Hi Pill

Designing medication packaging to encourage adherence

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Abstract

Failure to adhere to dosage time frames with prescribed medications is recognized as a global health problem. The World Health Organization (WHO), notes the level of nonadherence to drugs ranges from 30%-50% in developed countries and is even higher in developing countries (Sabate, Santé, Organisation, WHO, & UNAIDS, 2003). Importantly, the design of pillbox packaging has a positive impact on pill adherence (Zedler, Kakad, Colilla, Murrelle, & Shah, 2011). This research project explores how packaging and communication design of a pill organizer can encourage adherence improving potential health outcomes.

To investigate the issue, a human-centered design method was implemented. Through the methods of interviews and observation, users' requirements are explored, and analyzed. This information informed the design of the Hi Pill solution. The design was undertaken in stages, the initial investigation was presented in sketches and 3D models for initial usability testing, screened for development potential and then resolved into five key variations of the resolved design. The optimal solution was developed from these final variations and further tested with end users and stakeholders. The results supported the structural packaging concept integrated with communication design considerations as an effective means of promoting medication adherence with prescribed medication

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Chapter 1.0

Figure 1: My medicine in June 2017, Photograph by author (2017).

Introduction

1.1 Introduction

In June 2017, I was prescribed medication for a skin infection. Two weeks' worth of medication was supplied and packaged in a brown plastic bottle by the pharmacy; a small label on the bottle provided information about the medicine. The pharmacist told me that I should take this medication and two antibiotics three times a day, one hour before or after meals. I realised as a result, I am not a person who takes sufficient notice of dosage instructions, as I often forgot to take the medication in accordance with the instructions. This I found to be a common problem, Zullig, Granger, & Bosworth (2016, p.1189) claim that, "Over half of American adults are nonadherent, leading to annual avoidable health care costs ranging in hundreds of billions of dollars". Persistent medication nonadherence is recognized as a global public health problem (WHO, 2003).

The aim of my Master of Design Research project is to apply a human-centred design approach to understand, redesign and evaluate a packaging design solution that addresses nonadherence in prescription pill medication.

By observing and interviewing lead users and pharmacists in New Zealand, I obtained a good understanding of pill user's needs and wants. This informed the analysis of a range of contemporary pill organiser products. New designs were developed in response to this research and were tested and assessed with regards to performance and usability. The final design is presented as an integrated prototype suitable for field trials and user testing for medical compliance, usability and adherence.

1.2 Problems and opportunities

1.2.1 Medication adherence

Not taking medicine according to a doctor's instructions

and forgetting to take medicine constitute medication non-adherence. Medication nonadherence problems may be variously described as inadequate adherence, poor adherence and lack of adherence (Conn & Ruppar, 2017). “In developed countries, nonadherence to the treatment of chronic diseases ranges from 30%-50%, and this rate is even higher in developing countries.” (Costa et al., 2015, p.1303). Researchers have distinguished two kinds of non-adherence: intentional nonadherence and unintentional nonadherence. Unintentional nonadherence, is the subject of this study and has been characterised as “passively inconsistent medication-taking behaviour (forgetfulness or carelessness)” (Gadkari & McHorney, 2012, p.2).

1.2.2 Opportunities

Interventions for unintentional nonadherence try to help people remember to take medication, through the design of pill packaging, such as blister packs, pill organisers and Medisafe Medication Reminders.

Figure 2: Blister pack. Retrieved 19 September 2019 from http://kingsvillepharmacy.com/services/compliance-packaging/

Figure 3: Weekly pill organizer. Photograph by author (2019).

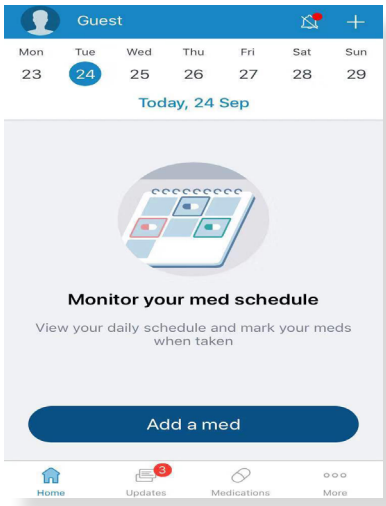


Figure 4: Screen shot of Medisafe. Photograph by author (2019).

Usability is a key factor for users in choosing to use medical products. (Notenboom, Leufkens, Vromans & Bouvy, 2017). The design purpose of medicial packaging should be to make it secure and easy for the patients to use. However, an analysis of existing pill organizers found problems in the usability, such as packages that is difficult to open or pill information is difficult to read). There is a gap between the existing pill organizer products and user needs. Calendar information in combination with other reminder strategies, can improve medication adherence (Zedler, Kakad, Colilla, Murrelle & Shah, 2011).

1.3 Research aims and methodology

1.3.1 Research aims and questions

The primary research aim is to design a pill packaging solution to enhance adherence through an improved user experience and communication of medication instructions. The secondary research aim is to improve the usability of the pill package by enhancing the current functionality and form.

The research addresses four questions:
1. How can the redesign of a medication packaging provide benefits for the market?
2. Do different consumer groups have different medication packaging needs?
3. What are the characteristics of an existing pill organiser?
4. What aspects of medication packaging can be improved to enhance the user's experience?

1.3.2 Research Methodology

Two research approaches are used in this research project: human-centred design and practice-based design investigation leading to embodied knowledge. These two

approaches use different methods to inform the development of pill packaging design concepts focused on improving adherence through a better product experience. The human-centered design approach was used in the packaging planning, conception, design and development process, enabling improvements to users' pill packaging needs to be identified. Research through practice involved designing, screening and prototyping relevant paper prototypes of pill packaging to optimize concepts and embody research findings.

1.4 Exegesis structure

This exegesis is presented through the following seven sections:

Chapter 1: Introduces and scopes the research areas, outlines the research position and research methods.

Chapter 2: Provides a critical analysis of pill packaging through a literature review that explores solutions, material and technology in pharmaceutical packaging.

Chapter 3: Summarizes the design specifications and design features of pill packaging by analyzing the usability of existing pill organizers.

Chapter 4: Focuses on theoretical analysis of user experience in drug packaging design and theoretical research on drug packaging.

Chapter 5: Presents a pill packaging design based on user needs determined from the primary research, in-depth analysis and understanding of the user's needs and wants.

Chapter 6: Presents the design investigation from the concept generation and development, to screening and development to final design.

Chapter 7: Evaluation, discussion and reflection on the design results that have been achieved and the development of future pill packaging.

Chapter 2.0

Figure 5: Pharmacy China, Photograph by author (2019).

Pill Packaging background research

Packaging plays a significant role in the pharmaceutical field, by identifying and protecting the product, and presenting information about it, thereby maintaining the product's integrity (Mehta Kunal, Akhilesh, Shyam Kumar, 2012). Pharmaceutical packaging has a market across the globe, which is advancing at constant pace. By 2018, the market was projected to be worth $78.79 billion (Pareek & Khunteta, n.d.).

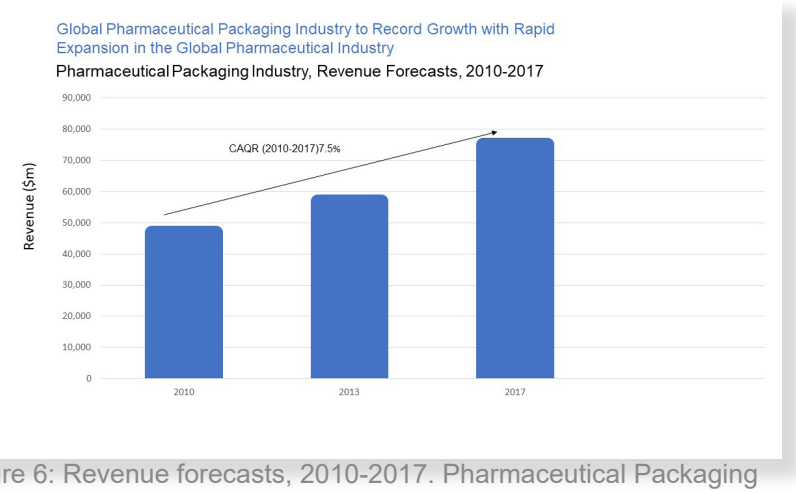


Figure 6: Revenue forecasts, 2010-2017. Pharmaceutical Packaging Industry. Source: Kunal, Akhilesh & Kumar (2012).

2.1 Pill characteristics

The packaging of medication changed with the development of pills. Pills can generally be divided into two categories, prescription pills and over-the-counter pills. Different types of pills have different packaging materials, forms and methods. Traditionally, about 51% of medications are oral solid pills such as tablets or capsules. Most of these pills are packaged in blister packs (commonly found in Asia and Europe) or in plastic bottles (especially in the United States) (Zadbuke, Shahi, Gulecha, Padalkar & Thube, 2013). It is impossible and unrealistic to design a package suitable for all kinds of medicines and this investigation will focus on solid pills (such as tablets and capsule).

Figure 7: Solid medicine (tablets and capsule). Retrieved 10 September 2019 from https://www.gizmodo.com.au/2012/10/giz-explains-why-some-pills-are-little-white-discs-and-others-are-big-red-torpedoes/

Figure8: Semisolid medicine Retrieved 10 September 2019 from https://www.contractpharma.com/issues/2018-06-01/view_fda-watch/semi-solid-dosage-forms/

Figure 9: Liquid medicine Retrieved 10 September 2019 from https://www.hunterlab.com/pharmaceutical-liquid-color-measurement.html

Figure 10: Gaseous medicine Retrieved 10 September 2019 from https://www.dailymail.co.uk/health/article-1219925/An-electric-jab-neck-ease-asthma.html/

2.2 Categories of Pharmaceutical Packaging

Packaging is defined as the collection of different components which surround the pharmaceutical product from the time of production until its used (Zadbuke et al., 2013). Pharmaceutical packaging consists of two parts, container and packaging information management. The container relates to the materials used, the shape and the manner of use. The container of the drug can also be divided into single dose containers and multi-dose containers according to different uses. The information management mainly refers to the colour, pattern, shape and text of the labels used to provide visual separation and graphic information.

Here (Fig 11 & 12) two different containers used in primary packaging for solid medicine. Single dose containers hold the product that are intended for single use like blister pack and glass; Multi-dose containers hold a quantity of material that will be used as two or more doses, like weekly pill organiser (Zadbuke et al., 2013).

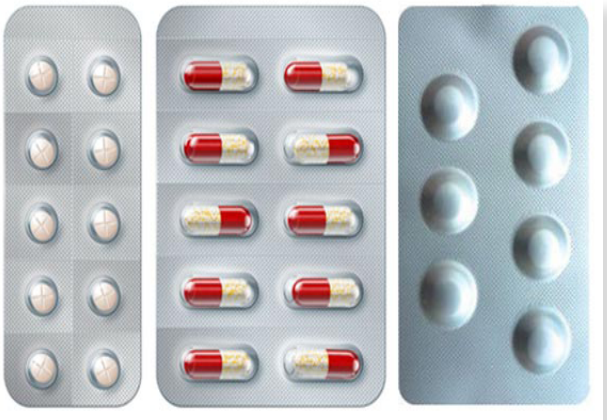


Figure 11: Single dose containers (Blister pack) Retrieved 10 September 2019 from https://mx.depositphotos.com/198610818/stock-illustration-realistic-3d-drugs-packaging-painkiller.html

Figure 12: Multi-dose containers(Weekly pill organizer) Retrieved 10 September 2019 from https://tr.aliexpress.com/item/32775871398.html

2.3 Functions of pharmaceutical packaging

Pharmaceutical packaging protects the pill and maintains its integrity, as well as providing information about the medicine. Several common details that are included in the information include patient safety advice, an expiry date, description of storage factors that may affect the products' integrity amongst other information.

Protection
Medical packaging is different from other general packaging. Pharmaceutical packaging needs to prevent the intrusion of water, light, heat, microorganisms and contamination from harmful substances. It also needs to protect against the impact of external forces and strictly prevent accidents such as failure, deterioration and misuse of drugs (Kunal, Akhilesh & Kumar 2012).

Presentation and information
Packaging requires clear and easy-to-read drug information, which consists of patient labels and drug instructions. At the same time, the drug packaging also needs to be helpful to the user to identify the drug quickly (Kunal, Akhilesh & Kumar 2012).

Pharmaceutical packaging considers protection as a primary factor. Pill packaging should be user-friendly. While meeting the above conditions, it should consider the aesthetics of drug packaging and improve user's medication adherence by design (Kunal, Akhilesh & Kumar 2012).

2.3.1 Packaging label decoration

Pharmaceutical packaging needs to convey accurately information about the properties, functions, quality, uses, usage and treatment targets of medicines.

Graphic elements, particularly text, are used to express the name, trademark, active ingredient, quantity, usage and dosage of a drug on the surface of the packaging container. Different countries and regions have different requirements for medication label design (Medsafe.pdf, n.d.). This project complies with New Zealand's relevant drug packaging regulations. Section 44 of the Medicines Act 1981 requires that all medicine containers be labelled "in the prescribed manner". Labels for all medicines and related products must contain all the mandatory requirements in English. Information must be presented in the required position and style, if this is specified and it must be legible and durable. The minimum information required to appear on the label of such containers is the name of the medicine, the names and quantities of the active ingredients, the batch number and the expiry date (Medsafe.pdf, n.d.).

Colour is used to convey visual information to attract consumers' attention, highlight differences between products and or to inform the patient of a schedule of when to take a pill. Colour adds an aesthetic element to packaging design that may provide a positive impact on people's psychology and enhances the user's experience (Reimann, Zaichkowsky, Neuhaus, Bender, & Weber, 2010)

Figure 13: Medicine label Retrieved 10 September 2019 from http://sledguide.info/bedsgn/

Figure 14: Pharmaceutical Packaging, Anne Kim Retrieved 10 September 2019 from https://www.packagingoftheworld.com/2014/03/pharmaceutical-packaging-student-project.html

In terms of packaging components, pharmaceutical packaging can be divided into two packaging levels. Primary packaging refers to the packaging of pills in direct contact (such as medicine bottles, medicine bags, blister pack, etc.). The main function of primary packaging is to protect pills from chemical or biological hazards (Mehta Kunal, 2012). Secondary packaging groups primary packages together e.g., cartons, boxes, shipping containers, injection trays, etc. Tertiary packaging is used for bulk handling and shipping e.g., barrel, container, edge protectors, etc. (Zadbuke et al., 2013). This study focuses on primary packaging.

Types of primary and secondary packaging material		
Material	Type	Example of use
Glass	Primary	Metric medical bottle, ampoule, vial
Plastic	Primary	Ampoule, vial, infusion fluid container, dropper bottle
	Secondary	Wrapper to contain primary pack
Metal	Primary	Aluminum foil, tin
Paper /Cardboard	Secondary	Box to contain primary pack

Table 1 : Types of primary and secondary packaging material. Source: Kunal, Akhilesh & Kumar (2012).

2.4 Pharmaceutical Packaging materials

Materials currently used for pharmaceutical packaging include: glass, plastic, metal and paper. This section explores the properties and applications of these material to identify materials that are user-friendly, ecofriendly and sustainable.

2.4.1 Metal

Tin, aluminum and iron are metals that have been used for

packaging, but the metal used most often is aluminum. Aluminum is a light, ductile, odorless, nontoxic, opaque metal (Singh, Sharma & Malviya, 2011). Its properties include having a good elongation ability, good strength and rigidity, good gloss and ability to withstand the influence of heat and cold. These qualities make it a good foundation for packaging containers, because it can provide the contents good protection. Compared with other packaging materials, such as plastics and paper, aluminum materials are more complex to generate and produce, increasing production costs.

Figure 15: Metal pill container. Retrieved 5 August 2019 from https://blog.adafruit.com/2012/11/01/print-for-minty-3dthursday/

2.4.2 Aluminum foil paper

Aluminum foil has high ductility, no shrinkage and metallic luster and good barrier properties. It has good printing performance and is strong and can be used as in shrink packaging (Zadbuke et al., 2013). Aluminum foil paper has good printing performance, can withstand high use and can be recycled and is increasingly applied to pharmaceutical packaging.

Figure 16: Aluminum foil paper. Photograph by author (2019).

2.4.3 Glass

Glass is a common primary packaging material. Glass is chemically inert and transparent (Zadbuke, Shahi, Gulecha, Padalkar & Thube, 2013). Compared with plastic, glass has the disadvantages of being delicate, vulnerable to breakages and costly. Glass is used to make small bottles, ampoules, dropper bottles and glass bottles (Singh et al., 2011).

Figure 17: Glass bottle. Retrieved 5 August 2019 from https://www.amphorea.co.uk/stories/show?story_id=58

2.4.4 Plastic

Plastic has many advantages that are not available in materials such as paper, glass and metal. It can be made into bottles, cans, bags, tubes and blister packs in various forms and sizes. The material is light, has good flexibility and elasticity making it resistant to tearing impacts. The disadvantages of plastic containers include oxygen and water vapour can permeate the packaging meaning the barrier effect of the packaging is poor and the drug is not always protected well. Under certain conditions, plastics will chemically react to particular factors, e.g., heat and this can degrade the security of the package and contents. (Raheem, 2013).

Figure 18: Plastic bottle. Retrieved 5 August 2019 from https://ecogreenlove.com/2013/07/04/reusing-plastic-pill-bottles/

2.4.5 Paper

Paper and paper containers are widely used in packaging. Made of various natural cellulose raw materials which are easy to obtain, paper is cheap. Paper has certain mechanical strength offering reasonable packaging protection. It is light, adaptable, easy to print and readily recyclable. Paper not only saves resources, but is also biodegradable. Paper is not naturally water resistant, so cannot protect contents effectively against moisture unless modified (Zadbuke et al., 2013).

Figure 19: Medicine paper packaging. Retrieved 5 August 2019 from http://www.unique-packaging.com/e_productshow/?168-medicine-paper-packaging-box-168.html

2.5 Automated Tablet Dispensing and Packaging System

Figure 20: Automated Tablet Dispensing and Packaging System. Retrieved 5 August 2019 from http://www.boscalicious.co.uk/profitable-report-on-pharmacy-automation-systems-market-considering-business-planning-research-key-opportunities-trends-and-forecasts-by-2025-having-top-key-vendors-abacus-rx-inc-accuchart-plus/

The global pharmaceutical industry is currently experiencing rapid expansion, with manufacturing processes, technological innovation and integrated packaging being the main drivers of growth in the global pharmaceutical packaging industry (Zadbuke et al., 2013). Automated Tablet Dispensing and Packaging Systems (ATDPS) enable drug classification, distribution, packaging, printing, packaging and storage management of drugs. It provides safer, more accurate, and efficient drug dispensing for pharmacies. The working principle is to dispense and pack all the tablets or capsule automatically for a particular patient. Prescription information, which is electronically transmitted from the drug information system, includes the patient information, drug information, drug administration details, and so on. About 60 packs of medicine can be dispensed per minute. ATDPS speeds up the dispensing of medicines, reducing the burden on pharmacists and improving dispensing efficiency (Begliomini, n.d.). Currently, plastic is the packaging material used most often by ATDPS. In the future, aluminum foil paper will be substituted for plastic packaging.

2.6 Summary

Due to its good sealing and printing properties, aluminum foil paper has been selected as the material of choice for this study. The design development focuses on a multi-dose container that is compatible with existing ATDPS. This packaging technology meets New Zealand's pharmaceutical packaging standards.

