BME Design-Fall 2025 - KENAN SARLIOGLU Complete Notebook

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Ryan Wahl

on

Dec 10, 2025 @07:29 PM CST

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Ryan Wahl - Dec 10, 2025, 6:26 PM CST

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Ryan Wahl - Dec 09, 2025, 8:32 PM CST

Course Number: 200/300

Project Name: Stethoscope with noise canceling headphones (and amplification option)

Short Name: ListenBetter

Project description/problem statement: Medical professionals often face issues when working in high-noise environments being able to listen to heart sounds with traditional acoustic stethoscopes and some medical professionals with hearing aids cannot use these stethoscopes. The goal of this project is to design an over the ear headset model that will have active noise cancelling and is not so expensive that it wouldn't be feasible on a mass scale. This stethoscope will be able to block out outside sounds and be used by all medical professionals.

About the client:

Dr. Lenard Markman was a retired family medicine physician who practiced for 30 years. He is trying to stay involved in medicine and is also involved in legislation mostly pertaining to epinephrine. He has even gotten three laws passed, including one requiring all emergency personnel in Wisconsin to carry epinephrine. Wisconsin is the only state moving towards this so that is a big accomplishment for him. He took interest in this project due to this background and general interest as a retiree in staying active in medicine.

SYLVIA HOLST - Sep 12, 2025, 12:17 PM CDT

Title: Client Meeting 1

Date: 9/10/25

Content by: Kenan, Ryan, Mohammed, and Sylvia

Present: Kenan, Ryan, Mohammed, and Sylvia

Goals: Establish project goals and parameters.

Content:

What should we focus on first?

Focus on the project without amplification

What is the project timeline and expected milestones?

Are there any size, weight, or power constraints (e.g., battery life expectations, weight under a helmet, etc.)? Less bulky=better

What is the budget?
With no amplification -\$50
With amplification -??

Who are the main end users (flight medics, ER doctors, general hospital staff, EMTs, etc.)?

What environments should we prioritize testing for (helicopters, airplanes, ambulances, hospitals)?

Are there competitors or existing products we should study for comparison?

Has this product been attempted before to your knowledge and were there any major roadblocks that caused it to not work out?

Miscellaneous notes:

Over the ears? Allows people to keep their hearing aids in.

Reduction and without amplification would be cheap and accessible

It is good to have different models but it's good to have a double headed system where two people can hear at the same time with two sets of headphones (attachment).

Medical students will use these headphones

Also for emergency medicine personal

All environments including helicopter

Make sure that the tube coming into the headphone is reflected into the ear canal

Work with communicative disorders for testing maybe?

Click them off and put around neck user friendly easy to carry around the head

Reversible, where a patient who is hard of hearing can hear the doctor through the stethoscope

Research hearing compromised groups

Conclusions/action items:

The client wants an over-the-hear, noise cancelling stethoscope design that suppresses sound in crowded/loud environments and potential amplifies the sound coming in through the stethoscope head.

Ryan Wahl - Dec 10, 2025, 7:28 PM CST

Title: Client Meeting 2

Date: 9/22/25

Content by: Sylvia

Present: Kenan, Ryan, Mohammed, and Sylvia

Goals: Review PDS and share ideas for design matrix.

Content:

Features:

- Battery-powered (AAA) vs. rechargeable
 - Battery pack vs. internal battery system (Electronic Stethoscope Having Battery Carriage patent)
- · Multi-headed vs. singular
 - · Selling stethoscope head and headset separately
- · Collapseable headband
- Electronic ANC vs. sound-absorbing material around the microphone
 - ANC and amplification vs. just ANC
 - ANC On/off switch
 - Mic and ANC vs. bell and diaphragm
- · Heated diaphragm or rubber lip

ANC Electric

Electric Non ANC

· with interchangeable ear nibs

Acoustic Non ANC

At least two mics and battery system

- One mic in diaphragm → transmit sound of heart/lungs to headset/ears to hear
- One mic in headset → transmit sound to ANC circuit for destructive interference





Conclusions/action items:

We need to decide what elements we want to include in each of the three designs for the design matrix.

SYLVIA HOLST - Oct 02, 2025, 4:46 PM CDT

Title: Client Meeting 3

Date: 9/30/25

Content by: Sylvia

Present: Kenan, Noah, Mohammed, and Sylvia

Goals: Review design matrix and discuss presentation.

Content:

The client sent an email last week citing specific features he would like the final design to have. We modified our designs to incorporate these features in the design matrix. When we showed these designs to the client, he actually wasn't as happy with them. He said that he miscommunicated what he wanted in the email.

Conclusions/action items:

We might need to revisit our designs and go back to an electronic model.

SYLVIA HOLST - Oct 13, 2025, 9:19 AM CDT

Title: Client Meeting 4

Date: 10/6/25

Content by: Sylvia

Present: Noah, Mohammed, Ryan, and Sylvia

Goals: Solidify our final design.

Content:

The client is okay with an electronic stethoscope design.

- We should be able to get a good cheap stethoscope online for about \$16
- Potential idea to record the sounds we hear
- Bluetooth idea is something to consider
- We need to make sure our product is unique and there may already be a product out there that is electronic that is patented
- We may need to just go through with our main current design and go from there

Conclusions/action items:

The patent that is similar to our electronic stethoscope design is expired, so we could change our design again to be an electronic stethoscope with ANC. This might make it easier to do a true over-the-ear headset without the nibs that go into the ear from the stethoscope and would also make the Bluetooth feature more feasible down the line.

SYLVIA HOLST - Oct 13, 2025, 9:38 AM CDT

Title: Client Meeting 5

Date: 10/12/25

Content by: Sylvia

Present: Noah and Sylvia

Goals: Meet with client in-person, acquire stethoscopes, and solidify final design.

Content:

We met with the client in-person. We revisited our design with him and explained that we would be going forward with the electronic stethoscope design instead of the acoustic stethoscope design. The client was happy with this. He also brought a pair of stethoscopes for the team to work with and he showed us how to use them.

Conclusions/action items:

The team can work with the stethoscopes. We could also begin gathering other resources for prototyping.

Ryan Wahl - Oct 27, 2025, 5:12 PM CDT

Title: 10/27/25 client meeting

Date: 10/27/25

Content by: Ryan Wahl

Present: Whole team

Goals: Learn about the ordering process and update our client on what is going on with our project.

Content:

This was a very short meeting where we just showed our client our current 3D printed ear cup model and talked about expenses. Our client is not familiar with paypal, venmo, etc., so he agreed to just write us a check/give us cash when the time comes for reimbursement.

Conclusions/action items: This week we are going to finalize our 3D printed model and prepare our pitch for the show and tell on October 31.

KENAN SARLIOGLU - Sep 26, 2025, 2:31 PM CDT

Title: Advisor Meeting 1

Date: 09/19/2025

Content by: Mohammed Ibrahim

Present: Whole team

Goals:

• Update advisor on what was completed this past week and discuss future plans

Content:

- · We need to add more numbers to our PDS
- It's not too early to begin working on prelim presentation
 - Make sure to clearly describe our problem
- · Focus of this week was narrowing down our client goals to finish PDS
- Maybe we should look into making more than 1 design matrix to narrow down our numerous design options
- · Plan to meet with client on monday and will discuss design ideas after
 - Current focus is on design, will begin working on prototypes after presentation
- Remember to ask client about how purchasing items will work in our next meeting

Conclusions/action items: We'll meet with the client soon to go over our progress and get clarity on purchasing. In the meantime, we'll keep working on the design and refine our design matrix to narrow down options. After the presentation, we'll shift focus toward prototyping.

KENAN SARLIOGLU - Sep 26, 2025, 2:30 PM CDT

KENAN SARLIOGLU - Sep 26, 2025, 2:31 PM CDT

Title: Advisor Meeting 2

Date: 9/26/2025

Content by: Kenan & Ryan

Present: Whole team

Goals:

Content:

Someone should come in 10 minutes early to open up the presentation on the main design

10 minutes for the presentation 5 minutes for the design

Dr Puccinelli sent a email with the schedule for the presentation

Highlight the part of the design that is the differentiator between the rest of the designs like a different color for example

Email Dr. Pucineli to ask if stethoscope is available

Invite client to poster presentation and preliminary presentation

Preliminary budget give the client a plan,

Printable polymers and foams

Broken down stethoscope communication with him maybe he can deliver it to us

SYLVIA HOLST - Oct 23, 2025, 11:52 AM CDT

Title: Advisor Meeting

Date: 10/10/2025

Content by: Mohammed

Present: Whole team

Goals: Discuss preliminary presentations/ what we've worked on this past week

Content:

- Presentation went longer than it should've
- Should have included more references, especially relating to the problem statement
- More numbers on the PDS would be helpful
- We have a few weeks before the next deliverable (show and tell)

- Fabrication of a first prototype before October 31st
- Meet with client in person

SYLVIA HOLST - Oct 13, 2025, 9:33 AM CDT

Title: Advisor Meeting 3

Date: 10/10/2025

Content by: Ryan Wahl

Present: Team

Goals: Understand what needs to be accomplished in the next week

Content:

How can we make the problem seem like a larger problem than just what our client says?

- can we find more sources to back this up?
- switch slides 4 and 3 so people know the background better.
- more numbers on the PDS
- clarify other competing designs and how ours is unique
- come to the show and tell with questions about our project so we can get feedback from other groups on our product.
- experiment with stethoscope in the next week once we get it from Dr. Markman

Ryan Wahl - Oct 17, 2025, 1:29 PM CDT

Ryan Wahl - Oct 17, 2025, 1:45 PM CDT

Title: 10/17/25 Advisor Meeting

Date: 10/17/25

Content by: Ryan Wahl

Present: n/a

Goals: Figure out what we need to accomplish in the next week

Content:

We plan on making an LTspice to figure out the electronic components of our headphones before we move on to the mechanical components.

We need to be able to figure out the right way to connect our ANC chip to our device.

We should have a more thorough discussion with our client during the next meeting about the process we should go through when we need to start buying things.

- -DigiKey, Mouser
- -Start thinking about batteries vs rechargeable (we are thinking batteries).

Ryan Wahl - Oct 24, 2025, 1:41 PM CDT

Title: Advisor Meeting 5

Date: 10/24/25

Content by: Ryan Wahl

Present: Whole team

Goals: Learn what we need to accomplish in the following weeks

Content:

We struggled over the last week with learning how to order materials from our client.

We are planning on buying a headset online and disassembling it but there are many considerations to make because the headset we want to buy is connected to a headphone jack. This hea

Ryan Wahl - Nov 07, 2025, 1:55 PM CST

Title: Advisor Meeting 6

Date: 11/7/25

Content by: Ryan Wahl

Present: whole team

Goals: understand what we need to accomplish in the next several weeks

Content:

We need to find a device ideally with an adjustable gain versus auto gain.

Ryan Wahl - Dec 09, 2025, 8:33 PM CST

Title: Advisor meeting 7

Date: 11/14/25

Content by: Ryan Wahl

Present: whole team

Goals: understand what needs to get done before Thanksgiving

Content:

- Poster presentations are coming up
- The week after poster presentations our final deliverables are due

Conclusions/action items: We must really start designing our final prototype so we are not behind during our final week.

Ryan Wahl - Nov 21, 2025, 2:04 PM CST

Title: Advisor Meeting 8

Date: 11/21/25

Content by: Ryan Wahl

Present: Ryan, Sylvia, Mohammed, Kenan

Goals: Understand what we need to accomplish in the next 2 weeks.

Content:

- Posters should be printed a couple days in advance just in case
- we should potentially just put together our actual circuit without the breadboard as this may produce a more clear sound.
- -need to focus on producing a final product and then if there is any time leftover we can try to make adjustments.

NOAHDIAH LISOWSKI - Nov 14, 2025, 3:12 PM CST

KENAN SARLIOGLU - Nov 05, 2025, 2:08 PM CST

Title: AutoCAD Design of Headset

Date: 10/24/2025

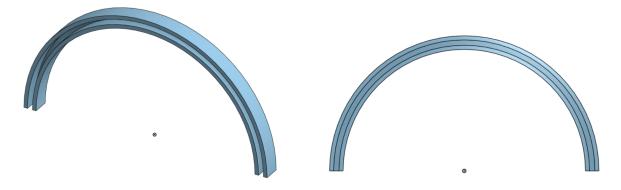
Content by: Noah

Present: Noah

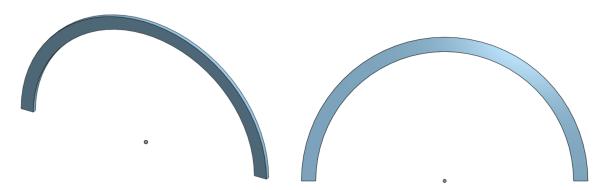
Goals: Create a CAD Design of Headset to 3D print for show and tell

Content:

Headband with cavity for wires

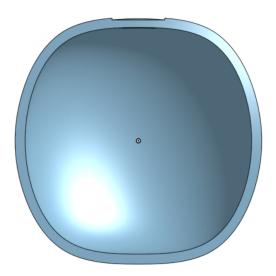


Cover for headband wire cavity



Earcups





KENAN SARLIOGLU - Nov

Title: Electronic Component Mock-up

Date: 11/10/2025

Content by: Team

Present: Team

Goals: Look into what components we need to order to complete mic to headphone connection.

Content:

https://www.amazon.com/WWZMDiB-GY-MAX4466-Electret-Microphone-Amplifier/dp/B0BVH1T8FC

MAX4466 Microphone Amplifier

We ordered the MAX4466 microphone amplifier because it boosts the tiny sound signal from the stethoscope capsule to a level that headphones can actua adjustable gain, which lets us make the signal louder or quieter depending on what works best. This part is essential because the raw microphone signal is own, so the MAX4466 gives us a clean and usable audio output.

· Computers & Accessories › Computer Components › Single Board Computers



3.5 mm TRS Female Audio Jack

We also ordered a 3.5 mm TRS female audio jack so we could plug the Sony headphones directly into our system. This jack gives us a simple way to connenne signal to both the left and right headphone channels. It basically acts as the bridge between the electronics and the headphones, making the setup ereliable.

https://www.amazon.com/CESS-Female-Stereo-Balanced-Socket/dp/B077D1NY4T/ref=sr_1_2?crid=M0K60M7CSZS2&dib=eyJ2|joiMSJ9.pxbCKOQml37dVf84YpAF9BmBDb2l1nkMeNRHQw49xJGcALKdo0gUnSBWA_HYxxwyuPv4hjf28ZmRkaV4s-U2l8UHI7JhQSO1j4-m64vZhRi2dwp4gTUwJH2cdYW28WxPpZ5d1f6Eq85mYSYf4hjhRa5HIZZJXJfhQgskeH1uvKScB5QUkJzjZmt6S4CYGNvnnrCdkhdQldyIIQ1XRn1seFo7Qc

_L4iej6lbQWY0aFWmGPENhYC7F8_tSbJuYzgNkkMAA&dib_tag=se&keywords=3.5mm+3-

 $\underline{pole+Female+Stereo+TRS+Balanced+Socket+with+Switch\&nsdOptOutParam=true\&qid=1763150409\&sprefix=3.5mm+3-pole+female+stereo+trs+balanced+socket+with+switch\&2Caps\%2C215\&sr=8-2\#averageCustomerReviewsAnchor}$



https://us.amazon.com/ShockLi-1150mAh-Battery-Rechargeable-Batteries-2/dp/B07WJ4GX5T#averageCustomerReviewsAnchor

18500 Battery + Charger

The 18500 battery and charger were ordered to give the microphone amplifier a portable power source. The MAX4466 needs a steady 3V–5V supply, and a battery works perfectly for this. Using a rechargeable battery lets us power the whole system without wires, which is important for making the device easy to



Conclusions/action items: These three components give us everything we need to power the microphone, amplify the sound, and send it into the Sony he setup stays simple, portable, and easy to connect. Now we can focus on assembling and testing the system.



11/14/2025 CAD Headphone band to Earcup Connection

NOAHDIAH LISOWSKI - Nov 14, 2025, 3:02 PM CST

Title: Headphone band to Earcup Connection

Date: 11/14/2025

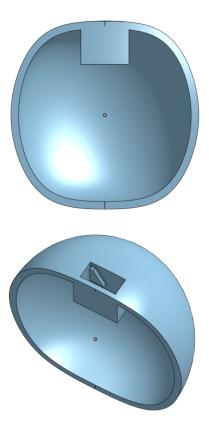
Content by: Team

Present: Team

Goals: Create a connection between the headphone band piece and the 3D printed earcups

Content:

We added a small divot into the 3D-printed earcup pieces so the headphone band could slide in and lock securely. This divot was modeled directly in the CAD software by carving out a recessed slot shaped to match the band's connection tabs. After inserting the band into the divot, we will use a strong adhesive such as super glue to permanently secure the connection and ensure the earcups remain firmly attached during use.



Conclusions/action items:

We successfully added a divot into the 3D-printed earcups to allow a secure connection with the headphone band. The feature was modeled directly into the CAD design, and we plan to reinforce the attachment with super glue once assembled. We have not yet tested this connection, so further adjustments may be needed after the first trial fit.

11/14/2025 Circuitry Design Meeting at Makerspace

KENAN SARLIOGLU - Nov 14, 2025, 2:49 PM CST

Title: Circuitry Design Meeting at Makerspace

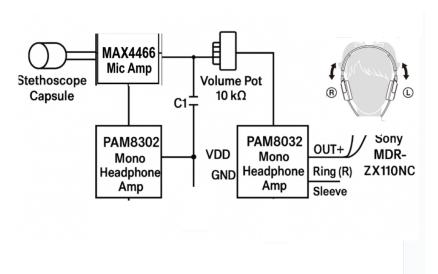
Date: 11/14/2025

Content by: Whole team

Present: Whole team

Goals: Create a plan to connect the different electronic microphone pieces to the TRS jack.

Content:



- 1. Stethoscope Capsule picks up sound and delivers it to MAX4466 Mic + preamp
- 2. The **MAX9814** output carries AC audio so capacitor **(C1)** blocks DC.
- 3. **PAM8302** Boost the signal to headphone level and provides adequate current
- 4. System is mono so connect

OUT+ \rightarrow Tip and Ring (so both ears get the same sound)

 $Sleeve \to Ground$

Tip = Left channel

Ring = Right channel

Sleeve = Ground

- 1. Stethoscope Capsule picks up sound and delivers it to MAX4466 Mic + preamp
- 2. The MAX9814 output carries AC audio so capacitor (C1) blocks DC.
- 3. PAM8302 Boost the signal to headphone level and provides adequate current
- 4. System is mono so connect

OUT+ → Tip and Ring (so both ears get the same sound)

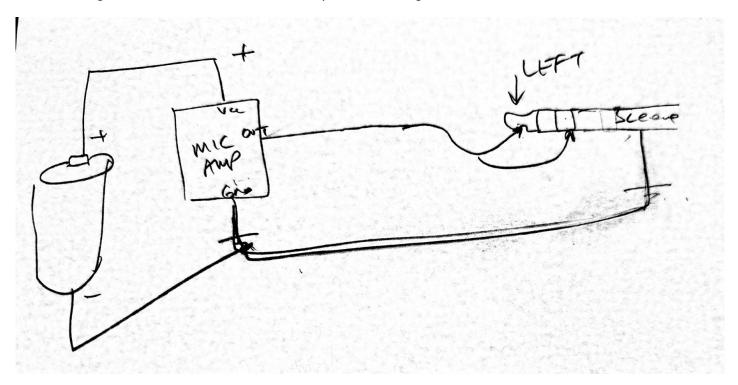
Sleeve → Ground

Tip = Left channel

Ring = Right channel

Sleeve = Ground

After consulting Lombardo at Wendt commons we updated the design to:



This design presents a simple connection without the need of an operational amplifier. This design utilizes a connection to a female TRS jack converter.

Conclusions/action items: The stethoscope capsule sends sound into the MAX4466 mic amplifier, which boosts the signal and sends it to the TRS headphone jack. The OUT line goes to both the left and right channels so the same sound plays in both ears. The sleeve pin is connected to ground, making the wiring simple without extra amplifiers.

11/21/2025 Mic+Preamp Connection discussion

KENAN SARLIOGLU - Nov 21, 2025, 2:41 PM CST

Title: Mic+Preamp Connection discussion

Date: 11/21/2025

Content by: Kenan Sarlioglu

Present: Team

Goals: Figure out a work around to the Mic+Pre amp connection to the headphone jack.

Content:

Cutting at the Y-Splitter is risky since it permanently alter the stethoscope's acoustic impedance and resonance, which degrades sound quality. The air leaks will destroy the pressure gradient and cutting the tubing short will cause distortion.

Option 1 Insert Mic + Preamp into the diaphragm surface using soft silicone or acoustic gel to ensure tight coupling but no air gap.

External Acoustic Coupling Remove the chestpiece diaphragm cover (temporarily). Mount an electret condenser microphone capsule (e.g., MAX9814 preamp) against the diaphragm surface using soft silicone or acoustic gel to ensure tight coupling but no air gap.

Littmann diaphragm \rightarrow Electret mic capsule \rightarrow MAX9814 preamp \rightarrow audio amplifier input \rightarrow Sony headphone TRS output

Option 2: Use one earpiece as the acoustic pickup for a mic + preamp, and Leave the other earpiece for your actual ear or remove both earpieces and make the stethoscope "purely electronic.

Important things to consider:

Keep it sealed

Treat the mic adapter like an eartip: airtight on the tube, airtight around the mic.

Minimize extra cavity volume

Don't create a giant hollow chamber at the end; you want a small cavity where the mic diaphragm is very close to the air column.

Use a tiny electret capsule

Something in the 4–6 mm range, wiring it off-board to your MAX9814 if the board is too big to sit there.

Strain relief the wires

A bit of heat-shrink or silicone at the exit so bending the wire doesn't rip pads off the mic.

KENAN SARLIOGLU - Nov 24, 2025, 6:10 PM CST

Title: Soldering For better Connections

Date: 11/24/2025

Content by: Team

Present: Team

Goals: Sucesfully Solder the preamp + mic, batteries, and headphones.

Content:

Today we worked on soldering all the main parts of our setup the mic + preamp, the battery leads, and the headphone wires. We decided to move away from the breadboard because it was giving us a lot of tiny connection issues that showed up as noise in the audio. The mic signal is super small, so any wiggly connection or extra resistance from the breadboard just makes everything sound worse.

Soldering gives us solid, clean connections that don't move around and don't add extra noise. With everything soldered, the preamp can actually send a stronger, clearer signal to the Sony headphones without random static popping in.

Conclusions/action items:

Overall, soldering just makes the whole setup feel more stable and "finished," instead of fragile like the breadboard version. In the future we will Test the sound quality again now that the connections are cleaner. Additionally we are thinking about fitting this soldered setup into the actual housing.



11/24/2025 CAD Microphone Capsule Design

NOAHDIAH LISOWSKI - Nov 25, 2025, 4:31 PM CST

Title: CAD Microphone Case Design

Date: 11/24/2025

Content by: Noah

Present: Team

Goals: Create a capsule that will house our microphone, two AA batteries and headset adapter (female end).

Content:





Conclusions/action items:

Test to see if all the components fit once it is finished printing and redesign any components if needed

NOAHDIAH LISOWSKI - Dec 10, 2025, 3:08 PM CST

Title: CAD Tube Connector

Date: 11/24/2025

Content by: Noah

Present: Team

Goals: Make a way for the stethoscope tube to connect to the Mic Capsule

Content:



Conclusions/action items:

Make sure the stethoscope tube fits the connector

11/25/2025 CAD Microphone Case Redesign

NOAHDIAH LISOWSKI - Nov 25, 2025, 4:28 PM CST

Title: CAD Microphone Case Redesign

Date: 11/25/2025

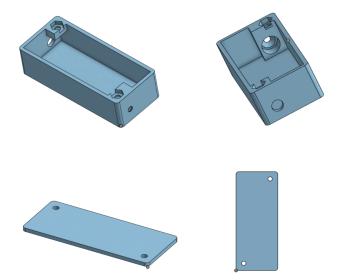
Content by: Noah

Present: Team

Goals: Redesign the microphone case to have the mic fit easier, increase height to allow more space for the wires, and

add a top

Content:



Conclusions/action items:

Test to see if the redesign fits all the components once it is finished printing and make sure the top attaches correctly

NOAHDIAH LISOWSKI - Dec 10, 2025, 3:05 PM CST

Title: CAD Headset Casing

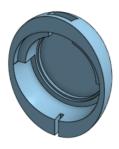
Date: 11/25/2025

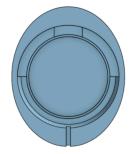
Content by: Noah

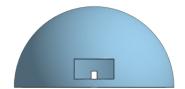
Present: Team

Goals: Create an outer casing for the headset

Content:







Conclusions/action items:

Make sure the Sony headset pieces fit inside



11/25/2025 Troubleshooting Headphone connection

KENAN SARLIOGLU - Nov 24, 2025, 6:33 PM CST

Title: Troubleshooting Headphone connection

Date: 11/25/2025

Content by: Team

Present: Team

Goals: Troubleshoot the Headphone connection

Content:

Headphones are a low-impedance load:

- ZX110NC: 45 Ω (passive) or 220 Ω (active).
- MAX4466 is happy with 10,000 Ω type loads.

