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PROJECT OVERVIEW

SUMMARY

The Queen Bee is a haptic audio device that is worn around the user's neck in a similar fashion to wireless neck fans [1]. It receives signals and information from a mobile application via a bluetooth connection to produce haptic feedback for the user. This haptic feedback follows the beat of the music, with differing vibration patterns for different bass frequency ranges. The mobile application is responsible for decomposing and analyzing audio files to determine which haptic feedback patterns to display. Additionally, the mobile application allows for organization of music through playlists, browsing of music through various means, and visual feedback in the form of a music visualizer.

HOOK

This device will provide an alternate way of experiencing music to users who are interested in such an experience. Over recent years, there has been a surge of interest in expanding or altering the experience of "listening" to music, particularly with haptic feedback [2], [3], [4]. Many of these devices have a significant number of drawbacks, including size, positioning, and/or comfort. This project aims to fix these issues while providing a similar or improved experience [5], [6]. Additionally, such a product will allow those in the hearing impaired community to experience musical vibrations in an increased capacity.

OBJECTIVES

Through this project, we intend to:

- Provide convenient and more affordable access to an enhanced and different method of experiencing music;
- Create a device that provides a user with haptic feedback which varies based on the frequencies of music being played
- Create a mobile application for Android that has a user-friendly interface for organizing and playing music, while accurately decomposing music to influence the signals sent to the neckband's haptic motors.

For this project, the mobile application will need to:

- Work on an Android device;
- Freely access and analyze the music stored on the Android device;
- Able to stop, play, and skip through songs;
- Display an audio visualizers
- Provide some level of control over the haptic feedback in the neckband device

Additionally, the neckband device will need to:

- Be lightweight and well-shaped for user comfort;
- Have minimal to no wires for little to no hindrances

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PROJECT FEATURES

The Queen Bee product has four main features: a music player, music decomposition, a music visualizer, and haptic feedback.

MUSIC PLAYER

The music player function of the Queen Bee is based out of the mobile application. It will allow the user to view, play, pause, organize, and browse the music files stored on their device. The user will be able to view, select, and create playlists through the music player application and will additionally be able to add new songs to already-created playlists. The user will also be able to view their music by playlist or by A - Z ordered song name. The music player also displays information about the device, such as its connection state and its battery level.

MUSIC DECOMPOSITION

The music player application will also have a secondary background function to decompose music. This function will take an audio file and convert it to an audiowave, thereby allowing the analysis of the frequency waves present at any given time in an audio file. The analysis of these frequency waves will be used to influence other features of the product.

MUSIC VISUALIZER

The tertiary function of the mobile application is to display music visually. A music visualizer stand-alone is nothing new to the market, but it will round out the music player application nicely and provide additional sensory input in response to the music and the frequencies present in the music to create a more rounded, multi-sense experience for “listening” to music.

HAPTIC FEEDBACK

The sole function of the physical device is to receive signals from the music decomposition aspect of the mobile function and provide the user with haptic feedback based on the frequencies being recognized in the decomposition. The haptic feedback will be present just below the user’s collarbones and will be provided by haptic motors working in parallel.

SCOPE

NECKBAND DEVICE

The neckband device will contain 1 haptic driver, 1 external battery pack, 1 HC05 bluetooth module, an Arduino Nano, a miniature sized breadboard, and 2 vibration motors. It will be contained within a single casing with 1 external wire leading to the external battery (recommended for safety purposes of the prototype). One fully functional device will be created for final presentation.

MOBILE APPLICATION

The mobile application will contain 7 distinct screens:

- Home Page
- Song List
- Playlist List
  - With a filtered song list for each playlist
- Visualizer page
  - At least one visualizer option available

Additionally, the application will display the connection status on the home screen and allow the user to connect to the device should it not already be connected.

TARGET AUDIENCE

The Queen Bee targets individuals who wish to experience their music in a new and different manner. This psychographic profile includes users who simply enjoy music and new experiences, as well as users who are less able to experience music in the traditional auditory manner due to some level of hearing impairment. Behaviourally, the product will be intended for relatively stationary and slower moving activities, rather than active or sports use. Additionally, product use is expected to be approximately daily, at the same usage rate as a pair of headphones. The device will be designed to be usable by a broad demographic with nothing structurally to make it specific to a given gender or age group.

ACCESSIBILITY

The use of haptic motors to deliver a non-audible musical experience makes the Queen Bee a good candidate as an accessibility device for the hearing impaired community. However, to avoid the device becoming an identifier of disability, and thus a point of discrimination, we will not be specifically targetting only the hearing impaired community, though we will be including them in the process and consider them throughout development. We will endeavor to make the device as usable and useful to this community as possible throughout production by consulting with members of the community on its functionality and design and will make every effort to include the community as part of our user testing process.

Figure 1. Targetable factors in marketing and product development

DELIVERY METHOD

The Queen Bee product will be delivered as an in-person experience at the senior project fair. There are no current production plans beyond this experience.

ASSETS

PURPOSE

In order to ensure cohesive and refined branding and designs throughout the project, we have generated specific sets of assets as well as guidelines for use of our designated brand colors, fonts, and logos in further asset development. This will assist us in communicating with the public, as we will be recognizable, and allow us to hold our design standards to a higher, more consistent quality.

LOGO

Our logo options can be seen to the right hand side in Figures 2 and 3. In these samples, spacing guidelines are indicated with the red lines present and these guidelines should be followed when in use. All available logo options are to be provided in vector format to ensure clear, unpixelated resizing.

Our larger logo (Figure 2) has a different tilt on the hexagon. It is intended for use in larger products, such as marketing posters, documentation title pages, and social media. Our small logo (Figure 3) features a hexagon pointing upright and is intended for use in stationary branding, documentation headers and footers, and on the physical product.

Logos presented with a darker backdrop are to be used on lighter background colors only, while logos with a lighter backdrop are to be used on darker background colors only.

Figure 2. The large Buzzin' Bees logo.

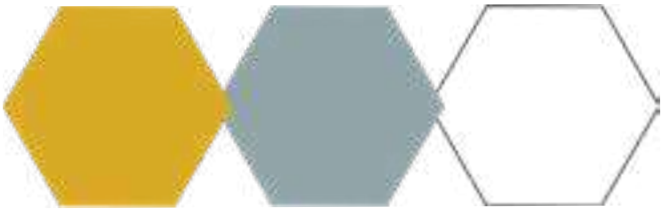
Figure 3. The small Buzzin' Bees logo.

COLOUR

For branding, we have both a primary color palette (Figure 4) and a secondary color palette (Figure 5). Our primary palette colors will appear in all designs and materials and is used for brand identification purposes. However, in certain situations, it is necessary to use similar colors outside of our primary palette for enhanced visual impact and balance. When this is necessary, only colors from our secondary palette should be used in conjunction with our primary palette.

CMYK: *80, 71, 51, 48* **WEB:** *2f3443*
CMYK: *20, 2, 6, 0* **WEB:** *c9e3e9*
CMYK: *2, 10, 53, 0* **WEB:** *fce08d*

Figure 4. The Buzzin' Bees primary colour palette.



CMYK: *15, 32, 100, 0* **WEB:** *dbaa27*
CMYK: *45, 27, 29, 0* **WEB:** *94a5aa*
CMYK: *0, 0, 0, 0* **WEB:** *ffffff*

Figure 5. The Buzzin' Bees secondary colour palette.

TYPOGRAPHY

Atrament [7] and New Frank [8] are the two official Buzzin' Bees fonts (Figures 6 and 7). The font colours are both primary and secondary colours, with specific colors used based on the background color of the material. In the case of a lighter background color, our darker colors will be used. In the case of a darker background color, our lighter colors will be used. This is to ensure contrast and readability.

Figure 6. A samples of the Atrament font.

Figure 7. A samples of the Frank New font.

Atrament will be primarily used for headers and title pages. It is to be used in capital letters with letter spacing of 50 points. This is for visual and aesthetic purposes. The use of capital letters allows for a bolder appearance, while the spacing allows for improved readability.

New Frank will primarily be used for body text and paragraphs for legibility and aesthetic purposes.

SHAPES & ICONS

The Buzzin' Bees main distinguishing attributes are bee icons and honeycombs. The bee reflects nature and a more organic approach. Bees follow a path to discover a new destination. They represent community, brightness and personal power. Ancient Druids saw the bee as symbolizing the sun, the Goddess, celebration and community [9]. The honeycomb is more representative of simplicity and is more geometric. It represents environmental protection, hard work, and the cooperation that exists inside the group.

From both a metaphoric and an aesthetic standpoint, the bee and honeycomb encompassed all that our company is.

SAMPLE

The sample is to showcase all the elements identified in the branding standards and how they can be applied to any design concepts, while keeping the brand integrated. Note the importance of these standards do not limit the flexibility of communicating various content with different tones and messages.

STATIONERY

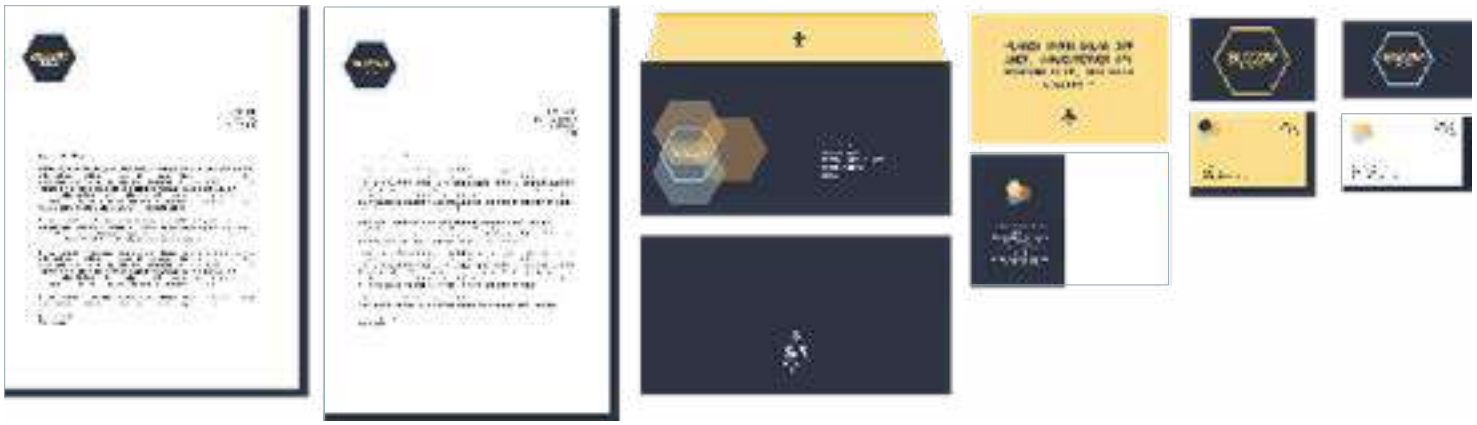


Figure 8. The Buzzin' Bees primary colour palette.

MUSIC

For our project, we will not be providing music assets as our decomposer will function with any and all songs the user can provide to the mobile application.

MOBILE APPLICATION

The mobile application will be developed and designed using Android Studio [10]. We will use GitHub [11] to house our repositories. Locally we will use the Git GUI client GitKraken [12] to more easily manage our code bases.

DEVELOPMENT

Our application development will be done within Android Studio. Android Studio is a free mobile application development environment for Android devices which multiple members of the team have at least a working understanding of in terms of the program's functions and its coding language (Java). Additionally, Android Studio allows for split development between the visual design and the functionality of the application, which will in turn allow us to split these components between multiple members of the team with little to no severe impacts or bottlenecks.

Our main task breakdown for the development being completed in Android Studio is as follows:

AUDIO DECOMPOSITION

Audio decomposition is to be developed in tandem with the Bluetooth communications (see below). It will be used for determining haptic patterns to send to our neckband device as well as for the animations contained within the application's music visualizer.

BLUETOOTH COMMUNICATIONS

Bluetooth communications, as mentioned above, will be developed in tandem with the audio decomposition. It will be in charge of sending the haptic patterns determined through the decomposition to the neckband device. We will be getting the Bluetooth connection transmitting data from an application as soon as possible.

AUDIO LIBRARY MANAGEMENT

As a lower priority task, audio library management will be developed as far as is necessary for testing audio decomposition and will then be placed on hold until our high priority development tasks are completed. After this, it will become a higher priority and will continue with development into something more refined and user-friendly.

APPLICATION DESIGN

Application design will continue to be developed throughout the production process. During earlier stages, it will focus on paper wireframes and development of the basic visual style, all of which will be informed by user testing. As this progresses, it will be developed in tandem with the audio library management system as well as separately where needed to ensure good user flow through the pages, a cohesive visual style throughout the project, and a pleasing experience with the visualizer itself.

APPLICATION FEATURES LIST

AUDIO DECOMPOSITION

Audio decomposition will be completed using Android Studio's Visualizer class. This will break the audio data into waveform data, which we can then analyze for specific frequency ranges. We will use bass frequencies for our targeted effects.

HAPTIC PATTERNS

Our chosen haptic driver has a wide variety of vibration patterns available for use. Through user testing, we determined that the best patterns for our project were the following:

Effect #1 (Strong Click, 100% strength)

Effect #4 (Sharp Click, 100% strength)

Effect #7 (Soft Bump, 100% strength)

Effect #24 (Sharp Tick, 100% strength)

Effect #47 (Buzz 1, 100% strength)

The exact vibration pattern playing at any given point will be determined by the decomposed audio data in the following manner:

Effect #1 will play when the FFT data reads strongest at 91.0 or above

Effect #4 will play when FFT data reads strongest between 36.0 and 60.9

Effect #7 will play when FFT data reads strongest between 61.0 and 90.9

Effect #24 will play when FFT data reads strongest between 16.0 and 35.9

Effect #47 will play when FFT data reads strongest between 0.0 and 15.9

VISUALIZERS

The visualizer will also use the audio decomposition data to create a visual experience within the application. It will have various animations that are affected by the frequency ranges recognized at any given time as well as the relative volume of these ranges in comparison to each other.

BLUETOOTH COMMUNICATION

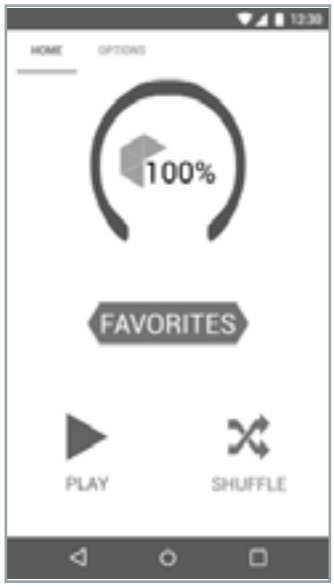
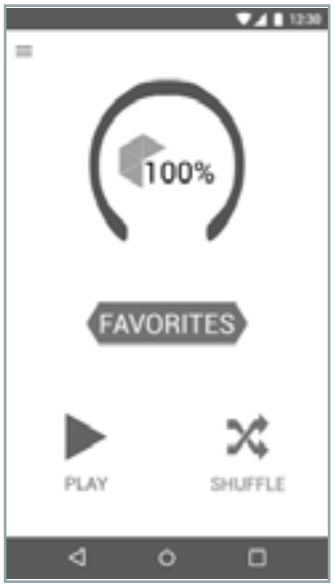
The application will be able to connect to our physical device using a Bluetooth connection, allowing the application to send signals to the neckband and influence the haptic motors.

