Leaving Cert 2021/2022 Technology Brief

Assistive Technology

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14/9/2021-8/4/2022

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Thematic Brief

The term disability can refer to any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) or interact with the world around them (participation restrictions). It is a complex phenomenon, reflecting the interaction between features of a person's body and features of the society in which he or she lives. (Adapted from https://www.cdc.gov/ncbddd/disabilityandhealth/disability.html).

There are many types of disabilities, including, but not limited to, those that affect a person's:

- Vision
- Movement
- Learning
- Communicating
- Hearing
- Social relationships

In this context and with a focus on modern materials and processes, design and manufacture a working model of a device, system or technological aid that could enhance or improve the quality of life of a person with a disability. Your solution should include an electro-mechanical element and should also be well presented.

Note: The maximum dimension of the artefact you present for assessment should not exceed 500 mm.
If multimedia presentations are used to enhance your display, a hardcopy printout and a digital file (USB flash drive) must be included in your portfolio.

Analysis of Thematic Brief

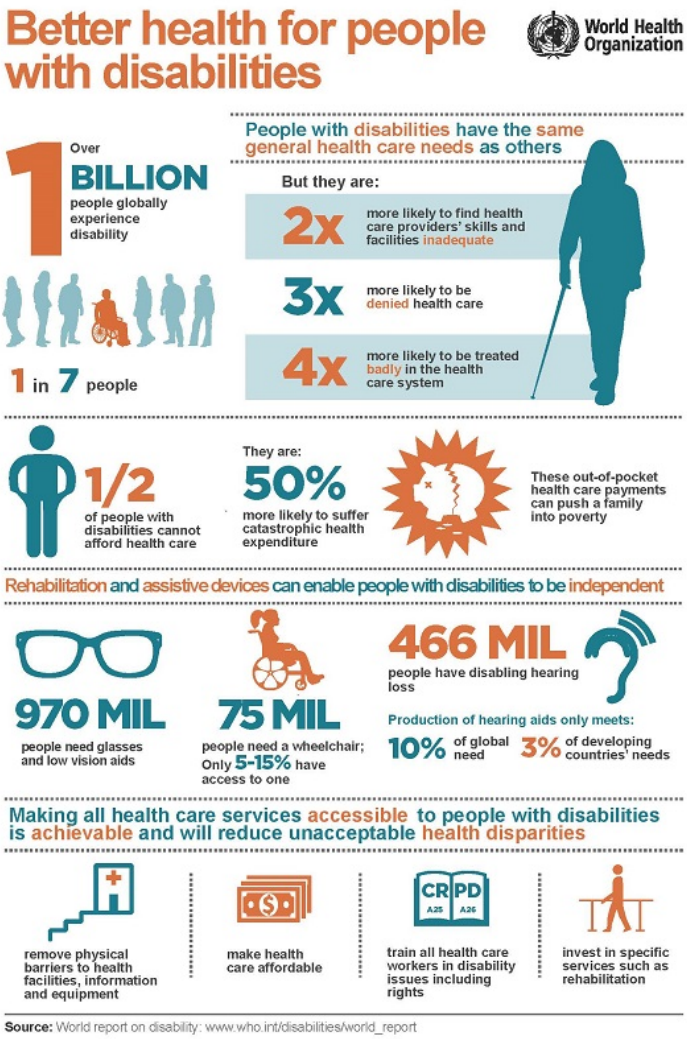
Disability

What is a disability?

A disability is an impairment to the mind or body. You can be born with or acquire a disability. Disabilities impact the ability of a person to do certain activities or tasks. A person may have more than one disability.

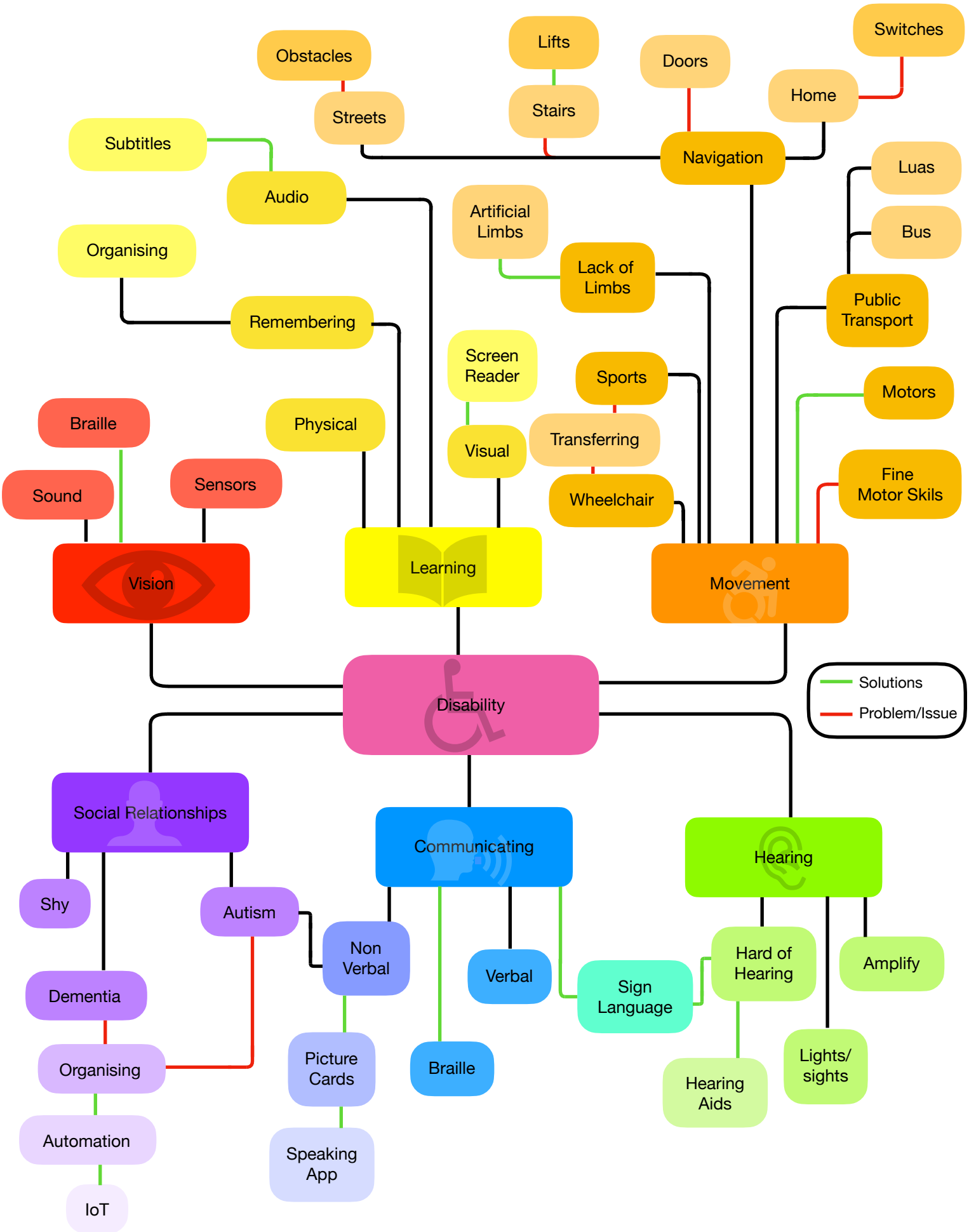
Disabilities affect many people in the world in fact In a 2016 survey it was found that 13.5% or 1 in 7 people have a disability.[1] Worldwide about 15% of the population has a disability.[2]

Disabilities affect many people so I think it is very important to develop accessible technology that can help make their lives easier.[3]



Brainstorming

Once I had received my brief I started by brainstorming things relating to disabilities to try and narrow down some areas of interest.


Switches
Lifts
Obstacles
Doors
Home
Stairs
Streets
Subtitles
Navigation
Luas
Audio
Artificial Limbs
Bus
Organising
Lack of Limbs
Public Transport
Remembering
Screen Reader
Sports
Motors
Braille
Physical
Transferring
Visual
Fine Motor Skils
Sound
Sensors
Wheelchair
Vision
Learning
Movement
Disability
Solutions
Problem/Issue
Social Relationships
Communicating
Hearing
Shy
Autism
Non Verbal
Verbal
Hard of Hearing
Amplify
Dementia
Sign Language
Picture Cards
Braille
Hearing Aids
Lights/ sights
Organising
Automation
Speaking App
IoT

Research

Secondary Research

Primary Research

For research I tried to get a good mix of primary and secondary research for the most accurate and fair results

To start my research I looked at the facilities in my area.

In my school I found:

- Wide door ways for wheelchair access
- Braille on all the classroom signs (see picture below)
- A lift for access to the second floor
- Accessible toilets

We were able to talk to a SNA in our school and she gave us lots of useful info about disabilities in the school. She told us about many issues student face like:

- Rooms being too small for easy wheelchair access
- Noise, lights, colours and smells being overwhelming for students
- The chairs not having great support

When I looked outdoors I specifically looked at road crossings, these have many features to help disabled people like:

- A basic layout of the road on the side of the crossing button
- A beeping noise to indicate when to cross the road
- A light to show when the button has been pressed and when to cross
- A tactile bump to show when to cross
- Bumps by the edge of the road to show where the road is

I researched how some disabilities can affect different people:

- Vision - May be blind or partially sighted, might have trouble seeing
- Movement - Might be in a wheelchair or missing a limb or have limited mobility, may struggle with walking or fine motor skills
- Learning - May have a learning disability like ADHD or dyslexia, might have trouble staying focused or reading and writing
- Communicating - May have trouble speaking or be non-verbal, might have difficulty communicating their needs
- Hearing - May be deaf or hard of hearing, might have trouble hearing and may use a hearing aid
- Social Relationships - May have autism or social anxiety, might have trouble communicating with others
- See picture below

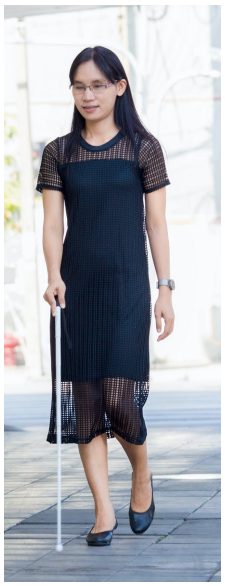
PEDESTRIAN CROSSING BUTTON

ROAD LAYOUT

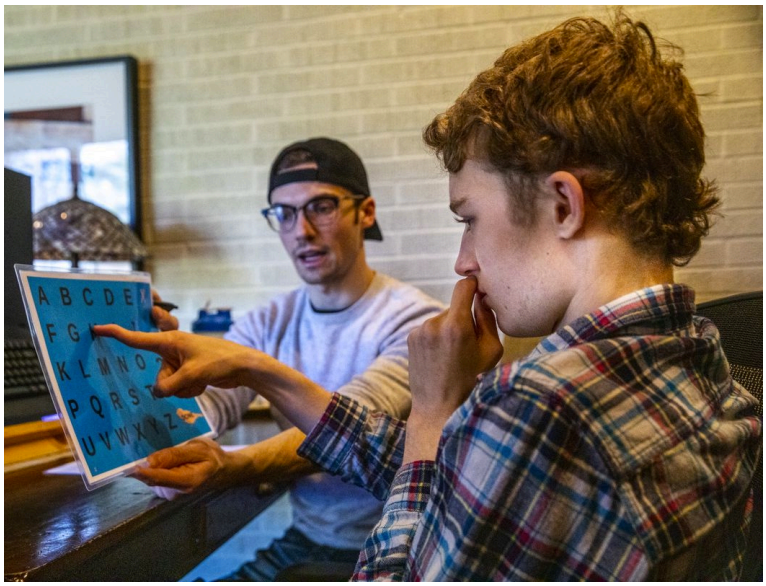
BUMPS AT EDGE OF ROAD

CLASSROOM SIGN WITH BRAILLE ON THE BOTTOM

Pictures of how disabilities could affect a person



VISUAL DISABILITY



COMMUNICATION DISABILITY

PHYSICAL DISABILITY

HEARING DISABILITY

Specification of chosen parameters

My project has to adhere to these parameters. It is expected to:

- be safe for a person to use
- be made of safe and reusable materials
- be designed and manufactured based on the skills gained in secondary school to date
- be easy and accessible to use
- be well presented and ascetically pleasing
- aid a disabled person and improve their quality of life
- include an electro-mechanical element
- not exceed 500mm
- have a minimal impact on the environment

Overall Management of the Project

Schedule for my project

September 2021

M	T	W	T	F	S	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

- Project Started
- Analysis of Brief
- Not in School
- Overall Management

October 2021

M	T	W	T	F	S	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

- Environmental Impact
- Research, investigation and specifications of brief
- Design ideas and selection of optimum solution
- Not in School

November 2021

M	T	W	T	F	S	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

- Design ideas and selection of optimum solution
- Sketches and drawings for manufacture
- Not in School

December 2021

M	T	W	T	F	S	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

- Sketches and drawings for manufacture
- Production planning
- Not in School

January 2022

M	T	W	T	F	S	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

- Not in School
- Prep for Mocks
- Mocks
- Production Planning

February 2022

M	T	W	T	F	S	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28						

- Production Planning
- Product Realisation
- Not in School

March 2022

M	T	W	T	F	S	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

- Product Realisation
- Testing, evaluation and critical reflection
- Not in School

April 2022

M	T	W	T	F	S	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

- Testing, evaluation and critical reflection
- Finishing up project
- Project due date

Gantt Chart of what I plan to do in each week

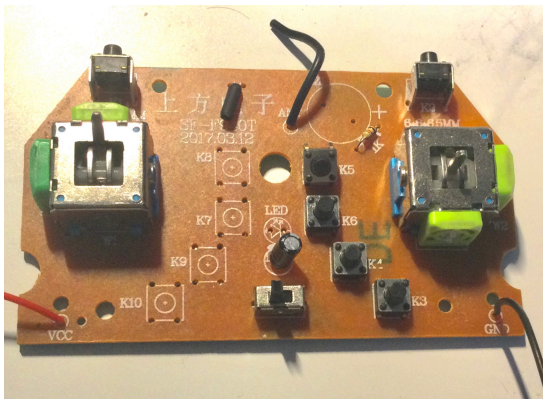
I have one single class and two double classes. I plan to do the project in the double classes.

