

GNG2101

Design Project User and Product Manual

**Hear we Glow
Hearing aid reminder**

Submitted by:

Hear We Glow A01.3

Alexander Wilson, 300219585

Jessica Hemstead, 300214909

Landon Deforge, 300233086

Rasheeq Mohammad, 300264515

Minjung Gong, 300080238

December 6, 2023
University of Ottawa

Table of Contents

Table of Contents	ii
List of Figures	iii
List of Tables	iv
List of Acronyms	v
1 Introduction.....	1
2 Overview.....	2
2.1 Conventions.....	3
2.2 Cautions & Warnings	3
3 Getting started.....	4
3.1 Configuration Considerations	4
3.2 User Access Considerations	4
3.3 Accessing/setting up the System.....	5
3.4 System Organization & Navigation	6
3.5 Exiting the System	7
4 Using the System	8
5 Troubleshooting & Support	10
5.1 Error Messages or Behaviors	10
5.2 Special Considerations	10
5.3 Maintenance	11
5.4 Support	11
6 Product Documentation	12
6.1 Business and design considerations	12
6.1.1 BOM (Bill of Materials)	12
6.1.2 Equipment list.....	13
6.1.3 Subsystem of design	14
6.2 Testing & Validation.....	16
7 Conclusions and Recommendations for Future Work	17
8 Bibliography	18
9 APPENDIX I: Design Files	19

List of Figures

Figure 1: Power and select button.....	5
Figure 2:USB -A cable.....	5
Figure 3: Hinge design.....	6
Figure 4:Power button and UI.....	6
Figure 5:Buzzer.....	6
Figure 6:LED	7
Figure 7:Cold restart	7
Figure 8: Power source	8
Figure 9:Power button.....	8
Figure 10:Set alarm.....	8
Figure 11:Adjust hour	8
Figure 12:Adjust minute	8
Figure 13: Alarm.....	8
Figure 14: Power source	9
Figure 15: Power and select.....	9
Figure 16: Set current hour	9
Figure 17:Set current minute.	9
Figure 18:Save current time.....	9
Figure 19:Turn off alarm.	9
Figure 20: Plywood and acrylic	14
Figure 21:Hinges.....	14
Figure 22: Cubic design	14
Figure 23:User interface	15
Figure 24:Color options	15
Figure 25:LED layout	15
Figure 26:Circuit design	16

List of Tables

Table 1. Acronyms.....	v
Table 2: Bill of Materials.....	12
Table 3: Equipment list.....	13
Table 4: Metrics	16
Table 5. Referenced Documents.....	19

List of Acronyms

Table 1. Acronyms

Acronym	Definition
BMC	Business Model Canvas
BOM	Bill of materials
GlowBox	This is our product name
LCD	Liquid Crystal Display
LED	Light-emitting diode
MDF	Medium-density fiberboard
RTC	Real-time clock
UI	User Interface

1 Introduction

The GlowBox Hearing Aid Reminder, developed by the "Here We Glow" team, addresses the needs of individuals with hearing aid disabilities. This product is made for users that are seeking a dependable and reliable product to serve as a reminder to wear their hearing aid. The user manual serves as a guide for user to fully comprehend the GlowBox and to maximise the user's experience containing important information like instructions, warnings, maintenance. It will also contain key elements of the design process, such as the problem statement, detailed design documentation, prototyping and more.

The manual is crafted for individuals with hearing aid disabilities who seem to have a hard time remembering to wear their hearing aids. Accessibility as a design choice was thus a high priority during product development. While the GlowBox primarily focuses on being a great reminder, note that the team kept safety in mind throughout the whole process, especially when considering the electrical components of the design.

2 Overview

Explanation of the problem

The common problem with individuals who have a hearing aid disability is the tendency to forget to wear their hearing aids consistently. Also, certain hearing aid charging devices contain a distracting light which goes against a sleep friendly or non-distracting environment. The importance of solving this problem is to improve the daily lives of individuals with hearing aid disabilities. Forgetting to wear hearing aids may lead to things such as not engaging in conversations and activities. Additionally, the disruptive light affects quality of sleep and is an overall distraction. Therefore, the GlowBox addresses these issues making our user's daily routines much easier.

