

GuidePod™

Project Summary



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COHESION
Connected Citizen Health

The Problem

Dementia

Dementia is an irreversible condition that causes progressive loss of cognitive capacity. It refers to a decline in person's ability to function emotionally, socially, and physically over time. There are many types of cognitive impairment that occur, and these include:




There is no cure, however there are some medicines available that slow down the symptoms in some cases. It is important to add that research indicates that therapeutic interventions and quality person centered care can be more successful than medical interventions.


885,000 people in the UK have a diagnosis of dementia, and this is expected to rise to **over 1.6 million** by 2040 ^[1]. With this comes **increasing demand for innovative solutions to improve the lives of people living with dementia and their families.**




Promoting Early Diagnosis

An early diagnosis of dementia would allow the individual to **plan for their own future** and have increased involvement in their care plan. However:

 75% of people with dementia worldwide have not been diagnosed ^[2]

 62% believe a diagnosis of dementia means **"life is over"** ^[3]

 56% put off seeking a diagnosis for a year or more ^[3]

Although there are a range of emerging early detection methods, it is important to first **create solutions to allow people to take control post-diagnosis, and plan for their future whilst they still have the capacity to make important decisions.**

Importance of Routine

It is crucial to embed good habits post-diagnosis. Maintaining a consistent routine has a number of benefits for people living with dementia, including improved independence and increased self-esteem. **Studies have shown that carrying out a specific task regularly will increase the likelihood of that skill remaining as dementia progresses.** ^[4]

The Brief

Design a product to improve the lives of people living with dementia through promoting routine. The product should be person-centered and allow the individual to be actively involved in planning for their future.

1. Raphael Wittenberg, "Projections of older people with dementia and costs of dementia care in the United Kingdom, 2019-2040,"

2. Alzheimer's Disease International, [Online].

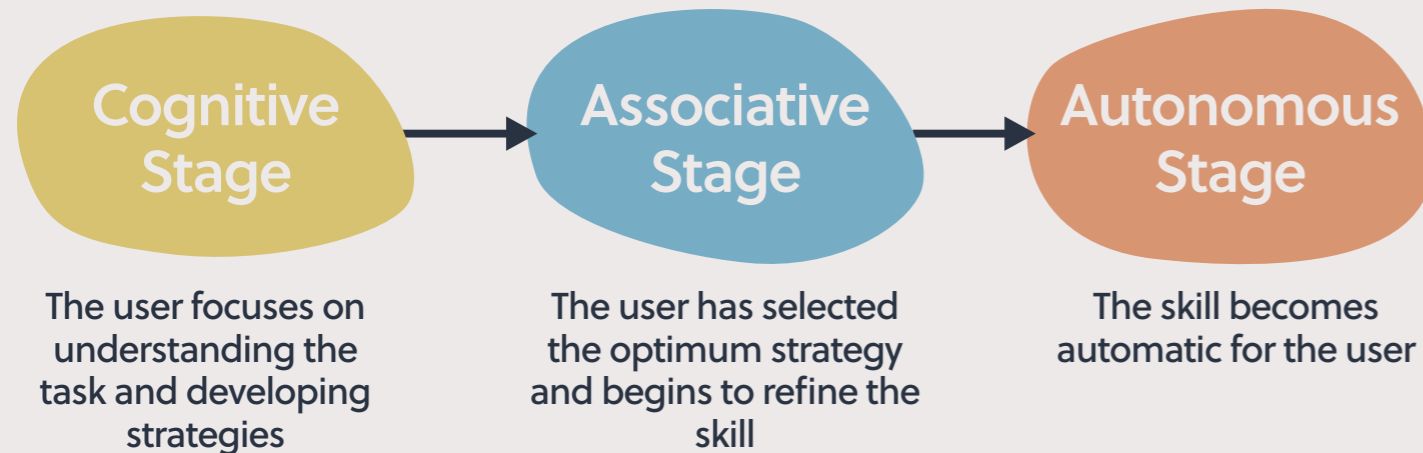
3. Alzheimer's Society, "Over half of people fear dementia diagnosis, 62 per cent think it means 'life is over'," 13 May 2016.