To get 1 mW into 45 Ω (which already gives ~110 dB/mW in these cans), you need about:

$$V_{rms} = \sqrt{P \cdot R} pprox \sqrt{0.001 \cdot 45} pprox 0.21 \ {
m V_{rms}}$$

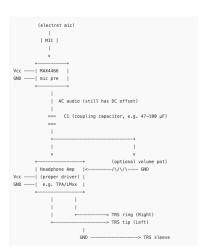
• That's ~0.6 V peak-to-peak and ~4.7 mA of current.

The MAX4466 is a tiny low-current op-amp; it's not designed to source several milliamps into a 45 Ω load continuously. Its datasheet examples and specs all assume loads around 10 k Ω .

What that means in practice if you plug the headphones directly into the MAX4466:

- It might make sound, but it'll likely be quiet, distorted, or both, especially with NC off (45 Ω).
- · The op amp is stressed by trying to act like a power amp

•



Conclusions/action items:



	. .			h	
	Price			Sum	
Part	(per	Quantity	Cost	of	Links
	part)		of Part	Costs	
Sony	400 70		\$00.70	\$00.70	Sony headset
Headset	\$23.73		\$23.73	\$23.73	<u>ebay link</u>
TRS female	Φ0.40		DO 40	\$00.00	TDO formals leads
jack	\$8.49	T	\$8.49	\$32.22	TRS female jack
Electret					
microphone	\$6.99	1	\$6.99	\$39.21	Electret Microphone Sensor
sensor					
F	ф1 4 O1	1	ф1 4 O1	F0 F0	https://www.amazon.com/dp/B097T6BRQJ?
Earcups	\$14.31	T	\$14.31	53.52	ref=cm_sw_r_cso_cp_apin_dp_T52EJ1YJBP3XF9T425S5&ref_=cm_sw_r_cso_cp_apin_dp_T52EJ1YJBP3XF9
Makerspace			\$00.00	\$00.0 F	
items	-	=	\$30.33	\$83.85	



SYLVIA HOLST - Dec 04, 2025, 4:13 PM CST

	Cost per			Sum of
Part	Item	Amount	Cost	Costs
First Print Earcups and				
headband for first	\$6.20	1	\$6.20	\$6.20
prototype				
Second Print of earcups	\$0.69	1	ቁ በ ഒበ	\$6.89
for first prototype	Φ0.09	1	ФО.09	Φ0.09
Third Print of earcups for	\$2.03	1	\$2.03	¢0 02
first prototype	Φ2.03	1	ΦΖ.03	Ф0.92
Super Glue	\$1.00	1	\$1.00	\$9.92
4 AAA Battery	\$0.75	4	\$3.00	\$12.92
First Print for Mic	\$0.44	1	<u></u> ተበ 44	\$13.36
Capsule	φυ.44	1	φυ.44	Φ13.30
2 6-32 x 3/8 Socket Head	\$0.035	2	ቀ በ በ7	\$13.43
Bolts	Φ0.033	2	φυ.υ <i>τ</i>	φ <u>τ</u> υ.4υ
2 6-32 Carbon Steel Hex	\$0.03	2	80 08	\$13.49
Machine Screw Nuts	ψ0.03	_	ψ0.00	Ψ13.43
Battery Holder	\$4.00	2	\$8.00	\$21.49
AA Battery	\$0.75	2	\$1.50	\$22.99
Second Print for Mic	\$0.66	1	\$ 0 66	\$23.65
Capsule	Φ0.00	T	φυ.υυ	Ψ23.03
Third Print for Mic	\$0.46	1	ቁበ <i>1</i> 6	\$24.11
Capsule	ψ0.40	.	ψ0.40	ΨΖ4.11
Third Earcups Print	\$1.89	1	\$1.89	\$26.00
Final Earcups Print	\$2.23	1	\$2.23	\$28.23
Velcro Soft Side	\$0.10 per	7	\$0.70	\$28.93
VOIGIO SOIL SIGE	inch	'		
Velcro Rough Side	\$0.10 per	14	ቁበ 70	\$30.33
Voloto Rough Slue	inch	<u></u>	Ψ0.70	Ψ00.00



Potential headphone model to buy and dissect

Ryan Wahl - Dec 09, 2025, 8:38 PM CST

Title: Sony MDR ZX110NC Noise Cancelling Headphones Black (11520377)

Date: 10/24/25

Content by: Ryan Wahl

Present: Whole team

Goals: Understand the feasibility of potentially buying a pair of noise cancelling headphones and utilizing their ANC

technology.

Content:

ebay link

Update (12/9/25): This was the pair of headphones we ended up buying and deconstructing for our final project. The active noise cancelling did not end up being very effective even in the original model we bought. Would recommend an alternative in the future. Link of these headphones from the manufacturer: <u>Sony headset</u>

Conclusions/action items: We will ask our client and get permission from the client to discuss the possibility or obtaining this headset.

10/24/25 Electronic Stethoscope with ANC

Ryan Wahl - Dec 10, 2025, 1:58 PM CST

Title: Electronic Stethoscope with ANC CAD

Date: 10/24/25

Content by: Sylvi Holst

Present: n/a

Goals: show a representation of the intended look of the final product we fabricate.

Content: Here is the developed CAD drawing for the final stethoscope we intend to fabricate. The headset contains the Sony headphones with ANC that we purchased and the tubing contains a battery pack soldered to a mic/preamp plus a female adaptor for the original wiring of the headphones.



Conclusions/action items: We will now begin to fabricate the final prototype once we have 3D printed the necessary materials.

11/25/25 Soldering Battery Configuration.

Ryan Wahl - Dec 10, 2025, 2:55 PM CST

Title: Soldering Battery Configuration.

Date: 11/25/25

Content by: Ryan Wahl

Present: Team

Goals: Solder the battery configuration that will be used in our final prototype.

Content: Here is the final soldered battery pack (Fig. 1) with wires soldered to battery holders and to the mic/preamp and the female adaptor. Links to these products can be found in the materials section. The battery holders are for 2 AA batteries. This configuration was then placed batteries faced down into the battery pack (Fig. 2). The image shows it without the lid but the lid can then be placed onto it and screwed in with screws. The wires are bulky but can be tucked into the battery pack effectively even with the lid on.



Figure 1: Soldered battery configuration.



Figure 2: Assembled battery pack configuration

Conclusions/action items: Now we can attach the tubing and work more on assembling the final prototype.

Ryan Wahl - Dec 10, 2025, 2:47 PM CST

Title: Headphone Assembly

Date: 12/2/25

Content by: Ryan Wahl

Present: Team

Goals: Assemble the headset

Content: The cushioning of the Sony headphones was easily removed. The speakers were then placed into the 3D printed ear cups and the headband was inserted into the slots on the top of the 3D printed ear cups (see CAD drawing of ear cups in Design Process folder). The side of the speaker with the internal battery was velcroed to the inside of the ear cup so it can be removed and the battery can be replaced. The other side was superglued to maximize sound blocking. The ear pads were then attached in the same way: the side with the internal battery was velcroed and the other side was superglued.



Figure 1: Headset with just Sony speakers inside.



Figure 2: Fully assembled headset

Conclusions/action items: The headset is now assembled and we can work on testing and finishing the poster.

Ryan Wahl - Dec 10, 2025, 3:05 PM CST

Title: Final Prototype Assembly

Date: 12/3/25

Content by: Ryan Wahl

Present: Team

Goals: Put together the final prototype.

Content:

To assemble the final prototype, the tubing of the original Littmann stethoscope was cut somewhat close to the chestpiece to maximize sound pickup at the mic. The tubing unexpectedly had two inner tubes, one that led to each ear. This was not a huge problem we just inserted the tube adaptor piece into only one of the holes of the stethoscope. On the other side, the adaptor was superglued to the battery pack. The male headphone jack from the Sony headphones was inserted into the female adaptor inside the battery pack on the other side.



Conclusions/action items: Finish poster.

Ryan Wahl - Dec 10, 2025, 3:05 PM CST

Ryan Wahl - Dec 10, 2025, 3:29 PM CST

Title: Testing Protocols.

Date: 12/3/25

Content by: Ryan Wahl

Present: whole team.

Goals: Identify the steps needed to record accurate data.

Content: ANC Test:

- 1. Speaker Placement: Mount speaker at ear height and mark position relative to the ground using SI units.
- 2. Headset position: Mark a position exactly 3 m away from the speaker this will be how far the headset is from the siren noise. Make sure headset height is the same as where the speaker is placed.
- 3. Test Siren: Play siren noise through the speaker at around 90 dB.
- 4. Control (No Headset) Location: Place Apple Watch without headset where headset is normally.
- 5. Recording Control: Start Siren, record dB at the highest level over 10 seconds.
- 6. Repeat for 5 trials
- 7. ANC Active Location: Enclose Apple Watch completely in headset with ANC active.
- 8. Use the mirror feature on iPhone to mirror the screen of the Apple Watch to an iPhone to be able to read dB.
- 9. Recording ANC Active: Start Siren, record dB at the highest level over 10 seconds.
- 10. Repeat for 5 trials.

Comfort Test:

- 11. Preemptive Inspection: Inspect pads, sterilize them, turn on ANC for realism.
- 12. Ergonomic Preparation: Adjust headband for each user, center cups over the ears.
- 13. Have the user put on the headset and start the stopwatch.
- 14. Baseline Survey: Have user rate overall comfort (1-5) 1 minute after stopwatch started.
- 15. Endpoint Survey: Have user rate overall comfort (1-5) 15 minutes after stopwatch started.
- 16. Sterilize headset and repeat 15 times with different subjects for a total of 15 trials.

Conclusions/action items: Now we know how to test the active noise cancellation and comfort of our device.

KENAN SARLIOGLU - Nov 24, 2025, 7:08 PM CST

Title: Testing Ideas
Date: 11/26/2025
Content by: team
Present: team
Goals: Put some testing Ideas down.
Content:
1. Maximum Sound Output Test (dB Test)
Goal: Measure the max sound level delivered by the electronic stethoscope through the Sony headphones during typical clinical-use sounds (heartbeat and breathing). This ensures the device is loud enough to be useful but not dangerously loud.
Equipment Needed: Electronic stethoscope prototype, Sony MDR-ZX110NC headphones, Decibel meter (phone appor calibrated meter), Anatomical test subject (human)
Stopwatch or timer
Quiet room (<40 dB baseline noise)
Measuring tape (to set headphone-meter distance consistently)
Setup
Place the decibel meter in front of one headphone earcup at 2–3 cm distance (consistent across all trials).
This distance mimics the natural position of the eardrum inside a human ear.

Turn noise-canceling ON and OFF for separate trial sets (optional).

Ensure the volume pot is set to the same position for all trials.
Have the subject sit comfortably and breathe normally to reduce movement artifacts.
Testing Procedure
A. Heartbeat Trials (10 Trials)
Place the electronic stethoscope chestpiece on the subject's chest at the left 5th intercostal space (apex) for strongest heart sounds.
Begin recording with the decibel meter.
Capture 10 seconds of data per trial.
Identify the peak sound level during each heartbeat cycle (S1/S2).
Record the maximum dB for that trial.
Repeat for a total of 10 trials, lifting the stethoscope off the chest between trials to reduce bias.
B. Breathing Trials (10 Trials)
Place the stethoscope over the right upper lung field (2nd intercostal space).
Instruct the subject to take slow, deep breaths:
"Inhale 3 seconds, exhale 3 seconds."

Measure the decibel meter during peak inspiratory and peak expiratory airflow sounds.

Record the maximum dB for each trial.

Repeat for 10 trials.

Conclusions/action items:

KENAN SARLIOGLU - Nov 24, 2025, 7:16 PM CST

Title: Testing Ideas

Date: 11/26/2025

Content by: team

Present: team

Goals: Put some testing Ideas down.

Content:

1. Maximum Sound Output Test (dB Test)

Goal: Measure the max sound level delivered by the electronic stethoscope through the Sony headphones during typical clinical-use sounds (heartbeat and breathing). This ensures the device is loud enough to be useful but not dangerously loud.

Equipment Needed: Electronic stethoscope prototype, Sony MDR-ZX110NC headphones, Decibel meter (phone app or calibrated meter), Anatomical test subject (human), Stopwatch, Quiet room (<40 dB baseline noise), Measuring tape (to set headphone–meter distance consistently)

Setup

Place the decibel meter in front of one headphone earcup at 2–3 cm distance (consistent across all trials).

This distance mimics the natural position of the eardrum inside a human ear.

Turn noise-canceling ON and OFF for separate trial sets (optional).

Ensure the volume pot is set to the same position for all trials.

Have the subject sit comfortably and breathe normally to reduce movement artifacts.

Testing Procedure

A. Heartbeat Trials (10 Trials)

Place the electronic stethoscope chestpiece on the subject's chest at the left 5th intercostal space (apex) for strongest heart sounds.

Begin recording with the decibel meter.

Capture 10 seconds of data per trial.

Identify the peak sound level during each heartbeat cycle (S1/S2).

Record the maximum dB for that trial.

Repeat for a total of 10 trials, lifting the stethoscope off the chest between trials to reduce bias.

B. Breathing Trials (10 Trials)

Place the stethoscope over the right upper lung field (2nd intercostal space).

Instruct the subject to take slow, deep breaths:

"Inhale 3 seconds, exhale 3 seconds."

Measure the decibel meter during peak inspiratory and peak expiratory airflow sounds.

Record the maximum dB for each trial.

Repeat for 10 trials.

Conclusions/action items:

Ryan Wahl - Dec 10, 2025, 5:22 PM CST

Title: Test Results

Date: 12/3/25

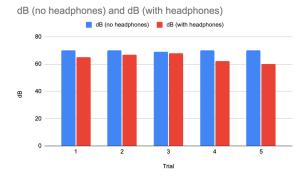
Content by: Ryan Wahl

Present: Team

Goals: Document the findings of our test results.

Content: Raw data from testing can be found in the attachment below but is messy.

ANC test:



Paired t-test p value: 0.0296

Average dB (no headphones): 69.8

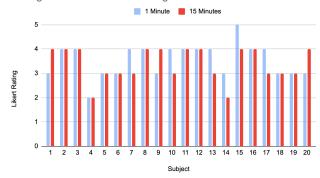
Average dB (with headphones): 64.4 dB

Standard deviation (no headphones): 0.447 dB

Standard deviation (with headphones): 3.362 dB

Comfort Test:

Rating After 1 Minute and Rating After 15 Minutes



Average rating after 1 minute: 3.55

Average rating after 15 minutes: 3.40

p value: 0.330

Tap Test:

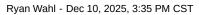
A small "tap test" was also performed to be able to analyze the propagation of sound through the stethoscope. This test was not very useful as tapping on the stethoscope head is much different than the sound generated from heart sounds, but it still displays the overall effectiveness of the circuit at transmitting sound.

Average sound pickup: 73.6 dB

Standard Deviation: 2.302 dB

Ambient room noise: 45 dB

Conclusions/action items: Now we have data from testing we can interpret to gauge the effectiveness of our final prototype.

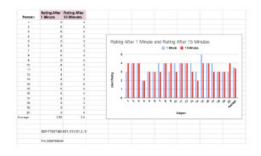




Download

Testing.xlsx (7.2 kB) Messy Raw data

Ryan Wahl - Dec 10, 2025, 7:02 PM CST



Comfort_Test_-_Sheet1.pdf (86.8 kB)



KENAN SARLIOGLU - Sep 26, 2025, 11:09 AM CDT

BMEDesigne Product Design Specification

Date: 91.525

Project differ Lister/Setter: Set forecope with ratios careeding heady here; (and amplification option)

Group Monthers:

Loaders Kernen Sarbo gla

Communications: Spicia II false

BSACC: Methorsel India

BSACC: Met

Download

Product_Design_Specification_PDS_2025_.pdf (249 kB)

KENAN SARLIOGLU - Sep 26, 2025, 11:08 AM CDT

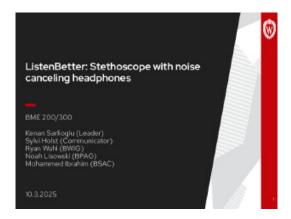
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Pictures							
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	Weight	Secre	Weighted				Weighted Seen
Criteria Sound quality	Weight 2s	Secre (max 5)	Weighted Score	(mas 5)	Score	(max 5)	
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Celteria Sound quality Ergonomics & comfort Byginu &	Weight 25 20	Secre (max 5) 3	Weighted Score L5	(max 5) 3	15 12	(man 5) 4 3	12
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Download

ListenBetter_Design_Matrix.pdf (583 kB)

10/3/25 Preliminary Design Presentation

SYLVIA HOLST - Oct 23, 2025, 11:49 AM CDT



Download

Fa25_Preliminary_Presentation.pdf (1.63 MB)

Ryan Wahl - Dec 09, 2025, 8:41 PM CST



Download

ListenBetterPoster.pdf (5.08 MB)

Ryan Wahl - Dec 09, 2025, 8:50 PM CST

BME Design: 200, 300, 301, 400 and 402

LictesBetter: Stethoscope with noise canceling headphones (and amplification option)

Date: 9/10/2025 - 9/13/2025

Client: Dr. Lengtl Markson Advisor: Prof. Justin Williams

Tearer.

Sylvia Hobit Moharmord Healtins

Noshilah Lisowski

Kenn Serlogh

Ryan Wald.

Problem statement

rathers statement.

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The scan is correctly working on selected ring the challenges that come with stributory as in high noise environments such an attent and anticlature. We have also writed to do come research on roting transplaces to chaselogies, any filtration incident, and been conduction methods to appear man with conductive theoring lost. Also the beaution in looking trips healthcome designs that combine with long term versafishly. Additionally we have selected a first receiving with the client has been schooled at (1906) with 1900 2000 to the conductive proof useful and constraints, and perform for constraints and performance constraints, and performance and gains cleared methods with the client has been schooled at (1906) with 1900 2000 to the constraints on the constraints and performance constraints.

Download

ListenBetter-Progress_Report-Week-1.pdf (290 kB)

Ryan Wahl - Dec 09, 2025, 8:51 PM CST

BME Design: 200, 300, 301, 400 and 402

LictorBetter: Stothoscope with noise canceling headphones (and amplification option)

Date: 9/15/25

Clicet: Dr. Lenaul Markman

Advisor: Prof. Imia William

Team Sylvia Hobit

Moharmord Healtins

Noshilah Lisowski

Kenn Serlogh Ryan Wald.

Problem statement:

A ser rote creating healphore specifically designed to contact the problems that some orbit stational in the support for healthcare point was the complex orbits and in the support of the problems of the contact of the stationary orbits and in administration. Further, the relativistic or creativistic contact orbits are contact or contact orbits. The contact of the contact of the contact orbits are contact or contact or contact orbits are contact or contact orbits. The contact orbits are contact or contact orbits are contact or contact orbits are contact orbits are contact or contact orbits are contact orbits.

This two k, our primary objective was to review and sale rated the cleant specifications for the districtic statescope. We conducted background research to identify approaches to constring the electronic stribescope and gathered quantitative data regarding equalifications design approach.

Download

ListenBetter__Progress_Report_Week_2.pdf (287 kB)

Ryan Wahl - Dec 09, 2025, 8:51 PM CST

BME Design: 200, 300, 301, 400 and 402

LictorBetter: Stothoscope with noise canceling headphones (and amplification option)

Clicet: Dr. Lenaul Markman

Advisor: Prof. Imia William

Team

Sylvia Hobit Moharmord Healtins

Noshilah Lisowski

Kenn Serlogh Ryan Wald.

Problem statement

Parklem statement:

A war note consoling healphore specifically designed to conduct be problem; that some with indistrial with cooper for healthcam profiles what has no hely or high vibration or intercents in which hospitals, stamil, and architecture. Factors like individual or conditions when the conditions of the c

Brief water update. On god this work was to communicate more with our client sheet our FD Sand work on our design matrix. With his hap, we came up with time potential designs for our surfaceaps including the accessic starbaseaps with active more concellation, which tracked for highest.

Download

ListenBetter__Progress_Report_Week_3.pdf (818 kB)

Ryan Wahl - Dec 09, 2025, 8:52 PM CST

BME Design: 200, 300, 301, 400 and 402

LictorBetter: Stothoscope with noise canceling headphones (and amplification option)

Clicet: Dr. Lenaul Markman

Advisor: Prof. Imia William

Team

Sylvia Hobit Moharmord Healtins

Noshilah Lisowski

Kenn Serlogh Ryan Wald.

Problem statement

Parklem statement:

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ListenBetter__Progress_Report_Week_4.pdf (815 kB)

Ryan Wahl - Dec 09, 2025, 8:52 PM CST

BME Design: 200, 300, 301, 400 and 402

LictesBetter: Stethoscope with noise canceling headphones (and amplification option)

Date: 10/9/25

Client: Dr. Lenaul Markman

Advisor: Prof. Justa William

Team: Sylvia Hobit

Mohormond Healting

Noshijah Lisowski

Kessa Serkogla

Byan Wald.

Problem statement

Problem statement

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ListenBetter__Progress_Report_Week_5.pdf (632 kB)

Ryan Wahl - Dec 09, 2025, 8:52 PM CST

BME Design: 200, 300, 301, 400 and 402

LictesBetter: Stethoscope with noise canceling headphones (and amplification option)

Clicet: Dr. Lenaul Markman

Advisor: Prof. Imia William

Team

Sylvia Hobit Moharmord Healtins

Noshilah Lisowski

Kenn Serlogh Ryan Wald.

Problem statement

Parklem statement:

A war note consoling healphore specifically designed to conduct be problem; that some with indistrial with cooper for healthcam profiles what has no hely or high vibration or intercents in which hospitals, stamil, and architecture. Factors like individual or conditions, the conditions of the condi

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ListenBetter__Progress_Report_Week_6.pdf (624 kB)

Ryan Wahl - Dec 09, 2025, 8:53 PM CST

BME Design: 200, 300, 301, 400 and 402

LictorBetter: Stothoscope with noise canceling headphones (and amplification option)

Date: 10/23/25

Clicet: Dr. Lenaul Markman

Advisor: Prof. Imia William

Team

Sylvia Hobit Moharmord Healtins

Noshilah Lisowski

Kenn Serlogh Ryan Wald.

Problem statement

Parklem statement:

A war note consoling healphore specifically designed to conduct be problem; that some with indistrial with cooper for healthcam profiles what has no hely or high vibration or intercents in which hospitals, stamil, and architecture. Factors like individual or conditions, the conditions of the condi

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ListenBetter__Progress_Report_Week_7.pdf (632 kB)

Ryan Wahl - Dec 09, 2025, 8:53 PM CST

BME Design: 200, 300, 301, 400 and 402

LictorBetter: Stothoscope with noise canceling headphones (and amplification option)

Client: Dr. Lenaul Markson

Advisor: Prof. Imia William

Team Sylvia Hobit

Moharmord Healtins

Noshilah Lisowski

Kenn Serlogh Ryan Wald.

Problem statement

Problem statement:

A are note consoling bandy here specifically designed to so what the problems that some with multional with suspense for healthcam providers such as noisy or high vibration are intenses in which hospitals, atomit, and architecture. Foreign like individual or conditionals, exceeding the condition of the properties of the content of the condition of the properties. But it is not encapturey until a proposed consocration which was much in incorrect our variable blood pressure random, Additionally, many providers expectates there is one condition due to the proposition of the content of the condition of the other properties are providering of our notation in their properties the chain content in talked with discipling and fiftherings of the relation of the condition of the other properties and in optional output for the facility of the condition of the condition

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ListenBetter__Progress_Report_Week_8.pdf (652 kB)



Ryan Wahl - Dec 09, 2025, 8:54 PM CST

BME Design: 200, 300, 301, 400 and 402

LictorBetter: Stothoscope with noise canceling headphones (and amplification option)

Client: Dr. Lenaul Markson

Advisor: Prof. Imia William

Team Sylvia Hobit

Moharmord Healtins

Noshilah Lisowski

Kenn Serlogh Ryan Wald.

