F. Design Constraints and Prototype 2

F.1 Design constraints

1. The first nonfunctional design restraint the impacts our project in the cost. With an original budget of $50 the project became near impossible but with a budget of $100 it is possible, but considerations need to be made. The second nonfunctional requirement would be size. The size of the enclosure will not affect the functionality, but it needs to fit the clients space. An additional requirement would also be weight. The client wants something that can be placed on a bedside table so making it to heavy would impact the placement but not the functionality.

2. For the first design constraint we decided that it would be better to use an Arduino in place of a raspberry pie. The second thing that was done to lower the cost was to use materials like plastic instead of acrylic. In order to keep the product within a desired size constraint we started with the size of the hearing aid charger and then used the minimum dimensions that we could, to house the electronics. This allowed to make the size reasonable. When considering the weight of the object, we decided to use materials like wood and plastic so that it would be durable and also light weight.

3. Provide proof (e.g. analysis, simple calculations and/or simulations, research) to demonstrate the effectiveness of your changes in satisfying the constraints. Justify the process and methods you used.

First, the expected budget is $50, which is insufficient to complete the project. Therefore, cost reduction is necessary to meet the expected budget. Thus, we decided that it would be more economical to use Arduino instead of Raspberry Pi. The price of Arduino is $17, and the price of Raspberry Pi is $83.95, making Arduino much cheaper. Also, Arduino kits cost over $100. So, we saved costs by choosing only the parts we needed instead of a kit. Additionally, costs were reduced by changing materials. Acrylic is generally more expensive than plastic. Therefore, costs could be reduced by using inexpensive materials such as plastic.

The second is size optimization. We must optimize the size of our products according to client needs. We started the design using the hearing aid height of 3 inches (7.62cm), depth of 1.5 inches (3.81cm), and width of 3.25 inches (8.255cm) as a standard. Then, we used CAD and a mock-up to determine the size of the enclosure and create a visual representation.

Lastly, weight optimization. Weight was determined by using lightweight materials such as plywood and plastic.

The weight of the plywood can be found as follows:

Thickness: 1/4 inch = 1/48ft

Length: 12 inches = 1ft

Width:24 inch=2ft

V (Volume) = Thickness x Length x Width

V = 1/48 x 1 x 2 = 1/24 ft^3

W (weight) = ρ (density) x V

Average of density =$\frac{25+50}{2} = 37.5 \frac{lbs}{ft^3}$

W = 37.5 x 1/24 = 1.5625 lbs = 708.74g

The weight of the plastic can be found as follows:

Common Thickness = 0.006 inch

Length = 11.75 inch

Width = 5.75 inch

V = 0.006 x 11.75 x 5.75 = 0.41 in^3

Common plastic density = 15.9$\frac{g}{in^3}$

W = 15.9 x 0.41 = 6.45g

Total weight = 708.74 + 6.45 = 715.19g

We can find out what's on the client's bedside table and how much weight it can bear.

4. Update your detailed design accordingly.

We decided to use Arduino as the core electronic component of the product. All connection ports and electronic components must be compatible with Arduino, and circuit diagrams and codes must be written accordingly.

Since we decided to use plastic instead of acrylic as the inner material of the enclosure, the laser cutting needs to be modified to suit the plastic processing method.

Electronic components and Arduino must be placed efficiently to fit that size since the design was based on the size of the hearing aid charger.

Plywood and plastic are durable and lightweight. We can consider adding a non-slip pad to the bottom to prevent the product from sliding easily off the bedside table.

By improving non-functional designs, products can be more optimized to suit customer needs and conditions.

F.2 Prototype 2

1.

Client feedback:

Incorporating client feedback, the preferred color palette for the product is a combination of yellow and purple, with purple for the wood/outside and yellow for the box's interior. The client is content with the specified box dimensions, weight, and thickness from project deliverable C. Furthermore, the client is enthusiastic about the product serving as a charging station and insists on ensuring that it includes the necessary ports and functionalities to support this feature.

Change/improvement in design:

Our client seemed very excited at the idea of the product serving as a charging station (having a couple different ports on the box to charge certain devices like usb-c for example). We have not included this into our prototype, however if time and budget constraints permit this may be something that we will try to include into our design, ultimately changing/improving it.

2.

Critical product assumptions not yet tested.

Electronics functionality assumptions:

The most critical product assumption that we have not tested yet is the electronics functionality which include the clock showing proper time, the alarm making an appropriate and loud enough sound, the alarm making a sound at the set time, the LCD lights turning on when alarm is on

Enclosure assumption:

Some cutouts are absent from the design as it is only to test if the electronics can fit inside and if it is structurally strong. Next step would be to measure the cord size and the cutout required for the LED lights on the front side.