4. B. C. H. a. S. Villages, "THE IMPORTANCE OF ROUTINE WHEN LIVING WITH DEMENTIA," 30 October 2020.

Research

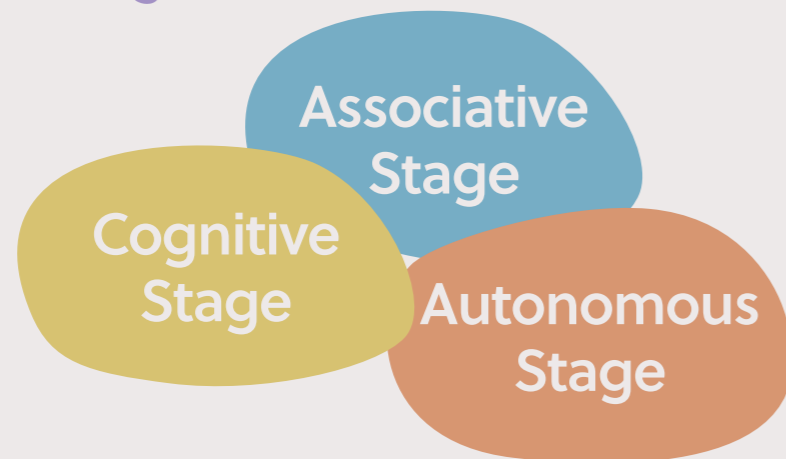
Motor Skill Learning

Explicit learning is an intentional and conscious process in which users pass through 3 distinct phases [1]:



Implicit learning is the acquisition of new skills without conscious awareness. In implicit learning, there is no clear distinction between the three stages. This means that skills may become autonomous with reduced cognition. It has been proven that implicit memories and implicit motor skill learning are preserved in people with Alzheimer's disease [2].

Implicit learning can be utilised in the early stages of dementia, which will allow these memories to act as prompts when the user reaches the later stages.



1. P. Fitts and M. Posner, "Human Performance," Brooks/Cole, Belmont, CA, 1967

2. Barbara E Harrison et al, "Preserved implicit memory in dementia: a potential model for care," American Journal of Alzheimer's Disease and Other Dementias, vol. 22, no. 4, pp. 289-293, 2007.

Sensory Stimulation

Sensory stimulation is highly effective in people with dementia, as it allows for **eased communication** and an increased understanding of the world around them.



Olfactory stimuli is capable of more effectively cueing autobiographical memories than other senses. A study asked people with dementia to memorise 24 words whilst being exposed to a scent. The participants were able to recall more words when being exposed to the same scent again.



Musical understanding stimulates multiple parts of the brain at once, meaning understanding is preserved as dementia progresses. "One of the most powerful cues to regain access to 'forgotten memories' is music".

As **understanding of these senses is maintained into the later stages of dementia**, scent and music were selected as the sensory stimuli to be used in the product.

Essential Oils

Using essential oils would provide further therapeutic benefits in addition to acting as prompts. Studies have found that exposure to specific essential oils including lavender, lemon and bergamot, rose and ylang ylang can:



improve sleep



ease pain and indigestion



stimulate appetite



reduce stress and anxiety



improve mood

Concept Development

Market Analysis

Many of the products on the market are unsuccessful as people do not want to use them until it is too late to effectively integrate into their daily routines. Often it is family or carers that introduce these interventions, with the individual often unwilling or unable to engage at that point. The motto for the project became **"do with, not for"**, to ensure a person centered product was developed.

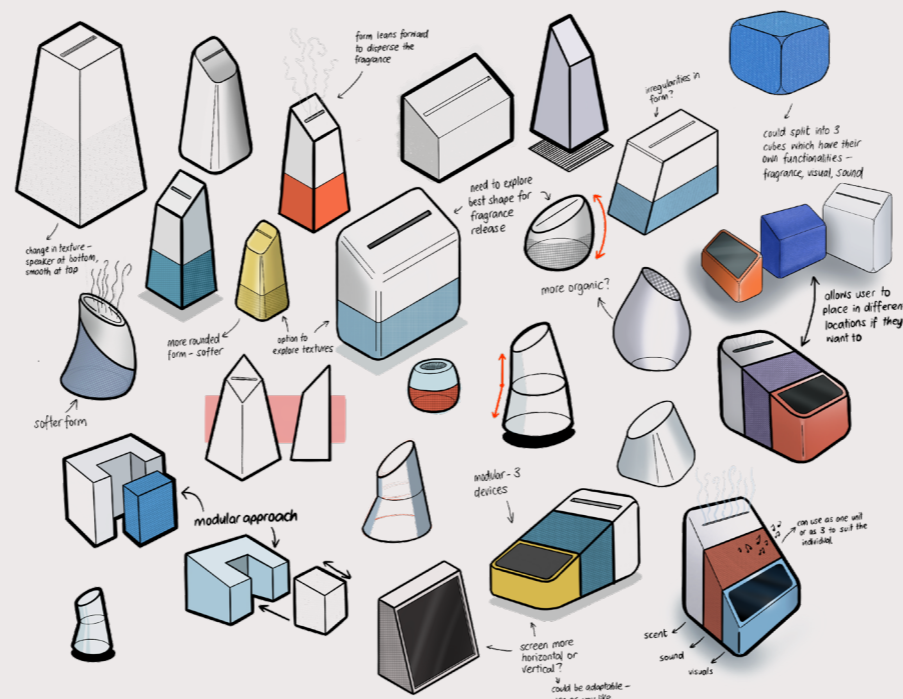
Stakeholder Engagement



couples people living alone carers professionals

I engaged with the **Alzheimer Scotland Inverclyde Dementia Reference group** for a number of sessions to gain valuable insights from people living with dementia, carers and professionals. This provided me with an **accurate representation of key stakeholders**, allowing me to take feedback on board and iterate designs.