Chapter 3.0

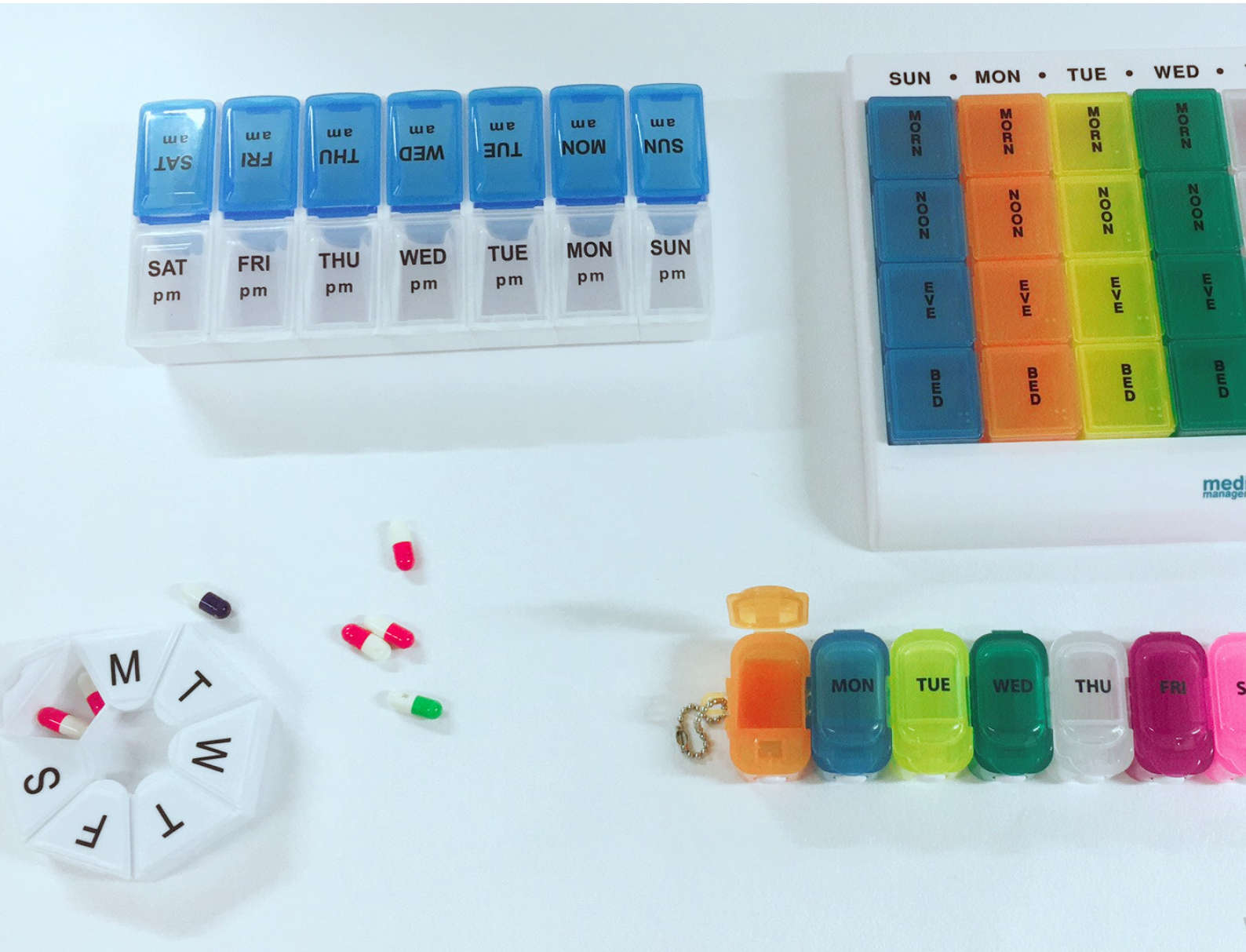


Figure 21: Weekly pill organisers. Photograph by author (2019).

Adherence Packaging Defined

The products covered in this chapter are either existing medicine boxes sold through pharmacies internationally, or award-winning packaging designs. The pill boxes purchased from pharmacies can be divided into two kinds: pill organizer products that the end users manually fills, and blister pack from the pharmacy pre-filled. Using a matrix table, information about existing boxes can be compared and analysed. The results of the analysis reveal the target specifications for product design, which are summarized in the initial stage of product design development.

3.1 Case studies Adherence Packaging Design

3.1.1 Product 1. Blister pack

Blister packs are widely by the pharmaceutical manufacturers. The cavities are made of transparent thermoplastics with a lid made of a combination of transparent plastics, or plastic-coated paper, or foil paper. The most important reason for applying blister pack technology is to provide patients with clearly labelled personal doses so that they can check if they have taken the prescribed medication on a certain day. Moreover, unused drugs remain in their original packaging, well protected and documenting there usage. Blister packs, accounting for about 85% of solid medicines dispensed in Europe (Zadbuke et al., 2013).

Issues:

According to feedback from a Wellington pharmacist, it takes 30 minutes to fill the blister pack each time. Some drugs need to be stored in the dark, and they need to be cut and packaged together with the original drug packaging, which is inconvenient to use. Since the plastic part is thick, it is not easily torn off from the package and needs to be cut to release the pill from the pocket, which can be inconvenient and presents a potential hazard.

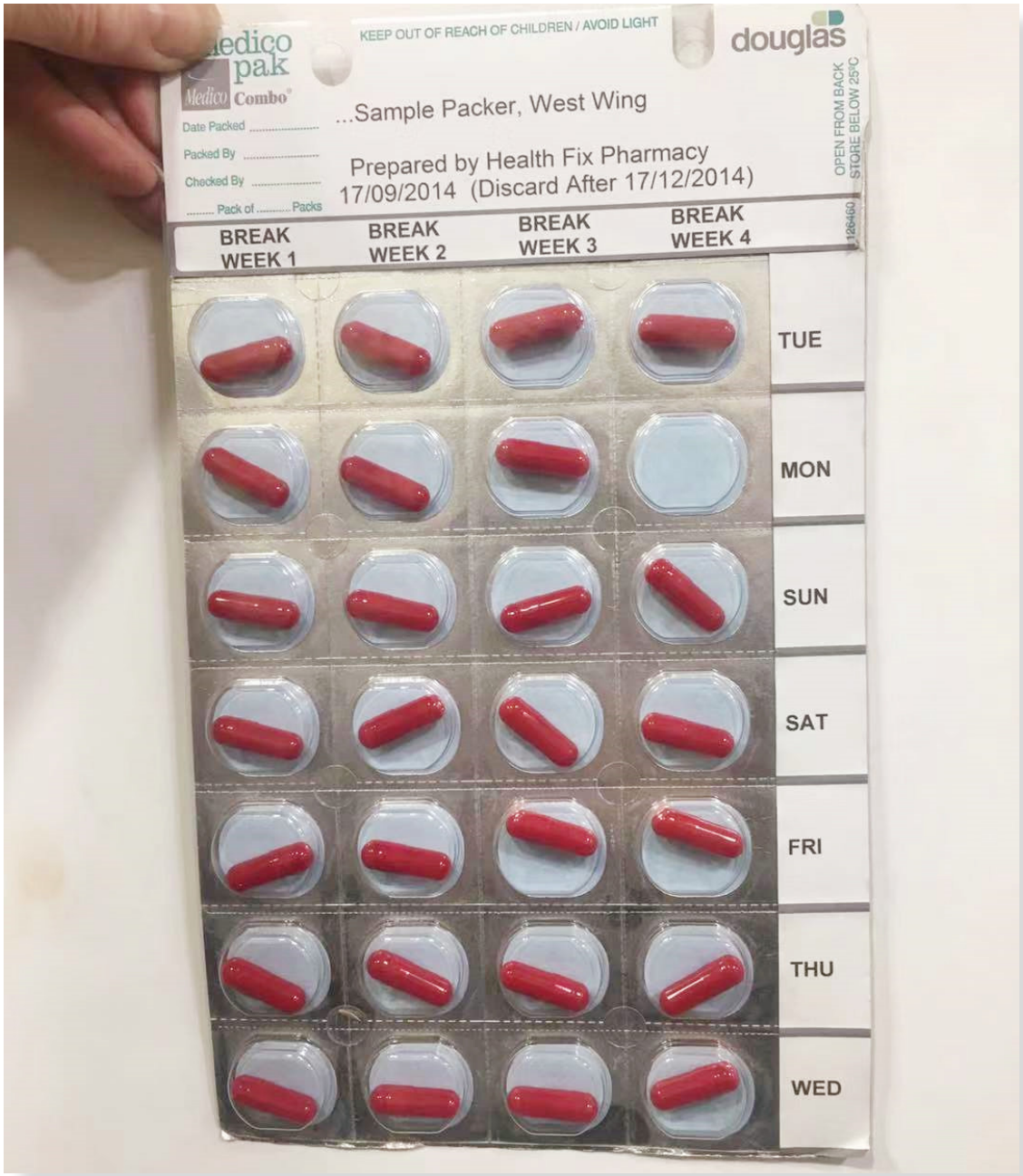


Figure 22: Blister pack. Photograph by author (2019).

3.1.2 Product 2. Memo box

Memo Box is readily portable, small enough to be carried in a pocket or bag. It's built-in micro-recording device can record the user's medication habits and cycles according to the time when the user opens the box, synchronizing that information to a mobile phone application. It can remind the user it is time to take the medicine or to prevent the user from double dosing. Memo Box is remotely able to remind the user's family that medication is due, if a user forgets to take the medicine on time, Memo Box informs the user by text message when medication is due.

Issues

Memo Box storage capacity is limited and cannot hold drugs of larger specifications. This electronic pillbox needs batteries to power ("Memo Box Smart Pillbox," n.d.).

Figure 23: Memo box. Retrieved 5 August 2019 from https://pillbox.tinylogics.com/products/memo-box-7-day

3.1.3. Product 3. Pill pack

In 2014, PillPack was launched with the aim to reduce the patient's time managing medication by individually packaging the drugs that need to be taken at each time according to the prescription then send them directly to the patient. The system can track each patient's medication records, automatically replenishing the medicine when it is due/reducing the pharmacist's workload. Its core is single plastic pill bag with time and date that puts your medicines in order in a blue box. Each individual sachet has generic medication information that is presented to the user in an easy-to-read format. In New Zealand, some large pharmacies have also begun to use machines instead of pharmacists to re-package patients' drugs. (PillPack.com)

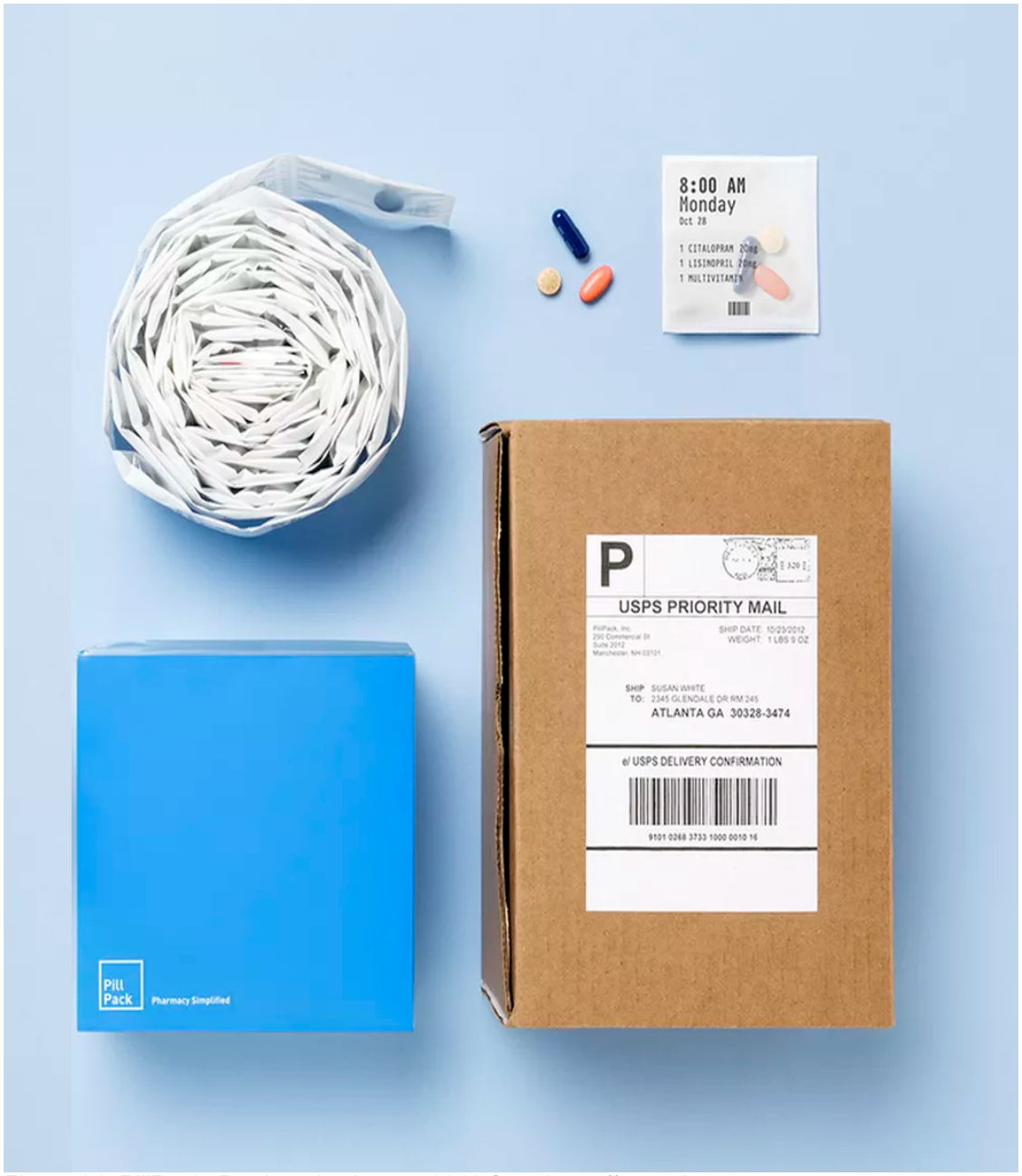


Figure 24: PillPack. Retrieved 5 August 2019 from https://www.theverge.com/2014/2/6/5386092/pillpack-raises-4-million-to-redesign-pharmacy-experience

3.1.4. Product 4. Asobu Pill Bottle

Asobu Pill Bottle combines a pillbox with a water cup. When the user takes the medicine, they need to drink water. The design seeks to simplify the user's medication action and improves user experience. The side of the cup is designed with a row of 7 storage cells which can carry seven-days-worth of medication. The drug compartment can also be detached from the bottle and the bottle can be used alone (asobubottle.com).

Issues:

The storage space of the medicine is limited, and only 2-3 pieces of large-sized pills can be stored in one unit. Therefore, it is apparent that the product cannot satisfy the need of patients who have to take medicine several times per day.

Figure 25: Asobu Pill Bottle. Retrieved 5 August 2019 from https://asobubottle.com/products/pill-bottle

3.1.5. Product 5. Pridrill

The PillDrill Smart Drug Tracking System, includes a small hub that looks like an alarm clock, a drug-sorting box, a scanning label and a tracking device called “mood cube”. PillDrill’s sends reminders to user’s phone via their home Wi-Fi network, and sends them audio and video alerts every time they forget to take medicine. After taking the medicine, the system records the medicine taken by the user that day. Users can track on a mobile app their own and their family’s medication history. There are five faces on the mood cube: feels very good, feels good, feels normal, feels bad and feels very bad. Each time you take the medicine, you can use these five emotions to record your physical reactions. (“PillDrill—Smart medication tracking that simply worksTM,” n.d.).

Issues:

Although compared to the seven-day-packed pillbox, PillDrill highlights the user’s experience however it is comparatively complex, requiring input from the user. During the process of analysis, after medication, the system firstly needs to be scanned by the hub and then device records whether the drug is completed. While the mood cube can record the user’s medication mood, it is more important to improve the user’s health than the user’s mood.

Figure 26: Pridrill. Retrieved 5 August 2019 from https://www.pilldrill.com/

3.1.6. Product 6. Apex Twice a Day Weekly Pill Organizer

This 7-day pillbox lets consumers organizer their medication for the morning and evening by the use of two different coloured transparent containers assisting organization. According to the sales staff of a Wellington pharmacy, this device is a popular product because its size and drug capacity meets the needs of most users.

Issues:

Although the user can check the drugs stored in the inside through lid, such design does not protect the drug well in some cases. This convenient opening method is convenient for users, but at the same time sacrifices the sealing ability of the box. This product needs to be cleaned and maintained regularly by the user when it is just purchased and after a period of use, and most users do not wash it regularly.

Figure 27: Apex Twice a Day Weekly Pill Organiser. Photograph by author (2019).

3.1.7. Product7.Pill Organizer Box Weekly Case

This 7-day pill organiser with 28 pill compartments is designed for those who take medication up to 4 times a day. Such organizers allow patients to plan seven-days-worth of medication in the morning, noon, afternoon and evening. Each compartment is clearly marked and each day has a different colour. Seven small cases can be easily stored in a pocket. According to a pharmacist from a Wellington pharmacy, the major users of such products are elderly people who generally need to take multiple drugs, so they need a spacious pillbox that can store many different drugs.

Figure 28: .Pill Organizer Box Weekly Case. Photograph by author (2019).

3.1.8. Product 8. Medisafe

Medisafe is a drug management app that aims to improve user compliance. Through the app, the user can set the type, dose, time and precautions of the drugs to be taken each day. When it is time to take medicine, the mobile phone initiates a reminder, which is cancelled once the user clicks to complete the action. Medisafe allows users to add a friend to the system who can be messaged to remind the patient to take medication if the patient has no digital connection.

Issues:

Although the mobile phone app issues a reminder to take medicine, if the medicine box is not near the user, the action of taking medicine is still not completed. Medisafe may improve users' drug compliance, but its functionality requires more research.

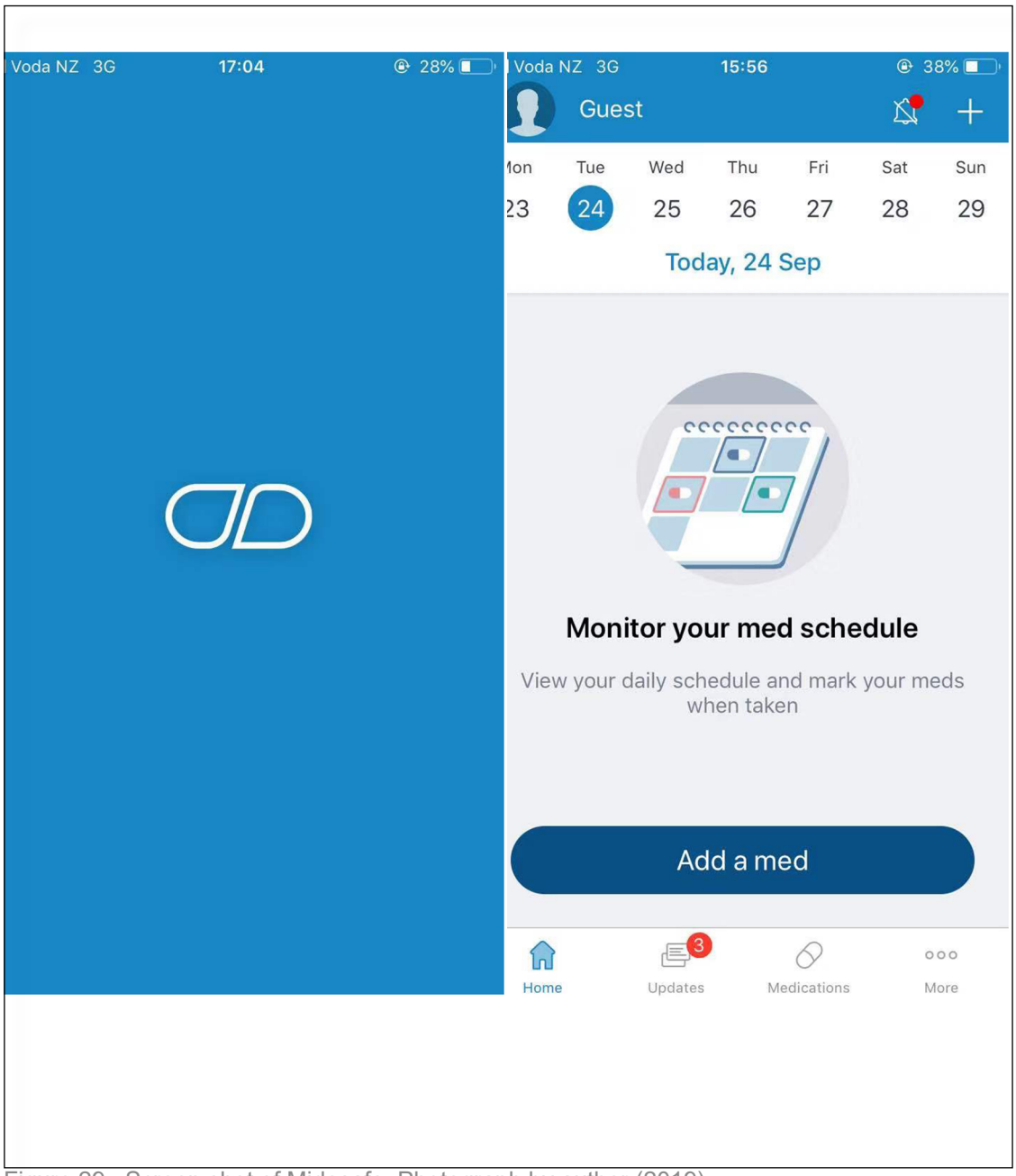


Figure 29: Screen shot of Midesafe. Photograph by author (2019).

