

# Dill·in

your medication station

The all-in-one storage, sorting and delivery unit for people with complex medication requirements



## Project Summary

Lois Jones MEng Product Design Engineering

# 1 Project Overview

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## The Problem

Polypharmacy - the prescribing of 5 or more medications - affects over 8 million people in England alone. It is most prevalent in the over 65s and, with an ever growing elderly population, is only set to increase.



How people manage the storing, sorting and delivery of their medications at home can play a part in their ability to organise their medicines safely and persevere with a prescribed course.

## The Solution

### What

Pill-in is an all-in-one medication station to store, sort and deliver medicines in the home.

### Who

It is aimed at people who are prescribed multiple medications, often for chronic conditions, and need to easily organise the appropriate doses accurately.

### Where

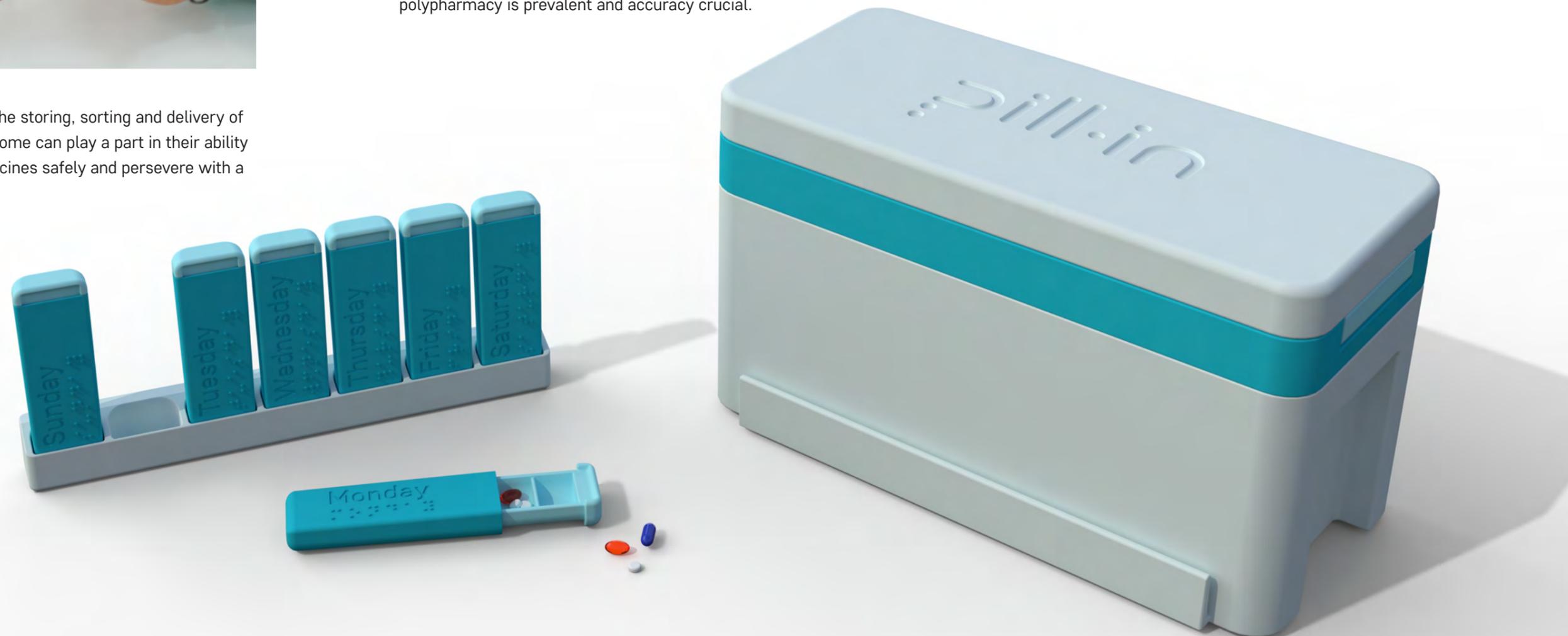
Pill-in has primarily been designed for home use but could be used in other locations, such as care homes, where polypharmacy is prevalent and accuracy crucial.

### Why

Reducing the burden of organising medication and simplifying the process for taking pills can improve the chances of people sticking with a prescribed course and reduce the risks of errors in the management of medicines.

### How

Pill-in provides a storage box for medications, a dispensing layer for accurate distribution, and individual, compartmentalised daily pill boxes for the seamless delivery of pills safely and accurately.



# 2 Research

## Existing Solutions

Medipacks, or dosette boxes, are a solution provided by many pharmacies on the NHS, delivering tailored doses of multiple medicines, organised by time and day in a pack that covers a week. These eliminate the chance of user error and the burden of home sorting, but they rely on people at the pharmacy performing the sorting function. This can be time consuming and requires careful checking before delivery. Limited time availability also means that access to this service is restricted to those who are unable to safely sort their own medicines. There are automatic systems on the market, but these rely on expensive machinery and still require a human interaction for less common drugs.



Home organisers are often basic pill boxes, which vary greatly in their ease of use and aesthetic appeal. It can be difficult, particularly for older users or those with limited hand function, to open small fiddly containers, particularly when repeating this again and again during the filling process.

There are some systems on the market that look to help with the filling process, but these often involve multiple touch points, which is not ideal, and none seem to deal with the issue of where to store the medication prior to sorting.

## User Group

At the start of the project interviews were conducted with people who take multiple medications, their carers, pharmacists and other healthcare professionals to try to understand the issues of polypharmacy from different perspectives.



