

First Aid Kit Design for Outdoor Sports

INTEGRATED PRODUCT DESIGN
MASTER THESIS

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Executive summary



The start point of the graduation project was including the RICE method inside the first aid kit, which was shifted to designing a first aid kit for outdoor sports. The new design focus is more valuable to develop a new product solving practical problems.



During the research phase, the literature research provides basic understanding of first aid kits, as well as the injury knowledge of the human body. It guides the project how and what the product should include and treat, making it sufficient and convenient for emergencies.



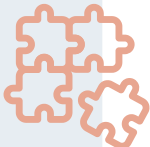
The interview and observation about outdoor sports are keys of scenario analysis. Helpful insights were obtained from videos and participants. The first design focus was found on how to apply treatment alone when one arm is injured and dysfunctional. Users have to apply treatment themselves with only one hand.



The second design focus comes from the evaluation of current first aid kit evaluation by going through all steps of treatments where all supplies are simply stacked and only designed to be used by two hands. The information obtained by users should be well arranged to improve the use efficiency.



To achieve the design goals, design focuses were detailed as a requirement list based on research insights. The whole product was divided into a few independent parameters, in which a few requirements should be fulfilled. Ideas were generated, compared and selected in each parameter and were integrated into a complete concept.



The concept was theoretically workable to be further developed in the next stage: concept validation. In this stage the concept was divided into different parts again, aiming to make cardboard or 3D printed prototypes for each parameter and help validate the concept through iterations respectively. The final design for each parameter was integrated into a complete product. The final prototype is a realistic and satisfying product, as proof of the concept that fulfils all design goals.



User tests and discussion were conducted as the last steps of the project. Participants were observed if they could quickly understand the design and used it smoothly. They pointed out the defects of design and gave advice for further development.

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INTRODUCTION

1.1 Project background

Sports, health and injuries

Doing sports is a good choice for people to entertain, keep healthy and communicate with others. The inclusion of new sports events such as surfing, skateboarding and sport climbing in the 2020 Olympic games gives emerging sports a lot of exposure among people all over the world. The professional sports contests are not limited to fields, but will include more outdoor ones and help to develop standardization and commercialization [1]. With a wider range of sports to choose from, people are likely to face injuries in more complex circumstances. In 2019, more than 3.7 million injury cases were reported in the US [2], and the number can go much higher with minor injuries that are even not reported. How to prevent injury and apply treatment in time when getting injured are popular topics that improve security and experiences for physical activities.

Injuries and first aid

A first aid kit is a typical series of medical supplies to provide in-time medical care for minor injuries or before the professional medical help arrives. It is widely used in a variety of circumstances wherever there is a risk of getting injured such as at home, working places, in wildness and military use [3]. The size and shape of first aid kits can vary a lot depending on the different uses, as well as supplies included in them. These supplies are always useful to treat the possible injury types happening in the future. In today's world, outdoor sports are relatively risky activities for human beings, while players are not well protected by medical help. The project starts from problems discovered in outdoor sports scenarios and provides feasible solutions.

1.2 Starting point and shift of design focus

Starting point

The starting point of the project was to include the RICE method into a first aid kit for all sports. RICE method is a widely used treatment for most of the soft tissue injuries. It includes proper steps to apply cold compresses: rest the injured site, apply Ice, compress the injured site and raise the site higher than heart level. By applying RICE method, the causality can significantly reduce the swelling and pain within a short time and minimize the consequences. However, this method is only limited within soft tissues and ice bags. The design focus was shifted to a first aid kit for outdoor sports.

The aim of the project is to design a first aid kit for outdoor sports. By looking into the problems of current first aid kit design, the improvement of user experience and efficiency will be improved in outdoor context, allowing users to conveniently apply the treatment even when injured alone on upper extremities.

Well secured indoor environment


First aid kits are found in most of the urban and semi-urban areas where there is a higher population density. Medical and emergency supplies are mandatory to be accessible in public working places within 30s according to the working condition act of the Netherlands and are recommended to have one kit for every 50 employees in large areas [4] [5]. Cooperative retailers such as EHBO-koffer and CarePlus sell sports first aid kits and provide professional advisory for their partners. First aid responders in every organization receive training every year, equipping themselves with knowledge to ensure the safety of employees.