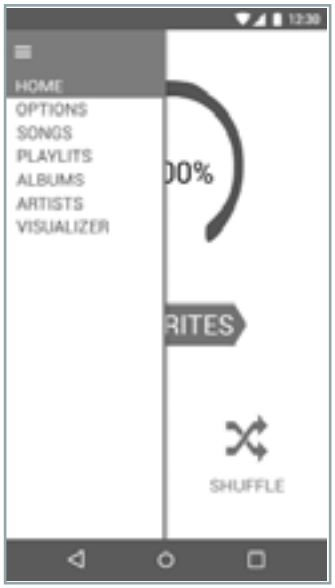
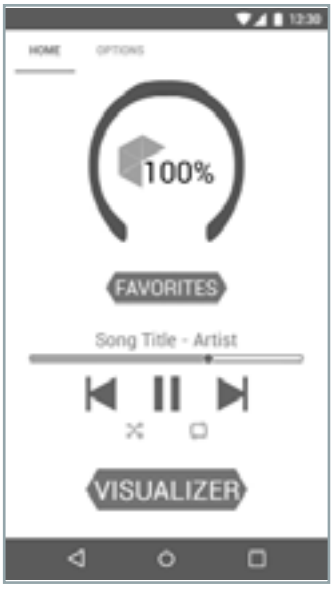
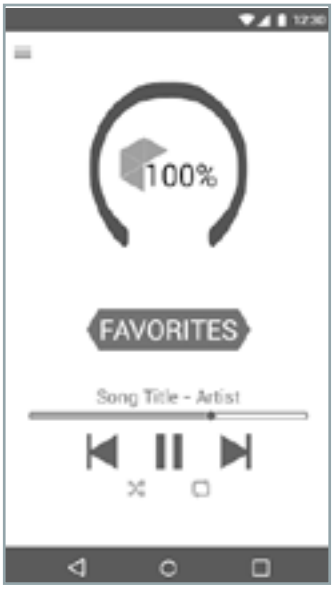
AUDIO LIBRARY MANAGEMENT

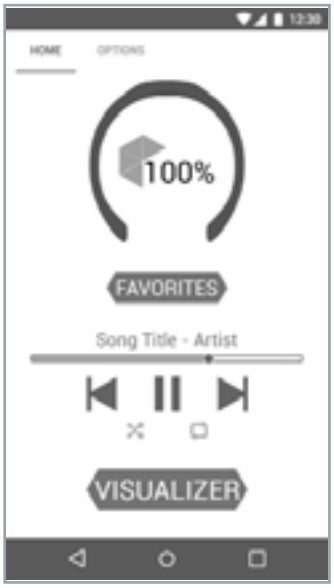
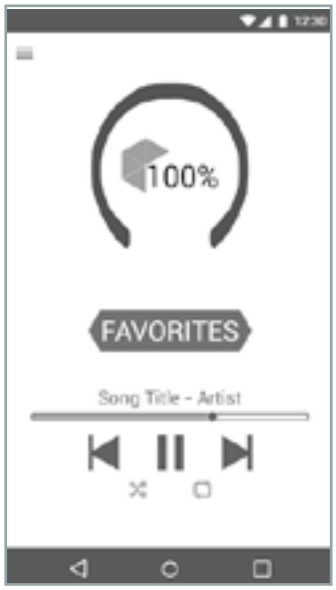
The application will be able to manage and organize a library of audio files. The user will be able to create and edit their own playlists, as well as view the whole library alphabetically by song.

WIREFRAMES

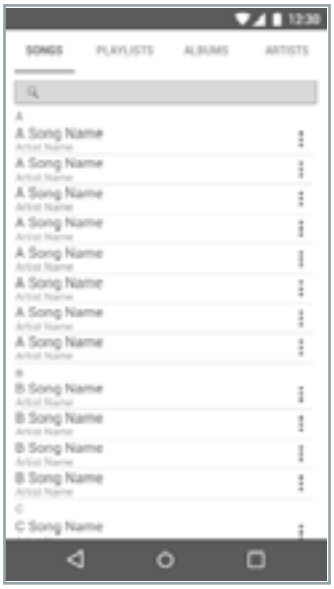
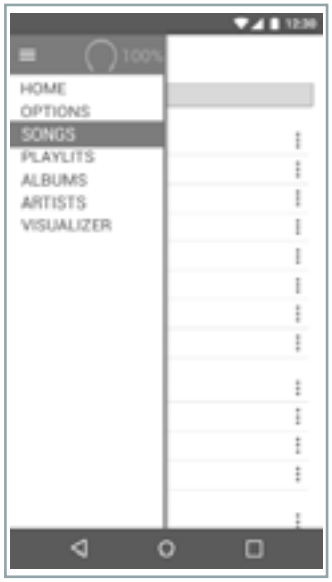
The following images are the wireframes for our mobile application. As we have two possible navigation types (discussed in Methods of Navigation), we have wireframes for both. Our tabbed navigation is presented on the left, with our navigational drawer navigation on the right. In instances where the screen is identical, there will be only one larger image, and in instances were the screen is only present in one navigational method, the image will be smaller and on the respective side to fall under the related wireframes. Additionally, on the right of each image set is a description labelling the screen, the state, and discussing the content and available interactions. These wireframes were used for user testing and were the initial inspiration for the application. However, final screenshots of the developed and branded application can be seen in the XML Layouts section below.

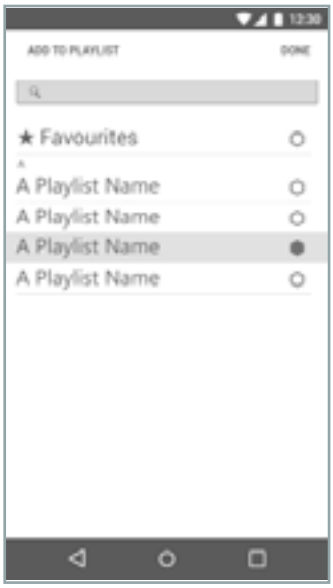
NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**SCREEN** • Home **STATE** • Device Connected • No Music Playing • Navigation Drawer Inactive* **ABOUT** • Main landing page • Displays battery percentage of device and navigation options • Displays Recently played queue **INTERACTIONS** • Navigation Tabs – Click or Swipe to change page • Navigation Drawer* – Click icon to open drawer • Music Queue Button [“Favourites”] – Open up music library • Play/Shuffle play – Play from currently selected music queue

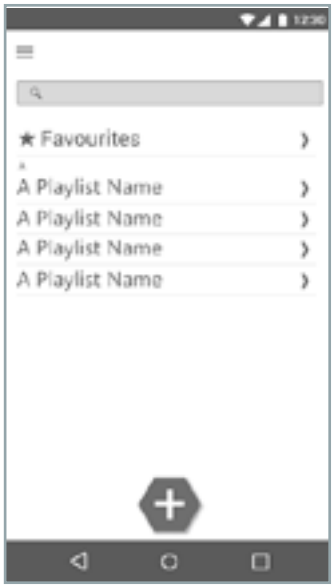
NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**SCREEN** • Home **STATE** • Device Connected • No Music Playing • Navigation Drawer Active* **ABOUT** • Navigation Drawer indicates current page to user and available pages to navigate to **INTERACTIONS** • Navigation Drawer – press page name to change view – \press menu icon to close drawer
		**SCREEN** • Home **STATE** • Device Connected • No Music Playing • Navigation Drawer Inactive* **ABOUT** • Control change when music is playing • Displays music player including song title • Old controls still available

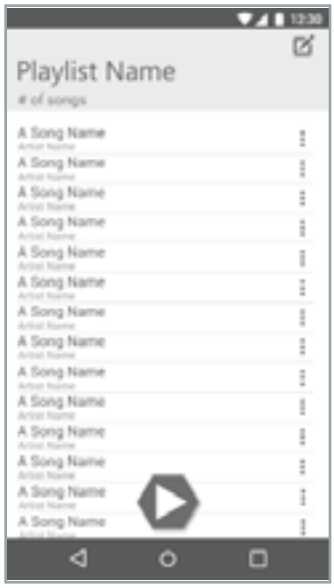
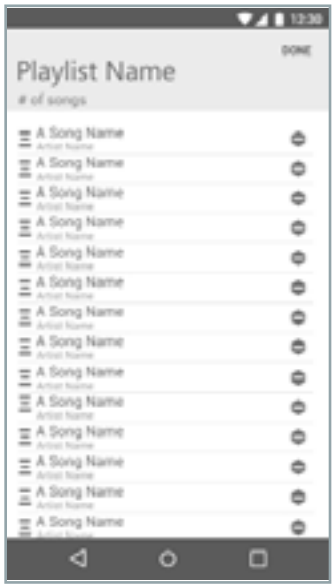
NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**INTERACTIONS** • Navigation Tabs – Click or Swipe to change page • Navigation Drawer* – Click icon to open drawer • Music Queue Button [“Favourites”] – Open up music library • Visualizer button – Click to change to the visualizer page • Pause – Pause current music • Skip Next/Back – Change songs to next/previous in queue • Loop – Loop current song • Shuffle – Play shuffled music queue • Scrub – Scrub through music on the slider
		**SCREEN** • Home **STATE** • Device Not Connected **ABOUT** • Device indicates to user that device is not connected to mobile • Other controls are disabled **INTERACTIONS** • Connect Button – Click to navigate to Android OS Bluetooth connection page

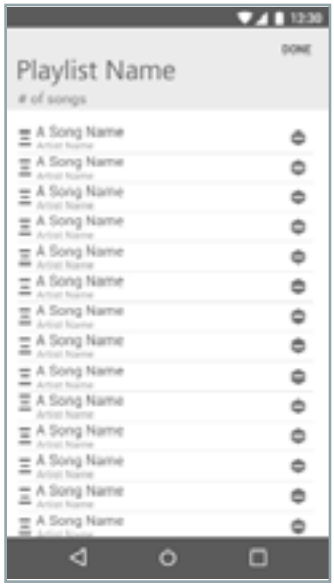
NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**SCREEN** • Options **STATE** • Navigation Drawer Inactive* **ABOUT** • Displays the options available for the user to modify as well as monitor more in depth information on the device/app **INTERACTIONS** • Navigation Tabs – Click or Swipe to change page • Navigation Drawer* – Click icon to open drawer • Vibration Strength Slider – Set the strength of the motors in the device • Bluetooth settings – Opens up Android OS bluetooth page • Dark Mode – Changes color palette of app
		**SCREEN** • Options **STATE** • Navigation Drawer Active* **ABOUT** • Navigation Drawer indicates current page to user and available pages to navigate to **INTERACTIONS** • Navigation Drawer – Press page name to change view – Press menu icon to close drawer

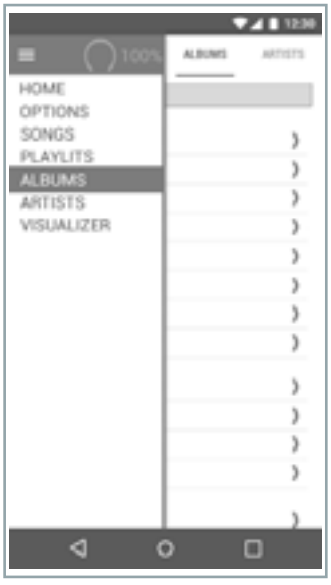
NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**SCREEN** • Songs **STATE** • Navigation Drawer Inactive* • No Music Playing **ABOUT** • Page shows all songs in alphabetical order **INTERACTIONS** • Navigation Tabs – Click or Swipe to change page • Navigation Drawer* – Click icon to open drawer • Search bar – Click to open OS keyboard – Filter songs through search text • Song option button – Opens up popup menu • Song button – Immediately plays selected song
		**SCREEN** • Songs **STATE** • Navigation Drawer Active* **ABOUT** • Navigation Drawer indicates current page to user and available pages to navigate to **INTERACTIONS** • Navigation Drawer – Press page name to change view – Press menu icon to close drawer

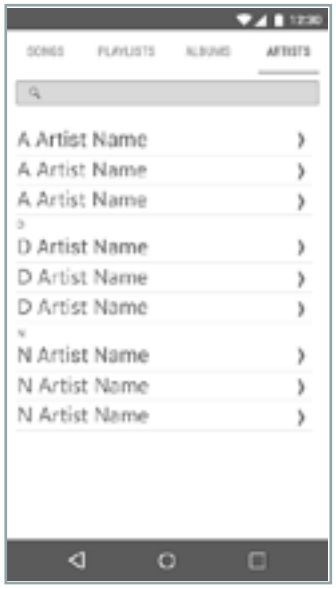
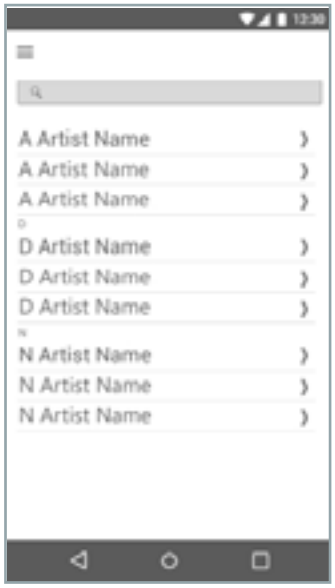
NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**SCREEN** • Songs **STATE** • Song Popup Menu active **ABOUT** • Page shows all songs in alphabetical order **INTERACTIONS** • Screen – Press anywhere on screen to exit menu • Play next – Adds song into queue • Add to Playlist – Changes view to the add to playlist page • Add to Favorites – Quick add to Favourites playlist
		**SCREEN** • Add to Playlist **STATE** • Adding song to playlist **ABOUT** • Appears when the “add to playlist” button is pressed from the song option menu • Allows user to quickly add song to multiple playlists at once **INTERACTIONS** • Select – Press to select playlist – Press again to deselect playlist • Done – Adds songs into selected playlist – Returns user to Songs page