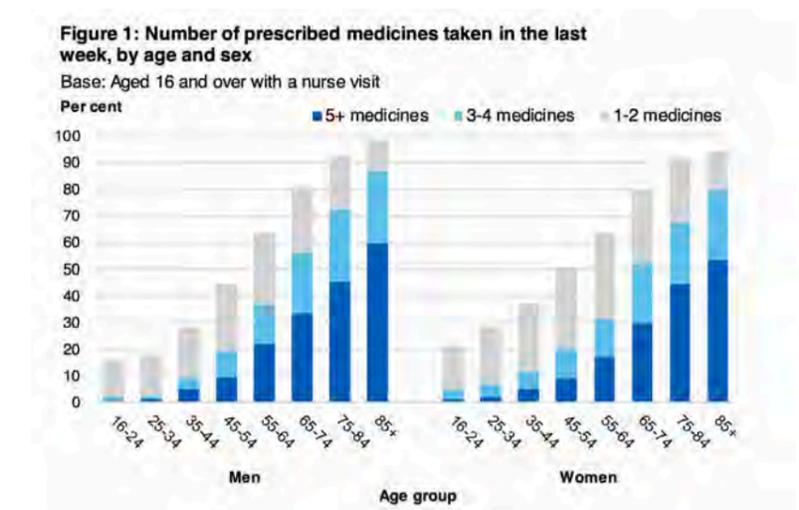
In trying to get a focus for the project, it became clear that the management of medicines in the home could be a challenge for patients and/or carers and errors can have serious implications.

Given that this problem is more widespread in an older demographic it was clear that any solution needed to be simple and easy to follow, to reduce the stress of medication burden.

## Market Opportunity

The Health Survey for England 2016, conducted for NHS England, identified that around 30% of the 65-74 age group took five or more medications, rising to over 50% in the over 85s.

What is clear is that life expectancy is growing and the ONS believes the number of people in the UK over 85 will have risen to 3.2 million by 2041 and 5.1 million by 2066.



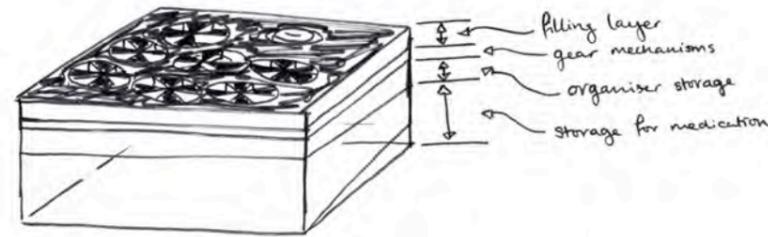
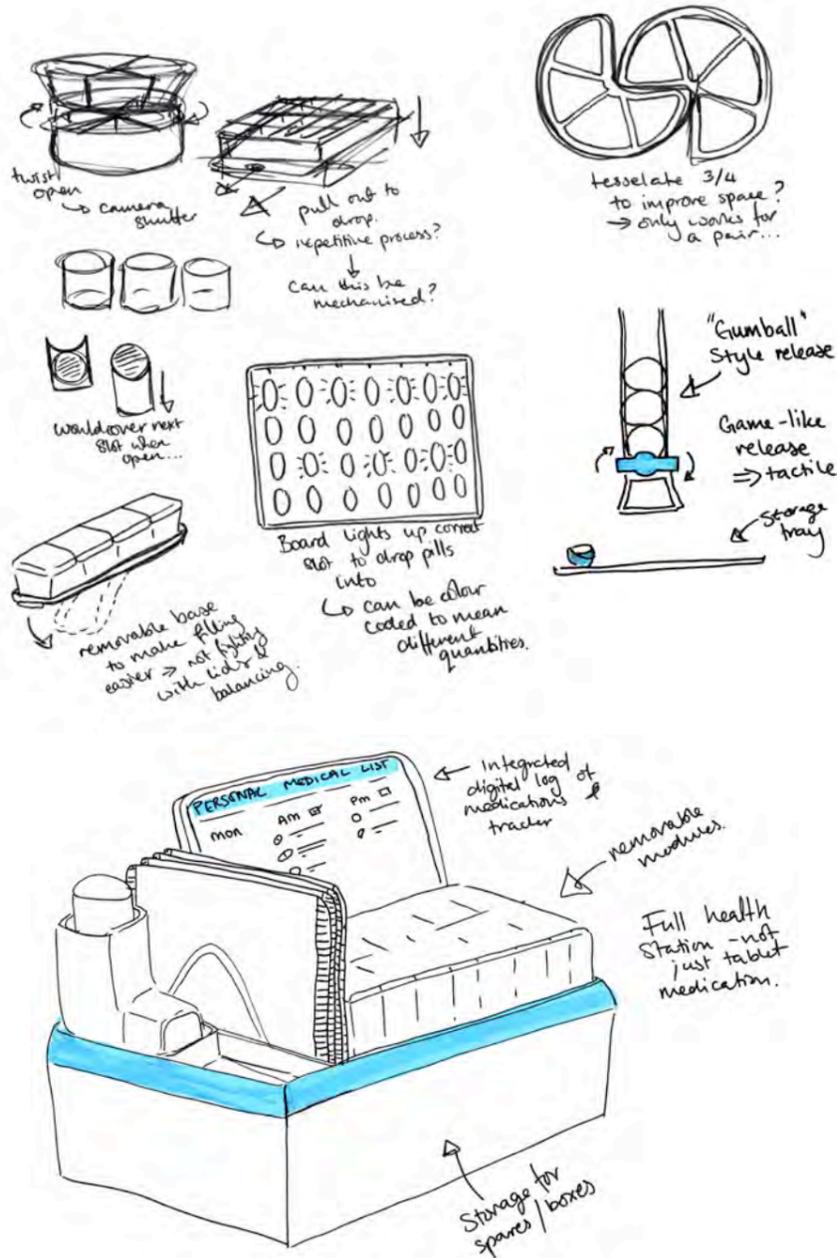
With over 8 million people regularly being prescribed 5 or more medications in England alone, and with an ageing population, the way these medications are stored, sorted and delivered in the home will become ever more important.

**Project Brief**

Design an all-in-one unit for the storing, sorting and delivery of multiple medications for users with chronic conditions.