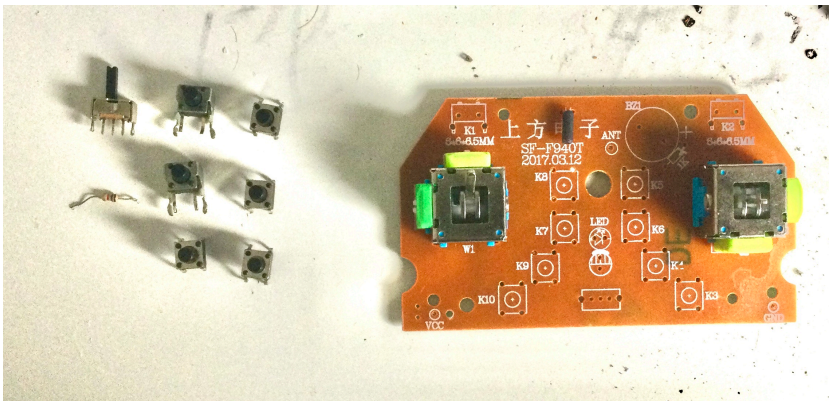
Environmental Impact of the Project

I wanted to be very aware of the environment while I produced this project. To reduce my environmental impact I will:

- design my project using Solidworks to reduce paper usage
- use CAM which will reduce waste material as all cuts will be accurate
- use materials from the waste bin in my technology room
- use semi-permanent joints so it can be taken apart and parts can be re-used
- add easy access to the electronics so repairs can be made instead of being thrown out
- use hand tools where possible to reduce energy consumption
- use breadboards instead of soldering so the electronics can be re-used
- use components from broken technology that are around my house

I plan to use acrylic for this project which isn't a very environmentally friendly material but it is what I am most familiar working with. To reduce the impact of this material I will re-use old acrylic where possible.



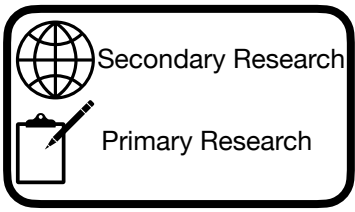


BROKEN CONTROLLER THAT I TOOK COMPONENTS FROM TO RE-USE

WASTE BINS IN MY TECHNOLOGY ROOM WHERE I CAN RE-USE MATERIAL

Research, Investigation and Specifications of the Brief

Further Research



For further research I decided to focus in on the areas of sport and organisation. I then continued to mind map to help refine ideas and points of interest. I also continued to do primary and secondary research

While I was at the National Aquatic Centre (NAC) I looked at what they had to accommodate disabilities. They had:

- lifts
- accessible changing rooms
- a lift to transfer someone into the pool (see picture below)

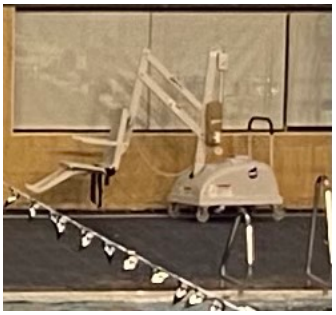
After seeing the transfer lift I remembered seeing a similar thing in Lisnasharragh Leisure Centre in Belfast

I looked online to find pictures of the lift and was able get some

I was able to visit other pools as well and was able to take photos of their transfer lifts

When looking into organisation I was able to get a look at a blister pack of medication

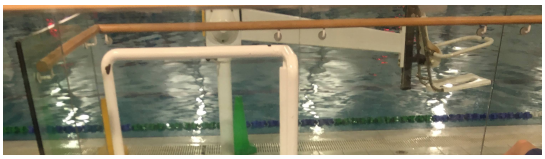
I also looked online for products that help people stay organised



LIFT IN NAC

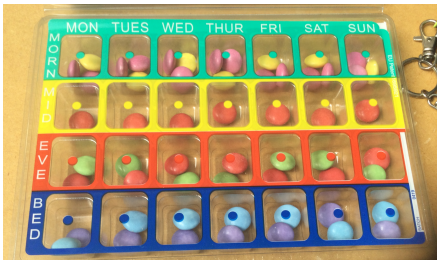
LIFT SIMILAR TO ONE IN LISNASHARRAGH

LIFT IN LISNASHARRAGH

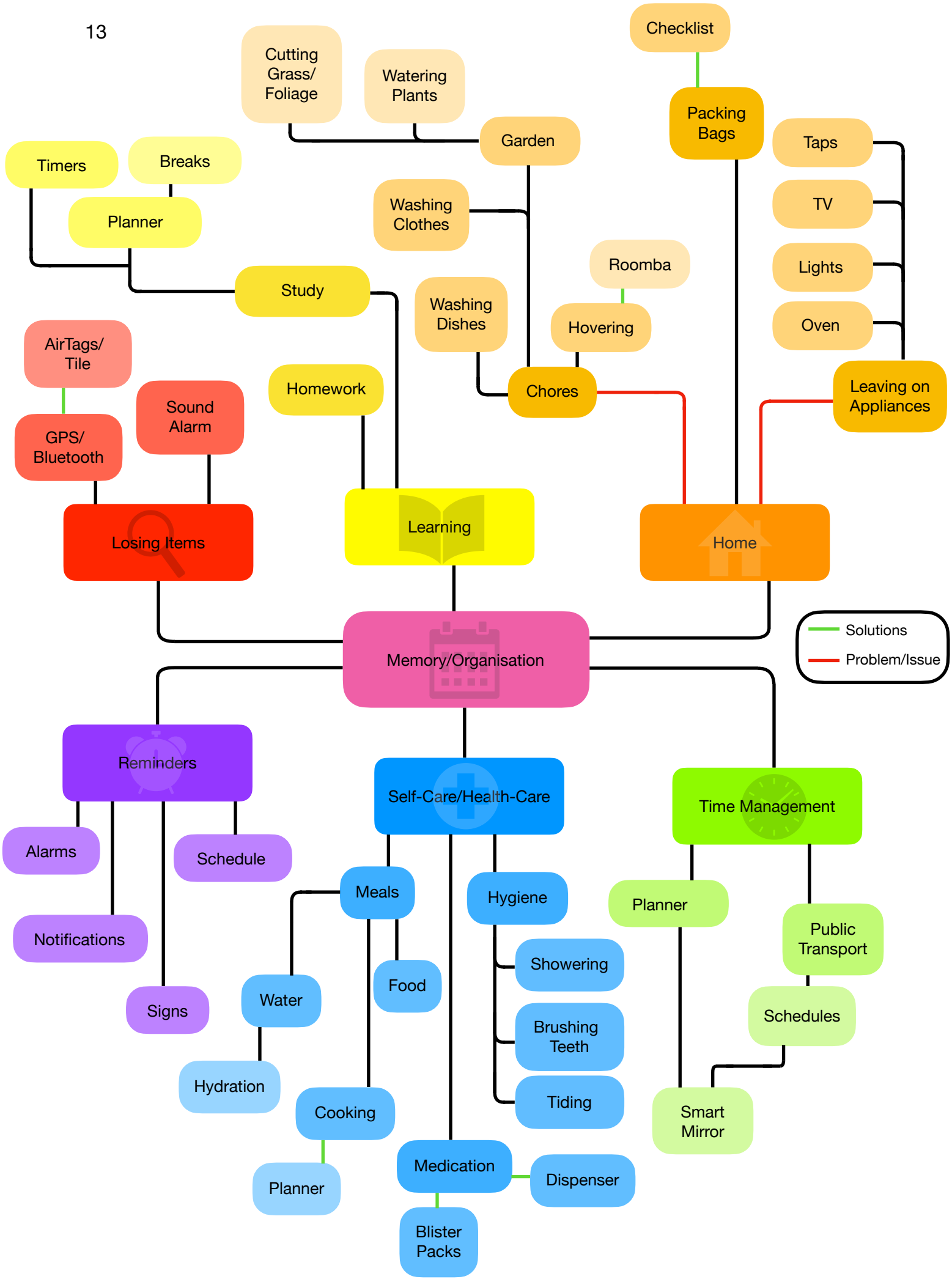


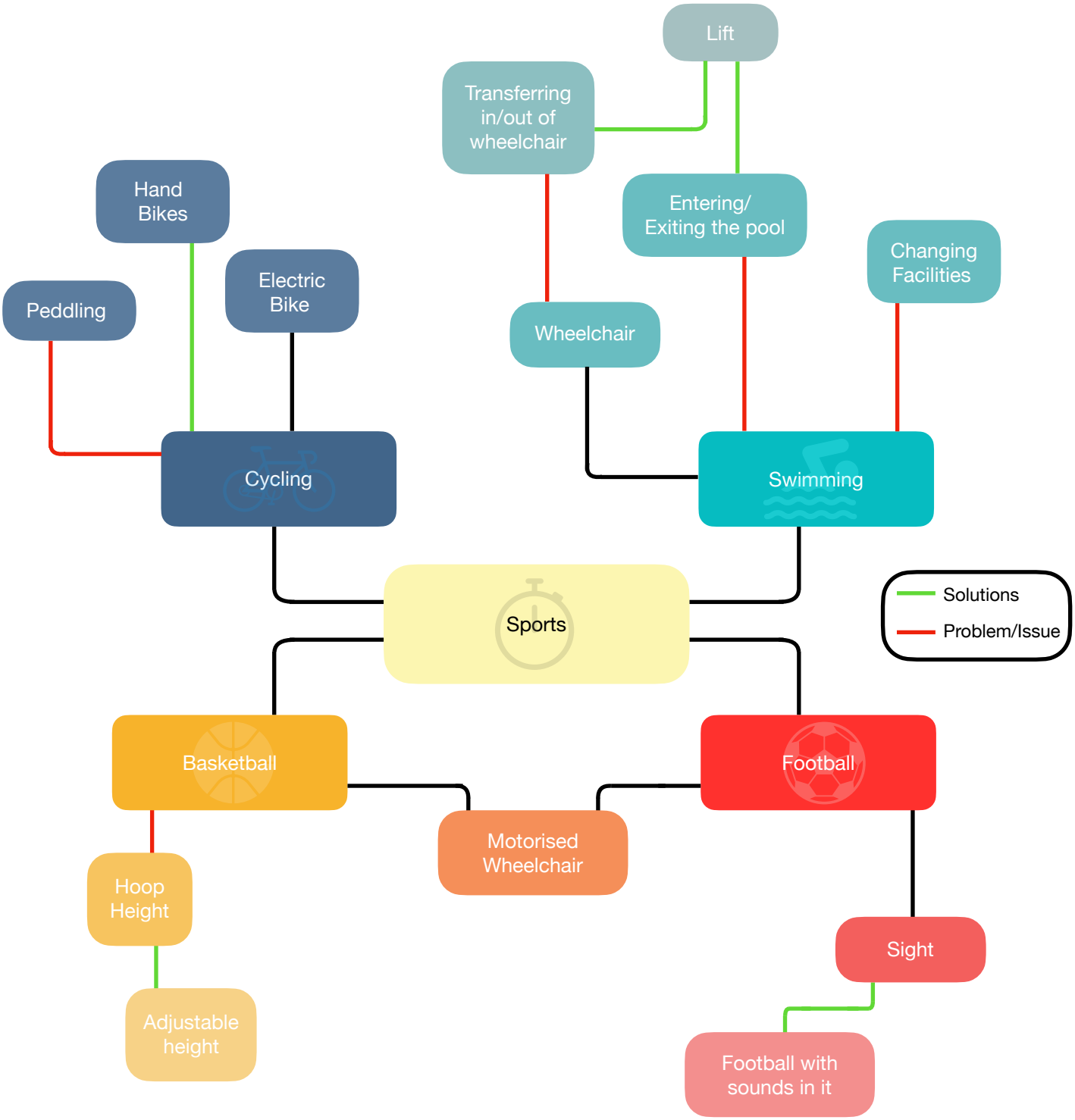
LIFT IN NUI GALWAY POOL

PILL DISPENSERS



BLISTER PACK

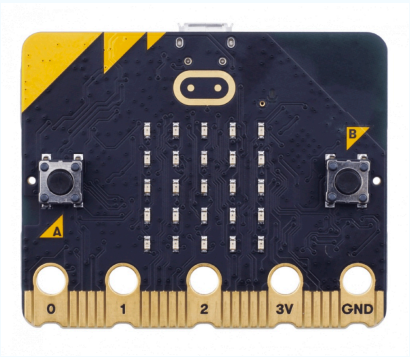
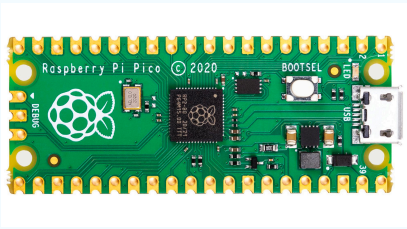

Checklist
Cutting Grass/ Foliage
Watering Plants
Packing Bags
Garden
Taps
Timers
Breaks
TV
Planner
Washing Clothes
Lights
Roomba
Study
Washing Dishes
Hovering
Oven
AirTags/ Tile
Homework
Chores
Leaving on Appliances
Sound Alarm
GPS/ Bluetooth
Losing Items
Learning
Home
Solutions
Problem/Issue
Memory/Organisation
Reminders
Self-Care/Health-Care
Time Management
Alarms
Schedule
Meals
Hygiene
Planner
Public Transport
Notifications
Showering
Food
Water
Signs
Brushing Teeth
Schedules
Hydration
Tiding
Cooking
Smart Mirror
Medication
Dispenser
Planner
Blister Packs


Lift
Transferring in/out of wheelchair
Hand Bikes
Entering/ Exiting the pool
Changing Facilities
Electric Bike
Peddling
Wheelchair
Cycling
Swimming
Sports
Solutions
Problem/Issue
Basketball
Football
Motorised Wheelchair
Hoop Height
Sight
Adjustable height
Football with sounds in it

Investigation of sub systems

Embedded Systems

I looked into two main embedded systems, the BBC Micro:Bit and the Raspberry Pi Pico.