Problem Statement

The following problem statement outlines the key elements of the product use and goals for solving the problem presented by the client.

“Design a device which encloses hearing-aids and enhances features of apparentness through increased size, contrasting aesthetic and loud alarm sound for patients who forget to wear their hearing-aids in the morning. The design will be cost effective, durable, grasp the user's attention when the alarm sounds but remain discrete when not activated.”

The following list the main priorities needs of the client.

- Device blocks light emitted from the hearing aid charger at night.
- Devices emit alarm sound and light to grasp user attention.
- Device is affordable.
- Device is durable.
- Device is simple to use.
- Device is of contrasting colors.

Key features

The key features of the GlowBox focus on a simple design that meets the needs of the clientele. The GlowBox includes a reliable alarm system able to remind the user that they must put on their hearing aid device. When the reminder is set off, the GlowBox has bright flashing LED strips and a loud 80db buzzer emitting a consistent tone to grasp attention. While the alarm is not on, the GlowBox has blackout capabilities, thus not allowing any light to escape the enclosure. This is essential for clients whom like a dark environment without distractions at night. The colour palette of the GlowBox highlight two contrasting colours, yellow and purple, chosen specifically to contrast the surroundings while remaining a unique nightstand device. The durability and cost effectiveness of the GlowBox cannot be overlooked as it is constructed with ¼ inch thick MDF with all the electronics components properly secured on the inside of the box therefore able to withstand vigorous shaking.

The GlowBox discreetly conceals the electronics components of the design in a compact location below the main function panel. This is designed to ensure the user will never have to manipulate live wires or possibly detach vital components of the design. The electronics are composed of an Arduino uno clone as the main processor able to communicate between inputs such as the buttons and outputs such as the LCD display and buzzer. Users are able to control the settings of the alarm with the easy-to-use large size push buttons and simple operation explained in detail in the following section.

2.1 Conventions

Action: Setting the alarm

- Check the UI (LCD) inside the enclosure and follow prompts.
- Press the power buttons to activate the alarm.

A detailed description of the system sequence for completing the task is provided in Section 3.

2.2 Cautions & Warnings

Cautions:

- **Do not attempt to access the inside of the GlowBox** or reconfigure wiring. This may damage the product and change the overall functionality while taking away the warranty. If any issues arise contact customer service.
- **Use a soft dry cloth** and avoid using liquid cleaners or strong products as this may damage the exterior and paint job of the box, when cleaning.

Warnings:

- **Keep the GlowBox away from any significant heat sources.** The MDF box is a flammable material and with enough heat may pose a fire hazard. Therefore, keep the GlowBox in a well-ventilated area.
- **Use only the provided power supply cord** that comes with the GlowBox as others pose a safety risk and may damage the GlowBox therefore taking away the warranty. If a replacement is needed checkout the GlowBox website or contact customer service.
- **Do not stare directly into the LED** lights when they are going off with alarm for a prolonged period. This may cause discomfort or irritation to the eyes.

3 Getting started

3.1 Configuration Considerations

Users must understand all components and operations of the product before using it. The GlowBox' are made of durable MDF and transparent plastic. Users must ensure that there is no damage to the product and that the hearing aid can be stored safely. Setting and disabling the alarm is done through the buttons and the LCD inside the GlowBox. Users should be able to set alarms through these UIs. The GlowBox's lid is hinged, and the user must ensure that the lid opens and closes smoothly and is properly secured.

3.2 User Access Considerations

The purpose of the system is to remind the user to wear their hearing aids, charge their hearing aids, and block the disruptive light. Therefore, the main users are hearing-impaired users who use hearing aids. Some consideration for the user was to include bright contrasting colors and large buttons in the design making the use of the GlowBox simpler to use. Further considerations such as an elevated interior platform lead to less restrictive access to the controls and a more accessible device.