Problem statement

Problem statement:

A are note consoling bandy here specifically designed to so what the problems that some with multional with suspense for healthcam providers such as noisy or high vibration are intenses in which hospitals, atomit, and architecture. Foreign like individual or conditionals, exceeding the condition of the properties of the content of the condition of the properties. But it is not encapturey until a proposed consocration which was much in incorrect our variable blood pressure random, Additionally, many providers expectates there is one condition due to the proposition of the content of the condition of the other properties are providering of our notation in their properties the chain content in talked with discipling and fiftherings of the relation of the condition of the other properties and in optional output for the facility of the condition of the condition

Download

ListenBetter__Progress_Report_Week_9.pdf (658 kB)

Ryan Wahl - Dec 09, 2025, 8:54 PM CST

BME Design: 200, 300, 301, 400 and 402

LictorBetter: Stothoscope with noise canceling headphones (and amplification option)

Date: 11/13/25

Client: Dr. Lenaul Markson

Advisor: Prof. Imia William

Team

Sylvia Hobit Moharmord Healtins

Noshilah Lisowski

Kenn Serlogh Ryan Wald.

Problem statement

Problem statement:

A are note consoling bandy here specifically designed to so what the problems that some with multional with suspense for healthcam providers such as noisy or high vibration are intenses in which hospitals, atomit, and architecture. Foreign like individual or conditionals, exceeding the condition of the properties of the content of the condition of the properties. But it is not encapturey until a proposed consocration which was much in incorrect our variable blood pressure random, Additionally, many providers expectates there is one condition due to the proposition of the content of the condition of the other properties are providering of our notation in their properties the chain content in talked with discipling and fiftherings of the relation of the condition of the other properties and in optional output for the facility of the condition of the condition

Download

ListenBetter__Progress_Report_Week_10.pdf (663 kB)

Ryan Wahl - Dec 09, 2025, 8:54 PM CST

BME Design: 200, 300, 301, 400 and 402

LictorBetter: Stothoscope with noise canceling headphones (and amplification option)

Date: 11/20/25

Client: Dr. Lenaul Markson

Advisor: Prof. Imia William

Team Sylvia Hobit

Moharmord Healtins

Noshilah Lisowski

Kenn Serlogh Ryan Wald.

Problem statement

Problem statement:

A are note consoling bandy here specifically designed to so what the problems that some with multional with suspense for healthcam providers such as noisy or high vibration are intenses in which hospitals, atomit, and architecture. Foreign like individual or conditionals, exceeding the condition of the properties of the content of the condition of the properties. But it is not encapturey until a proposed consocration which was much in incorrect our variable blood pressure random, Additionally, many providers expectates there is one condition due to the proposition of the content of the condition of the other properties are providering of our notation in their properties the chain content in talked with discipling and fiftherings of the relation of the condition of the other properties and in optional output for the facility of the condition of the condition

Download

ListenBetter__Progress_Report_Week_11.pdf (668 kB)

Ryan Wahl - Dec 09, 2025, 8:55 PM CST

BME Design: 200, 300, 301, 400 and 402

LictorBetter: Stothoscope with noise canceling headphones (and amplification option)

Date: 11/23/25

Client: Dr. Lenaul Markson

Advisor: Prof. Imia William

Team

Sylvia Hobit Moharmord Healtins

Noshilah Lisowski

Kenn Serlogh Ryan Wald.

Problem statement

Problem statement:

A are note consoling bandy here specifically designed to so what the problems that some with multional with suspense for healthcam providers such as noisy or high vibration are intenses in which hospitals, atomit, and architecture. Foreign like individual or conditionals, exceeding the condition of the properties of the content of the condition of the properties. But it is not encapturey until a proposed consocration which was much in incorrect our variable blood pressure random, Additionally, many providers expectates there is one condition due to the proposition of the content of the condition of the other properties are providering of our notation in their properties the chain content in talked with discipling and fiftherings of the relation of the condition of the other properties and in optional output for the facility of the condition of the condition

Download

ListenBetter__Progress_Report_Week_12.pdf (677 kB)

Ryan Wahl - Dec 09, 2025, 8:55 PM CST

BME Design: 200, 300, 301, 400 and 402

LictorBetter: Stothoscope with noise canceling headphones (and amplification option)

Date: 124/25

Client: Dr. Lenaul Markson

Advisor: Prof. Imia William

Team Sylvia Hobit

Moharmord Healtins

Noshilah Lisowski

Kenn Serlogh Ryan Wald.

Problem statement

Problem statement:

A are note consoling bandy here specifically designed to so what the problems that some with multional with suspense for healthcam providers such as noisy or high vibration are intenses in which hospitals, atomit, and architecture. Foreign like individual or conditionals, exceeding the condition of the properties of the content of the condition of the properties. But it is not encapturey until a proposed consocration which was much in incorrect our variable blood pressure random, Additionally, many providers expectates there is one condition due to the proposition of the content of the condition of the other properties are providering of our notation in their properties the chain content in talked with discipling and fiftherings of the relation of the condition of the other properties and in optional output for the facility of the condition of the condition

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ListenBetter__Progress_Report_Week_13.pdf (721 kB)

SYLVIA HOLST - Sep 15, 2025, 5:38 PM CDT

Title: Team Meeting 1

Date: 9/12/25

Content by: Sylvia Holst

Present: Kenan, Noah, Ryan, Mohammed, and Sylvia

Goals: The goal of this meeting was to figure out what we could research for our project and what we could do for our

design. We also met with the professor to discuss the project, as well as upcoming deadlines.

Content:

Conclusions/action items:



SYLVIA HOLST - Sep 15, 2025, 5:38 PM CDT

Title: Team Meeting 2

Date: 9/15/25

Content by: Sylvia Holst

Present: Kenan, Noah, Ryan, Mohammed, and Sylvia

Goals: The goal of this meeting is to work on the PDS and brainstorm ideas for the design.

Content:

PDS: https://docs.google.com/document/d/1Bmxr7hhn-hsxxZ0ozP5MjtawwWrO0xE_xnVRzeyeobo/edit?tab=t.0

Conclusions/action items:

We were unable to meet with our client again to discuss parameters and specifications for the project, so we will email our draft of the PDS to him so that he may provide input. We will also try to schedule another meeting with him.

SYLVIA HOLST - Sep 19, 2025, 1:35 PM CDT

Title: Team Meeting 3

Date: 9/19/25

Content by: Sylvia Holst

Present: Kenan, Noah, Ryan, Mohammed, and Sylvia

Goals: The goal of this meeting is to brainstorm and develop ideas for the design matrix.

Content:

Conclusions/action items:

SYLVIA HOLST - Oct 06, 2025, 5:13 PM CDT

Title: Team Meeting 4

Date: 10/2/25

Content by: Sylvia Holst

Present: Kenan, Noah, Ryan, Mohammed, and Sylvia

Goals: The goal of this meeting is to practice our preliminary design presentation.

Content:

We practiced our presentation as a team to make sure we each spoke for an appropriate amount of time and that we were prepared and confident in presenting. We made some modifications to our slides so they didn't have too many words on them. Noah created CAD model in Onshape for each design.

Conclusions/action items:

We will each practice more individually so that we don't go over our allotted presenting time and so that everyone presents well.

SYLVIA HOLST - Oct 23, 2025, 11:34 AM CDT

Title: Team Meeting 5

Date: 10/17/25

Content by: Sylvia Holst

Present: Kenan, Mohammed, Noah, Ryan, and Sylvia

Goals: The goal of this meeting is to figure out what ANC chip we could buy, and work on understanding how the chip will be integrated into the prototype itself.

Content:

The team discussed some potential ANC chip options for purchase. We also met with John Lombardo to consult him about fabrication since most of the team has minimal experience in building electronics from scratch. He gave us some good advice, explaining that we could use LTspice to construct a readable circuit diagram. He also agreed that we could consult him more in the future as we continue to make progress. The team also considered what we would have done for the informal Q and A on October 31st. We decided that we would fabricate the ear cups. Noah said that he could model them in Onshape, and then we could 3D print them and insulate them with a sound absorbing material that we have yet to decide on.

Conclusions/action items:

The team will produce a circuit schematic and fabricate a tangible part of the prototype (ear cups) for 10/31.

Ryan Wahl - Dec 10, 2025, 6:35 PM CST

Title: Team Meeting 6

Date: 10/20/25

Content by: Sylvia Holst

Present: Kenan, Mohammed, and Sylvia

Goals: The goal of this meeting is to figure out what ANC chip we could buy, and work on understanding how the chip will be integrated into the prototype itself.

Content:

The team discussed how the ANC chip would work and the process that may be required to successfully integrate it into the prototype once we begin fabrication. We also discussed what the actual circuit might look like. Mohammed used LTspice to construct a circuit schematic.

Conclusions/action items: Further research ANC technology and get help from John at the Makerspace.

Ryan Wahl - Dec 10, 2025, 6:38 PM CST

Title: Team Meeting - Assembly

Date: 11/17/25

Content by: Ryan Wahl/Team

Present: Ryan, Mohammed, Kenan, Sylvia

Goals: Try to put together our electronic system for our stethoscope

Content: Microphone worked but was super crackly and not very functional.

Dr. Williams suggested during team meeting to just solder everything together and this should form better connections.

Conclusions/action items: Solder together our electric circuit

Note: The next several team meetings were fabrication meetings and can be found in the fabrication folder named after the part being fabricated that meeting.

10/6/2025 Research On Main Competing Designs

KENAN SARLIOGLU - Oct 16, 2025, 9:29 PM CDT

Title: Research On Main Competing Designs

Date: 10/14/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Figure out the main competing designs for electronic stethscope.

Content:

Existing Devices/Current Methods



Figure 1: Eko CORE 500™ Digital Stethoscope

The Eko Core 500 Digital Stethoscope pictured in Figure 1 is one of the most advanced electronic stethoscopes available in the market. This design uses a digital sound transmission through the ear tip speakers with active noise control rather than a hollow acoustic tube. It also has bluetooth connectivity which allows it to pair with wireless earbuds or hearing aids making it partially compatible with the clients over the ear specification. The Eko Core 500 also includes an Al-assisted murmur detection which can help improve diagnostic accuracy even if the clinician doesn't properly hear the sounds in either clinic or emergency transport environments satisfying the clients request perfectly. However, this design is still not over the ear which could cause ear fatigue in health professionals. Additionally this design is very expensive coming in at \$434.99 which is around \$300 more expensive than the budget the client would allow for a stethoscope that would have the same function [1].



Figure 2: 3M Littmann CORE Digital Stethoscope

The 3M Littman Core digital Stethoscope in figure 2 combines a traditional chestpiece design with digital noise amplification up to 40x which would give it a clean acoustic sounding performance. This device also has active noise cancellation which is a good touch because it would be able to work in noisy environments such as emergency transport environments. This stethoscope is unique since it is able to readily switch from acoustic to digital with a toggle switch that would let users go between modes which is great in the clinic but not necessarily a function that the client would need. Lastly, this stethoscope is \$349.99 which exceeds the clients budget by around \$200 which is not optimal [2].



Figure 3: Adscope 658 Electronic Stethoscope

The ADC Adscope 658 Electronic Stethoscope shown in Figure X focuses on noise filtration by using a contact activated piezopolymer microphone that minimizes background interference and amplifies the body sounds to a maximum of 18x. It is also more durable than most stethoscope models because it uses rugged thermoplastic housing and stainless steel earbuds. The

device also has a rechargeable battery that can perform around 400 exams per charge which is great for longevity since it can go for multiple days without charging. This electronic stethoscope does not feature any noise canceling specific features like ANC which does not align with what the client wants and the cost is also \$475 which is around \$325 more than the clients budget which makes this design not ideal [3].

References:

[1]"Eko Health | CORE 500TM Digital Stethoscope," Eko Health, 2025. https://www.ekohealth.com/products/core-500-digital-stethoscope?srsltid=AfmBOoqewJAQbJMEnylVH25LHWEHC4T4XYs_caQHzV8XlwOlcn75i_G-&variant=39999867879520 (accessed Oct. 09, 2025).

[2]"3MTM Littmann® CORE Digital Stethoscope | Littmann," Littmann.com, 2024. https://www.littmann.com/en-us/home/f/b5005222000/

[3]"ADC Adscope 658 Electronic Stethoscope for sale at Dr's Toy Store," Dr's Toy Store, 2015. https://www.drstoystore.com/product/adc-adscope-658-electronic-scope/?srsltid=AfmBOor-NsH0p1gTVwyp86fl54BFNEH5YAdiri5k917zPbSRoigEzML5 (accessed Oct. 09, 2025).

Conclusions/action items: Existing digital stethoscopes include key ANC technology. All current devices exceed the client's budget specification. None of the existing devices fully meet the client's over-the-ear headset form factor.

9/12/2025 Bone conduction in Stethascope Research

KENAN SARLIOGLU - Sep 12, 2025, 11:48 AM CDT

Title: Bone conduction in Stethoscope Research

Date: 9/12/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: To understand the feasibility of integrating bone conduction technology into a digital stethoscope system to enhance auscultation in noisy environments and improve provider comfort.

Content:

Background

Traditional stethoscopes rely on air conduction through earpieces inserted into the ear canal. However, auscultation is often limited by:

- Environmental noise interference in helicopters, airplanes, or emergency settings.
- Ear canal sensitivity and irritation from prolonged earpiece use.
- User variability in ear canal anatomy and stethoscope positioning, which can result in inconsistent readings.

Bone conduction (BC) bypasses the external and middle ear, transmitting sound vibrations directly to the cochlea via cranial bones. This approach has proven effective in hearing rehabilitation and is increasingly used in both implantable bone-anchored hearing aids (BAHA) and consumer bone conduction headphones.

NASA recently evaluated bone conduction headsets for the xEMU spacesuit, confirming their long-duration comfort, feasibility in high-noise environments, and potential to replace bulkier traditional audio systems

Their findings parallel the challenges in medical auscultation—comfort, fidelity, and noise reduction are critical.

Hypothesis: By combining a chestpiece microphone, bone conduction transducers, and optional active/passive noise cancelation, auscultatory signals can be delivered effectively to providers without requiring in-ear contact.

Methods

Materials

- Sensors: Electret condenser microphone, piezoelectric stethoscope microphone.
- Amplification: LM386 analog amplifier, MAX98357A class D amplifier.
- Bone Conduction Transducers: Off-the-shelf 16–20 mm disc drivers (Shokz/OpenComm salvaged units for comparison).
- DSP Platform: Arduino Due (real-time filtering), Raspberry Pi 4 (advanced DSP, bandpass filtering).
- Noise Sources: Helicopter/aircraft noise recordings (70–95 dB SPL).

• Reference Device: Littmann Classic III stethoscope for baseline comparison.

Procedures

- 1. Baseline Recording: Capture heart (20–200 Hz) and lung (100–600 Hz) sounds using standard and digital stethoscopes.
- 2. BC Transmission Testing: Drive transducers at mastoid/condyle placement sites. Record user perception of clarity.
- 3. Noise Simulation: Playback auscultatory sounds under 80-95 dB noise; compare clarity via BC vs. air conduction.
- 4. Frequency Response Analysis: Measure low-frequency attenuation in BC pathway. Apply DSP bandpass filters to enhance critical ranges.
- 5. User Comfort Study: Testers wear prototypes for 2–4 hours. Record pinch points, comfort scores, and qualitative feedback following NASA's human-in-the-loop evaluation protocols ICES_final_manuscript_Cavanaugh...

Results (Planned/Expected) Signal fidelity just means how true the sound or signal is to the original. BC = bone conductor

- Signal Fidelity: BC transducers expected to attenuate lowest frequencies (<50 Hz), but amplification and filtering may restore clinical usability.
- Noise Immunity: BC stethoscope performance should improve relative to standard earpieces in simulated high-noise conditions.
- Comfort: BC avoids canal irritation; long-duration wear feasibility aligns with NASA headset testing.
- Diagnostic Accuracy: Anticipated non-inferior recognition of S1/S2 and lung crackles compared to control stethoscopes.
 - S1 ("lub") \rightarrow the first heart sound, caused by closure of the atrioventricular valves (mitral + tricuspid) at the start of systole. S2 ("dub") \rightarrow the second heart sound, caused by closure of the semilunar valves (aortic + pulmonary) at the end of systole, start of diastole.

Discussion

Findings from implantable BC research indicate that transducer placement, static force (~2–5 N), and transmission pathway critically impact fidelity.

Although skin-drive BC attenuates high frequencies, clinical studies show functional improvement when paired with amplification and optimized coupling. For auscultation, the greater challenge will be preserving low-frequency fidelity, which is weaker in BC pathways.

NASA's research further validates that BC is ergonomically viable for professional use in extreme environments. Their emphasis on comfort, fit, and protrusion translates directly to the clinical context, where providers must wear headgear for extended shifts without discomfort or interference.

Thus, integrating noise cancellation + BC delivery into a stethoscope is both feasible and novel. It directly addresses provider comfort and diagnostic reliability in noisy environments, filling a gap in existing stethoscope design.

Next Steps

- 1. Build prototype (chestpiece microphone → amplifier → BC driver).
- 2. Conduct initial user tests under quiet and noisy conditions.
- 3. Optimize DSP for frequency-specific amplification.
- 4. Perform comparative study: traditional vs BC stethoscope diagnostic accuracy.

Takeaway:

A bone conduction (BC) stethoscope could solve three big problems with traditional stethoscopes — background noise, ear canal discomfort, and inconsistent fit. BC works by sending vibrations straight to the inner ear through the skull, bypassing the ear canal. NASA has already shown that BC headsets are comfortable and reliable in noisy, high-stress environments, and research suggests that with some amplification and filtering, the sound quality (signal fidelity) can be good enough for accurate diagnosis.

References:

[1] S. Reinfeldt, B. Håkansson, H. Taghavi, and M. Eeg-Olofsson, "New developments in bone-conduction hearing implants: a review," Medical Devices: Evidence and Research, vol. 8, pp. 79–93, 2015, doi: 10.2147/MDER.S39691. https://ntrs.nasa.gov/api/citations/20240005885/downloads/ICES_final_manuscript_Cavanaugh.pdf

[2] B. Cavanaugh, "Bone conduction headphone research and testing for xEMU communications applications," in Proc. 53rd Int. Conf. Environ. Syst. (ICES-2024-209), Louisville, KY, USA, Jul. 2024.

https://www.tandfonline.com/doi/epdf/10.2147/MDER.S39691?needAccess=true

Conclusions/action items: This project will move forward by developing a prototype stethoscope that integrates bone conduction drivers with noise cancelation to improve auscultation clarity and provider comfort. Initial testing will focus on capturing heart and lung sounds, evaluating bone conduction fidelity under noisy conditions, and refining DSP amplification for low-frequency preservation. Following prototype validation, the team will document results for a potential WARF submission and prepare for larger-scale usability studies.

KENAN SARLIOGLU - Sep 12, 2025, 11:35 AM CDT

Title: Comparing Acoustic and Electronic Stethoscopes for Enhanced Auscultation

Date: 9/12/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: To compare performance of acoustic and electronic stethoscopes with the goal of identifying design strategies for a next-generation stethoscope that integrates noise cancelation and bone conduction to improve diagnostic clarity and provider comfort.

Content:

Background

The acoustic stethoscope has remained the dominant auscultation tool for over a century due to its simplicity, and ease of use. However, acoustic transmission suffers from tubular resonance, reduction at higher frequencies, and lack of amplification, which limits its effectiveness in noisy or challenging environments.

The electronic stethoscope addresses some of these limitations by amplifying body sounds, offering digital filtering, and enabling computer-aided analysis. Yet, drawbacks include sensitivity to noise while in contact, susceptibility to ambient noise, and ergonomic issues.

Emerging research highlights the potential of computer-aided auscultation using electronic stethoscopes paired with digital signal processing (DSP), noise reduction algorithms, and machine learning classifiers. This could support objective diagnosis of murmurs, S3/S4 sounds, and valve pathologies a major advancement over traditional auscultation

Methods (Planned)

1. Acoustic Stethoscope Evaluation:

- Record and analyze frequency response, attenuation, and user ratings for heart and lung sounds.
- Reference models: Littmann Cardiology II, Harvey Elite, Rappaport-Sprague (as in Grenier et al.).

2. Electronic Stethoscope Evaluation:

- Assess amplification, noise handling, and DSP capabilities.
- Reference models: Labtron, EST40, Starkey ST3 (Grenier study), plus newer MEMS microphonebased devices reviewed by Leng et al.

3. User Feedback:

- Clinician surveys on sound clarity, ergonomics, comfort, and ambient noise isolation.
- Comparison of auscultation accuracy in simulated noisy conditions (70–90 dB).

Results (Expected Based on Literature)

- Acoustic stethoscopes were preferred 71% of the time in clinical trials (p < 0.0001), especially for cardiovascular auscultation, due to more natural sound quality and lower susceptibility to electronic noise
- Electronic stethoscopes offered significant advantages in amplification and digital recording, but their utility was diminished by handling artifacts and lack of standardized filtering
- Modern electronic stethoscopes with DSP and MEMS sensors can mitigate noise, segment heart cycles, and classify pathologic murmurs with >90% accuracy using machine learning approaches

The comparison reveals that while acoustic stethoscopes remain favored by clinicians for reliability, the next generation of electronic stethoscopes shows promise when integrated with advanced DSP and noise cancellation. For our project, the key insight is that a hybrid approach preserving the natural fidelity of acoustic auscultation while layering electronic amplification, filtering, and potential bone conduction delivery could overcome current limitations.

This aligns directly with our project objective to develop a noise-canceling, bone conduction—based stethoscope that maintains diagnostic integrity even in noisy environments such as helicopters, airplanes, or crowded wards.

References:

[1]S. Leng, R. S. Tan, K. T. C. Chai, C. Wang, D. Ghista, and L. Zhong, "The electronic stethoscope," BioMedical Engineering OnLine, vol. 14, no. 1, Jul. 2015, doi: https://doi.org/10.1186/s12938-015-0056-y

[2]M.-C. Grenier, K. Gagnon, J. Genest, J. Durand, and L.-G. Durand, "Clinical Comparison of Acoustic and Electronic Stethoscopes and Design of a New Electronic Stethoscope," The American Journal of Cardiology, vol. 81, no. 5, pp. 653–656, Mar. 1998, doi: https://doi.org/10.1016/s0002-9149(97)00977-6

Conclusions/action items:

KENAN SARLIOGLU - Oct 02, 2025, 6:29 PM CDT

Title: Noise Canceling Applications to Electronic Stethoscopes and Headphones.

Date: 9/19/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Figure out a way to integrate noise cancelling headphones into the electronic stethoscope

Content:

Background

- **ANC Principle:** A microphone inside the ear cup measures incoming noise. The system processes this signal and generates an opposite-phase anti-noise waveform, reducing perceived noise at the ear.
- **Digital Feedback ANC:** Instead of predicting incoming noise, feedback ANC cancels noise that has already entered the headphone. This is more robust against unpredictable or diffuse sound fields.
- Challenge: Latency from digital-to-analog conversion and signal processing limits ANC bandwidth. Prediction filters are used to overcome this by estimating future noise samples.

Design Integration

In our electronic stethoscope design (see system diagram from prior entry):

- 1. Primary Microphone (Chestpiece): Captures biological sounds (heart/lung).
- 2. Pre-amp & Variable Gain: Amplifies signal for clarity.
- 3. **Headphone Output:** Uses over-ear headphones to deliver sound to the user.
- 4. ANC Headphones: Can include built-in error microphones to cancel external noise, improving listening accuracy.

By combining **biological signal amplification** with **ANC-driven environmental noise suppression**, the stethoscope can operate in settings where traditional models fail.

Key Findings from Literature (IET Signal Process., 2013)

1. Prediction Filters:

- Adaptive filters (e.g., LMS) adjust in real time but require high computational cost.
- Fixed prediction filters based on passive ear-cup attenuation are simpler and stable.

2. Performance:

- · ANC is most effective between 200-600 Hz, where ambulance and helicopter noise is strongest.
- Frequencies below 100 Hz are harder to cancel, but passive ear-cup damping helps.

3. Experimental Data:

- Group delay from digital conversion is about 100 μs, requiring prediction to maintain ANC effectiveness.
- Measured results show ANC bandwidth improvements up to **1.5 kHz**, sufficient for stethoscope use.

4. Robustness:

 ANC performance is stable even under varying headphone fit conditions, as long as prediction filters are properly tuned.

Fabrication/Implementation Plan

1. Headphone Selection:

- Use over-ear ANC headphones with built-in microphones.
- Ensure compatibility with stethoscope amplifier output.

2. Integration:

- Route biological sound through low-noise amplification chain.
- Deliver final signal into headphone speakers, while ANC module independently cancels ambient noise.

3. Testing Protocols:

- Simulate noisy environments (ambulance sirens, rotor noise).
- Record user ability to discern heart/lung sounds with and without ANC.
- Compare performance against non-ANC stethoscope design.

References:

[1]M. Guldenschuh and R. Höldrich, "Prediction filter design for active noise cancellation headphones," *IET Signal Processing*, vol. 7, no. 6, pp. 497–504, Aug. 2013, doi: https://doi.org/10.1049/iet-spr.2012.0161.

Conclusions/action items: Active noise cancellation can help to improve the usability of electronic stethoscopes in noisy environments. By using the ANC headphone technology, clinicians can properly hear biological signals more clearly without the risk of increasing volume levels which would increase fatigue and worsen diagnostic accuracy. The next step will be prototyping with ANC-enabled headphones and running bench and field tests to quantify improvements.



9/25/2025 Acoustic Stethoscope Design Research

KENAN SARLIOGLU - Sep 26, 2025, 2:28 PM CDT

Title: Acoustic Stethoscope Design Research

Date: 9/25/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Analyze what makes a components make for a listening experience for the acoustic stethoscope design.

Content:

Conclusions/action items:

10/1/2025 The Electronic Stethoscope Research

KENAN SARLIOGLU - Oct 02, 2025, 6:13 PM CDT

KENAN SARLIOGLU - Oct 02, 2025, 6:26 PM CDT

Title: The Electronic Stethoscope Research

Date: 10/2/2025

Content by: Kenan S

Present: n/a

Goals: Figure out the electrical mechanism and fabrication of an electric stethoscope variant.

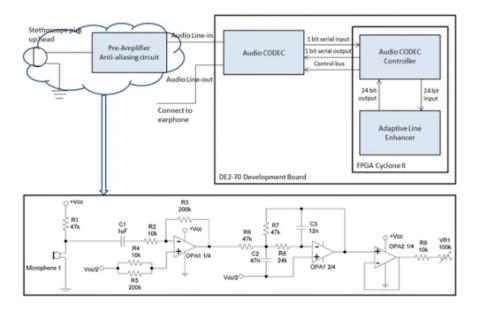
Content:

Electronic stethoscopes detect heart sounds through MEMS capacitive sensors, which convert diaphragm vibrations caused by acoustic pressure into electrical signals. These signals are amplified, filtered, and digitized for clinical use or Al-based analysis.

The electrical pathway is:

MEMS Sensor → Pre-Amplifier (OPA134) → Low-Pass Filter (~2 kHz) → Audio CODEC → Microcontroller/FPGA

This setup boosts weak biological signals, removes high-frequency noise, and enables digital recording or real-time playback.



This figure illustrates the complete signal pathway and circuitry behind an electronic stethoscope. The system converts mechanical heart sounds into electrical signals through a microphone, amplifies and filters the signal to remove noise, and then digitizes it for further processing on an FPGA board. The circuit's design ensures that even faint biological sounds are captured accurately and reproduced with minimal distortion.

Key Points:

Microphone (Sensor): Detects acoustic vibrations from the chest and converts them into a small voltage signal.

Pre-Amplifier Circuit: Built using OPA134 and OPA124 op-amps; boosts the weak signal and removes high-frequency noise through low-pass filtering (~2 kHz cutoff).

Feedback Resistors and Capacitors: Control amplification gain and determine the circuit's frequency response.

Audio CODEC: Converts the amplified analog signal into a high-resolution (24-bit) digital signal for processing and playback.

FPGA Cyclone II: Hosts the Audio CODEC controller and adaptive line enhancer for digital noise suppression and real-time processing.

Audio Output: Cleaned, amplified signal is sent to earphones or a computer interface for listening or diagnostic recording.

Overall Function: Provides a stable, low-noise, and high-fidelity pathway from biological heart sounds to a digital output suitable for medical or research applications.

Conclusions/action items: In conclusion, this circuit effectively transforms weak heart sounds into clear digital signals through amplification, filtering, and noise reduction. The combination of op-amps, an audio CODEC, and FPGA processing ensures high signal quality and real-time performance. Overall, the design provides a reliable foundation for accurate and clinically useful electronic stethoscope systems.

KENAN SARLIOGLU - Oct 02, 2025, 6:29 PM CDT

The electronic stethoscope

Grand Language Company of the Company

Download

s12938-015-0056-y_1_.pdf (3.52 MB)

10/10/2025 Adaptive Feedforward Control for Active Noise Cancellation In-Ear Headphones

KENAN SARLIOGLU - Oct 16, 2025, 9:31 PM CDT

Title: Adaptive feedforward control for active noise cancellation in-ear headphones

Date: 10/7/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Figure out the specific ANC components needed for fabrication.

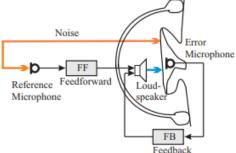
Content:

Overview of ANC Principles

- ANC Mechanism: ANC uses microphones to capture noise and then generates an "anti-noise" signal to cancel out the disturbance via the speaker.
 - Feedback Control: Uses an error microphone *inside* the headphone to pick up the residual noise, which is then fed back and filtered to control the loudspeaker output.
 - Feedforward Control: Uses a reference microphone *outside* the headphone to capture the disturbing noise, filters it, and feeds it forward to the loudspeaker.
 - Combined Control: Headphone systems may use both feedback and feedforward control strategies simultaneously .

Limitations of Static ANC Filters

- Static filters (filters with fixed parameters) normally used in in-ear noise-canceling headphones exhibit large variances in attenuation depending on the user.
- This variability is largely due to inter-subject variability (differences between users), particularly in:
 - Ear geometries.
 - How the headphone fits into the ear canal.
 - These differences affect the secondary path the transfer function from the anti-noise output to the error microphone), which significantly influences the optimal filter and limits the effectiveness of static filters.
- A static filter designed to achieve the best average attenuation across subjects cannot match the
 performance of adaptive controls for individual users (demonstrated by the single dotted red line vs. multiple



black lines in Figure 4).

Figure 1:Combined feedback and

feedforward control of supra-aural headphones.

This figure shows a hybrid active noise control system that uses both feedforward and feedback control. The reference microphone picks up outside noise and sends it to the feedforward controller, which creates an opposite sound to cancel the noise. The loudspeaker plays this anti-noise inside the ear. The error microphone then measures any leftover noise, and the feedback controller adjusts the system to make the cancellation better. This setup helps reduce noise more effectively in headphones or similar devices.

Advantages of Adaptive ANC Control

Adaptive Control (specifically adaptive feedforward control) automatically adjusts the noise-cancellation filter parameters to the user and the changing noise conditions.

Mechanism (FxLMS): The control uses the Filtered-Reference Least-Mean-Square (FxLMS) algorithm to calculate the optimal filter coefficients

Key Benefits:

Compensation for User Differences: It automatically adjusts for interpersonal differences (ear geometry, fit) by calculating an optimal filter for *every* subject, leading to much better attenuation than static filters. Adaptation to Noise: It finds the optimal filter for every kind of outside noise, not just for predesigned ones. Improved Performance: Adaptive filters achieve much better attenuation than static filters. User Friendly: It eliminates the need for manual adaptation of the headphone to the user. Semi-Adaptive Systems: Digital semi-adaptive headphones, with adjustable parameters, can compensate for *some* interpersonal differences and offer different filters for different noise spectra, but are less effective than fully adaptive systems.

References:

[1] S. Priese, C. Bruhnken, D. Voss, PeissigJ., and E. Reithmeier, "Adaptive feedforward control for active noise cancellation in-ear headphones," *Proceedings of Meetings on Acoustics*, pp. 040004–040004, 2013, doi: https://doi.org/10.1121/1.4792245.

Conclusions/action items:

Adaptive ANC is required because static filters fail to account for individual user differences like ear geometry. The FxLMS algorithm is the necessary mechanism for dynamically adjusting the noise cancellation filter in real time. Therefore, the headset design must incorporate a fully adaptive, digital ANC system for optimal performance.



Download

pma.v18.i1.040004_1.online.pdf (776 kB)

10/15/2025 Active Noise Control in The New Century: The Role and Prospect of Signal Processing

KENAN SARLIOGLU - Oct 16, 2025, 9:18 PM CDT

Title: Active Noise Control in The New Century: The Role and Prospect of Signal Processing

Date: 10/16/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Determine optimal Active Noise Cancellation (ANC) and Digital Signal Processing (DSP) architecture for

electronic stethoscope

Content:

1. ANC Architecture Rationale

The primary goal is to maximize the Signal-to-Noise Ratio (SNR) of the biological sounds received from the electronic stethoscope. Ambient noise (e.g., HVAC, chatter, monitors) must be aggressively cancelled to isolate the heart/lung sounds.

- Selected ANC Method: Adaptive Feedforward Control
 - Reasoning: Feedforward ANC is highly effective for external, predictable noise, which makes up most ambient clinical/hospital environments (low-frequency rumble, fans, steady-state sounds).
 - Mechanism: An Reference Microphone (outside the earcup) captures the external noise x(n). A
 Digital Signal Processor (DSP) uses an adaptive filter to generate an anti-noise signal y(n) which
 is emitted into the ear canal to cancel the primary noise path d(n). A final Error Microphone
 (inside the earcup) measures the residual noise \$e(n)\$ to tune the adaptive filter.
- Key Algorithm: The Filtered-x Least Mean Square (FxLMS) algorithm is the standard choice for adaptive feedforward ANC. It dynamically adjusts the filter coefficients to minimize the error signal e(n), which is crucial for accommodating different user ear geometries and varying external noise environments.

2. Digital Signal Processing (DSP) Requirements

A high-performance Digital Signal Processor (DSP) is essential to handle the complex, real-time audio computations required by a medical ANC headset. First, the system requires high-fidelity Analog-to-Digital and Digital to Analog conversion, necessitating a high-resolution codec (ideally 24-bit) and a high sampling rate to accurately capture and reproduce the subtle, high-frequency components of biological sounds. The ANC core itself demands the real time execution of the Filtered x Least Mean Square algorithm. This means the DSP chip must be optimized for fast Multiply and Accumulate operations to allow for continuous, rapid updates of the filter coefficients for adaptive noise cancellation. Crucially, the system must operate with extremely low latency. If the anti-noise signal is delayed, it will arrive out of phase with the noise, which will actually amplify the background sound instead of cancelling it. Finally, the DSP must be capable of providing robust Signal Enhancement by implementing additional digital filters (like Chebyshev or specialized adaptive filters) on the stethoscope audio feed. This secondary filtering chain is necessary to suppress residual electronic or physiological noise while selectively isolating and amplifying the specific frequency bands corresponding to cardiac and pulmonary sounds.

3. Stethoscope Signal Integration & Processing

The electronic stethoscope signal is the desired signal, and its path must be isolated from the ANC path as much as possible.

- Input: The signal is fed directly into the DSP, bypassing the ANC reference microphone.
- Noise Separation: The DSP must implement an additional signal processing step (e.g., an Adaptive Noise Canceller (ANC) filter on the stethoscope signal itself) to remove *correlated noise* (like body movement artifacts or electronic noise) from the desired biological sounds. Algorithms like NLMS (Normalized Least Mean Square) are applicable here to track and subtract this correlated noise.
- Frequency Isolation: The DSP must use band-pass or band-stop filters to:
 - o Auscultation Mode 1 (Cardiac): Isolate lower frequencies

Auscultation Mode 2 (Pulmonary): Isolate higher frequencies

References:

[1] D. Shi, B. Lam, W.-S. Gan, J. Cheer, and S. J. Elliott, "Active Noise Control in The New Century: The Role and Prospect of Signal Processing," *INTER-NOISE and NOISE-CON Congress and Conference Proceedings*, vol. 268, no. 3, pp. 5141–5151, Nov. 2023, doi: https://doi.org/10.3397/IN_2023_0730.

Conclusions/action items:

KENAN SARLIOGLU - Oct 16, 2025, 9:33 PM CDT

Title: Fabrication Plan Version 1 (Active noise Canceling headset)

Date: 10/16/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Write up and diagram the ANC headset.

Content:

Conclusions/action items:

9/23/2025 Electric Wire Design without ANC Design

KENAN SARLIOGLU - Sep 26, 2025, 11:27 AM CDT

Title: Electric Wire Design without ANC Design

Date: 9/23/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Create a all electric stethoscope design that does not regiure an acoustic stethoscope.

Content:

Overall Design:

This stethoscope is a fully electronic system that utilizes a microphone, amplifiers, and electronic circuitry to pick up and process noise into a pair of headphones. The boxes in the diagram represent electronic components, while the arrows represent wiring connections which would be encased in a flexible tubing to protect wiring and give it a smooth finish.

Components:

1. Primary Microphone (in TPE Acoustic Capsule)

- The microphone is housed inside a thermoplastic elastomer (TPE) acoustic capsule providing an encasing around the microscope that reduces vibration and captures chest sounds clearly.
- This replaces the diaphragm/bell in a traditional stethoscope.

2. Low-Noise Pre-amp (Stage 1)

- The weak electrical signal from the microphone is boosted by a low-noise pre-amplifier.
- "Low-noise" is important because heart and lung sounds are very faint, and you don't want extra static or background noise that can interfere.

3. Variable Gain Controller

- This component lets the user adjust how much the signal is amplified.
- Functionally, it works like a volume control for the stethoscope.

4. Headphone Driver

- This circuit powers the headphones.
- It ensures the amplified sound is clean and strong enough to be heard without distortion.

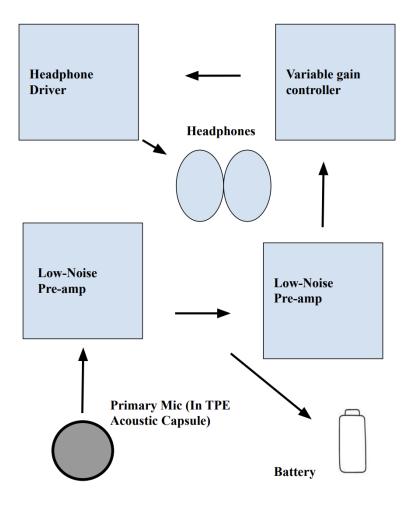
5. Headphones

Over ear headphones (shown in the diagram) receive the sound.

• These could be standard or ANC-equipped, depending on the design choice.

6. Battery

- Powers all the electronics.
- Likely a rechargeable Li-ion battery, depending on space and cost.



Fabrication Plan

1. Microphone Module

- Mount the microphone inside a TPE capsule, shaped similar to a stethoscope chest piece.
- TPE Capsule can be purchased separately or manufactured via a CNC machine.

2. Electronics Assembly

- · Use a printed circuit board (PCB) to mount the pre-amps, gain controller, and headphone driver.
- Choose a low noise op-amps (like TL072 or LM4562) for the amplification.
- Variable gain can be added with a potentiometer or digital volume IC.

3. Wiring and Tubing

- Route wires from the mic capsule through protective flex tubing (imitating stethoscope tubing but carrying signals, not sound).
- This provides a familiar look and keeps the system durable.

4. Battery Integration

• Add a rechargeable battery pack with a simple charging circuit (USB-C recommended).

5. Headphone Connection

• Either use a standard headphone jack or integrate fixed over-ear headphones.

o

Conclusions/action items: This design integrates the best parts of an acoustic stethoscope and transforms it into an electrical varient. It achieves this by taking chest vibrations via a mic in an acoustic capsule and sending them through two low noise pre-amps which are then passed through a variable gain controller, and drives the headphones with a powered circuit. A rechargeable battery is able to power the entire stethoscope making it easy to use and portable.

10/2/2025 Electronic Stethoscope Design #2

KENAN SARLIOGLU - Oct 02, 2025, 9:05 PM CDT

Title: Electronic Stethoscope Design #2

Date: 10/2/2025

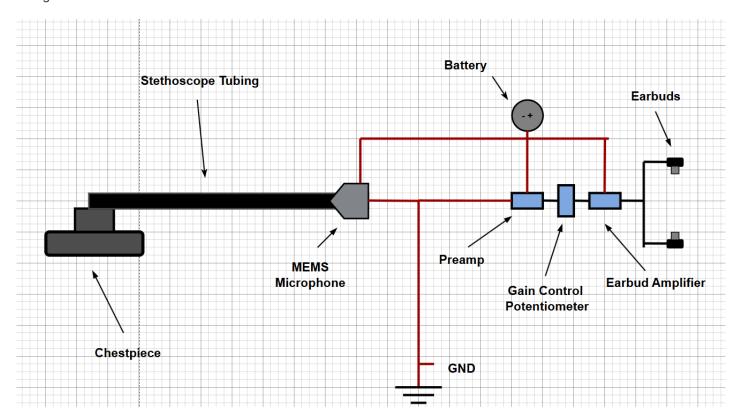
Content by: Kenan Sarlioglu

Present: n/a

Goals: Create an improved Electric Stethoscope Design.

Content:

Design 2 Schematic:



MEMS Microphone Integration:

The MEMS microphone is placed inside the stethoscope tubing close to the chestpiece, where it picks up vibrations from internal body sounds like heartbeats and breathing. MEMS (Micro-Electro-Mechanical Systems) technology is chosen because it is compact, highly sensitive, and well-suited for detecting low-frequency sounds that are important for medical listening.

Preamplifier Stage:

This stage boosts the faint signals coming from the MEMS microphone to a level that can be processed more easily. By using a low-noise op-amp or a dedicated microphone preamp, the system amplifies subtle heart and lung sounds without introducing noticeable background noise. This helps ensure clean and clear audio.

Gain Control Potentiometer:

A variable resistor is included to let users adjust the amplification level. This allows the user to tailor the volume based on the environment, such as a quiet clinic or a noisy ambulance. It also adapts to different patient body types that may affect how well sounds travel.

Earbud Amplifier and Output:

Once the signal is amplified and fine-tuned, it is sent to an earbud amplifier that powers standard headphones or earphones. This keeps the audio strong and free from distortion, giving medical professionals reliable and clear sound through their earbuds.

Battery Power Supply:

A compact battery powers the system, making the stethoscope fully portable and independent from external power. The design is energy-efficient to allow for long periods of use between charges or battery replacements. This is especially useful in mobile or field healthcare situations.

Overall Design Intent:

The goal is to create a lightweight and user-friendly electronic stethoscope that maintains the feel of a traditional one while providing electronic amplification for better sound clarity. This design also opens the door to future features like digital signal processing, Bluetooth connectivity, and heart sound recording to support more advanced diagnostics.

Conclusions/action items: This electronic stethoscope design combines traditional usability with modern amplification to improve diagnostic accuracy. Its portable, low-power setup supports use in various medical environments without sacrificing sound quality. The system also lays a foundation for future enhancements like digital analysis and wireless connectivity.



10/15/2025 UW-Madison Personnel Human Subjects Training

KENAN SARLIOGLU - Oct 15, 2025, 1:51 PM CDT





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UW-Madison_Personnel_Human_Subjects_Training_CITI_Training_completion_.pdf (242 kB)

KENAN SARLIOGLU - Sep 10, 2025, 2:01 PM CDT

Title: Career Prep Lecture Notes

Date: 9/10/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Take down lecture notes about the career prep slides.

Content:

Stephanie Engineering Career Services -

Job Search Tips

Keep track of what you do- Extensive documentation, ECS tracking sheet.

Quality of source matters. (linkedin, indeed, handshake)

Connect before you are a candidaate

Applying is step 1 -follow up (2-3 weeks)

Think skills, industry, exposure.

Resume Tips

Tailor your resume to the position

Create a balanced application - full picture of experience

Make sure to include nuance to resumes to make experiences unique to you

Cover Letter Experiences

Have it based on the job posting and make it custom to each job

Display your greatest selling points while being clear and concise

Demonstrate employer knowledge

Address to person

Recommended vs required

Cover Letter Outline

Outline - BASICS

 Intro: who you are, applying for, where you found it, and "thesis" statement:

Based on my experience in A and B, I believe I would be able to make a difference in the X role at Y company.

- Paragraph all about A
- Paragraph all about B
- Why this employer/role + closing/next steps

Career fair advice (bme)

Look where your experiences that overlaps with other disciplines

Research the employer

Identify the value that you bring

Look for overlapping course work with other common engineering majors

Employer POV in Handshake

Job Role --> Major Groups --> Engineering --> Engineering Disciplines

Engineering Career Fair

Sept. 15-18, 2025 EH Lobby, ME Lobby and ECB Lobby

ENGINEERING CAREER FAIR- *Fall 2025*

September 15, 16, 17, and 18 11:00 am – 5:00 pm

Location: Engineering Campus

Open to all UW Madison students and UW Madison degreed alumni Student ID (wiscard) REQUIRED

See who's attending via <u>Handshake</u>

Conclusions/action items: During this lecture I learned about how to aquire experiences such as summer internships, jobs, research. More specifically I learned tips in how to prepare my resume, how to talk to the recruiter and writing a coverletter. Action items would be to prepare to the Engineering Career Fair 9/15/2025/ to 9/18/2025.

KENAN SARLIOGLU - Sep 17, 2025, 2:03 PM CDT

Title: Leadership Style Lecture

Date: 9/17/2025

Content by: Kenan S

Present: n/a

Goals: Learn how to be a effective leader and mentor for the BME 200 students.

Content:

I feel like I am a 7/10 leader. I prefer to lead when I am knowlegeable about the subject and feel competent to make the important calls and descions.

Important Qualties of a leader - Being a good leader requires you to have good interpersonal/intrapersonal skills, being open minded, effectie communication and knowlege on the topic.

Self-Awareness

Vision

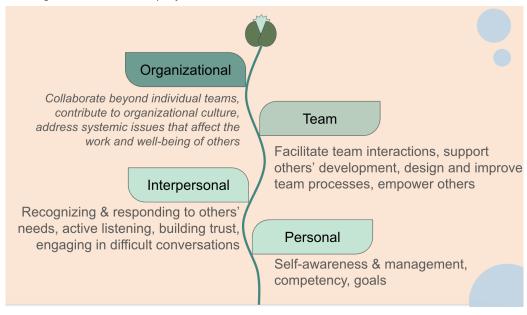
Transparency

Communication

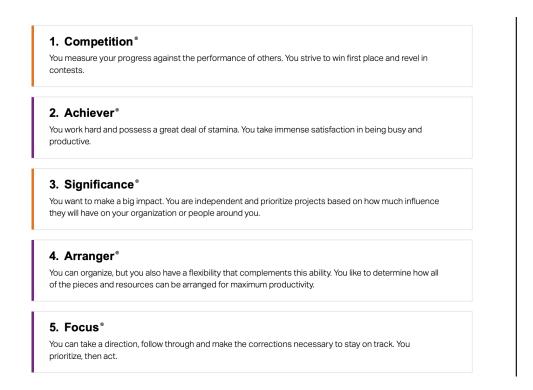
Decision making

Empathy

Leadership can be visualized and practiced at many levels shown below.



My top clifton strengths are as follows:



My CliftonStrengths show that I'm driven, hardworking, and motivated to perform at a high level. I like setting goals, organizing resources, and making an impact through meaningful work. At the same time, I stay focused, flexible, and energized by challenges, which helps me get things done effectively.

Personal leadership goal:

What leadership goal would you like to develop?

1.I'd like to work on becoming a better communicator as a leader. For me, that just means being clearer when I share ideas and making sure I'm actually listening to others too.

How would you practice this skill?

2. I'll practice by being more intentional in team, advisor, and client meetings. Things like asking questions, making sure everyone's on the same page, and just being open with what I say.

What would sucess look like?

3. Success would look like smoother conversations where people leave knowing exactly what's going on. If folks feel comfortable talking with me and trust what I say, I'd know I'm on the right track.

Conclusions/action items:

This leadership lecture showed how important skills like communication, self-awareness, and vision are for becoming a stronger leader. I realized that good leadership isn't about having all the answers but about connecting with people and guiding them in the right direction. Growth in leadership comes from practice and reflection, not overnight changes.

KENAN SARLIOGLU - Sep 24, 2025, 1:48 PM CDT

Title: Kenan Sarlioglu

Date: 9/24/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Understand the why and how to be a better mentor.

Content:

Why are you mentoring BME 200 students?

Answer:

Mentoring BME 200 students because it gives me the chance to help others learn while also sharpening my own communication skills. It's a lot like a real work environment where you might have to train or guide a new intern to the team. I think it's a good way to practice leadership and collaboration in a low stakes setting.

Important Skills attributed to mentoring

- Leadership
- Communication
- Active Listening
- Study practices
- Self awareness
- Interpersonal skills

What does it mean to be a "good mentor"?

Answer: Being a good mentor means being patient and willing to listen. It's about sharing what you know in a way that helps others grow. You guide, but also let them learn on their own.