# 3 Concept Development

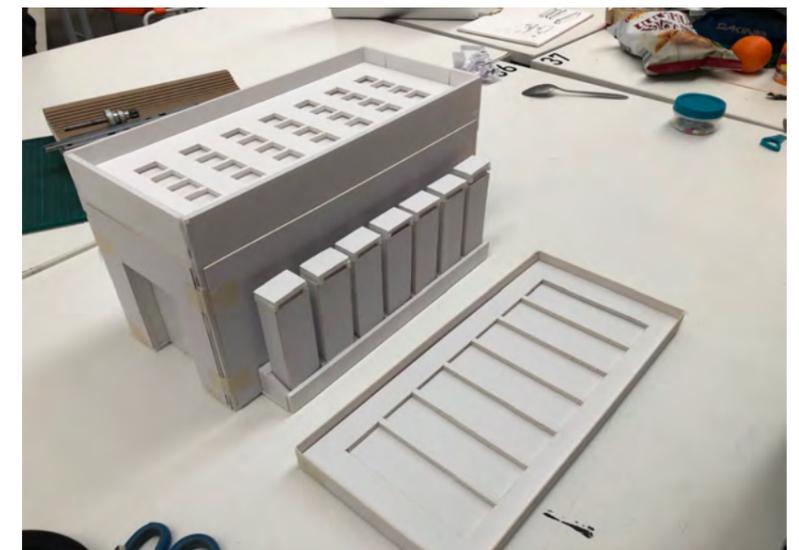
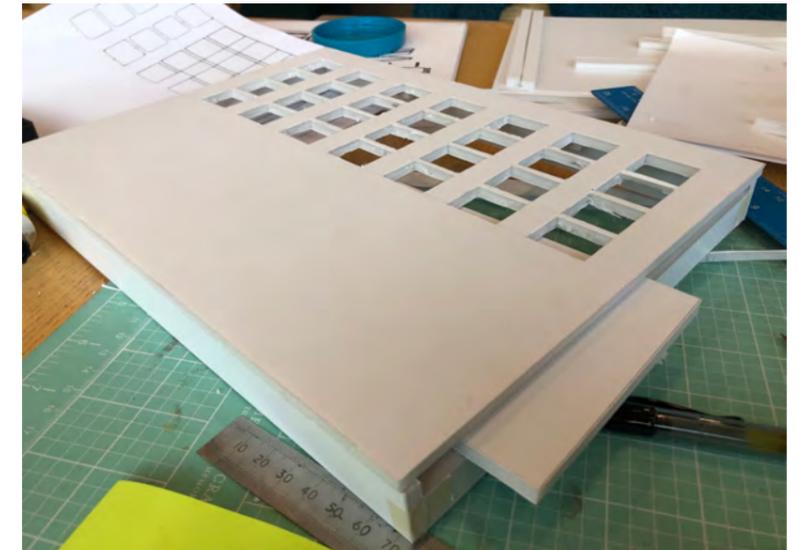
Identifying of the final brief was a long process, largely because of the scope of the topic. A range of concepts were generated, from an individual medicine dispenser to an automatic dose sorting machine. Gradually, the challenge of sorting multiple medicines at home became the focus and concepts were devised to simplify the process and improve the accuracy of home sorting.



Initially, a dispensing tray was devised for circular pill boxes, using a series of interlinked gears to drop the medicine into the compartments. The need to be able to clean the dispenser and a desire to keep individual parts to a minimum for cost purposes, meant that this approach was developed into a simpler, sliding mechanism, dispensing the pills into rectangular pill drawers.



Various iterations of the pill boxes, made up of an inner drawer which slides into an outer sleeve, were trialled and the dispensing unit was enhanced with the addition of a medicine storage box. A working prototype was made of card and foamboard and given to prospective users to trial.



# 4 Product Overview

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## Dock

Makes pill box management easy  
Detachable from storage box to allow convenient positioning for user

## Dispensing Unit

7 days x 4 times per day for easy sorting  
Place tablets in correct positions before checking and releasing into pill boxes  
Release handle can be orientated for left or right handed users

## Storage Box

7.5 litre capacity to store multiple medications  
Moulded carry handles



## Pill Boxes

Subtle, stylish aesthetic - not overtly medical  
Days of week shown in text and braille  
Drawer style ensures pills are revealed in dose order throughout the day  
Portable

## Lid

Protects dispensing unit when closed  
Used for holding pill box drawers during filling process  
Mouldings ensure pill box drawers are held in the correct position

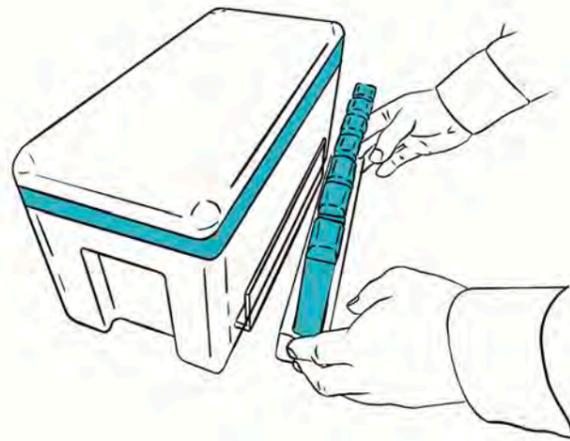
## App

Directs user to accurately dispense medication  
Provides a direct visual check before dispensing