3.3 Accessing/setting up the System

The GlowBox will arrive in the packaging fully assembled and ready to for use immediately after opening the packaging. There are no exterior components needed for assembling and using the device. The following steps will illustrate and explain the function of setting up the GlowBox.

1. Connect the USB power cable to a USB female port. This will provide the power to the GlowBox. Some examples include a power brick or a USB to wall plug. (Figure 2)
2. Lift the enclosure lid upward and insert the hearing aid into the box. Notice the hole on the back of the box leading to the interior holding compartment. (Figure 1) This is designed to feed the power supply cord from the charging device.
3. Set the enclosure alarm. This will allow the user to personalize the alarm time as well as turn on and off the signals. Detailed explanations about how to use the device are provided in section.

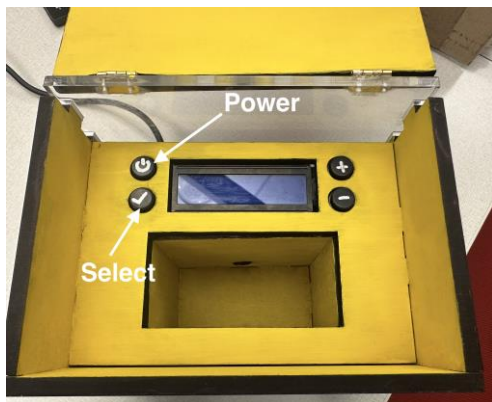


Figure 1: Power and select button

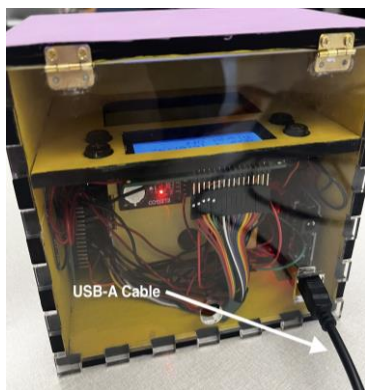


Figure 2:USB -A cable

3.4 System Organization & Navigation

Enclosure

- The lid, sides, front, and bottom are all made of one-fourth inch MDF. The back built out of acrylic and each element has been laser cut to the desired dimensions. All bonds are secured using strong adhesive.
- The enclosure hinges open and close the lid with a 180-degree range allowing maximum visibility when using the user interface inside.



Figure 3: Hinge design

User Interface system

- The user interface displays the current time and the alarm time of the system to the user. It has simple messages making the use of the system easy to operate.
- Large buttons are included in a symmetrical format around the display for easy understanding and aesthetic purposes. The + comes above the - as is standard and the power is above the select button. Easy symbols on the button are used to clarify their purpose to the client.
- All the buttons and LCD display are connected using wires and solder to the Arduino Uno processor. These are all hidden in the electronic box out of reach of the user.

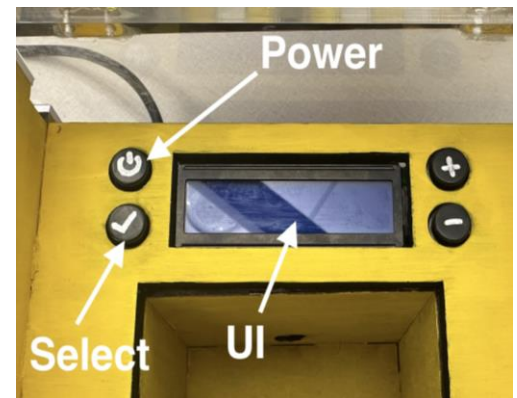


Figure 4: Power button and UI

Auditory alarm system

- The Piezo buzzer included in the design alternates between a “A5” and “F2” tone.
- It is operated by the Arduino uno and connected using solder and wires.



