SMART
MED-ASSISTANT

# SMART MED-ASSISTANT

### NEVER MISS A MEDICATION AGAIN!

**Masters Project: Design Process Summary**

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# Executive Summary

Medical non-adherence is a significant obstacle in a patient's treatment pathway. It can result in delays or even halt their path to recovery. The primary aim of this project was to design an intelligent solution to the medication non-adherence problem.

A set of conversations with doctors, members of staff, and the public helped identify the needs and problems faced by a patient during their treatment. Additionally, a range of commercially available medicine dispensing systems were researched, and it was inferred that none of the products could control the storage environment of the medicines, along with lacking an interactive user notification system. This journey of discovery, trial, and error led us to the final design concept, The Smart Med Assistant. The product designed for this project is a novel, user-friendly and interactive medicine dispensing solution with unique features such as temperature control, a detachable travel case, sturdy med packets, and a multifaceted notification system.

This product could not provide a solution for liquid medicine or the storage capacity of the travel case. The promising idea for a real-time medicine patch was briefly discussed but was able to materialize due to the lack of technology and resources required. Nonetheless, The Smart Med Assistant is definitely a step up from the available medicine dispensing systems
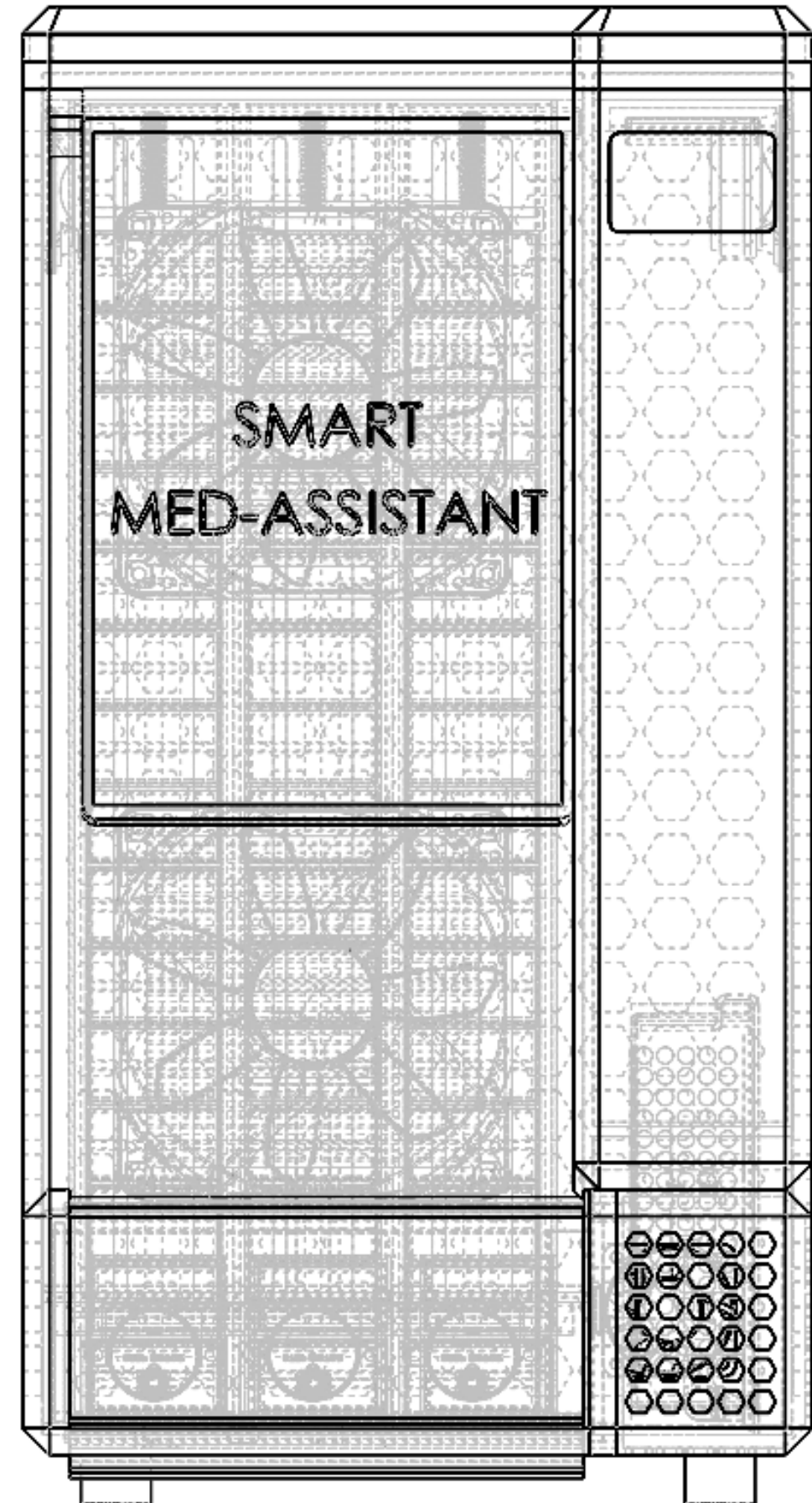
# Defining the problem

## Motivation

Early in 2021, I was on some medications and was told to take medicines every morning for the next 180 days. This medication could not be skipped, nor the timings of the dose. This made me think about the importance of taking medicines at a particular time. I also wondered, how do people with Alzheimer's or Dementia deal with these problems? There are new products in the market that attempt to deal with these problems; however, each has its own drawbacks.

## Background

The consumption of the appropriate medication at the right time is essential to the healing/recovery process in the patient pathway. The failure to take prescribed medications on time is a critical issue. It affects how well a patient responds to therapy and costs the healthcare system unnecessary amounts of money. According to a report by Epilepsy Research UK in June 2017, 75% of people with various medical conditions fail to consume their medication correctly. (Poll shows that almost 50% of people forget to take their medication at least once a month | Epilepsy Research UK, 2017)

Two main factors can lead to medical non-adherence. Firstly, the health system factors include medication cost, access to medication due to geographical reasons and poor doctor-patient relationships, among multiple other reasons. Secondly, therapy-related factors include: - Complex medical regimens. - High medication concentrations. - Lack of medication education. - No pillbox/reminder system. (Alloway, 2009)
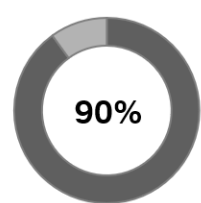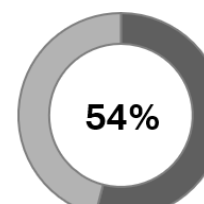
**90%** People are responsible for their own medication
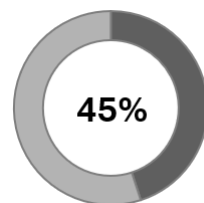
**45%** People forgot to take their medication
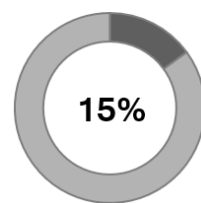
**15%** People are taking medicine at the wrong time

**54%** People usually forget to take medicine at the right time

## Problem

Taking medicine on time, as prescribed, is essential to ensure that the body has an adequate amount of the drug at all times. A failure to do so can cause the disease to develop a resistance to the medicine or prolong the time it takes to recover completely. To manage chronic diseases, treat acute ones, and promote general health and wellbeing, taking prescription medications as directed is critical. In most cases, As mentioned above, patients can either forget to consume the drugs on time or forget them altogether. Some drugs follow a strict regime, should not be skipped, and should be 8 consumed according to a fixed regime. In a few cases, the amount of medication or schedules can be very complicated to track accurately. Additionally, people with diseases like Alzheimer's or Dementia often have problems remembering the medication.

## Design Opportunity

The opportunity involves designing a product for patients to improve the quality of care by providing the medication on time and ensuring that the patient has medications more effectively and accurately. The product must also aim to maintain the quality of the medicines by storing them properly. Additionally, the availability of a detachable and independent travel unit that performs the above function for the patient on the go.

Furthermore, patients mentioned that being on heavy medication makes them drowsy and dizzy, which prevents them from sorting and taking the medication. What would happen if the patient overslept? How could the user maintain his medicine doses while traveling? This is something that was to be kept in mind while brainstorming different concepts.
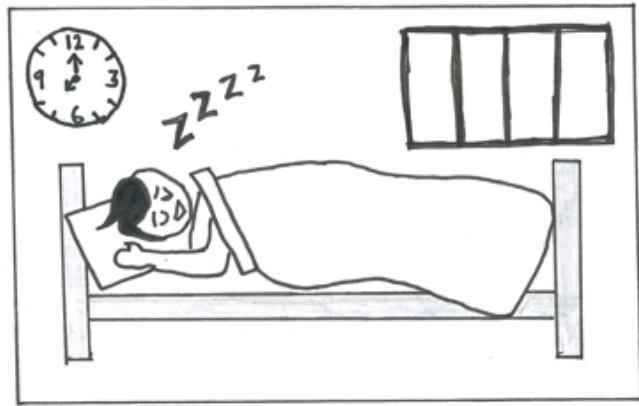
## Why is this worth doing?