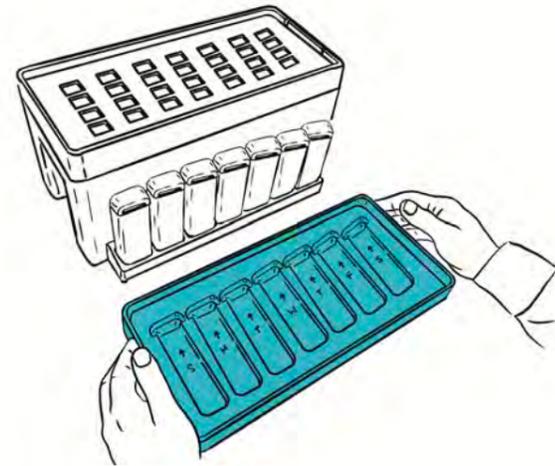
# 5 User Journey

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1

Bring together the storage box and the dock



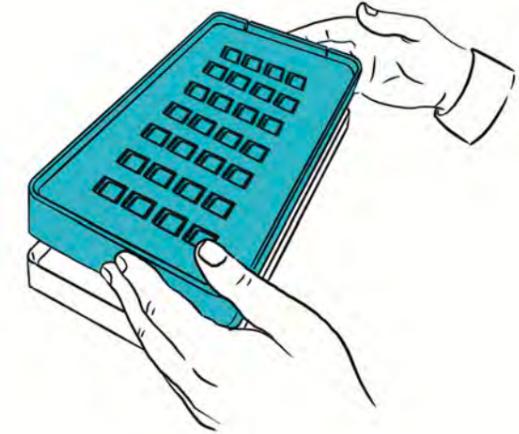
2

Remove the lid, place it face down on the table



3

Remove the pill drawers from the sleeves and place them in the mouldings on the lid



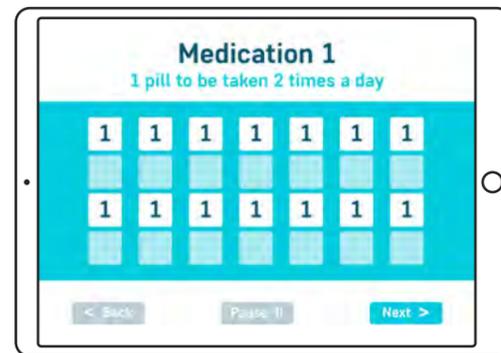
4

Remove the dispensing unit and place this over the lid



5

Choose the first medication and find it on the app



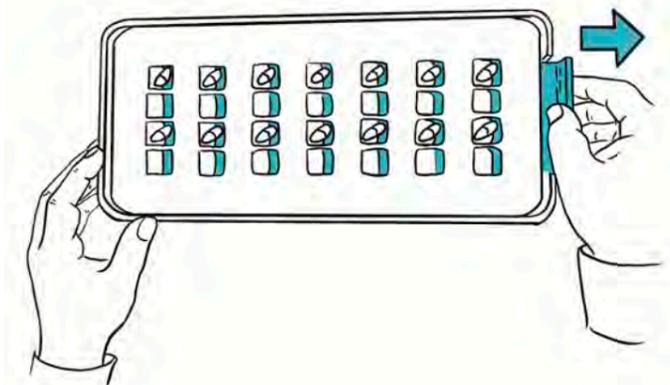
6

The app will display, via a schematic, where and in what quantities the medication is to be placed on the dispensing layer