2D Exploration



2D exploration allowed for quick evaluation of concepts, as well as the ability to communicate my ideas with my user group.

Although early concepts used abstract visual prompts in addition to olfactory and auditory, I decided to move away from this and instead create an ambient and unobtrusive home product.

The easiest and most flexible form of user input was determined to be via an app; allowing adaptable inputs from the user and/or their family. The product has been designed to encourage the user to create routines in the early stages, and then use these routines as cues in the later stages.

3D Exploration



Physical 3D prototyping allowed me to evaluate concepts and test user interactions within their intended context. I asked other members of my household to interact with them and provide feedback on the user experience.

This process led to the decision that the product should be a single unit rather than modular. I believed it was of the highest importance that the product unobtrusively blended in with the home environment, staying in a consistent location. The product was designed for the user to "fit and forget", with any refilling or maintenance being communicated via the app.

Product Overview

GuidePod™ is a smart device to promote routine for people living with dementia through sensory prompts.

GuidePod™ empowers people with dementia to take control post-diagnosis and **plan for their future**, and **enables daily functions to be maintained for longer**.

It can be used as a **standalone product**, or **integrated with existing sensor suites**.

Replaceable **Scent Pods** allow for **safe and easy refilling**, allowing the person with dementia to carry out this task in the earlier stages. When the device detects a Scent Pod is low in liquid, a **notification** will be sent to the user and/or a carer.

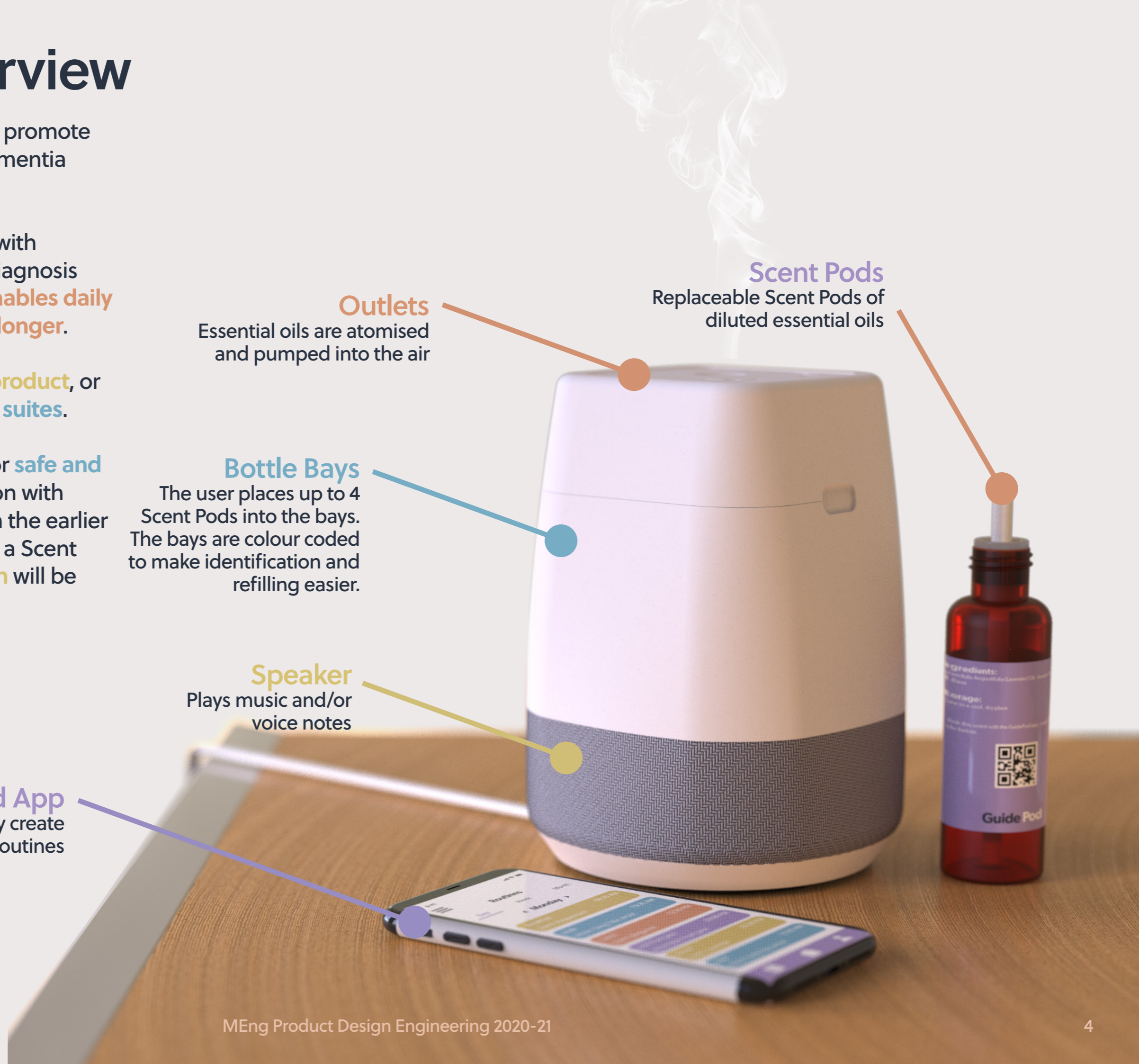
GuidePod App
User and/or family create and modify routines