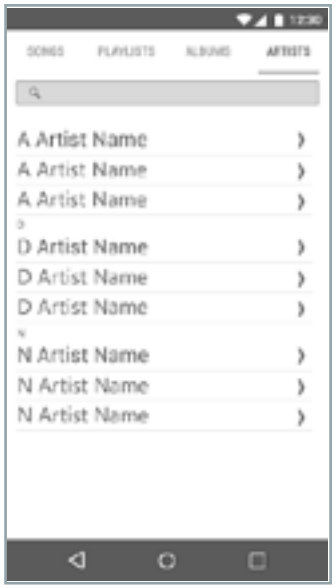
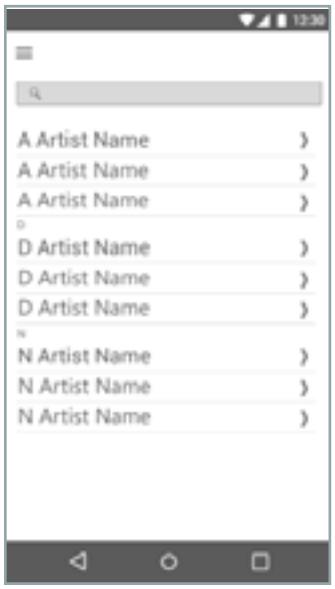
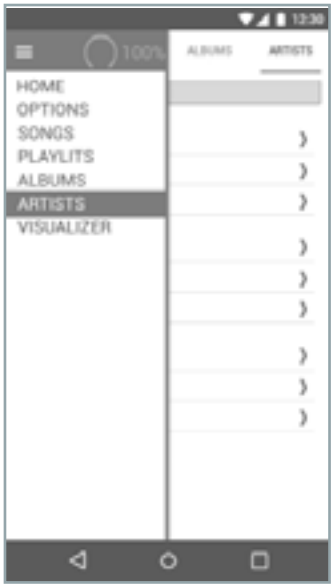
NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**SCREEN** • Playlists **STATE** • Navigation Drawer Inactive* • No Music Playing **ABOUT** • Shows all of the user's custom playlists in alphabetical order, with the default Favourites always present at the top of the list **INTERACTIONS** • Navigation Tabs – Click or Swipe to change page • Navigation Drawer* – Click icon to open drawer • Search bar – Click to open OS keyboard – Filter songs through search text • Playlist button – Progress to playlist page – Long press to play • New playlist button – Changes view to New Playlist page
		**SCREEN** • Playlists **STATE** • Navigation Drawer Active* **ABOUT** • Navigation Drawer indicates current page to user and available pages to navigate to **INTERACTIONS** • Navigation Drawer – Press page name to change view – Press menu icon to close drawer

NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**SCREEN** • Playlist **STATE** • No Music Playing • Edit mode inactive **ABOUT** • Shows Playlist content and allows users to play and edit the list **INTERACTIONS** • Play button – Changes current music queue to that of the playlist – Plays playlist from first song • Song button – Changes current music queue to that of the playlist – Plays playlist from song selected • Song option button – Opens up popup menu – (see song popup menu page) • Edit button – Enables edit mode on playlist
		**SCREEN** • Add to Playlist **STATE** • No Music Playing • Edit mode active **ABOUT** • Shows Playlist content and allows users to play and edit the list

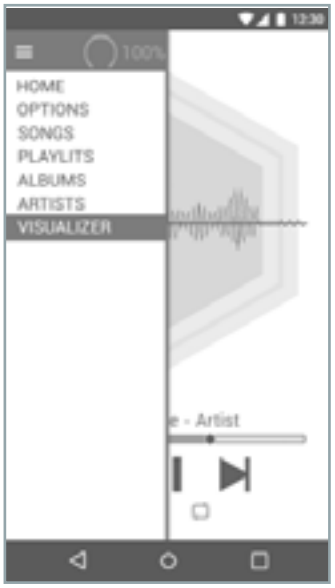
NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**INTERACTIONS** • Done – Saves changes to playlist • Back – Leaves edit without saving changes • Playlist Name – Click name to bring up OS keyboard and edit playlist name • Song move button – Hold and drag song bar to change the order of the playlist • Remove song button – Removes song from playlist
		**SCREEN** • Add to Playlist **STATE** • Adding song to playlist **ABOUT** • Appears when the “add to playlist” button is pressed from the song option menu • Allows user to quickly add song to multiple playlists at once **INTERACTIONS** • Select – Press to select playlist – Press again to deselect playlist • Done – Adds songs into selected playlist – Returns user to Songs page

NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**SCREEN** • Albums **STATE** • Navigation Drawer Inactive* • No Music Playing **ABOUT** • Shows all of the albums within the users device in alphabetical order. **INTERACTIONS** • Navigation Tabs – Click or Swipe to change page • Navigation Drawer* – Click icon to open drawer • Search bar – Click to open OS keyboard – Filter songs through search text • Album button – Progress to album page – Long press to play from selected album
		**SCREEN** • Albums **STATE** • Navigation Drawer Active* **ABOUT** • Navigation Drawer indicates current page to user and available pages to navigate to **INTERACTIONS** • Navigation Drawer – Press page name to change view – Press menu icon to close drawer

NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**SCREEN** • Playlists **STATE** • No Music Playing **ABOUT** • Shows album content **INTERACTIONS** • Play button – Changes current music queue to that of the album – Plays album from first song • Song button – Changes current music queue to that of the playlist – Plays playlist from song selected • Song option button – Opens up popup menu – (see song popup menu page)
		**SCREEN** • Artisrts **STATE** • Navigation Drawer Inactive* • No Music Playing **ABOUT** • Shows all of the artists within the users device in alphabetical order.

NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**INTERACTIONS** • Navigation Tabs – Click or Swipe to change page • Navigation Drawer* – Click icon to open drawer • Search bar – Click to open OS keyboard – Filter songs through search text • Artist button – Progress to artist page – Long press to play from selected artist
		**SCREEN** • Albums **STATE** • Navigation Drawer Active* **ABOUT** • Navigation Drawer indicates current page to user and available pages to navigate to **INTERACTIONS** • Navigation Drawer – Press page name to change view – Press menu icon to close drawer

NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**SCREEN** • Artist **STATE** • No Music Playing **ABOUT** • Shows all of the albums and songs related to artist in alphabetical order **INTERACTIONS** • Play button – Changes current music queue to that of the album – Plays album from first song • Album Button – Opens up album page • Song button – Changes current music queue to that of the playlist – Plays playlist from song selected • Song option button – Opens up popup menu (see song popup menu page)
		**SCREEN** • Visualizer **STATE** • Music Playing • Navigation Drawer Inactive* **ABOUT** • Graphics respond in real time to the music being streamed through the device • Controls allow user to direct the music listening experience

NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**INTERACTIONS** • Pause – Pause current music • Play – Visible when music is paused – Plays music • Skip Next/Back – Change songs to next/previous in queue • Loop – Loop current song • Shuffle – Play shuffled music queue • Scrub – Scrub through music on the slider • Control visibility – Press the screen to toggle control visibility
		**SCREEN** • Visualizer **STATE** • Navigation Drawer Active* **ABOUT** • Navigation Drawer indicates current page to user and available pages to navigate to **INTERACTIONS** • Navigation Drawer – Press page name to change view – Press menu icon to close drawer

NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**SCREEN** • Music Controls bottom screen ticker • Any music library page excluding the "add to playlist" and "add new playlist" pages **STATE** • Music Playing **ABOUT** • Bar appears on lower portion of the screen while in the music library and music is playing/paused • Limited controls Icons indicate if loop or shuffle is active, but are not interactive **INTERACTIONS** • Pause – Pause current music • Play – Visible when music is paused – Plays music – Play shuffled music queue • Scrub – Scrub through music on the slider
		**SCREEN** • Widget • Seen in OS pulldown menu **STATE** • App Open • Music Playing • Device Connected **ABOUT** • Gives user access to app and device status outside of the application while it is still open on the mobile device

NAVIGATION TYPE 1: TABS	NAVIGATION TYPE 2: DRAWER	DESCRIPTION
		**INTERACTIONS** • Pause – Pause current music • Play – Visible when music is paused – Plays music • Skip Next/Back – Change songs to next/previous in queue • Loop – Loop current song • Shuffle – Play shuffled music queue • Scrub – Scrub through music on the slider • Stop – Stops playing music queue completely

XML LAYOUTS

The wireframes above were used as a base to develop the application, although some design changes were made during the application development and design user testing. Final XML layouts, with color and branding implemtened, can be viewed below.

[A] [B]

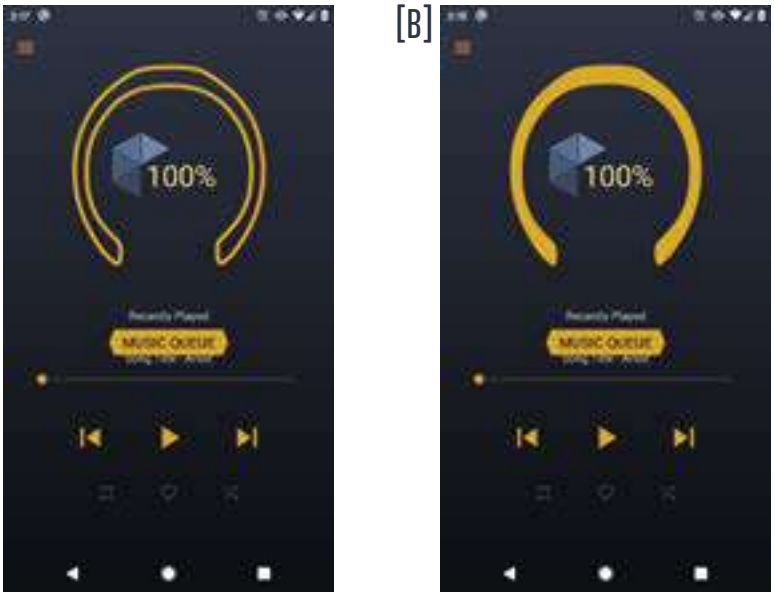


Figure 9. Home page XML, colored and branded, in both (a) disconnected and (b) connected states.

[A] [B]

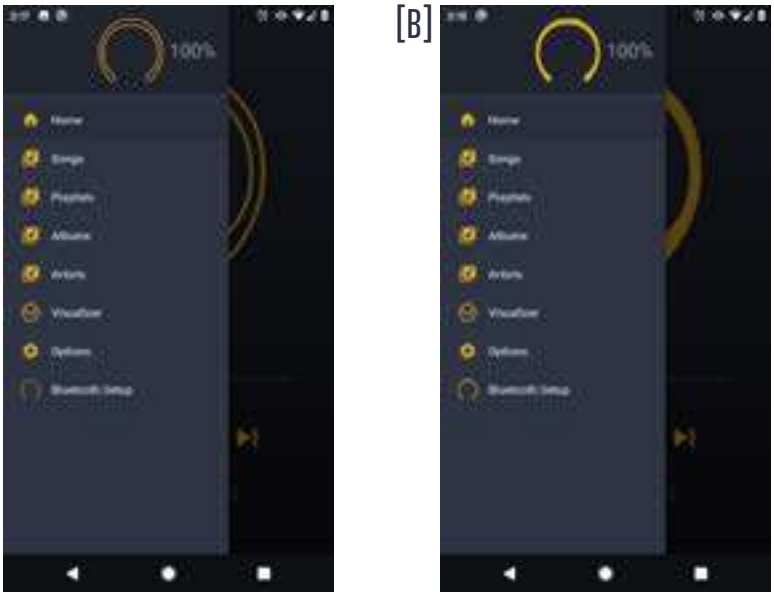


Figure 10. Nagivation Drawer XML, colored and branded, in both (a) disconnected and (b) connected states.

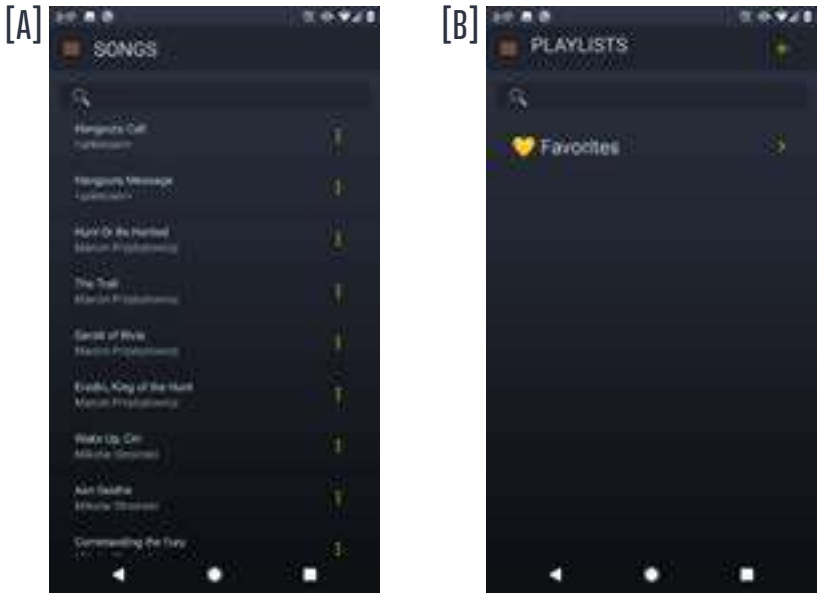


Figure 11. XML song list pages, featuring (a) the list of all songs and (b) the playlists page.

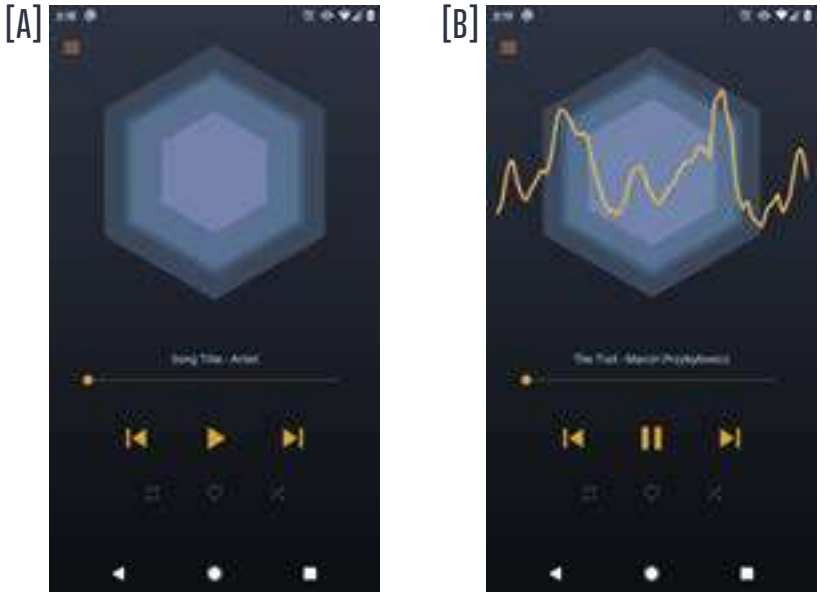


Figure 12. Visualizer XML, colored and branded, in both (a) not-playing and (b) playing states.

Figure 13. Bluetooth XML, colored and branded, with (a) initial load, (b) connection search, (c) connection selection, and (d) connected screens.

CONTROL SUMMARY

Below is all of our planned controls for our application.

PLAY

The Play function will start playback of a selected audio file.

PAUSE

The Pause function will pause playback of whatever audio file is currently playing.

SHUFFLE

The Shuffle function will shuffle the queue of audio files so that playback is randomized.

CREATE PLAYLIST

The Create Playlist function will allow users to create a new playlist, consisting of a user-defined set of audio files.

SELECT PLAYLIST

The Select Playlist function will bring users to a song list which contains only songs assigned to the selected playlist.

ADD TO PLAYLIST

The Add to Playlist function will add the selected song to a user-defined playlist.

SELECT VISUALIZER MODE

The Select Visualizer Mode will switch the current view (whichever view it may be) to the audio visualizer.

