - if alternative is true, teaching model does not do a sufficient job of improving the understanding of medical students
- Test #2: T-Test on data from a population of people without prior knowledge
 - expect that the baseline score is 33.33% or answering at random
 - null: mean will be equal to that of the baseline score of 33.33%
 - alternative: mean will be greater than the expected outcome
 - if the alternative is true, the teaching model improves on the understanding of subjects
- Test #3: Two-Sample T-Test on means of both populations
 - null: two means are equal
 - alternative: mean from the other's population is less than that of the medical students

Conclusions/action items:

Collect data and perform statistical tests to draw conclusions.



2021/04/20-Results from Testing

JENNA EIZADI (eizadi@wisc.edu) - Apr 27, 2021, 9:10 PM CDT

Title: Results from Testing

Date: 04/20/2021

Content by: Jenna

Present:

Goals: To analyze the data using the outlined statistical tests.

Content:

Population #1: 46 Subjects without previous exposure or knowledge of V/P

- Average score: 0.7935 or 79.35%
- Standard deviation: 0.073 or 7.3%

Population #2: 5 Medical Students with prior knowledge of V/P

- Average score: 0.98 or 98%
- Standard deviation: 0.06 or 6%

T-Test on Population #1

- P-value: 4.479e-9
- Accept alternative hypothesis at an alpha of 0.05
- Conclude that the average score is above the expected result of randomly answering questions
- Suggests that the device can improve a subject's understanding of V/P

T-Test on Population #2

- P-value: 0.17
- Reject alternative hypothesis at an alpha of 0.05
- Conclude that the average score is close to the expected of 100%
- Suggests that the device improves upon existing knowledge of medical students

Two-Sample T-Test on Population Means from #1 and #2

- P-value: 7.25e-4
- Accept alternative hypothesis that the mean from 1 is less than that from 2
- Conclude that prior knowledge of V/P is important for effectiveness of teaching model

Conclusions/action items:

Write-Up data into the journal and prepare for final presentation and report.



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.



Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items: