# Smart Headphones for

*Product Design Specifications*

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**Client:** Dr. Jeffrey Koziol

**Team:** Ethan Hannon ehannon@wisc.edu
Mustafa Al-Sakhbouri alsakhbouri@wisc.edu
Rachel Nossen rnossen@wisc.edu
Kyle Everson kbeverson@wisc.edu
Mark Rice mjrice2@wisc.edu

**Problem Statement:**

The team has been tasked by the client to design and develop headphones to record a cardiac pulse signal and pair this with a smart watch to measure PTT and PWV. The design of the headphones should be small and portable with a microphone that would be attached instead of a speaker. A bluetooth link to the user's watch and phone with the headphones will be required. Both the headphone and the user's watch will create a pulse that should thus measure the Pulse Transit Time and Pulse Wave Velocity of the body. This data will be recorded and shown on an app that can be accessed by the user on their phone or smart watch. The design of the headphones should be similar to that of Apple airpods and should work with ios systems.

**Function:**

Heart disease and high blood pressure are a rising phenomenon that has been affecting the U.S. The need to track and monitor such issues has thus become a much more important goal for many to ensure their cardio health is properly monitored. This device will cover such issues by utilizing a highly receptive microphone that is attached to the headphones that will be capable of listening and recording the rate of the pulse. The headphones will be paired with a smartwatch via bluetooth and will track the pulse rate from the wrist node of the artery to the arterial node the headphones are listening to and thus be capable of calculating and recording the Pulse Transit Time (PTT) and Pulse Wave Velocity (PWV). An app will also be provided where the recorded data will be stored and showcased to the user in an informative and graphical manner.

**Client Requirements:**

- The device must be able to connect via bluetooth to phone
    - Headphones should be linked to an app
    - Data recording should be continuous and stored on the app
- Headphones should be able to work like regular headphones (i.e. able to play music)
- Headphones and accompanying devices should be capable of gathering and calculating Pulse Wave Velocity (PWV) and Pulse Transit Time (PTT)

- App should be capable of displaying user's cardio health and statistics

**Design Requirements:**

1. **Physical and Operational Characteristics**
    a. *Performance Requirements:*
        i. The device should be able to function for everyday use.
        ii. Block out noise so that the heart measurements are not tampered with.
    b. *Safety:*
        i. Ensure that material will not be invasive to the ear.
        ii. The audio levels (decibels) should be within range of comparable items on the market.
    c. *Accuracy and Reliability:*
        i. It is expected that the blood pressure measurements from the headphones should mirror that from a typical blood pressure cuff device.
            1. For healthy individuals: The diastolic should be within the range of 50-80. The systolic should be within the range of 100-120[1].
            2. For individuals with heart problems, these values should be either significantly higher or lower than these ranges.
    d. *Life in Service:*
        i. Lifespan is approximately two years.
    e. *Operating Environment:*
        i. The headphones will be exposed to a variety of conditions.
            1. The device will pick up measurements under heavy background noise.
            2. When used outside, the device will withstand environmental conditions such as severe humidity.
    f. *Ergonomics:*
        i. The headphones should be portable and easy to wear for the user with little to no weight difference to regular headphones.
            1. Exercise and most daily activities with this device should feel comfortable.
    g. *Size:*
        i. The headphones should not be too bulky on the head/ear.
        ii. The size will be similar to that of an average headphone.
    h. *Weight:*
        i. Mass and weight of the smart headphones shouldn't exceed 20% more than the mass and weight of normal air-pods or headphones
            1. A singular air-pod weighs 4.00 grams
            2. An average headphone weighs about 0.65 lbs

*i. Materials:*

i. The material should be smooth for the inner ear. The materials that can be used for this include several types of plastic, rubber, and bendable metals

ii. To detect signals, a microphone and/or an LED will be used.

**2. Production Characteristics**

*a. Target Product Cost:*

i. The research, development, and initial production should be within a $5,000 budget.

*b. Quantity:*

i. One set of headphones will be created for this project.

**3. Miscellaneous**

*a. Standards and Specifications:*

i. A user must not exceed over 80dB of sound over 48 hours[2]

*b. Customer:*

i. Adults from the age of 40 to 80 years old

*c. Patient Related Concerns:*

i. The user's data will be stored on the app.

*d. Competition:*

i. No known competing designs found.

**References:**

[1]"High blood pressure symptoms and causes," *Centers for Disease Control and Prevention*, 18-May-2021. [Online]. Available: https://www.cdc.gov/bloodpressure/about.htm. [Accessed: 19-Sep-2022].

[2]“Safe Listening Devices and Systems.” World Health Organization and International Telecommunication Union, Geneva, 2019. [Accessed: 23-Sep-2022].