Taking the right medicines at the required time is necessary for:

• Better treatment results
• Fewer medication errors
• Increased patient safety
• Better quality of care
• More efficient working methods for healthcare professionals
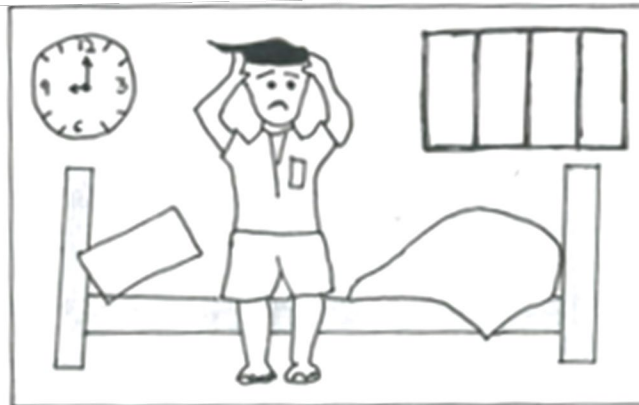
# Current Scenario


User sleeping


The alarm goes off, a reminder for taking medicine.


User misses the alarm, still sleeping


User waking up late, and have skipped medicine taking slot

## Existing Products

Research for existing products was performed to find improvement opportunities but also to get some idea of commercial availability. In the process journal (page 11), a comparison of the existing product and its features is added.

Most of the products contain prepacked drug packets, which makes it easy for the consumer to access medicine and eliminates the risk of exposing the medicine to humidity. Also, features of notifying the caretaker and loved ones are available in most of the products. However, all the products lacked temperature control and user notification systems. Additionally, the available med packers are mostly fragile and pose a risk for the drug to be crushed or damaged.

## User

This product mainly focuses on the following user groups:
- People with new long-term conditions that require medication for 6 to 24 months. For example, conditions like Tuberculosis, Cancer, Skin conditions, where users don't have a habit to take medication regularly.
- People with conditions like Alzheimer or Dementia, that are prone to forgetting by helping them keep up with their medication regularly.

## User Environment

This device consists of two units:
- Main Unit - To be used in the house, placed over a table, bedside table, or kitchen slab.
- Travel Unit - Travel unit is designed to be used outdoors, just like a water bottle (rough environment). Whenever the travel unit is attached to the main unit, the working environment is the same as the main unit.



## Product Requirements

From interviews, observations, and market research, the following requirements were decided to be focused upon:
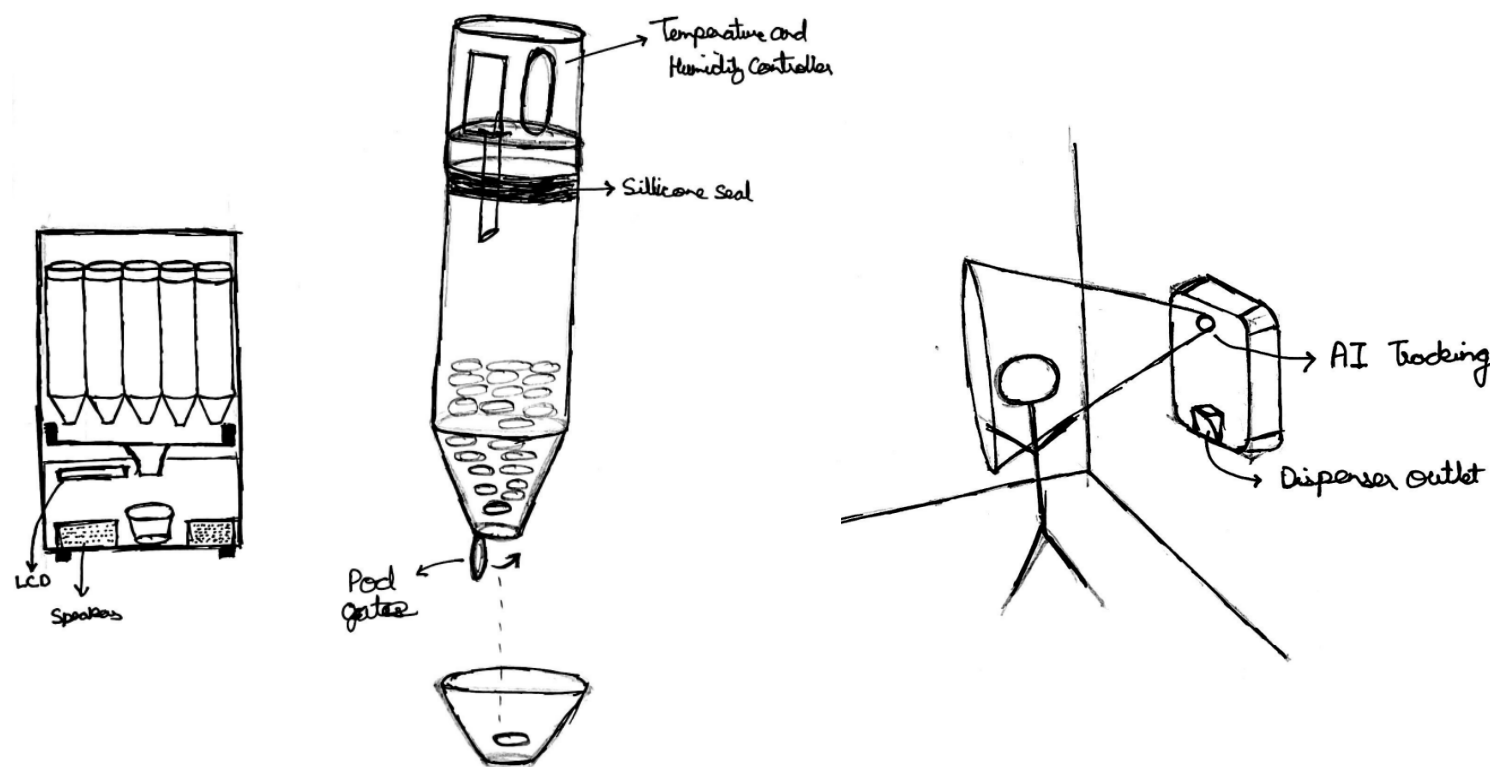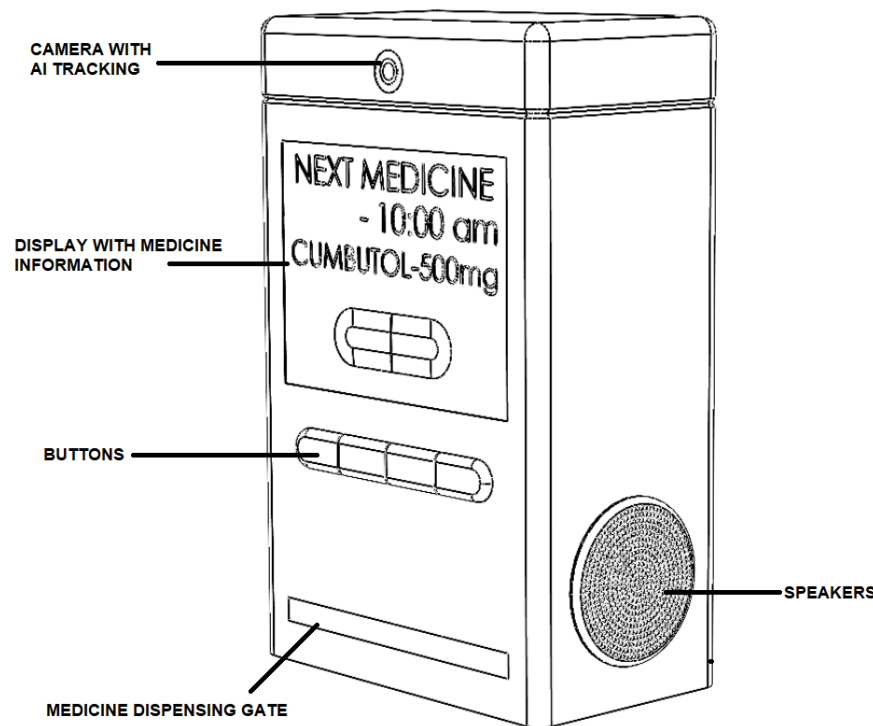- Reminder system for the patients
- User-Friendly
- Considerable storage space
- Storing medicines in lab-like conditions (Clean, humidity, and temperature-controlled environment)
- Carry case for travelling
- System to monitor patient's progress
- System to check if the patient has taken the medicine or not.