System	BBC Micro:Bit	Raspberry Pi PIco
Max Output Voltage	3.3v	5v
Real Time Clock	No	Yes
Support for modules	Limited	Unlimited
GPIO Pins	19	26
Code	Code Blocks or Limited version of Micropython	Micropython
Support for LCD screen	No	Yes
Support for motors	With add-on board	Yes
Picture		

Input Devices

LDR

BUTTON

SWITCH

POTENTIOMETER

Output Devices

LED

LCD SCREEN

MOTOR

BUZZER

SPEAKER

Design Ideas and Selection of Optimum Solution

Option 1 - Automatic Pill Dispenser

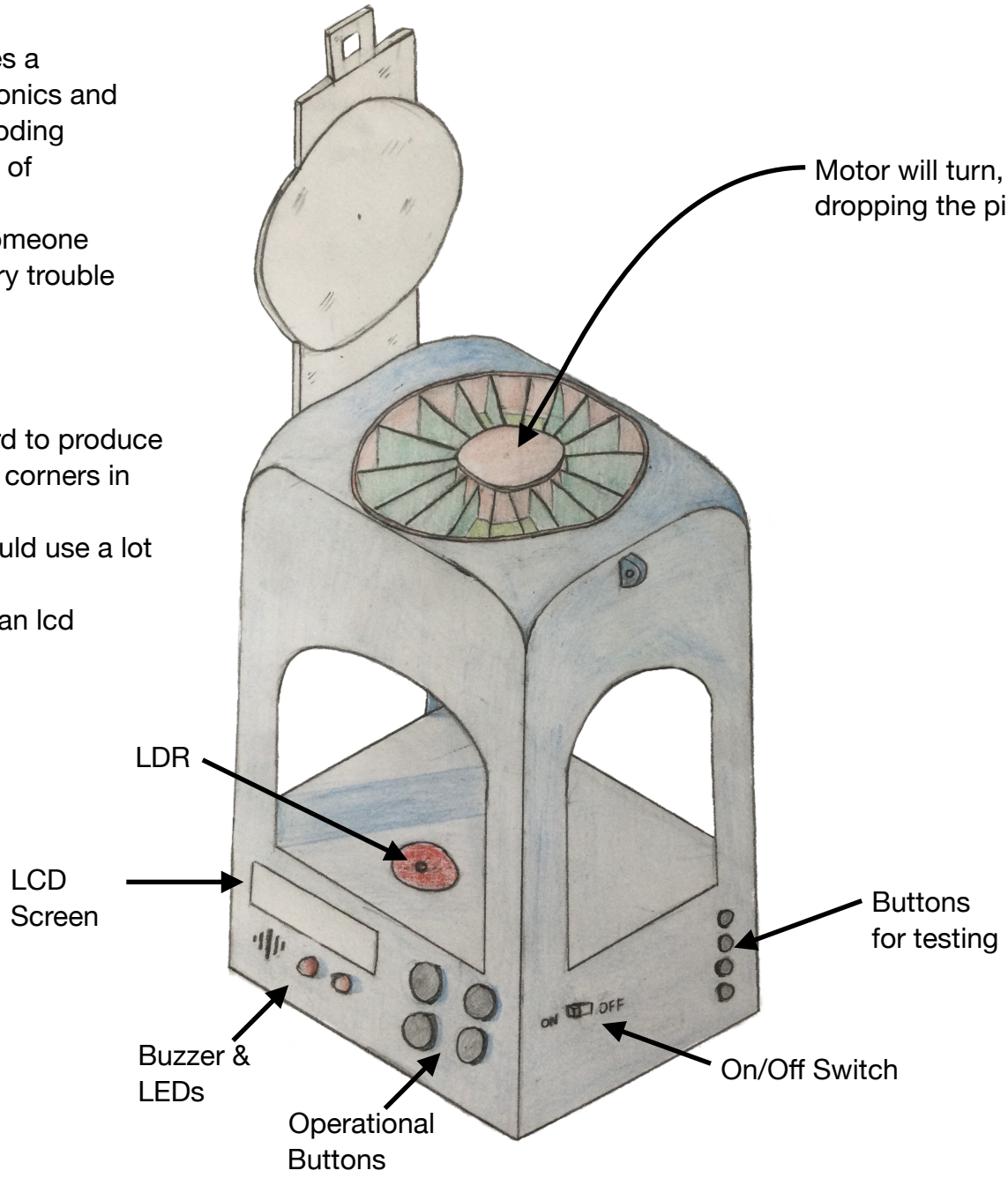
This project is to help people remember to take their medication
A person can place their pills into the storage area on top.
The fan like piece will rotate and a pill will drop down into a cup placed on the red marker
A led will flash and a buzzer will turn on until the cup has been picked up
The LCD will show information on the system

Pros

- This project uses a variety of electronics and would rely on coding which are areas of strength for me
- It would help someone who has memory trouble

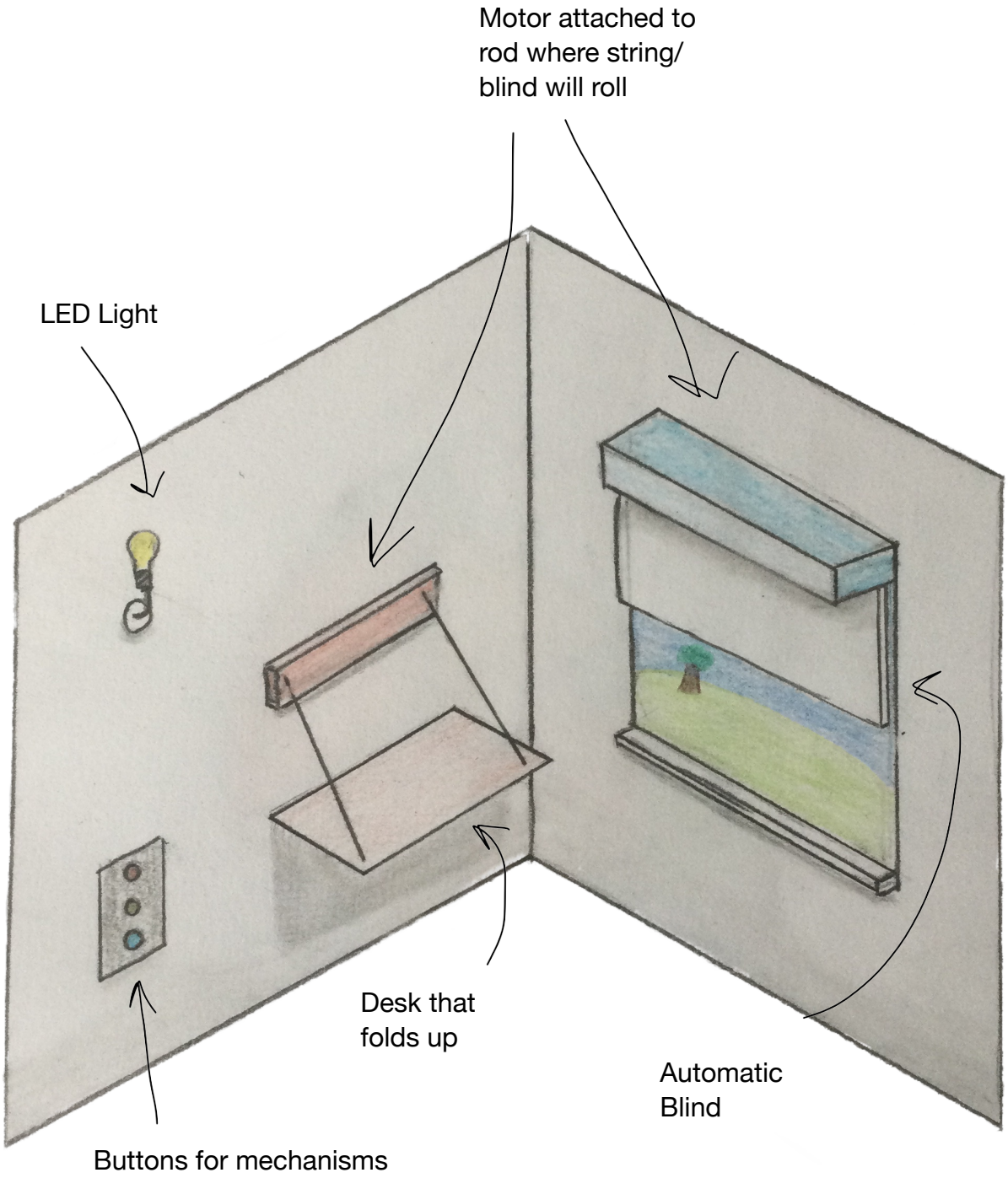
Cons

- It would be hard to produce the circles and corners in this project
- This option would use a lot of material
- I haven't used an lcd display before



Option 2 - Accessible Room

This would be an accessible room for a person in a wheelchair or limited mobility. It will have many features like a blind that will open and close automatically, a light that turns on and off and a desk that can be brought up and down so there is more room for the person
All of this will be controlled by an accessible panel with buttons



Pros

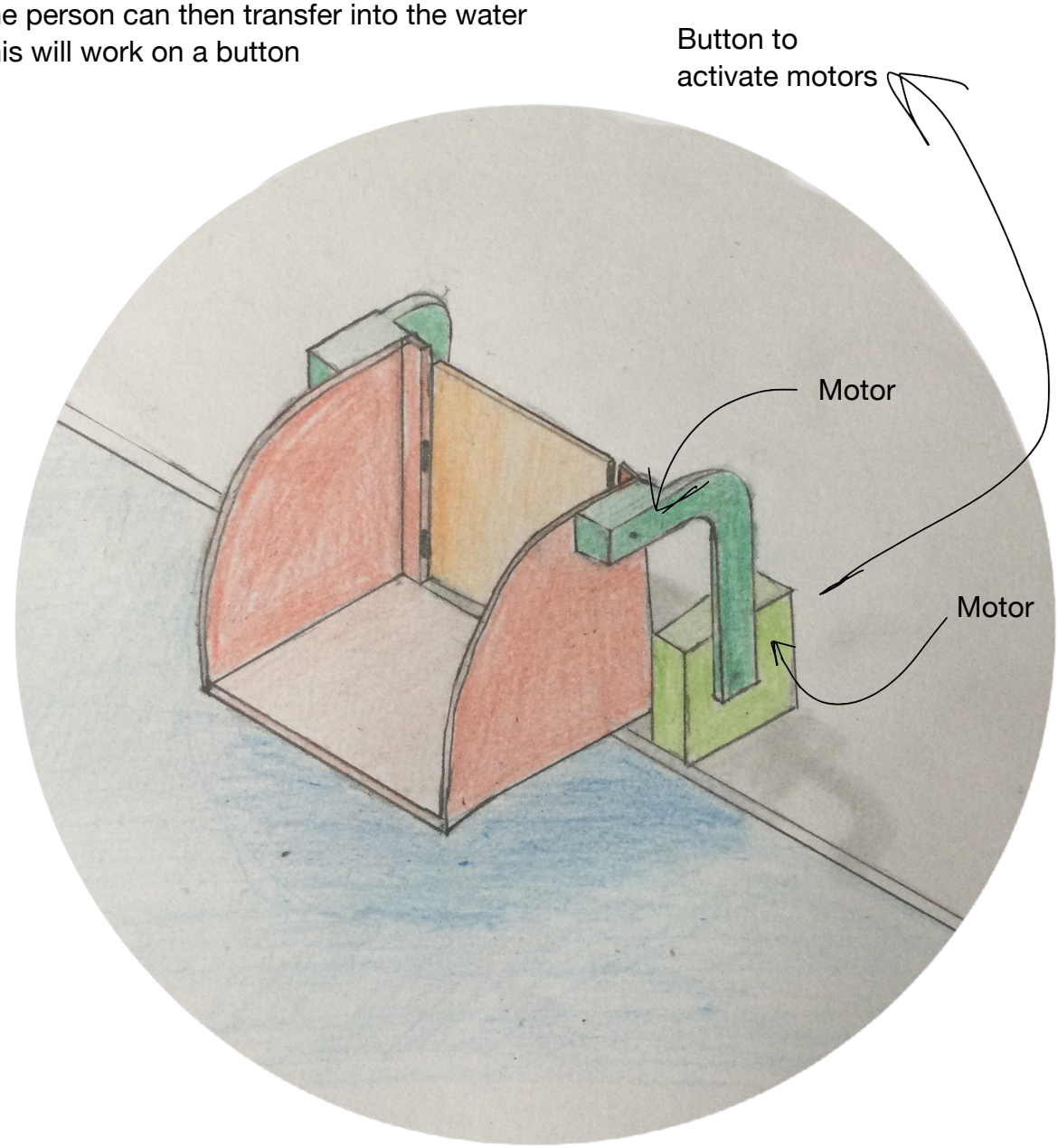
- This project would be easy to make
- It would help someone who couldn't do these type of tasks easily
- The electronics would be easy to wire

Cons

- This is a basic project that wouldn't show all of my skills
- The areas where the motors are would be very bulky and and take up a lot of room

Option 3 - Pool Transfer

This project is a lift to help people get in and out of the pool.
It will open from the back and the person can wheel/walk onto the platform
The arm (dark green) will rotate and submerge the platform into the water
The person can then transfer into the water
This will work on a button



Pros

- This project would be easy to make
- It would help someone who couldn't easily get into a pool
- The electronics would be easy to wire

Cons

- The movement to get the platform to submerge into the water while staying flat would be hard to do. You would need two motors, one rotating one way and the other counter rotating to keep the platform flat while moving with the first motor
- The areas where the motors are would be very bulking and and take up a lot of room

Selection Of Optimum Solution

I decided to go with option 1 as I feel it will be the most feasible to do while showing the full extent of my skills. I also have an interest in this area. This option will:

- Use mechanical and electronic components
- Answer the brief
- Help someone with a disability

This option is the Automatic Pill Dispenser. It can be set up to dispense pills 3 times a day for 7 days. It will alert the person once the pill has been dispensed and the system will continue to remind them until they take their medication. This will help someone with a cognitive disability remember to take the medication, allowing them to live independently while ensuing they take all medication.

How will it work?

The user will turn on the machine, they can then use the buttons on the front (up, down, yes, no) to navigate through the menus. For my system I plan to have two modes, demo mode and full mode.

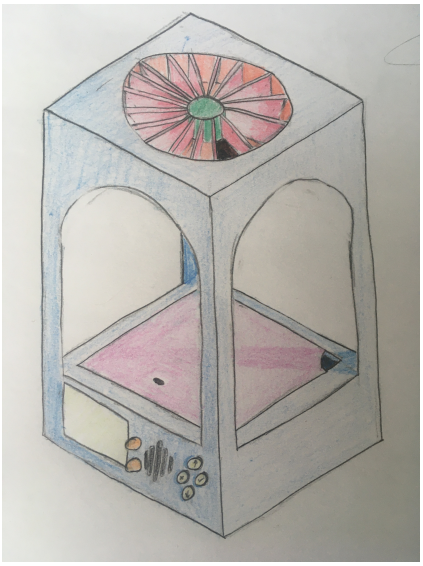
The full mode is how the machine would work in the real world. It starts with having the user set the clock and dose times. Once that is set up the main display will be shown. This will have a fully functioning clock and show when the next dose time is. Pills will only dispense when it is the dose time. It also has a settings option.

The demo mode is for testing purposes. It dose't require any times to be set up. It shows a mock up of the main display from full mode. It doesn't have a working clock. Pills can be dispensed at any time by pressing the button on the back of the machine.

Regardless of mode, once a pill has been dispensed it will alert the user. A LED will flash and a buzzer will turn on. This means this machine is accessible for visual impaired and hard of hearing people.
The flashing will stop after a minute and a timer will start, if the cup hasn't been picked up within that time the flashing will resume until the cup has been picked up or the cancel button has been pressed.

Refining my solution

I changed the curves on the top to regular corners as they would be hard to produce
I now plan to rotate a disc underneath the area that contains the pills, I did this as I believe the motor won't be powerful enough to turn the original fan design.
I got rid of the cover as I think that would be hard to produce and I wouldn't have time to make it.