Outlets
Essential oils are atomised and pumped into the air

Bottle Bays
The user places up to 4 Scent Pods into the bays. The bays are colour coded to make identification and refilling easier.

Speaker
Plays music and/or voice notes

Scent Pods
Replaceable Scent Pods of diluted essential oils



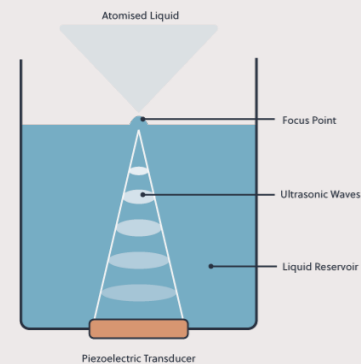
Scent Delivery

A range of scent dispersal methods were researched in-depth in order to select the best method for the application.

Heat initially seemed like a great option due to the small scale of components available. However, the downfall is that **temperatures greater than 32 degrees can cause damage to essential oils**. Air flow was also considered, however deemed inappropriate due to the noise and higher maintenance requirements.

Ultrasonic atomisation occurs as the result of capillary waves becoming increasingly unstable, resulting in droplet pinch-offs. **Ultrasound was selected due to its low noise and maintenance.**

Ultrasonic Configurations



Reservoir

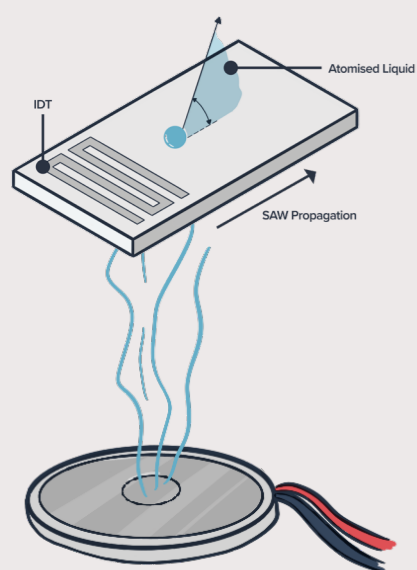
A piezoelectric transducer produces ultrasonic waves that propagate through the liquid, causing atomisation at the surface.

Surface Acoustic Wave (SAW) Device

Less established than the other two configurations. Difficulties include inconsistencies in droplet positioning.

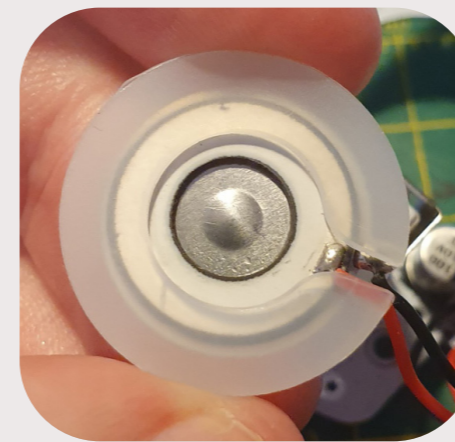
Mesh Atomiser

A piezoelectric transducer with a matrix of holes in the centre, allowing liquid to be atomised and pumped through simultaneously



Testing

Product testing and **teardowns** gave me further understanding of the operation of these mechanisms, as well as how the components fit together in existing products.