# Initial Concepts

The First concept for solving this problem was to design a Smart Medicine Dispensing device, which monitors patients' progress, reminds them to take medicines, and stores them in lab-like conditions.
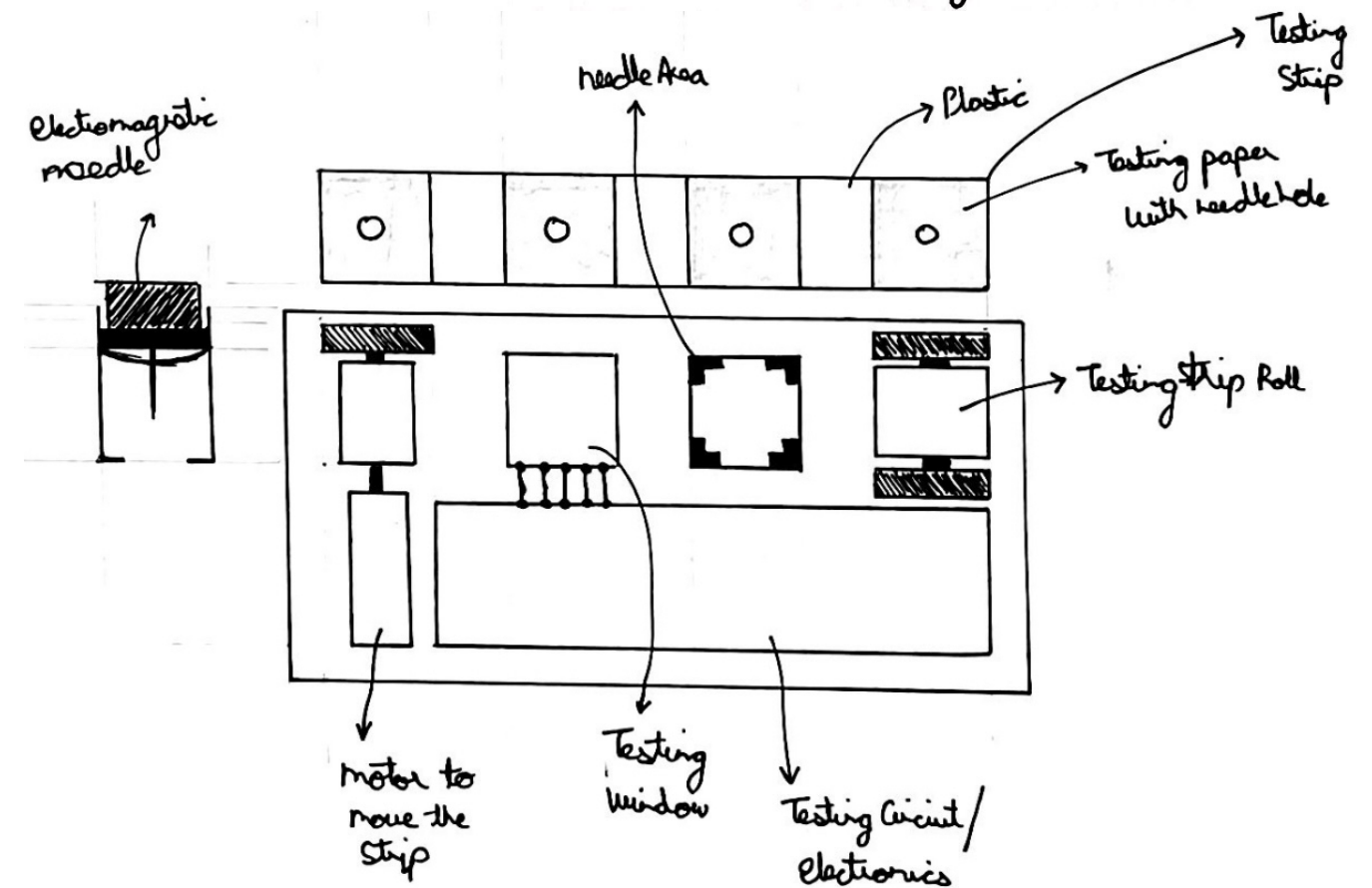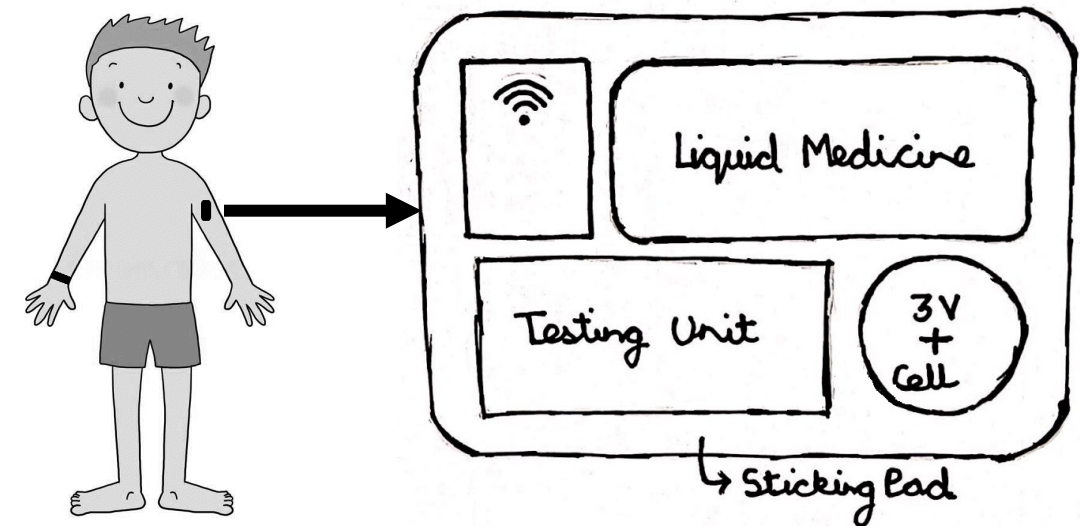
This concept didn't answer some questions like:

• What if the user needs to go out for work/needs to travel

• What if the user didn't take medicine in front of the AI Camera



CAMERA WITH AI TRACKING

NEXT MEDICINE
- 10:00 am
CUMBUTOL-500mg

DISPLAY WITH MEDICINE INFORMATION

BUTTONS

SPEAKERS

MEDICINE DISPENSING GATE

Temperature and Humidity Controller

Sillicone seal

Pod gates

AI Tracking

Dispenser outlet

LCD

Speakers

Many components were required to make that possible (extra components meant more chances for the product to fail, by reducing the number of components, reliability is increased, which is necessary for this product)

The Second concept aimed to fulfill almost all product requirements. This concept was based on Therapeutic Drug Monitoring, a method to test the drug concentration present in the blood. This idea consists of a wearable patch that monitors the plasma concentration of the drug the patient needs to consume and consists of liquid medicine, which could be directly injected into the bloodstream gradually whenever required.



Liquid Medicine

Testing Unit

3V + Cell

Sticking Pad

Electromagnetic needle

needle Area

Plastic

Testing Strip

Testing paper with needle hole

Testing strip Roll

motor to move the strip

Testing window

Testing Circuit/ Electronics

Despite being a useful concept, this idea was discarded, For this concept to exist a lot of technologies are needed, which haven't been developed, like real-time therapeutic drug monitoring techniques. Presently, this concept could only be used for one medication.

# Concept Development

Due to the lack of technologies and development in the field of real-time therapeutic drug monitoring, I refocused again on refining the first concept – Smart Medicine Dispensing Device.

The new design should be a sizable improvement over the existing technology. I decided to work on a device with the following features:

- Medicine dispensing system
- Temperature and humidity control
- Multiple user-notification system
- Travel/carry case
- Safety and monitoring systems

The design started with a basic layout of what a dispensing device looks like, followed by designing a basic unit "Med-Pack" which will be responsible for storing the medicines in a clean and humidity-free environment.

Different kinds of med-pack shapes and dispensing systems were considered and were further developed based on logical thinking and testing with prototypes. Being a continuous process; things were gradually getting modified as the product developed.

A reusable air-tight container was chosen as the med-pack as it could easily be reused and protect medicine inside them from getting crushed due to its stiff structure. A refill system was introduced for maintaining medicines in a particular order and for the pharmacy to re-stock them comfortably.