3.2 Case study matrix

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
								
Size	265*158*20	100*76*22	171*171*89	230*75*75	190*85*75	182*90*25	108 * 175 *	
Material	Pet & Aluminum	PP & ABS	PE	PP	PP&ABS	PP	PP	
Color	Blue & white	Blue & white	Blue & white	Candy color	Blue & white	Blue, purple	Candy color	Blue & white
Dose	4 times a day (7 days)	Customized	Customized	1 time a day (7 days)	Twice a day (7 days)	Twice a day (7 days)	4 times a day (7 days)	Customized
Open method	Push-Through-Package	Open & Mobile control	Tear off & Peel	Open	Open & Scan Mobile control	Open	Open	Mobile control
Maximum number of pills (1 unit)	5	9-15	10-15	3	6	8	8	
Price (NZD)	$12	$315		$ 27	$442	$20	$27	

Table 2. Case analysis matrix

3.3 Conclusion

The problems in the design of the existing multiple dose pill organisers are as follows:

1. Pill organiser products store drugs in a relatively small container, the size of which determines the amount of medication stored.

2. The size and access to the individual storage units in the pill organisers can make retrieving the medication difficult for large fingers and hands.

3. The cost of a smart pillbox is generally high, and the separate reminding app is physically separated from the product, which does not work well in reminding the time of taking medicine.

4.Detailed drug information is not shown. Most of the products are only used as a container for storing drugs. Users can see the drugs inside through the lid, but they do not know the details of the drugs.

5. Most pill organisers are easy to open b due to the close proximity of the individual storage units, opening one can often inadvertently lead to opening the adjacent unit.

6. The sealing ability of pill organiser is variable and does not provide a secure moisture seal to protect the enclosed medication.

7. Pill organiser products are generally difficult to clean due to their sharp cornered box form designs.

As stated in section 2, I have selected aluminum foil paper is as design material, which can address the poor sealing of existing products.

Due to good printing function, it is possible to print on the surface of aluminum foil paper to help users identify the relevant information. On the basis of the design principle of PillPack, the future packaging of medicine can be packed separately according the user's needs using ATDPS technology. In addition, users can be assisted by different color schemes, making it easier track what drugs should be taken at a particular time. Users can choose different schemes according to their own needs (such as twice a day or three times a day). As the dose of each user is different, a package in the form of a pouch can effectively increase the maximum amount of medicine in a single unit (such as a pouch form of Pillpack, which can hold 10-15 pills in a single pouch).

Chapter 4.0

Figure 30: Research wall. Photograph by author (2019).

Understanding user experience in pill packagin

This section studies the relevant theory of user experience and packaging design. It relates the role of user behaviour in pill case packaging design to the classification of packaging design and user experience.

4.1 Understanding user behaviour

Norman's concept The Seven Stages of Action, asserts that knowledge is both in head and in the world. Behaviour determined by head knowledge, world information, and limiting factors. (Norman, 2004). In terms of the process of taking pills, the user takes the drug for his own health, which is the subjective purpose of the user. For various reasons, they may forget to take their medicine so the pill organisers help remind users to take medicine on time. The usability of a product is the factor that limits the user from completing this action; that is the process of interaction between user and the pill organiser.

Figure 31: Adapted from Donald Norman (2004)

4.2 Emtional design three levels

Norman separates product user experience into three different levels, visceral, behavioural, and reflective.

The visceral level reflects the sensory experience generated by the product, and is determined by details such as modelling lines, colours, etc., emphasizing visual comfort. The behavioural level relates to the experience of interacting with the product, determined by product features and functions. The reflective level expresses the user's psychological and emotional experience, emphasising the degree of psychological recognition. Good product design combines the three product experience design levels to fulfil the user's experience (Norman, 2004). Therefore, to optimise the pill organiser, the user experience design principle needs to be applied by combining these three levels and considering them in a unified manner.

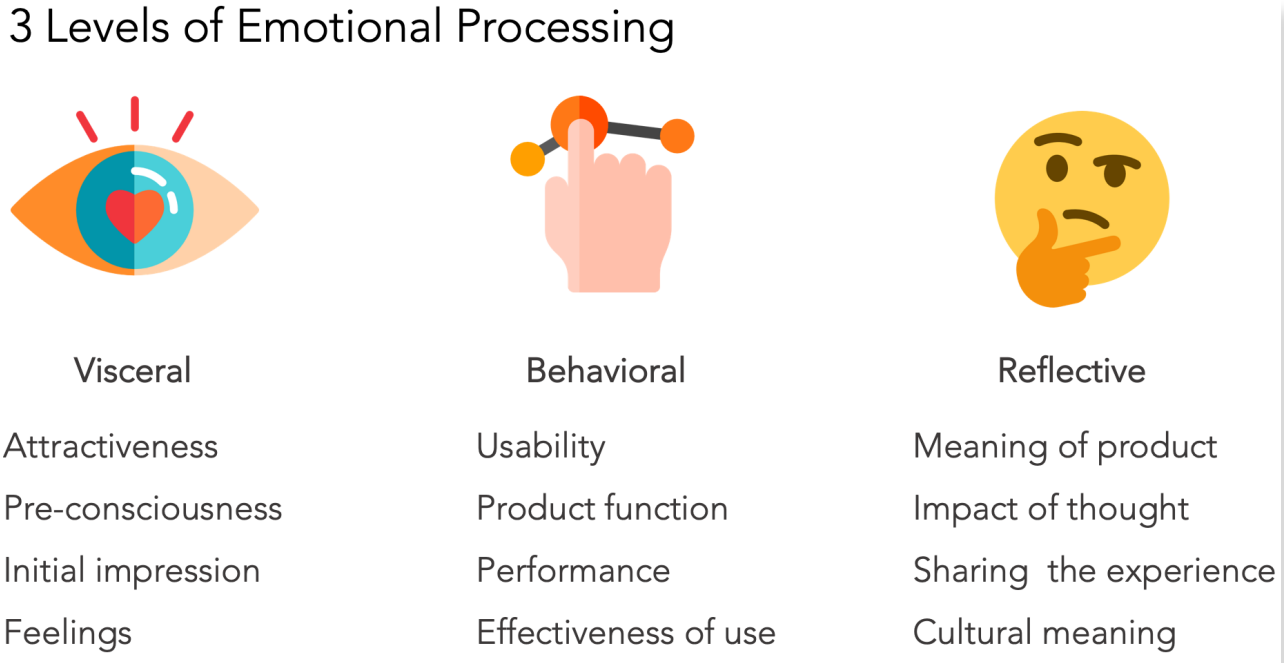


Figure 32. Three levels of emotional processing. Retrieved 20 August 2019 from https://medium.muz.li/the-art-of-emotion-normans-3-levels-of-emotional-design-88a1fb495b1d (As interpreted by the original concept of Donald Norman Emotional design)

4.3 Human and packaging interaction design

A study undertaken by Hurley, Galvarino, Thackston, Ouzts & Pham (2013) explored the interaction between packaging and users. By uniting the physical characteristics of the package, such as its size, colour, material and pattern,with the emotional attributes of the user, such as pleasure,

special feeling for a certain way of using the product, formed a positive reflective appraisal. Moon Sun-Hee's Medi Flower Fig 33. shows how creative pill packaging design can encourage users to interact with the product by considering the shape of the packaging to appear as a flower rather than a dull row of capsules. The number of petals could be modified to reflect the duration of a course of drugs, thereby encouraging patients to complete the course.

Figure 33: Moon Sun-Hee's Medi Flower. Retrieved 20 August 2019 from https://thedieline.com/blog/2009/12/14/medi-flower.html

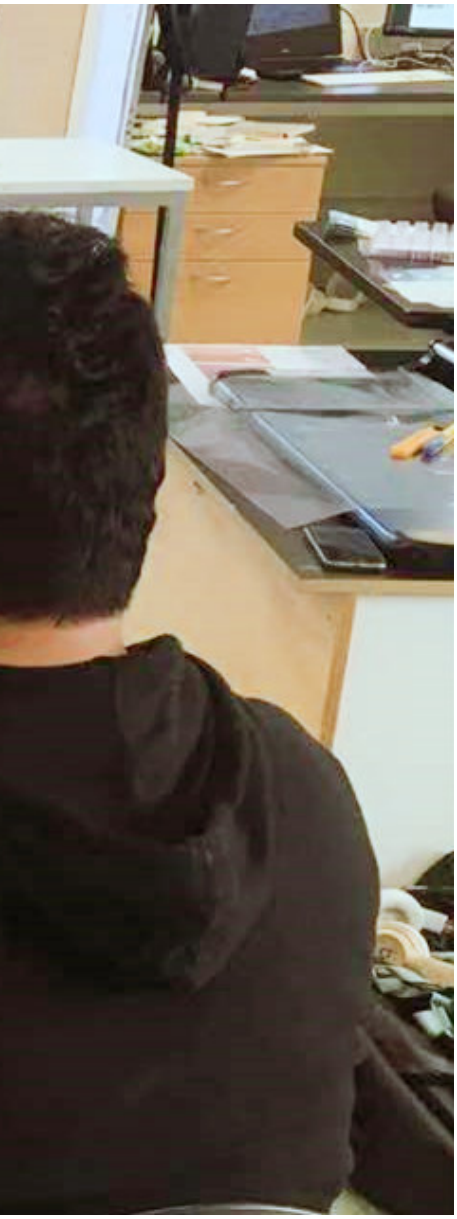
4.4 Summary

User experience design encourages drug packaging design to optimize the user's medication experience, as well as guiding the user to take the drug properly by integrating the pill packaging information. The appearance of the product is used to attract users by using the medication as design elements through different shapes, different colors and materials. This enhances the interactive relationship between users and the product to optimize engagement and affect a positive experience for the end user.

Chapter 5.0

Figure 34: User interview. Photograph by author (2019).

Market research approach



This section is divided into two parts. In the first part, a human-centred approach is used to understand users' needs and identifying the interaction between users and products. The second part uses interviews and observation to study users' usage habits to determine the issues faced by users using pill organisers. The interviews with professional pharmacists and packaging design experts are summarised. The product-centred journey map and personas are produced through user visits and synthesis.

5.1 Human-centred design approach

The focus of human-centred design is to increase the usability of the product or service, making it more relevant and meaningful to the user's life. The purpose is to understand the user, and their needs and wants. By being sympathetic to this, a strategy for design and evaluation can be established.

A focus of this research project is therefore to optimise the usability of pill packaging based on the user's needs and wants. According to the WHO, in developing countries, the proportion of medication nonadherence is about 30-50%, and in developing countries, it can reach 70% (Brown & Bussell, 2011).Over half of American adults are nonadherent, leading to annual avoidable health care costs of hundreds of billions of dollars (Zullig, Granger, & Bosworth, 2016).

The younger the user's age, the worse the medicine compliance. In 2013, the long-term study of drug compliance and clinical outcomes in patients with type 2 diabetes showed that of the 2,334 patients sampled in Southern California, younger patients had poorer adherence (An & Nichol, 2013). In a study of unintentional nonadherence to chronic prescription medications, respondents in the 40-49 age group were almost twice as likely to be nonadherent compared to those over 70 years old (Gadkari & McHorney, 2012).

Taking multiple drugs at the same time is also a reason for increasing medication nonadherence (Costa et al., 2015).

5.1.1 The Target Market

The target user in this research project is a nonadherent adult who takes multiple medications a day for a period of time. The target user for this study is between 25-50 years old. The research indicates that these users would most benefit from a product that is designed to remind them to take medicine day-to-day, as they are more likely to forget to take medicine on time.

5.2 Primary market research methods

The research process consisted of four methods:

- Interview lead users
- Observation
- Journey mapping
- Persona development

5.2.1 Interview lead users

The main purpose of the interview is to let the user express the demand clearly.

1. Record the problem and experience of the respondent's product use through the access of the guiding problem.

2. Through interviews, explore the problems that target users face when using products, and discuss how to increase product availability and optimize user experience by communicating with users.

In this project, a lead user is defined as one who uses pillbox products, such as a blister pack or a pill organizer. Seventeen users, aged 25-50 were invited to the interview. Five of them were pharmacists, four consumers used a pill reminder; eight of the interviewees were pillbox users.

	Lead users	Users	Retailer (Pharmacists)
Pill organizer	5	3	5
Pill reminder	2	2	
Total	17 interviewees, 12 of them used pillbox or related products,		
Duration	Activity: 0.5 hours – 4weeks Oct.2018 Follow-up: 0.5 hours – 4weeks July.2019		
Physical requirements	Notebook, post note, photo camera Agreements (consent and confidentiality agreement)		
Questions	• When and why do you use this type of pill packaging product? • What do you like about the existing products? • What do you dislike about the existing products? • What issues do you face when using this product? • What improvements would you make to the product? • How do you feel about this product?		

Table 3. Leader users interview

Detailed data analysis form attachments are in Appendix 1. The results of the user interviews reveal some common themes.

Findings:

- The reason users choose to buy weekly pill organizers is that they think that using this product can help them take medicine, but the process of restock pills each time is hassle, so they stop using it.

- Users generally believe that the existing product design style is old fashioned and the shape and color are aesthetically lacking.

- When users need to take different kinds of drugs,

they need to see the drug instructions and dosage usage every time, which is very troublesome when they have to take many different drugs.

5.2.2 Observation

In order to understand more about the problem of the product in use, I invited 5 users to participant in this observational study. I recorded the study using text and photos. Two of the participants use pill organizers, one used a reminder app, one used blister pack and the last used the original drug pack. See the Figures below:

Pill organizer usability issues

Figure 35. Blister pack container capacity. Photograph by author (2019).

Figure 36. One time per day pill organizer container capacity. Photograph by author (2019).

The storage capacities of existing pill organizers that have separate containers are limited.

Figure 37. One time per day pill organizer protect test. Photograph by author (2019).

Figure 38:One time per day pill organizer protect test. Photograph by author (2019).

As a pill packaging design, the main function of pill organizer should be to protect the drug from the impact of environment. However, through case studies and interviews with pharmacists and lead users, it is apparent that most of the pill organizers on the market are not tightly sealed, which causes direct contact between drugs and air.

Figure 39. Blister pack container usability test. Photograph by author (2019).

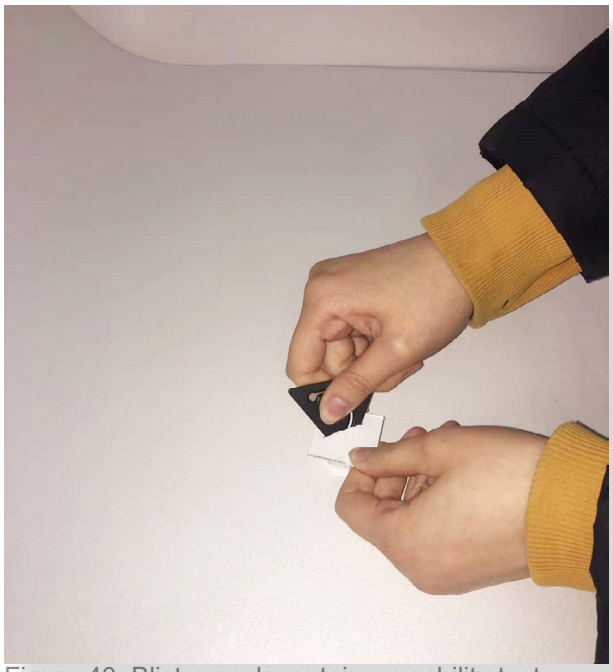


Figure 40. Blister pack container usability test. Photograph by author (2019).

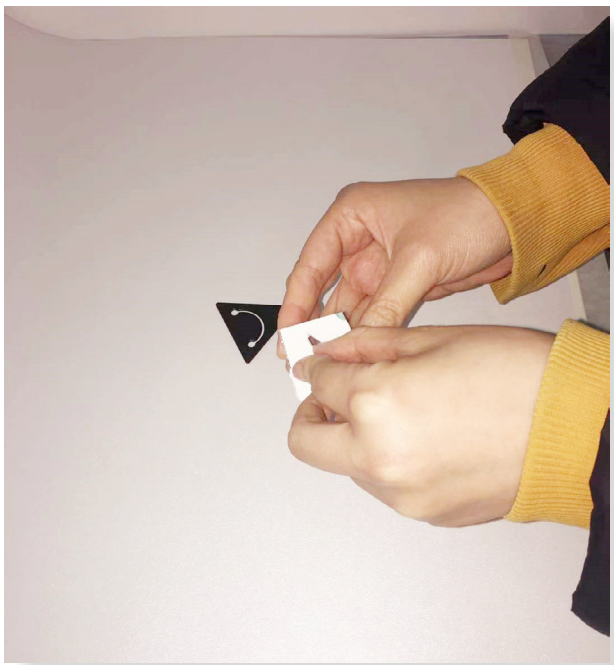


Figure 41. Blister pack container usability test. Photograph by author (2019).

Figure 42. Blister pack container usability test. Photograph by author (2019).

Figure 43. Blister pack container usability test. Photograph by author (2019).

Figure 44. Blister pack container usability test. Photograph by author (2019).

By observing pharmacists and users with blister packs, it was clear that the blister pack and the lid of the blister pack are glued together tightly, making it difficult for users to tear the container surface in some cases. And even though there is a perforation around each unit, it is still difficult for the user to tear it apart. This means they have to resort to using tools to open the seal of the blister pack.

Pill label issue

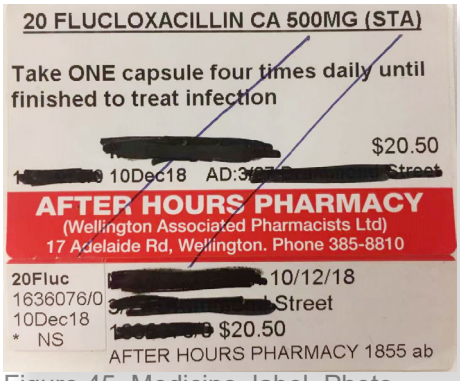


Figure 45. Medicine label. Photograph by author (2019).

Findings:

There are many problems with the existing medicine label. All the information is printed on a piece of small paper, which is not easy for the user to read. The content contains the drug information (such as name, quantity, dose, expiration date, administration instructions), pharmacy information (such as pharmacy name, address, telephone number) and patient information (including patient name and address). When users need to take multiple drugs, each label seems to be similar and contains complicated information, requiring users to spend more time extracting valid information.

5.2.3 Journey mapping

Based on the analysis of the results of the user's interview and observation, two product-centered journal maps were made - an original pill packaging centered journal map and a blister pack centered journey map. These start at the beginning of the action when the user obtains the medicine from the pharmacy to the end of the action when the user takes the medicine. Through the journey map of two different products, this paper analyses the problems of different products in the process of users' use, and improves these problems to improve user experience.

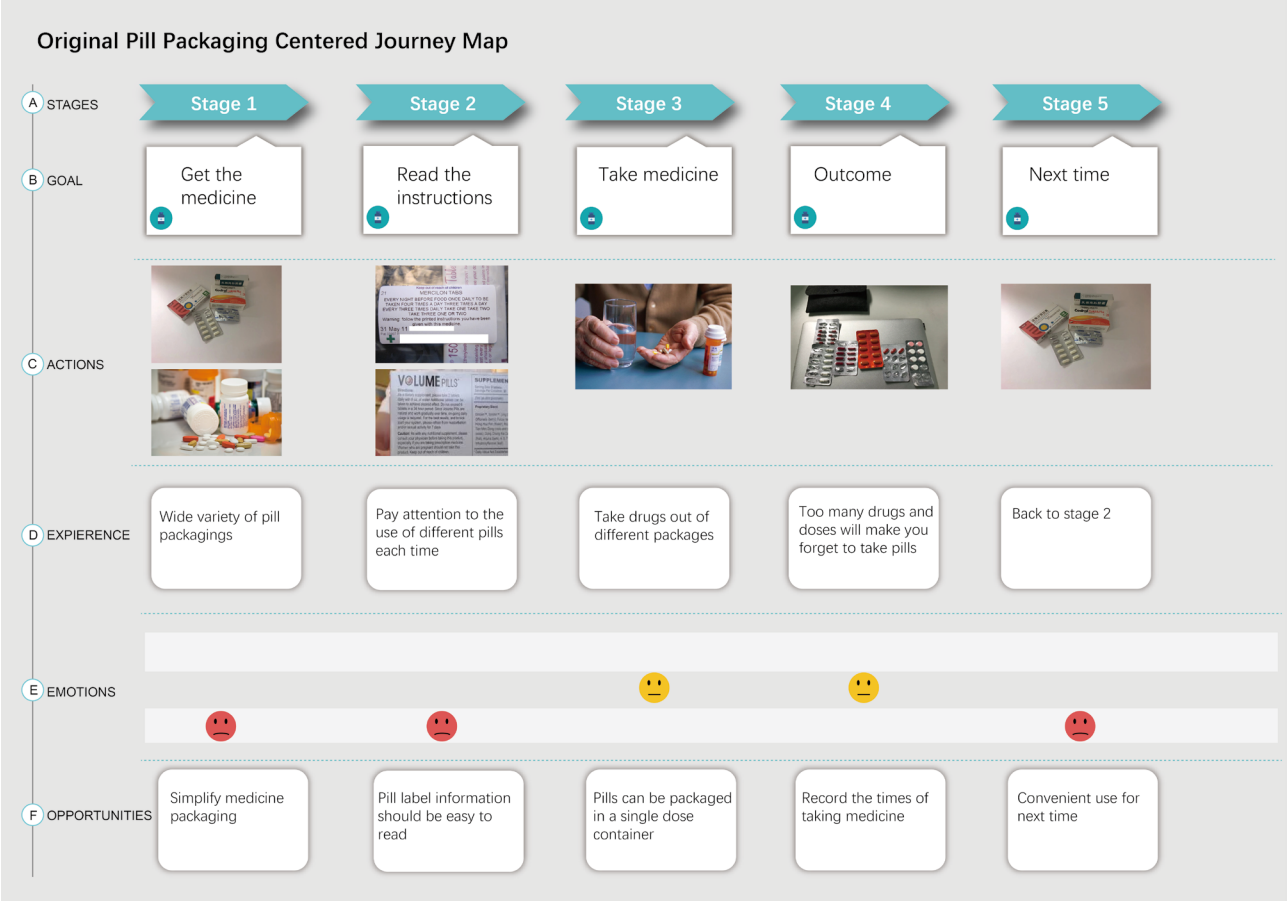


Figure 46. Original pill packaging centered journal map. Photograph by author (2019).