SELECT SONG

The Select Song function will allow a user to select a specific audio file without immediately playing it.

SONG MENU BUTTON

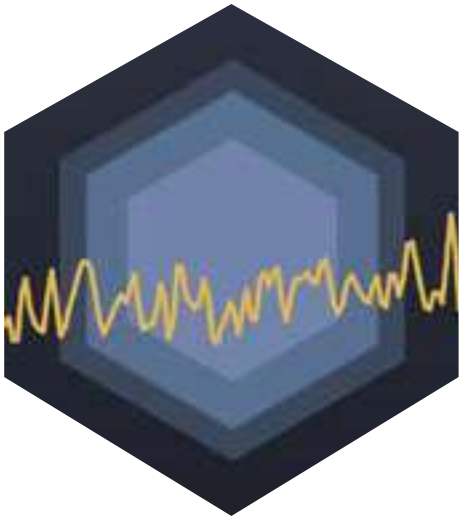
The Song Menu button will open an option menu that allows the user to either add the song to a custom playlist or quick-add/remove the song from the 'Favourites' playlist.

CONNECT TO BLUETOOTH

Users must activate the bluetooth functionality on their mobile device for it to connect to the neckband device. They will do this either manually through their mobile device's Bluetooth settings (external to the application) or through a button in the application that will prompt users to allow a Bluetooth connection.

VISUALIZER

Our visualizer will utilize 2D graphics for better performance and less lag during the use of the visualizer. Additionally, this will reduce battery consumption of the mobile device the music player is located on. The graphic elements will be made featuring our branding color palettes and will respond to different frequencies and song volume.



GRAPHICS

- Layered hexagons
- Waveform

RESPONSES

- Size of outer hexagon increases based on song volume at current time; inner hexagons are time-lapsed from this
- Waveform displays frequencies in song at current time

APPLICATION FLOW

The following figures demonstrate user control flows through each page of the mobile application.

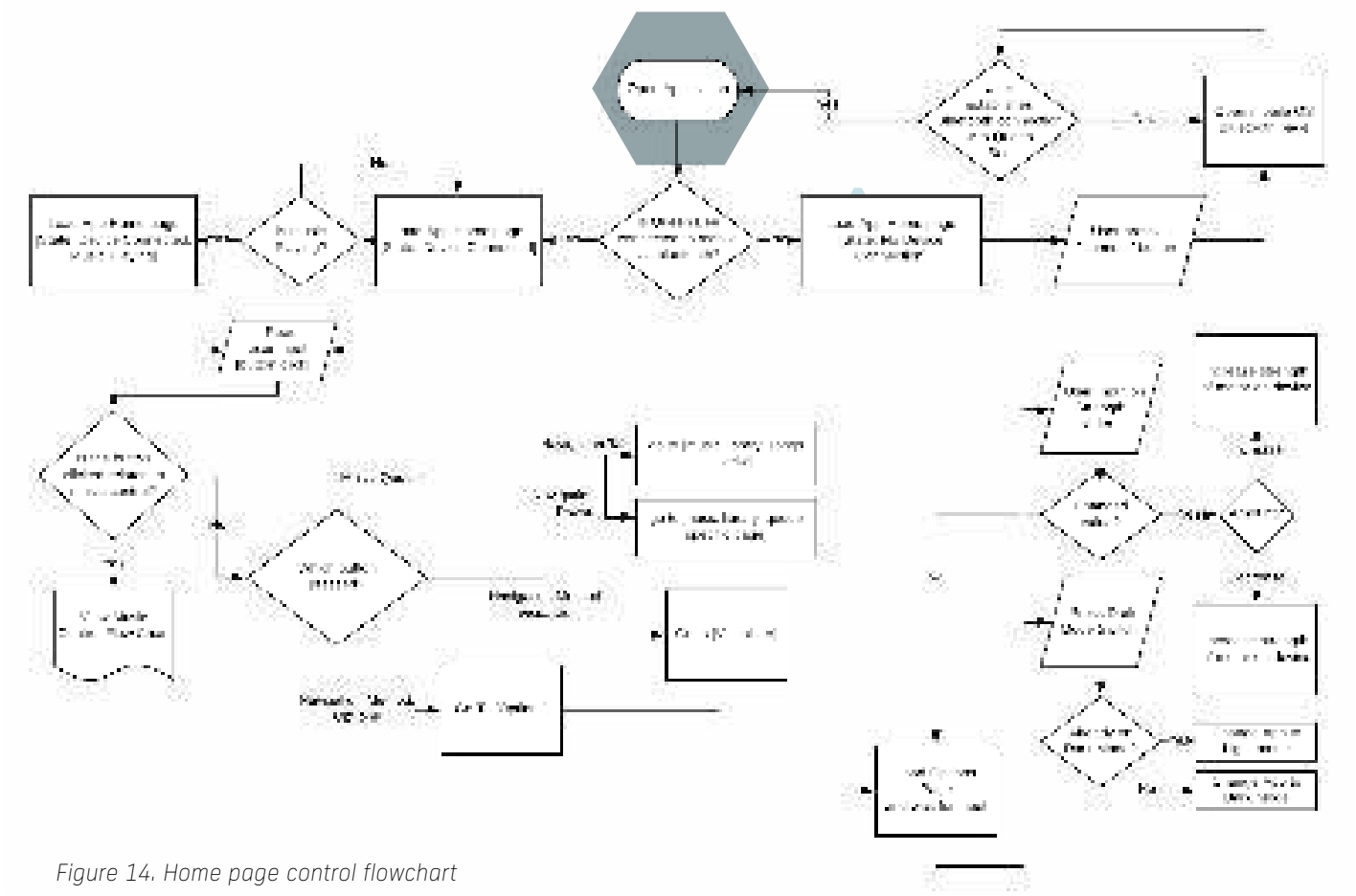


Figure 14. Home page control flowchart

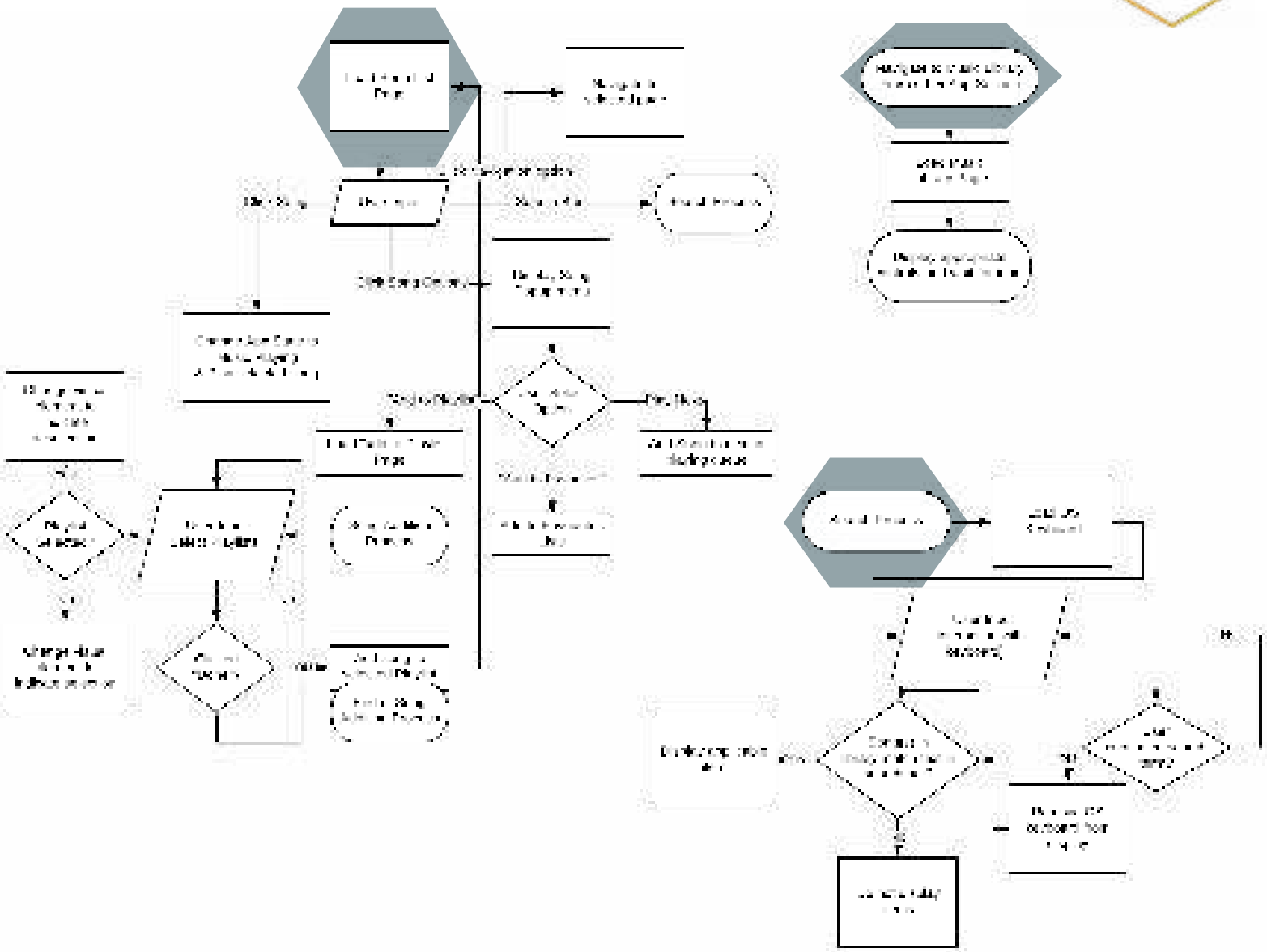


Figure 15. Song list page control flowchart.

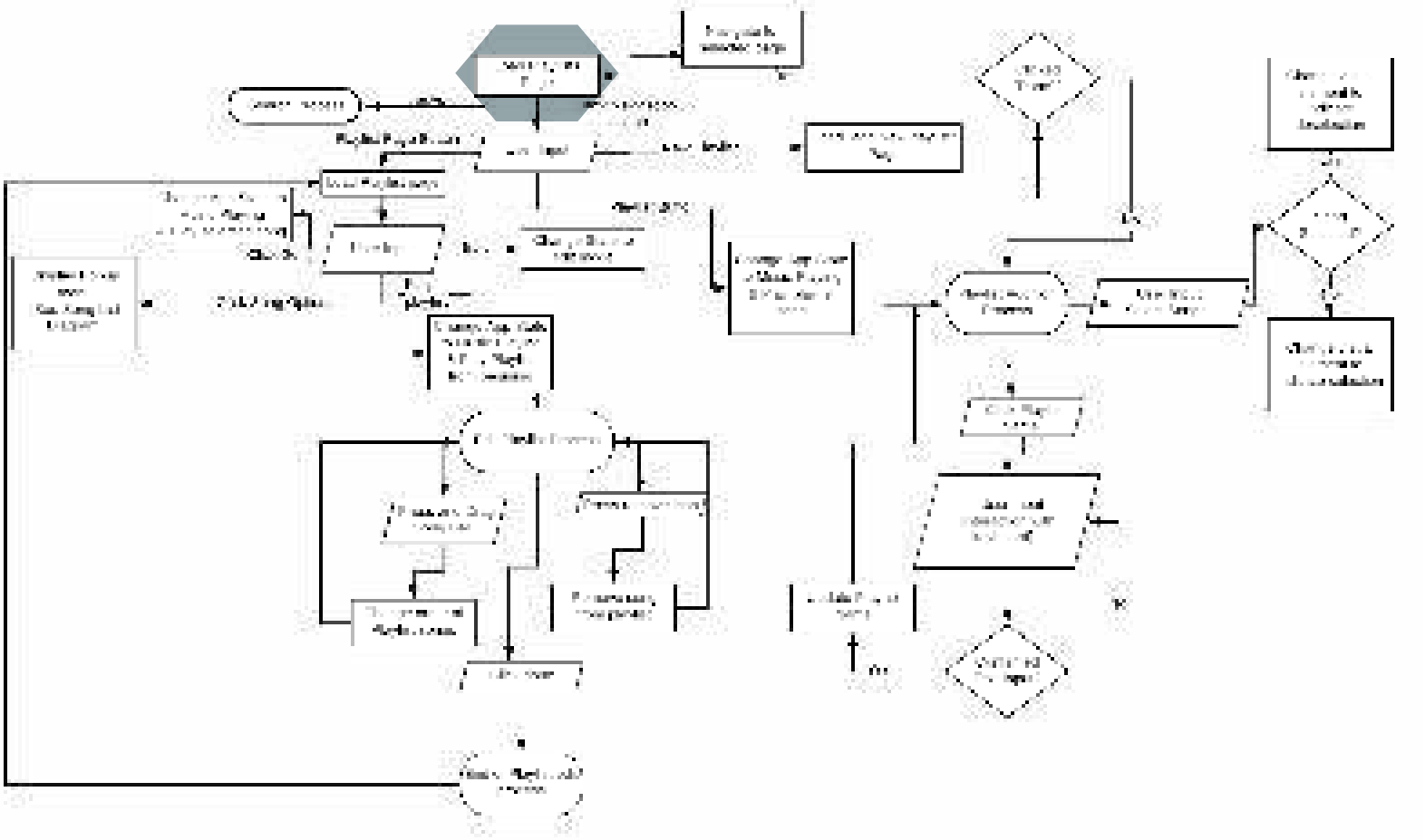


Figure 16. Playlist page control flowchart.