Mesh Atomiser



Mesh Atomiser on a Damp Paper Towel



Reservoir Atomiser



A piezoelectric transducer and PCB were used to test the atomisation of essential oils with wicking materials including a cotton wick and paper. The ability for wicking lends itself well to replaceable cartridges instead of refilling reservoirs.

Technical Development

Experiments

Experiments were carried out to establish relationships between essential oil concentration, distance and time.

These experiments were also useful in highlighting the challenge of olfactory fatigue. As I was mixing the essential oil mixtures, I became 'immune' to the scent. This highlighted the need for scents to be released in short, sharp bursts.

The relationships derived from the experiments are as follows:

$$\text{time} = 57.7e^{(-0.2 \cdot \text{concentration})} \quad \text{time} = 9.99e^{(-0.83 \cdot \text{distance})}$$

The ideal concentration that ensures quick bursts of scent was found to be 4%. This was multiplied by nine as a study by Nordin et al found that **people with Alzheimer's have a smell threshold an average of nine times less than health adults.**

This concentration allows for a short period of actuation of 30s. The ideal volume per reservoir was then calculated:

$$\begin{aligned} \text{Volume / Actuation} &= 30 \times 0.097 = 2.91 \text{ ml} \\ \text{Volume / Day} &= 2.91 \times 4 = 11.64 \text{ ml} \\ \text{Volume / Month} &= 11.64 \times 30 = 349.2 \text{ ml} \\ \therefore \text{Ideal Volume / Reservoir} &= \frac{349.2}{4} = \underline{87.3 \text{ ml}} \end{aligned}$$

Scent Pods

To allow the option for people with dementia to independently use the product, particularly in the earlier stages, it was critical to **design a safe and intuitive refilling process.** Therefore, a replaceable cartridge system was implemented. This concept led to the final design using a cotton wick, meaning the user never has to physically come into contact with any liquid.

Outsourcing bottles was deemed to be the most commercially viable option. Although the calculated ideal volume was 87.5ml, however this has to be compromised due to limited sizes available.