Less secured outdoor environment


When urban and semi-urban areas are well protected by mandatory first aid kits and responders, outdoor recreations happening in the wilder locations have rare protection from the first aid system. The over-large places for these sports are difficult to be covered in a similar way as working places. Therefore., users need to bring first aid kits themselves and apply basic medical treatment when an injury really happens.

Based on the research in 2.1, outdoor sports in wilderness causes situations of individual treatment application which are more likely to happen than urban areas because of low population density, over-large area and high sport speed, under which circumstance the injury of upper extremity significantly limits the treatment application since none of medical supplies are designed for single-hand use. Currently a first aid kit designed for outdoor enthusiasts in the market taking care of those injuries on the upper extremity alone does not exist.

1.3 Assignment



Find problems of the current first aid kits in outdoor sports applications and provide a solution for easily use medical supplies with only one hand, improving information efficiency and use experience throughout the using process.



1.4 Design approach

The design process of the whole project is typically divided into four stages: Discover, Define, Develop and Deliver, known as the double-diamond method (**Figure 1**). The first half of the project consists of Discover and Define stages. The information collected during the “Discover” stage was analyzed and

concluded into a list of requirements and visions in the “Define” stage serving as a start point for creating solutions. The Develop stage takes up most of the second part including ideation, idea selection, concept embodiment and iterations. Product tests will be conducted during the Deliver stage in the end.