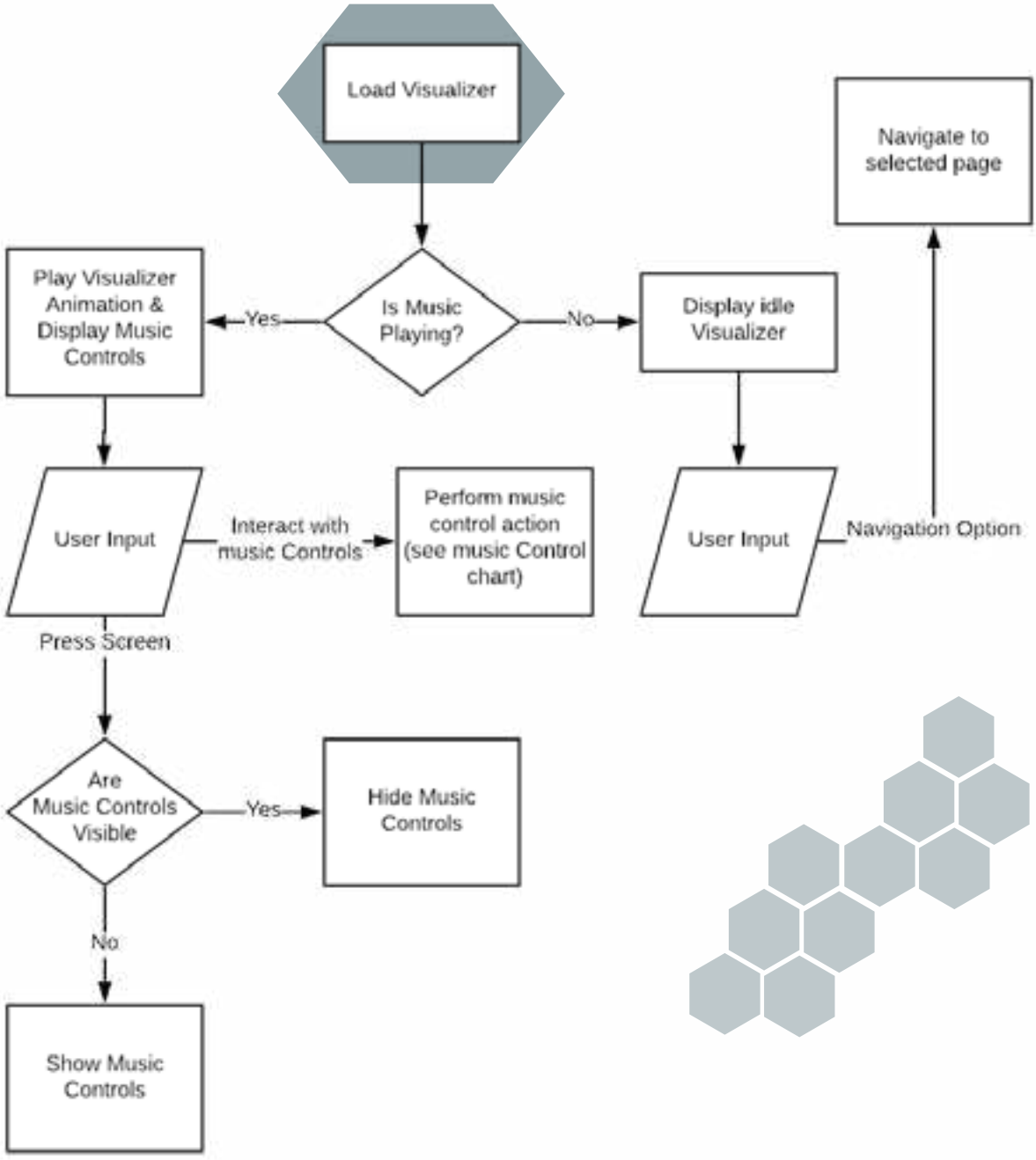


Figure 17. Music visualizer flowchart.

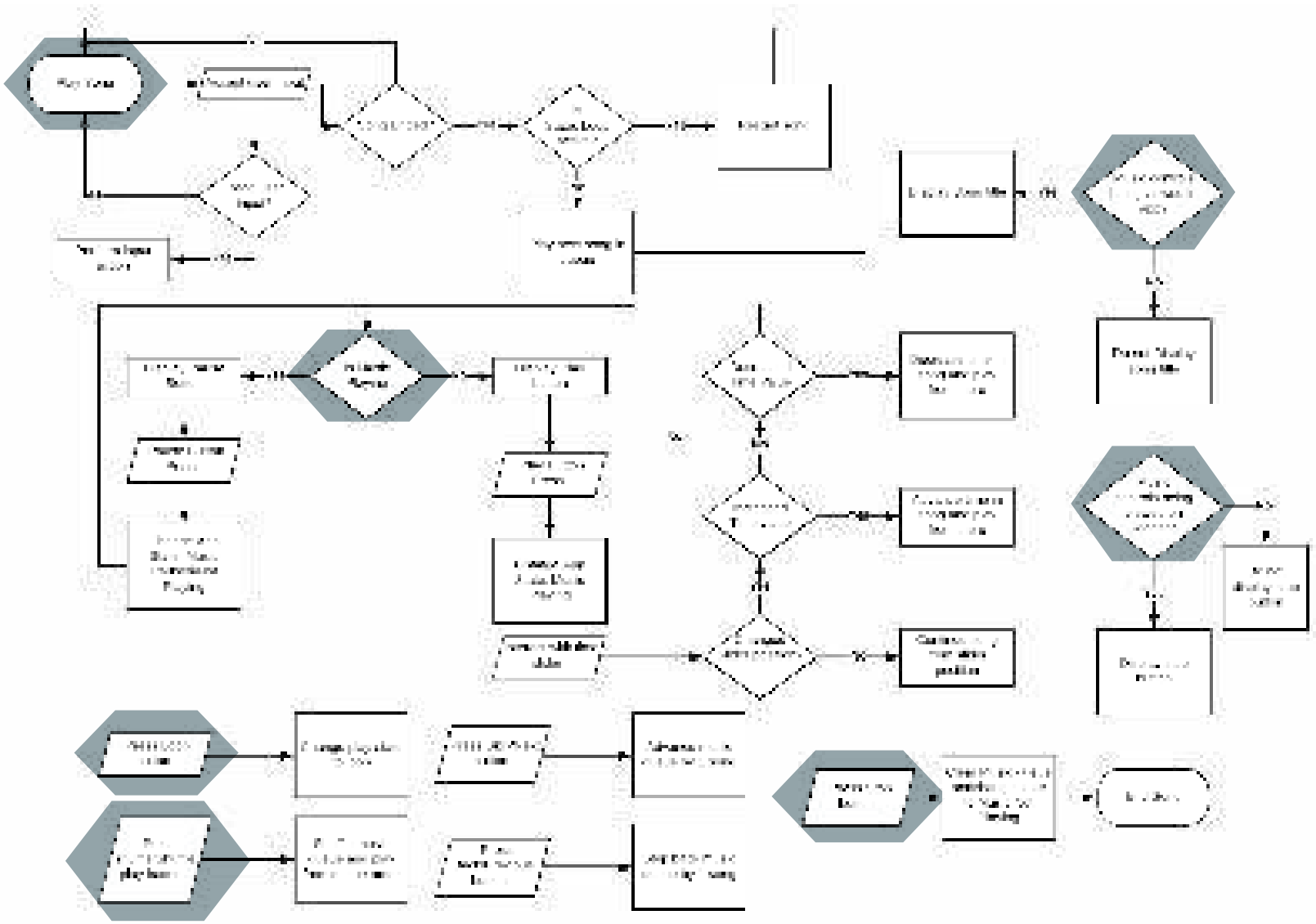


Figure 18. Music controls flowchart.

METHOD OF NAVIGATION

Our application is split into three main functions: monitoring of the neckband device, the music library with song organization, and the music visualizer component. Navigating between different pages related to these functions can be done in three possible ways: a navigation drawer (hamburger menu), a bottom navigation bar, or a tabbed content setup [13]. To determine the most user-friendly form of navigation for our application, we ran a user test of application flow with the navigation drawer and the bottom bar tabs. This resulted in the final decision to use the navigation drawer method. A summary of each considered method can be found below.

NAVIGATION DRAWER

The navigation drawer option in Android places a button in the top left corner of the application [14]. Users can then interact with this button to open up a side card with top-level destinations the user is capable of navigating to. Typically, this method is recommended for applications with five or more top-level pages. If we place the music library pages as top-level pages (Songs, Playlists, and so on), then we would have four top-level pages, making this a distinct option for navigating our mobile application.

TABBED NAVIGATION

In Android, tabs are typically found in the top portion of the page and list the pages available for users to navigate to [15]. They are recommended for use when pages have a similar context or hierarchy but contain differing information or usage goals. Although there is no recommended grouping size for tabs, due to horizontal scrolling, it is still easier and more accessible to navigate tabs when the tabs are fixed with no horizontal scrolling. As such, fewer tabs is more feasible. As our content can also be split up into three distinct hierarchical groups, tabs have also been deemed a plausible fit for navigating our application.

BOTTOM NAVIGATION

An alternative to the above two options is the bottom navigation. This form of navigation uses either icons or a combination of icons and text to communicate different page groups available to the user [16]. It is best used with three to five top-level destinations. We have chosen to not consider this form of navigation, however we do intend to look into it further should user testing on the previous two navigation methods not prove easily usable or either tested navigational method requires a secondary menu option.

Firgure 19. Mockup of possible bottom bar if implemented

VERSION CONTROL

All of our code bases will be stored in our group's GitHub page [17]. There will be three repositories:

- the project website;
- the Arduino code and haptic driver libraries; and,
- the Android Application, which will have four branches:
  - Bluetooth communication;
  - audio decomposition;
  - audio library management; and,
  - visual layout.

GitKraken will be used to manage these repositories locally.

WEARABLE

In this section we will be discussing the components of the wearable device, along with reasons and considerations of the design.

Figure 20. Illustration of neckband being worn.

NECKBAND USE

CONVENIENCE

The device can be small without interfering with additional wearables, such as SmartWatches, or other items, such as clothing, backpacks, etc, allowing it to be discreet.

The device would be easy to put on and off and would be held in place by gravity, negating any need for straps, closures, or anything of the sort to hold it in place.

LOCATION CONSIDERATION

The back of neck is highly innervated and much more sensitive, so caution is needed. The device must be well-shaped and lightweight and, preferably, a little bit flexible to account for different body types.

The front of chest and collarbone area are innervated, but underneath thicker muscle and bone primarily, which can make it more difficult to feel faint sensations or smaller changes in sensation.

The musculocutaneous nerve is part of a nerve cluster that runs just underneath the humerus bone and has a much thinner layer of muscle over top of it (see Figure 21). This muscle provides a buffer, while still leaving the nerve itself available to sense the haptic vibrations easily.

Figure 21. A diagram of the musculocutaneous nerve (yellow) [18]

Caution is needed using the musculocutaneous nerve, as it is sensitive and has the ability to produce acute and chronic pain, weakness, and circulation issues. These issues usually only arise in individuals with pre-existing internal issues from Thoracic Outlet Syndrome, but nonetheless, we will be aiming to keep the neckband light.

DEVELOPMENT

ARDUINO

During development, the goal of the Arduino software and code is to pass the Adafruit vibration patterns (see Components and Materials) to the connected vibration motors. Additionally, it will handle the bluetooth data that will be received from the phone

Figure 22. The Android Studio icon

Figure 23. Visual Studio Code icon

PRE-PRODUCTION

BLUEPRINTS

When designing our blueprints (Figures 26 and 27), we researched the measurements of various neckband devices, including fully-extended over-the-ear headphones, and averaged the circumference measurements we found. We also took into consideration the sizes of the circuitry we planned on using to ensure the chips, motors, and wiring could all be contained within the neckband device. To avoid as bulky of a back piece on the neckband, we oriented the chips in an upright position, so that the bulk rested down the nape of the neck instead. The battery is then placed furthest from the neck for improved heat transfer to keep the battery (and the back of the user's neck) cooler. We also included gooseneck tubing inside the neckband's arms to allow for a semi-customizable fit of the neckband. The gooseneck tubes are flexible enough to bend with directed pressure, stiff enough to hold their shape without direct pressure from the user, and do not stiffen further after extended use as marature wire would.

Figure 24. Adobe Photoshop icon

Figure 25. Adobe Illustrator icon

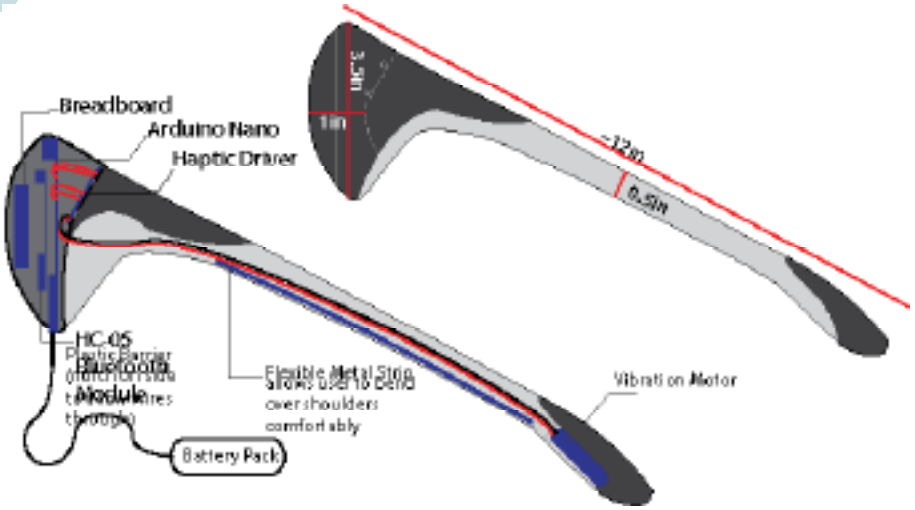


Figure 26. The side view blueprint of our planned neckband.

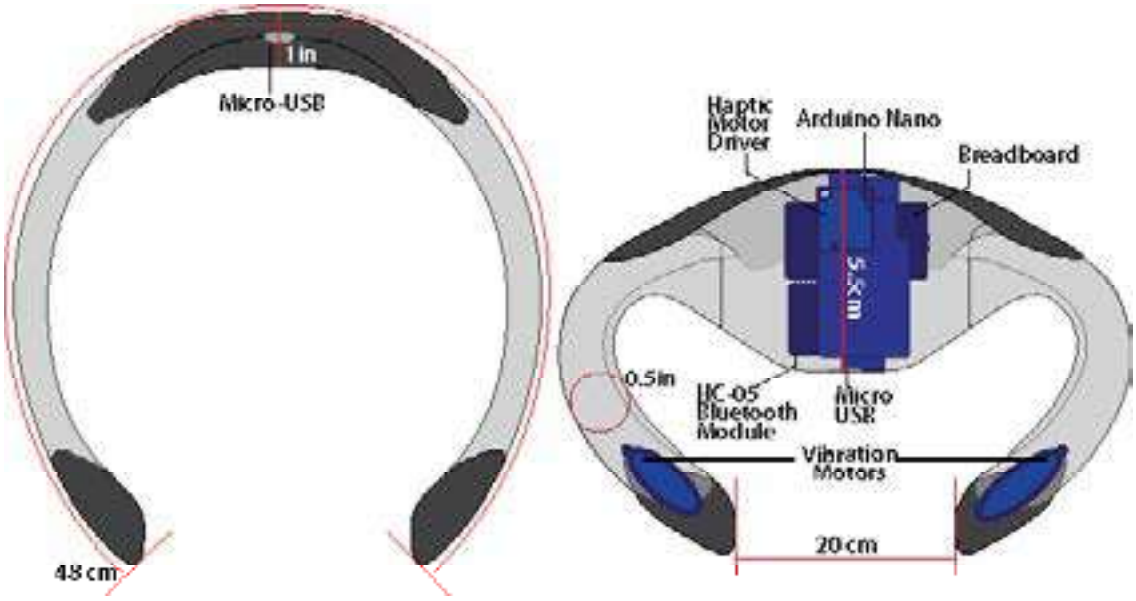


Figure 27. The top and perspective view blueprints of our planned neckband.

MODELING IN MAYA

Based off the produced blueprint, we used specific measurements in order to model the neckband in Maya (Figure 28 through 30). The file is editable in case we encounter adjustments that need to be made during user testing. If we deem it to be necessary, we will be creating more than one size, however, we intend on creating a 'one-size-fits-all' device with the help of the selected flexible filament (see Components and Materials). The model itself requires two portions in which to house the vibration motors. These sections would have a slight downwards curve to them to rest near the collarbones of the user. We decided to have this section sit near the collarbones as it is an anatomical section which features a cluster of nerves.