Placement of cooling systems, notification systems, and other essential electronics was also decided. The travel unit was taken into consideration, which would work as a tray when attached to the main unit, a feature like a weight scale was brought in to monitor the time the medicine is being taken and to check if the correct medication was consumed by the user.
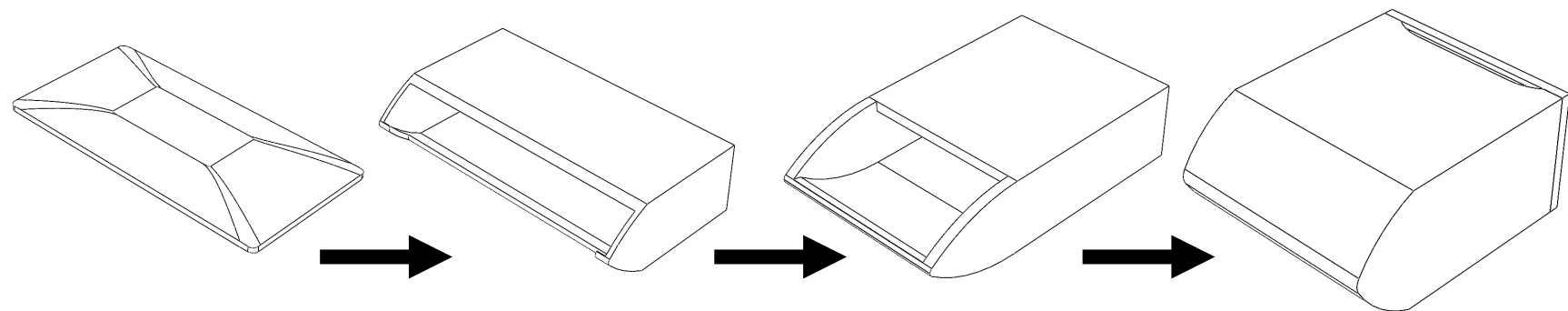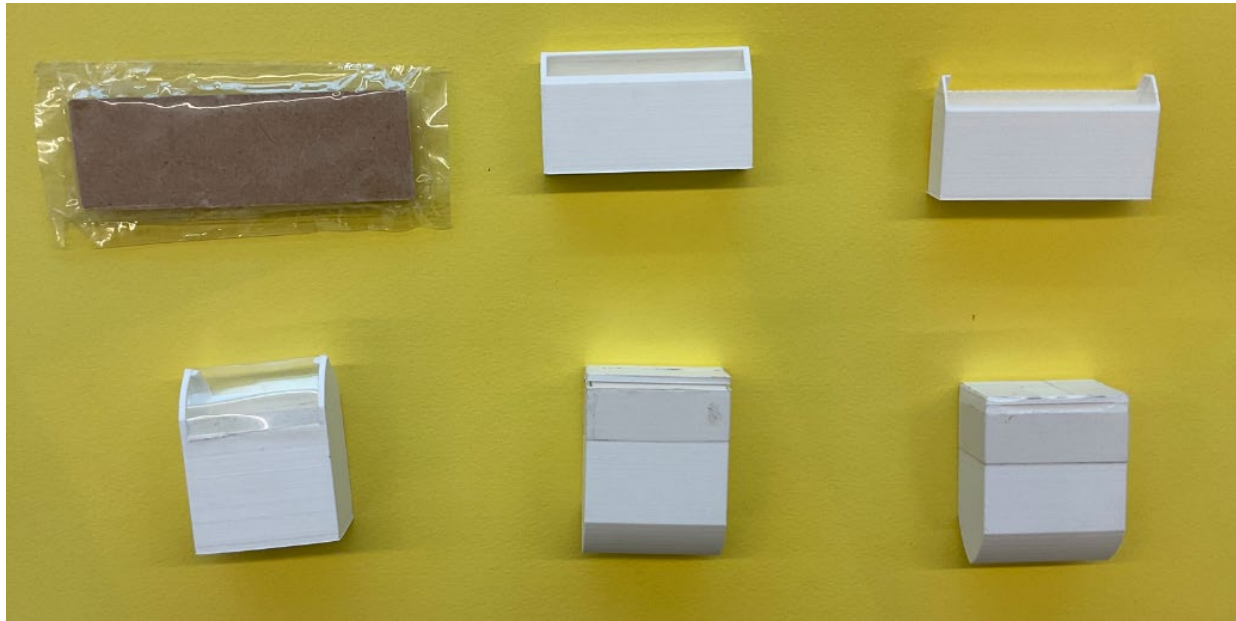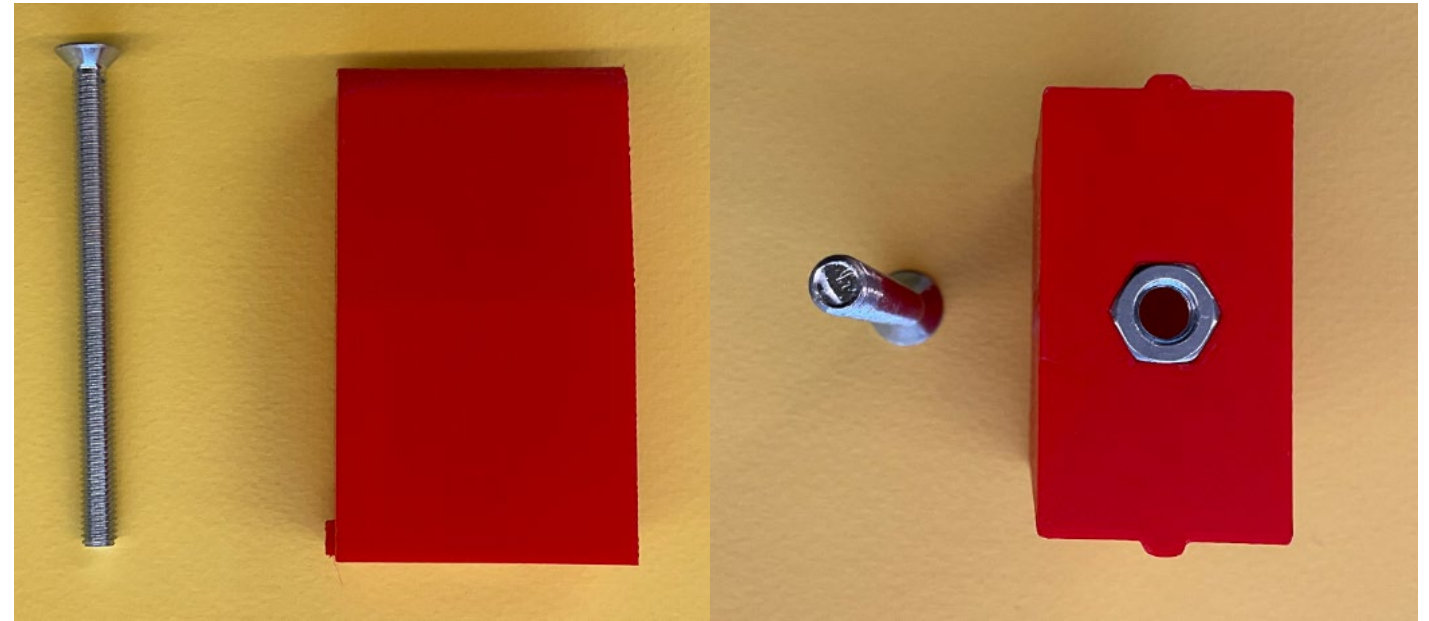