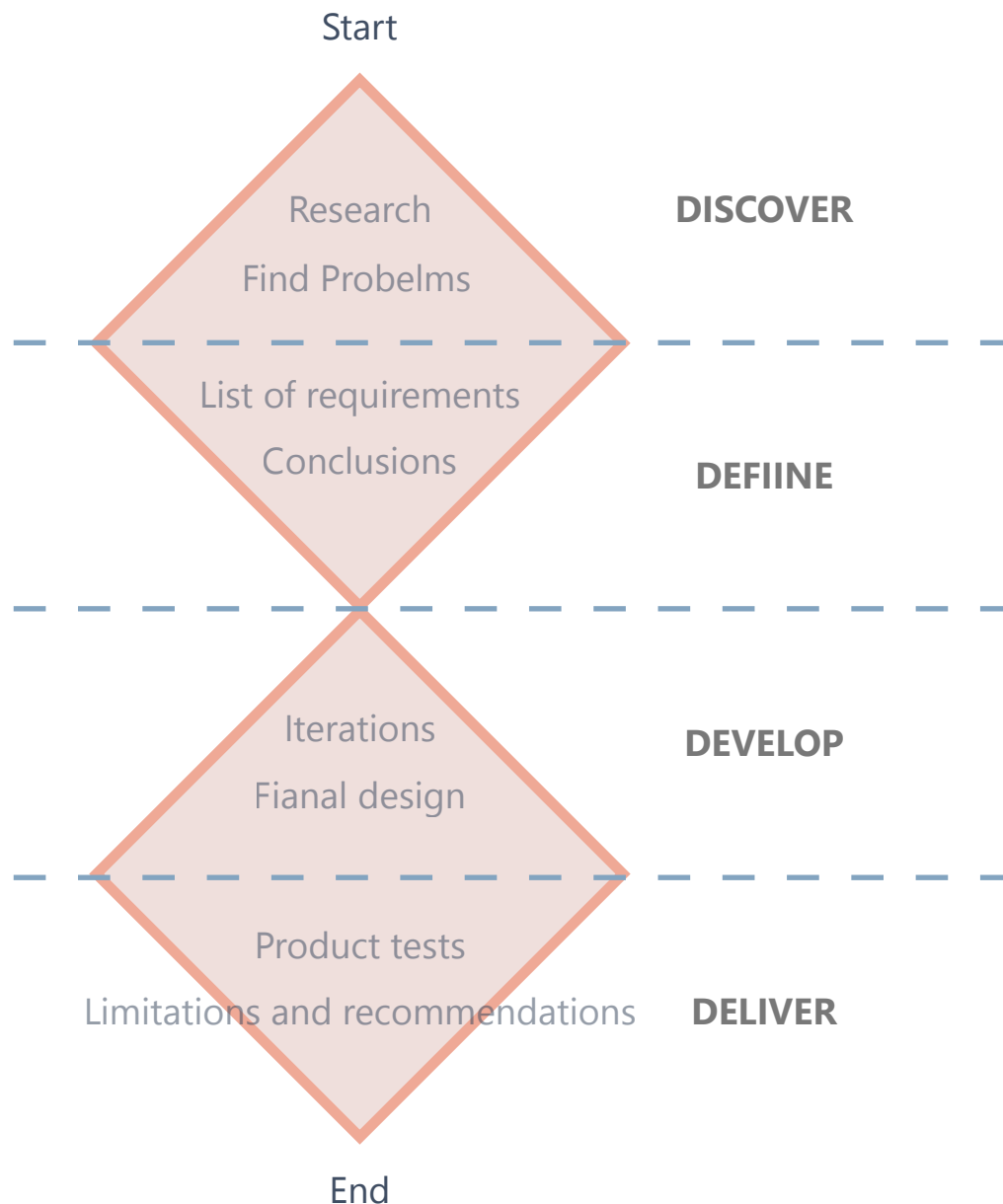


Figure 1: Double diamond method

2

DISCOVER

2.1 Outdoor sports

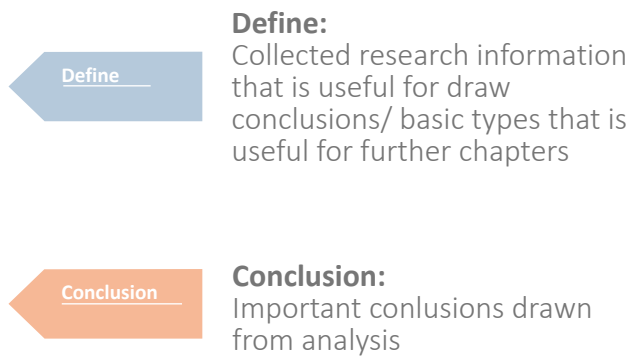
2.1.1 Introduction

The first part of the Discover phase is outdoor sports research. It gives a definition about what outdoor sports are in scope, which is “sports happening in sub-urban, far from the city or in the wilderness”. The formally classified outdoor sports are listed in this part, including the basic understanding of them and more specifically their locations. These outdoor sports are

compared with those happening in the city and help to draw conclusions on their characteristics, showing the necessity of designing a first aid kit for these activities.

Besides, With all in-scope sports listed, scenarios in the “user analysis” chapter are selected as the most representative examples from this part.

Marks for important information (for DISCOVER section)



2.1.2 What are the target outdoor activities?

The good examples of outdoor sports are formally classified ones selected from the sports list (**Appendix A**), as shown in the following **Figure 2**. The table provides basic understanding and background about in-scope sports with brief descriptions. The sports selected as design

targets are **intensive sport activities played in sub-urban, far from the city or in wilderness**, which fit the definition in the design focus. The happening of these sports requires large areas outdoors instead of being restricted within well-designed indoor fields.