Figure 5: Buzzer

Visual alarm system

- The LED strip is positioned at the base of the enclosure for a modern aesthetic look.
- The lights are connected to the Arduino by soldering wires to the +5V input of the light strip and the ground to the RGB of choice. This model has the B blue option.
- The Arduino Uno controls the LED.

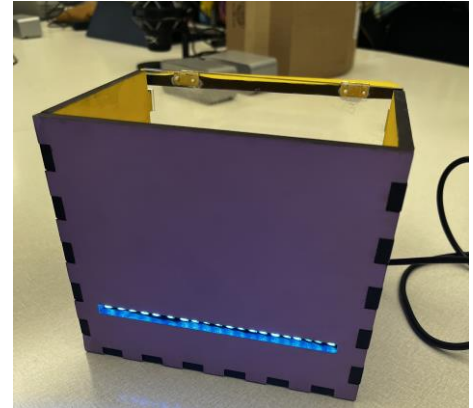


Figure 6:LED

3.5 Exiting the System

To perform a cold restart or turn off the GlowBox, simply unplug the USB from the power source. This will completely reset the saved clock time and reset the system. All the local memory of the alarm clock time will disappear from memory. Note that the real time clock has a battery enabling it to count the time when it loses power, thus it will maintain the current time. Store the GlowBox in a dry environment to protect the electronic components.

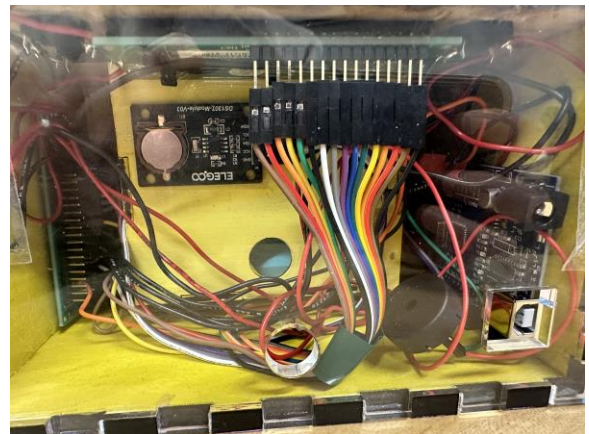


Figure 7:Cold restart

4 Using the System

The design of the user interface was implemented with the client in mind. This section will explore the steps required to set the alarm, turn off the alarm.

4.1 Setting up the alarm.

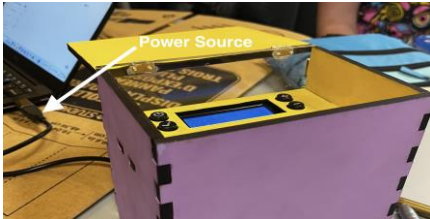


Figure 8: Power source

4.1.1 Ensure the system is connected to a power source and the LCD display is turned on.



Figure 9: Power button

4.1.2 Press the power (□) button to turn on the alarm. The Off words will disappear and indicate the current time of the alarm.

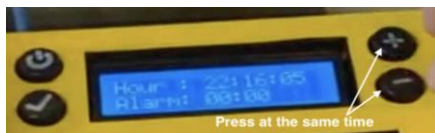


Figure 10: Set alarm.

4.1.3. Press the + and – buttons at the same time to change the alarm time. Preset time is set to 00:00am



Figure 11: Adjust hour

4.1.4. Follow screen directive and set the hour using the + and - buttons and press the check (✓) button.



Figure 12: Adjust minute

4.1.5. Set the minutes in the same way as in 4.1.4.



Figure 13: Alarm

4.1.6. Alarm is set.

4.2 Setting the current time.



Figure 14: Power source

4.2.1 Ensure the system is connected to a power source and the LCD display is turned on.



Figure 15: Power and select

4.2.2 Press the select (check mark) button to indicate change of current time.



Figure 16: Set current hour

4.2.3. Follow screen directive and set the hour using the + and - buttons and press the check (✓) button.



Figure 17: Set current minute.