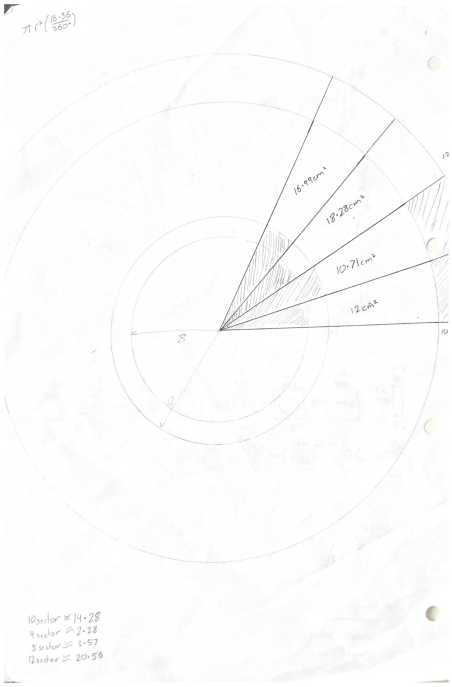
FINAL SKETCH

Sketches and Drawings for Manufacture

Planning

I wanted 22 sections for my dispenser. This is enough for someone to take 3 pills a day for 7 days plus a blank.
I drew out on paper the sizings and area of different size compartments

$$360 \div 22 = 16.36$$

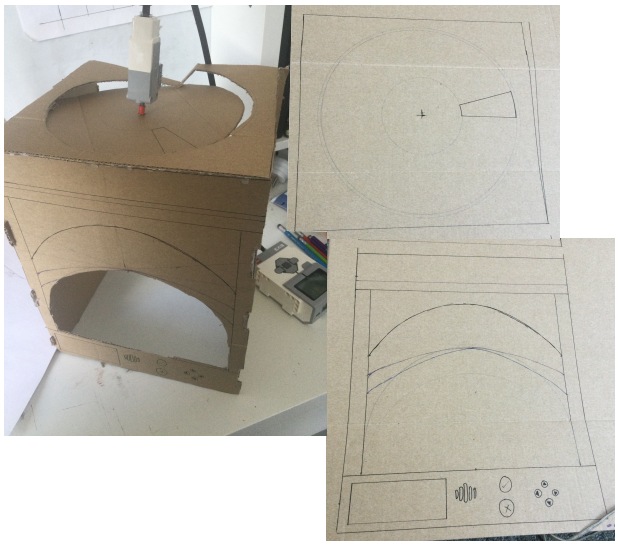


Through research I found out the stepper motor I was using has 2038 steps for a full rotation. I divided this by 4 due to the code running 4 steps at once, I then multiplied that by the degrees I needed the motor to turn. This gave me the amount of steps the motor needed to be turned.

$$2038 \div 4 = 509.9 \times \frac{16.36}{360} \approx 23 \text{ steps}$$

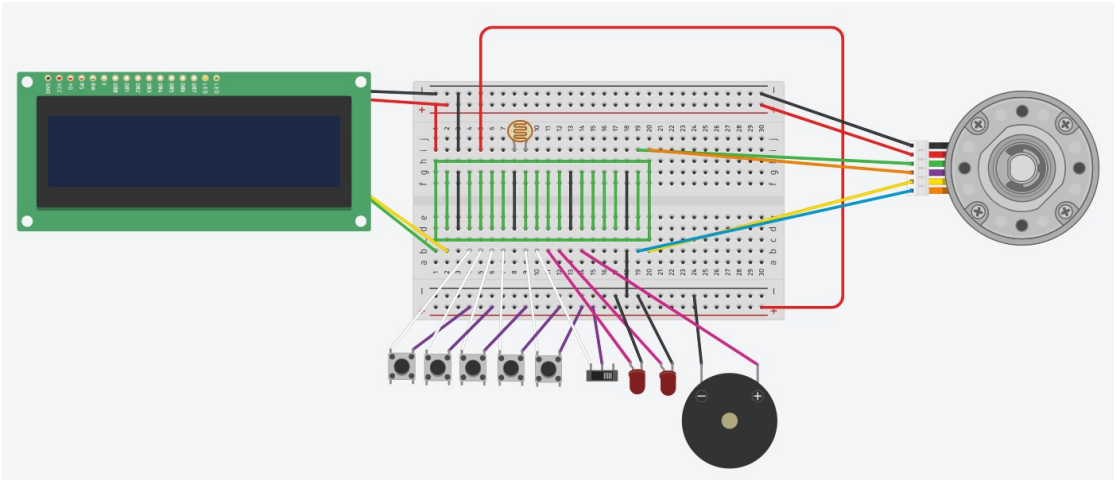
Prototyping

To test out the concept of my project I made a basic prototype of the dispenser out of cardboard. This helped me gauge the size I needed to made the dispenser and work out any issues with the idea.
I also used Lego Mindstorms, which is a hardware and software structure which uses motors that can be easily programmed, to make sure everything would function correctly when I used a motor.



Circuit

I used circuit diagrams to map out exactly what components I would need and where I would wire them. *note the rectangle of green wires represents where the pico will go

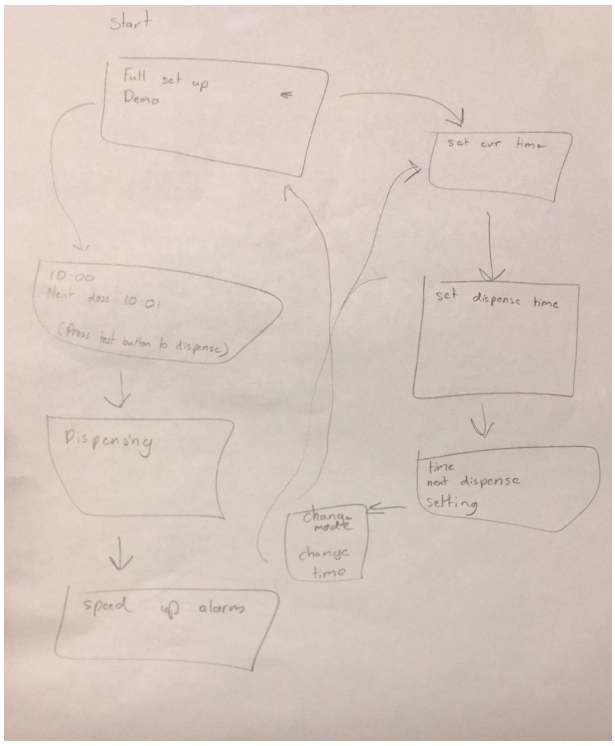


List of electronics

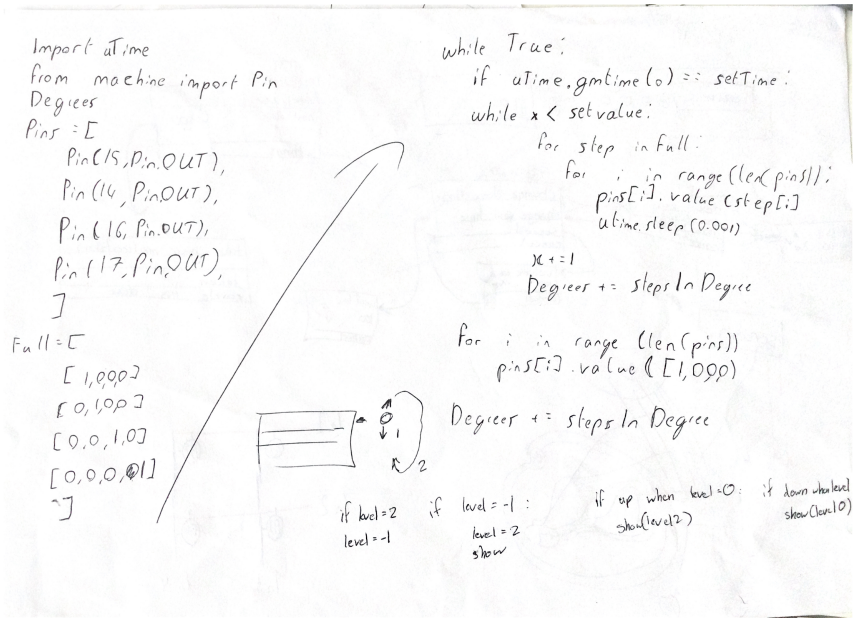
- LCD Screen - will be used to show info and set the dose times
- Buttons (x5) - will be used for menu navigation and testing
- LEDs (x2) - will be used to show when the motor is turning and when a pill has been dispensed
- Buzzer - will be used to show when a pill has been dispensed
- LDR - will be used to see if the cup has been picked up showing the medication has been taken
- Raspberry Pi Pico - will connect everything and run the code

Code

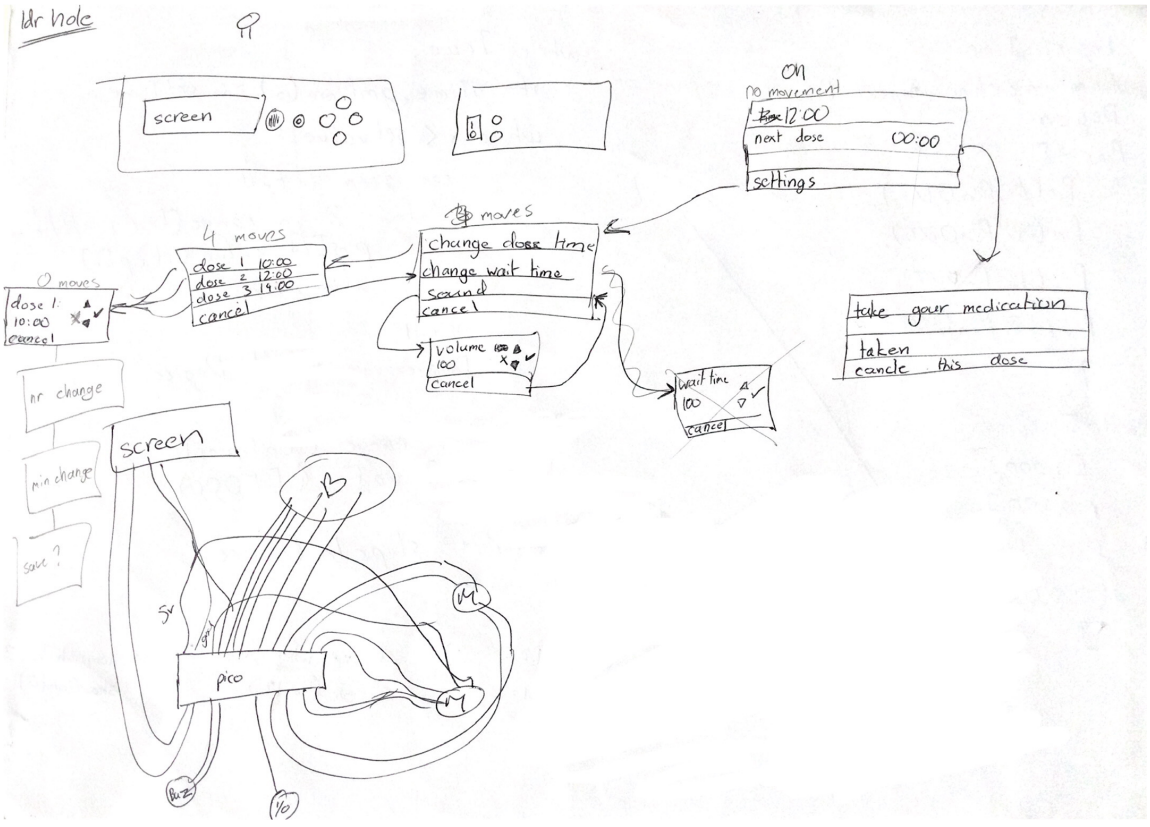
I used a variety of flow charts and pseudo code to design my code. This helped me plan the exact functions I wanted in my code.