Define
In-scope outdoor sports for the project

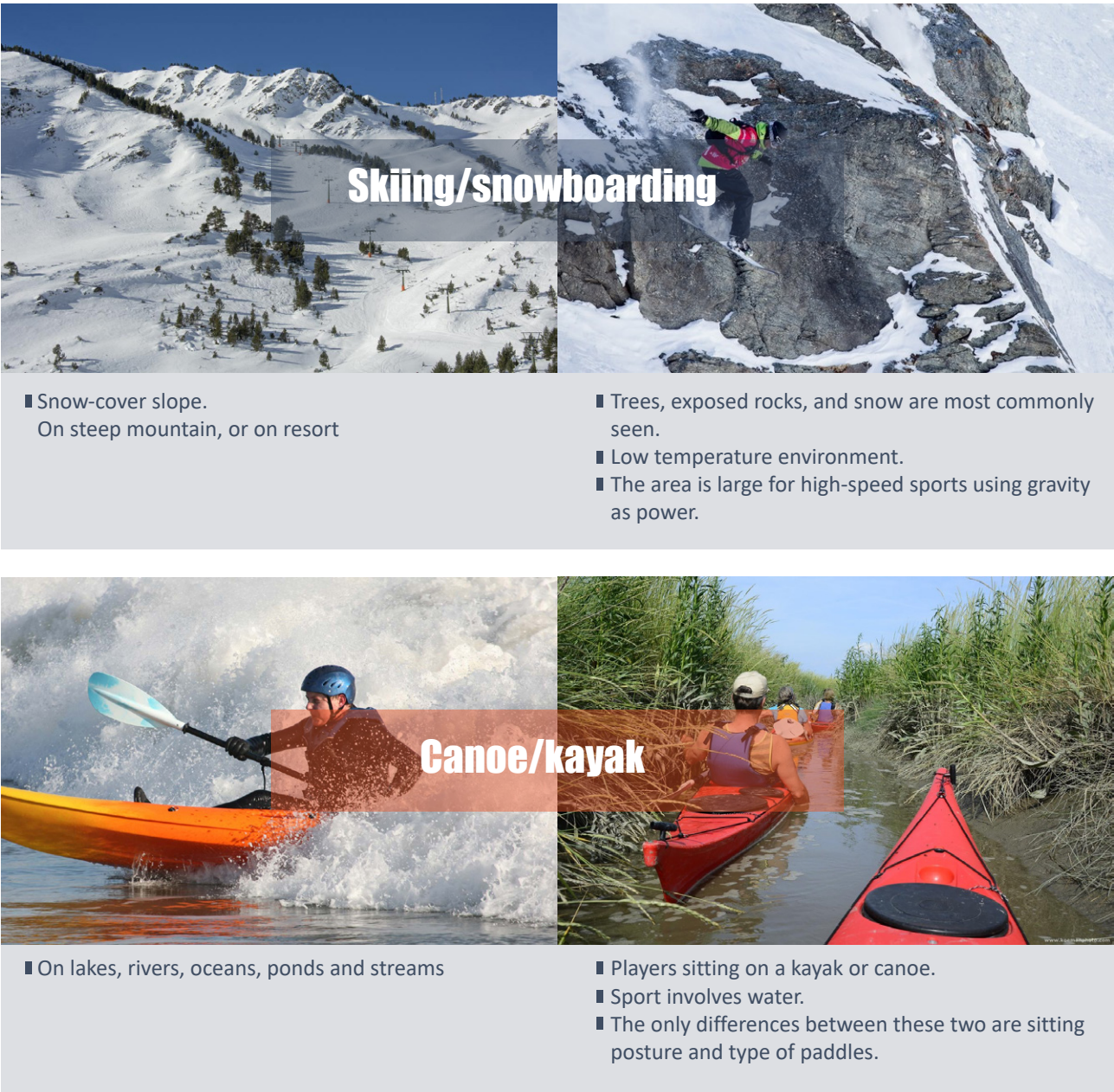


Figure 2: In-scope outdoor sports



Cycling far from city/ Mountain biking

- On off-road trails with various road conditions with plants, rocks, water crossing etc.
- Some mountain biking activities focus on riding downhill.
- Any objects like trees and exposed rocks can be dangerous to riders under high speed, depending on road conditions.
- The area is large for high-speed sports using gravity or body strength as power.



Orienteering/running

- Can happen anywhere (mountain, forest, etc.) with different difficulty levels.
- Use body strength as power to move.



Surfing/kitesurfing

- On open water, lake or seas
- Sport involves water.
- The area is large for high-speed sports using wind as power.