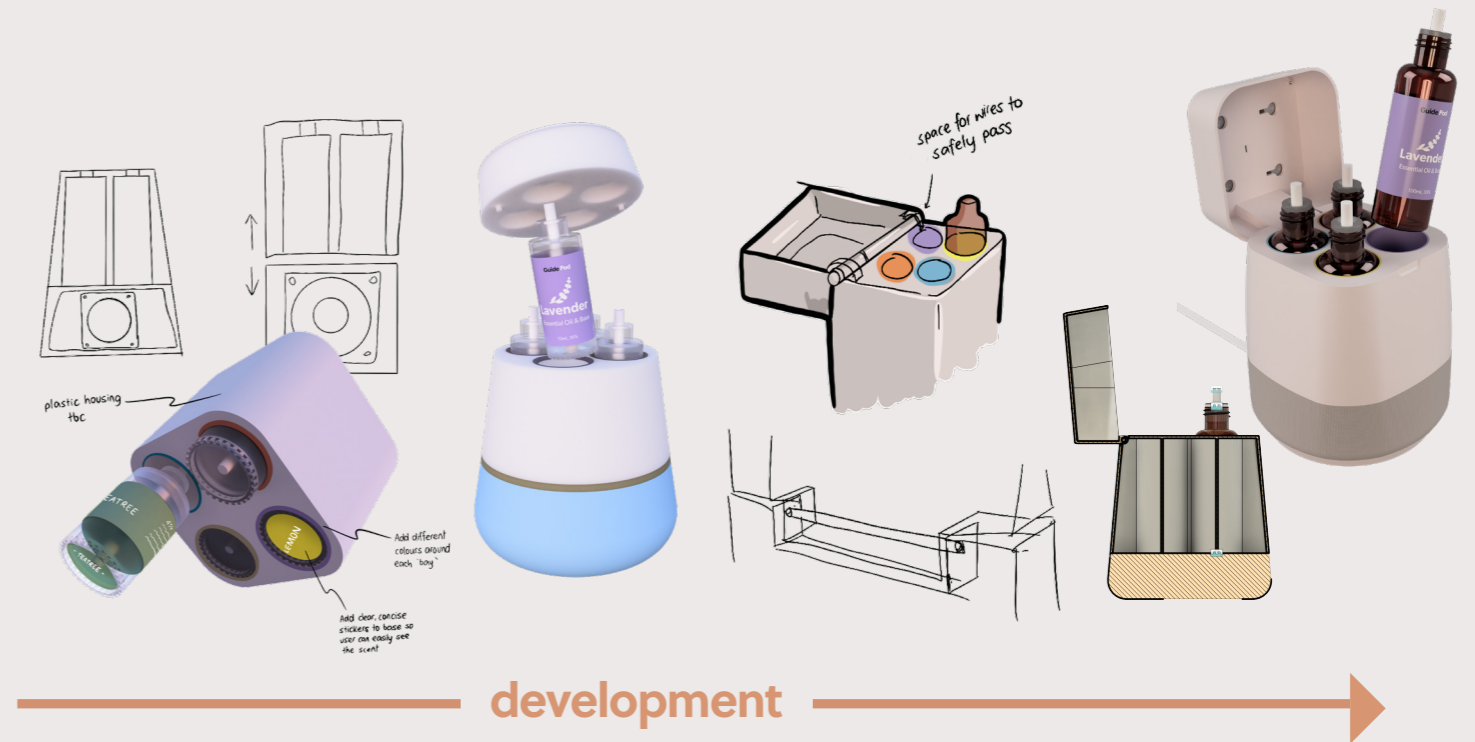


Refilling

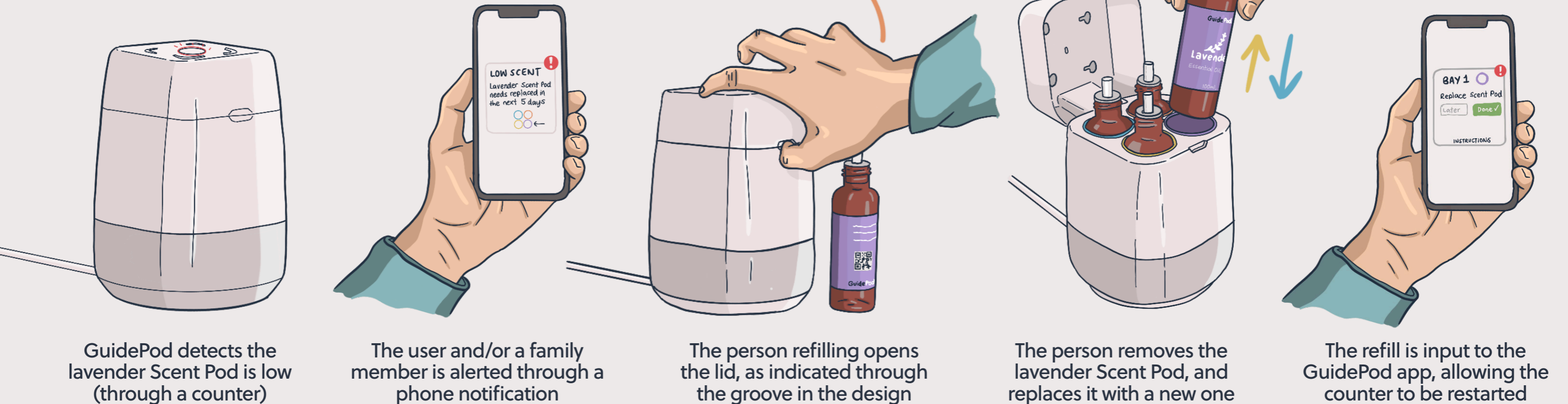
Development

As the product takes into account the whole journey of dementia, it is important to create an easy and intuitive method of refilling to allow people in the early stages of dementia to do this independently. However, it is anticipated that as their dementia progresses, a family member or carer may start to refill the device on their behalf.

Earlier concepts involved the user having to lift the top section of the product to place the Scent Pods in through the base, however the weight would be at least 500g which could be awkward for some users to hold up. A hinged lid was developed to allow easy access to replace the Scent Pods, whilst not requiring a high degree of dexterity.



User Journey



GuidePod detects the lavender Scent Pod is low (through a counter)

The user and/or a family member is alerted through a phone notification

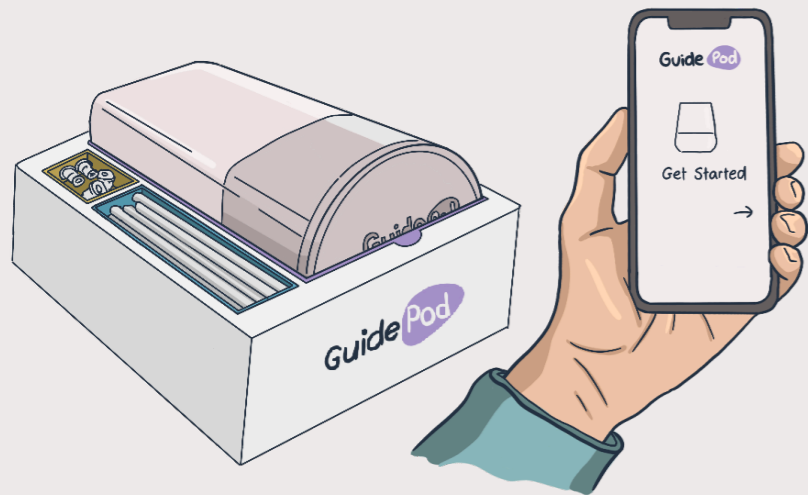
The person refilling opens the lid, as indicated through the groove in the design