Development of Med-Pack
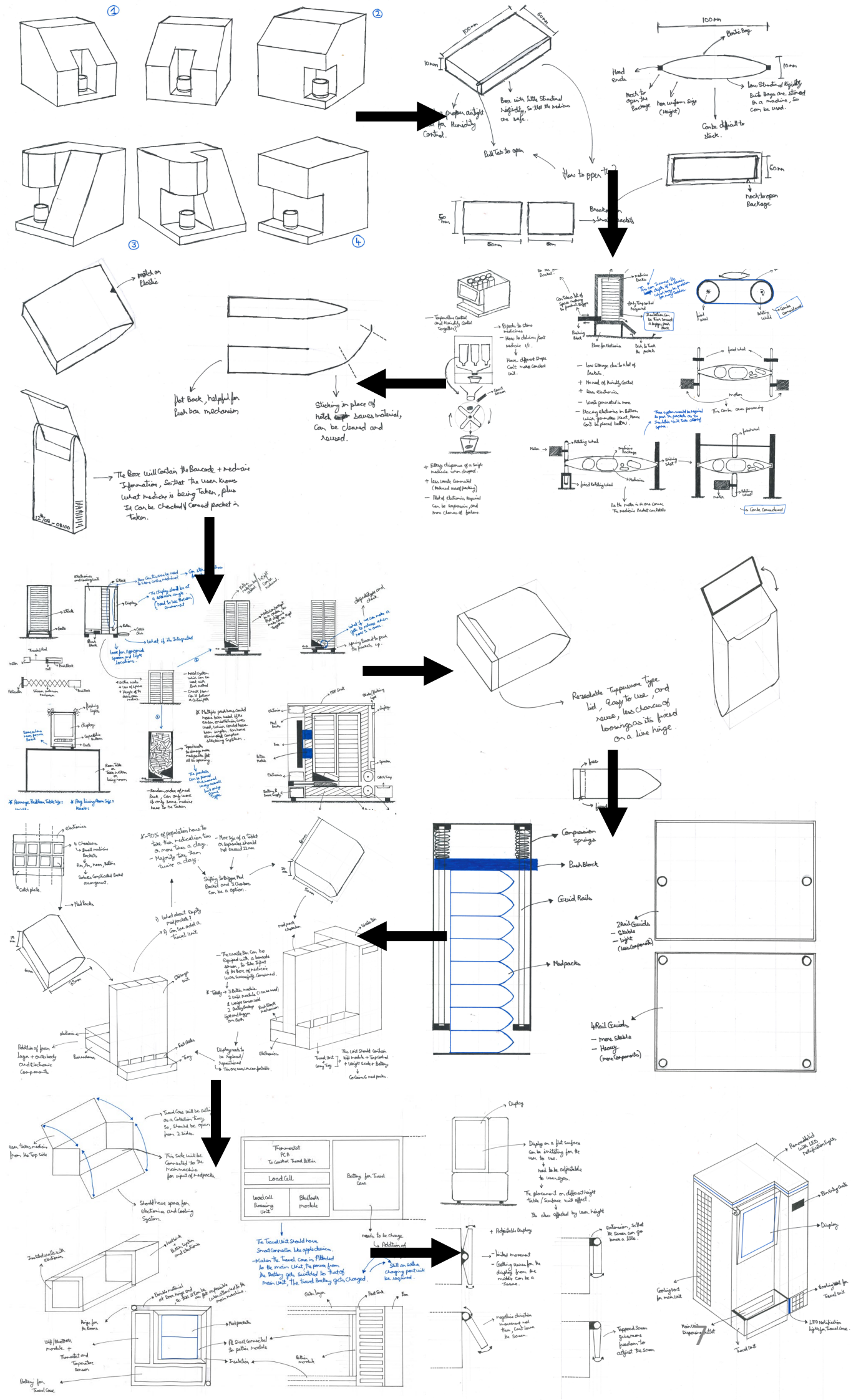
# Prototyping

Various prototypes were created in CAD and in real life to check the useability and the feasibility of the concepts which were thought off.
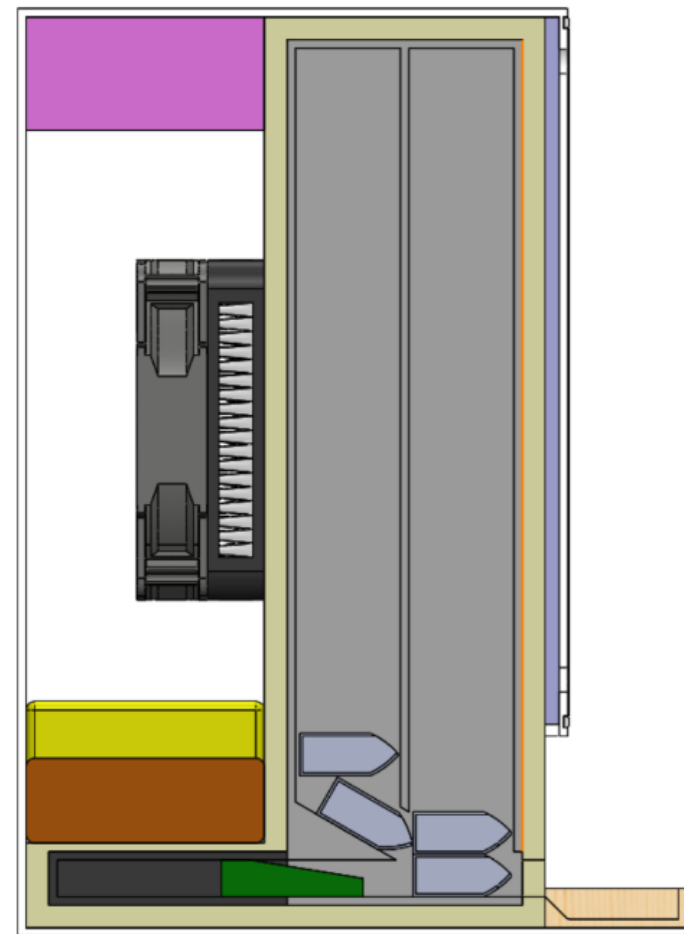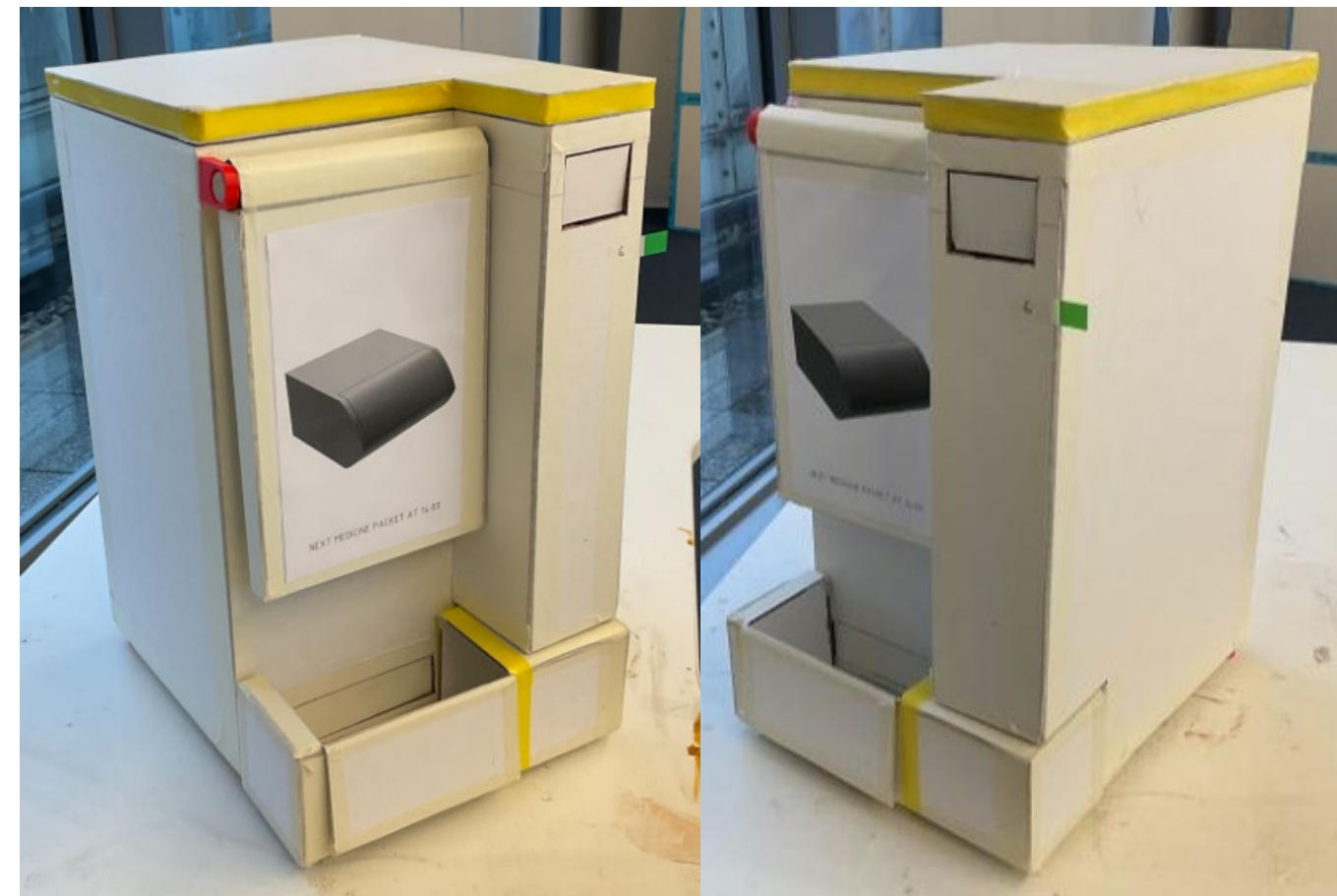

Development of Med-Packs


Lead Screw Mechanism


Testing of various refill systems


2nd Iteration of the CAD Model


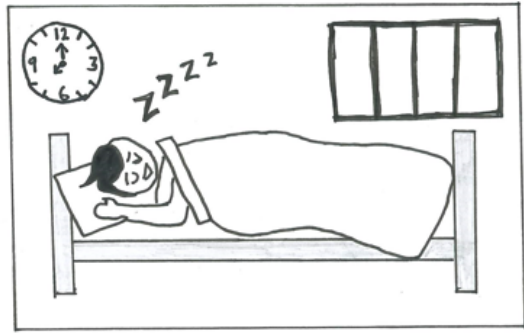1:1 Scale Model of the designed Product

# 3D CAD Model & Rendering:



# SMART MED-ASSISTANT
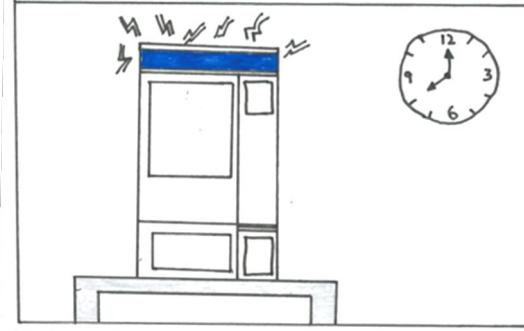
**Features:**
- Temperature Control System (2°C to +30°C)
- Re-Usable & Stiff Plastic Med-Packs
- Battery Back-up
- Travel Unit (Up to 6 Med-Packs)