Figure 2: In-scope outdoor sports

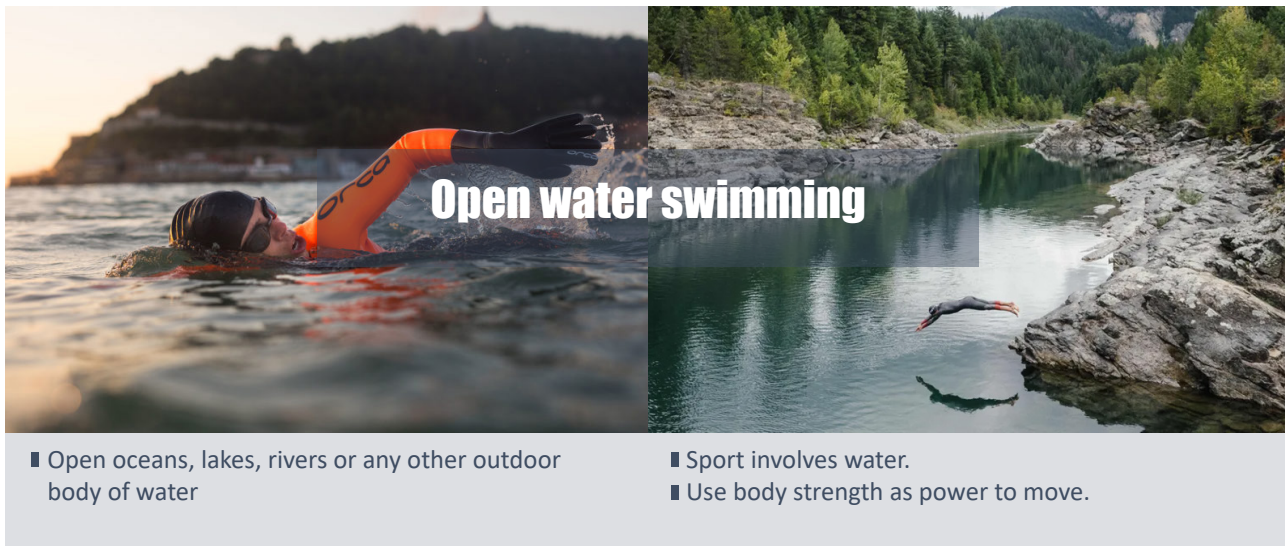


Figure 2: In-scope outdoor sports

Although these sports are grouped as in-scope activities, the differences between them will influence the design requirements. Based on power use and intensity of outdoor sports, **there are mainly two types of sports (Figure 3)**: The first type includes sports using natural power such as gravity, wind, water, or transportation tools to save energy and move at

a high speed. (skiing, snowboarding, kitesurfing, mountain biking). The second type includes sports using the strength of the body to move at a relatively low speed, requiring minimum extra weight on the body. (Running, orienteering, rock climbing). They are shown in the map below.

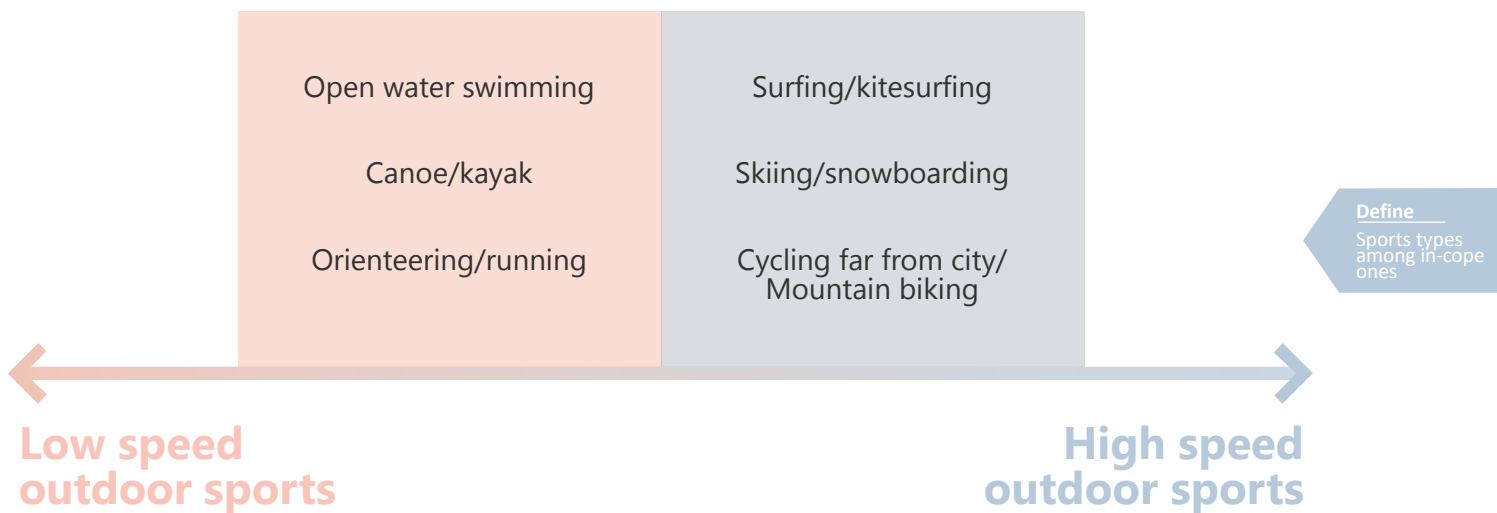


Figure 3: Two outdoor sports types

The information of Figure 3 here is preliminary grouping of selected sports. More differences and how they influence the requirements are discussed in the following chapters:

1. The power use of the sports determines how extra weight a player can carry, thereby influencing the experience of sporting. The map gives insights to analysis in chapter **2.3.4** and

helps decision making on size requirements of first aid kit design.