7

Place the pills on the dispensing layer and check it matches the schematic



8

Open the slider to release the pills into the pill boxes then close the slider

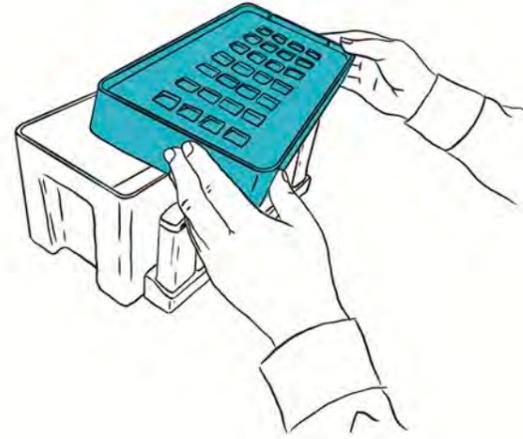
# 6 User Journey

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9

Repeat process with the next medication



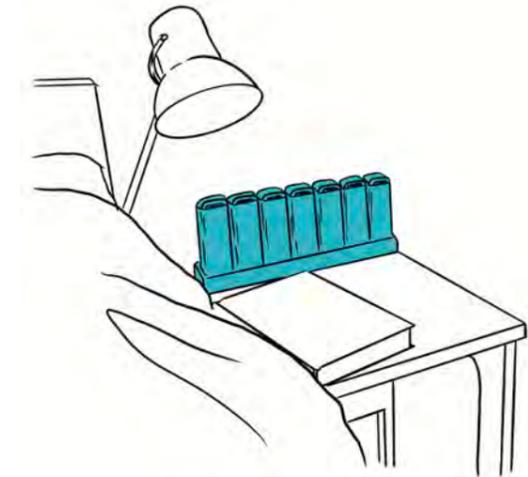
10

When all medication is dispensed, return the dispensing unit to the storage box



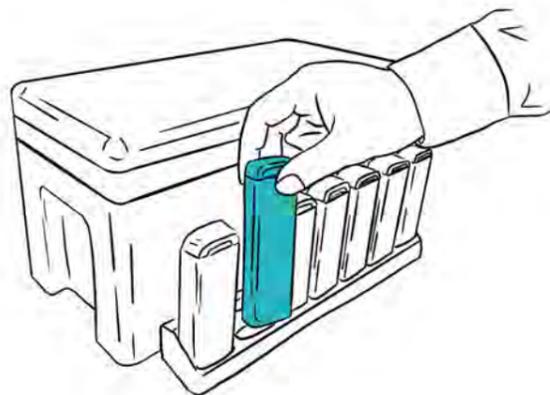
11

Place the pill drawers back in their sleeves, and replace in the dock



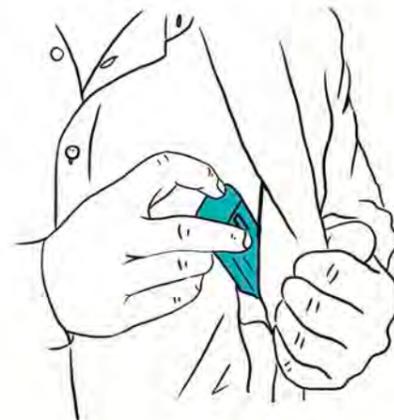
12

Replace the lid and return the storage box and dock to where they're kept



13

For your day's medication, remove the appropriate pill box from the dock



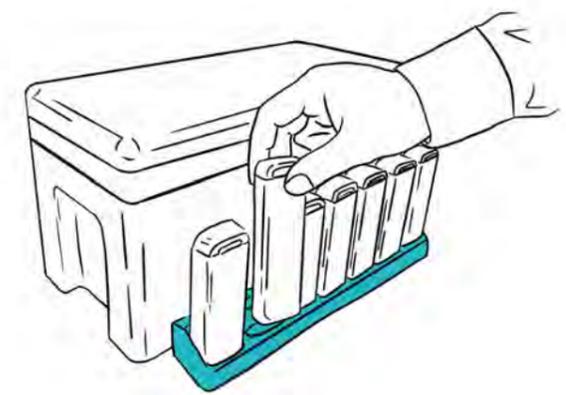
14

Place the pill box in the most convenient location, or take it with you if going out



15

To take the first dose, slide out the drawer to reveal the first compartment



16

At the end of the day, return the pill box to the dock

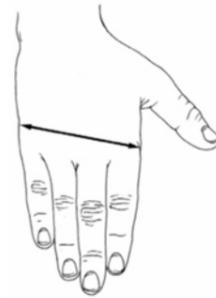
# 7 Design Detail

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## Storage Box

The handles of the storage box are 92mm wide. Anthropometric data used focused on hand breadth, the distance across the palm, rather than across the fingertips. The lower 5th percentile of female hands is only 73mm wide, and the upper 95th of male hands is 97mm. As hands tend to taper in towards the fingertips, however, it is reasonable to assume that this upper measurement would be greater than the width at the fingertips.

Hand Breadth					
FEMALE N = 2208			MALE N = 1774		
Centimeters	Mean	Inches	Centimeters	Mean	Inches
7.94	3.13	3.13	9.04	3.56	3.56
.38	.15	.15	.42	.17	.17
9.80	Maximum	3.86	10.60	Maximum	4.17
6.60	Minimum	2.60	7.70	Minimum	3.03
Percentiles			Percentiles		
7.09	1 <sup>st</sup>	2.79	8.07	1 <sup>st</sup>	3.18
7.19	2 <sup>nd</sup>	2.83	8.19	2 <sup>nd</sup>	3.22
7.25	3 <sup>rd</sup>	2.86	8.27	3 <sup>rd</sup>	3.25
7.34	5 <sup>th</sup>	2.89	8.36	5 <sup>th</sup>	3.29
7.47	10 <sup>th</sup>	2.94	8.51	10 <sup>th</sup>	3.35
7.56	15 <sup>th</sup>	2.98	8.61	15 <sup>th</sup>	3.39
8.63	20 <sup>th</sup>	3.00	8.69	20 <sup>th</sup>	3.42
7.69	25 <sup>th</sup>	3.03	8.75	25 <sup>th</sup>	3.45
7.74	30 <sup>th</sup>	3.05	8.82	30 <sup>th</sup>	3.47
7.79	35 <sup>th</sup>	3.07	8.87	35 <sup>th</sup>	3.49
7.84	40 <sup>th</sup>	3.09	8.93	40 <sup>th</sup>	3.51
7.89	45 <sup>th</sup>	3.11	8.98	45 <sup>th</sup>	3.54
7.93	50 <sup>th</sup>	3.12	9.03	50 <sup>th</sup>	3.56
7.98	55 <sup>th</sup>	3.14	9.09	55 <sup>th</sup>	3.58
8.03	60 <sup>th</sup>	3.16	9.14	60 <sup>th</sup>	3.60
8.08	65 <sup>th</sup>	3.18	9.20	65 <sup>th</sup>	3.62
8.13	70 <sup>th</sup>	3.20	9.26	70 <sup>th</sup>	3.64
8.18	75 <sup>th</sup>	3.22	9.32	75 <sup>th</sup>	3.67
8.25	80 <sup>th</sup>	3.25	9.40	80 <sup>th</sup>	3.70
8.32	85 <sup>th</sup>	3.28	9.48	85 <sup>th</sup>	3.73
8.42	90 <sup>th</sup>	3.31	9.59	90 <sup>th</sup>	3.78
8.56	95 <sup>th</sup>	3.37	9.76	95 <sup>th</sup>	3.84
8.66	97 <sup>th</sup>	3.41	9.86	97 <sup>th</sup>	3.88
8.74	98 <sup>th</sup>	3.44	9.93	98 <sup>th</sup>	3.91
8.86	99 <sup>th</sup>	3.49	10.04	99 <sup>th</sup>	3.95



## The Dock

The dock can be attached to the storage box, or removed and placed where it's most convenient for the user. If a carer who fills their patients pill boxes needs to keep the medication stores away from the patient, the pill boxes can remain accessible to the patient independently from the main Pill-in unit.

During the filling process, the sleeves in the dock line up with the pill drawers in the lid, minimising the risk of mixing up different day's medication.



## The Pill Boxes

The pill box sleeve has the day of the week debossed in 48pt Core Sans Bold text and embossed in braille to widen the accessibility of the product. All the edges are curved to provide comfort, whether it's held in the hand or sitting in a pocket.

The design enables the user to open the drawer one compartment at a time, revealing the appropriate medication at different points throughout the day. The compartments are curved at the base to allow for easier retrieval of the pills.

In the closed position, the drawer is held in place by a snap fit mechanism. This helps prevent the drawer coming out accidentally, even when the pill box is dropped, but is not such a tight hold that it can't be easily opened when required.

## The Dispensing Unit

The organising layer slots into the main body of the dispensing unit, sandwiching the sliding layer with the dispensing layer, which is integrated into the body of the unit.

All three layers feature holes in a regular 7 x 4 grid pattern to reflect up to four doses of medication delivered for seven days. The holes in the sliding layer are offset with the ones in the organising and dispensing layers so that in the closed position the pills cannot drop into the pill boxes beneath. The sliding layer is operated by a handle, which forms part of the side wall of the unit, and can be orientated for either left or right handed users.