4.2.4. Set the minutes in the same way as in 4.2.3.



Figure 18: Save current time

4.2.5. The current time is set when return to main page and displays indicated saving in progress.

4.3 Turning off the alarm.



Figure 19: Turn off alarm.

4.3.1 To turn off the alarm but keep power to the system, press the power button. When "Alarm: Off" appears on the LCD, the alarm has successfully turned off. This will turn off the buzzer sound and the LED.

5 Troubleshooting & Support

5.1 Error Messages or Behaviors

Hinges:

- Occasionally, due to their size or an unfortunate drop, the hinges on your GlowBox might break. Grab a screwdriver, carefully unscrew the broken hinge fragments from both the lid and the back of the GlowBox. Once completed, use the same screws to attach the new hinges into the existing slots. Your GlowBox will be good as new in no time!

Buttons:

- The buttons are secured within the compartment and have been secured in place with adhesive. Should they become loose, please contact the service team which will be able to fix the issue or guide user through reinstallation process.

“RTC Module not Present”

- Should the RTC module disconnect from its hardware connection this message will appear on screen. Please contact customer service for assistance with this behavior.

“RTC power failure, reset the time!”

- If the above message is displayed on the LCD, the RTC has drained its battery and required a new CR1220 battery replacement. After adding the new battery proceed to reset the current time.

5.2 Special Considerations

- Since the final design remains a prototype, the Arduino connections have not been soldered to the board. In turn some of the wires may require replacing. In that case visit the design manual or consult customer service.
- The system is vulnerable to elements such as water or fire and is to be kept in a dry environment. It is designed to keep stationary on the bedside table.

5.3 Maintenance

- When needed wipe the exterior of the GlowBox with a soft dry cloth to remove dust or smudges.
- Check the power cord periodically for any sign of wear and tear, damage, exposed wires, or any other possible safety risks. If you do notice any issues safely discard the flawed cord and replace.
- Periodically check the LED lights or LCD clock display for any irregularities. If you notice anything that may look wrong, contact customer support for guidance.
- Replace RTC batteries once they run out of power.

5.4 Support

Emergency Assistance:

For severe Emergencies or incidents involving an injury requiring attention, contact local authorities for ambulance assistance.

For non-life-threatening emergencies related to the GlowBox, call our 24/7 assistance line at 1-700-464-2101

System Support:

For general system support, help desk assistance, customer service, or more, please contact any one of our team members at the 24/7 assistance line (1 700 100 1000) or at the following emails

Jessica Hemstead – jhems014@uottawa.ca

Alexander Wilson – awils129@uottawa.ca

Rasheeq Mohammad – rmoha096@uottawa.ca

Minjung Gong – mgong043@uottawa.ca

Landon Deforge – ldefo091@uottawa.ca

Reporting Problems:

To report any problems, issues or possible improvements with the GlowBox, please email one of our team members above or HereWeGlow@gmail.com

Note:

For any immediate danger or harm to a person, please contact local authorities first. The emergency assistance line is for non-life threatening GlowBox related incidents.

6 Product Documentation

6.1 Business and design considerations

6.1.1 BOM (Bill of Materials)

Table 2: Bill of Materials

Item #	Name	Description	Dimensions	Quantity	Cost (CAD\$)	Link
001	plywood	Birch Materials of the exterior of the enclosure	12 * 24	2	2x3.95	wood
002	Clear Polycarbonate Plastic Sheet	Clear plastic to encapsulate led	6x12	1	4.96	plastic
003	Arduino	Arduino + USB cable Power supply	3.3*2.2	1	17.00	Arduino
004	display	Liquid Crystal Display LCD	16*2	1	12.98	LCD
005	hinges	Small Connector for opening and closing the enclosure lid on the enclosure	0.08	1	0.96	hinge
006	Led strip	5pk Visual alarm	Blue	1	8.00	led
007	buzzer	Auditory alarm	0.496" Dia 1.5V	1	1.00	buzzer
008	wires	Connect electronics		5ft	1.60	makerstore
009	Resistors(22 0ohm)	Decrease current		5	0.01	makerstore
010	DS3231 RTC module	Real time clock	22W x 38H mm	1	10.99	amazon
011	Push Buttons	To operate system	6 x 6 x 5 mm	4	0.61	button
Total					66.02	

6.1.2 Equipment list

The following table illustrates all the equipment and tools used to complete the design of this project. It includes, the box designs the electronic components and the software components.