ROUGH FLOW CHART



ROUGH PSEUDO CODE

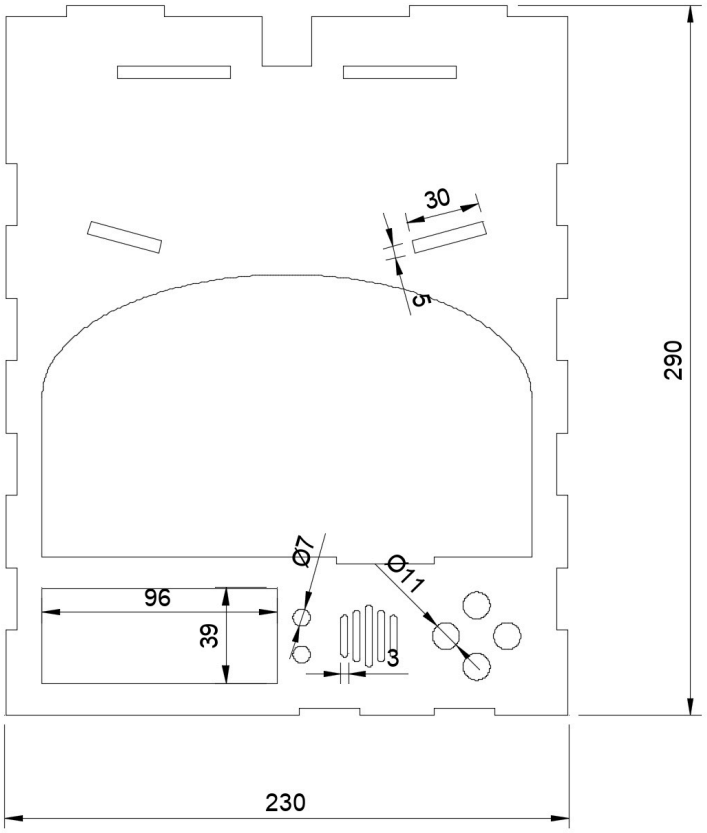


BASIC CIRCUIT DIAGRAM AND IDEA OF HOW THE LCD WOULD WORK

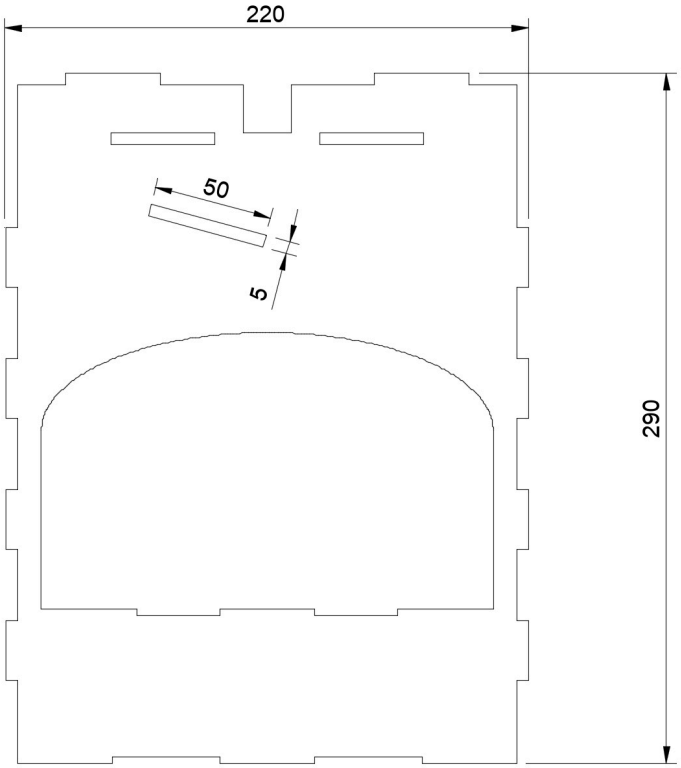
FULL FLOW CHART

Sketches

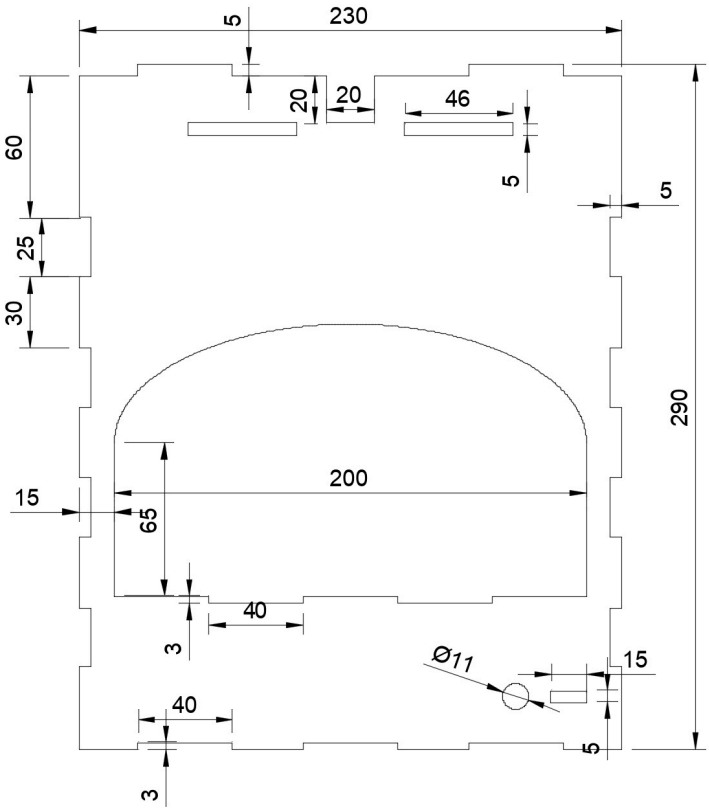
As my design is quite complex I have broken it down by going through the front, back and side panels and then each layer of the project.



FRONT PIECE

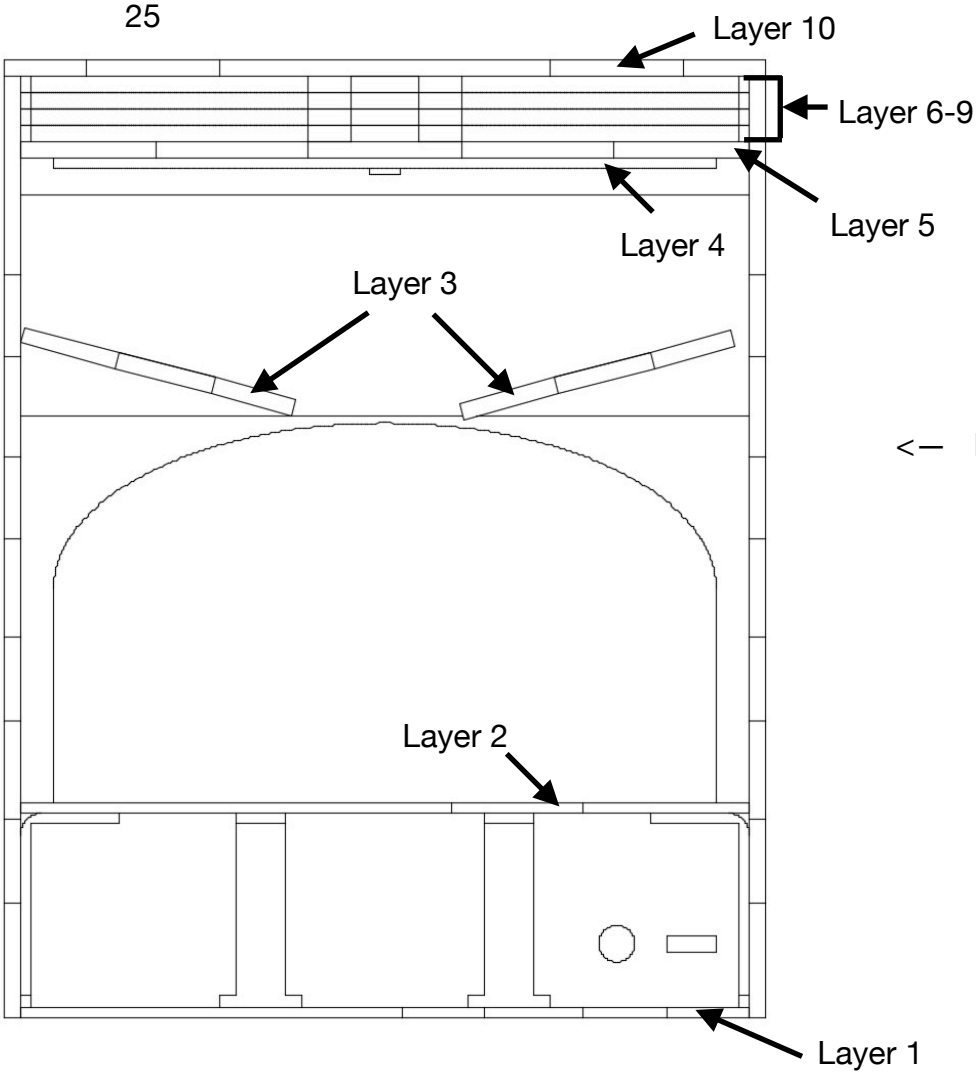


SIDE PIECE



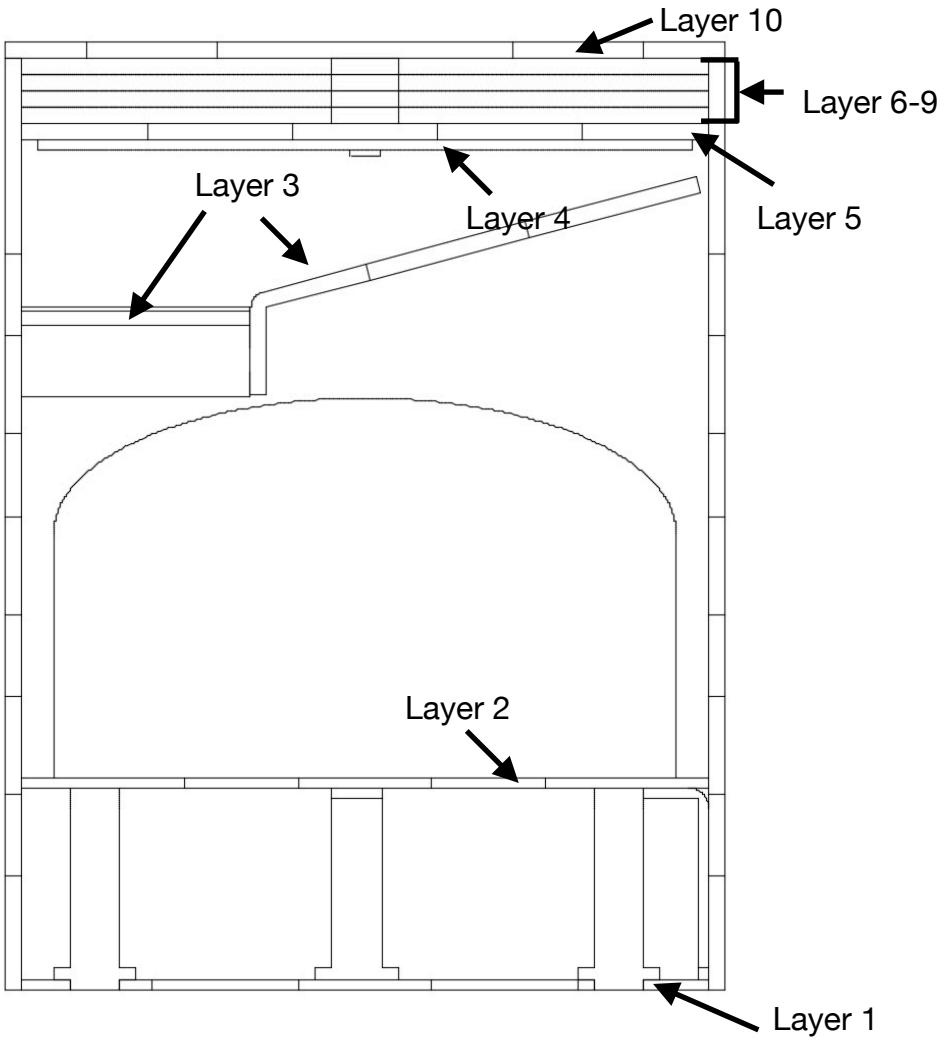
BACK PIECE

Each piece interlocks to each other. They have slots to hold up the different layers. The front and back panels also have holes for the electronics.



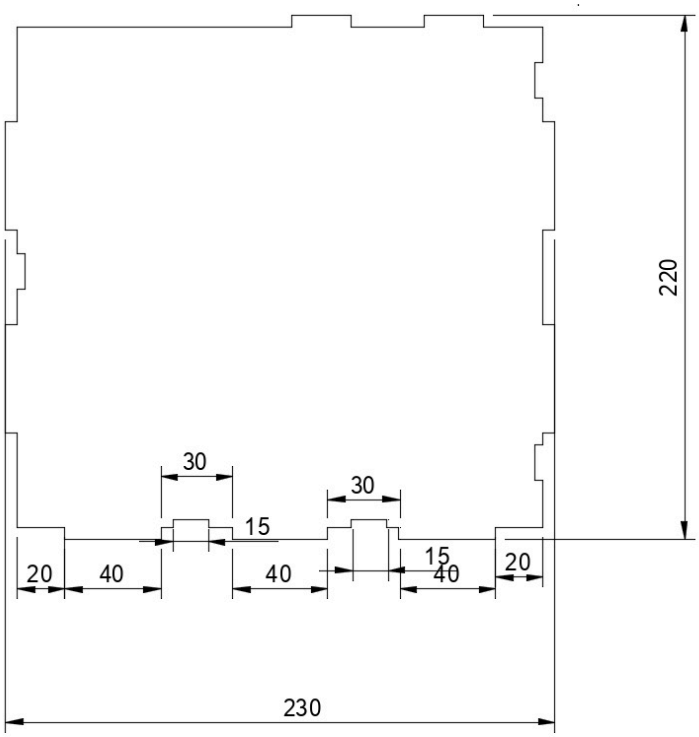
<— Front View

Side View —>

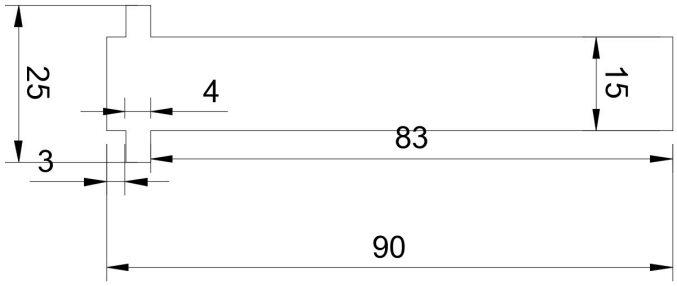


Layer 1

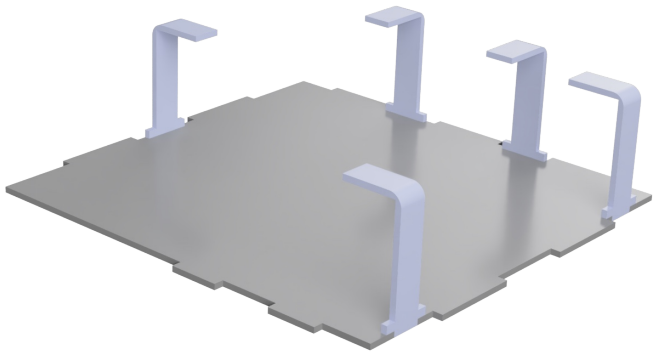
This is the bottom piece. It has slots to fit the front, back and side pieces. It also has slots to fit in the pieces that hold up layer 2