The back of the neckband will be greater in size as it houses the Arduino Nano, HC05 bluetooth module, breadboard, and haptic driver (along with accompanying wires). The model accounts for a USB port opening that will allow for a user to plug in their external battery to the Arduino Nano as a source of power. The Maya model also accounts for panels which leave open slots for the team to insert the internal components and access these components to fix and/or replace components as needed. Finally, a back clip and vibration motor clips are included in the model. These clips hold the panels in place as well as provided added support and protection to the internal components, due to being printed in a non-flexible PVA.

Figure 28. Top view of the neckband model.

Figure 29. Persepctive view of the neckband model.

Figure 30. Persepctive view of the neckband clips.

CIRCUIT TESTING

Three separate circuit tests were completed, with each test building off what was learned in the last to reach our final circuitry.

The first test included the use of an Arduino Uno, a breadboard, and vibration motor. We simply connected the Arduino to the breadboard in order to supply power and an output to the vibration motor. This test made us come to the realization that we would like to have a greater variation of effects outputting from the vibration motors instead of a simple binary on/off function. This led us to the discovery of the Adafruit haptic driver and its numerous effect capabilities.

The second test included the use of an Arduino Uno, an Adafruit haptic driver chip, a breadboard, and a vibration motor. The addition of the haptic driver allowed for a various amount of effects to be outputted to the vibration motor. This was great for testing purposes, however, we are looking to create a wireless connection from the phone application to the neckband. This would require a bluetooth chip with the same capabilities as the Arduino Uno. This is when we came across the nRF52840 mini breakout board.

The third test included the use of the mini breakout board as well as a compatible battery. This test would verify the recharging capabilities of the battery. We have since moved on to establish a bluetooth connection from an Android device to the mini breakout board.

COMPONENTS & MATERIALS

Prior to deciding which components would be the best for our build, we ran numerous tests and researched the best type of components to incorporate inside the neckband, as well as the type of material to use to encase those components. The following materials are those that we anticipated using and/or did use during the build of the Queen Bee.

BLUETOOTH CONNECTION - nRF52840 MINI DEVELOPMENT BOARD

A main priority of ours was to achieve a seamless, light, and cordless design. This detail meant that, although a basic Arduino Uno or nano board could achieve these goals, they would not check the cordless requirement. This drove our research towards the nRF52840 Mini Development Board [19]. The nRF52840 consists of many features, however, there are a few notable ones that are useful for our project. It consists of Bluetooth 5 which is considerably better than Bluetooth 4.2 due to the faster speed, further range capabilities, lower power requirements, and message capacity, to name a few of the improved features [20]. The mini development board is, in simple terms, remapped to have the same pin features as a arduino uno (Figure 31). However, it is much smaller, hence, lighter. Ultimately, this chip was decided against for the final prototype. Due to lack of development resources, we were unable to determine how to fix power supply issues that the nRF52840 board had, which prevented a paired connection from being available. We instead chose to use the HC05 bluetooth module discussed below.

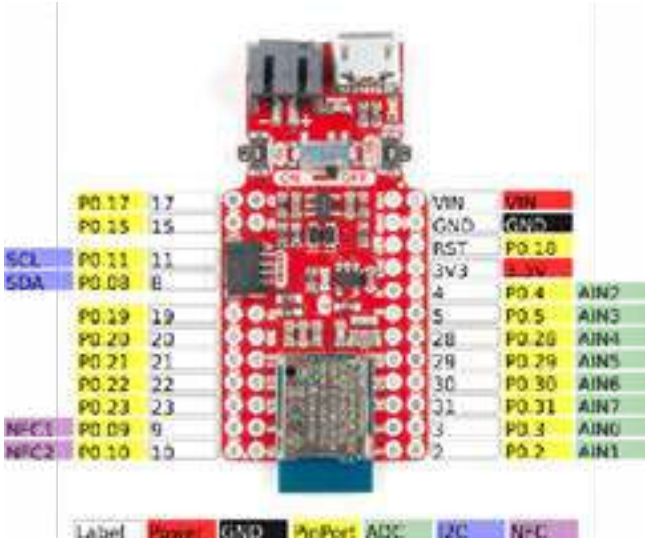


Figure 31. Pin mapping diagram of the nRF52840 Mini Breakout Board.

HC05 BLUETOOTH MODULE AND ARDUINO NANO

In order to achieve a reliable bluetooth connection that allowed for device pairing, we resorted to the HC05 bluetooth module. This module uses bluetooth low energy (BLE) to share data between devices. The chip is lightweight and small enough to fit in our neckband, while allowing transmission of the type of data we need to transmit. In addition, there are many more development resources for this module than the nRF52840 board. We will pair it with the Arduino Nano; the smallest available Arduino, in an effort to keep the neckband as slim and lightweight as possible.

Figure 32. The HC05 bluetooth module.

Figure 33. The Arduino Nano.

HAPTIC DRIVER

As the sound decomposition process will be producing different frequency ranges, the team was looking for a way to transform these frequencies into unique haptics. We encountered the Adafruit haptic driver [21]. This haptic driver contained an Arduino library of over 110 unique vibration patterns. A sample of these is visible in Figure 34. This feature would allow us to differentiate frequencies instead of having a simple binary (on/off) output to the haptic motors. The Adafruit haptic driver is approximately the same size of a quarter (see Figure 35).

Effect ID#	Waveform Name
1	Strong click – 100%
2	Strong click – 60%
3	Strong click – 30%
4	Sharp click – 100%
5	Sharp click – 60%
6	Sharp click – 30%
7	Soft bump – 100%
8	Soft bump – 60%
9	Soft bump – 30%
10	Double click – 100%

Figure 34. A sampling of the haptic patterns available with the Adafruit haptic driver.

Figure 35. A size comparison of the Adafruit haptic driver.

HAPTIC MOTORS

Once again, a main priority of our was to obtain a lightweight design. However, we did not want to sacrifice the quality of the components that we were using. This is when we came across the small, yet powerful, vibration motors sold by SparkFun [22]. The haptic motors are smaller than a quarter (see Figure 36). We will be using two of these motors by circuiting them in parallel in order to achieve a balanced design. As they are circuited in parallel to the haptic driver, both motors will be outputting identical patterns based on the communicated frequencies. This was decided as an alternative to needing an additional haptic driver, which would have added more weight to the product, defeating one of our main priorities of a lightweight product.

Figure 36. A size comparison of the SparkFun haptic motor.

Ni-Mh AAAA BATTERIES, 500mAh

Prior to designing the final product, we expressed interest in our product having rechargeability. We realised that once plugged into the USB B port, an attached battery would need recharging. While understanding the requirements of the mini development board, it was recommended to avoid using any lithium-ion battery as they do carry a negative history. Lithium batteries require proper ventilation and cautious circuiting, as they otherwise may explode. Due to these repercussions, we decided to explore further into other rechargeable products that would achieve the same capabilities. This is when we came across Geilienergy batteries [23]. They carry over-voltage, over-current, over-charge, and short-circuit protection. These batteries would limit risk while maintaining our goal. However, due to circuiting changes made mid-term, a rechargable battery of any kind no longer functions with our circuit and so we changed to an external battery pack.

Figure 37. The Geilienergy battery packs.

EXTERNAL BATTERY PACK

As mentioned, an internal rechargable battery pack is no longer feasible with our updated circuit. However, we can still have some level of rechargability by using an external battery pack. Any commercial external battery pack will provide ample power to our device; no specific battery pack is required at this time.

3D PRINTING OF THE QUEEN BEE

Prior to printing, the team discussed the Queen Bee's capabilities relating to our target audience and users. In attempts to avoid exclusion, we came up with the idea of having a "one-size-fits-all" neckband. However, this would require product flexibility. We believe that using the Ultimaker 3D Extendable would allow for a greater bed size, hence, more room to produce 2 clean prints for the top and bottom pieces of the collar. The multiple printing setting allows us to choose between a custom percentage of infil while printing as well as structural supports while printing. Along similar lines, we require 2 separate filaments and 2 different nozzles:

- TPU 95 filament (thermo polyurethane) which requires a nozzle of AA 0.4
- PVA water dissolvable filament which requires a BB 0.4 nozzle

The process will create a durable yet flexible product which will be able to carry internal chips.

We also encountered the Forms Labs 3D laser printer. This option is an alternative, but requires printing in 8 separate pieces and much higher amounts of post-printing prototyping, construction, and alterations to the collar. We will only be using this in case we come across issues with the Ultimaker.

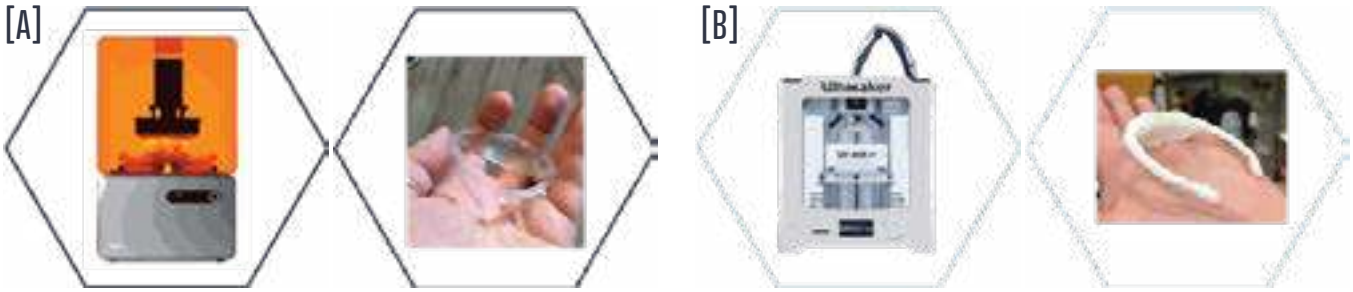


Figure 38. The mini test prints of the neckband via (a) the Forms Labs 3D laser printer and (b) the Ultimaker 3D Extendable printer.

CIRCUIT DIAGRAMS

The iniital circuit in Figure 39 is how we planned on producing our product. On the left, we have the mini breakout board. The board itself will be communicating to the application via Bluetooth 5 and will be receiving frequency instructions based on the decomposed music. Once instructions have been received, it will use the analog pins to signal the haptic driver, which will output the correct library pattern to the vibration motors.

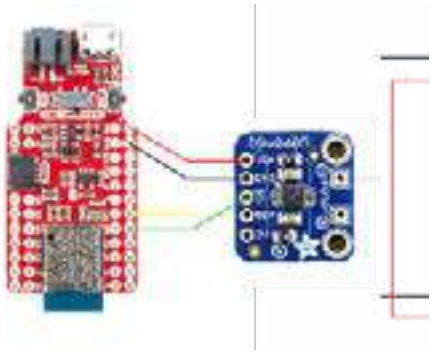


Figure 39. The circuit diagram of the Queen Bee, with the mini breakout board (left), Adafruit haptic driver (middle), and vibration motors (right).

As mentioned previously, issues were encountered using the main piece of the above circuit: the nRF SparkFun bluetooth development board. After ample testing to determine the source of our circuiting issues, we concluded that the issue was this board and that we would need to develop an alternate circuit with a different bluetooth chip. This caused a circuit change to the circuit displayed in Figure 39 to the circuit in Figure 40. This updated circuit has an Arduino Nano and HC05 bluetooth chip in place of the previous nRF SparkFun board. This results in the need for external power and therefore the need for one wire running between the external battery pack and the neckband.

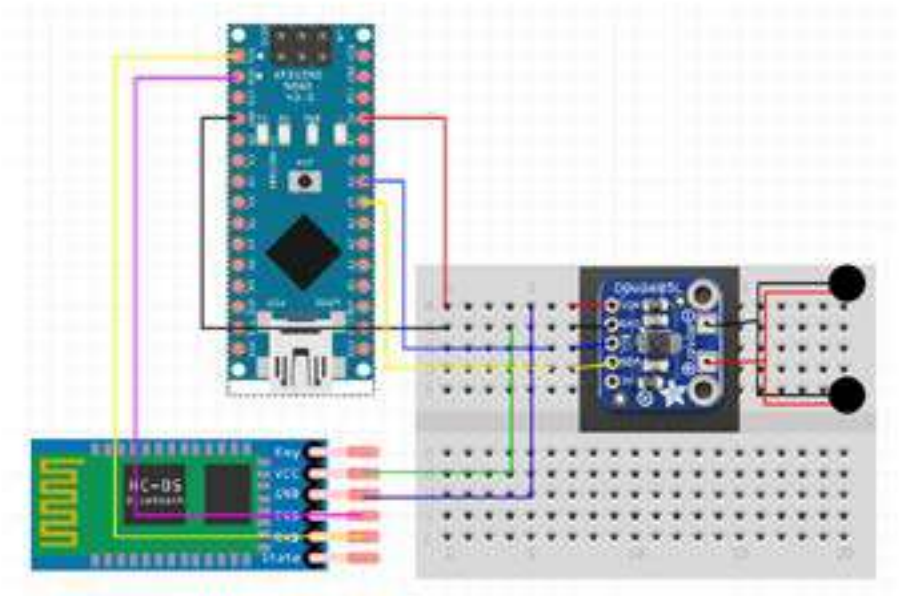


Figure 40. The updated circuit of the Queen Bee.

CONTROL SUMMARY

This control summary relates to the physical controls found on the exterior of the neckband.

POWER ON/ POWER OFF

To provide power to the neckband, the user will plug the battery pack into the neckband via a USB

USER TESTING

As our product is both a physical device and a mobile application working in tandem, we believe it is necessary to refine our designs beyond this document through as many user tests as possible. This is particularly important to ensure that both pieces of our product function well individually as well as together, and that each serves its purpose within the experience and is not seen as useless and extraneous to the experience. As such, we have planned three user tests for the mobile application, two user tests for aspects of the physical device, and a final user test for the experience as a whole once both the application and the device are communicating correctly.

MOBILE APPLICATION FLOW TEST

The Mobile Application Flow Test will be the first user test conducted and will be run with two separate flows through the application's screens. The purpose of this test is to determine which flow is more natural for the user and so participants will be separated into two separate groups: one group for flow A, one group for flow B.

Each participant, regardless of group, will be tested in person with an identical questionnaire (see Appendix A). Assignment of a person to group A or B will be at random, through simply alternating back and forth between the two different flows for each test. This will ensure a roughly equal number of users for each test, regardless of any other personal identifiers.

Tests will be conducted in person and the test as a whole will have a minimum of 10 participants (5 participants per group). The test will be run by one facilitator who has not worked on the mobile application and will have at least one notetaker. Contact information will be taken on separate documents for participants who wish to be kept informed of our progress or participate in further user tests that do not conflict with this test.

MOBILE APPLICATION DESIGN TEST

The Mobile Application Design Test will be looking at the colored mockups of the application screens. It will be used to ensure the buttons that do not have a text label are intuitive to users and that the design does not have issues with aspects such as font readability and contrast. Questions are available in Appendix B.