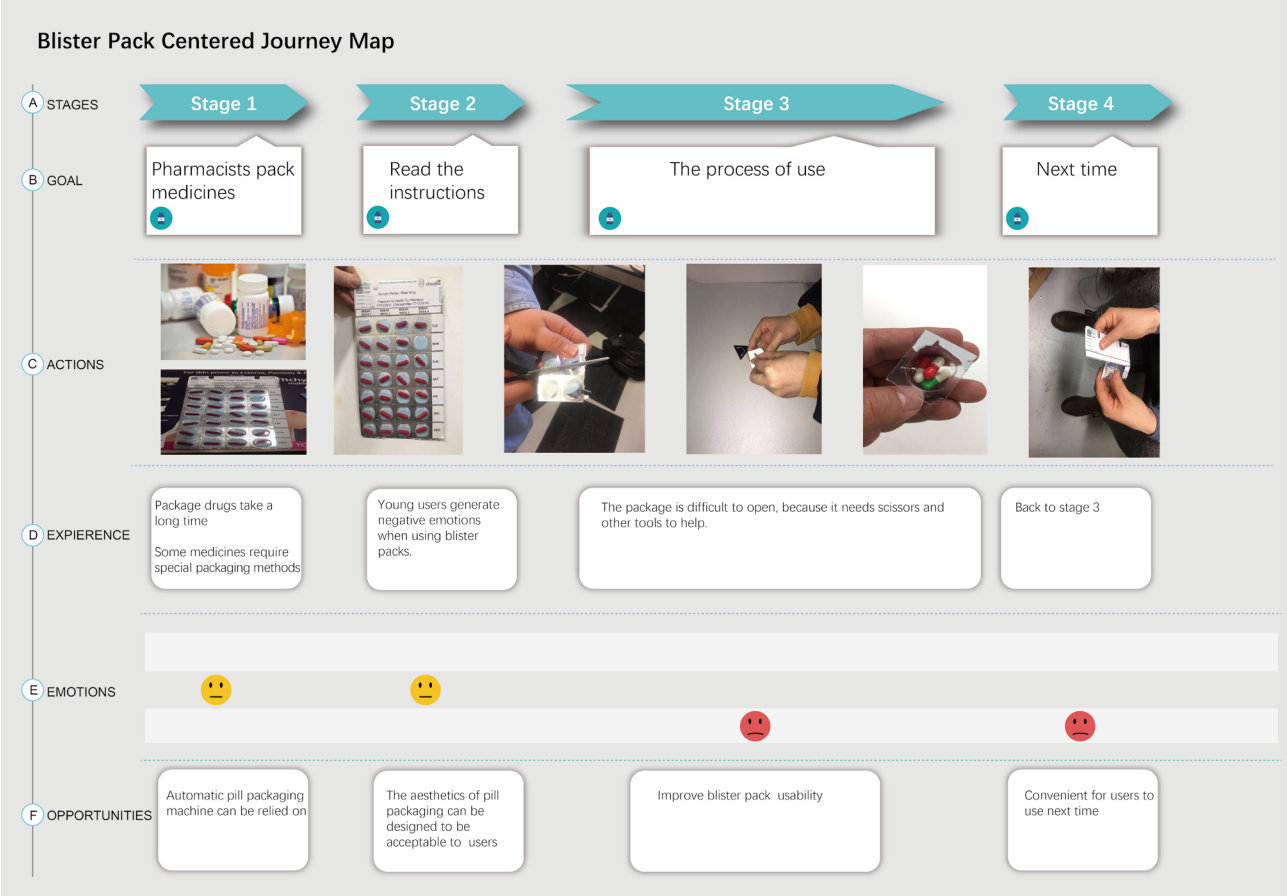


Figure 47. Blister pack centered journey map. Photograph by author (2019).

Findings:

By using the Journey Map it shows that the user's current medication experience is not ideal. Each time a user need medicine they need to re-open a different pill package, remind themselves of the dosage and usage interaction.

5.2.4 Persona development

These are representational characters envisioned by the researcher based on characteristics of user profiles. Personas help bring the target group closer and truly consider the practicality and diversity of products in the design process. The scene construction, personas and contact points form an important design mind map to guide pill-packaging design, and develop products and services to meet the needs of target users. I made two persona models based on the information collected through the interviews with pharmacists and users. These personas were then used as reference profiles in concept design and development.

PERSONA 1

Jim Smith

Name

45	M	Owner of a print office in Wellington, NZ
Age	Sex	Occupation

Married, 1 son	New Zealand
Marital status	Nationality

Due to skin infection, Jim needs to take three different medicines twice a day, with three pills each time. Pills should be taken together with food.

Mediicine information

Jim is a printer. Because of an accident that caused his wound to become infected, he needs to take antibiotics. Jim was very healthy before and didn't have the habit of taking pills, so he often forgets to take his own medicine. He marks reminders on his own schedule every day. But he will still forget. Because of that, he does not take antibiotics continuously, and the wound infection is getting more serious.

General description

Figure 48. Persona 1 development. Photograph by author (2019).

PERSONA 2

Jane Lee

Name

36	F	Project manager in a travel company, NZ
Age	Sex	Occupation

Married, 2 daughters	New Zealand
Marital status	Nationality

Jane suffers from stomach issues because of busy work.she needs to take two types of pills,three times a day for a week

Mediicine information

Jane is the mother of two daughters. She is a project manager at the travel company. Because she often needs to work overtime and also needs to take care of the two children, Jane's health is not very good. Sometimes she even needs to take some medicines regularly. Jane's work is very busy, and she often forgets to take medicine. She used to use a weekly pill organizer, but gave up because she needed to restock the pills when it runs out.

General description

Figure 49. Persona 2 development. Photograph by author (2019).

5.3 Summary of primary research insights

The following table summarises the key outcomes from the four research methods discussed.

Product form	The shape is dull, the lines are blunt and the proportion of the products is not coordinated. Ergonomics: The product is too big to be portable The capacity of some products is too small to meet the demand for multiple drugs. The product is made of simple plastic material and looks low. Product color looks cheap
Way of use	The pill box is not easy to open Poor sealing, not able to protect drugs
Packaging interface	Medicine label interface information is too complicated Lack of information guidance, it takes time to distinguish effective information in the reading process
Feeling	Lack of emotional design, some products give users an anxious feeling Most products make users feel vulnerable and cause psychological stress

Table 4. Key findings from primary research

5.4 Contribution of findings to development of design criteria

Easy to use

1. Protection: Pill packaging protects drugs from environmental impacts and degredation.

2. Ergonomics and capacity: A single pill container can hold the required medication and provides easily managed access, retrieval of medication and resealing.

3. Remind function: The design remind users to take medicine through a combination of form and graphic design elements.

4. Portability: The kit can be wrapped or folded to assist usability and transportation in a range of mechanisms (wallet, bag, purse, etc.)
5. Easy to open: Individual pill containers are easy to open and convient to use.

Easy-to-read

1. Design the labels, to distinguish between drug information, user personal and pharmacy information.

2. Use different colours and graphics to guide end users increasing adherence and reducing misuse.

3. Refine the content of the drug information so that users can understand the details of the drugs they take.

By satisfying the above design criteria, user experience will be improved and medical adherence will be strengthened, leading to positive health benefits through timely completion of prescribed medication.

Chapter 6.0

Figure 50: Design studio. Photograph by author (2019).

Design

The double diamond design process is used as a generic process for the iterative development and discovery of new concepts in relation to pill packaging. A continuous feedback loop between research, concept generation, and prototyping is achieved.

Figure 51: Design thinking process. Photograph by author (2019).

There are six phases in the design and evaluation of the pill packaging.

1. Concept Generation
2. Concept Screening
3. Concept Development and Prototyping Trials
4. Design Review
5. Final Design
6. Evaluation

6.1 Concept generation

The methods I used to generate concepts include mind maps, external and internal searches. The figure below shows a mind map that shows my early consideration of the direction of the pill package design.

6.1.1 Mind mapping

Mind maps use a diagram to represent ideas, tasks, or other information linked to and arranged around a central key word or idea (De Bono, 2006). Through this device, existing pill packaging-related products, literature reviews and user analysis are combined to provide a representation of structure.

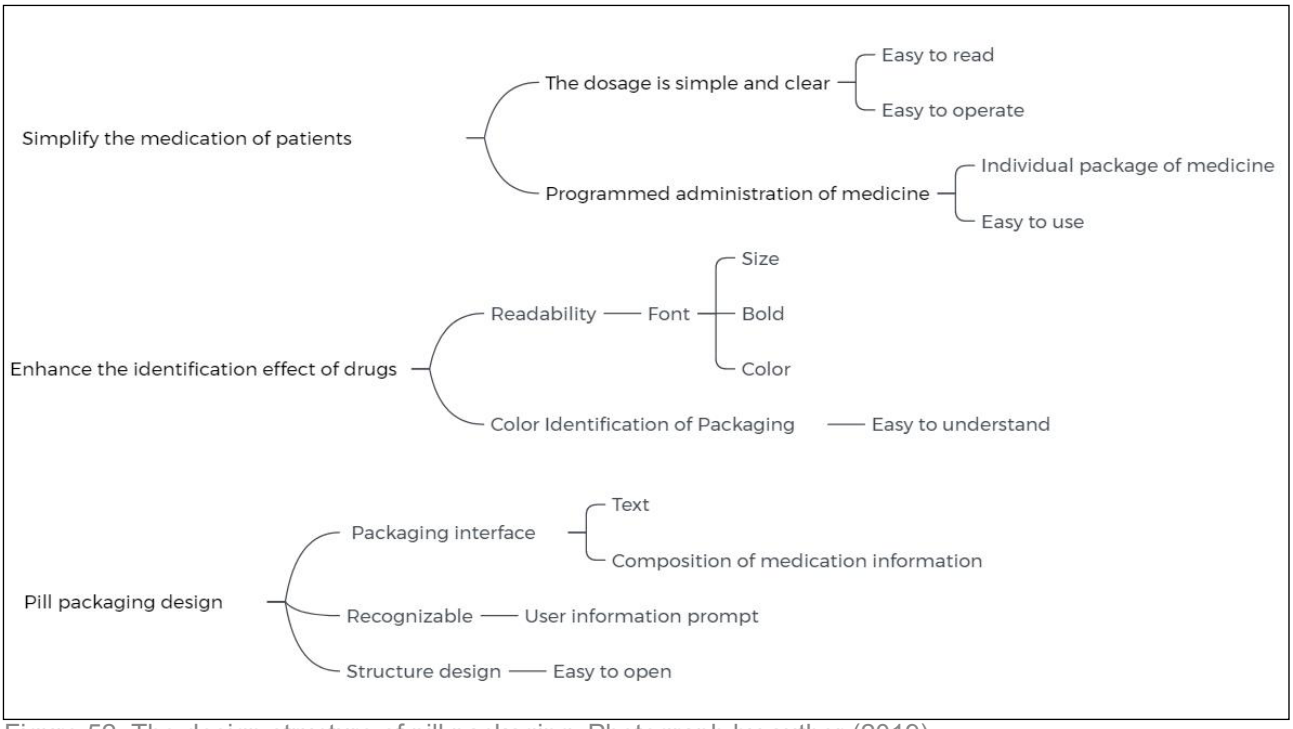


Figure 52: The design structure of pill packaging. Photograph by author (2019).

6.1.2 Search externally and internally

The design method divides the structure of pill packaging into several sub-issues; data is collected for these issues separately.

A, The working mechanism of the number on the calendar

Figure 53: Six Birth Control app. Retrieved 20 August 2019 from https://dotunimg.pw/mefertil-app.html

Figure 54: The days. Retrieved 20 August 2019 from https://hitohana.tokyo/note/25

Figure 55: McDonald's napkin dispensers . Retrieved 20 August 2019 from https://marcuspessoa.com.br/calendarios-criativos-2/

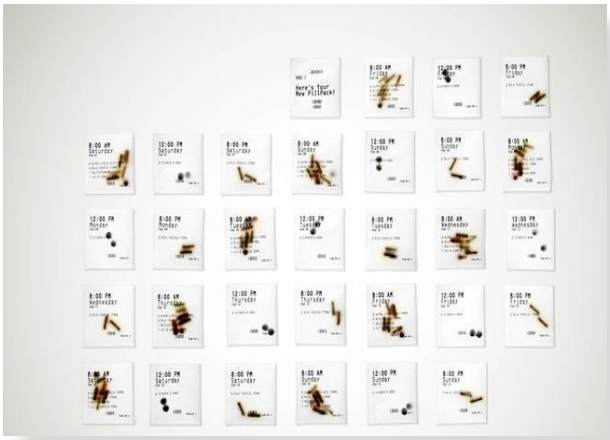


Figure 56: Pills are sorted into envelopes with the day and time each batch should be taken. Retrieved 20 August 2019 from https://www.forbes.com/sites/sarahhedgecock/2015/04/15/this-pharmacy-startup-wants-to-change-the-way-you-take-your-medicine/#20ae8117de04

Calendar packaging, especially in combination with other reminder strategies, can improve drug compliance. By collecting calendar product packaging products, it was possible to explore the impact of calendar date and digital elements on increasing the frequency of user use in product packaging

B, The way to use the packaged product

Figure 57: BAND-AID PACKAGING DESIGN. Retrieved 20 August 2019 from http://www.steph-anie-toole.com/band-aid

Figure 58:Pull! - An Easy Pill Dispenser. Retrieved 20 August 2019 from https://thedieline.com/blog/2013/12/5/concept-pull-an-easy-pill-dispenser.html

Figure 59: 8 munkar. Retrieved 20 August 2019 from https://www.packagingoftheworld.com/2015/06/8munkar-student-project.html?m=1

Figure 60: Aeroplay DIY Kite Kit Designed by Lily Li. Retrieved 20 August 2019 from https://www.buzzfeed.com/br/peggy/os-25-designs-mais-legais-de-embalagens-de-2013

The usability of a product is an important factor that affects the use of medical products by users. Therefore, understanding the different ways that different drug packaging products are opened can help to further understand the user's usage habits. It also assists users by enabling optimization of the method of opening drug boxes.

C, Creative pill organizer packaging

Figure 61: Medisure designed by John Whiteley. Retrieved 20 August 2019 from https://www.behance.net/gallery/6682403/Medical-Packaging

Figure 62: Isdinceutics Flavo-C Ultraglican, Dureo Packaging S.A.U.P.Retrieved 20 August 2019 from http://www.worldstar.org/winners/2018/medical-pharmaceutical?page=1

Figure 63: Merck Zepatier Medication Package from WestRock..Retrieved 20 August 2019 from https://www.packagingdigest.com/adherence/pmp-compliance-prompting-packaging-innovation-celebrated-170505

Figure 64: First Aid Kit designed by Kevin Harald Campean.Retrieved 20 August 2019 from https://www.packagingoftheworld.com/2016/08/first-aid-kit-redesigned-student-project.html

Pill product packaging should be convenient for users to use. Through creative design to help users take pills in order.

6.1.3 Pill container developing and capacity test

As discussed in Sections 3 and 4, users need a container that has a large storage capacity for different forms of pills. The early sketches focused on the shape of the pill container. The design concept of the pill-packaging container explores means of increasing the amount of drug stored in a single container, without increasing the volume of the overall product.

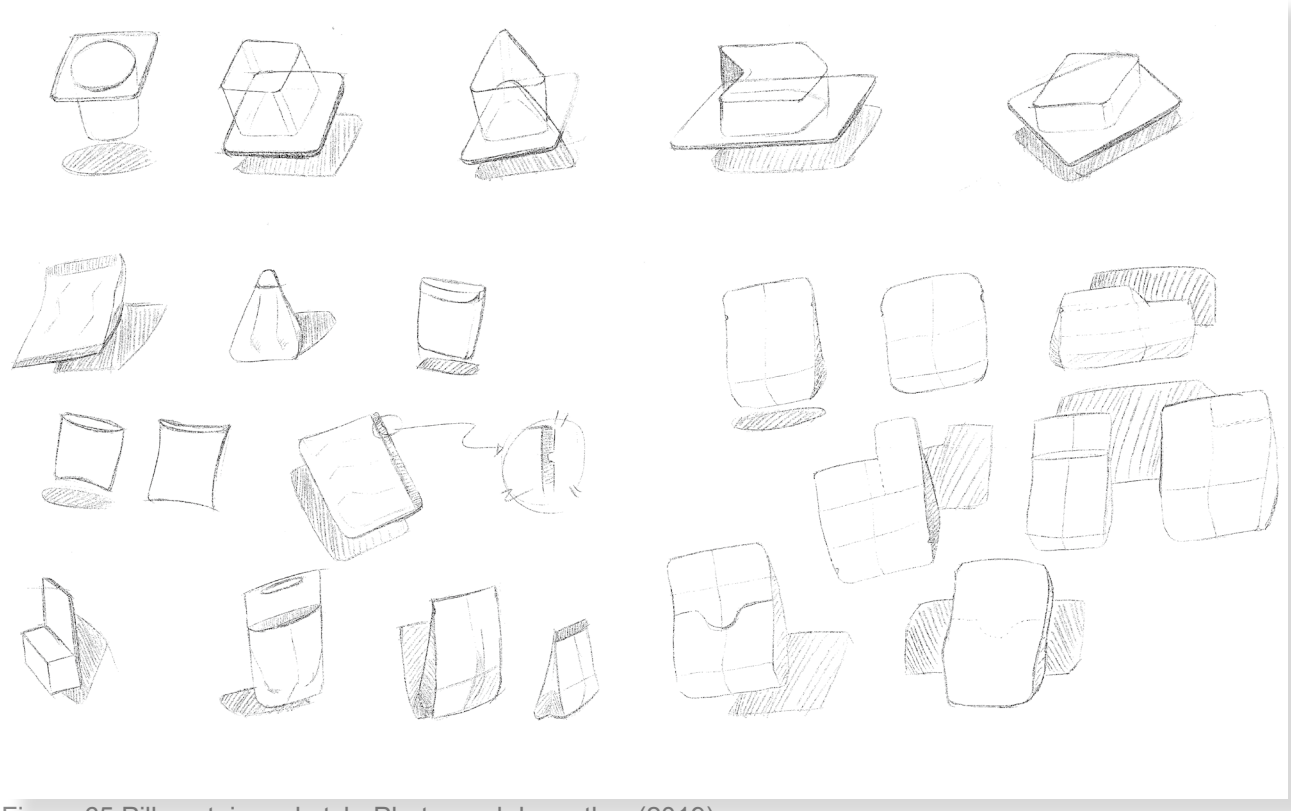


Figure 65.Pill container sketch. Photograph by author (2019).

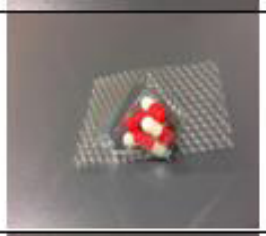
	Circular shape container	2 capsules
	Square shape container	4 capsules
	Square shape container (Large)	6 capsules
	Triangular shape container	8 capsules
	Arrow shape container	8 capsules
	Bag container	**15 capsules**

Figure 66. capacity test. Photograph by author (2019).