- Improved Patient Notification and Interaction System
- Storage of 45 Med-Packs in the Main Unit
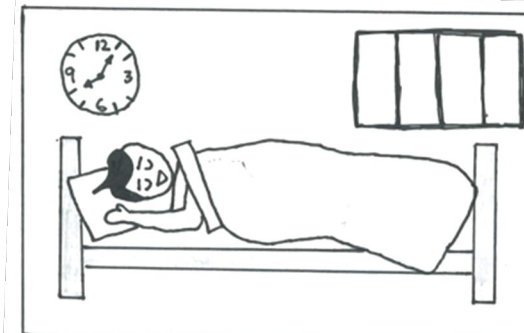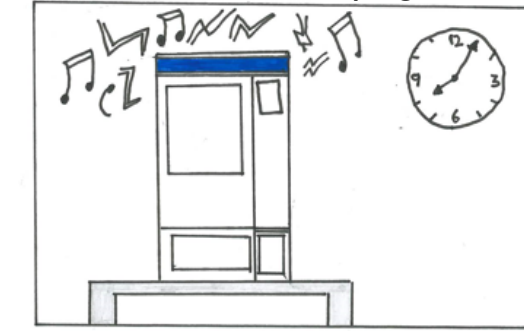- Weight Scale for Monitoring
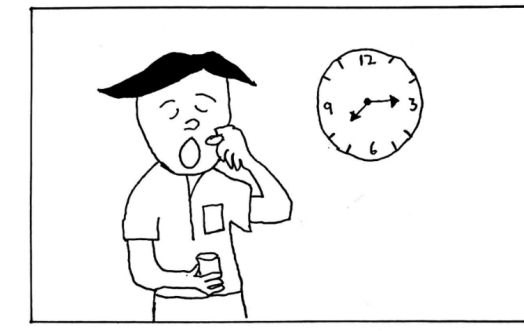
# Main Unit


User sleeping


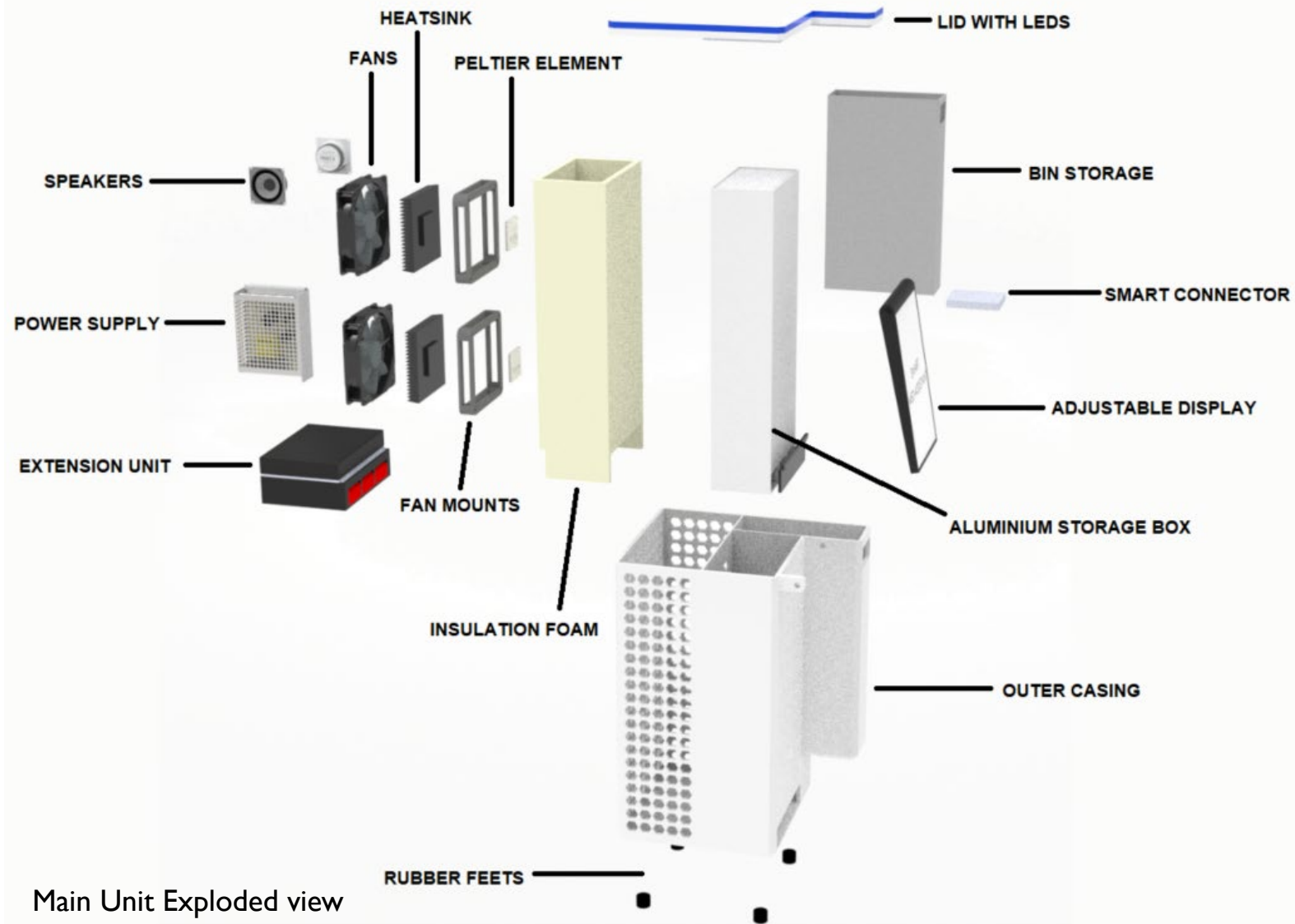Smart Med-Assistant Plays alarm and flickering light