How to be a good listener:

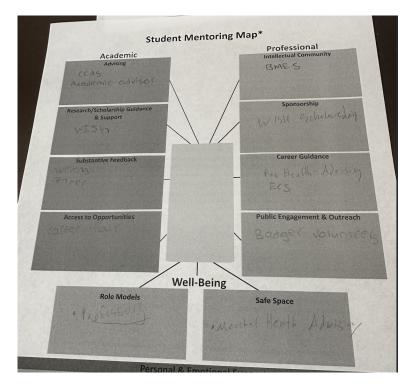
- Get Rid of Distractions
- Stop Talking
- Act Like You're Interested
- Look at the Other Person
- Get the Main Idea

- Ask Questions
- Check for Understanding
- · React to Ideas, Not to the Person
- Avoid Hasty Judgments

What do you wish you knew in bme 200?

I wish I had experience writing the different types of papers like PDS and design matrix before taking bme 200 rather than it being a surprise. I also wish I understood the pacing of the class better from client specifications to prototyping to final report and presentation.

Mentor Map:



I'll share tips I wish I knew in BME 200, like focusing on teamwork and communication, not just grades. I'll check in often with students, answer questions, and let them try things themselves while guiding when needed. This way it feels like real work, where you help train newcomers but also give them space to grow.

Conclusions/action items:

From mentoring, I learned how important patience, clear communication, and teamwork are when helping others. I realized BME 200 is less about assignments and more about practicing real-world skills like leadership and collaboration. Overall, mentoring showed me how guiding others also helps me grow.

10/1/2025 Sustainability in BME Lecture Notes

KENAN SARLIOGLU - Oct 01, 2025, 1:59 PM CDT

Title: Sustainability in BME Lecture Notes

Date: 10/1/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Better understand how we can reuse byproduct and other materials and understanding sustainability in the context of BME.

Content:

Sustainability defined - The natrual enviorement that we have now that fuel all of our societal processes should be well kept and maintained so it can be reused for future generations.

Sustainability 3 Cornerstones

- 1. Environment- represents ecological health, conserving natrual resources and protecting ecosystems are prioritized here.
- 2. Economic Focuses on finiacial and material ensuring that activities are profitable without harming people or the enviorement.
- 3. Human and community well being.

Product life Cycle: Explains the stages a product goes through from creation to disposal.



GHG Emmisions (g CO2e): Representes Green house gas emissions measured in carbon dioxide equivalents.

	Centers for Disease Control and Prevention (CDC) classification system				Food and Drug Administration (FDA) classification system		
Risk level	Category (infection risk) ^a	Contact tissue	Reprocessing requirements ^b	Examples	Category (safety)	Regulatory requirements	Examples
Low	Noncritical	Intact skin	Low-level disinfection (for example, alcohol, bleach, quaternary ammonium)	Stethoscopes, blood pressure cuffs, pulse oximetry probes, laryngoscope handles	Class I	General controls ^c	Bandages, tourniquet cuffs, single-use disposable scissors
Intermediate	Semicritical	Mucous membranes	Intermediate- or high-level disinfection with chemical disinfectants	Endoscopes, laryngoscope tongue blades, vaginal specula	Class II	General controls, performance standards, postmarket surveillance, patient registries, and premarket notification	Ultrasound probes, blood pressure cuffs, bronchoscope biopsy forceps, pulse oximeter sensors, compression sleeves, most laparoscopic equipment
High	Critical	Blood and normally sterile tissues	Sterilization with steam, ethylene oxide, or other chemical sterilants	Surgical instruments, implants, scalpels, needles	Class III	General controls, class III premarket notification, premarket approval	Implanted pumps, intra-aortic balloon pumps, transluminal coronary angioplasty catheters, percutaneou tissue ablation electro

Table compares CDC and FDA classify medical devices based on infection risk and regulatory control.

Conclusions/action items: Through this lecture I learned the sustainability is studied through data backed CO2 equivalent released about certain production processes. Lifetime and material criticality is also important since elements like lithium might be in a shortage soon, so considering different substitutes are important. Lastly, reusing certain materials by recycling like plastics are sometimes not effecient as once thought because of the energy required to reuse materials.



10/8/2025 Introduction to WARF, IP, Disclosing and Licensing.

KENAN SARLIOGLU - Oct 08, 2025, 2:00 PM CDT

KENAN SARLIOGLU - Sep 26, 2025, 2:30 PM CDT

Title: Introduction to WARF, IP, Disclosing and Licensing.

Date: 10/8/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Learn more about intellectual property, WARF and licensing.

Content:

Technology Transfer: Moving research results from campus out into the market. WARF works at this interface to facilitate securing IP rights and commercial licenses.

Examples:

Intellectual property licenses

Industry sponsered research

consulting arrangements

Fee for service

Intellectual Property Overview:

Four common type of IP:

- 1. Patents
- 2. Copyrights
- 3. Trademarks
- 4. Trade secrets

Overview of Non-Patent ID:

Copyrights -> Protection for creative works that are expressed in a tangible medium

Trademarks -> Protection for names, marks, logos, dress, etc.

Trade Secrets -> Can be used to protect anything of value

Patents:

A patent is a property right granted by a governmental agency

- -> USPTO
- -> No such thing as global patent

Three different types of design patents..

- 1. Design (15 year term)
- 2. Plant (20 year term)
- 3. Utility (provisional 1 year.)

Utility Patents: Issued for the invention of a new and useful process machine manufacture or composition of matter.

Requirements for patenting:

- 1. Eligible can't be a product of nature or natrual phenomenon.
- 2. Novel it must be new
- 3. Non-obvious it cannot be a simple modification or combination of existing concempts
- 4. Enabled and described must provide enough detail to teach others how to make or use the invention.

Disclosing an innovation: Describing the innovation, identifying the advantages, the ontributors, funding etc. Also have to meet with WARF to discuss the innovation in detail.

Assesing University Inventions:

WARF bases its descision on accepting an innovation into our porfolio on:

IP Considerations: Type of IP protection

Potential breadth and strength of IP protection

Public disclosure

Stage of development

Marketing and Licensing:

-> Market analysis

Market status

Size and type

Potential Licenses.

Conclusions/action items: This presentation has made me understand WARF at a deeper level and how they move university research into the marketplace by protecting intellectual property and managing patents. Additionally

I learned how to get a patent: invention must be new, non obvious and well described for a chance at approval. An action item could be to identify a component that from our electric stethoscope design that could be submitted to WARF for patent application.

10/15/2025 Valuation of Intellectual Property

KENAN SARLIOGLU - Oct 15, 2025, 2:10 PM CDT

Title: Valuation of Intellectual Property

Date: 10/15/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Learn about careers in intellectual proerpty and learn about litigation.

Content:

Importance of Intellectual Property

- 1. BMEs create solutions to problems
- 2. IP protection allows research to safely transfer into products, and processes.
- 3. Ip enables investment, parternship and ethical competition.

Legal Career Paths for Engineering in IP Technical Advisor

Patent Agent - STEM degree

Patent Examiner - STEM degree + Patent Bar

Patent Atorney - LAW degree + Patent Bar

Patent Litigator- Law Degree (STEM degree + patent bar)

IP License Attorney - Law degree (STEM degree + patent bar)

Tech Transfer Manager- Stem degree

Engineer - STEM degree

Intellectual Property Ownership in the Biomedical Industry

University: Disclose before publicshing university usually owns IP

Company: employer typically owns inventions, trademarks, copyrights and other IP review employee agreements

Startup: you owns IP file early use NDAs document development

Timing and Publication:

Disclose internally first

Publishing before filing and offers for sale = lost patent rights abroad and possible loss of rights in US.

Posters or abstracts can count as public disclosures

Legal and Ethical Duties of Engineers

Respect others IP

Keep invention notebooks

Understand inventorship vs authorship

Maintain confidentiality agreements

What makes and invention patentable?

Novelty - must be new

Non obviousness - more than a routine change

Utility - must work

Enablement - must describe how to make and use

Patents creates a monopoly and stops others from doing anything with the invention. Two types of patents Utility Patents and Design Patents. Patents are especially critical in biomedical engineering, where innovation drives competitive advantage.

Counterfeit Biomedical and Pharma Products

Counterfits threaten patient saftey reputation and business value

The global counterfeit medical products market is worth a lot hence is very dangerous.

Conclusions/action items:

Biomedical engineers make new solutions, and intellectual property protects those ideas so they can become real products. IP encourages fair competition, investment, and jobs like patent agent, attorney, or tech manager. To get a patent, the invention must be new, useful, and not obvious, and engineers must respect others, keep records, and share ideas before publishing.

KENAN SARLIOGLU - Oct 22, 2025, 1:25 PM CDT

KENAN SARLIOGLU - Oct 22, 2025, 1:51 PM CDT

Title: Kenan Sarlioglu

Date: 10/22/2025

Content by: Kenan Sarlioglu

Present: Mohamed

Goals: Learn about careers in BME post graduate.

Content:

Masters is the stepping stones / change directions gain depth /expand creditionals for the future. e.g. preparing for medical school or PhD programs, Industry focused.

Doctoral, PhD Desire to be an independent researcher Write research grants Work in academia Lead projects in industry, startups, and consulting

Reasons Rewrite your story MD: Need time to prep for MCAT or apply for Med Schools PhD: Cannot find a fundeding MS will make you more desirable Fill gaps in your resume Higher level of skills - More lab time with less class time More experiences - teaching, mentoring, research thesis Older, more maturity Really powerful if you add in industry experience

Reasons Opens doors (credentials and experience) Higher starting salary Another opportunity for summer for internships Can co-op during the MS as well (BME 702) Time to find the dream job MS will make you more desirable (ditto)

Research (Typically 1.5-2 yrs) For those continuing on for a PhD here Can be funded as RA/TA/PA (tuition remission and stipend) Thesis required (Must have a lab PI identified & willing to support before applying)

Accelerated Programs (1 year) Funding (TA only) stipend only (no tuition remission \$1200/credit) NO co-op allowed (internship is OK)

Explorer opportunities and interests MEng MS in Global Health MS in other Engineering Dept. (generally takes longer) MBA – generally industry pays for credits or evening options

Explorer opportunities and interests MEng MS in Global Health MS in other Engineering Dept. (generally takes longer)

MBA – generally industry pays for credits or evening options Similar to advice earlier and for PhD programs later Find faculty/labs performing research/work in: Your passion area Area that aligns with your industry interests Less competitive than PhD programs, generally not funded, some admit to MS or PhD programs

Apply early and list names – most do rolling review

Generally >3.5 GPA and 75%ile Quantitative GRE Review process Faculty individually review applications that align with their research

Highly sought after candidates are invited for "Visit Weekends"

NSF GRFP awardees are VERY highly sought after!

Visits are in spring semester (Feb-March)

Tour the department, meet faculty, meet other prospective students Looking for the best fit – both ways

Conclusions/action items: Overall, this lecture was really useful in deciding future education in biomedical engineering but also in other disciplines like medical, or other engineering fields. The 1 year accelerated masters program is a good way to learn and get more experience in a specific discipline in biomedical engineering. Lastly there are ways to get funded like NSF - GRFP or being a TA in the graduate school.

KENAN SARLIOGLU - Oct 29, 2025, 1:57 PM CDT

Title: Regulatory Pathways

Date: 10/29/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Learn about the regulations for medical devices in the U.S. and when it is important to regulate.

Content:

Early pacemakers failed often and unpredictably, which led to repeated emergency surgeries and showed why regulation became necessary.

Those early failures reminded everyone that safety rules usually come after real harm has already happened.

Regulation exists to protect patients, but it can also slow innovation.

Finding the right balance between safety and progress is always a challenge.

Making safe implants is harder than it sounds.

The body corrodes materials, damages electrodes, and exposes flaws that lab tests sometimes miss.

Even when devices look great in small animal studies, they can fail once scaled up in humans.

Key Point: FDA Aware Non-Clinical Safety Testing has Limited Predictivity for Human Use at Scale (IRB, Not So Much)

- Low n chronic animal studies don't identify supply chain issues that occur at scale
- FDA stages clinical trials to limit risk exposure in the large jump from animals to humans
- FDA Staging Risk:
 - Early Feasibility (under 10 patients)
 - Feasibility (under 100)
 - Pivotal (often 200-400 patients)

Kenan Sarlioglu/10/29/2025 125 of 211

Conclusions/action items: Regulation protects patients from unsafe devices and prevents the mistakes seen in early implants. Making safe medical devices is difficult because the body is unpredictable and tough on materials. The goal is to find balance so safety is ensured without slowing down progress.

KENAN SARLIOGLU - Nov 05, 2025, 2:08 PM CST

KENAN SARLIOGLU - Nov 05, 2025, 2:14 PM CST

Title: Regulatory Strategy

Date: 11/5/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Learn the rules and structure of the FDA and understand how this impacts product development.

Content:

The FDA creates laws and guidance that make sure new therapies are safe and effective.

They also support companies with resources to help them follow these rules.

Devices, drugs, and biologics each follow different approval paths like PMA, NDA, or BLA.

Advanced therapies often mix things like gene delivery and cell therapy.

Products called 351s are highly regulated like drugs, while 361s have fewer rules.

This means 351s take more time and testing before reaching patients.

Each product decision carries safety risks that need careful review.

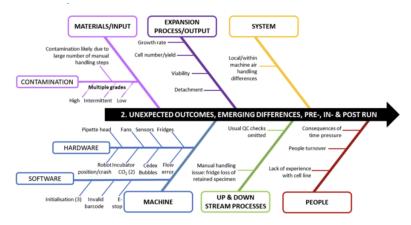
The FDA checks how a product affects the body and if it's used safely.

A Target Product Profile (TPP) is like a roadmap for a therapy.

It defines the drug's purpose, safety, and how it will be used.

Quality means finding what went wrong and improving the next time.

It also includes reducing contamination, improving processes, and training people.



Working in a regulated industry can involve chemistry, manufacturing, and quality control.

Jobs focus on testing, compliance, documentation, and improving product design.

Conclusions/action items: The FDA's regulations make sure new medical products are safe, effective, and reliable. Developing these therapies takes teamwork across science, engineering, and quality control. Overall, understanding regulation helps create safer innovations that improve patient health.

11/7/2025 Tong Lecture Building a Career Impact

KENAN SARLIOGLU - Nov 07, 2025, 12:42 PM CST

Title: Tong Lecture Building a Career Impact

Date: 11/7/2025

Content by: Kenan Sarlioglu

Present: Whole team

Goals: Learn about engineering in healthcare

Content:

Run towards the hard problems they are the ones that change the world.

Foundation: Work towards getting a large breadth of experiences, e.g. jobs and internships/

Climb the growth curve: Combine EQ with IQ to multiply impact and reach.

Build and Transform: Drive system level impact through innovation and scale.

What does great healthcare look like 1. Improved Provider Experience 2. Lower cost of care 3. Improved patient outcome 4. Improved patient experience.

Its complicated to give healthcare since there are >900 insurers.

Underlying challenges: misaligned incentives, fragmented financing and regulation, data silos and inequities.

Healthcare should be an integrated system to enable health and wellness for all.

Take on the hardest projects classes and experiences you can find. Effort and range are your foundation.

Conclusions/action items: Overall this lecture described the complexity in why the issue if adequate and ideal healthcare is more complicated to fix than it looks. There are a lot of different factors like physician incentives, different types of insurances, differeng in clinics throughout the country that make it difficult to fix. Seek diverse exposure to explore different sections teams and geographies.

11/12/2025 Intro to Research and IRB

KENAN SARLIOGLU - Nov 12, 2025, 1:54 PM CST

Title: Intro to Research and IRB

Date: 11/12/2025

Content by: Kenan Sarlioglu

Present: n/a

Goals: Learn a more about research and IRB.

Content:

A lot of older research was unethical and harmed people.

- Tuskegee, Nazi experiments, Guatemala experiments, and Willowbrook are the major examples.
- These studies had no real consent and caused real suffering.

Ethical rules were made to stop this from happening again.

- Nuremberg Code focused on voluntary consent.
- Helsinki Declaration focused on medical research ethics.
- The National Research Act led to the Belmont Report and IRBs.

The Common Rule is the federal rulebook for human research.

- It explains protections, IRBs, and rules for vulnerable groups.
- Updated in 2018 to make things easier.

IRBs have to be diverse.

- They include scientists, non-scientists, and community members.
- This helps make decisions fair and balanced.

The IRB's job is to protect people in studies.

- They use ethical principles, federal rules, and local policies.
- They make sure the study is safe before it starts.

The IRB review process has three parts.

- Administrative check for completeness.
- Pre-review for clarity and rule compliance.
- Committee review for final approval or revisions.

Conclusions/action items: Overall, research with human participants has strict rules to keep people safe and treated fairly. IRBs help make sure every study follows these rules and respects the rights of participants. Ethical guidelines like the Belmont Report are there to remind researchers to stay responsible and do the right thing.

NOAHDIAH LISOWSKI - Oct 09, 2025, 10:04 PM CDT

Title: Wireless Stethoscope Patent

Date: 10/9/25

Content by: Noah

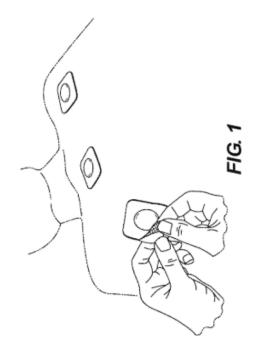
Present: Noah

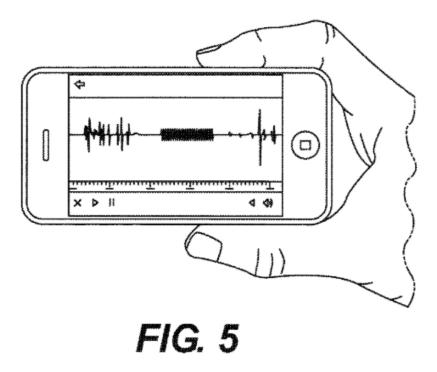
Goals: To see what a competing design looks like in order to make something unique but also facilitate brainstorming

Content:

This patent is for a wireless stethoscope that helps doctors listen to heart, lung, and stomach sounds without using traditional stethoscopes, which can spread germs. Small, disposable sensors are placed on the patient's body to pick up sounds, filter out background noise, and send the sounds wirelessly to a phone, tablet, or other device. The system can also send the sounds to other devices or store them for later. It helps doctors safely and easily monitor multiple patients at once.

This patent could helpful for our product because sending the heart sounds to a device instead of straight to earpieces/headset is not something I had thought of yet and something we could potentially do is record the sounds coming from our stethoscope so that other doctors could hear it as well to get a second opinion. Making our project wireless is something we could also look into by using Bluetooth or something like it.





https://patents.google.com/patent/JP2019162442A/en?q=(bluetooth+stethoscope)&oq=bluetooth+stethoscope

Conclusions/action items:

This patent is about a wireless stethoscope that uses small disposable sensors to listen to body sounds and send them to a phone or tablet instead of headphones. We could also record the sounds to allow for them to be shared with other doctors to help with second opinions. In our project we could also entertain adding recording, sharing, and maybe use Bluetooth to make it wireless too.

NOAHDIAH LISOWSKI - Nov 06, 2025, 6:37 PM CST

Title: Sound Absorption Research

Date: 11/6/25

Content by: Noah

Present: Noah

Goals: To find ways to help block out sound besides ANC

Content:

https://link.springer.com/article/10.1007/s40857-017-0097-4

Key Factors Influencing Sound Absorption

- Bulk Density: Pack it in tighter, and it gets better at soaking up the higher-pitched noises.
- Thickness: The fatter the material, the better it kills low, rumbly sounds.
- Porosity: Stuff with lots of tiny holes and air pockets is good. The sound goes in and gets lost.
- Fiber Diameter: Skinnier, fuzzier fibers are better. They create a crazy maze that sound has to navigate, which wears it out.
- Airflow Resistivity: This is basically how hard it is for air to blow through it. If air has a hard time, sound has a hard time. (Could be used for testing)
- Tortuosity: How twisty and turny the little paths inside are. More twists = more sound getting lost.
- Surface Impedance: If the material's surface feels like air, sound will just go right in. If it feels hard, sound will bounce off.
- Compression: Squishing it usually makes it worse because it gets thinner. Sometimes squishing can help, but mostly it's bad.
- Air Gap: Leave a little space behind it. This is a magic trick for making it better at stopping low booms and bass.
- Multilayers & Combos: Don't just use one thing. Stack different materials like a sandwich to block all kinds of sounds.

Conclusions/action items:

For our design we should keep all of these things in mind. The most important things we should think about when deciding on our extra sound insulation material is how thick how think it is, how easily is can be compressed and make sure to use a combination of materials layered on top of each other. When we test our materials we should test to see how easy airflow gets through because according to the article airflow resistivity and sound absorption are linked.



Acoustic Stethoscope with ANC - CAD Drawing

NOAHDIAH LISOWSKI - Oct 03, 2025, 12:55 AM CDT

Title: Acoustic Stethoscope with ANC - CAD Drawing

Date: 9-25-2025

Content by: Noah

Present: Noah

Goals: Model our acoustic stethoscope design in CAD

Content:





Conclusions/action items:

This model will help us explain our design idea in our design matrix. This will also be used in our preliminary design presentation. Next week I will need to create our other two designs in CAD and complete our preliminary design presentation.



Electric Wire Design without ANC - CAD Drawing

NOAHDIAH LISOWSKI - Oct 03, 2025, 12:55 AM CDT

Title: Electric Wire Design without ANC - CAD Drawing

Date: 10-2-2025

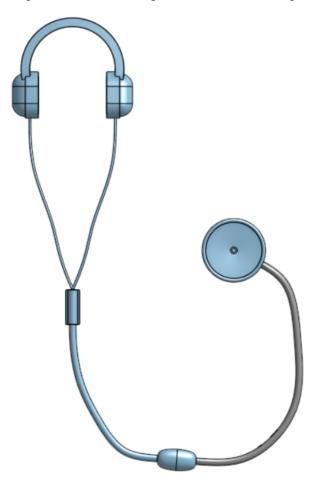
Content by: Noah

Present: Noah

Goals: Model our Electric Wire Design without ANC design in CAD

Content:





Conclusions/action items:

This model also be used in our preliminary design presentation. This model will also be used to explain our ideas to the client easier. Next week I will need to create our other two designs in CAD and complete our preliminary design presentation.

Electric Wire Design with ANC - CAD Drawing

NOAHDIAH LISOWSKI - Oct 24, 2025, 1:24 PM CDT

Title: Electric Wire Design with ANC - CAD Drawing

Date: 10-2-2025

Content by: Noah

Present: Noah

Goals: Model our Electric Wire Design with ANC design in CAD

Content:



Conclusions/action items:

This model also be used in our preliminary design presentation. This model will also be used to explain our ideas to the client easier. Next week I will need to create our other two designs in CAD and complete our preliminary design presentation.