The person removes the lavender Scent Pod, and replaces it with a new one

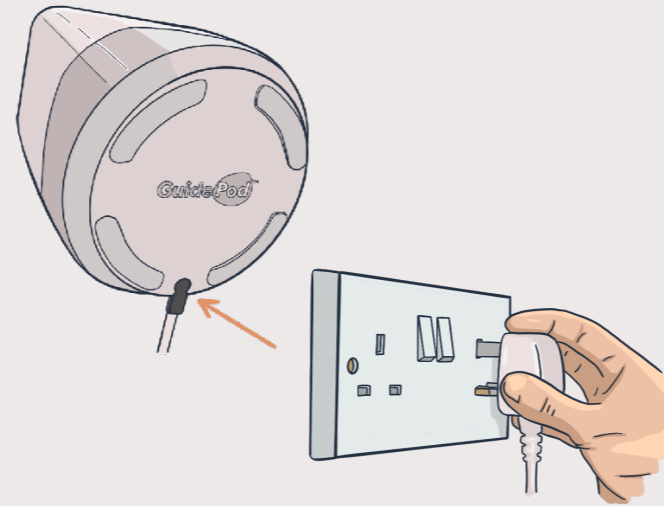
The refill is input to the GuidePod app, allowing the counter to be restarted

User Interactions

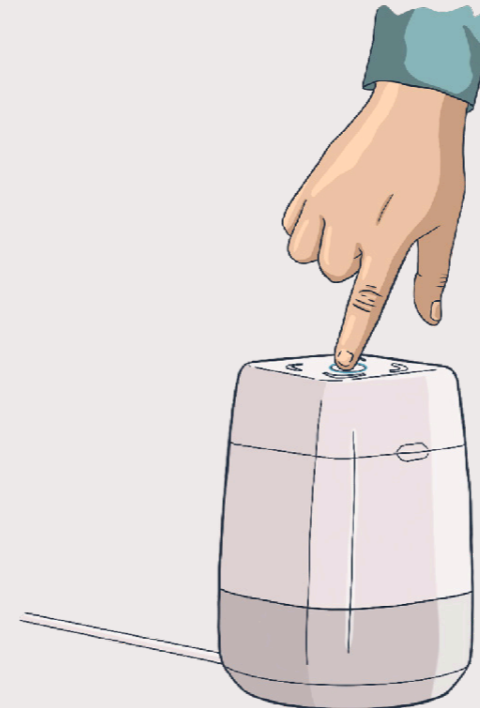
Set Up



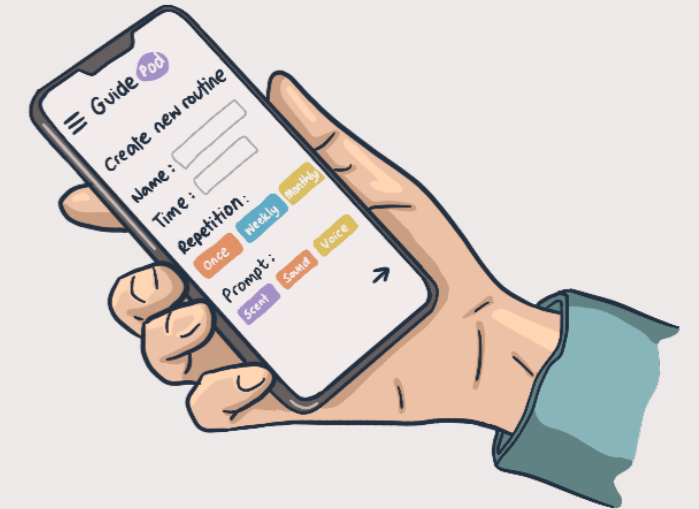
Product packaging instructs the user to download the app, which guides through the set up process in detail



The power connection is pushed into the base of the GuidePod, then plugged into the mains and switched on