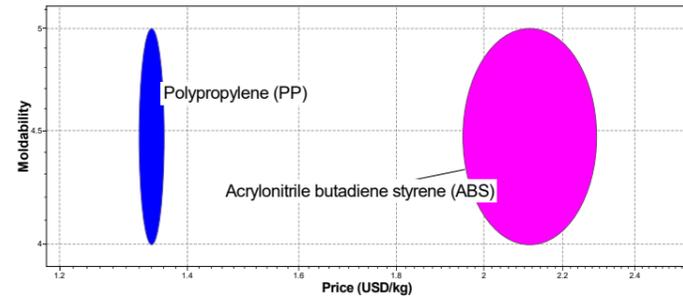
## Maintenance

There are no fixings involved in the manufacture of the Pill-in, allowing all compartments to be easily disassembled and reassembled by the user for cleaning. All parts can be hand washed with warm water and liquid detergent.

# 8 Technical Detail

## Materials and Manufacturing

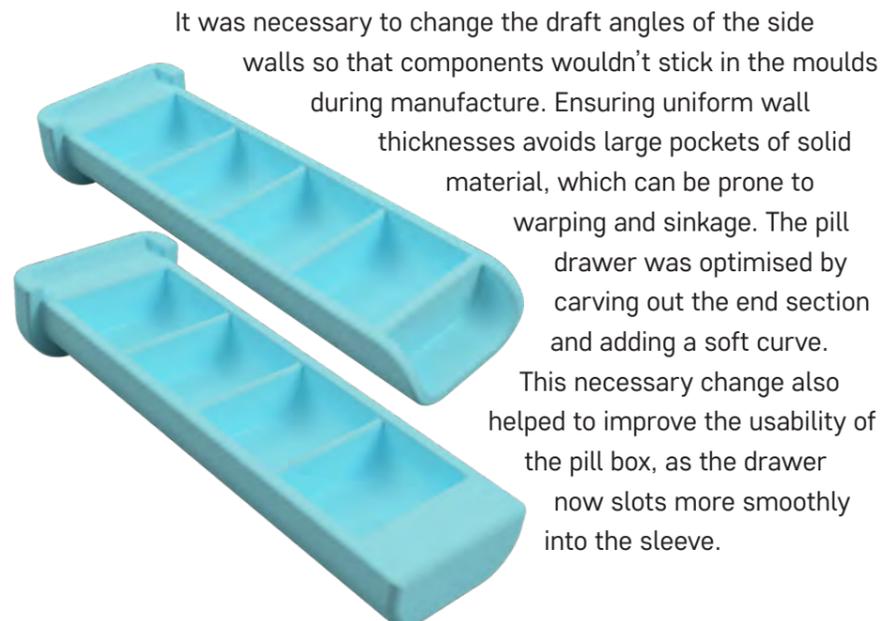
One of the main project objectives was to keep the product simple and functional, so the decision was made to injection mould all the components.



Of the materials suitable for injection moulding, Polypropylene and Acrylonitrile Butadiene Styrene (ABS) were the two most appropriate, so a Mouldability vs Price chart was produced to compare their characteristics. Polypropylene proved cheaper than ABS and was eventually selected for its flexibility, aesthetics and food safe qualities.

## Manufacturing Optimisation

To make all of the components suitable for injection moulding, they had to be optimised according to specific guidelines.



It was necessary to change the draft angles of the side walls so that components wouldn't stick in the moulds during manufacture. Ensuring uniform wall thicknesses avoids large pockets of solid material, which can be prone to warping and sinkage. The pill drawer was optimised by carving out the end section and adding a soft curve. This necessary change also helped to improve the usability of the pill box, as the drawer now slots more smoothly into the sleeve.

## Surface Textures

For the majority of the components, a Dull Textured Finish (SPI Standard D-2) was specified as it offers improved grip quality and masks deformations. The added friction between the drawer and sleeve of the pill boxes will also help regulate the speed of opening.

The organising, sliding and dispensing layers are specified as a Medium Matt Finish (SPI Standard C-2), both as an aesthetic contrast with the rest of the components and to allow the free movement of the sliding layer when in use.

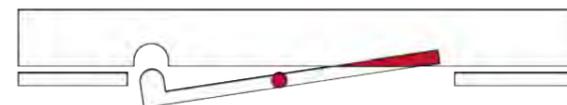
## Pill Box Closure

Keeping the pill box closed was a major part of the product development and the pill drawers and sleeves went through several iterations to discover the ideal closing mechanism.



Initially, magnets were considered but were quickly dismissed because of the extra finishing required in the manufacturing and their tendency to separate if the pill box was dropped.

A button snap fit was then considered. This offered an additional security feature, requiring the user to push on a button to displace an index by way of a lever. However, this was also dismissed as there was no space for the button displacement within the body of the pill box, due to the close fit between the sleeve and the drawer.



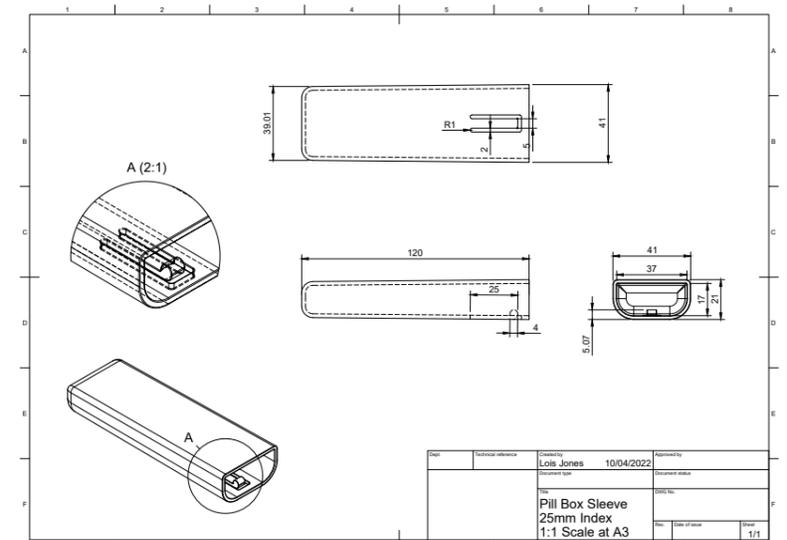
The final design utilised a simple snap fit and pocket mechanism. The user pulls apart the sleeve and drawer, displacing the snap fit as they do so. This keeps the box closed when in transit, but requires minimal dexterity to open and access the pills inside.