2. Different sport speeds also determine how risky they are and then determine the most frequent injuries of these sports. Medical supply selection will be made based on the injuries. This definition will be used in **2.3.4**.

2.1.3 Features of outdoor sports

The **Figure 4** below compares indoor and outdoor sports in terms of their locations, environments and how well they are secured.

Some conclusions can be drawn from the figure and validate why outdoor sports are more risky and need protection too.



Figure 4: Comparison between indoor and outdoor sports

1 Uncertain places and lack of medical resources

Outdoor recreations can happen in a wide range of locations including mountain, forest, snowfield, open water, etc. Unlike working places and indoor sports with a secured first aid kit protecting the whole area, outdoor space is much larger and impossible to be covered in a similar way. A long distance from the city means

a long time waiting for medical help. Therefore, preparing the medical supplies for emergencies is necessary for outdoors sports enthusiasts themselves.

2 Insured place and complex environment

Sports in the cities usually have well-planned and designed areas for players to focus on sports as shown in the Figure above. The environment

Conclusion

Differences between indoor & outdoor sports

is much more secure than in the wilderness that will not change a lot over time. Dedicated equipment and competition rules are designed for preventing injuries to some extent. On the contrary, Outdoor sports are full of uncertainty due to the complex environment such as local weather, terrain, altitude or temperature. They are uncontrollable factors causing unexpected injuries to the human body or bringing inconvenience to treatment application.

3 Playing alone and far from each other

The unrestricted area gives outdoor sports more freedom and people can go far away from their partners, especially the sports with high speed and over-large locations. When injured, they are probably not noticed by anyone else due to the long distance. Under this circumstance, they need to take measurements themselves. The same could happen to those who love to do outdoor sports alone.

4 Prepared equipment

To do sports far from home, players usually prepare necessary items so that they get ready for future events. Because of the distance to the city, they will carry more needed supplies than doing sports in the city. Large and bulky sports gears usually require a larger carrier, which can be an opportunity to bring a first aid kit.

The conclusions above show **the necessity of ensuring safety of outdoor sports players** who are facing less secured and more complex environments outdoors. The project will focus on these sports and use information in this part to do further analysis on following chapters.

Basic decision

Necessity of a first aid kit for outdoor sports

2.2 Medical background & system

2.2.1 Introduction

First aid kit serves as a series of tools for first aid, thus the **principles of first aid** apply to it too.

The chapter starts with the principles of first aid, which restricts and provides the basic guide for the design.

The knowledge of sports injuries and their basic treatments are fundamentals that help design a first aid kit. The analysis of injuries, symptoms and recommended treatment determine not only what sports injuries should be covered, but help conclude **what medical supplies should be included** for direct treatment application. It will be adjusted according to the analysis of high speed and low speed sports in **2.3.4**.

2.2.2 First aid and first aid kit rules

First aid plays an important role in dealing with emergencies involving various types of injuries from minor cuts to major injuries. First aid skills are efficient measurements of first aiders to stop the loss and minimize the further influence

on the human body. The need for further treatment is determined depending on the severity. There are first aid golden rules well concluded by Indian Red Cross Society [6].

- Do the first thing first; this includes assessing the situation for any immediate danger, **quickly and methodically** without panicking, giving priority to the most urgent situation / condition.
- Resuscitate the victim, if necessary and carry out general treatment of unconsciousness.
- Loosen all tight clothing or materials around the victim's neck, waist, wrist, etc.
- Arrest bleeding, cover all wounds, burns or scalds and immobilize all fractures.
- Do not allow people to crowd a victim and do not move a victim unless you really have to (**dangerous environment**, risk of falling debris, explosion etc).
- Reassure the victim and get help **as soon as possible**. Improvise **all necessary materials**, which are not readily available.
- **Guide** against or treat for shock.
- Dispose/transport the victim properly.

What does it mean for a first aid kit?