The test will be an online survey run through Google Forms with a minimum of 10 participants and no maximum. There will be a link provided for a separate survey so that participants can enter contact information anonymously, should they wish to be kept informed on the progress of the product's development or participate in further user tests which do not conflict with this test.

MOBILE APPLICATION HOME PAGE DESIGN TEST

We believed it was important to achieve a high level of clarity on the first screen users would see in the application - the home page. As such, there was an additional Google Forms survey compiled to test different home page layouts for clarity and further iconography clarification.

The test will be an online survey run through Google Forms with a minimum of 10 participants and no maximum. There will be a link provided for a separate survey so that participants can enter contact information anonymously, should they wish to be kept informed on the progress of the product's development or participate in further user tests which do not conflict with this test.

DEVICE LOOK & FEEL TEST

The Device Look and Feel Test will be conducted within the first month of development to ensure the physical device is appropriately light, comfortable, and reasonable shaped and sized for users. Although the device will not be branded or circuited, and so will have no functionality, it will be printed at full size, assembled, and have the casing smoothed out as if it were a completed product. Any buttons or switches that would be labelled on the final product will also be labeled for this test, although labelling may be done with permanent marker. Buttons or switches intended to be left unlabelled will be represented as such.

The test will be conducted in person with at least 5 participants. There will be one facilitator who has not worked on the construction or design of the physical device as well as at least one notetaker. Participants will be asked a variety of questions to determine if the use of the device is clear and if the device fits our design goals in terms of comfort (see Appendix D). If participants are interested in participating in other user testing or wish to be kept up to date on our development, their contact information will be taken on a separate document so as to keep the tests anonymous.

HAPTIC SENSOR STRENGTH TEST

Our Haptic Sensor Strength Test will be inteded to test the viability of feeling vibrations of haptic motors we chose, viability of feeling the vibration patterns we chose, and feasibility of feeling differences between the vibration patterns we selected. This will allow us to ensure that the product does what it is supposed to and will inform us as to how many vibration patterns we can and should include in our final product.

Tests will be conducted in person with at least 5 participants. The facilitators will conduct comparison tests of an unknown “Pattern A” and unknown “Pattern B”, during which participants will be asked to identify if they felt both patterns. If they are, users will be asked if they could discern a difference between these two patterns.

EXPERIENCE TEST

As a result of the Covid-19 pandemic, this user test was unable to be completed as scheduled. However, in future iterations of this project, it remains *highly* recommended.

As the last user test, we will be looking at the experience as a whole. The test will be run in person and will test the application and device together. As such, this user test will be our longest and most in-depth test. The test will be run by one facilitator - ideally one who has not worked heavily on the programming and construction of the product although this may become unavoidable throughout development. There will additionally be at least one notetaker. Participants will be asked to consent to audio, video, and screen recording, although only screen recording will be mandatory to remain in the study. The complete protocol can be found in Appendix E.

MARKETING

SOCIAL MEDIA

Our social media efforts create a simple outlet to reach a wide audience of potential customers and investors. By keeping an online presence from the outset of our project, it establishes a sense of loyalty. This can humanize the brand to our audience as they embark on the journey with us, seeing our hard work and dedication throughout the development of our product.

As we finalize our product and prepare for the launch we will utilize our social media platforms to create a large buzz for our product. This will also aide in chartering relationships with future businesses and hiring partners.

In efforts to create an online presence, we have created two separate social media accounts:

Instagram: @_buzzinbees
Facebook: Buzzin' Bees

Additionally, we will create at least one Snapchat filter for the Senior Project Fair.

WEBSITE

The objective of our website is to promote our company and product, all whilst marketing and informing the public of our key elements. The website itself use our branding package; including colours, fonts and our logo. The website will be made in a responsive manner to allow for viewing on all devices. A sample of the website is provided in Appendix F, but the full site can be viewed at: https://buzzinbees.site.

NAVIGATION

Navigation will be located on the top menu bar which will be presented in a banner-like display on page load. Once the user scrolls past a designated point on the page, the banner will collapse in and change to a fixed top menu which takes up a minimal portion of the user's screen. This will ensure that the menu is always easily accessible while maintaining a large view space for website content.

Additionally, there will be a footer bar. This footer bar will contain links which lead off of the website to involved organizations (Carleton University, Algonquin College, and the Bachelor of Information Technology home pages) in the form of hyperlinked logos. Also within the footer bar will be hyperlinks to the Buzzin' Bees social media accounts (Facebook and Instagram).

LAYOUT & STRUCTURE

The website will have three distinct pages: the Index page (“The Queen Bee”), the Design Process page, and the Team page. All three pages will be linked from the main navigation menu at the top of each page.

The index page will be the landing page for the website. It will contain all the necessary information about the product in terms of what it is and what it does. If we were to market this product actively and produce it for the public, this page would also contain the price and a link to purchase the device. The Design Process page will contain information regarding the design of the device. This will include more specific information than the Index page, including the materials used and specifications of the circuitry involved. Minimum system specifications for the mobile application will also be listed on this page.

The Team page will contain a brief overview of each team member, their role within the team, and their photo. Additionally, any pertinent contact information will be displayed within each team member’s profile.

PLANNED PROMOTIONAL MATERIALS

In efforts to promote our product to the public as well as future employers, we will be producing promotional material to distribute near Senior Project Fair day.

BUSINESS CARDS

Each team member will have their name and role listed. This will be accompanied by examples of a few major tasks they completed over the course of the year to contribute to Senior Project. This will be of great use for any potential hiring industry professionals.

STICKERS

Souvenir stickers will be handed out to the public during the Fair.

PROMOTIONAL VIDEO

A promotional video which includes the creation process of the product will be featured during Senior Project Fair. It will include an informative voice-over for spectators to enhance the experience. This promotional video will be completed with the help of Adobe After Effects, Adobe Premiere Pro, and Adobe Audition.

TEAM T-SHIRTS

In efforts to be recognized by the public during Senior Project Fair day, we plan on getting t-shirts made with our team logo, as well as our roles clearly labelled.

SENIOR PROJECT FAIR VISION

For the Fair, we have a very distinct end vision and goal of how our station will look to best emphasize the product (Figure 41). We anticipate having two large, portrait-orientation posters with team member pictures, roles, and tasks on either side of a table found in the middle. The table will have all prototype versions and iterations in order. In the front and center of the table, we will have a bust that will be holding the functional product. Behind this main prototype table, we will have a TV that will be demonstrating our promotional video to the public.

Figure 41. A rendering of the planned senior project fair set-up.

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APPENDIX A

NAVIGATION TEST

Introduction
Thank you for agreeing to test our application. Before we begin, we will be taking notes about what you say and do during this process. These notes will not be attached to your name in any way.

Do we have your permission to take notes? Y / N

(If no, politely end the test, thanking them for their time.)

During today's tests, we are hoping to see how our mobile application screens flow and how user-friendly the options presented are. Currently, we are in the design phase and so all application screens will be paper sketches during this test. You will be asked a variety of general questions as well as some questions specific to the sketches provided to you. Some of these questions may be tasks.

It is important to understand that during this process, there are no wrong answers or incorrect actions. Any difficulties you encounter during this test is a flaw in our design, not a failure on your part. As such, should you encounter difficulties, I cannot help you. If you do not understand the task or question and need clarification, however, please ask. I will help if I am able.

General
For context, our application is designed as a partner app to a physical device. The application itself will function as a music player and music visualizer. Later, this application will connect to our physical device and include vibration sensations through the physical device. All visual changes and vibrations will occur in time with the music.

1. What do you think of this concept?

2. Have you heard of similar devices before? Y / N
    a. Can you recall the name of the device?

3. Have you experienced similar devices before? Y / N
    a. If yes, what did you enjoy about the experience?
    b. What did you dislike about the experience?

Application Flow
(At this point, take out the sketch of the initial screen)

1. This is a sample of the potential interface design. What are your first impressions?

2. How would you check if the physical device is connected?
    a. Please rate the difficulty of this task on a scale of 1 to 5 where 1 is very easy and 5 is very difficult?

3. Can you show me where the power level of the physical device is on this wireframe?
    a. Please rate your confidence in what indicates the device's power level on a scale of 1 to 5, where 1 is extremely confident you selected the correct element and 5 is extremely uncertain if you selected the correct element.
4. How would you navigate to your playlists?
    a. Please rate the difficulty of this task on a scale of 1 to 5 where 1 is very easy and 5 is very difficult?

5. How would you view songs by artist?
    a. Please rate the difficulty of this task on a scale of 1 to 5 where 1 is very easy and 5 is very difficult?
6. How would you view songs by album?
    a. Please rate the difficulty of this task on a scale of 1 to 5 where 1 is very easy and 5 is very difficult?

7. How would you change to the music visualizer view?
    a. Please rate the difficulty of this task on a scale of 1 to 5 where 1 is very easy and 5 is very difficult?

8. If I showed you this song list, how would you add any of these visible songs to a playlist?

Closing Questions
1. Those are all the tasks and questions we have for you today. Before we close, do you have any comments, questions, or concerns regarding the test, the application, or the device?

2. Would you be interested in further user tests for this product? Y / N

(If yes, record their contact information separately from this sheet on a list of interested parties. A minimum of name and email is required.)

APPENDIX B

APPLICATION DESIGN TEST

Introduction
Thank you for taking our survey. The following questions will ask you about what you like and dislike about certain visual elements of the design of our mobile application, as well as what symbols you associate with what functions. Where applicable, you will be provided with digital mockups in full color to reference. All answers will be anonymous.

Symbol Associations
Below, we will ask you to select which symbol you most associate with a given function.

1. Which symbol do you associate with the “Play Music” function?

Symbols: →   

2. Which symbol do you associate with the “Pause Music” function?

Symbols:    

3. Which symbol do you associate with opening a navigation menu? (pick top two)

Symbols:     

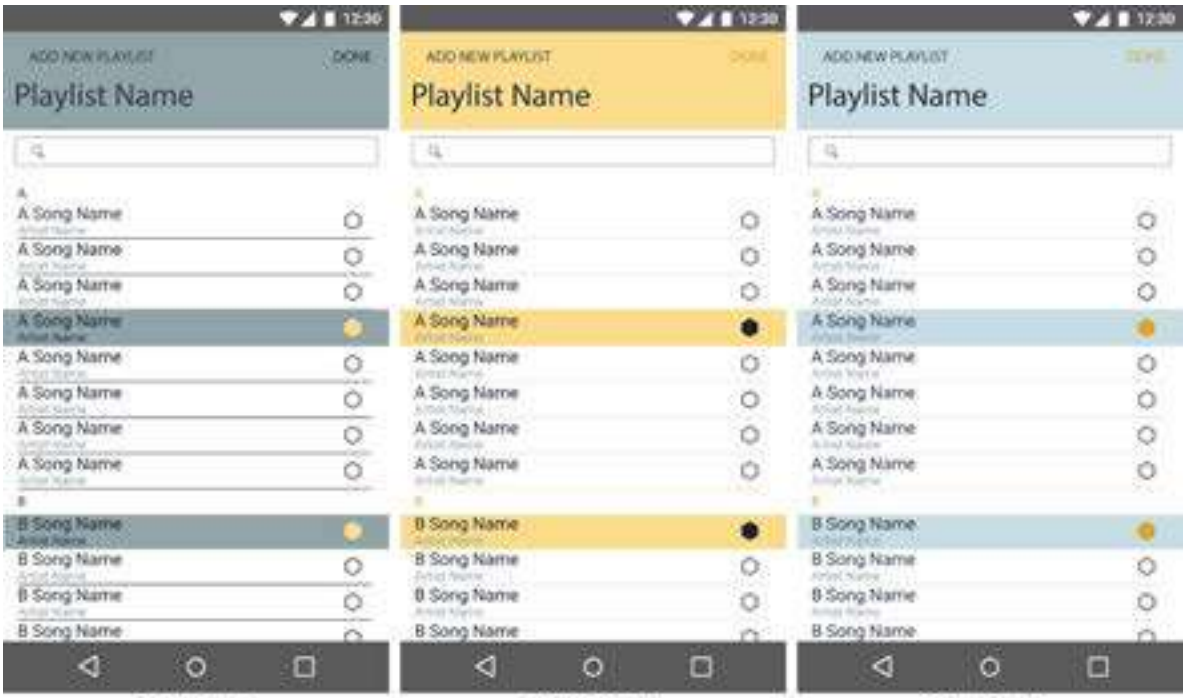
4. Which symbol do you associate with opening a song options menu? (pick top two)

Symbols:   

5. Which symbol do you associate with editing a playlist? (pick top two)

Symbols:      

Light Mode
Below are three different color schemes on identical mockups. Please answer the following questions based on these mockups.



1. How easy is it to read the words on the screen? (rating each option from 1 - Impossible to 5 - Easy)

2. Which color scheme do you most prefer?

3. Why did you pick this color scheme as your favourite?

4. Is there anything you dislike about this color scheme despite this?

5. Which color scheme do you dislike the most?

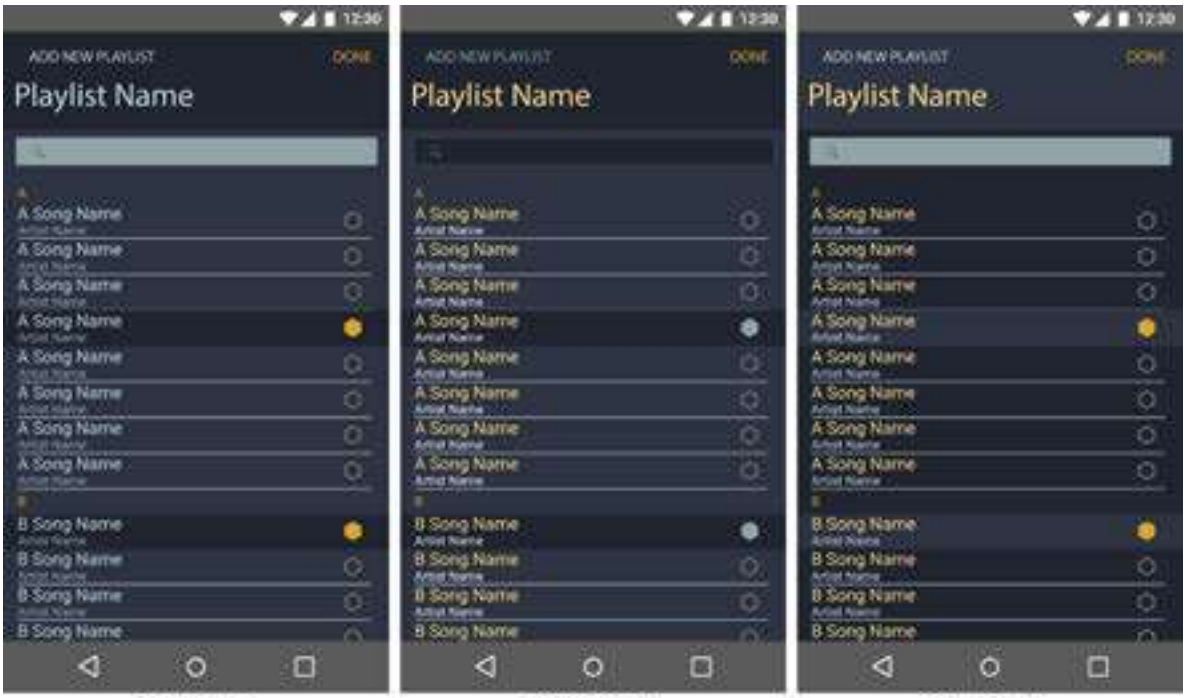
6. Why did you pick this color scheme as your least favourite?