NOAHDIAH LISOWSKI - Oct 24, 2025, 1:22 PM CDT

Title: First Prototype CAD Drawing

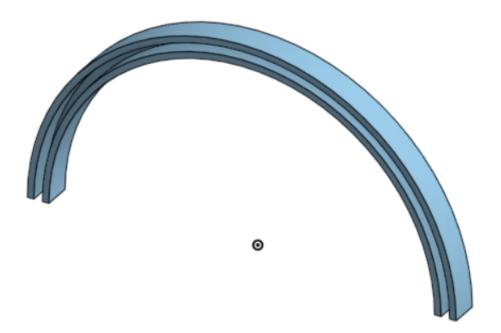
Date: 10-24-2025

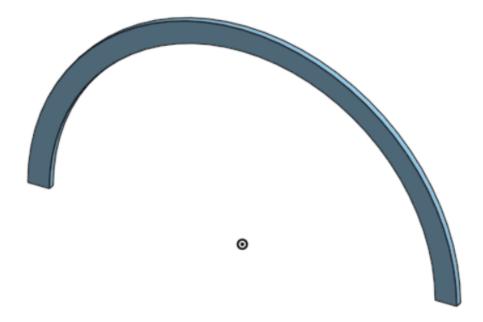
Content by: Noah

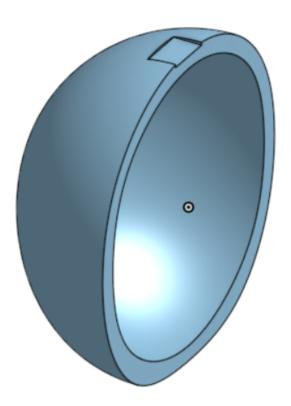
Present: Noah

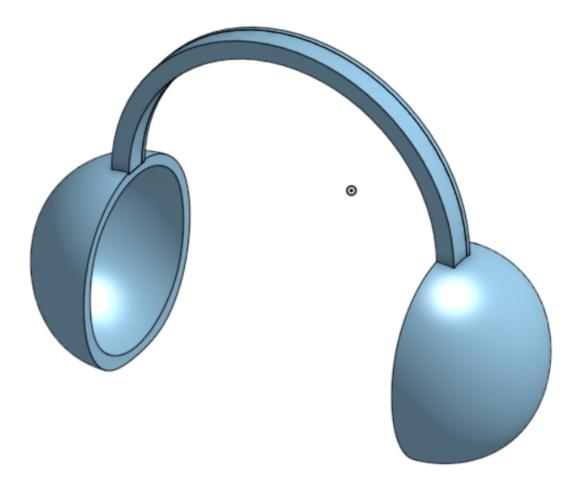
Goals: Create a first prototype for our show and tell

Content:







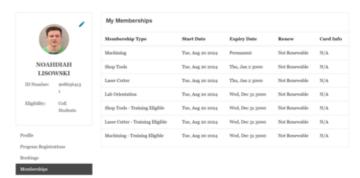


Conclusions/action items:

This CAD drawing will be 3D printed to use during our show and tell

To do: 3D print this design before the show and tell next Friday

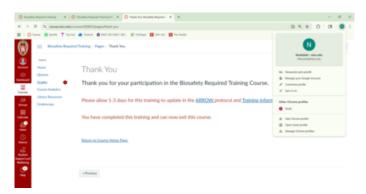
NOAHDIAH LISOWSKI - Oct 31, 2025, 4:07 PM CDT



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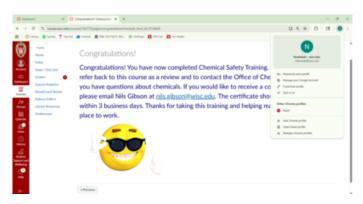
NOAHDIAH LISOWSKI - Oct 31, 2025, 3:59 PM CDT



Download

Screenshot_2025-10-31_150727.png (196 kB)

NOAHDIAH LISOWSKI - Oct 31, 2025, 3:59 PM CDT



Download

Screenshot_2025-10-31_155203.png (335 kB)

SYLVIA HOLST - Sep 18, 2025, 5:15 PM CDT

Title: Noise Cancellation in AirPods

Date: 9/11/25

Content by: Sylvia Holst

Present: N/A

Goals: My goal is to understand how adaptive noise cancellation works in an existing and effective product so that it can be modeled in our own

design.

Content:

https://thegreatestsong.com/airpods-noise-

canceling/#:~:text=Noise%20cancellation%20uses%20microphones%20to,more%20difficult%20to%20cancel%20out.

The Airpods Max employ hybrid ANC with an array of 8 mics placed internally and externally to achieve attenuation. These microphones pick up external sounds. The waveforms of these sounds are inverted and then played back in order to destructively interfere with the original sound picked up by the microphone, effectively cancelling it out. The device responsible for producing the inverted sound waves is called an ANC circuit (chip).

Feedforward ANC

- This method implements a microphone outside the ear cup of the headphones, thereby picking up sound before the user
- The advantage of the Feedforward technique is that it is equally effective on high and low frequencies
- The disadvantage of the Feedforward technique is that it does not account for how the sound travels within the ear canal of the user

Feedback ANC

- This method places the microphone inside the earcup, picking up sound at the same time as the user
- The advantage of this technique is that it takes into account how the sound is traveling in your ear
- The disadvantage of this technique is that it is only effective at attenuating low-frequency noise

Hybrid ANC (best method)

- This method employs the advantages of both the Feedforward ANC technique and the Feedback ANC technique
- Headphones that use Hybrid ANC tend to cost more because they employ more microphones and the ANC circuit or processor needs to be able to compute the extra information from multiple microphones fast enough to produce an effective anti-noise signal
- [1] "AirPods Noise Canceling: All Your Questions Answered." Accessed: Sep. 18, 2025. [Online]. Available: https://thegreatestsong.com/airpods-noise-canceling/

Conclusions/action items:

Similarly to the design we are considering for the stethoscope, the AirPods Max are an over-the-ear style of headset, so hopefully we can use similar technology. I intend to do more research on ANC chips, as well as the anatomy of the inner ear.

SYLVIA HOLST - Sep 18, 2025, 7:48 PM CDT

Title:

Date: 9/15/25

Content by: Sylvia Holst

Present: N/A

Goals: The goal of this research is to understand more about how sound is heard and how it is affected by motion and the environment.

Content:

https://www.sciencedirect.com/science/article/pii/S0003682X25004608?pes=vor&utm source=scopus&getft integrator=scopus

When a person wearing earplugs moves, the earplugs can shift as well.

Waves can propagate through the tissues of the outer ear before indirectly acting on the hearing protection or traveling toward the inner ear.

[1] C. Blondé-Weinmann, S. De Mezzo, J. Wendling-Bandelier, and P. Hamery, "Estimation of acoustic test fixture tilting compensation in front of high-level impulsive sounds," *Applied Acoustics*, vol. 241, p. 110988, Jan. 2026, doi: 10.1016/j.apacoust.2025.110988.

Conclusions/action items:

These issues with earplugs may mean taht the over-the-ear design preferable. We could also maybe use ATFs to test our prototype.

SYLVIA HOLST - Sep 18, 2025, 6:46 PM CDT

Title: Sound Pick-up, Sound Pick-up Equipment, and Noise Eliminating Method (Patent)

Date: 9/18/25

Content by: Sylvia Holst

Present: N/A

Goals: The goal of this research is to understand more about noise cancellation technology.

Content:

https://patents.google.com/patent/CN108574892B/en?q= (noise+cancellation+stethoscope)&oq=noise+cancellation+stethoscope

[1] 栾浩杰, "拾音器、拾音设备及消除噪音的方法," CN108574892B, Apr. 02, 2024 Accessed: Sept. 18, 2025. [Online]. Available: https://patents.google.com/patent/CN108574892B/en?q= (noise+cancellation+stethoscope)&oq=noise+cancellation+stethoscope

SYLVIA HOLST - Sep 18, 2025, 7:15 PM CDT

Title: Telemedical Stethoscope (Patent)

Date: 9/18/25

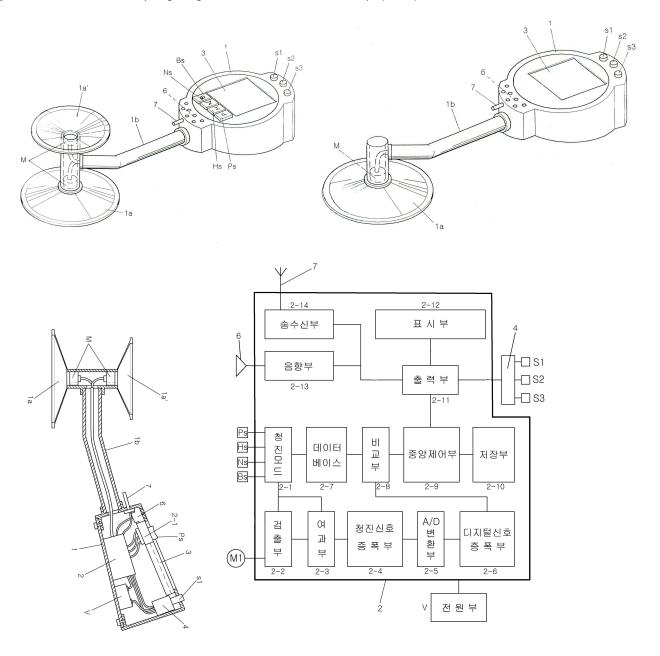
Content by: Sylvia Holst

Present: N/A

Goals: The goal of this research is to understand more about existing devices that are similar to that which the team will be developing. Maybe certain qualities can be replicated in our product.

Content:

https://patents.google.com/patent/KR101178867B1/en?q=(stethoscope)&oq=stethoscope



[1] 이병훈 and 김주한, "원격진료 청진기," KR101178867B1, Sept. 03, 2012 Accessed: Sept. 18, 2025. [Online]. Available: https://patents.google.com/patent/KR101178867B1/en?q=(stethoscope)&oq=stethoscope

9/18/25 - Active Noise Control Stethoscope (Patent)

SYLVIA HOLST - Sep 18, 2025, 7:32 PM CDT

Title: Active Noise Control Stethoscope (Patent)

Date: 9/18/25

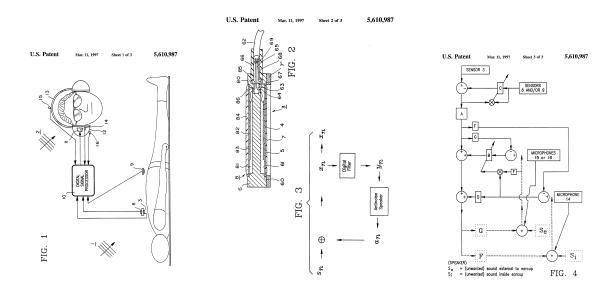
Content by: Sylvia Holst

Present: N/A

Goals: The goal of this research is to understand more about ANC in stethoscopes.

Content:

https://patents.google.com/patent/US5610987A/en



The stethoscope must limit both the direct detection of extraneous sounds by the sensing device of the stethoscope and the effect of noise which penetrates past the earpiece of the stethoscope.

There are several advantages to having a sensor with electronic output. First, the electronic output is amenable to filtering in order to receive the frequency band of interest. Thus, noise outside the frequency band of interest can be removed. Second, heart and lung sounds often get garbled by reverberation in the rubber tubes of conventional stethoscopes, but the electronic signal produced by the electronic sensor is not susceptible to such reverberations. Third, a sensor that generates an electronic signal is advantageous in that the electronic signal can be amplified and filtered to compensate for hearing loss specific to an individual physician. Finally, the electronic signal generated by the sensor can be used in conjunction with adaptive noise control techniques to further reduce unwanted noise.

It is a first objective of the invention to provide an electronic stethoscope that enables emergency medical personnel to auscultate in the presence of a high background noise level, by providing an improved primary signal sensor and an optimized combination of both passive and active noise cancellation technology in order to increase the signal-to-noise ratio of the signals output to drive a headset speaker, and reduce the effect of external airborne noise which can mask sounds output by the headset speaker.

It is a second objective of the invention to provide an active noise cancellation (ANC) or active noise reduction (ANR) system capable of cancelling random as well as periodic noise.

These objectives are accomplished in part by a unique detection sensor for picking up sound from the patient directly, in which the transducer has an impedance which is matched to that of human flesh rather than with the air, and therefore is much less sensitive to external airborne noise than commercial electronic stethoscopes with conventional microphones having very light diaphragms designed to minimize the impedance mismatch with air.

[1] T. R. Harley, "Active noise control stethoscope," US5610987A, Mar. 11, 1997 Accessed: Sept. 18, 2025. [Online]. Available: https://patents.google.com/patent/US5610987A/en

Conclusions/action items:

This device seems very similar to the one we are looking to develop. We need to consider what features of this device we can implement in our own design, but we also need to consider how to make ours unique.

SYLVIA HOLST - Sep 18, 2025, 7:25 PM CDT

Title: Apparatus and Method for Auscultation and Percussion of a Human or Animal Body (Patent)

Date: 9/18/25

Content by: Sylvia Holst

Present: N/A

Goals: The goal of this research is to understand how electric stethoscopes work.

Content:

https://patents.google.com/patent/US7533758B1/en

[1] A. J. Frech, "Apparatus and method for auscultation and percussion of a human or animal body," US7533758B1, May 19, 2009 Accessed: Sept. 18, 2025. [Online]. Available: https://patents.google.com/patent/US7533758B1/en

SYLVIA HOLST - Sep 19, 2025, 12:54 PM CDT

Title: Electronic Stethoscope Having Battery Carriage (Patent)

Date: 9/18/25

Content by: Sylvia Holst

Present: N/A

Goals: The goal of this research is to understand features of an electronic stethoscope and how it is powered.

Content:

https://patents.google.com/patent/US5367575A/en

[1] A. P. Dieken and G. E. Drake, "Electronic stethoscope having battery carriage," US5367575A, Nov. 22, 1994 Accessed: Sept. 18, 2025. [Online]. Available: https://patents.google.com/patent/US5367575A/en

Conclusions/action items:

We need to think about how we want to power our device. It could run on batteries, or we could try to make it rechargeable. Additionally, the stethoscope in this patent doesn't have ANC, so our design may require more power than this one.

SYLVIA HOLST - Oct 10, 2025, 12:21 PM CDT

Title: Sound Absorption

Date: 10/9/25

Content by: Sylvia Holst

Present: N/A

Goals: The goal of this research is to figure out materials that are good at absorbing sound, so they can hopefully be incorporated into the ear cups of the noise-cancelling stethoscope. Ideally, this material would prevent ambient sound from entering the ear cups, so that it can't interfere with auscultation.

Content:

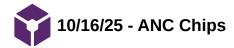
https://www.scopus.com/pages/publications/105015369420?origin=resultslist

Acoustic rainbow trapping has demonstrated significant potential in applications such as noise control, acoustic sensing, and stealth or isolation technologies. This method can be implemented to isolate specific sound frequencies and trap them at precisely defined spatial locations.

[1] J. Zhao *et al.*, "Optimized Broadband Acoustic Insulator With a Modular Side-Branch Structure Based on the Rainbow-Trapping Effect," *J Vib Acoust*, vol. 148, no. 1, 2026, doi: 10.1115/1.4069630.

Conclusions/action items:

This is a very cool concept, but I'm not sure if it is too realistic for our design. I may need to look into other sound-absobing materials.



SYLVIA HOLST - Oct 17, 2025, 1:42 PM CDT

Title: ANC Chips

Date: 10/16/25

Content by: Sylvia Holst

Present: N/A

Goals: The goal of this research is to figure out how the team might acquire or fabricate an ANC chip for the prototype.

Content:

https://ams-osram.com/products/sensor-solutions/active-noise-cancellation/ams-as3435-active-noise-cancellation

- AS3435-EQFM - https://www.mouser.com/Checkout/Shipping

https://www.amazon.com/ANC-Mini-Sweep-Radio-Adjustable-Controller/dp/B09Y4P6H5P

https://en.eeworld.com.cn/news/qrs/eic674121.html

Conclusions/action items:

ANC chips are difficult to buy for independent projects. The team might have to consider dismantling or recycling electronics with ANC chips embedded in them.

SYLVIA HOLST - Nov 06, 2025, 8:08 PM CST

Title: Sound-Absorbing Materials

Date: 11/6/25

Content by: Sylvia Holst

Present: N/A

Goals: The goal of this research is to figure out the optimal soundproofing/ sound-absorbing materials for the headphones.

Content:

https://www.soundproofcow.com/noise-canceling-

headphones/#:~:text=A%20regular%20foam%20tip%20can%20give%20great,but%20rubber%20is%20also%20a%20popular%20choice.

https://wickedcushions.com/blogs/news/foam-vs-rubber-how-to-really-cancel-noise-in-your-

headphones#:~:text=There%20are%20expensive%20rubber%20headphones%20but%20if,even%20if%20it%20is%20a%20cheaper%20option.

Acoustic foam

- Description: Open-celled foam that comes in various shapes, such as wedges or pyramids.
- Best for: Absorbing and reducing echoes and high-frequency sounds.
- Pros: Lightweight, cost-effective, and easy to install.
- Cons: Less effective at absorbing low-frequency noise compared to denser materials.

Memory foam

- Description: A type of foam that molds to the shape of your ear.
- Best for: Creating a tight, secure seal to block out external sounds.
- Pros: Provides excellent passive noise isolation by physically blocking sound waves.
- Cons: Primarily relies on a good fit; sound absorption properties vary.

SYLVIA HOLST - Sep 25, 2025, 8:16 PM CDT

Title: Sketch for Design Matrix

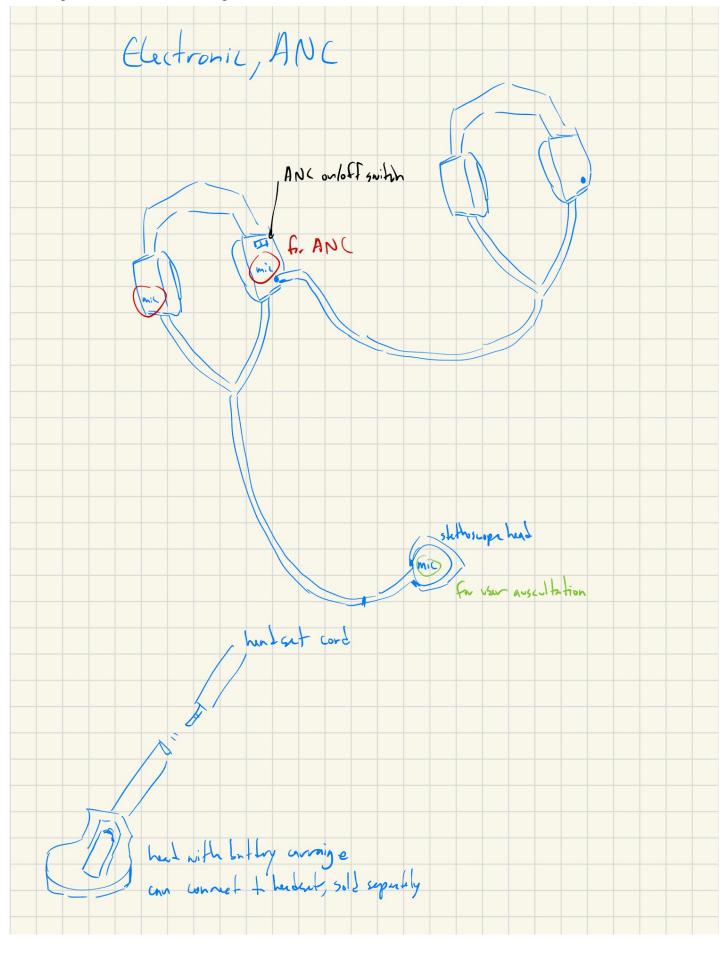
Date: 9/24/25

Content by: Sylvia Holst

Present: N/A

Goals: The goal is to illustrate concepts and features for the design.

Content:



Conclusions/action items:

I should probably refine the sketch so that it is more clear for the preliminary design presentation.

SYLVIA HOLST - Nov 23, 2025, 3:12 PM CST

Title: Battery/Mic Housing

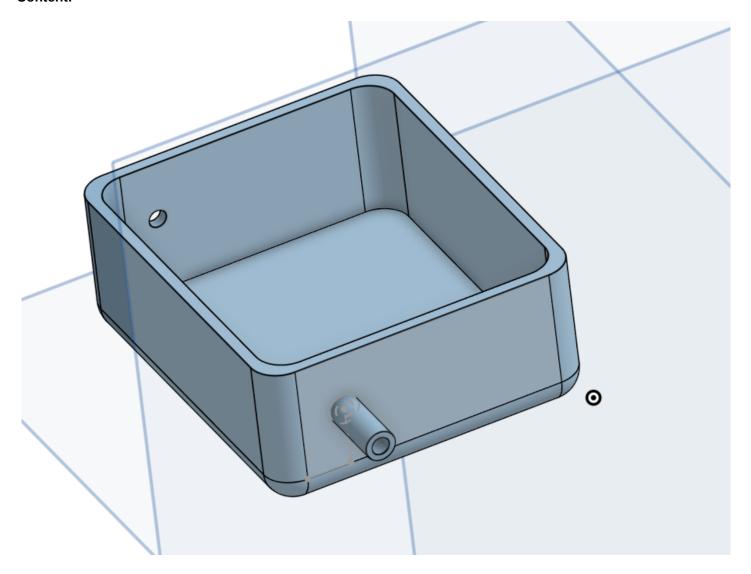
Date: 11/21/25

Content by: Sylvia Holst

Present: N/A

Goals: The goal is to make a 3D model of the battery/mic housing so that it can be printed and used.

Content:



Conclusions/action items:

I should confirm the dimensions and print the model.

SYLVIA HOLST - Oct 24, 2025, 12:54 PM CDT

Title: Proof of Completed Training

Date:

Content by: Sylvia Holst

Present: N/A

Goals:

Content:

Conclusions/action items:

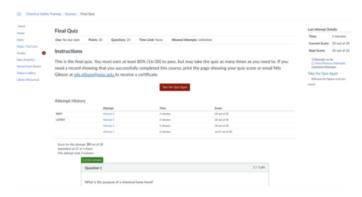
SYLVIA HOLST - Oct 06, 2025, 5:15 PM CDT



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Screenshot_2025-07-27_at_2.49.41_PM.png (257 kB)

SYLVIA HOLST - Oct 06, 2025, 5:16 PM CDT



Download

Screenshot_2025-07-27_at_2.46.11_PM.png (344 kB)

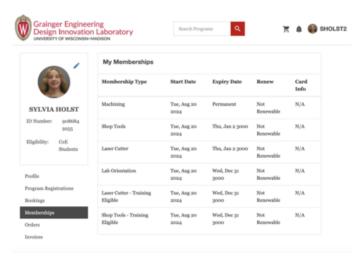
SYLVIA HOLST - Oct 06, 2025, 5:17 PM CDT



<u>Download</u>

Screenshot_2025-10-06_at_5.17.28_PM.png (138 kB)

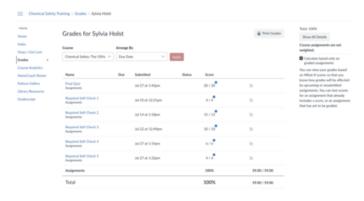
SYLVIA HOLST - Oct 20, 2025, 4:45 PM CDT



Download

Screenshot_2025-10-20_at_4.45.02_PM.png (515 kB)

SYLVIA HOLST - Oct 24, 2025, 12:51 PM CDT



Download

Screenshot_2025-10-24_at_12.51.17_PM.png (300 kB)



Download

Screenshot_2025-10-24_at_12.53.11_PM.png (212 kB)

Sylvi Holst/11/7/25 - Tong Lecture 162 of 211

SYLVIA HOLST - Nov 07, 2025, 12:48 PM CST

Title: Tong Lecture

Date: 11/7/25

Content by: Sylvia Holst

Present: N/A

Goals: The goal of attending this lecture is to understand the need for engineers in healthcare and business.

Content:

- Combine EQ with IQ to multiply impact and reach
- Take on leadership rolls (delegation and heading large teams)
- Drive system-level impact through innovation and scale
- You don't need to know your final destination just follow hard problems and build skills that allow you to make an impact
- Quadruple Aim Improved provider experience, improved patient experience, improved patient outcomes, lower cost of care
- The U.S. spends 18% of it's GDP on healthcare, but there are still poor outcomes (funding isn't the problem)
- Fix the broken healthcare system (not meant to be one system
- Work hard and build range
- Look for companies where you could work in an office with other people (good to collaborate)
- Seek diverse exposure (gain perspective and learn how systems connect, not just how individual parts work)
- Surround yourself with successful and driven people who will have a positive impact on your life
- Stand by your values
- Take care of your mental and physical health
- Embrace challenge and continue growing

Conclusions/action items:

I should start to consider in more depth what I want my future as a biomedical engineer to look like.

MOHAMMED IBRAHIM - Oct 31, 2025, 7:08 PM CDT



Download

CompletionReport.pdf (78.6 kB)

MOHAMMED IBRAHIM - Sep 17, 2025, 1:24 PM CDT

KENAN SARLIOGLU - Sep 10, 2025, 1:13 PM CDT

Title: BME Career Prep

• Date: 09/10/2025

Content by: Mohammed Ibrahim

Present: Kenan

Goals: Learn about potential future careers/ career prep in the BME field

Content:

- summer internship-summer only, co-op- summer + fall or spring semester
- Keep track of where/when/ how we've applied to(ECS tracking sheet)
- Website- Handshake-LinkedIn
- o Follow up is required
- · Apply even if the internship isn't "perfect"
- Tailor resume to position
- Resume is always under construction
- o Cover letter are custom to the job
- Intro- Paragraph about _- Paragraph about _- Why this role/next steps
- o Develop you "value added" statement
- Handshake postings are very broad
- o Career Fair September 15-18
- Objective statements are fine for career fairs not individual applications
- More time in handshake= better algorithm for recommending jobs

- Update resume
- · Look for who's attending career fair
- · Research companies I want to speak to
- Go to ECS about internship help
- · Build internship tracker

MOHAMMED IBRAHIM - Sep 17, 2025, 2:01 PM CDT

Title: Exploring your leadership style

Date: 09/17/2025

Content by: Mohammed Ibrahim

Present: Kenan

Goals: Learn how to be a good leader for BME 200 Students

Content:

- I'd say im a 7 in terms of leadership
 - o I don't like telling people what to do but if I have to, I'll fill in
- · Important qualities for leaders include
 - Communication, confidence, understanding, etc
 - Skills are people oriented
 - Self awareness, vision, transparent, etc
- Can be a leader at multiple levels
 - Organizational, team, interpersonal, personal
- Self-assessment tools (CliftonStrengths) help with self awareness
- · Models of leadership
 - Power
 - Hierarchy, authority, command
 - Authentic
 - Transparency
 - Servant
 - Empathetic
 - Power is the type of leader that I don't want to be since i don't like telling people what to do
- I would consider myself mostly a thought or process oriented leader
- · Goal setting will be placed in action items

- Develop communication/ people oriented skills through this group design project
 - I will practice this by forcing myself to speak up more in group meetings, texting in team group chat, and getting to know teammates outside of this class
 - Success would like like a closer, more personal relationship with my teammates, all opinions of mine being spoken in group meetings, and learning how to balance the need for communication with my introverted nature.