Based on the full size of the prototype, the capacity of a single container is tested in different forms. Capsule drugs with 1mg are selected and placed in different forms of containers for quantity measurement. Through the capacity test, the form of the pill bag can meet the needs of users.

6.1.4 Pill packaging concepts developing

Conceptual design is the beginning of the design process, used to explore a range of different possible directions before determining one or two specific options. Two main areas were explored at the early concept ideation stage:

1. Explore the use of pill packaging and the optimization of its usability based on the user's needs and wants derived from section 5 primary research.
2. Explore the impact of the pill packaging design with good printability on the user experience based on the right packaging materials.

Sketches made in the early design phase explored a number of concepts that were later applied to schematic design and design details. According to the sketch concept scheme, a real size model was used for the paper prototype.

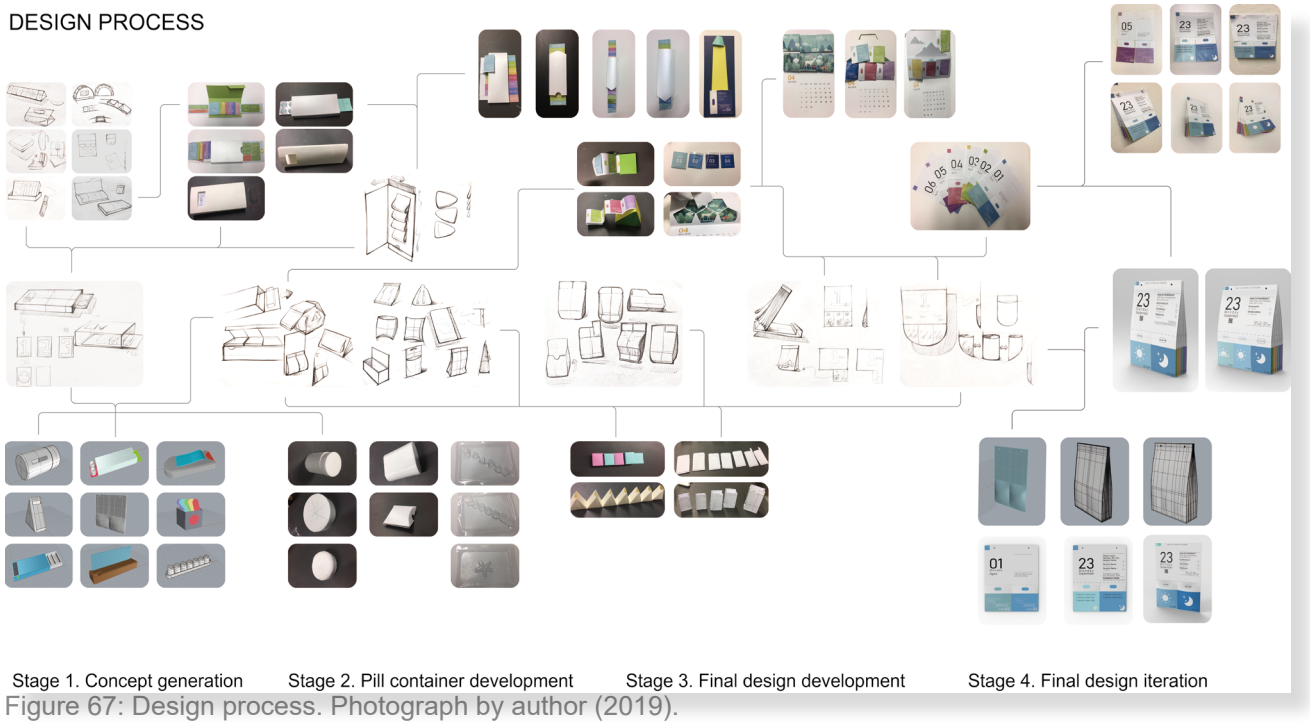


Figure 67: Design process. Photograph by author (2019).

Concept sketches started with a diagram of the pill package container; these were then combined with the calendar's working mechanism. From the conceptual sketches and models above, five concepts were selected to develop further and elaborate the design concept.

Concept 1

Figure 68. Reverse pull operation pillbox. Photograph by author (2019).

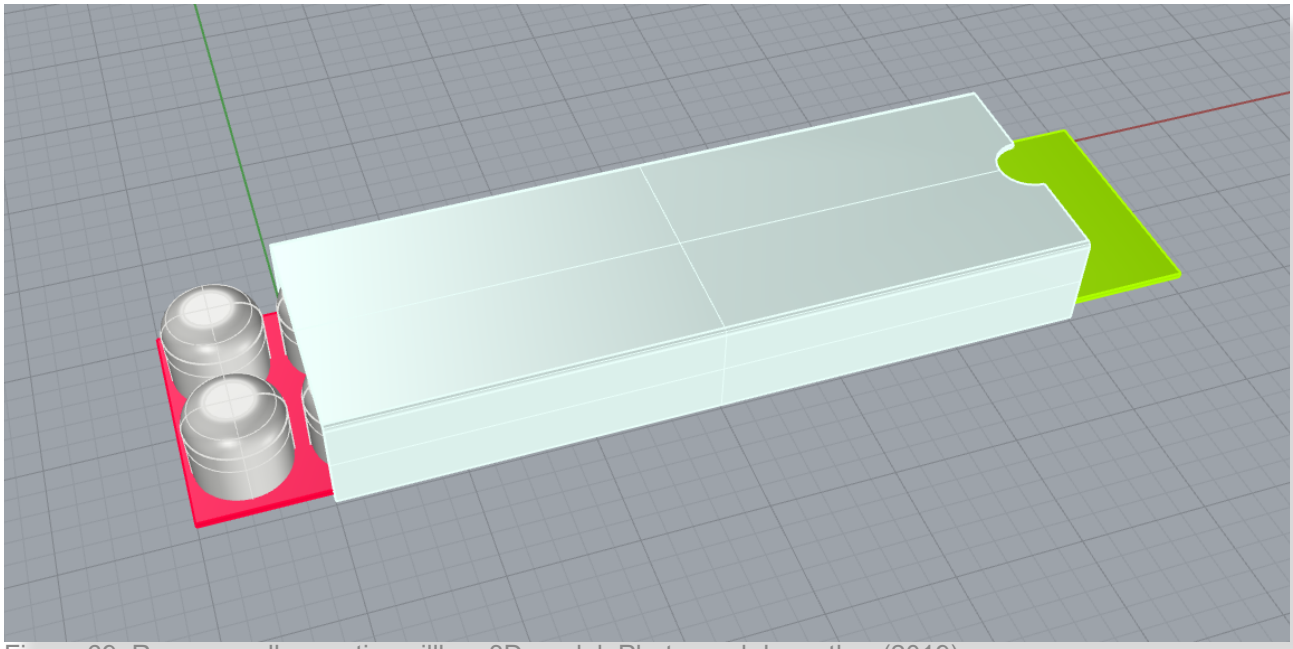


Figure 69. Reverse pull operation pillbox 3D model. Photograph by author (2019).

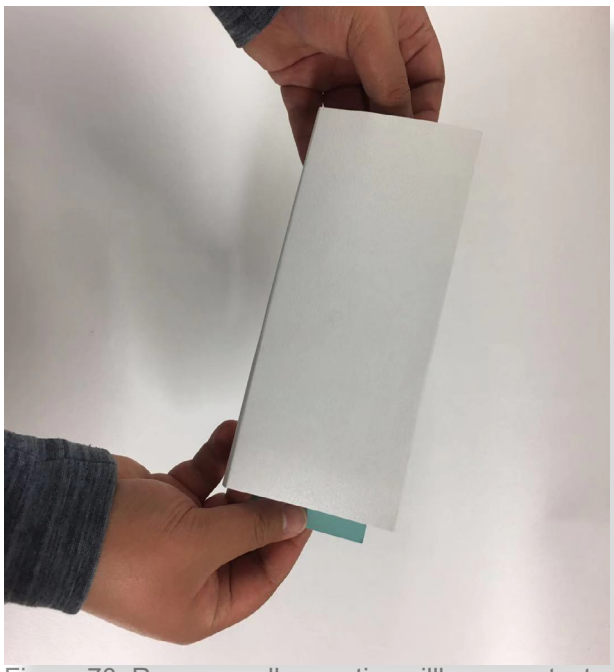


Figure 70: Reverse pull operation pillbox user test. Photograph by author (2019).

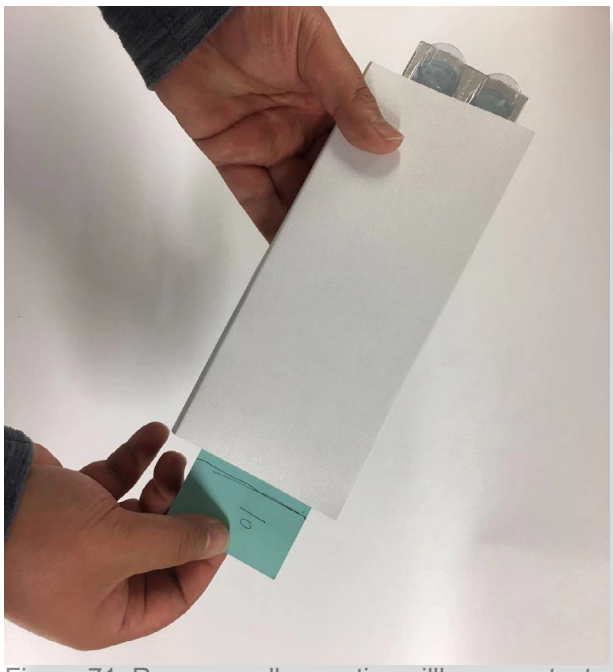


Figure 71: Reverse pull operation pillbox user test. Photograph by author (2019).

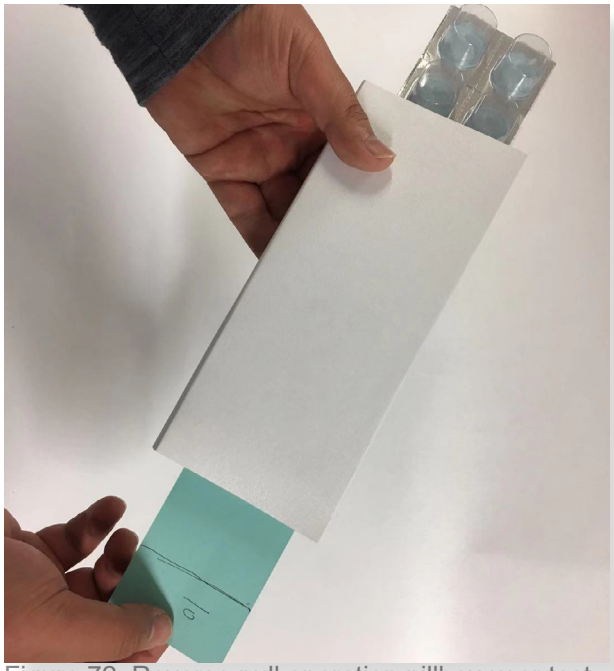


Figure 72: Reverse pull operation pillbox user test. Photograph by author (2019).

Figure 73: Reverse pull operation pillbox user test. Photograph by author (2019).

Reverse pull operation pillbox

This pillbox is designed with a special operation. Pulling out the green part on the right-hand side of the box pushes out the pill containers on the left-hand side of the product. The special design in opening method different from the conventional one is used to attract users. In addition, the green part of extraction also can display the day of week. The further the green tab is pulled out, the more of the left pillboxes appear.

Concept 2

Figure 74: Origami style pill bag. Photograph by author (2019).

Figure 75: Origami style pill bag user test. Photograph by author (2019).

Figure 76: Origami style pill bag user test. Photograph by author (2019).

Figure 77: Origami style pill bag user test. Photograph by author (2019).

Figure 78: Origami style pill bag user test. Photograph by author (2019).

Origami style pill bag

This product is the medicine bag designed with calendars, and the upper part is a weekly medicine bag; the drug administration information is printed on the medicine bag. Each time it is used and torn off, the medicine will be left with a hollow figure. When the medicine is used for the whole week, the graphics hollowed out that are left will be combined into a single picture, which is designed to be an encouraging for people not to forget to take medicine through a self-reward.

Concept 3

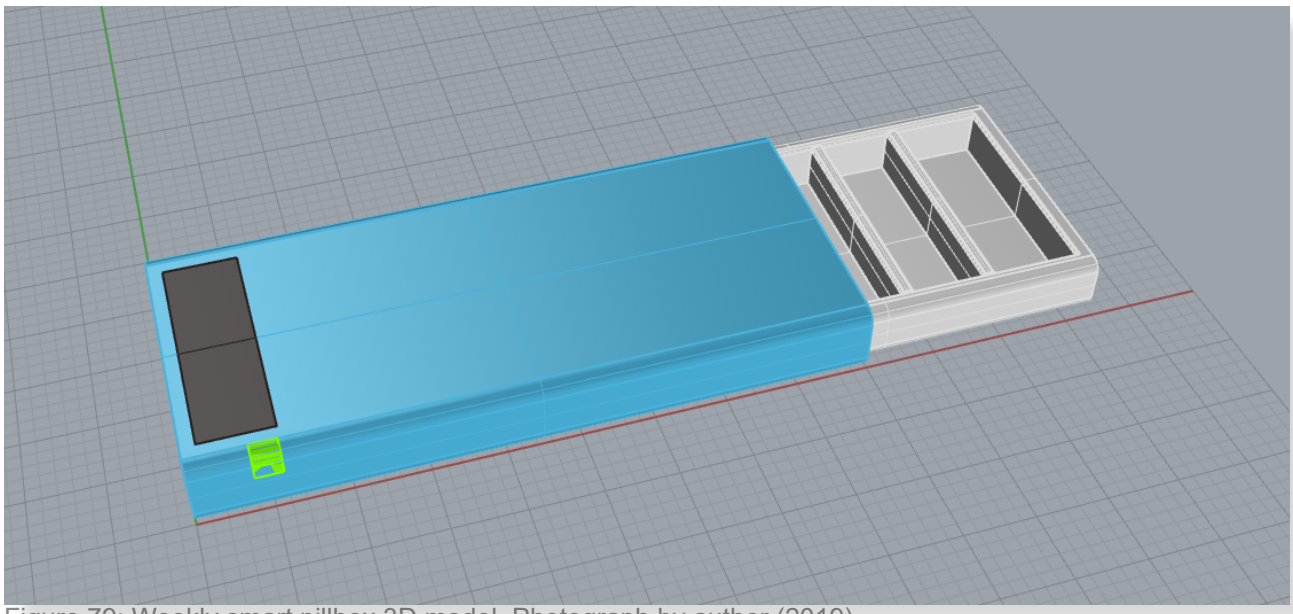


Figure 79: Weekly smart pillbox 3D model. Photograph by author (2019).

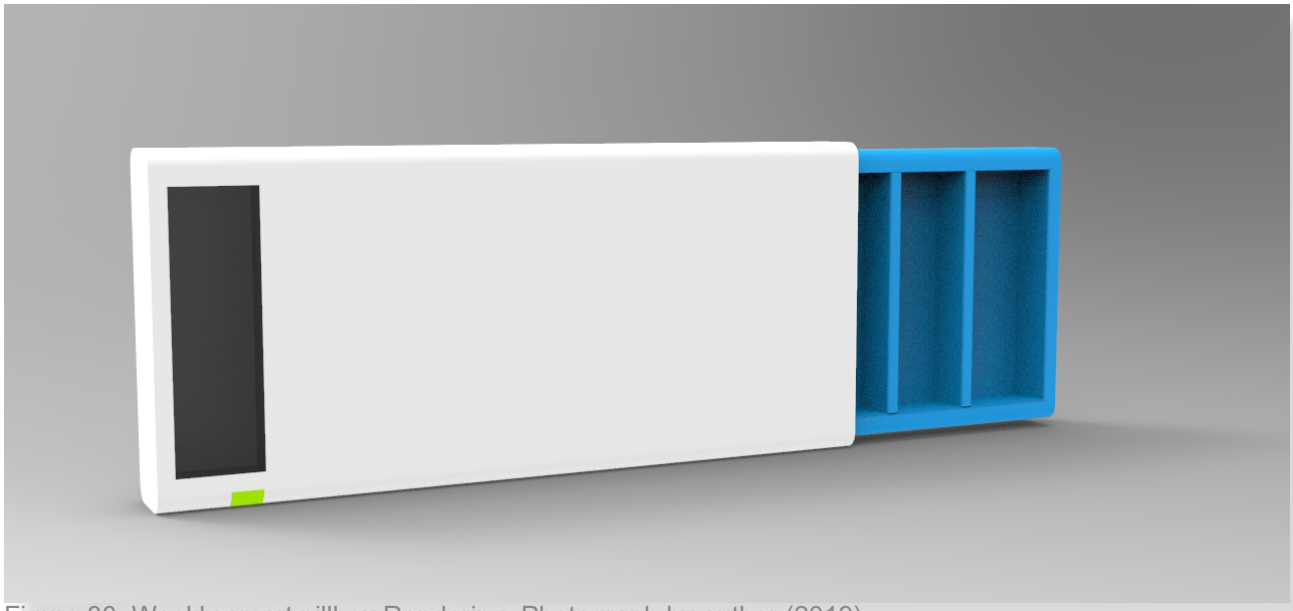


Figure 80: Weekly smart pillbox Rendering. Photograph by author (2019).

Weekly smart pillbox

The left side of the product is a touch screen that displays the time and date. With the touch screen and setting the reminder time for taking medicine, the indicator light below the screen will turn red when the set time is reached. At the same time, it will emit a reminding message out through the internal speaker within the box. The box will be divided into seven tablet storage spaces to prepare the dose for one week.

Concept 4

Figure 81: Calendar medicine bag. Photograph by author (2019).

Calender pill bags

This product is a calendar with integral small pouches. When the user sees the calendar every day, it reminds the user to take the medicine from the integrated medicine bag. In addition, the calendar is designed to be similar to a sticky note, with the reverse side being tacky, enabling it to be pasted anywhere to make it convenient for the user.

Concept 5

Figure 82: Mood-suggestion pillbox. Photograph by author (2019).

Figure 83:: Mood-suggestion pillbox user test. Photograph by author (2019).

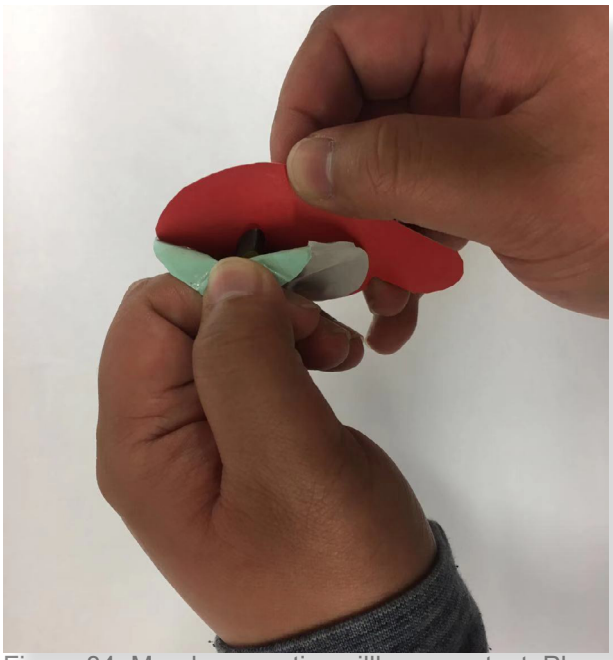


Figure 84: Mood-suggestion pillbox user test. Photograph by author (2019).

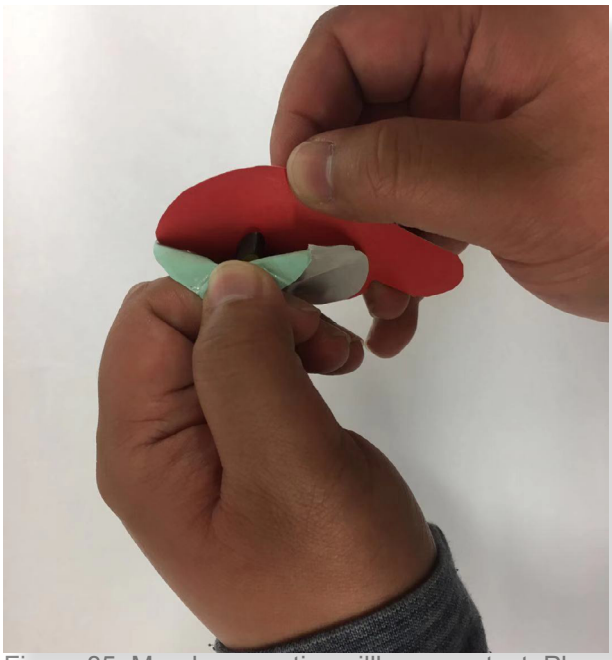


Figure 85: Mood-suggestion pillbox user test. Photograph by author (2019).