BOTTOM



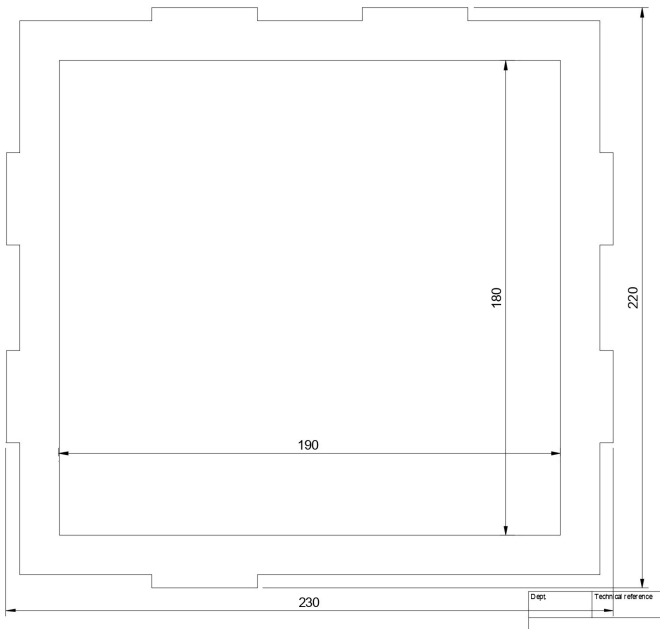
PIECE THAT HOLDS UP LAYER 2



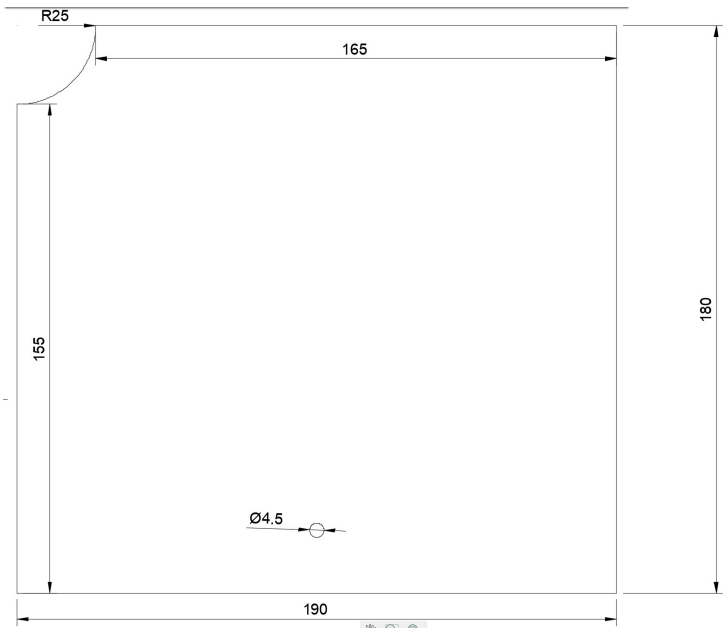
HOW THE BOTTOM AND HOLDS INTERACT

Layer 2

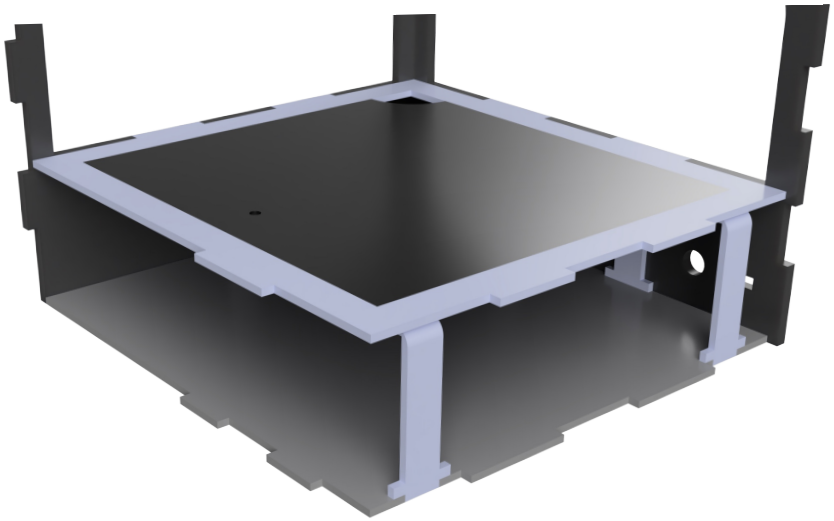
This is where the cup will be place for the pills to be dispensed. Piece 1 lays on top of slots of the side pieces. Piece 2 fits into piece 1, it is able to be lifted off giving access to the electronics stored between layer 1 and 2. Piece 2 also has a hole for a LDR.



PIECE 1



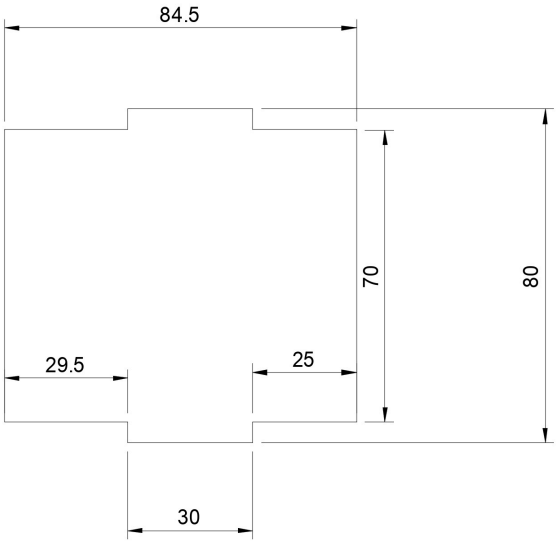
PIECE 2



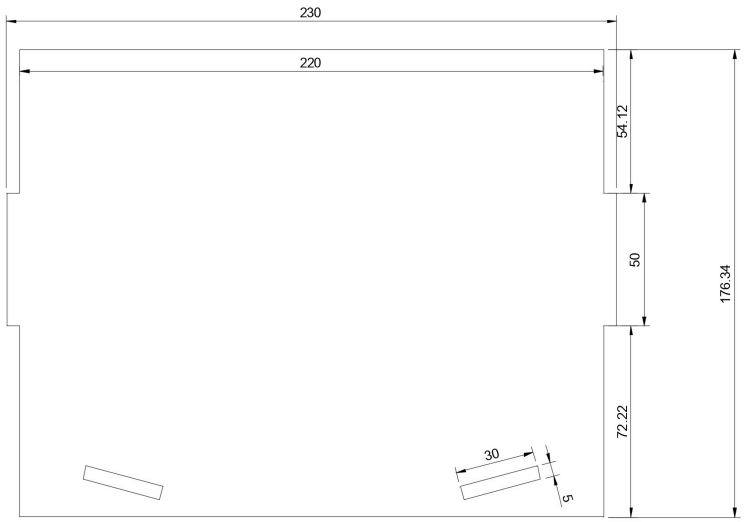
LAYER 2

Layer 3

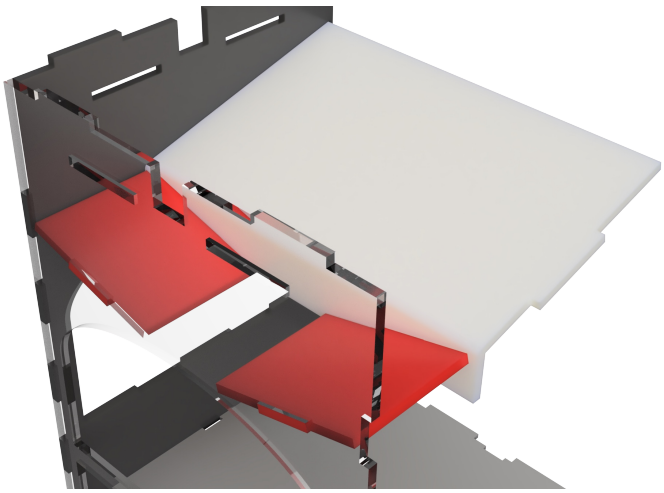
Layer 3 is where the pills will slide down after being dispensed. It has two identical smaller slides and one larger on. They all slot into each other and side pieces.



SMALLER SLIDE (*2)



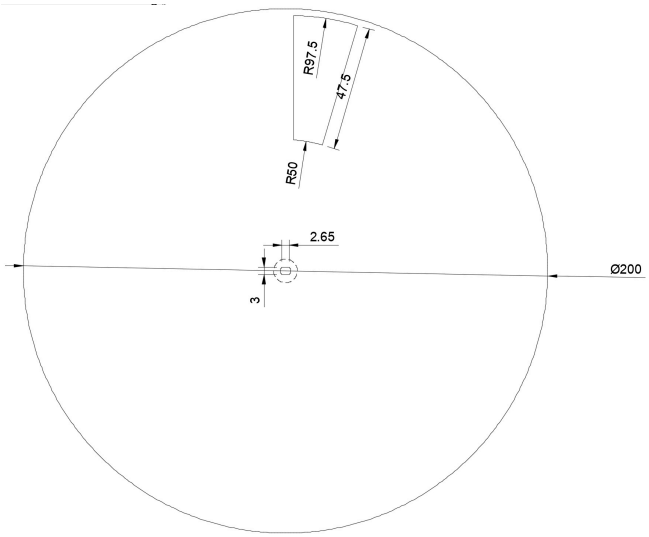
LARGER SLIDE



LAYER 3

Layer 4

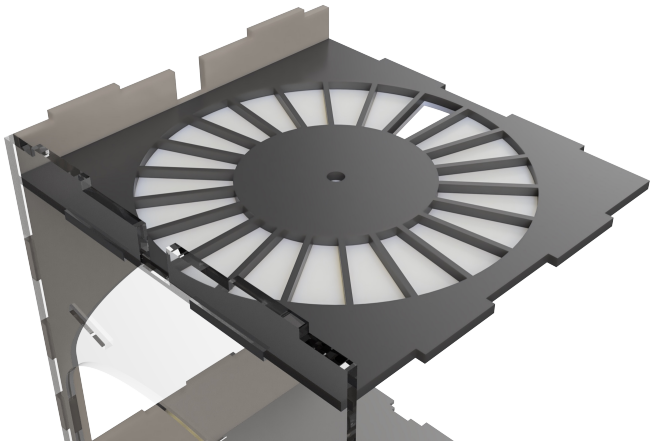
This is the rotating piece where the pills will fall from. It will be held in place by the motor.



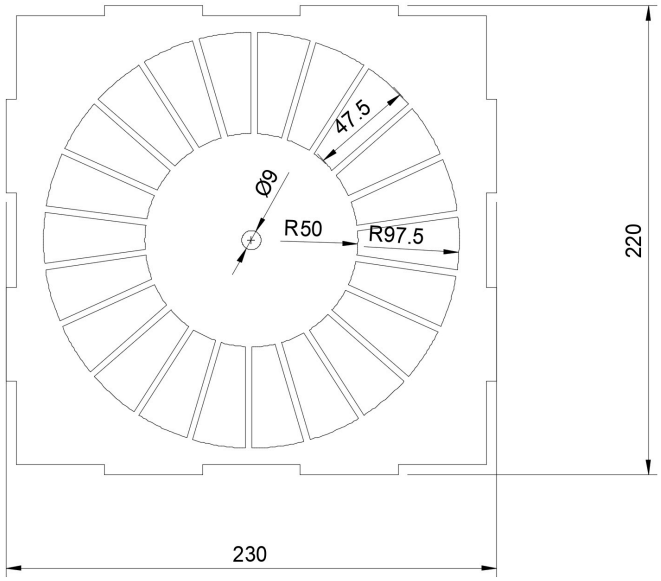
SPINNING PIECE

Layer 5

This piece supports the layers 6-9 and the 3d printed piece. It slots into the side pieces



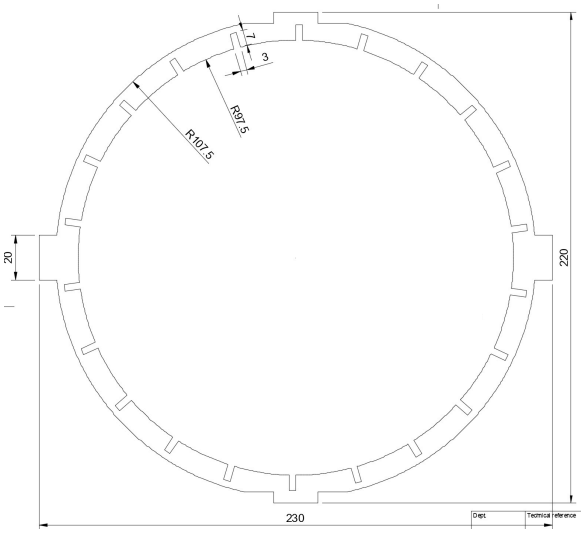
LAYER 4 & 5



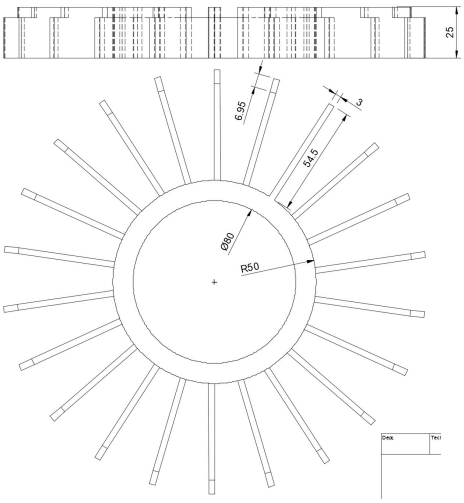
SUPPORTING PIECE

Layer 6 - 9

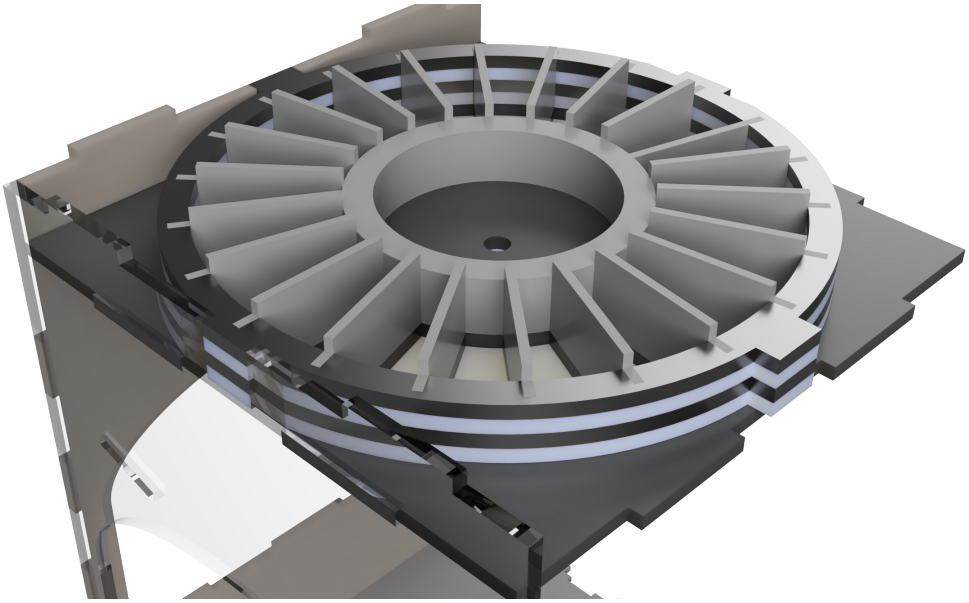
Layer 6 to 9 are 4 identical ring pieces that will slot into the 3d printed bit and side pieces. They act as a barrier for the place where the pills are stored. This is also where the 3d printed piece is.There is also a cover for the motor that will be stored in the middle of the fan