As a container of medical supplies, the main function of the first aid kit provides sufficient tools and guides to assist the first aider. How successful the treatment application is depends on the first aiders themselves but it can be improved with a better first aid kit and its instructions. Concluded from golden rules of first aid, there are some basic rules or functions apply to the first aid kit:

1. [Quick] A first aid kit helps to apply the in-time first aid treatment. Not only the treatment application but the whole process including being noticed and accessed should be as quickly as possible so that the treatment opportunity won't be lost, especially for acute injuries.

2. [Sufficient] A first aid kit provides medical supplies for common injuries of activity. It focuses on the possible injuries while the rest causes expiration to medical supplies.

3. [Sufficient] A first aid kit prepares for the worst situation. Injury can appear in any form or any place and is always unexpected. The casualty can't always count on others to help. [<https://www.mfasco.com/blog/health-topics/why-is-a-first-aid-kit-important.html>]

4. [Guide] A first aid kit assists and guides first aiders. Apart from physical tools, the information and knowledge provided by the kit can make a big difference in an emergency. Most of the first aid kits have a first aid guide helping users to apply treatment even if they have no experience.

5. [Less disturbances] A first aid kit should minimize the influence of the environment in treatment application. Complex environments of outdoor sports could cause inconvenience to first aid kit use. To increase the efficiency during treatment application, the threats or disturbances from outdoor complex environments should be minimized.

but not least, the first aid kit should be designed according to user behaviour and minimize the influence of the environment during treatment application.

Define
Rules for first
aid kits

What should the design for outdoor sports follow?

They are fundamentals for all following designs. The use of the first aid kit should firstly be as quick as possible and is a prior rule on top of the rest. Secondly, the design should cover all possible sports injuries during outdoor activities and provide handy application ways for the worst but possible situation. Then the design should have efficient and sufficient information conveyed from product to users to guide them and improve user efficiency and experience. Last

2.2.3 Sports injuries

Sports injuries are defined as ‘damage to the tissues of the body that occurs as the result of sport or exercise’ according to the IOC manual of sports injuries [7]. Clinical Sports Medicine [8] listed the possible acute sports injuries (**Figure 5**) based on the different sites of injuries and is the most common classification method for them. The sports injuries include soft tissue injuries, bleeding. Soft tissue injuries, including fractures, result from the large force exerted externally that exceeds the strength of the tissue, while bleeding involves the different levels of broken blood vessels, internally or externally. A sports

injury can be accompanied by another one, such as an open fracture happening with both bone fracture and bleeding, or turn more severe if the first aid treatment is delayed. 80% of the injuries arising during the sports are located in the soft tissues, such as muscles, tendons, ligaments and joints, among which the vast majority of them do not require specialized treatment. The other 20% of the injuries correspond to fractures and damage of internal organs.

Body sites	Injuries
Bone	Fracture Periosteal contusion
Articular cartilage	Osteochondral/chondral fracture Minor osteochondral injury/lesion
Joint	Dislocation Subluxation
Ligament	Sprain/tear (grades I - III)
Muscle	Strain/tear (grades I - III) Contusion Cramp Compartment syndrome (acute)
Tendon	Tear (complete or partial)
Bursa	Traumatic bursitis
Nerve	Neuropraxia
Skin	Laceration Abrasion Puncture wound