This design is designed with a circular cut out on the surface of the pillbox. Each individual small pillbox has a different expression on the surface. It aims to give a positive emotional hint, or tries to pass different expressions to influence the mood of the user when using through a series of expression changes. The highlighted part of the inner pillbox is printed with the day of week to make it convenient to be used orderly according to different colours and dates.

6.2 Concept screening and scoring

After developing the paper prototypes, the concepts were screened using the method proposed in the 1980s by Stuart Pugh. The purpose of screening is to reduce the number of concepts rapidly and improve their quality (Karl, 2016).

I chose five concepts and one reference product blister pack. Design criteria derived from section 4 informed the concepts selection process. In concept screening (Figure 6-5), the leftmost column references the design criteria. Concepts are compared to the reference blister pack. A + indicating improvement, 0 indicating similar and – indicating the concept is worse than the reference blister pack.

	1 	2 	3 	4 	5 	Blister Pack
Protect	0	-	+	+	+	0
Remind	0	+	0	+	+	0
Dose	-	0	+	0	0	0
Easy to use	0	+	+	0	0	0
Portability	+	0	-	0	-	0
Interaction	+	+	0	+	0	0
Ergonomics	+	0	-	0	0	0
Feeling	0	0	0	-	0	0
Aesthetics	0	0	0	0	-	0
Sum + Sum 0 Sum -	3 1	3 1	3 2	3 1	2 2	 0
Total Score	2	2	1	2	0	0
	1 .4 combine	2.3 combine	Develop	1.4 combine	NO	

Table 5: Concept screening

Through the comparative analysis of concepts, concept 4 and 1, concept 2 and 3 can be combined with further integration and improvement, and concept 3 can be further developed. Concept 5 was abandoned because it had the lowest score.

Concept scoring

After completing the concept screening, the two concept schemes were merged and optimised, resulting in two new concepts. These two developed concepts were scored to arrive at the final design.

Developed Concept 1

Figure 86: New calendar pill bag packaging. Photograph by author (2019).

This design has the functionality of a calendar. The upper part of the product is the area showing the date, and the lower part of the product is two separate small medicine bags. The colors for each day are different. Users can place this weekly pill bag to the working area or paste the surface of the refrigerator, so that the user can naturally notice his medicine when working or just when checking the date. The method of usage is also very simple, the user's drugs information is printed on the surface of the pill bag, the user only needs to follow the order, tear off the medicine bag from the calendar, open and use it directly.

Developed Concept 2

Figure 87: New Reverse pull operation pillbox. Photograph by author (2019).

This packaging also takes the form of a pill bag instead of a traditional container for drug storage. The user only needs to pull it out from the right hand side, and the medicine bag will come out on the left hand side. How many days' worth come out on the left depends on the length of the pull. The user can see their detailed medication information and instructions for use on the right hand side. The pill information in the medicine bag are also printed independently on the medicine bag on the left side.

Selection Criteria	Weight	Concept 1	Concept 2	Blister Pack (Ref)
Function				
Protect	15	4 60	3 45	2 30
Remind	10	3 30	3 30	2 20
Dose	5	3 15	3 15	2 10
Easy to use	10	3 30	3 30	2 20
Use in different locations	5	3 15	2 10	2 10
Portability	5	3 15	1 5	1 5
Interaction	10	3 30	3 30	1 10
Ergonomics	10	2 20	2 20	1 10
Emotion	15			
Aesthetics				
Form	5	3 15	4 20	2 10
Color	5	3 15	4 20	3 15
Material	5	4 15	3 15	2 10
Total score		**310**	**295**	**165**
5 is excellent, 4 is very good, 3 is good, 2 is fair, 1 is bad.				

Table 6

Concept scoring criteria are based on user needs and the importance of pill packaging. For example, as the main function of drug packaging design is to protect the drug, the protection function scores 15 points, and then each function is divided into 5 levels. Then after calculation, the concept of the highest total score was chosen to be final design. Because the calendar pill bag scored the highest, so it is the final design concept that was selected for further design optimization.

6.3 concept development and prototyping trials

For this stage of the design process, prototypes were created and tested with target audiences. This enabled feedback to be collected from users and issues to be identified. I used this information to modify the prototype again before retesting.

6.3.1 prototype 1 and user testing

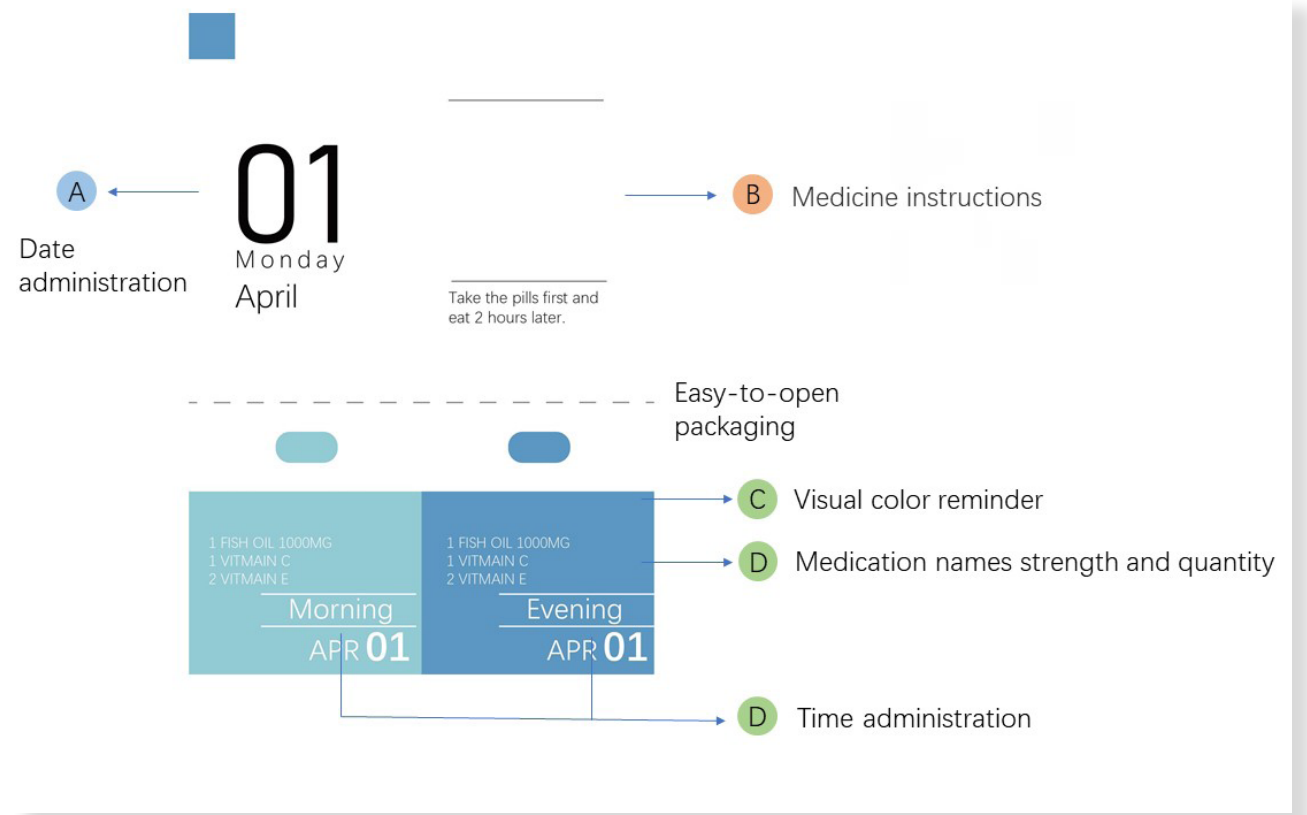


Figure 88: prototype 1 annotated map. Photograph by author (2019).

Figure 89: prototype 1 Front view rendering. Photograph by author (2019).

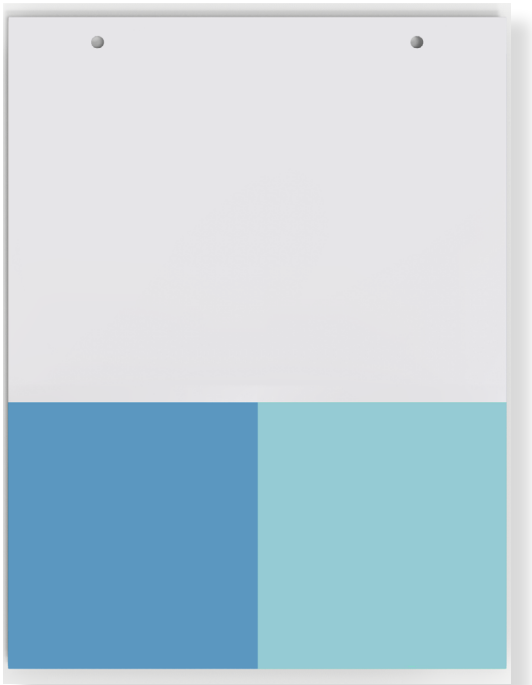


Figure 90: prototype 1 Black view rendering. Photograph by author (2019).

Design specification

In the final packing design model 1, the whole design can be divided into 3 parts.

- The left side of the model's upper half is area A, which show the date and month.

- The right side is area B, which showa the medicine instructions and other information.

- The half bottom of the model is area C, which is divided into individually packaged medicine bags.

The name and quantity of medicine in the inner bags are printed on the surface of each medicine bag, and date and time (morning and evening) are printed on the bottom right corner of the medicine bag. Users choose the needed medicine bag every time according to their needs, and tear from the whole package to use. The medicine packaging is a series of seven days a week, and the different coloured drug bags representing different days helps users identify the day quickly.

Test feedback

Figure 91: prototype 7 days pill packaging. Photograph by author (2019).

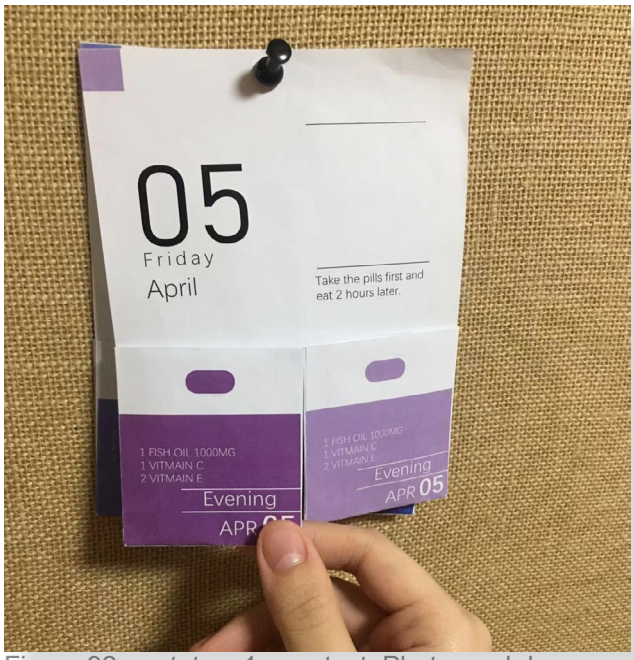


Figure 92: prototype1 user test. Photograph by author (2019).

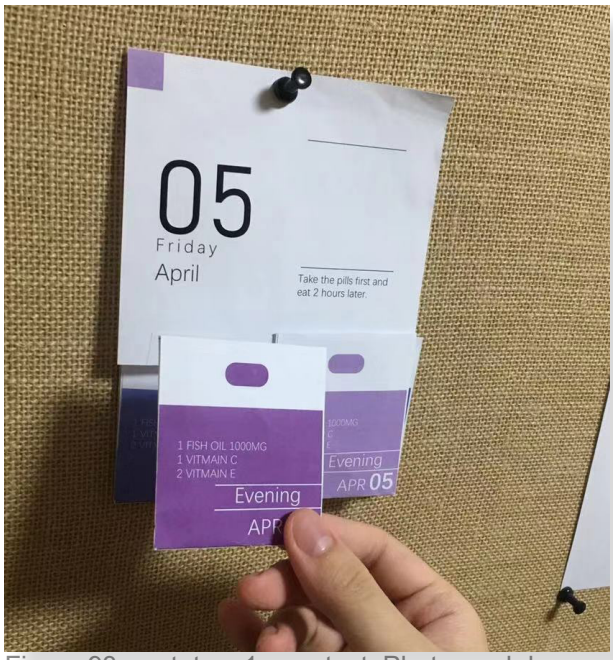


Figure 93: prototype1 user test. Photograph by author (2019).

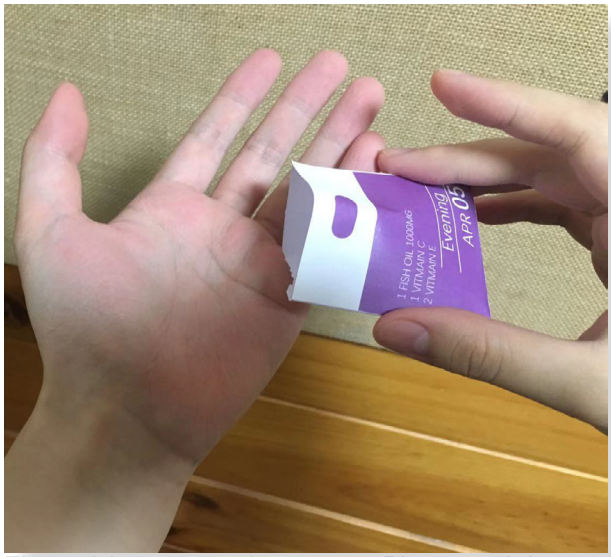


Figure 94: prototype1 user test. Photograph by author (2019).

Figure 95: prototype1 user test. Photograph by author (2019).

Users provided the following feedback:

- The bag was paste on the calendar part. Although the bag can be attached to the place where it is needed after taking it off, it will fall easily if the pill bag is too heavy.

- All drug information is printed on the part of the pill bag, so that the amount of information in the bag part is too much, and there are too many blank parts in the section B.

- The color of font on the medicine bag is white, , which is easy to mix with the background color, and it is hard to read the medicine information.

- The information of the medicine bag is a text description. Can you use symbolic elements instead of morning and evening?

- How are the entire products combined?

6.3.2 prototype 2 and user testing

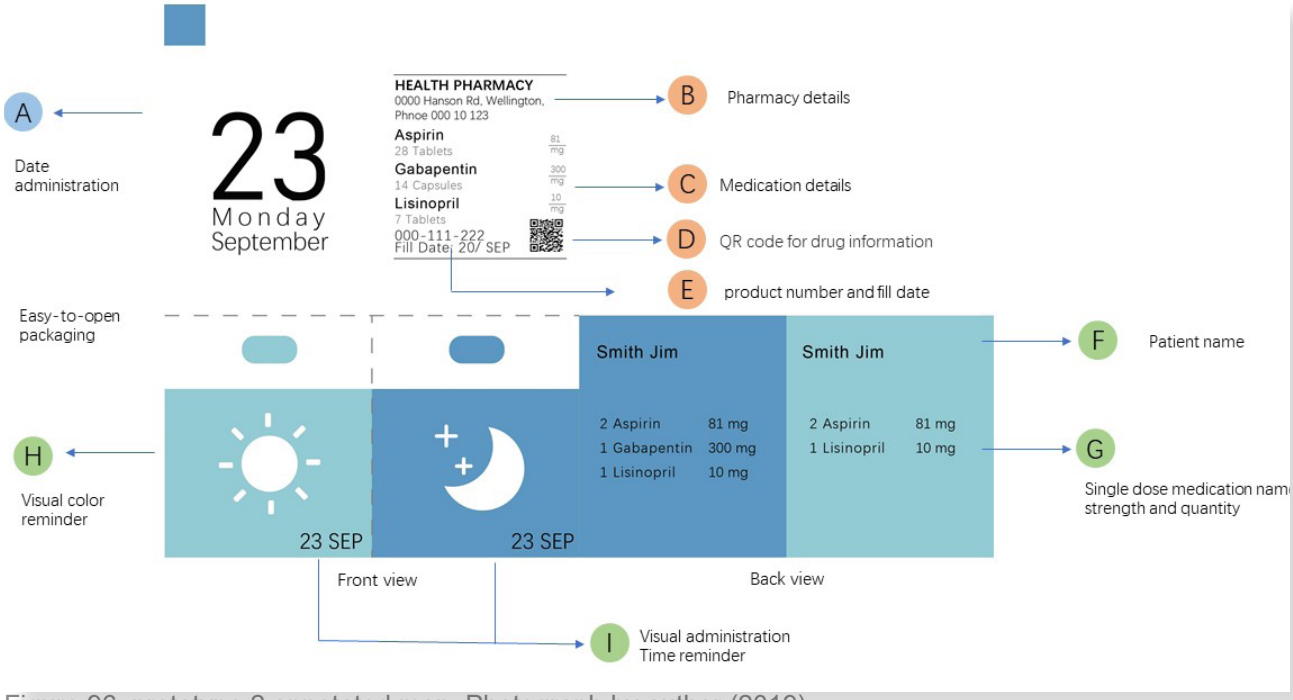


Figure 96: prototype 2 annotated map. Photograph by author (2019).

Figure 97: Prototype 2 Front view rendering. Photograph by author (2019).

Figure 98: Prototype 2 Black view rendering. Photograph by author (2019).

According to the feedback of the first user trial, the prototype was modified, such as expanding the display of the medicine information, using a black font, different font sizes and weights to distinguish the different levels of information. At the same time, the sun and moon symbols were printed in the lower part of the medicine bag to replace the text display. The bag and the calendar are combined and a perforation line was added between different medicine bags, as well as between the bag and the calendar as well

Font size test

Figure 99: Font test, Arial, size 12. Photograph by author (2019).

Figure 100: Font test, Arial, size 14. Photograph by author (2019).

Figure 101: Font test, Arial, size 16. Photograph by author (2019).

Font size plays a key role in making the medicine packaging information easy for users to read. Therefore, I tried 3 design of different sized fonts and retested it test. Although users could read the size 12 font, they preferred size 14. Size 16 was determined to be too big. Therefore, I chose size 14 as the reference standard font size of the packing design

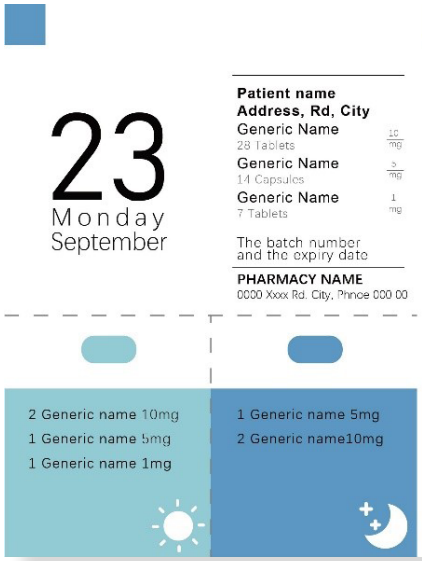


Figure 102: Typographic test, Symbol. Photograph by author (2019).

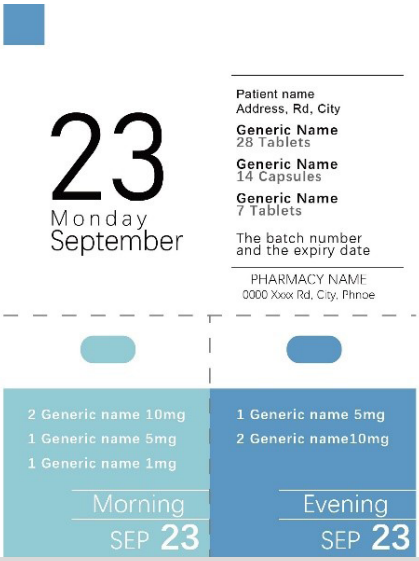


Figure 103: Typographic test, White font. Photograph by author (2019).