RING PIECE

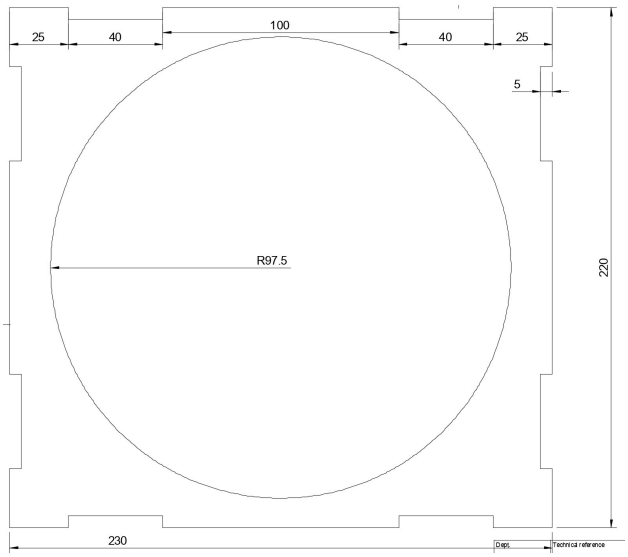


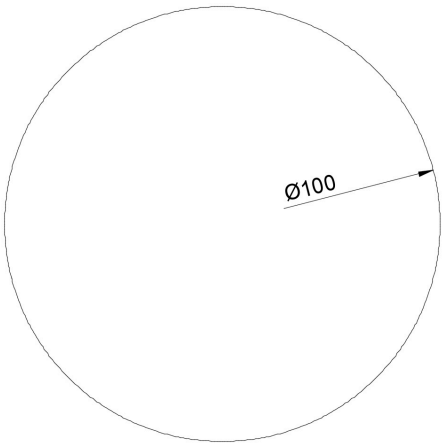
3D PRINTED PIECE

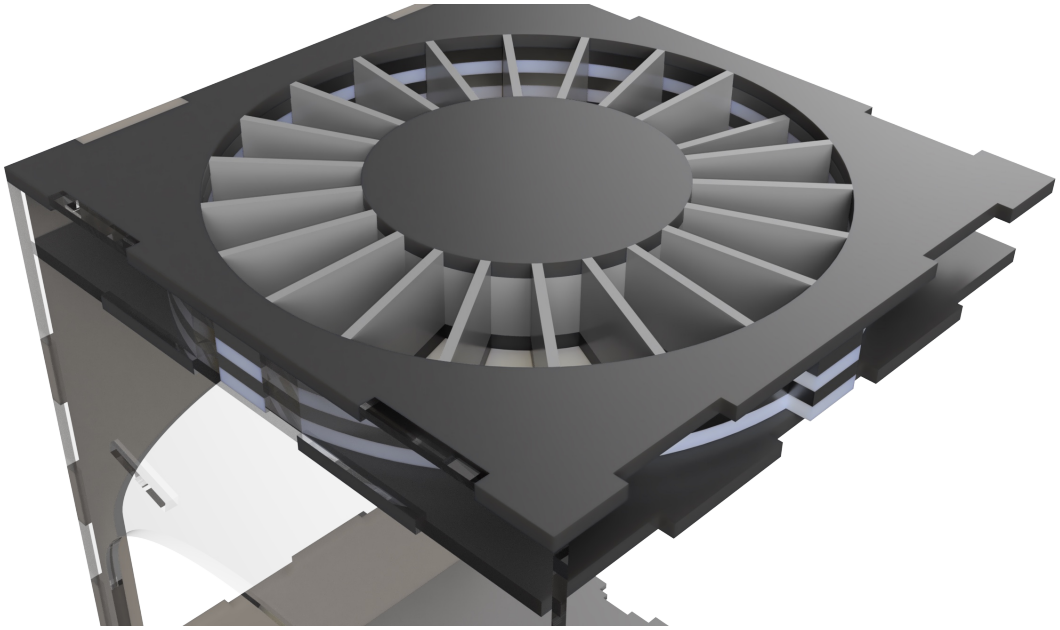


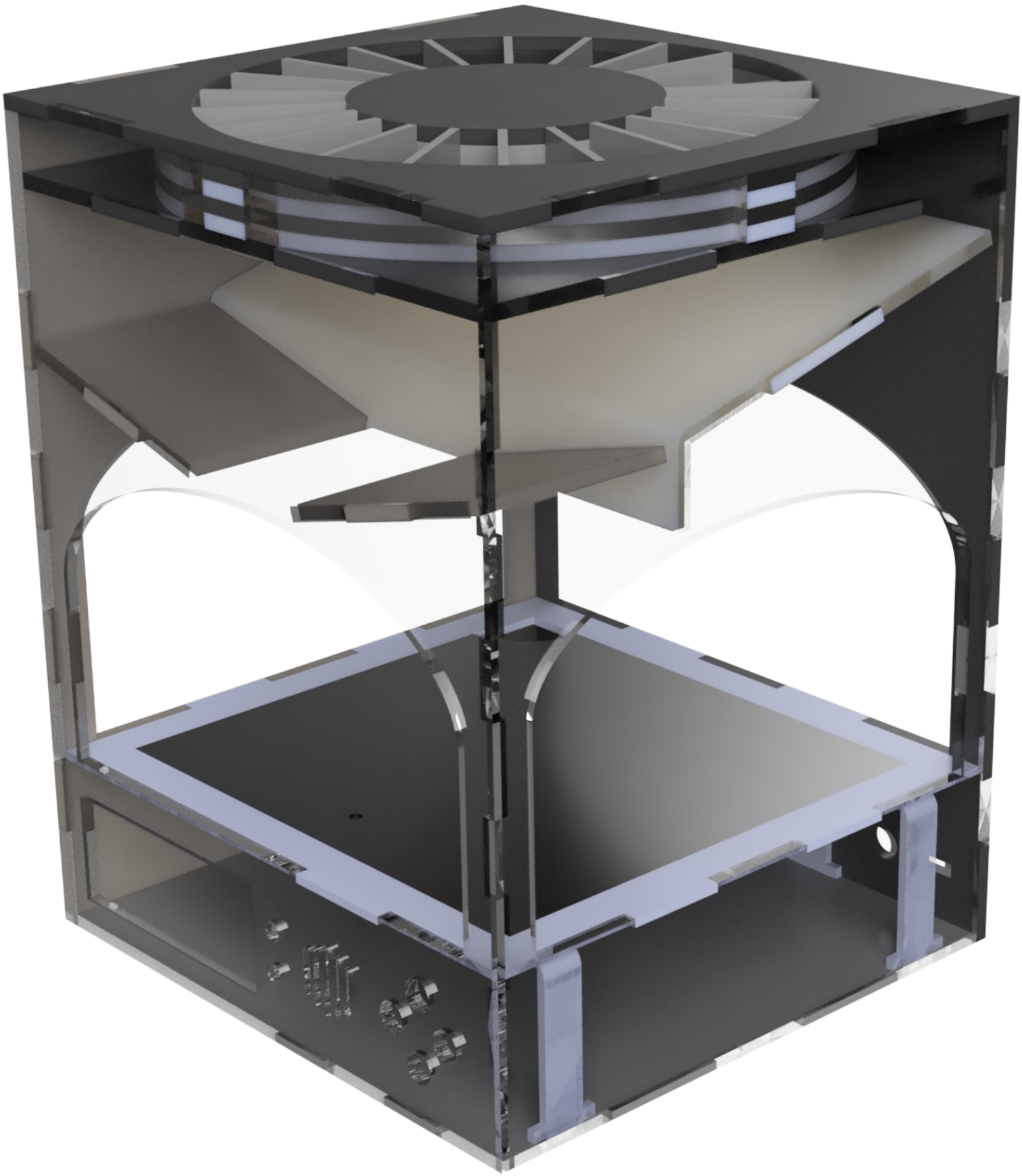
Layer 10

This layer consists of cover where electronics will go.



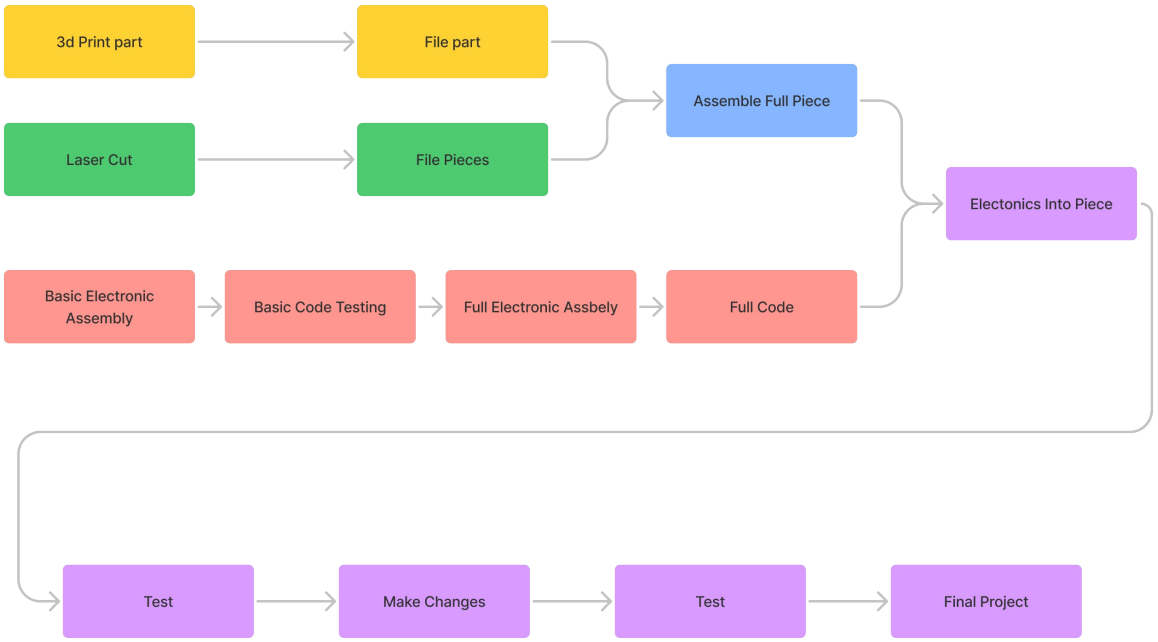




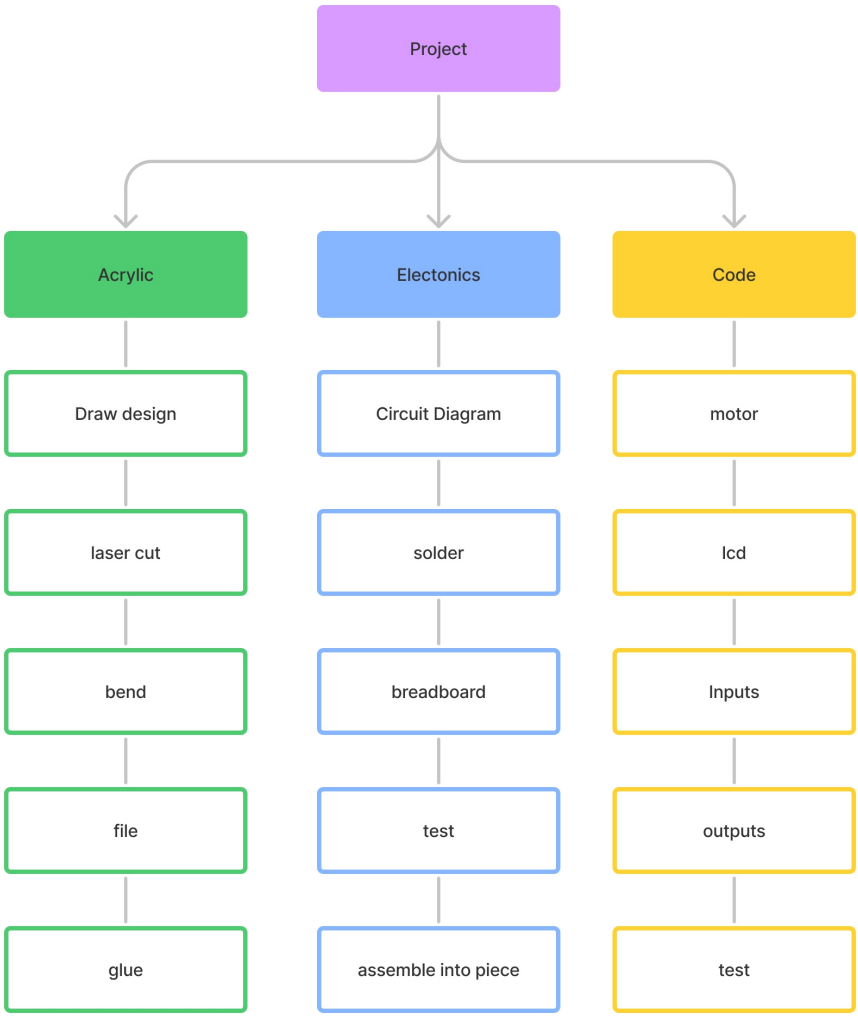


FULL RENDER OF PROJECT

Production Planning



CRITICAL PATH DIAGRAM



WORK BREAKDOWN STRUCTURE

Costings

Material	Quantity	Cost (€)
Acrylic		5
Buttons	5	0.5
Switch	1	N/A (recycled from broken electronic)
LDC Screen	1	12
PLA		
Breadboard	1	1
Jumper Cables	15	0.5
Raspberry Pi Pico	1	4
LDR	1	0.5
LED	2	N/A (recycled from broken electronic)
Buzzer	1	N/A (recycled from broken electronic)
Motor	1	1
Total		24.5

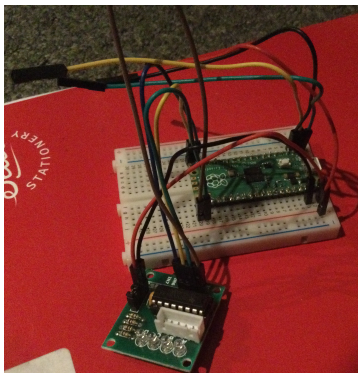
Gantt charts for project realisation

	Week 14	Week 15	Week 16	Week 17
Laser Cutting				
Bending				
3d printing				
Soldering				
Assembling Project				
Assembling Electronics				
Sanding/ FInishing				
Coding				

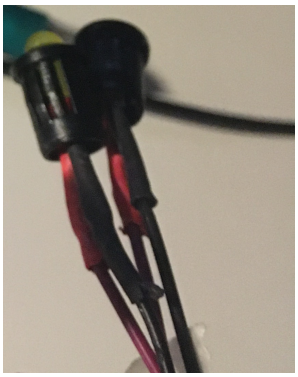
Production Realisation

- When I started this project the laser cutter was broken. As I needed the laser cutter to cut the majority of my pieces I started to assemble to electronic. At first I used crocodile clips to make sure all of my electronics worked. I then soldered jumper cables to any electronics that didn't already have them. This is so everything could be plugged into the breadboard.
- While assembling my electronics I wrote basic scripts to make sure everything worked. Once that had all been completed I wrote the full code. I started working on my main script. I had to split my code into a few different scripts due to the complexity of the code. (See the last pages for code explanations)

SOLDERING JUMPER CABLES

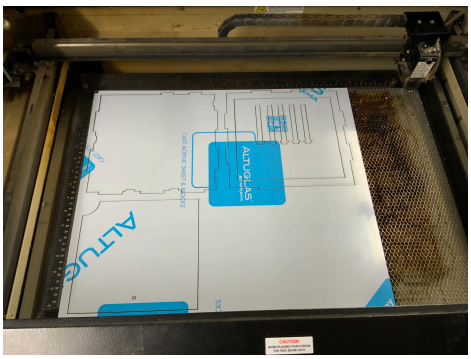


TESTING THE ELECTRONICS

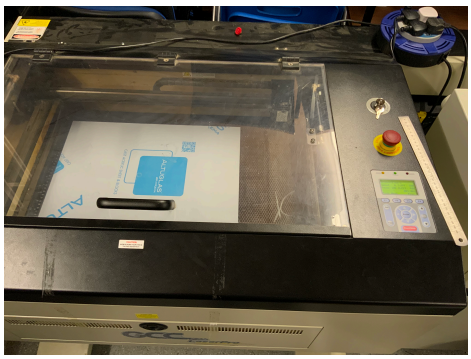


SOLDERING LEDS

- Once the laser cutter was fixed, I started my project by laser cutting all my pieces.