User still sleeping
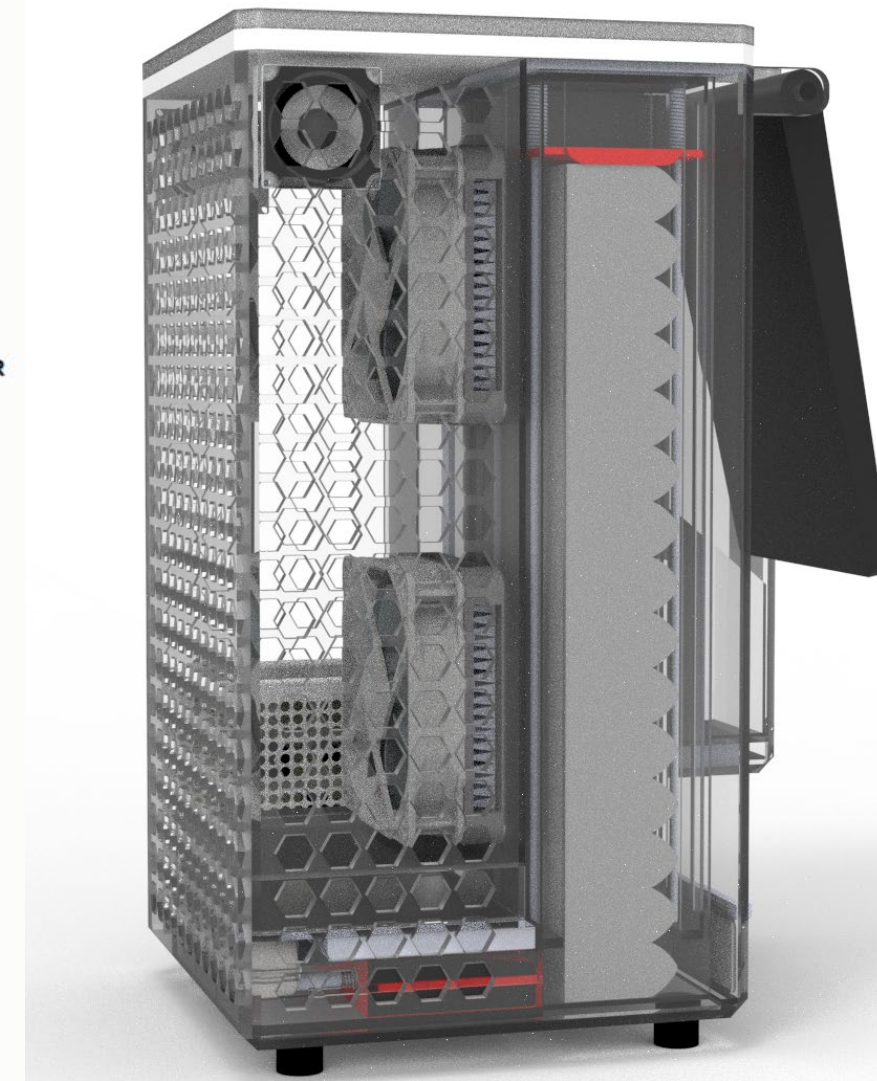

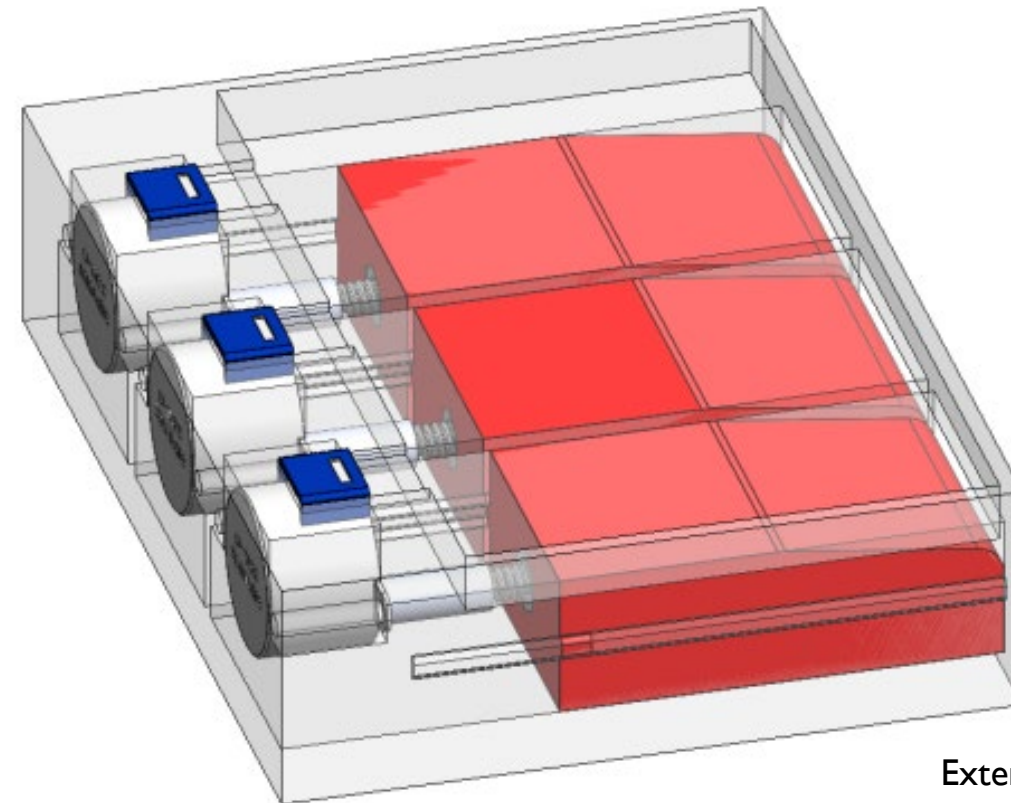Smart Med-Assistant changes alarm tune & intensity with more instance flickering light


The user Wakes up & takes medicine in the time slot.



SPEAKERS

POWER SUPPLY

EXTENSION UNIT

FANS

HEATSINK

PELTIER ELEMENT

LID WITH LEDS

BIN STORAGE

SMART CONNECTOR

ADJUSTABLE DISPLAY

ALUMINIUM STORAGE BOX

FAN MOUNTS
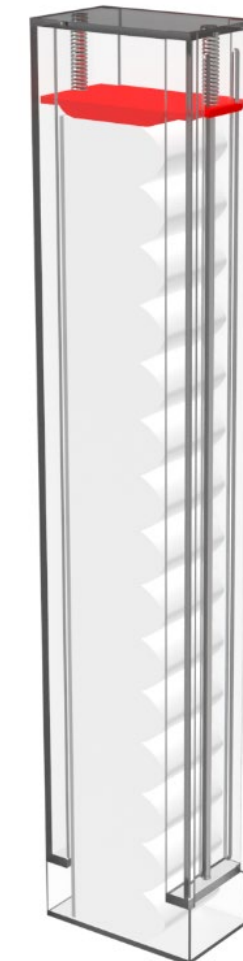
INSULATION FOAM

OUTER CASING

RUBBER FEETS

Main Unit Exploded view
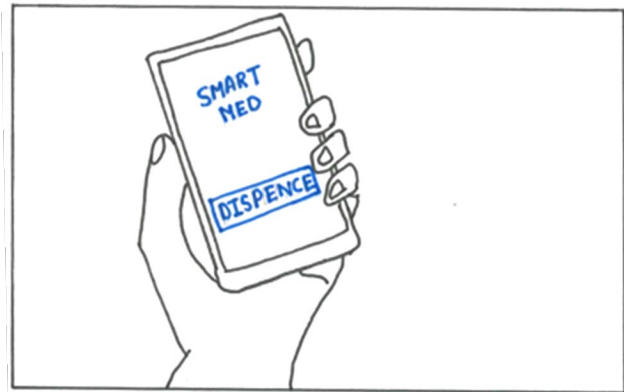

Packaged Unit with Clean Casing


Extension Unit


Med-Pack Refill
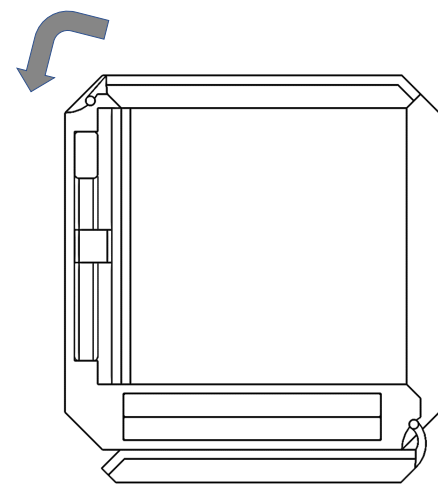
# Travel Unit


User Getting ready for work


User Using the mobile application to pre-dispense med-pack into travel unit


Taking off the Travel Unit containing dispensed med-pack for the main machine


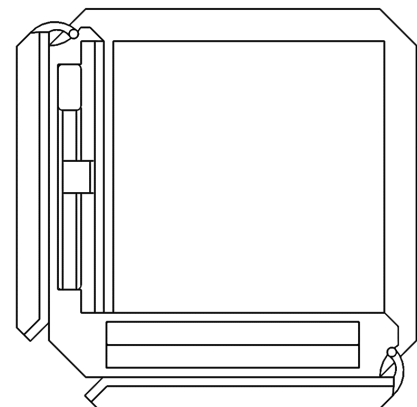Taking off the Travel Unit containing dispensed med-pack for the main machine


The door on the travel unit is in a closed position.
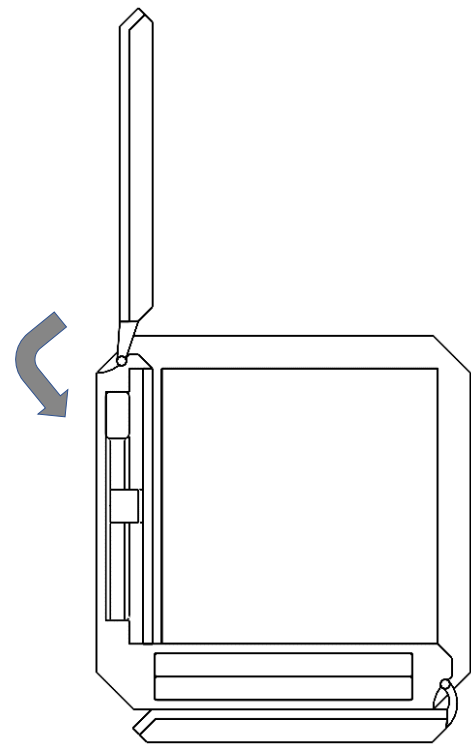