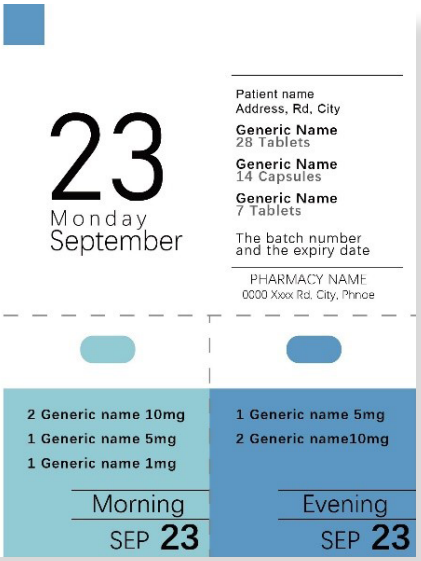


Figure 104: Typographic test, Black font. Photograph by author (2019)

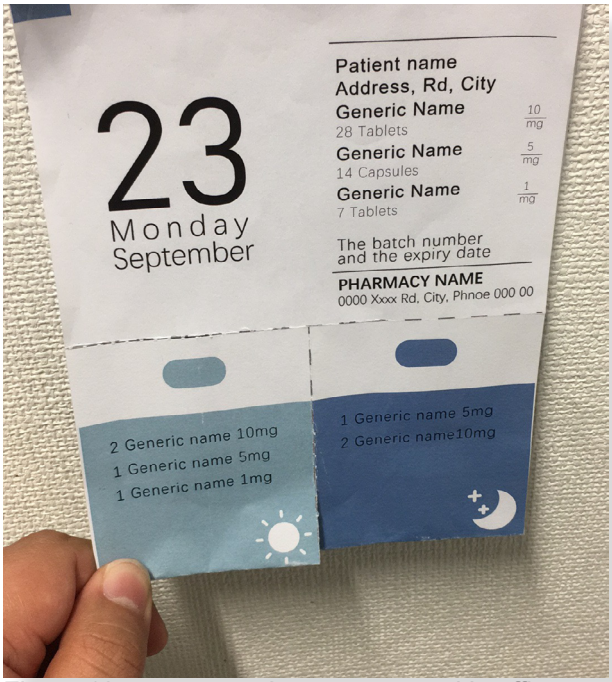


Figure 105: prototype 2 user test, used in office. Photograph by author (2019).

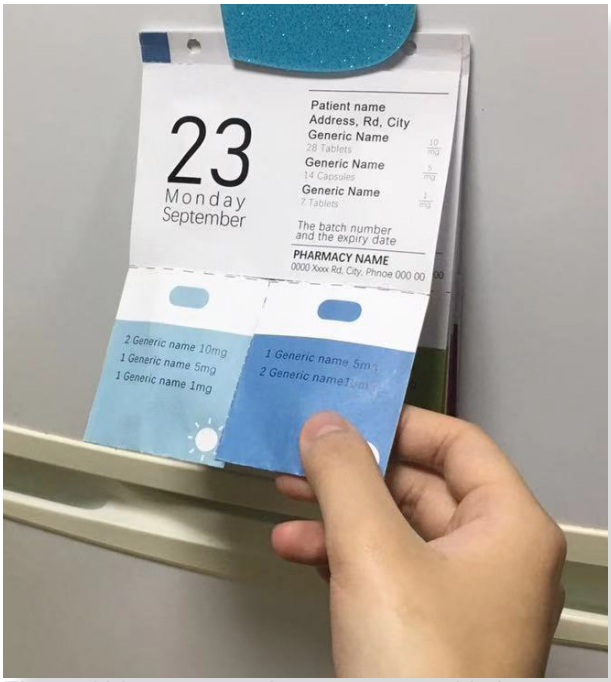


Figure 106: prototype 2 user test, used in home. Photograph by author (2019).

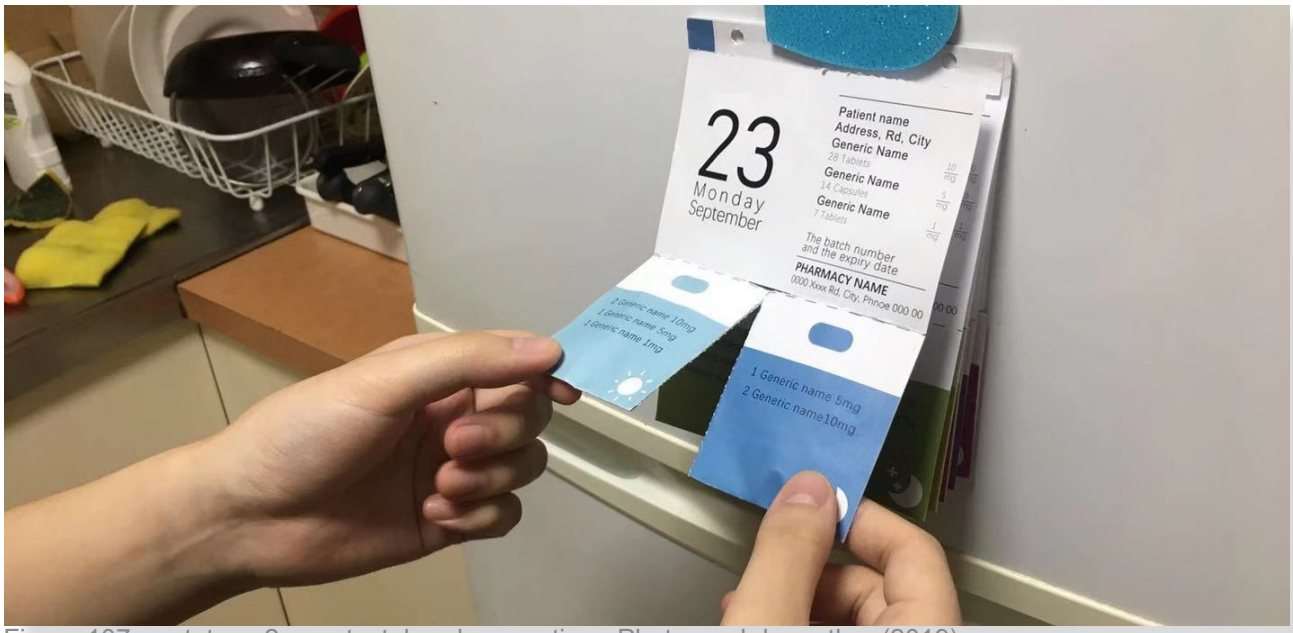


Figure 107: prototype 2 user test, hands operation . Photograph by author (2019).

Figure 108: prototype 2 user test, tear off the pill bag. Photograph by author (2019).

Figure 109: prototype 2 user test, peel the bag. Photograph by author (2019).

Figure 110: prototype 2 user test, peel the bag. Photograph by author (2019).

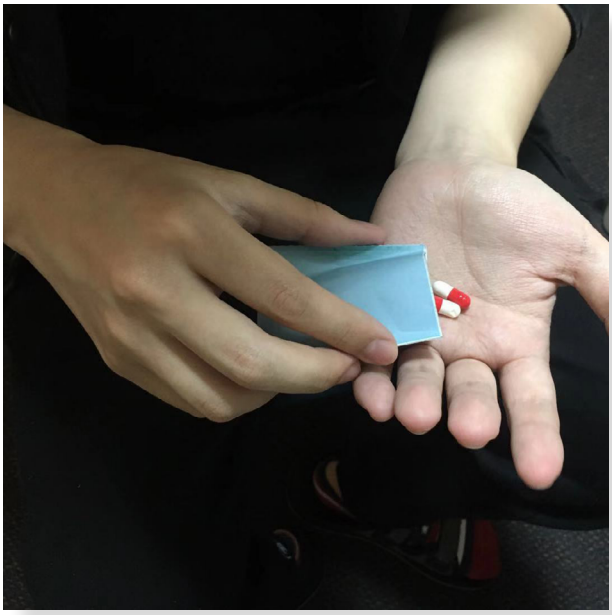


Figure 111: prototype 2 user test, take out pills. Photograph by author (2019).

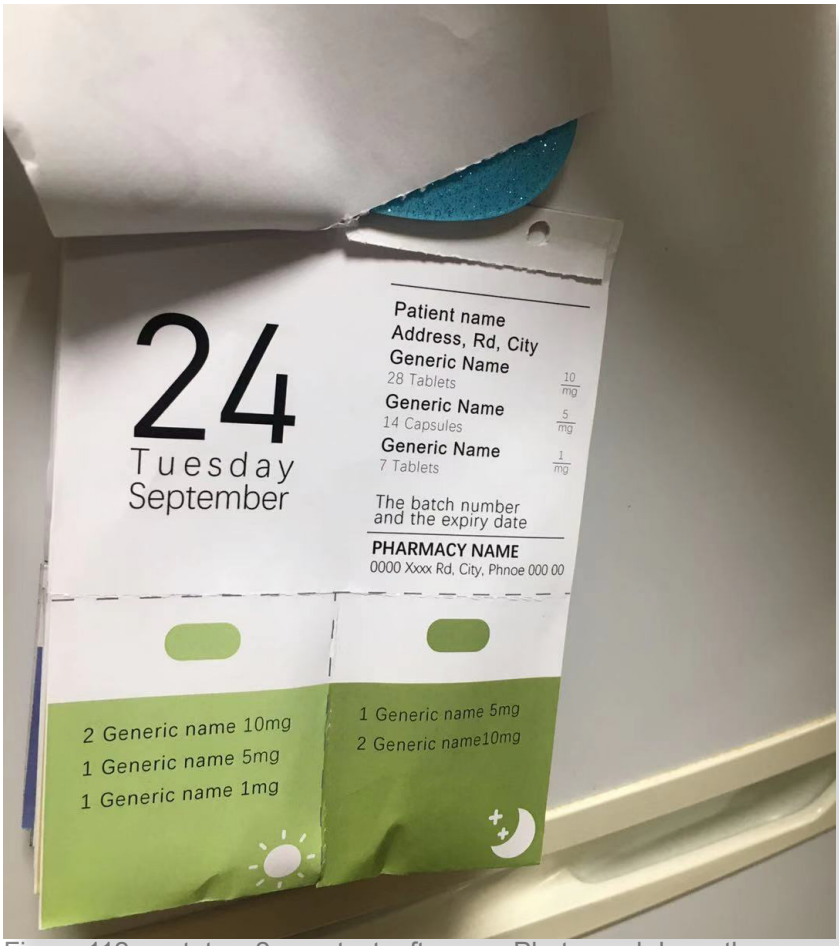


Figure 112: prototype2 user test, after use. Photograph by author (2019).

- The perforation lines are not very efficient. The medicine bags were not easy to tear apart.
- User's personal information remains on the date page after removing the medicine bag for the day. How can I protect my private information after using it?
- The overall text information of the medicine bag is too complex. Although the graphic is used to indicate different times, in relation to instructions about the sequence in which different drugs should be taken, the graphic symbols are too small.
- All the information is concentrated on the same side, making the whole product look complicated. Can some of the information be simplified?
- The medicine bags every day are attached together. How to ensure that I can easily tear off the bag after using the medicine today?
- How can I used the product if I need to take the medicine three times a day?

6.3.3 prototype 3 and user testing

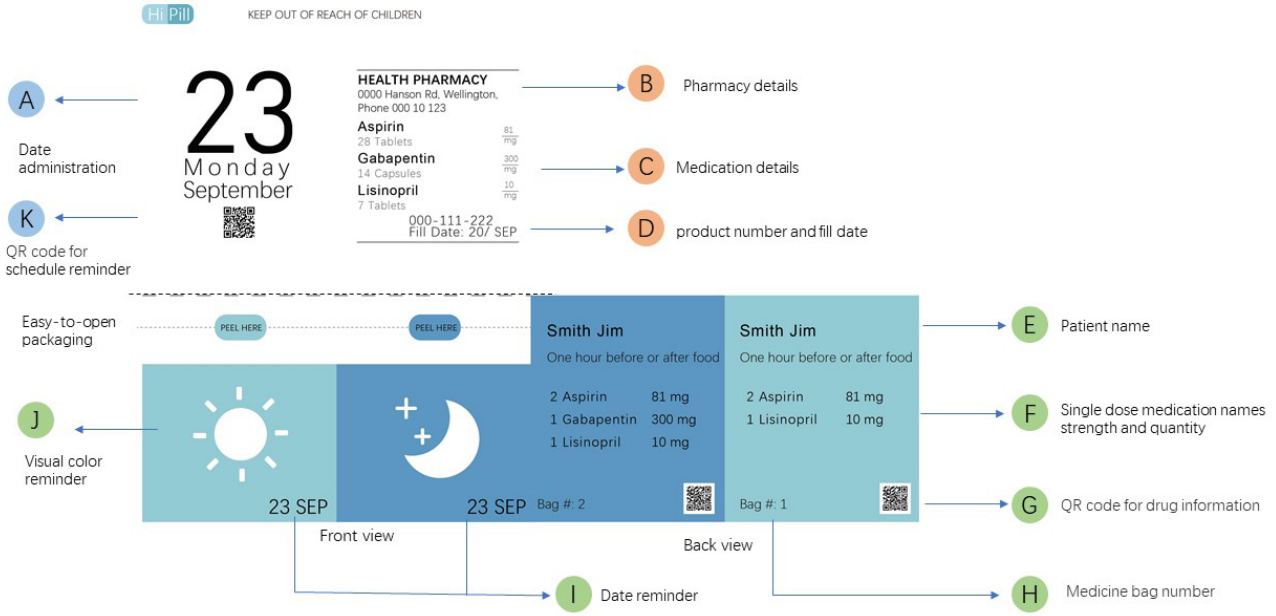


Figure 113: prototype 3 annotated map. Photograph by author (2019).

Figure 114: Prototype 3 Front view rendering. Photograph by author (2019).

Figure 115: Prototype 3 Black view rendering. Photograph by author (2019).

Following the second user trial, I improved the usability and layout of the product further. I increased the sun and moon graphics to make the user register the difference of times more intuitively. I optimised the overall information layout and put the user's name and the drug information in a single pill bag on the back of the product. In this way, after the user tears off the medicine bag, the user can view his own drug information when he needs. A QR code is added to the medicine packages, for users to gain more detailed information if required. With the user's name is at the position of the medicine bag opening, the user's name will be separated while the user open the medicine bag, effectively protecting the user's private information. To address the issue of the perforation, different types and weights of paper were tested and their performances evaluated. A customized options enables users to choose a twice a day bag or multiple times a day according to their needs.

Test feedback

Figure 116: prototype 3, 7 days packaging . Photograph by author (2019).

Figure 117: prototype 3, 7 days packaging . Photograph by author (2019).

Figure 118: prototype 3, user test, using process . Photograph by author (2019).

Figure 119: prototype 3, user test, using process . Photograph by author (2019).

Figure 120: prototype 3, user test, using process . Photograph by author (2019).

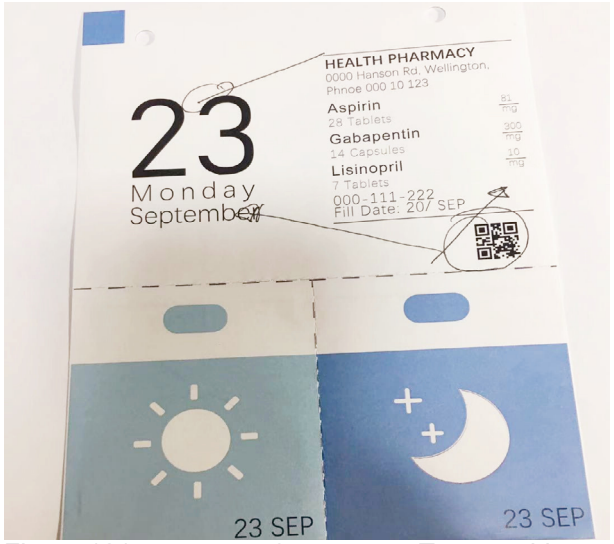


Figure 121 : prototype 3, user test, Typographic test feedback. Photograph by author (2019).

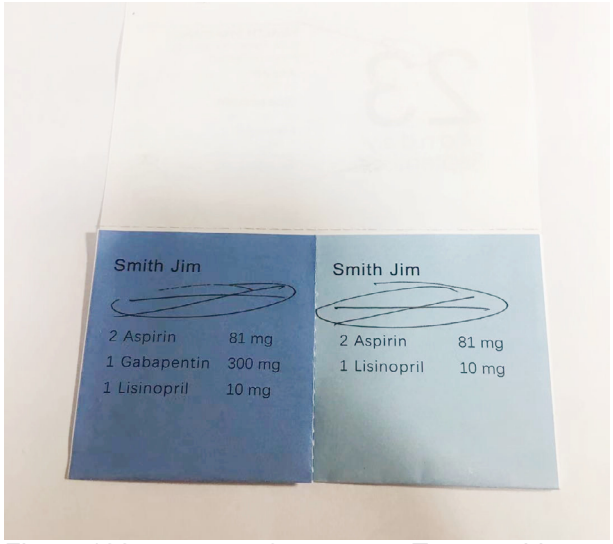


Figure 122: prototype 3, user test, Typographic test feedback. Photograph by author (2019).

Feed back included the following comments:

The enlarged graphic elements are more intuitive, telling me different times for different drugs. Moreover, I am very happy with the graphics of the sun and the moon.

Because graphic elements especially remind me of the sunny day in the weather forecast. I am very happy after seeing the whole package.

The information on the use of drugs behind could be clearer. For example, whether the medicine is taken before meals, after meals, or with food.

6.3.4 prototype 4 and user testing

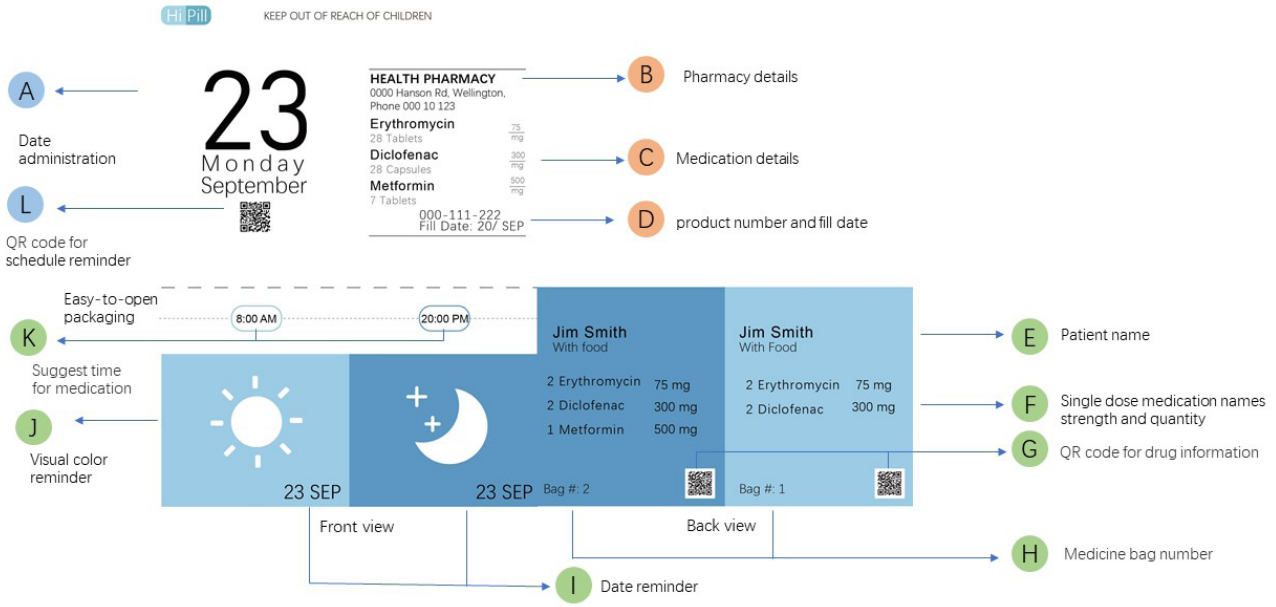


Figure 123: prototype 4 annotated map. Photograph by author (2019).

Figure 124: Prototype 4 Front view rendering. Photograph by author (2019).

Figure 125: Prototype 4 Black view rendering. Photograph by author (2019).

From the third feedback sessiopn, the QR code was shifted to under the date. A reminder function was added so that, for example, Google calendar could send users a message to remind them to take their medication. A separate QR code behind the medicine bags contains information about the drug in more detail.

Test feedback

Figure 126: prototype 4, user test, using process . Photograph by author (2019).

Figure 127: prototype 4, user test, using process . Photograph by author (2019).

Figure 128: prototype 4, pill bag before use. Photograph by author (2019).