7. Is there anything you like about this color scheme despite this?

8. Do you have any additional comments about any of the designs?

Dark Mode
Below are three different color schemes on identical mockups. Please answer the following questions based on these mockups.

Dark Mode
Below are three different color schemes on identical mockups. Please answer the following questions based on these mockups.



OPTION 1. OPTION 2. OPTION 3.

1. How easy is it to read the words on the screen? (rating each option from 1 - Impossible to 5 - Easy)

2. Which color scheme do you most prefer?

3. Why did you pick this color scheme as your favourite?

4. Is there anything you dislike about this color scheme despite this?

5. Which color scheme do you dislike the most?

6. Why did you pick this color scheme as your least favourite?

7. Is there anything you like about this color scheme despite this?

8. Do you have any additional comments about any of the designs?

Wrap-Up
Would you be interested in any further user testing for our project? Y / N

(If 'Yes') Please go to the following link to leave your contact information. This will direct you to a different survey so that your information is not attached to your answers. https://forms.gle/FgrY-2vpzfJ7jg4FeA

(If 'No') Thank you for participating in this survey. We greatly appreciate your feedback.

APPENDIX C

HOME PAGE DESIGN TEST

Introduction

Thank you for taking our survey. The following questions will ask you about what you like and dislike about certain visual elements of the layout of our mobile application, as well as what symbols you associate with what functions. Where applicable, you will be provided with digital mockups in grey-scale to reference. All answers will be anonymous.

Symbol Associations

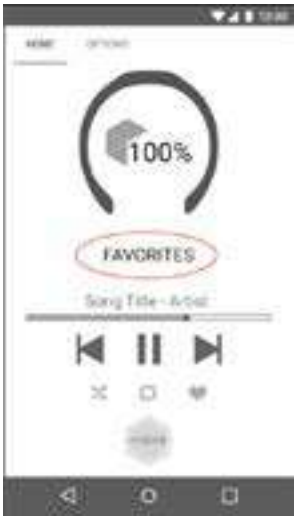
Below, we will ask you to select which symbol you most associate with a given function.

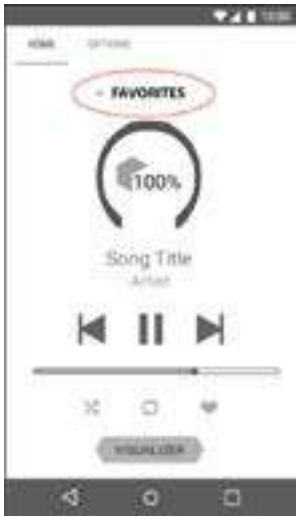
1. Which symbol do you associate with “Favourites” function?

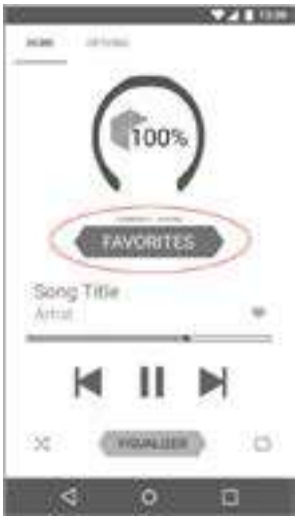
Symbols: ♥ + ★ 🔖

2. Would you be able to distinguish this icon as a “Visualizer” button?

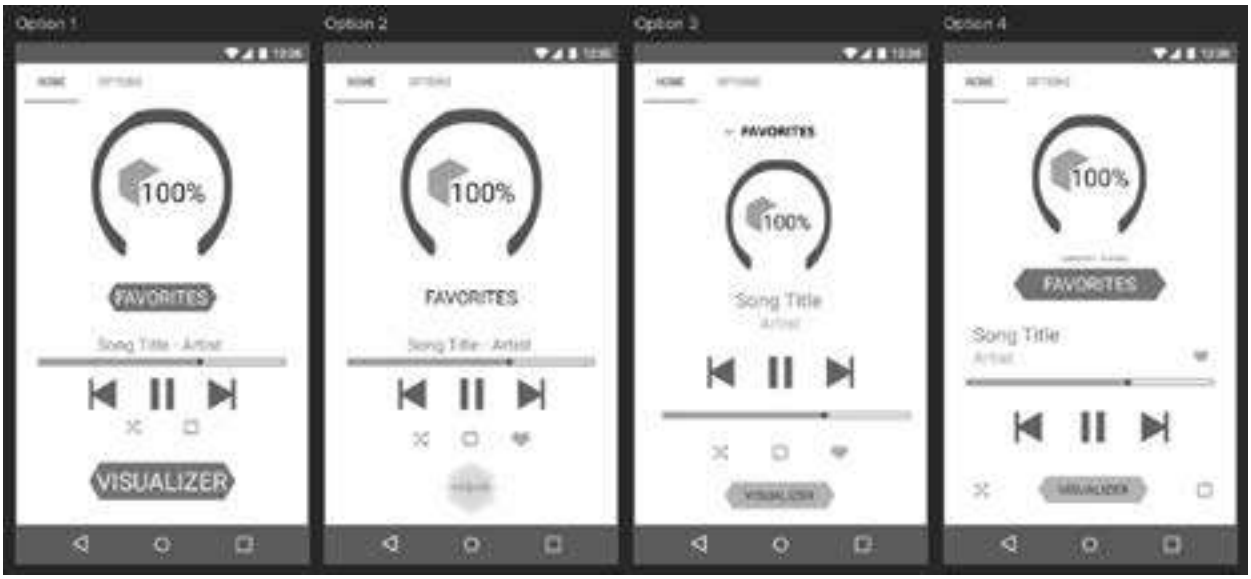
3. What do you believe would happen if you were to click on red circled button? (repeat for each)







Home Page Layout
Below are four greyscale mockups of the same Home page (some with varying icons). Please answer the following questions based on these mockups.



1. How clear is the functionality of this page (rank for each option from 1 - very unclear to 2 - very clear)

2. Which page layout do you prefer?

3. Why did you pick this page layout as your favourite?

4. Is there anything you dislike about the layout despite this?

5. Which page layout do you dislike the most?

6. Why did you pick this page layout as your least favourite?

7. Is there anything about the page layout you like despite this?

8. Do you have any additional comments about any of the design layouts?

Wrap-Up
Would you be interested in any further user testing for our project? Y / N

(If 'Yes') Please go to the following link to leave your contact information. This will direct you to a different survey so that your information is not attached to your answers. https://forms.gle/FgrY-2vpzfJ7jg4FeA

(If 'No') Thank you for participating in this survey. We greatly appreciate your feedback.

APPENDIX D

LOOK & FEEL TEST

Introduction
Thank you for agreeing to test our application. Before we begin, we will be taking notes about what you say and do during this process. These notes will not be attached to your name in any way.

Do we have your permission to take notes? Y / N

(If no, politely end the test, thanking them for their time.)

During today's tests, we are going to be introducing you to the physical device portion of our project. You will be asked a few general questions as well as complete a few short tasks, such as showing us where you believe a specific button is located.

It is important to understand that during this process, there are no wrong answers or incorrect actions. Any difficulties you encounter during this test is a flaw in our design, not a failure on your part. As such, should you encounter difficulties, I cannot help you. If you do not understand the task or question and need clarification, however, please ask. I will help if I am able.

Device Look and Feel
(At this point, take out the prototype)

1. This is a prototype of the device. What are your first impressions on the:
    a. Shape of the device?
    b. Size of the device?
    c. Flexibility of the device?
    d. Material used for the device?

2. Please show me how you would turn the device on.
    a. Please rate the difficulty of this task on a scale of 1 to 5 where 1 is very easy and 5 is very difficult.

3. Please show me how you would turn on bluetooth pairing, in order to connect this device to your phone.
    a. Please rate the difficulty of this task on a scale of 1 to 5 where 1 is very easy and 5 is very difficult?

4. Please show me how you would place this device in order to use it.
    a. Please rate your confidence in the placement of the device on a scale of 1 to 5, where 1 is extremely confident it is placed correctly and 5 is extremely uncertain if it is placed correctly.

5. Now that the device is in place, please rate the comfort of the device, where 1 is very comfortable and 5 is very uncomfortable.

Closing Questions
1. Those are all the tasks and questions we have for you today. Before we close, do you have any comments, questions, or concerns regarding the test, the application, or the device?

2. Would you be interested in further user tests for this product? Y / N

(If yes, record their contact information separately from this sheet on a list of interested parties. A minimum of name and email is required.)

Thank you again for your time. If you would like to follow the project to completion, you can find us on various social media platforms and we encourage you to consider coming to the Senior Project Fair to try the final product. All information is provided on this card, and contact information for the team is on the back should you have questions, concerns, or wish to withdraw your consent at a later date.. (Provide participants with info card)

APPENDIX E

HAPTIC MOTOR TEST

Introduction
Thank you for agreeing to test our application. Before we begin, we will be taking notes about what you say and do during this process. These notes will not be attached to your name in any way.

During today's tests, we are going to be placing this circuit around your neck and holding the vibration motors against your collarbones so that you are not influenced by holding them yourself. If you are uncomfortable with this or would rather have someone else hold the vibration motors, please tell us now. (Wait for confirmation it is okay/the request for someone else, accommodate where possible but do not allow them to hold the motors themselves).

Keep in mind, this test is solely informative for us; we will be using the results to determine if our vibration strength is strong enough and possible vibration patterns for our device. All we ask is that you answer the questions honestly.

Haptic Motors
(At this point, set the circuit in place)

1. Okay, we are going to activate some different vibration patterns now. We will preface each vibration with 'One' or 'Two' so that you know when a vibration is present and there will be ten seconds between each pair of vibration patterns for you to answer. If you cannot feel one or either vibration, please inform us. If you can feel both, simply tell us if you could tell the difference between the vibrations.
    a. This (play strong click) and this (play sharp click)? Y / N
    b. This (play strong click) and this (play soft bump)? Y / N
    c. This (play strong click) and this (play medium click)? Y / N
    d. This (play strong click) and this (play sharp tick)? Y / N
    e. This (play sharp click) and this (play soft bump)? Y / N
    f. This (play sharp click) and this (play medium click)? Y / N
    g. This (play sharp click) and this (play sharp tick)? Y / N
    h. This (play soft bump) and this (play sharp click)? Y / N
    i. This (play soft bump) and this (play medium click)? Y / N
    j. This (play soft bump) and this (play sharp tick)? Y / N
    k. This (play sharp tick) and this (play sharp click)? Y / N
    l. This (play sharp tick) and this (play soft bump)? Y / N
    m. This (play sharp tick) and this (play medium click)? Y / N

Closing Questions
1. That's all we need for today's test. Do you have any remaining questions, comments, or concerns?
2. Would you be interested in further user tests for this product? Y / N

(If yes, record their contact information separately from this sheet on a list of interested parties. A minimum of name and email is required.) Thank you again for your time. If you would like to follow the project to completion, you can find us on various social media platforms and we encourage you to consider coming to the Senior Project Fair to try the final product. All information is provided on this card, and contact information for the team is on the back should you have questions, concerns, or wish to withdraw your consent at a later date. (Provide participants with info card)

APPENDIX E

EXPERIENCE TEST

Introduction
Thank you for agreeing to test our product. Before we begin, we will be taking notes about what you say and do during this process. These notes will not be attached to your name in any way.

Do we have your permission to take notes? Y / N

(If no, politely end the test, thanking them for their time.)

During today's tests, we are going to be introducing you to three things: the concept behind our product, the physical product, and the companion application. You will be asked questions relating to the concept, the feel of the device, the ease of application use, and the experience as a whole.

It is important to understand that during this process, there are no wrong answers or incorrect actions. Any difficulties you encounter during this test is a flaw in our design, not a failure on your part. As such, should you encounter difficulties, I cannot help you. If you do not understand the task or question and need clarification, however, please ask. I will help if I am able.

Concept
For context, our product is a neckband which provides vibration feedback of music in real-time. The companion application allows for the playing of this music, some organizational features, and a visualizer component. This allows for users to expeirence music with up to three of their five senses. The application connects to the device via bluetooth.

1. What do you think of this concept?

2. Have you heard of similar devices before? Y / N
    a. Can you recall the name of the device?

3. Have you experienced similar devices before? Y / N
    a. If yes, what did you enjoy about the experience?
    b. What did you dislike about the experience?

Device
(At this point, take out the neckband)

1. This is a prototype of the device. What are your first impressions on the:
    a. Shape of the device?
    b. Size of the device?
    c. Flexibility of the device?
    d. Material used for the device?

2. Please show me how you would place this device in order to use it.
    a. Please rate your confidence in the placement of the device on a scale of 1 to 5, where 1 is extremely confident it is placed correctly and 5 is extremely uncertain if it is placed correctly.

3. Now that the device is in place, please rate the comfort of the device, where 1 is very comfortable and 5 is very uncomfortable.

Application
(At this point, take out the phone with app pre-loaded)

1. This is the application. What are your first impressions?

2. How would you connect the application to the device's bluetooth?
    a. Please rate the difficulty of this task on a scale of 1 to 5 where 1 is very easy and 5 is very difficult?

3. How would you navigate to your song list?
    a. Please rate the difficulty of this task on a scale of 1 to 5 where 1 is very easy and 5 is very difficult?

4. How would you add a song to your favourites?
    a. Please rate the difficulty of this task on a scale of 1 to 5 where 1 is very easy and 5 is very difficult?

5. How would you navigate to your playlists?
    a. Please rate the difficulty of this task on a scale of 1 to 5 where 1 is very easy and 5 is very difficult?

6. How would you make a new playlist?
    a. Please rate the difficulty of this task on a scale of 1 to 5 where 1 is very easy and 5 is very difficult?

7. How would you edit this playlist?
    a. Please rate the difficulty of this task on a scale of 1 to 5 where 1 is very easy and 5 is very difficult?

8. When you select a song to play, the application will bring you to the visualizer page automatically. Please do this now. (Allow them to select a song) Could you tell me what you think each of these icons does? (Indicate the music player section at the bottom of the app)

Experience
1. Now, I want you to focus on the whole experience. Please rate your experience with the neckband from 1 to 5, where 1 is very unpleasant and 5 is very pleasant.
    a. What do you dislike about the experience?
    b. What would improve the experience?

2. Next, please rate your experience with the visualizer from 1 to 5, where 1 is very unpleasant and 5 is very pleasant.
    a. What do you dislike about the experience?
    b. What would improve the experience?

Closing Questions
1. Those are all the tasks and questions we have for you today. Before we close, do you have any comments, questions, or concerns regarding the test, the application, or the device?

APPENDIX F
WEBSITE SAMPLE

Figure 35. The website index in desktop mode. Full site visible at: https://buzzinbees.site