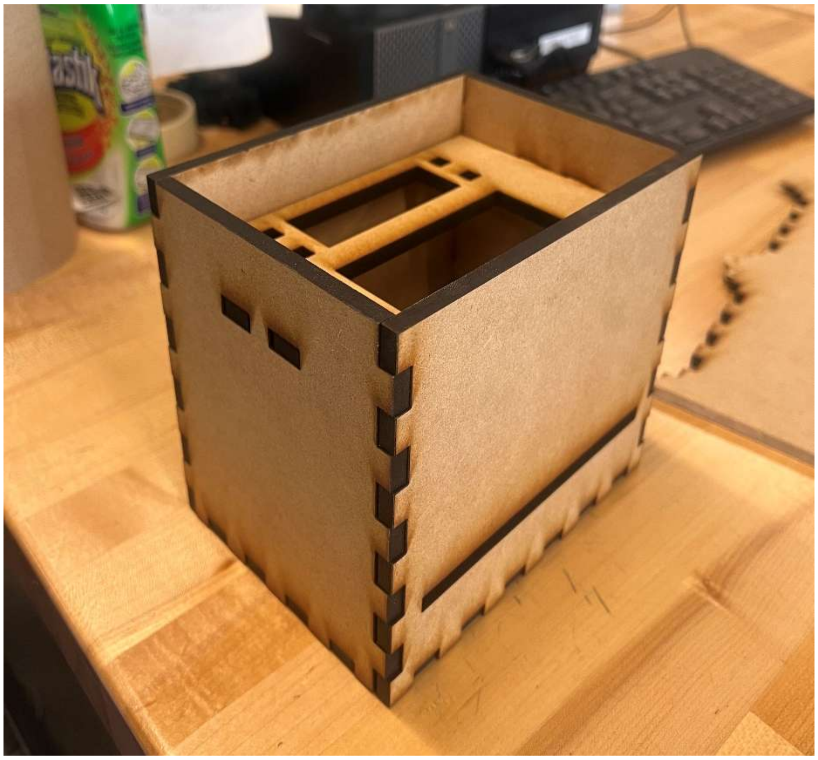
Dimensions assumptions:

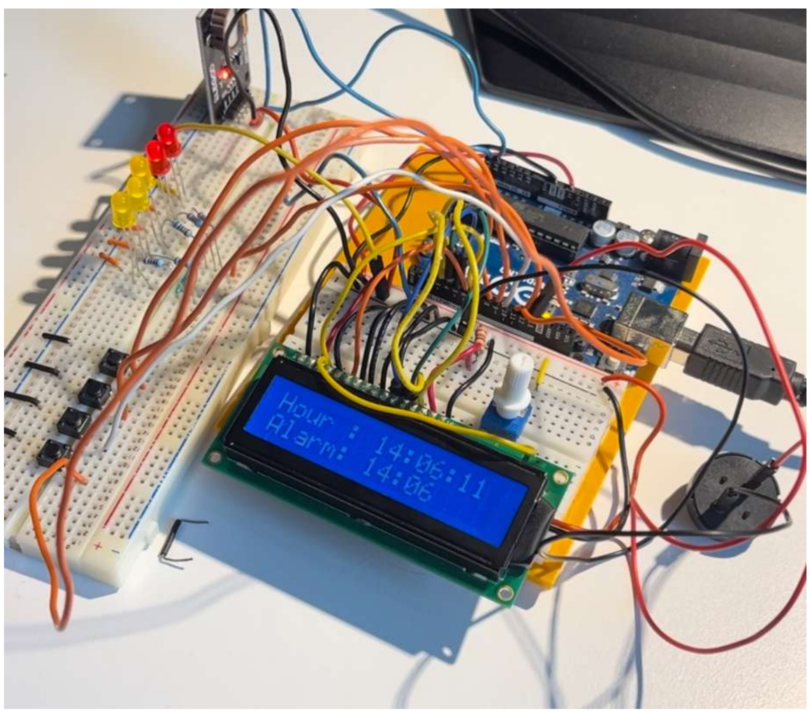
Need to make sure the electronics (include wires, Arduino, buttons, speaker, etc…) will fit properly in the designated slot of the box

Updated target specifications

#	Metric	Unit	Marginal Value	Ideal Value	Prototype 1	Prototype 2
1	Weight of box and alarm combined	kg	<1.8	1.35	0.2	0.782
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
3	Maximal sound of alarm clock	db	<85	80	N/A	80
4	Thickness of box only	in	<1/2	1/4	3/16	1/4
5	Cost of our final product	CAD $	<100	85	0$	10$ + 20$ + 65$ = 95
6	Sustainability	1-5 scale	<3	4	3	3
7	Reliability of electronics	1-5 scale	<4	5	N/A	2
8	Aesthetic/contrast	1-5 scale	<4	5	2	2

Pictures of prototype





F.3 Project plan update

https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=p77F3PEY9zoM4OQrEiSa9ixF0NxSwJiH%7CIE2DSNZVHA2DELSTGIYA