Table 3: Equipment list

System	Equipment
Box design	<ul style="list-style-type: none">– Plywood– Laser cutter– Yellow and purple paint– Hinges– Screws– Black/gray sharpie– Clear polycarbonate plastic sheet
Electronic components	<ul style="list-style-type: none">– Arduino Uno Clone– DS3231 RTC model– Liquid Crystal Display (LCD)– Push buttons– Protoboard– LED lights– Wires/solder– Piezo Buzzer
Software	<ul style="list-style-type: none">– Arduino IDE– Wires.h library– RTCLib.h library– LiquidCrystal.h library– Open source code<ul style="list-style-type: none">○ Tiziano Bianchettin “Alarm Clock with Arduino”, (2017) https://projecthub.arduino.cc/tittiamo68/alarm-clock-057133 , consulted Oct 9, 2023

6.1.3 Subsystem of design

Subsystem 1. Material and Safety

- Material: The material of the product is plywood and transparent plastic. Plywood is sustainable and lightweight, easy to laser cut during manufacturing and assembly.



Figure 20: Plywood and acrylic

- Safety: Using the 180 folding flip top hinge mechanism, the enclosure lid can be opened and closed smoothly, and the hearing aid is designed with a system that allows easy insertion and removal, ensuring safe protection.



Figure 21: Hinges

Subsystem 2. Aesthetic

- Design: The product has a cubic shape. The cubic-designed angled corners take up little space and can be easily aligned with other square objects or furniture to utilize space efficiently. Additionally, the cubic design with flat sides and edges allows it to stand stably and has high strength and durability to withstand impacts.

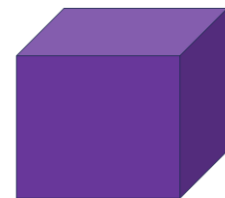


Figure 22: Cubic design

- UI: The product's UI is the LCD and buttons installed inside. It is designed to allow users to intuitively set times and alarms.

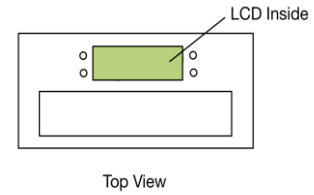


Figure 23:User interface

- Customization: Provides visual appeal by providing various colours or patterns to suit the user's taste. Also, choosing a colour and pattern to suit the user's taste ensures that the user does not forget to wear their hearing aid.



Figure 24:Color options

Subsystem 3. Notification system

- Sound alarm: A digital alarm system was designed to remind users to wear their hearing aids. Settings can be made and the alarm can be turned off through the internal UI.
- Visual alarm: An LED strip was used to remind users to wear their hearing aids.

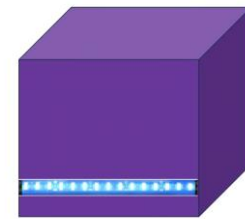


Figure 25:LED layout

Subsystem 4. Power supply and electronics management

- Power: Power is supplied to the Arduino board at +5V and is distributed through the circuit. The Arduino is the processor of the circuit and makes all decisions relating to the flow of the implementation. The power supply cable connect to the Arduino and has a USB – c compatible.