PIECES AFTER BEING LASER CUT



PIECE BEFORE BEING CUT

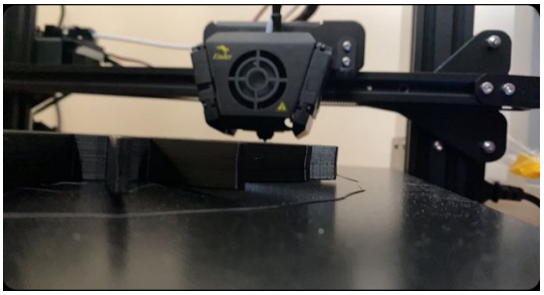
FILE BEING PREPARED

- The holes for the electronics were slightly too small so I filed those holes to fit the electronics. I drilled and filed a hole for the power wire for the Pico. I made gaps for the wiring. I used the strip heater to bend some of my pieces.

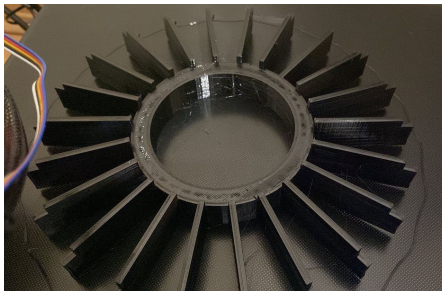
BENDING THE PIECE

HEAT STRIP

- I was able to get a friend to 3d print my fan like part. Once I received this I filed it and made sure it fit.



PIECE BEING PRINTED

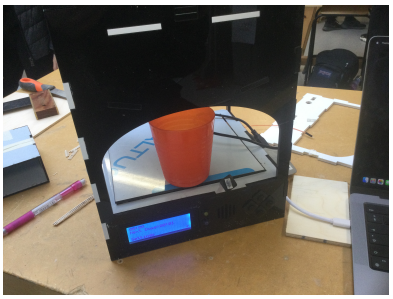


PIECE AFTER PRINTING

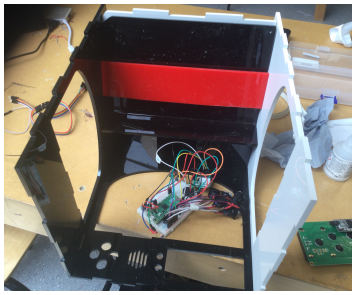
SANDING PIECE

- I then had all my pieces and began assembling. I tried to glue the least amount of things possible. This was easy as my piece slot together well

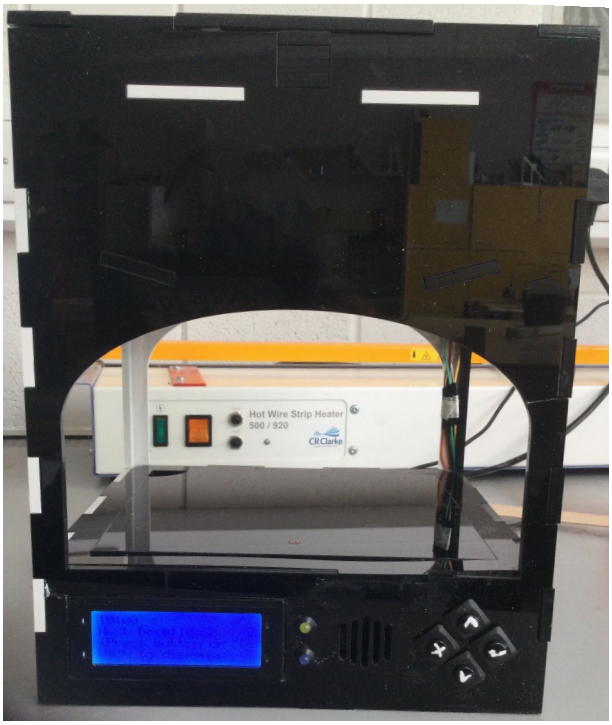
- I then tested out all the electronics before securing them



TESTING THE ELECTRONICS



ASSEMBLING THE PROJECT



FINAL ASSEMBLY OF THE PROJECT

Testing, Evaluation and Critical Reflection

What worked well?

Overall I am happy with how my project turned out. I believed I have achieved this brief as I have built a product that could help someone with a disability. This project could help someone with a mental disability remember to take their medication on time which would work toward helping them lead an independent life.

- I am particularly happy with my code as it took a long time to perfect and I am happy it all works.
- I am also pleased with my drawings and I feel I learned a lot while making them.
- I feel I considered environmental impact well. To do this I did a number of things including:
  - My pieces were quite big so I was able to pair up with a friend in my class so they could cut some of their smaller pieces inside my large gaps.
  - All the electronics are accessible and could be replaced.
  - I was able to re-use old material and electronics.
  - I did all my designing on Solidworks which reduced paper use
  - There is a switch on the back to turn off the display for power saving

What I could have improved on

There are a few cracks in the acrylic I used. This happened as while I was working these pieces a few fell off the table and snapped into a few pieces. I was able to fix this with glue but if I was so redo this I would make the small columns wider so they are less prone to breaking.

While I was testing the concept I used cardboard to find an angle where the pill would slide down the ramp. Once I built my project the pills would get stuck on the ramp as there is a higher coefficient of friction for acrylic than cardboard.To remedy this I used a spray that reduces friction.

One of my pieces (larger slide) needed to be bent at a particular point to perfectly fit into the project. I bent the piece at the wrong point so it wouldn't fit into the project. To fix this I cut off the sides of the piece the slot into the side panels. I then cut another piece to go into these slots. This means the larger slide rests on top of the new piece so it works the same.

In very bright light the machine might not be able to sense when the cup in on the LDR. This means the second alarm won't work properly. To fix this I put tape on the bottom of the cup I was using and coloured it black to eliminate any light shinning through. A better way to fix this would be using a cup that isn't translucent.

Further Refinements

I would have liked to get a better finish on the project like slightly rounding the corners and edges but a didn't have time.

If this was to be produced on a larger scale all the material would need to be food safe which this is not. In particular the spray I used to reduce friction would need to be food safe.

If I had more time I would have liked to add more features to my code like a notification to see when the medication had run out or options to delay a pill being dispensed.

I also would have liked to add a cover to the top and I did develop the drawings for it but the laser cutter broke again on the last week so I wouldn't of had time to make it.

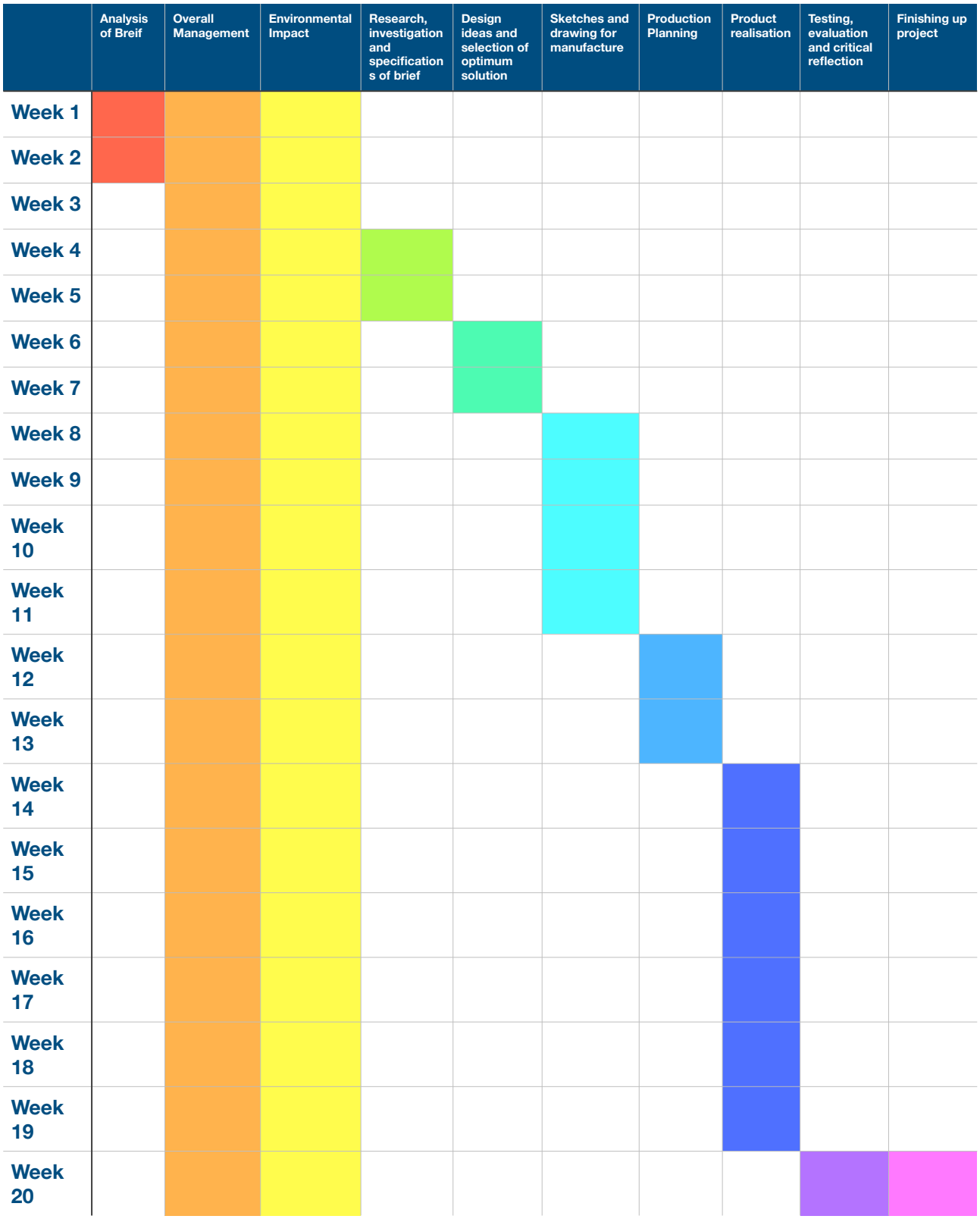
Once the machine has been turned off the times that have been set will not save. To fix this I could add a small battery so the pico has enough power to save the time.

My stepper motor doesn't turn the exact degrees I want. I think it would need extreme fine tuning to turn the exact 16.36° which I didn't have time do to.

See a video of the project working here

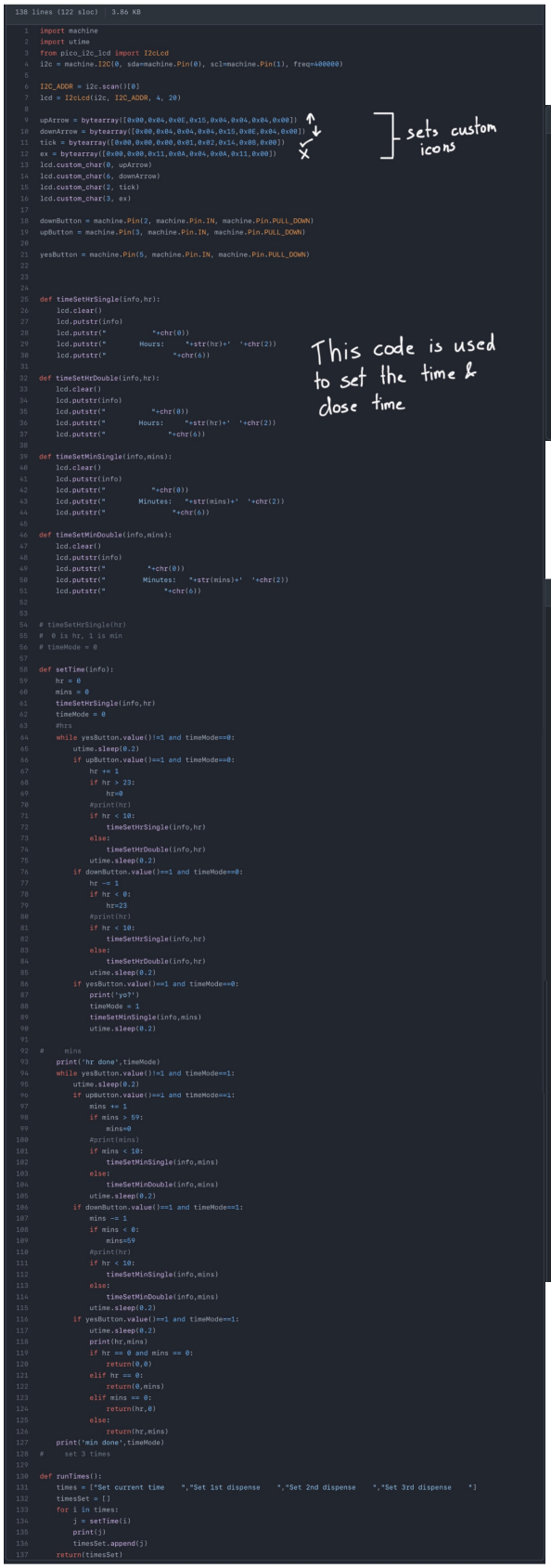
Final Schedule

As seen below I was keeping to my original schedule well but the laser cutter was broken for 3 weeks. This meant I became was behind my schedule and had to add two week to product realisation. This severely impacted this project and meant I didn't have a lot of time to put together my project.



Code Explanations

main.py



<— settingTime.py

buzzerAlarm.py

displays.py

[1] http://nda.ie/resources/factsheets/nda-factsheet-1-disability-statistics-briefing-information.pdf

[2] https://www.who.int/teams/noncommunicable-diseases/sensory-functions-disability-and-rehabilitation/world-report-on-disability

[3] https://www.euro.who.int/en/health-topics/Life-stages/disability-and-rehabilitation/multimedia/infographic-better-health-for-people-with-disabilities