The door straightened to fold backward
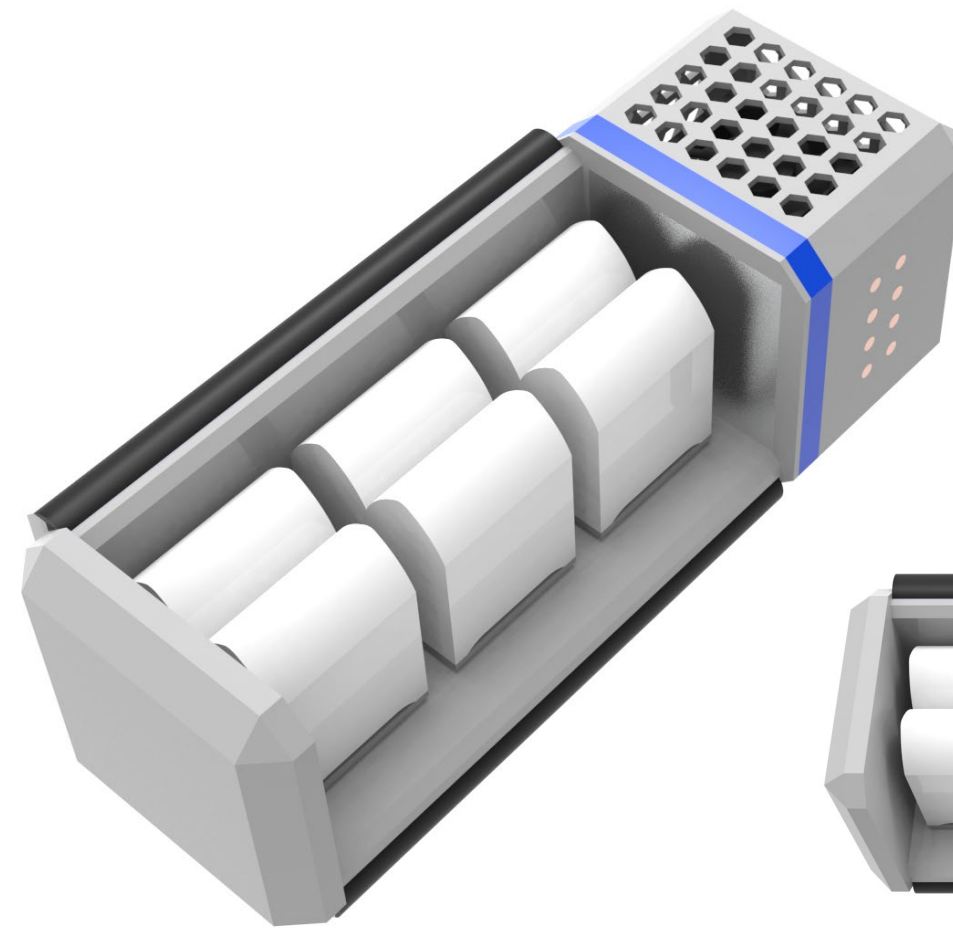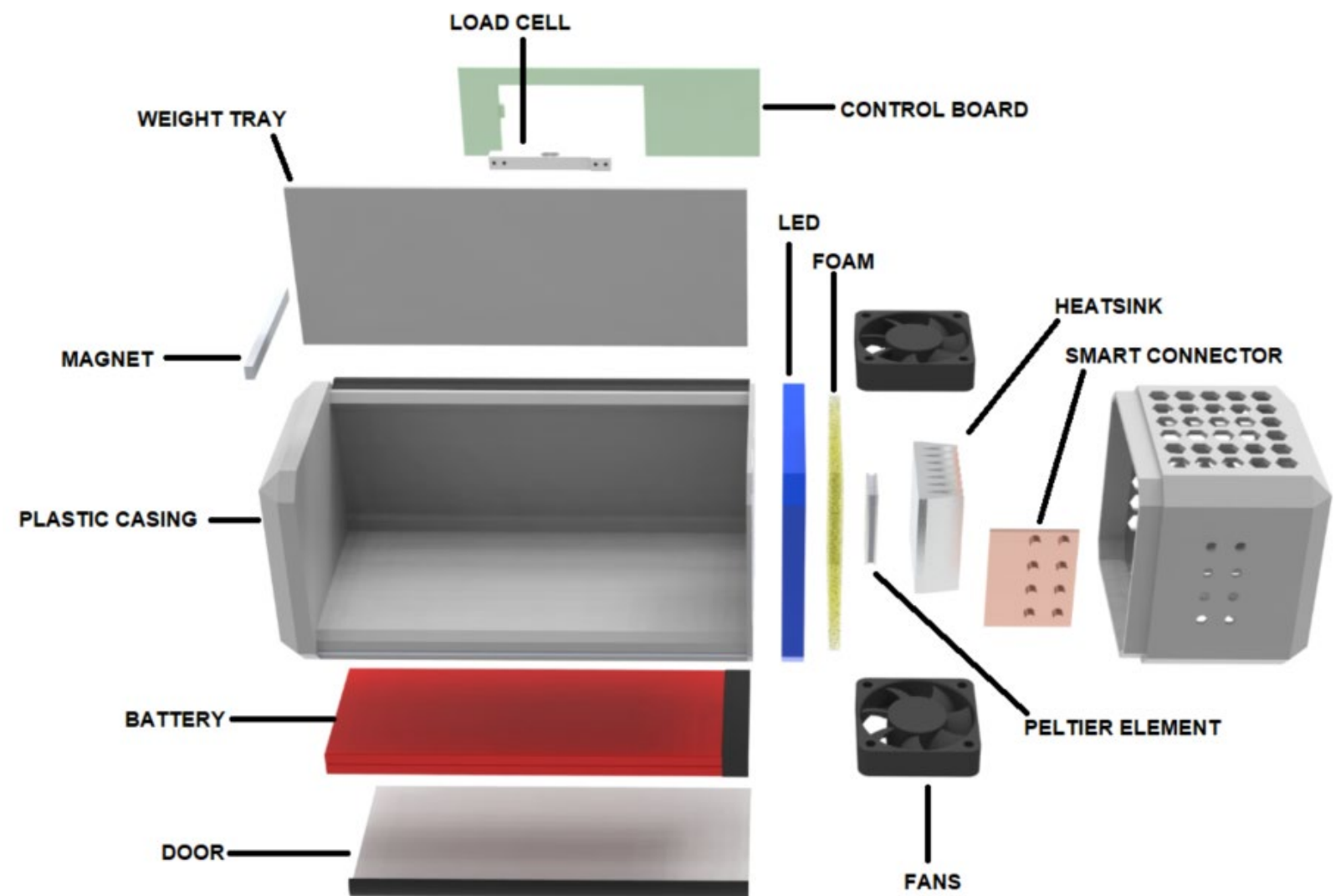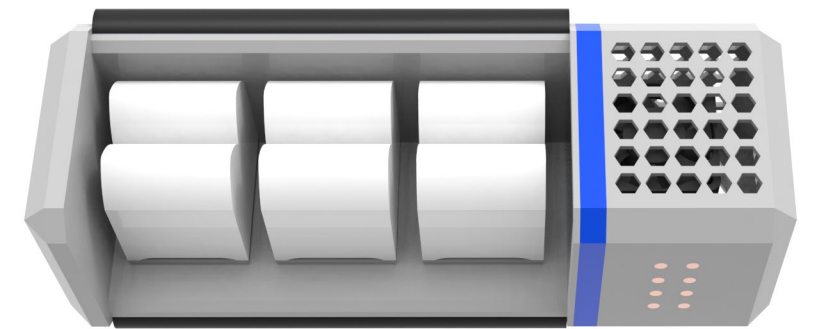
The travel unit is a mini version of the main unit, equipped with temperature control, weight scale, lights, speaker, control board, battery, smart connector, and a storage capacity of 6 med-packs.





Travel Unit Exploded view

11

# Reflection

This was the first big individual project I worked on from scratch. Being from a mechanical engineering background and learning about product design engineering helped me tackle problems faced in every step. A month before the project started, I was off medications. I'm glad I went in this way. It gave me a lot of enthusiasm for the project, which I believe was a big plus.

Also, during this project, I realised the importance of drawing and developing the product on paper. Drawing on paper gives extra time to think about the particular thing you are designing. Earlier, I used to prefer only to create using CAD software, which I felt was easier to describe my ideas to others.

I also want to thank Stuart Bailey, Hugh Paizy, Samia Cunningham for the valuable feedback and advice during the tutorial meetings.

# Future Work

Completing all the necessary work for a ready-for-production device was difficult as the final project had a minimal timeframe. The designed product was able to answer a majority of questions we posed at the start, but there is always a scope for the betterment of the product. The following are some of the questions the product did not address:

• What if the user drops a single medicine from the med-pack? Since the medicines are packed and numbered, no extras are being provided.
• What if the medicine is in the form of liquid?
• Missing notification wristband.

The future work would include testing the proposed design. The product includes a cooling system, so testing in various weather conditions is crucial. Also, a bigger med-pack unit and travel unit storage will be valuable. A device, which helps the pharmacy to refill the med-packs easily, would be advantageous for the whole Smart Med-Assistant Service.

# References

- Epilepsyresearch.org.uk. 2017. *Poll shows that almost 50% of people forget to take their medication at least once a month | Epilepsy Research UK*. [online] Available at: <https://epilepsyresearch.org.uk/poll-shows-that-almost-50-of-people-forget-to-take-their-medication-at-least-once-a-month/#:~:text=Across%20all%20conditions%2C%20it%20has,not%20take%20their%20medicines%20properly> [Accessed 5 August 2022].

- Alloway, R., 2009. *Non-Adherence Definitions – Monitoring – Prevention/Maintenance*.

# Appendices

## Appendix 1

| Product Name | Company | Year | Advantages | Disadvantage |
|---|---|---|---|---|
| Philips Medication Dispensing device Service | Philips Lifeline | 2012 | Medicine stored in pods | No Temperature Controlled environment to store medicine |
| | | | Battery Backup in case of Power cuts | Use of same sound notification |
| | | | Notifies loved ones/ Caregiver | Physical buttons (difficult for old people to use) |
| | | | | The patient cannot pre-dispense medicine (Which is not useful when the user travels) |
| | | | | The user needs to set the medication |
| PillPack | PillPack (By Amazon Pharmacy) | 2013 | Prepacked med-packs | No Temperature Controlled environment to store medicine |
| | | | Phone application to notify the user of taking medicine | Inconvenient to carry the medicine packets |
| | | | | Difficult to store capsules, as medicines are stored in plastic packets |
| MedReady 1700 Medication Dispencer | MedReady | 2014 | Handy/Portable | Works on battery - 48hrs battery backup ( Need to be charged regularly) |
| | | | Call Centre to monitor ( They contact caregivers for skipped medicines) | The user needs to set the medication |
| | | | | No Temperature and humidity controlled environment to store medicine ( All medicine is exposed to the environment when the user opens the device to take the required medicine.) |
| Spencer | Spencer Health Solutions, inc | 2019 | Prepacked med-packs | No Temperature Controlled environment to store medicine |
| | | | Medicine on the go (User can dispense medicine when he/she needs to leave the house) | Use of same sound notification |
| | | | Notifies loved ones/ Caregiver | No Battery backup |
| | | | | Time tracking is not available |
| | | | | Difficult to store capsules, as medicines are stored in plastic packets |

Rubber is used to join the hinge and the insulating door