MOHAMMED IBRAHIM - Sep 24, 2025, 2:06 PM CDT

Title: Near Peer Mentoring

Date: 09/24/2025

Content by: Mohammed Ibrahim

Present: Kenan

Goals: Learn about how to be a better peer mentor

Content:

- Why we're mentoring BME 200 students?
 - We've recently been in their positions so we can relate and guide them
 - Mimics real world (Teams are comprised of more experienced members and new trainees)
 - Leadership skills
- What is a good mentor?
 - Good listener
 - Shouldn't feel like you're talking to a boss/manager
 - Gives practical advice
 - Dr.P list: Building trust, psychological safety, reliability, support, being available, transparent, humanizing their challenges
- What I wish I knew in BME 200
 - o I didn't take 200 so this isn't very applicable to me

Conclusions/action items:

• Apply what I've learned today in all future communications/meetings with BME 200 students.

MOHAMMED IBRAHIM - Oct 01, 2025, 1:48 PM CDT

Title: Sustainability In BME

Date: 10/1/2025

Content by: Mohammed Ibrahim

Present: Kenan

Goals: Learn about how sustainability looks in engineering

Content:

- 3 Pillars of sustainability are environmental, social, and economic
- · Circular economy means keeping resources in the economy instead of letting them go to landfills
 - Recycling glass or cans
- · Life cycle assessment
 - Can get water or carbon footprint
 - Turns out the white paper at the Doctor's office was removed from hospitals because of its environmental impact(and economic)
- · Reusable vs single use speculums
 - Over time, the reusable one becomes more environmentally efficient
- Things to think about when selecting anesthetics
 - How well it works, how long it works, how much it costs, Environmental impacts
- · What does a circular economy look like in BME
 - Things like stethoscopes are already reused a lot
 - o Things like needles usually don't get reused due to infection risks
- How do we use these tools(assessments) to engineer a more sustainable world
 - Leaning into things like reusable gowns(which do require more cleaning/labor)

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- Remember to always consider environmental factors in our own design projects
- Take assesments to look for break even point in our projects(when do reusable products become more
 efficient than single use)

MOHAMMED IBRAHIM - Oct 08, 2025, 1:57 PM CDT

Title: Date: 10/8/2025

Content by: Mohammed Ibrahim

Present: Kenan

Goals: Learn about patents/WARF

Content:

- WARE
 - Non-profit on campus thatt supports research on campus
 - · Sees if devices have real world applications and helps people move forward with intellectual property(tech transfer)
 - Invention-Disclosure-Assesment-Protection-Marketing-Liscensing-Financial Return
- IP
- 4 common types: Patents, copyrights, trademarks, trade secrets
 - Other: Biomaterials, technique, data
- Patents: A property right, granted by USPTO (no global patents)
 - 3 types: Design (15 year), Plant (20 year), Utility (Provisional(1 year) vs Non-Provisonal (20 year))
 - Utility(Non-P) are issued for the invention of a new and useful process, machine, manufacture, or composition of matter
 - Often take 2-5 years to issue after filing (patent examination)
 - Costs on average 30k (mostly attorney fees)
 - 90% of patents issued by USPTO are non provisional utility patents
 - Requirements
 - Eligible: can't be a product of nature, abstract idea, or natural phenomenon
 - Novel: must be new
 - Non-obvious: it can't be simple modification or combination of existing concepts
 - Enabled and described: must provide enough detail to teach others how to make ot use their invention
- · Disclosing info to WARF
 - WARF recieves 400 new innovations per year
 - Disclosing
 - Describe the innovation, identify its advantages and potential applications
 - Name contributors
 - Provide funding and public disclosure details
 - Meeting
 - Discuss in more details, ask questions about WARF, discuss next steps
 - IP Considerations
 - Type/breadth/strength of protection, public disclosure, stage of development
 - · Licensing Considerations
 - Applications, likelihood of identifying commercial partner, likely return from licensing (money WARF will get)
 - Marketing/Licensing
 - Market analysis: Market status, size/type, potential licensees
 - License negotiation: Type and terms, consideration
 - Ongoing: Tech development, enforcement, amendment, termination
- Al and IP
 - o Patents:
 - Al can't invent
 - Al's ability to assist in inventing is evolving under Panni Factors

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- Go back to team and educate them on what WARF does
 - Maybe reach out once we have a functioning prototype?

MOHAMMED IBRAHIM - Oct 15, 2025, 2:10 PM CDT

Title: Bioengineer It. Protect It

Date: 10/15/2025

Content by: Mohammed Ibrahim

Present: Kenan

Goals: Learn more about Dickinson Wright and Intellectual Property

Content:

- · Andrea Arndt is a BME Alum who now works on the legal side of engineering
- IP allows research to safely transfer inot products, processes and systems
 - Device-Patent-Marketplace
 - Also enables investment, partnerships and ethical competition
- · Legal Careers for engineers:
 - Technical advisor, patent advisor, patent examiner, patent attorney, patent litigator, IP license attorney, tech transfer manager, engineer
 - Andrea is a patent attorney so she had to take the regular+patent BAR exam
- How engineers influence law and innovation
 - · Research-determine if an invention is truly new
 - · Analytical reasoning-claim drafting/ infringement analysis
 - · Technical Writing- translate complex technical concepts into clear, precise, language
 - · Communication- explaining tech no non-experts
 - Creativity- problem solving in patents/ creating competitive products
 - o Collaboration- cooperate with colleagues and external professionals
 - Project management- manage resources, meet deadlines, and organize tasks
- Who owns your IP
 - · University: University usually owns IP
 - · Company: Employer typically owns IP
 - · Startup: You own IP
- · Timing and publication
 - · Disclose internally first
 - · First to file, not first to invent
- · Ethical duties
 - Respect others IP
 - · Keep invention notebook
 - · Understand inventorship vs authorship
 - · Maintain confidentiality agreements
- · Start up road map
 - · Invent something new- conduct patent search- file patents early- use NDAs- file trademarks- form business entity...
- · What is a patent
 - Creates a monopoly/stops others
 - Two main types: Utility(20 years), design(15 years)
- What is a trademark
 - Essentially a logo
- Counterfeit
 - · Counterfeits threaten patient safety, reputation and business value

Conclusions/action items:

· Think about next steps after we have a satisfactory prototype

MOHAMMED IBRAHIM - Oct 22, 2025, 2:01 PM CDT

Title: Post Graduate Planning

Date: 10/22/2025

Content by: Mohammed Ibrahim

Present: Kenan

Goals: Learn about how to get where I want after graduation

Content:

- · User undergrad experience to build a story
 - Gain experience while it's easy(as a student)
 - Tie them together
 - Research is important for all post-degrees and helpful for industry
- Do your homework-never too late
 - · What does your ideal career look like
 - What programs have the opportunities you are looking for
 - Location, career development, people, disease, research, courses
- Think about letter writers or references early-3 strong ones
- School- Prepare for MCAT?GRE early
- Writing your story
 - Don't just say "will do anything, I just want experience"
 - Start with what you want to do-thesis
 - Specific area of medicine like cancer stem cells, etc
 - Your narrow experience and how that applies to your broad interest
 - Specific to each position/ place you apply
- Graduate options
 - Masters, MS
 - Stepping stone/ change directions, gain depth, expand credentials
 - Rewrite your story(want to change from instrumentation to mechanics)
 - Need time to prep for MCAT or apply for med schools
 - Cannot find PhD funding
 - Industry focused
 - Generally 1 year
 - Fill gaps in resume
 - Higher level op skills(More lab time and less class time)
 - More experiences- teaching, mentoring, research thesis
 - UW MS Options
 - Research(1.5-2 years)
 - For those continuing on for PhD here
 - Can be funded as RA/TA/PA(tuition+stipend)
 - Thesis required(Must have a lab PI identified and willing to support before applying)
 - Accelerated(1 year)

- Funding(TA only) stipend only(no tuition- \$1200/ credit)
 - No co-op allowed
 - Two types
 - Accelerated
 - Coursework only and independent study/research is allowed
 - Biomedical innovation, design, and entrepreneurship
 - Project based- project required
 - Partnership with business school
- Applying
 - Statement of purpose
 - Research MS only: List the PI who will support you
 - Letters of rec: input Janna three times
 - Research MS only: At least 1 from PI that has agreed to mentor you
 - Deadline of 12/15
 - Application is reviewed separately, and special consideration is given to BME undergrads.
 - If you have a 3.0 you are guaranteed admission
- Masters elsewhere
 - Master in engineering, MS in Global Health, MS in other engineering Dept(takes longer), MBA(industry will often pay for credits or evening options
 - Less competitive than PhD programs
- o Doctoral, PhD
 - Want to be an independent researcher
 - Write research grants, work in academia, lead projects in industry, startups, and consulting
 - Follow your passion
 - Network, conferences, and utilize your lab PI here at Madison
 - Build your resume
 - Application Process
 - Apply early and list names- most do rolling review
 - Generally 3.5 GPA and 75% QuantitativeGRE
- Pre Health
 - Requirements
 - Pre-health advising- check requirements early
 - Special requirements for most medical schools
 - 2 semesters of general chem
 - Chem 344 and 345
 - 2 semesters of physics
 - 2 semesters of english
 - Psych 202 and sociology
 - Biochemistry 501
 - All can be satisfied in BME 128 credits
 - Beyond classroom

 Research, volunteering, shadow physicians, patient contact time, build relationships(letter writers), use your design experiences(physician clients), other requirements vary by degree

•

Conclusions/action items:

• Take next steps towards filling out my resume

MOHAMMED IBRAHIM - Oct 29, 2025, 2:09 PM CDT

Title: To Regulate Or Not To Regulate

Date: 10/29/2025

Content by: Mohammed Ibrahim

Present: Kenan

Goals: Learn about regulations and how they apply to medical devices

Content:

- FDA has 3 centers: Center for Devices and Radiological Health, Center for Biologics, Center for Drugs
- · 3 Classes of devices
 - Low risk, Moderate/ controlled risk, High risk
 - Class 1 is essentially exempt from FDA
 - Class 2 goes through 510k or 510k De Novo pathway
 - Class 3 go through PMa or HDE
- Most people think the FDA is pretty fairly regulated in general
- History of regulations
 - FDA didn't start regulating medical devices until 1976
 - 1958 first pacemaker was made
 - Between surgeon and engineer, no regulatory body
 - Didn't last long(claimed to be 3-5 years, only lasted a few weeks)
 - Dalkon Shield(contraceptive) was the reason the FDA began regulating
 - Post market research showed that it didn't stop pregnancy, and led to higher rates of maternal death
 - FDA became required to regulate medical devices
 - Center for devices was started in 1982
- 5 Hypothesis
 - o Abnormal returns attributable to medical device recalls are negligible
 - o Abnormal returns attributable to recalls are less negative for firms with greater project scope
 - Abnormal returns attributable to recalls are more negative for firms with high...
- Medical device recalls usually don't make huge news, so companies aren't socially punished for failures
- FDA device studies are failure mode analysis based
 - What can go wrong, how can we limit it, what are the safety concerns if it goes wrong

Conclusions/action items:

Have a conversation with team about what the risks of our device our, and what FDA regulations we would have to go through to get our device to market.

MOHAMMED IBRAHIM - Nov 05, 2025, 2:10 PM CST

Title: Regulatory Strategy

Date: 11/5

Content by: Mohammed Ibrahim

Present: Kenan

Goals: Learn how to think about regulations when making a product

Content:

- Different places have different regulatory bodies(we have the FDA)
- Devices are regulated by CDRA(Pre market approval, 510(k), IDE)
- · Advanced Therapeutics include genome editing, gene delivery and cell therapy
- Laws(Congress)-Regulations(FDA)-Guidance(FDA+Public)
- · 2 Paths of regulations for cell
 - 351: Taken from patient and given back to patient(No significant manipulations)
 - 361: Non homologous
- Each stage of the product development cycle faces its own risks and challenges, and proper management
 of these risks is vital for successful commercialization
- Target Product Profile is a living document that shows the product vision(similar to the PDS we do)
 - Broad question: Is it medically and commercially compelling
- Considerations
 - Manufacturing consistency, sustainability, potency, etc
- Quality Management
 - System that documents policies, processes, internal rules, procedures, and other records to ensure consistent quality
- Huge number of careers in regulation
 - Quality management, regulations, etc

Conclusions/action items:

 Meet with team/ advisor to talk about what we need to do to ensure we're compliant with all FDA regulations/ guidelines

MOHAMMED IBRAHIM - Nov 07, 2025, 12:47 PM CST

Title: Building a Career of Impact

Date: 11/7/2025

Content by: Mohammed Ibrahim

Present: Whole Team

Goals: Learn about why the world needs more engineers in healthcare

Content:

- · BS from UW, Masters from Harvard
- Run towards the hard problems, they are the ones that change the world
- Grew up in Wisconsin-Went to UW- Worked at Medtronic- MBA from Harvard- Skyline Ventures- Arboretum Ventures- Aetna- Unified Women's Healthcare-Hopscotch Health- Blue Cross Blue Shield Association
- · Quadruple aim
 - Improved provider experience, improved patient outcomes, improved patient experience, lower cost of care
- We spend 2x as much on healthcare but have much worse experiences/outcomes when compared to other developed countries
- Future of healthcare is an integrated ecosystem of health and care
 - Healthcare needs better systems and systems are what engineers build best
- Work hard and build range
 - Take on the hardest projects, classes and experiences you can find. Effort and range are your foundation
- · Seek diverse exposure
 - Explore different sectors, teams and geographics. Gain perspective and learn how systems connect, not just how parts work
- · Choose your people wisely
 - Surround yourself with curious, driven, high-integrity people. They will shape who you become
- · Know your values and protect them
 - Define what matters most and make decisions that align
- Embrace challenge and keep growing
 - o Run towards hard problems. Growth lives on the edge of discomfort- where big impact starts
- To avoid burnout-be comfortable saying no

Conclusions/action items:

Keep these things in mind going forward with all of my classes/work/ anything engineering related

MOHAMMED IBRAHIM - Nov 12, 2025, 2:00 PM CST

Title: An introduction to research and the IRB

Date: 11/12/2025

Content by: Mohammed Ibrahim

Present: Kenan

Goals: Learn about how IRBs work in research/ resources in IRB office

Content:

- · Historical Problematic Research
 - US Public Health Service Untreated Syphilis Study at Tuskegee
 - WWII Nazi Prisoner Experiments
 - US Public Health Service Guatemala Syphilis Experiments
 - Willowbrook State School Hepatitis Experiments
- Ethical Research Frameworks
 - Nuremberg Code,1947
 - Emphasis on voluntary consent
 - o Declaration of Helsinki, 1964
 - Focus on medical research
 - National Research Act, 1974
 - US response to syphilis study at tuskegee
- Belmont Report
 - o 3 Principles Are Autonomy, Beneficence, Justice
 - Common Rule
 - Criteria for approving research
 - Protections for vulnerable groups
 - Requirements for IRB operations
 - 2018 Revision: Reduce administrative burdens
- · IRB Composition
 - o Diversity of membership required
 - Race, gender, cultural backgrounds
 - Scientific expertise(MD,PhD,MPH/ Faculty, Clinicians)
 - Non-Scientists
 - Community members and IRB staff
- IRB Purpose
 - Protect rights and welfare of people enrolled in research
 - Review human research according to Belmont Report, Common Ruled, HIPAA, HERPA
- · Review Requirements
 - All research involving human subjects at UW requires IRB review
 - Research can't begin until study is IRB approved
- · Common Rule Definitions

- Research is a systematic investigation designed to develop or contribute to the knowledge in a field of study
- · De-identifying data
 - Levels of identifiability are: Directly Identifiable, Coded/Indirectly Identifiable, Anonymized/ De Identified
- Non exempt-research
 - Surveys of children, analysis of identifiable samples, intervention beyond category 3, administering a drug, device studies
- · Examples of medical devices
 - Anything that acts on the body to diagnose, treat, cure a disease that isn't a drug
 - Pacemaker, insulin pumps, prostheses, contact lenses, MRIs, etc
- · Amending an existing study
 - Submit change of protocol in ARROW for any new or revised study
- IRB Review Process
 - o Administrative review--IRB Pre-Review-- Committee or Non-Committee Review
- After Approval
 - Begin your study
 - Follow IRB approved documents
 - Changes of protocol
 - Must have change approved before implementing the change
 - Reportable events
 - Something unexpected happens
 - Continuing reviews
 - Annual progress reports
- Tips for successful submissions
 - Answer the questions being asked
 - · Rushing or cutting corners will not save time
 - It's okay if you don't agree with a reviewer note- just explain why or contact the reviewer
- Resources
 - IRB Website
 - ARROW

Conclusions/action items:

• Talk to BME 200s to teach them about IRBs and give them this information early

MOHAMMED IBRAHIM - Nov 19, 2025, 1:56 PM CST

Title: New Product Development

Date: 11/19/2025

Content by: Mohammed Ibrahim

Present: Kenan

Goals: Learn how medical companies decide and move forward with new product development

Content:

- Selecting and prioritizing projects
 - Corporate Business Strategy, Product Portfolio Review, Project Review, Budgeting and Resource Allocation
- · Types of NPD Projects
 - Line extensions: Adding sizes and configurations
 - Product Improvements: Existing product changes due to market feedback
 - New-to-Company: Product line that is new to your company but not new in general
 - New-to-World: Completely new market
- Managing NPD:
 - Ideation, exploration, concept development, design development, design confirmation, design transfer and commercialization, post market surveillance
- Case study: fluid management solutions(Orwell)
 - Stage 0: Choose area of opportunity, review market trends, conduct primary and secondary market research, identidy customer unmet needs, create high-level ideas
 - Need to make something cleaner that doesn't have a smell
 - Stage 1: Define problem, review list of ideas from stage 0, create concepts for 8-10 ideas,
 develop high-level business case, conduct preliminary technical scouting and IP landscaping
 - Got down to 8 designs
 - Defining the problem is arguable the most important step of the design process
 - Stage 2:
 - Based on customer interviews and use-case assessments go down to 1 leading concept, develop robust business case, conduct comprehensive IP examination, make go/ no go decision
 - Got down to 3 more detailed design concepts, and decided on 1
 - Stage 3:
 - Move to functional prototype, continue design process, confirm regulatory pathway, begin formal design control documentation
 - Went through design process to build prototype and looked into what regulations were required(since it was a new product with software involved)
 - Stage 4:
 - Conduct extensive verification and validation testing, finalize product and component models, accelerate manufacturing process, freeze design, submit regulatory

documentation

- Froze design(even though there were still small changes made)
- Stage 5:
 - Complete testing, make final changes, build molds, assembly/test equipment, create instructions and user manuals, develop service plan and resources, finalize go to market strategy
 - Made final system
- o Post Market Surveillance:
 - Regulatory agencies expect that companies are monitoring customer complaints and field issues post launch
 - Companies continuously track customer and salesforce feedback via interviews and surveys
 - On a 4-6 month cadence, project teams report out to stakeholders
 - Competition launched new version while lowering prices
 - Installation and service price for ORwell was higher than expected
 - ORwell was discontinued
- Medical device development is expensive, complex, and collaborative
- Most businesses have instituted processed like stage gate
- Good product design and development is necessary for commercial success but not sufficient

Conclusions/action items:

Think about which stage we are in and how we should best move forward to ensure our project succeeds.

MOHAMMED IBRAHIM - Sep 12, 2025, 11:48 AM CDT

Title: First BSAC Meeting

Date: 09/12/2025

Content by: Mohammed Ibrahim

Present: Mohammed Ibrahim

Goals: Understand how BSAC meetings work and discuss start of semester

Content:

The draft was fine, there needs to be a better system other than shouting

We need to be more informed on the expectations of research entries

Wonder how clients propose projects

BME 200 students have to do machining trainings now(I did it in 201)

BME 300 need to have ethics training done

Find info for trainings on canvas under "training throughout the curriculum"

Students should do more trainings for technical skills(coding, excel, solidworks)

Students should be able to filter projects by number of proposals

Students should know about the BME area electives earlier to plan out degree better(after progression)

Communicate budget with client!!!

Conclusions/action items:

MOHAMMED IBRAHIM - Sep 26, 2025, 11:40 AM CDT

Title: Second BSAC Meeting

Date: 09/26/2025

Content by: Mohammed Ibrahim

Present: Mohammed Ibrahim

Goals: Learn about BME Faculty and talk about how design has been going

Content:

- How was the process of submitting the PDS/client communication
 - o Client communication has been good
 - o PDS was fine but client changing his mind on the design threw a wrench in what we planned
- We wish there were more clear guidelines for how our notebook should look
- Training throughout the curriculum
 - Wish it was more clear what we're expected to do, and when it was due
- Need to let students know about advising resources earlier

Conclusions/action items:

Take this information back to my teammates(specifically 200 students)

.

MOHAMMED IBRAHIM - Oct 10, 2025, 11:19 AM CDT

Title: Third BSAC Meeting

Date: 10/10/2025

Content by: Mohammed Ibrahim

Present: Mohammed Ibrahim

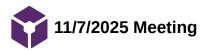
Goals: Talk about the trainings we need to complete this semester

Content:

- I wouldn't mind there being an asynchronous lecture for BME 200 but it would need to be 3 credits
- Training through the currcivulum google form has been made
- I'm not a mentor so that program doesn't really apply for me
- Preliminary presentations were fine, but it's very easy to get lost in other groups presentations when you don't understand the basic science behind a lot of problems/ devices
- Report wasn't too bad but it felt a little early to come up with such specific plans for testing and fabrication so some of that stuff just had to be best guesses
- We're getting ready to order the necessary parts to start fabrication
 - Haven't been able to do much actual work since we've had so many deliverables due these past few weeks
- Show and tell expectations aren't really clear since they haven't been talked about

Conclusions/action items:

•



MOHAMMED IBRAHIM - Nov 07, 2025, 11:27 AM CST

Title: Meeting 5

Date: 11/7/2025

Content by: Mohammed Ibrahim

Goals: Talk about how projects and training are going

Content:

- BME 200 and 201 can't be switched
- People aren't fans of the BME 300 training since it felt inapplicable to most students
- Things were still shipping so show and tell wasn't the most useful
- Seems like groups are trying to finish prototypes this week and then start testing next week
- People in our group are still waiting for grades and don't like not knowing where they stand in the class
- Show and tell is helpful for working on the elevator pitch for your project

Conclusions/action items:

· Bring information back to my team and keep them informed

MOHAMMED IBRAHIM - Nov 21, 2025, 11:52 AM CST

Title: Meeting 6

Date: 11/21/2025

Content by: Mohammed Ibrahim

Goals: Talk about how projects have been going/ how the rest of the semester will look

Content:

- · Teams have been experiencing difficulties with clients responding
- Everyone seems to have had to experience a learning curve since they were on groups with no expertise
- Too many deliverables early in the semester, caused prototyping to be slowed down
- 200 students have had varying experiences on the mentorship from 300 students
- · Bioinstrumentation students are struggling with enrollment since ECE students get priority

•

Conclusions/action items:

Get testing done before Thanksgiving break



Ryan Wahl - Dec 10, 2025, 7:00 PM CST

Title: If It Sounds Too Loud, It Is Too Loud

Date: 9/18/25

Content by: Ryan Wahl

Present: n/a

Goals: understand the safety aspect of our headphones and what sounds are safe to be transmitted to the ear.

Content:

Hearing Health Foundation, "Keep Listening | What Are Safe Decibels?," *Hearing Health Foundation*, 2023. https://hearinghealthfoundation.org/keeplistening/decibels

Sounds over 70 dB damage the ear over time.

- the intensity of sound is logarithmic, meaning that 20 dB is actually 10 times more intense than 10 dB.
- when sound can be heard coming out of someone else's headphones, that means that sound is most likely at around 85 dB and is unsafe for that person to listen to for extended periods of time. In general, it will not cause harm when only played at that level for a little bit.
- -headphones usually can reach up to about 100 dB, which is unsafe for the ears over time. The same limit for listening to music or other audio through headphones is usually at about 50-60% of the maximum volume those headphones are capable of.