To develop the optimum snap fit size, several Fusion360 force studies were conducted, which tracked the displacement, stress and relevant safety factor for a variety of loading forces.



The width and length of the snap fit were varied, and the optimum length was chosen as 25mm, and the width as 5mm.



# 9 App Design

The development of an app to support the Pill-in medication station is important to aid with the accurate management and dispensing of multiple medicines.

The initial setup of the medication details should be as straightforward as possible, with the app making informed suggestions, based on the information entered, as to when doses should be administered. There should, however, be the facility for the user to make amendments based on their personal routines.

The simple layout of the dispensing layer allows for a clear schematic to be used to indicate where the individual doses of medication should be positioned and in what quantities. Checking the completed layer matches the schematic before releasing the pills should largely eliminate dispensing errors.

The pause button will allow the user to stop midway through the dispensing process if they are called away. They can then resume in the same place without having to check what they've already dispensed.

Touchscreens can be difficult for older people to use due to the reduced moisture levels in their skin. Scrolling will therefore be avoided in favour of clear buttons, giving users large target areas when making selections, either with their fingers or a stylus.

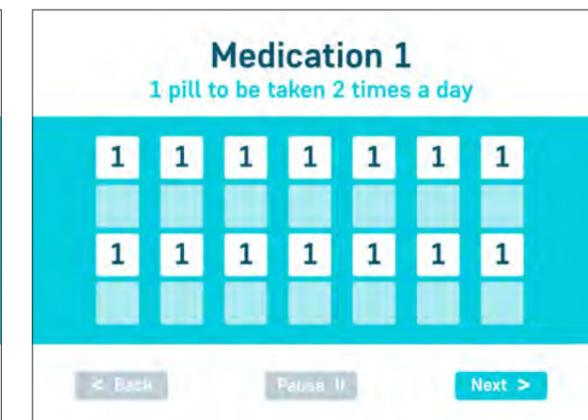
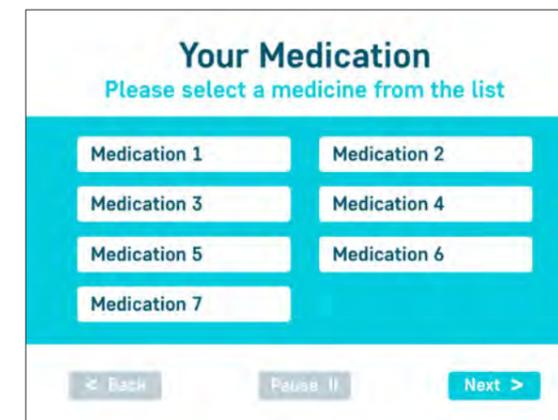
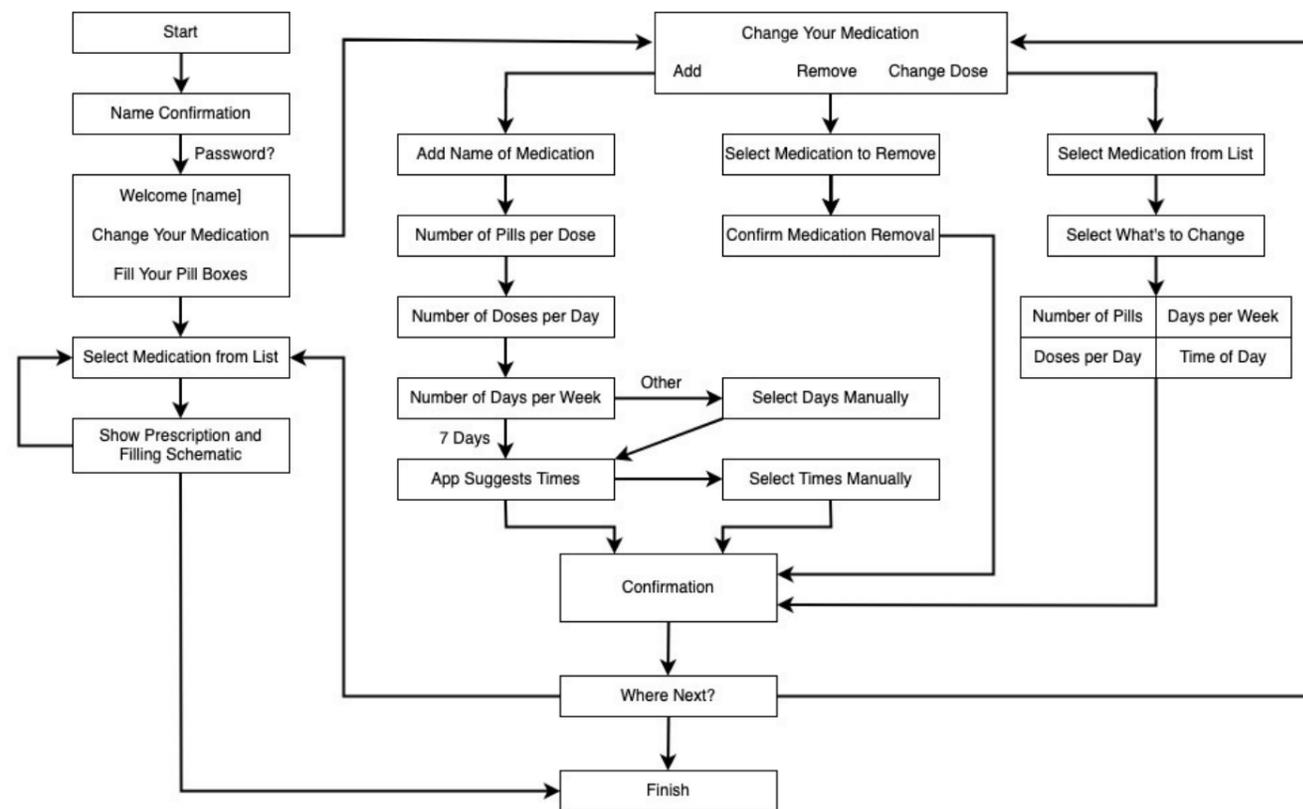
## Future Development