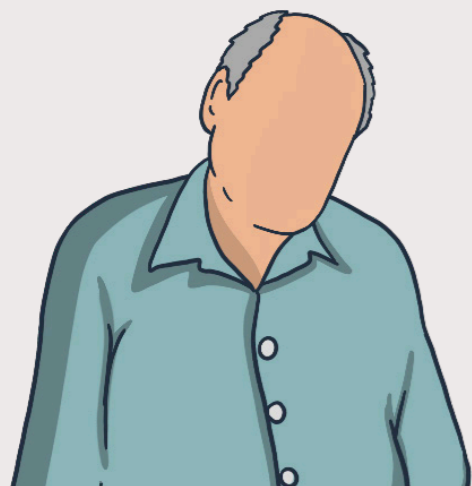


To enter pairing mode, the user presses the button for 5s, before the user confirms connection on the app



Now the device is connected, the user can begin to create routines and invite family members

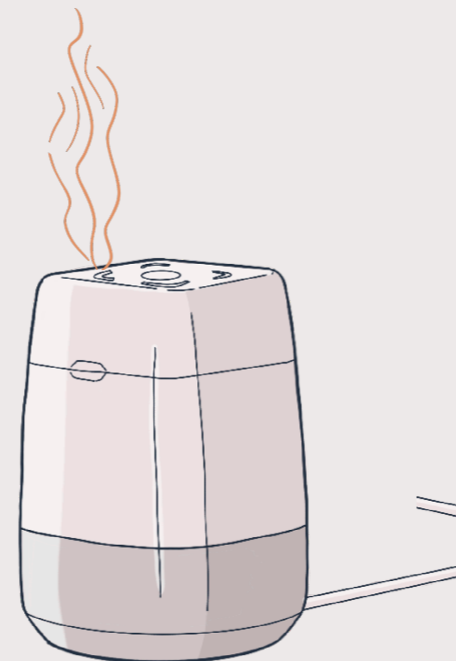
George's Routine



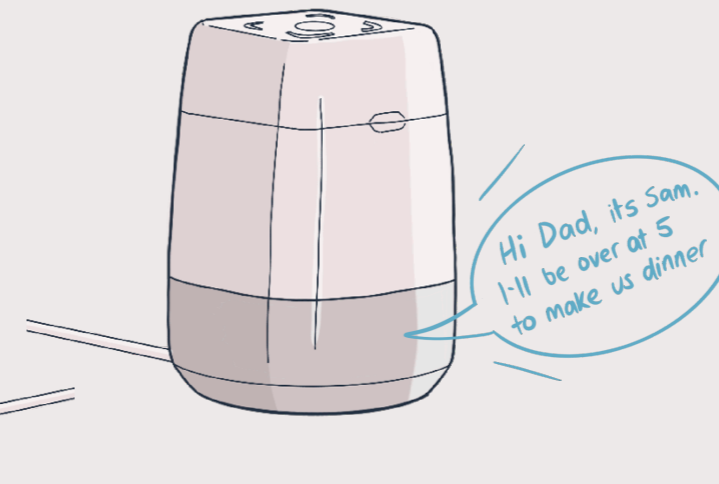
George is in the mid stage of dementia, and has been using GuidePod since his diagnosis



The scent of orange is released, reminding him that it is breakfast whilst also stimulating appetite



A scent of peppermint in the late morning stimulates the mind, whilst reminding the time of day



A voice note recorded by George's son prompts that he will be over soon, also providing an emotional connection



Lavender scent is released in the evening, alleviating sundowning and relaxing George before bed

Design for Manufacture

Principles

Ensuring **longevity** of the product to allow it to be with the user throughout their journey was a key consideration when designing for manufacture. Therefore, all of the **fastening mechanisms used are reversible** (with the exception of the rubber base, which does not affect the functionality).

Manufacturing

Standard parts were used where possible to simplify manufacturing methods and ultimately reduce cost. All custom parts were designed for injection molding. Note that the lid component requires side action, and the base components will be injection molded in two parts then ultrasonically welded to reduce mold complexity and cost.

Electronics Design

PCB including a Wi-Fi module to allow for internet connectivity. Wire organisation has been designed into the product, allowing wires to go from the PCB to the lid as required.

4 x Piezoelectric Transducers

Outsourced. 16mm with silicone seal.

Lid Main Body, Lid Outlets

Injection molded from ABS.

4 x Bottle Subassemblies

Bottles and wicks standard parts.
Seals injection molded from silicone.

Bottle Bay Housing

Injection molded from ABS.

Visaton BF 37

Full-range driver.

4 x M2.5 8mm Screws

Standard Part.

Base Housing [2]

Injection molded from ABS

4 x M1.6 8mm Screws

Standard Part.

Tactile Switch

Standard Part.

Spring Pin

Standard Part.

Fabric

Outsourced.

4 x M2.5 6mm Screws

Standard Part.

PCB

Outsourced.

Base

Injection molded from silicone rubber