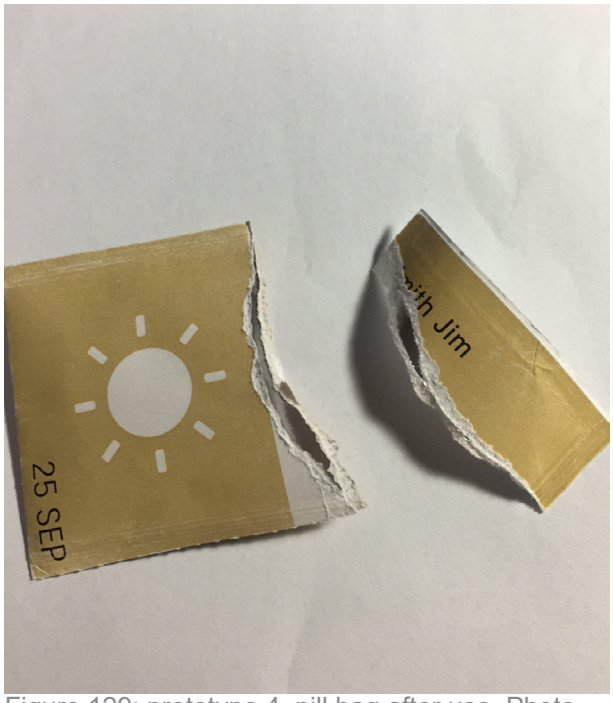


Figure 129: prototype 4, pill bag after use. Photograph by author (2019).

- According to the feedback of pharmacist, usage time of medicines can be added on the package. In this way, the interval time of taking medicines can be seen directly by users, and choose corresponding medicine based on the probable time.
- The packaging presents as convenient with key information presented.
- The function of QR code is in line with the behaviour of young digital natives.

6.4 design review

The usability of the product is improved and the overall packaging design is convenient. Pill information is easy-to-read. By designing graphic symbols, numbers and different typesetting of text, product identification is improved. By incorporating user feedback in iterative design and build cycles, the packaging design developed to meet users' needs and wants. The design aids the medical adherence to prescribed medication.

6.5 Final design: the “Hi pill” package

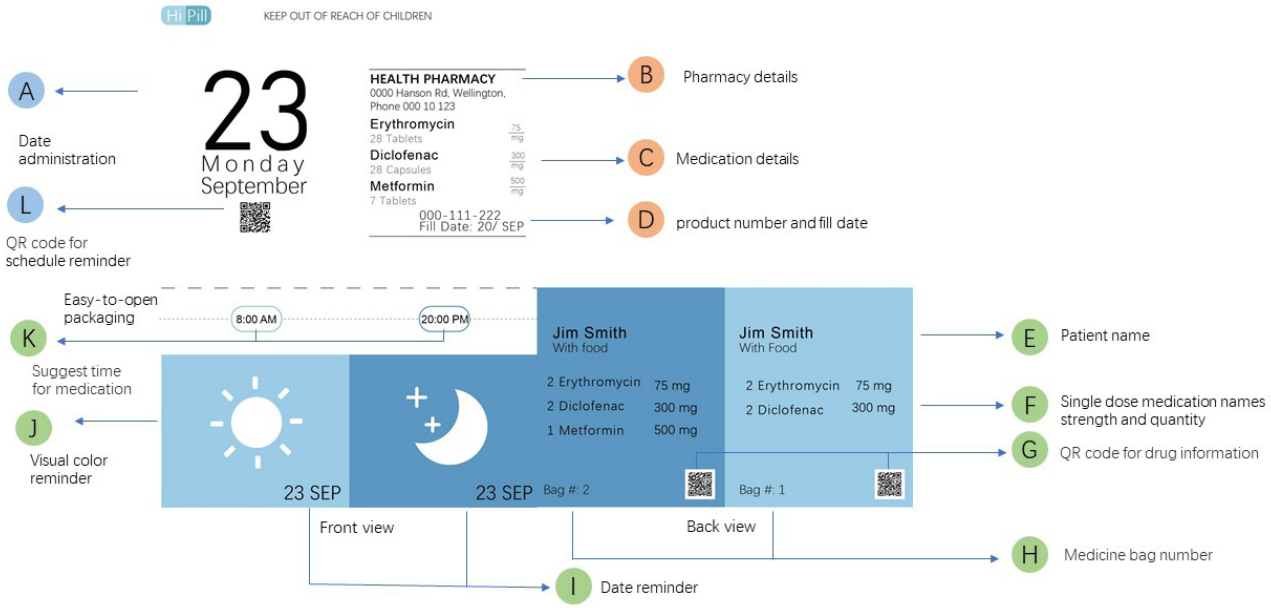


Figure 130: Final design annotated map. Photograph by author (2019).

Branding

“Hi pill” name is based on a daily greeting. Through this familiar expression “hi” the distance between the user and the product is psychologically brought closer.

The “Hi pill” package is packaged in one-week dose units, and users can choose packages to dispense either twice a day or three times a day. The medicine for each day is distinguished by different colors. The “Hi pill” package is divided into 4 sections and detailed in Fig 130.

Figure 131t view rendering. Photograph by author (2019).

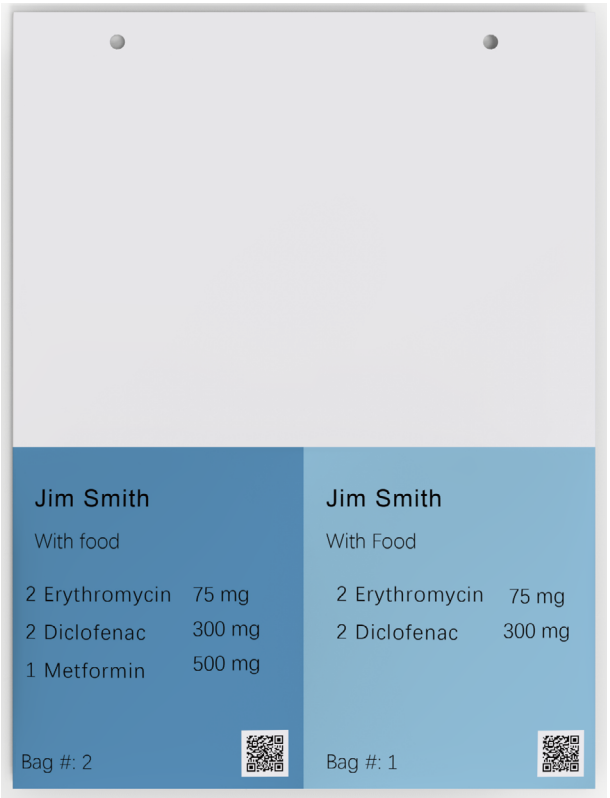


Figure 132: Final design, twice a day pill packaging. Black view rendering. Photograph by author (2019).

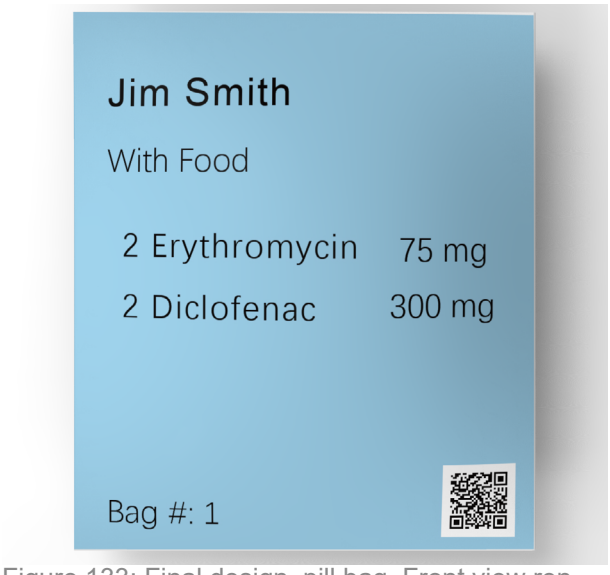


Figure 133: Final design, pill bag. Front view rendering. Photograph by author (2019).

Figure 134: Final design, pill bag. Black view rendering. Photograph by author (2019).

Section 1 indicates the date, and users can see today's date intuitively.
Section 2 is the presents the medicine name, total quantity and related medicine information.
Section 3 is the package frontage, users can tear the package bags that is needed along the perforation line.
Section 4 is the back of the pill bag. The user's name and medicine name are printed on the pill bag. The bag code and QR code are printed on the bottom of the bag so that users and pharmacists can check the detailed information of the medicine.

The top front of the package shows the time the medicine needs to be taken. Large graphical visual elements (sun and moon), allow users to identify clearly the time and frequency that they need to take the medicine. The date is printed in the lower right corner of the bag. The whole product can be customized according to the needs of users, for example, twice a day and seven days a week. The pill organizer packaging is based on ATDPS and uses aluminum foil paper as the packaging material. This protects the pill, is nontoxic, ecofriendly, easy to obtain, and has good shading and sealing properties. At the same time, the interface of medicine information is optimized, which is easy for users to understand and operate. The product adopts the calendar working mechanism, and the users can tear off the independent pill bag based on the different date, simplifying the usage method and improving their experience.

Figure 135: Final design, twice a day pill packaging. Front view rendering. Photograph by author (2019).

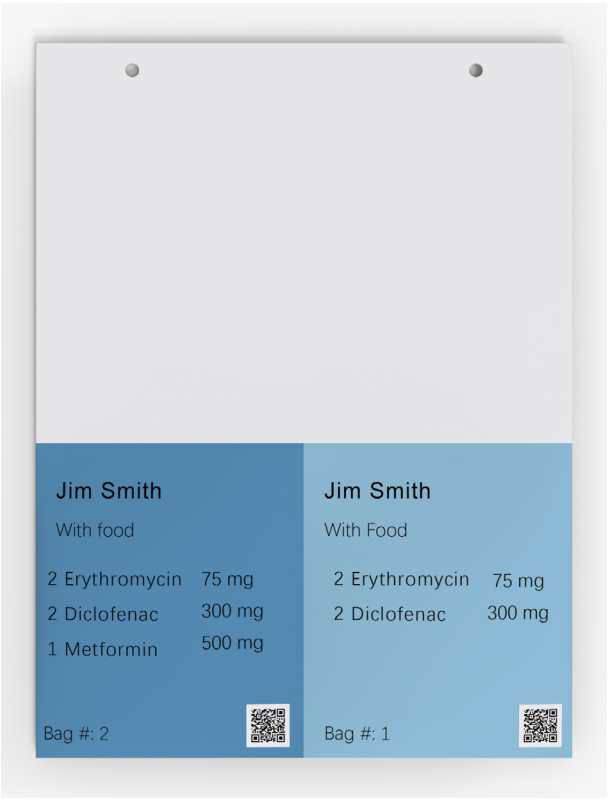


Figure 136: Final design, three times a day pill packaging. Black view rendering. Photograph by author (2019).

Figure 137: Final design twice a day pill packaging prototype. Photograph by author (2019).

Figure 138: Three times a day pill packaging prototype. Photograph by author (2019).

Figure 139: Final design twice a day pill packaging rendering. Photograph by author (2019).

Figure 140: Final design, three times a day pill packaging. Black view rendering. Photograph by author (2019).

Figure 141: Final design twice a day pill packaging, before use. Photograph by author (2019).

Figure 142: Final design times a day pill packaging prototype. Photograph by author (2019).

6.6 Evaluation

Figure 143: Final design twice a day pill packaging prototype. Photograph by author (2019).

Figure 144: Final design times a day pill packaging prototype. Photograph by author (2019).

Figure 145: Final design twice a day pill packaging. Photograph by author (2019).

Figure 146: Final design three times a day pill packaging. Photograph by author (2019)

Packaging design should take into account the needs and capabilities of the widest range of potential users their interaction with pills at home. Consideration should also be given to the needs of pharmacists, especially how they identify, classify and differentiate pill packaging. Some core tasks are critical to the safe use of pill packaging. To evaluate the “Hi pill” product design, opinions were sought from a panel of 20 reviewers. The goal is to assess how users find the information they need and how they use the product based on that information. The review panel was made up from 10 patients, 5 pharmacists, 1 stakeholder and 4 designers.

According to the problem of design evaluation, the testers were divided into three categories (user group, pharmacists group and design group) to ensure that the evaluation results have longitudinal and deep significance.

1. Observe the users' use of the product and record it.

2. Which packaging design is the most convenient for intuitive operation?

3. Which packaging design is the easiest to read for medicine information display

4. Which packaging design is the most beautiful and practical?

5. Record user experience

Figure 147: Final design Evaluation process. Photograph by author (2019).

The panel's participants ranged in age from 25 to 50 years and have different occupations and levels of education. The evaluation results are as follows.

Easy to use: According to the observation records of the interviewees, users did not need extra training after they received the product - they knew intuitively how to use the product. The whole process of tearing off the independent pill bag was smooth. When using a single pill bag, the hole is very convenient to tear apart, without causing any trouble to users.

Easy-to-read: The design of the product is appealing to users. They reported finding the visual elements (sun and moon) and the date on the surface, pleasing and easy to distinguish. The colour, graphics and number of bags indicates the number of times each day that users need to take the pills. Product certification is printed with generic pill information and pharmacy detail, and the back of the bag is printed with the information of the pill content in a single pill bag. The entire reading flow is clear and users can simply extract useful and valid information.

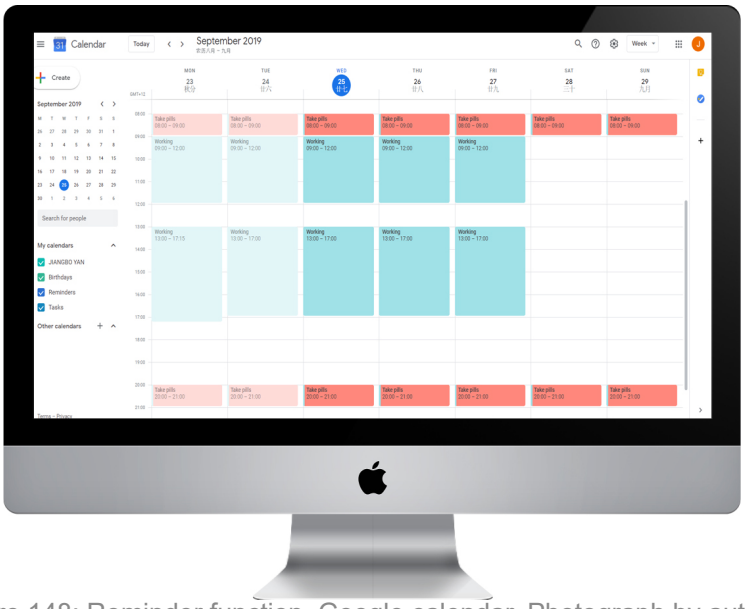


Figure 148: Reminder function, Google calendar. Photograph by author (2019)

Auxiliary function:

Young users are readily attracted to the QR code function. After scanning, it can connect to the user's own electronic calendar to set up auxiliary reminder function. Also, further detailed information about the pills can be obtained through QR code.

Feeling:

In contrast to the perceptions of existing products being "old fashioned", "Hi pill" emphasizes the participation of the users during and after the use. The visual element stimulates the visual pathways create a relaxed and pleasant user experience.

Chapter 7.0

The aim of this research project is to apply the human-centred design approach to design pill packaging that can help adults improve their medication adherence and provoke a good user experience through an aesthetically acceptable design.

The literature review reveals many of the conditions during the design of pill packaging. The main function of pill packaging should be protective. Secondly, to encourage adherence, drug instructions should be provided and be clear and pill packaging should be user-friendly. The By analysing the design features and faults of existing products, together with drawing upon user experiences, enabled me to devise alternative products that would meet the users' needs and wants without the recreating the faults of the pre-existing products.

The "Hi pill" design scheme solves the research problem of medical adherence through a gradual process of design iteration.

Conclusion

Primary research provided insights that shaped my design process focused on the needs and wants of users. While being mindful of challenges identified during the case study analysis, I proposed design concepts that responded to the context of use, developing practical design features and solutions that collectively aid adherence and usability.

The resulting ‘Hi pill’ product has a calendar mechanism that helps to remind users to take their medicine. Made from aluminum foil paper the product is environment-friendly, but sufficiently robust to protect the pills. By having a printable surface, it is easy to provide users with information about their drugs, which is intuitively accessed. The easy ‘tear-to-unpack’ presentation is convenient and enhances users’ experience.
“Hi pill” packaging design has received good initial user feedback and provides a clear direction for future commercial development aligned with contemporary packaging technology with a focus on medical prescription adherence and improving national health benefits.

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Image reference list

Figure 1: My medicine in June 2017, Photograph by author (2017).
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Appendix

Appendix 1. Interpret needs in terms of customer statement

Currently uses: Pillbox/ Pill reminder Type of user: Customers/ patients		
Question	Customer statement	Interpreted need statement
Typical uses	• I am very busy because of work, so it is easy to forget to take medicine. • It is easy for me to forget to take medicine just because of bad memory.	• Pillbox can help people take medicine • Pillbox can remind people to take medicine
	• Only by putting the medicine in the make-up box can I remind myself to take the medicine on time. • I will put the medicine that I need to take next to food when eating breakfast, so that I will remember to take medicine every time when having breakfast.	• Putting the pillbox in an obvious position makes it easier for people to use • Pillbox should be portable
	• Usually, I set an alarm clock on my mobile phone to remind myself to take medicine, but I may be busy with other things when the alarm rings, so that I might miss taking the medicine. • I have downloaded a software to remind myself to take medicine, but it makes taking medicine depend much more on the mobile app for me. Moreover, the app has only the reminder function, as a result of which I will ignore the reminder of the phone when I am busy. In addition, there are too many reminders on the phone every day, so that I have to intentionally ignore some of them.	• Have a function connecting with the mobile phone to enhance the reminder function • The pillbox is not connected to the phone, and it can still have a reminder function.
	• When I need to take a variety of drugs, I am always busy looking for instructions on drugs as some drugs are very hard to find.	• The drug information on the pill box package should be clearer to read.
	• Some drugs need to be kept in the environment without air and light. When I dispense the tablets, I always pack them with the package of the drug.	• The function to protect the tablets inside needs to be enhanced
	• For users who often forget to take medicine, never forget to take the medicine is the most important thing as it is useful and better to take the medicine once a day than forget to take the medicine at all.	• The purpose of the pillbox is to help remind users to take their medicine not just on time.
Likes- current product	• I like the current design of the pill box as it can enable us to put different drugs together, so that it only needs to be packed once for a whole week's use. • The appearance of some pill boxes is cute, and the customers will have desires to buy and use.	• The pillbox can hold different kinds of medicines together • Aesthetics is one of the factors that users consider for purchase.

Dislikes-current product	● The blister pack used now is not good-looking and looks like the exclusive one for the elderly. I don't want to use it when I am going out.	● Existing blister packs should be designed to be more attractive
	● Although I have set up a mobile app reminder, I still ignore the phone reminder because I am too busy at work.	● Different reminders
	● The pillbox I use is not reasonable in design. It is inconvenient to carry, and it will make a sound of drug collision.	● Improve or enhance the portability of the pill box product ● There is no sound when carrying the medicine box
	● It is very troublesome to clean the dirty pill box after using it for a while.	● Pillbox that does not need cleaning
	● The quality of the pill box is poor, and the seal is not tight, which causes my medicine to become moist.	● The pillbox must protect the medicine very well
	● I can only put different kinds of medicine boxes in my pill box. Therefore, before using it, I need to think about how many tablets need to be taken.	● The interior design of the pillbox should be reasonable
	● Some pill boxes are not scientifically designed. When using them, they will cut hands, which is annoying. ● Easy to open	● Easy to use
Suggested improvements	● I want a nice-looking medicine box that looks suitable for young people	● In line with the aesthetics of young people
	● It can be put together with my mobile phone and laptop ● It could be incorporated into my everyday items	● Easy to carry (Portability) ● The motivation of using the product can be linked with daily life
	● Friendly materials	● Products should consider more environmentally friendly materials

Organize the needs into a hierarchy

According to the user's needs statement, a detailed interpretation of user needs can be obtained. To further understand and analyze the needs of users, I organize user needs into different hierarchies （Primary need and Secondary need）. Primary need is the most general requirement, and secondary need is more detailed compared with primary need.

*Protect function

The pillbox needs to use non-toxic materials to prevent chemical reactions between the drug and the material itself.

Avoid direct exposure to light of the drug

Avoid contact of the drug with moisture in air using good sealing

***Remind function**

The box can be used as a reminder with different colors and additional functions

Dose

There is enough space inside the box to store different kinds of drugs.

Interaction

Human-packaging interaction

***Ergonomics**

Convenient storage

Lightweight

Portability

Integrated into daily life

***Easy to use**

The pillbox is easy to open and close

Easy for people to divide pills into pillbox

No sound is produced during use

Clear display of drug use information

Communication

The pill box can show different appearance to enhance the connection between users and the pill box.

Aesthetics

Remain attractive to users with changeable shapes

Meet the needs of users aged differently with diversified colors

***Pillbox material should be environmentally friendly materials**

Importance rating for the secondary needs are indicated by *