Conclusions/action items: This article was short but provided us with important information about the safety requirements of our stethoscope.

Ryan Wahl - Oct 02, 2025, 8:16 PM CDT

Title: Stethoscope Accoustics

Date: 10/02/2025

Content by: Ryan Wahl

Present: n/a

Goals: understand how sound is transmitted through a stethoscope to make sure that our design will not interfere with that process.

Content:

M. Nussbaumer and A. Agarwal, "Stethoscope acoustics," *Journal of Sound and Vibration*, vol. 539, p. 117194, Oct. 2022, doi: https://doi.org/10.1016/j.jsv.2022.117194.

Lately there has been an increase in use of electronic stethoscopes due to many problems that standard stethoscopes can have, despite them being very cost-effective. Electronic stethoscopes transmit vibrations in the chest into signals which make them very effective, but their performance can rely heavily on many factors, including the chest piece.

The article did not prove as useful as I thought but it did mention something interesting about the tubing. When the tubing of a stethoscope is too long, there are echoing effects and low frequency signals such as heart sounds are weakened. Also, both chest piece volume and use of a diaphragm influence signals. Even the weight of a hand pressing down on the chest piece influences signals. Both the amplitude and frequency of signals are affected by this added weight.

Conclusions/action items: Again, this article was more in-depth than I would have liked but my main takeaway is that we need to pay attention to the tubing length. I would like to do more research into this topic because I'm curious wether there is a "standard" tubing length for stethoscopes that produces the most effective auscultation.

Ryan Wahl - Oct 08, 2025, 12:53 PM CDT

Title: What your doctor really listens for with a stethoscope

Date: 10/8/25

Content by: Ryan Wahl

Present: n/a

Goals: understand the actual function of a stethoscope and why it would be bad if a doctor could not hear sounds in a stethoscope during a critical time like an injured patient in a helicopter.

Content:

B. Scott, "What your doctor really listens for with a stethoscope."," *Scrubbing In by BSWHealth*, Apr. 28, 2020. https://www.bswhealth.com/blog/stethoscope

By listening to heart sounds, physicians can diagnose certain diseased based off of what they hear. Stethoscopes essentially allow for direct listening of the heart. Physicians can hear valve leakage, which could be more applicable to our main issue outlined because someone in a helicopter could be being transported due to an injury and thanks to our device, an EMT would be able to hear that the problem is a valve leakage in the heart.

Doctors can also hear atrial fibrillation, which can be caused by heart failure; also applicable to our purpose.

Conclusions/action items: This was a short article but it gave me a lot of insight into why we should actually care about the project at hand. Now I am better informed as we go on to write our preliminary report.

Ryan Wahl - Oct 16, 2025, 1:00 PM CDT

Title: How to use a stethoscope

Date: 10/16/25

Content by: Ryan Wahl

Present: n/a

Goals: Learn how to use a stethoscope because we have recently obtained some from our client and I would like to be able to properly demonstrate during future presentations how to actually use our device versus just understanding how our noise cancellation works.

Content:

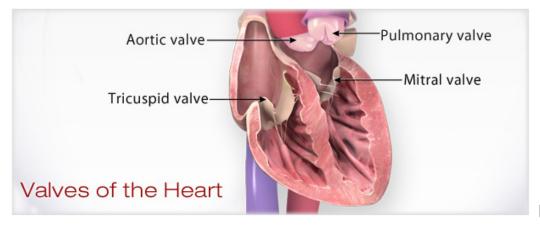
The drum is the larger side of the stethoscope chest piece that is placed onto the body to be able to effectively pick up sounds. The other side is the bell which is used to listen to lower frequency sounds.

There are four main parts of the heart that a stethoscope is placed to listen to heart sounds, which includes each of the four major heart valves.

- The aortic valve is often the first valve listened to which is on the right side of the chest next to the sternum.
- On the left side you listen to the pulmonary valve, where blood flows to the lungs.
- Vertically down is the tricuspid valve, and on the lateral left is the mitral valve.

A murmur would be a sound that is not typically heard when listening to the heart. In older people a common murmur is a aortic stenosis, which is a narrowing of this valve (this causes a whooshing sound).

The other sound that doctors listen to is sound in the lungs, including inspiration and expiration. Doctors listen for crackles or the sound of fluid, wheezing, or more. Doctors can also listen for bowel sounds.



[1] American Heart Association, "Roles of Your Four Heart Valves," www.heart.org, 2016. https://www.heart.org/en/health-topics/heart-valve-problems-and-disease/about-heart-valves/roles-of-your-four-heart-valves

[2]Dr Ollie Burton, "How Doctors Use Stethoscopes | The Doctor's Toolkit," *YouTube*, Nov. 10, 2022. https://www.youtube.com/watch?v=BlygVkBwcxU (accessed Oct. 16, 2025).

Conclusions/action items: I feel a little more informed now should I actually need to demonstrate how to use a stethoscope and I feel a little more confident if I needed to speak to doctors about our project.



Ryan Wahl - Oct 23, 2025, 1:57 PM CDT

Title: Earmuff comfort

Date: 10/23/25

Content by: Ryan Wahl

Present: n/a

Goals: Understand whether measuring the contact pressure distribution between the earmuff cushions and the head would develop a reliable comfort index.

Content:

S. N. Y. Gerges, "Earmuff comfort," *Applied Acoustics*, vol. 73, no. 10, pp. 1003–1012, Oct. 2012, doi: https://doi.org/10.1016/j.apacoust.2012.04.015.

From the research paper Earmuff Comfort by Samir Gerges, Gerges brought about a different problem: People who work in high noise environments such as contruction workers may require hearing protection to attenuate noise, but these devices must also be comfortable because they are used for long periods of time. Overall, this problem is applicable to us; we need to develop a noise reducing stethoscope that attenuates noise but is comfortable, so doctors can wear these for long periods of time if needed.

In their study they measured contact pressure distribution between the earmuff cushions and the head to develop a comfort index.

The key results of their study found that comfort depends on how evenly pressure is distributed and not just about the total force. This makes it very important to focus on headband design and the flexibility of the cushions, so that force coming from the headphones around the ears can be evenly distributed.

Conclusions/action items:

Moving forward, it is important we select materials that are flexible, especially for the cushions, so that comfort is optimized. Future research needed would be on what materials we could use for the cushions that would be comfortable without risking a loss of attenuation.

Ryan Wahl - Sep 12, 2025, 12:19 PM CDT

Ryan Wahl - Sep 12, 2025, 1:30 PM CDT

Title: The electronic stethoscope

Date: 9/12/2025

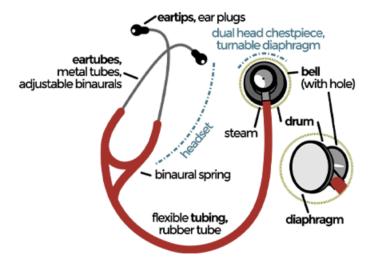
Content by: Ryan Wahl

Present: N/A

Goals: My goal is to understand the fundamentals of how electronic stethoscopes work so I can better understand how noise cancellation could be implemented within them.

Content: https://link.springer.com/article/10.1186/s12938-015-0056-y

Stethoscopes need to have a high selective sensitivity to decipher the differing heart sounds. Electronic Stethoscopes contain a battery.

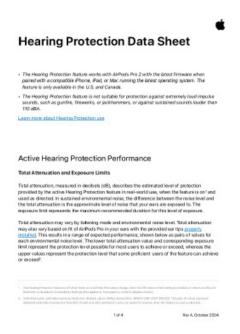


Traditional stethoscopes operate using tubes that connect to the listeners ears and are purely mechanical. The bell, as pictured above, transmits low frequency heart sounds and the diaphragm transmits high-frequency sounds. The problem is that these sounds levels are very low, which is where amplification would be helpful, but is not our main focus. Amplification is however already implemented in electronic stethoscopes, where this amplification is helpful for amplifying heart sounds but not breathing sounds. A microphone is put behind the chest piece to convert the sound pressure to electric signals.

Conclusions/action items:



Ryan Wahl - Oct 09, 2025, 5:48 PM CDT



Download

Hearing_Protection_data_sheet_October_2024.pdf (2.67 MB)

Ryan Wahl - Oct 09, 2025, 5:48 PM CDT

Ryan Wahl - Oct 09, 2025, 5:53 PM CDT

Title: AirPod NRR

Date: 10/8/25

Content by: Ryan Wahl

Present: n/a

Goals: Look into the noise reduction rating (NRR) of other devices to set a goal for how much sound our device should be able to cancel out.

Content:

See file attached.

The passive NRR for AirPod Pros is 10 dB, meaning that the AirPod Pros block out 10 dB of noise without the active noise cancellation feature activated. Our headset should aim to cause greater attenuation than this value, due to the addition of ANC. This would therefore demonstrate the effectiveness of ANC in our system.

Conclusions/action items: Now we at least have a baseline value that we can use for comparison when testing our device, which would be an important step after fabricating the prototype.

Ryan Wahl - Sep 12, 2025, 1:02 PM CDT

Title: Client meeting notes from 9/10/25

Date: 9/10/25

Content by: Ryan Wahl

Present: Whole team

Goals: Understand the basics of the project and brainstorm possible ways to go about finding a solution.

Content:

General cost

• With no amplification -\$50? this would make the product widely accessible to medical students and practitioners.

Miscellaneous notes:

- Over the ears? Allows people to keep their hearing aids in.
- Reduction and without amplification would be cheap and accessible
- It is good to have different models but it's good to have a double headed system where two people can hear at the same time with two sets of headphones (attachment).
- · Medical students will use these headphones
- · Also for emergency medicine personal
- · All environments including helicopter
- Make sure that the tube coming into the headphone is reflected into the ear canal
- · Work with communicative disorders for testing maybe?
- · Click them off and put around neck user friendly easy to carry around the head
- · Reversible, where a patient who is hard of hearing can hear the doctor through the stethoscope
- · Research hearing compromised groups
- · NRR is the noise reduction rate that represents how much noise is reduced

Conclusions/action items:

The client indicated that we should begin with focussing on developing an item without amplification for simplicity's sake so that will be our next step.

Ryan Wahl - Sep 22, 2025, 5:07 PM CDT

Title: Client Meeting - PDS

Date: 9/22/25

Content by: Ryan Wahl

Present: Team

Goals: understand whether our current PDS has the correct specifications and whether anything needs to be added or

changed

Content:

For or budget should there be a way to use more than the \$100 allotted by our client

For on the market (no noise amplification) (\$50-100)

With amplification - about \$50-\$100 more

It'd be better to use AAA batteries for safety reasons as compared to

- rechargeable would be great as it is the future it is just less feasible

Best scoring criteria

- -effectiveness should have the most weight
- -ease of use
- -comfort (rubber for neck as opposed to metal)
- -many stethoscopes last a very long time but they should realistically be able to last much longer than that. The head of the stethoscopes is what often separates a cheap stethoscope from a cheap one.

Conclusions/action items:

- We should now update our PDS with any relevant changes that need to be made and now continue with designing our design matrix

SYLVIA HOLST - Oct 06, 2025, 5:20 PM CDT

Title: 10/6/25 client meeting

Date: 10/6/25

Content by: Ryan Wahl

Present: Ryan, Sylvia, Noah, Mohammed (via Zoom)

Goals: Understand what project is going to be our final project.

Content:

Client is in fact okay with an electronic stethoscope design

- we should be able to get a good cheap stethoscope online for about \$16
- potential idea to record the sounds we hear.
- bluetooth idea is something to consider
- we need to make sure our product is unique and there may already be a product out there that is electronic that is patented.
- we may need to just go through with our main current design and go from there.

Conclusions/action items:

It turns out the patent was expired so we are going to change our design again to be an electric stethoscope with ANC because we would like there to not be eartips that go directly into the ear so those with hearing aids can use it.



Ryan Wahl - Sep 15, 2025, 5:16 PM CDT

Title: Meeting notes 9/12/25

Date: 9/12/25

Content by: Ryan Wahl

Present: Whole team

Goals: understand what we need to get done next week and review how the last week went.

Content:

- preliminary presentations are in three weeks.
- -build next list of questions for the clients based on the PDS
- -ask more about the budget for prototyping
- -\$50 budget at the maker space
- -coordinate all the buying of materials through the client

Questions

- would there be an advantage of having the microphone placed at one spot in the tube versus another?

Conclusions/action items:

Ryan Wahl - Sep 19, 2025, 1:46 PM CDT

Title: Notes 9/19/25

Date: 9/19/25

Content by: Ryan Wahl

Present: Whole team

Goals: Understand what we've accomplished so far and what needs to be done in the coming week.

Content:

In the next PDS find numbers you can use during your testing phase. We need to be able to know whether we've been successful or not.

- 3 design ideas and the matrix are due in the next week.
- It is not too early to start working on slides for the preliminary presentations.
- Design ideas are not due until next Friday but they can be reviewed earlier

Possible differences for design matrix:

- · Battery-powered vs. rechargeable
 - Battery pack vs. internal battery system (Electronic Stethoscope Having Battery Carriage patent)
- Multi-headed vs. singular
 - · Selling stethoscope head and headset separately
- Collapsable headband
- Electronic ANC vs. sound-absorbing material around the microphone
 - ANC and amplification vs. just ANC
 - ANC On/off switch
 - · Mic and ANC vs. bell and diaphragm

Conclusions/action items:



Ryan Wahl - Sep 26, 2025, 2:01 PM CDT

Title: Advisor Notes 9/26

Date: 9/26/25

Content by: Ryan Wahl

Present: Team

Goals: Understand what needs to be done in the next week in preparation for the preliminary presentations.

Content:

- Practice the presentation as a team before the next meeting
- Check training in email that is needed (under resources on the design site) safety and training. document training in the notebook
- For money, document what we will need if we need to spend more than \$100
- use the makerspace for a lot of stuff (\$50 budget)
- noise cancelling products are going to be the most expensive so this is likely something we will want to just buy considering the tradeoffs.

Conclusions/action items:

I need to provide documentation in my Notebook of designs I've been working on and we need to finish up our preliminary presentations in the next week to be prepared to present on Friday.

Ryan Wahl - Sep 14, 2025, 3:05 PM CDT

Title: Adaptive Noise Cancellation: Principles and Applications

Date: 9/14/25

Content by: Ryan Wahl

Present: N/A

Goals: Understand how noise cancellation works and how it can be implemented in devices other than headphones/AirPods, such as stethoscopes.

Content:

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1451965

General description: Noise cancellation technology uses an input in a noise field where the signal is weak or absent and the input is then filtered and subtracted from an input with signal and noise, allowing the primary noise to be cancelled out.

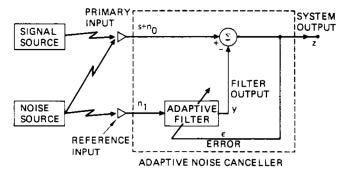


Fig. 1. The adaptive noise cancelling concept.

The s represents the sound that one would want to hear; in our case, s represents heart sounds, lung sounds, etc. n0 is the added sound that is not wanted, which in our case could be helicopter sounds, people talking at a football game, etc. Primary input therefore represents the total sound coming into the device. The bottom line, the reference input, is the other microphone that picks up ambient sounds. The filter then tries to take this sound and make it match the sound coming in from the primary input. Finally, subtraction occurs, removing the outside sound through creating an opposite version of these sound waves.

Conclusions/action items: The rest of this article did not end up proving to be much help as it was largely mathematical, which is why this analysis did not end up being very long, yet I do now have a very good understanding of what will be needed in our device. We must have separate microphones, one picking up the heart sounds which could be placed right near the chest piece tubing; the other microphone should be put somewhere further away such as in the actual headset.

Ryan Wahl - Oct 17, 2025, 1:52 PM CDT

Title: Engineering Healthy Science: Using Noise-Cancelling Headphones to Block Harmful Sound

Date: 9/15/2025

Content by: Ryan Wahl

Present: Whole team

Goals: understand how much our product should be able to reduce ambient sounds

Content:

Article Link

R. Pak, "Engineering Healthy Silence: Using Noise-Cancelling Headphones to Block Harmful Sound – USC Viterbi School of Engineering," *illumin.usc.edu*, Apr. 01, 2024. https://illumin.usc.edu/engineering-healthy-silence-using-noise-cancelling-headphones-to-block-harmful-sound/

Typically, ANC (active noise cancelling) headphones reduce noise by around 20-40 dB.

Conclusions/action items: Obviously, the more outside noise is reduced the better, so we should aim to be within this range in terms of how much sound our stethoscopes block out.

Update (10/17): we have set our goal to reduce noise by about 15 dB as our baseline goal. More would certainly be

Ryan Wahl - Sep 26, 2025, 12:23 PM CDT

Title: Anatomy of a Stethoscope

Date: 9/25/25

Content by: Ryan Wahl

Present: n/a

Goals: Gain a fundamental understanding of the features of the stethoscopes which I still lack and also a little more information about the materials that we shou. This can be used to better understand where we can change a stethoscope and where its features must be kept the same so as to not risk altering the functionality of the stethoscope.

Content:

https://www.littmann.in/3M/en_IN/littmann-stethoscopes-in/education/how-to-choose/anatomy/

The bell of the diaphragm of the stethoscope has a larger and smaller side, the larger of which is used on adults. The tubing on stethoscopes is important and is used to resist the oils often found on human skin so that the tubing lasts longer. In Littmann stethoscopes specifically, no rubber latex or phthalate plasticizers are used for both environmental and safety reasons.

The headset contains eartubes, tension springs, and eartips. It is important that these eartips are placed at the correct angle so that they fit into the ear canals in an ergonomically correct way. The eartubes (the portion directly under the eartips) are made of aluminum alloy in these specific stethoscopes (Littmann) for strength and weight purposes. In these stethoscopes their eartips come in both small and large sizes, which is something we will want to think about with our design so that the clinician also has optimal comfort.

Conclusions/action items:

I can now use this information to better inform the materials that we should be using and the way in which we must implement our design. For example, will the headset surrounding the stethoscope provide challenges to being able to position the stethoscope at the correct angle?

Ryan Wahl - Nov 07, 2025, 12:50 PM CST

Title: Tong Lecture

Date: 11/7/25

Content by: Ryan Wahl

Present: n/a

Goals: Learn about healthcare

Content:

How much do we spend on healthcare in the US? Over \$5 trillion.

What if we build an integrated system to enable health and wellness for all?

aligned incentives - physicians rewarded for outcomes and not activity.

- 1. work hard and build range
- take on the hardest projects, classes, and experiences you can find.
- 2. Seek diverse exposure
- explore different sectors, teams, and geographies
- 3. choose your people wisely
- surround yourself with the right people.
- 4. know your values and protect them
- define what matters most
- make decisions that align
- 5. embrace challenge and keep growing
- run towards hard problems. growth lives on the edge of discomfort where big impact starts.

Conclusions/action items:

Ryan Wahl - Sep 30, 2025, 5:09 PM CDT



electronic_stethoscope_with_ANC (295 kB)

Ryan Wahl - Sep 30, 2025, 5:18 PM CDT

Title: Electronic Stethoscope Design Idea

Date: 9/30/25

Content by: Ryan Wahl

Present: n/a

Goals: understand the possibility of an electronic design with speakers being placed inside the stethoscope's tubing.

Content:

Please click on the image to see text.

The image itself describes a lot of the function of this stethoscope, but it is basically this: a microphone near the chest piece picks up the wanted heart sounds and relays those sounds through tubing in the stethoscope to the headset's ANC chip, which also picks up outside sounds from microphones placed in each of the headset's muffs. The chip produces a signal opposite to the sound from the headsets outer microphones so that this sound is blocked out. The remaining sound from the chestpiece is then relayed to speakers in the headset that play these heart sounds to the individual wearing the headset. A battery pack and on/off switch would be found in the binaural spring of the stethoscope.

Conclusions/action items: Due to regulations, our client has advised us against an electronic design, so this will not likely move forward, but it does give us some good ideas on how to implement noise cancellation into our stethoscope.

Ryan Wahl - Oct 23, 2025, 1:17 PM CDT

Title: ANC Chip research

Date: 10/23/25

Content by: Ryan Wahl

Present: n/a

Goals: Find out what type of ANC chip to use for our headphones.

Content:

I reached out to a company Cardinal Peak after reading one of their blocks about ANC chips and asked them for some recommendations. Here is what they said:

"I asked my engineering team for their recommendations regarding your efforts to develop a pair of noise cancelling headphones. Here's their response. Hope this helps! Let us know how it goes.

ANC is going to be quite involved, as it requires tuning, and multiple mics. Even with the kits above, there's going to be significant work to wire up the mics and tune the ANC to your headset body. There's also some work involved in installing the ADK/SDK, and getting the ANC code running on them. That said, here are 5 development kits you can explore for ANC/headset/audio-board prototyping."



 Qualcomm DK-QCC5124-AVSHS-A-0 Smart Headset Kit: Reference smart-headset design using the QCC5124 SoC with support for ANC/noise reduction. URL: <u>DigiKey detail page DigiKey+1</u>



• Qualcomm DB-QCC5124-VFBGA90-A-0 Dev Kit (QCC5124 module): A more modular dev board built around the QCC5124 audio SoC. URL: <u>DigiKey detail page DigiKey+1</u>



 Qualcomm DK-QCC5120-VFBGA124-A-0 Dev Kit (QCC5120): Slightly lower tier chipset in the QCC51xx family. URL: DigiKey detail page <u>qualcomm-electronics.com</u>



• Qualcomm DB-QCC5125-VFBGA90-A-0 Dev Kit (QCC5125): Another variant in the QCC51xx series which features integrated noise cancellation per chip spec. URL: DigiKey detail page Qualcomm



Nordic nRF5340 Audio DK: Alternate vendor option for audio development (Bluetooth LE Audio) —
may require additional ANC/microphone integration. URL: <u>Nordic product page Nordic</u>
Semiconductor

Conclusions/action items: I will need help analyzing these products to see if they would work for our project. Some, like the first two products shown, seemed incredibly expensive so those are not realistic options.

Ryan Wahl - Oct 23, 2025, 1:28 PM CDT



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AS3412_ANC_CHIP.pdf (1.86 MB) This file provides information on a potential ANC device we can use in our headset. I have sent an email to the company requesting samples.

Ryan Wahl - Oct 30, 2025, 4:25 PM CDT

Title: Potential ear cushion materials.

Date: 10/30/25

Content by: Ryan Wahl

Present: n/a

Goals: understand what materials should be used for the ear cushion part of our headphones in a way that provides maximum attenuation and maximum comfort.

Content: After researching in several databases, not a lot of information was available about "optimal" headphone ear cushion materials. Previous research of mine led to my finding of that for optimal comfort, pressure should be balanced around ear ear. Knowing this, and after looking up online what materials are typically used in headphone ear cushions, the best option seems to be some sort of foam or memory foam that will distribute pressure around the ear evenly, will feel comfortable in contact with the ear, and will be dense enough to still attenuate sound and not let in too much outside sound.

UPDATE: not a research paper, but one good article from an audio engineer mentioned different pros and cons to using different materials for the earcups.

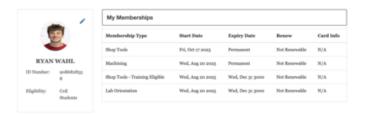
HeadphonesAddict, "Why You Should Care About Headphone Earpads," Oct. 12, 2020.

https://headphonesaddict.com/headphone-earpads/

- 1. Synthetic leather comfortable, easy to clean, provides passive noise attenuation, but peels frequently -- not a good option for us due to the desire for a long shelf life. Polyurethane leather would not be a bad option as this lasts longer, but it still would eventually peel.
- 2. fabric- comfortable, long lifespan, but get dirty easily and poor passive noise attenuation -- not a good option for our needs.
- 3. Velour long lifespan, good noise attenuation, but can get dirty and may not be cheap. This would be a good option if materials could be found for a reasonable price.

Conclusions/action items: From this article, velour would be the best option moving forward to use for our earcups.

Ryan Wahl - Oct 28, 2025, 6:37 PM CDT



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Screenshot_2025-10-28_at_6.35.59_PM.png (236 kB)

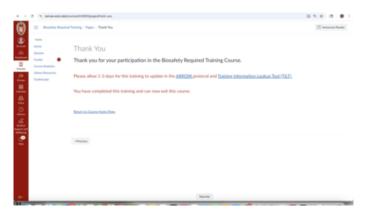
Ryan Wahl - Oct 24, 2025, 12:50 PM CDT



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rwahl.pdf (114 kB) Completion of my chemical safety OSHA training.

Ryan Wahl - Oct 28, 2025, 6:38 PM CDT



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