The app could be developed to offer reminders to the user to take their medication. It could also have a button to confirm when the medication has been taken, which can then inform a carer. There

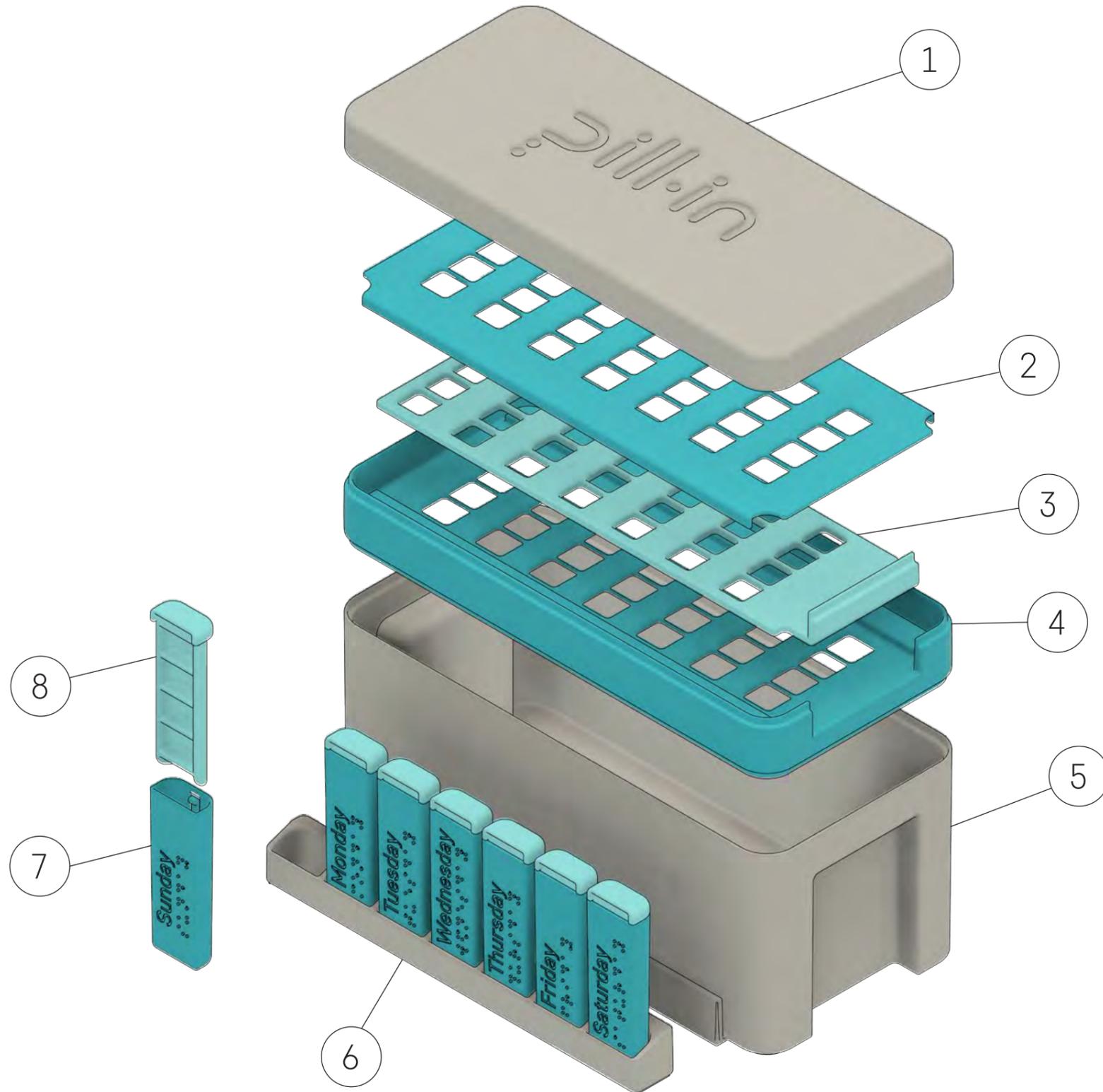
could be the facility to input stock levels when a prescription arrives and prompt the user when they need to reorder.

A QR code system, whereby the pharmacy attaches a sticker with the prescribed doses of individual medicines, would save the user having to input details manually, further reducing the chance of errors.

The tactile nature and simplicity of the grid system on the dispensing layer means that the Pill-in could be used by blind or partially sighted users. The app could be made to deliver instructions verbally, guiding the user by row and column to place the medication.



# 10 Assembly



Parts List			
Part Number	Quantity	Part Label	Material
1	1	Lid	Polypropylene Homopolymer
2	1	Organising Layer	
3	1	Sliding Layer	
4	1	Dispensing Layer	
5	1	Storage Box	
6	1	Dock	
7a	1	Pill Sleeve (Sunday)	
7b	1	Pill Sleeve (Monday)	
7c	1	Pill Sleeve (Tuesday)	
7d	1	Pill Sleeve (Wednesday)	
7e	1	Pill Sleeve (Thursday)	
7f	1	Pill Sleeve (Friday)	
7g	1	Pill Sleeve (Saturday)	
8	7	Pill Drawers	