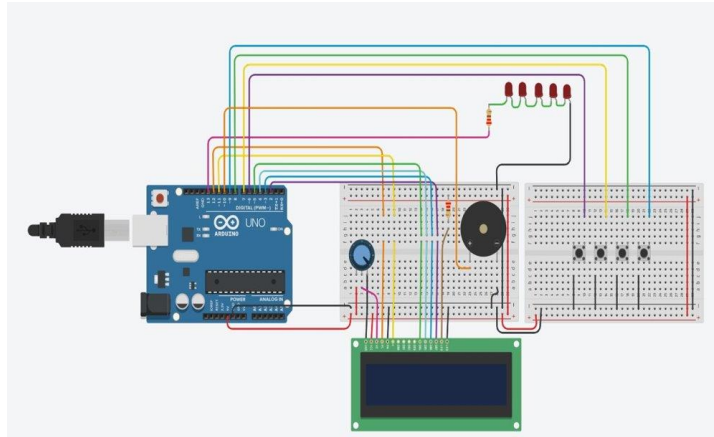


Figure 26: Circuit design

6.2 Testing & Validation

The following table illustrates the metrics used to evaluate the prototypes throughout the design process.

Table 4: Metrics

#	Metric	Unit	Marginal Value	Ideal Value	Prototype 1	Prototype 2	Final Prototype
1	Weight of box and alarm combined	kg	<1.8	1.35	0.2	0.782	1
2	Dimensions of box (not including alarm attached)	in	<7 long <5 high <5 depth	6.5 4.5 4.5	6.5 5.5 4.75	6.5 5.5 4.75	6.5 5.5 4.75
3	Maximal sound of alarm clock	db	<85	80	N/A	80	80
4	Thickness of box only	in	<1/2	1/4	3/16	1/4	1/4
5	Cost of our final product	CAD \$	<100	85	0	95	66.02
6	Sustainability	1-5 scale	<3	4	3	3	4
7	Reliability of electronics	1-5 scale	<4	5	N/A	2	5
8	Aesthetic/contrast	1-5 scale	<4	5	2	2	5

7 Conclusions and Recommendations for Future Work

In conclusion, our team, Hear We Glow, had a successful learning experience with this project. We were able to find a solution to the client's problem and develop a prototype by communicating with client, determining limits and ideal values through benchmarking results, and determining design concepts. We were also able to perform business analysis and evaluate the value of our products through BOM, BMC, Income statement-3 years and NPV analysis.

If our team is given a few more months to work on the project, we will improve the quality of the product by focusing more on its functionality and user convenience. First, the durability of the enclosure can be further improved by creating a mechanism to hold the lid when opening the box. Next are the functions of the alarm. The idea is to provide a choice for the type of alarm sound, create a sensor that will notify you when the hearing aid is removed, and a switch that will keep the light on even if you disable the buzzer. Additionally, functionality can be improved by adding a USB port that acts as a charging dock, allowing users to charge multiple devices simultaneously. Lastly, adding automation systems adds the ability to be compatible with smart devices. Adding more of these features is likely to increase the convenience and usability of the product.

8 Bibliography

- University of Ottawa of Fall GNG 2101 lectures – Hanan Anis
- Tiziano Bianchettin “Alarm Clock with Arduino”, (2017)
<https://projecthub.arduino.cc/tittiamo68/alarm-clock-057133> , consulted Oct 9, 2023

9 APPENDIX I: Design Files

The following table includes all design files and links to MakerRepo.

MakerRepo: <https://makerepo.com/jhems014/1831.gng2101a3hearweglow>

Table 5. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
PD. A	PDA in MakerRepo	2023/09/13
PD. B	PDB in MakerRepo	2023/09/27
PD. C	PDC in MakerRepo	2023/10/6
PD. D	PDD in MakerRepo	2023/10/16
PD. E	PDE in MakerRepo	2023/10/18
PD. F	PDF in MakerRepo	2023/11/10
PD. G	PDG in MakerRepo	2023/11/27
PD. H	PDH in MakerRepo	2023/11/29
PD. J	PDJ in MakerRepo	2023/11/29
Arduino Code	alarm_v2 in MakerRepo	2023/12/4