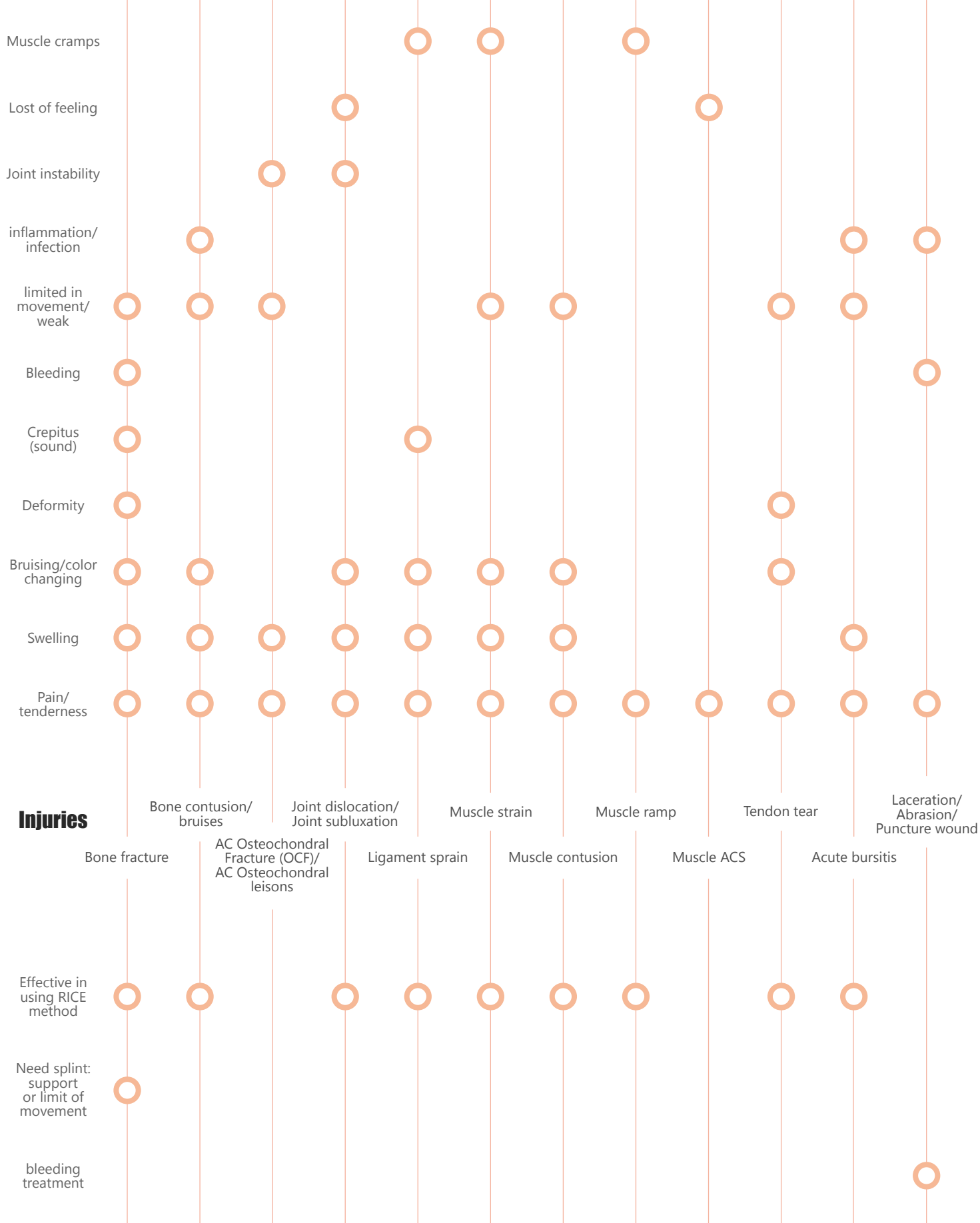
Define
All Sports
injuries

Figure 5: Possible sports injuries

To find out what are symptoms of these injuries and what first aid treatments should be applied, a chart is used here to conclude them (**Figure 6**). The symptoms are possible symptoms that

appear differently depending on the severity and sites. And the treatments are recommended first aid measurements for the casualty to apply themselves.

Symptoms



Recommended treatment for non-medical practitioner

Figure 6: Sports injuries symptoms and treatment chart

One conclusion can be drawn from the figure is that injuries has similar symptotoms between each other which are hard to tell the differences and can change a lot depending on the severity and body sites. Without professional knowledge and medical instruments, **users are only able to judge the very basic types of injuries** such as physical abnormality of their body and obvious common symptoms such as showing blood, pain, swelling, deformity, etc. The **medical supplies in the first aid kit as well as the instruction will be divided based on very basic injury types** that users can easily judge themselves.

The symptoms of sports injuries include severe ones such as limit in movement, huge pain, loss of feelings and deformity. **The casualty cannot**

use the injured body sites at that moment because of them, and can cause inconvenience to the treatment application when they are alone.

Additionally, from the above figure it is clear that the injuries of sports not only appear in soft tissues, but also include bleeding that are quite common everywhere in our life. The RICE method is not enough for all possible injuries here, and treatment for bleeding should also be included so that all of them can be covered. According to the research of their treatment steps, severe injuries and minor ones require different responses. Therefore they are mainly divided into four basic sports injury types as shown in **Figure 7**.

Conclusion
Symptoms causes dysfunction

Conclusion
Users can only judge basic symptom types

Conclusion
Injury type for the first aid kit design

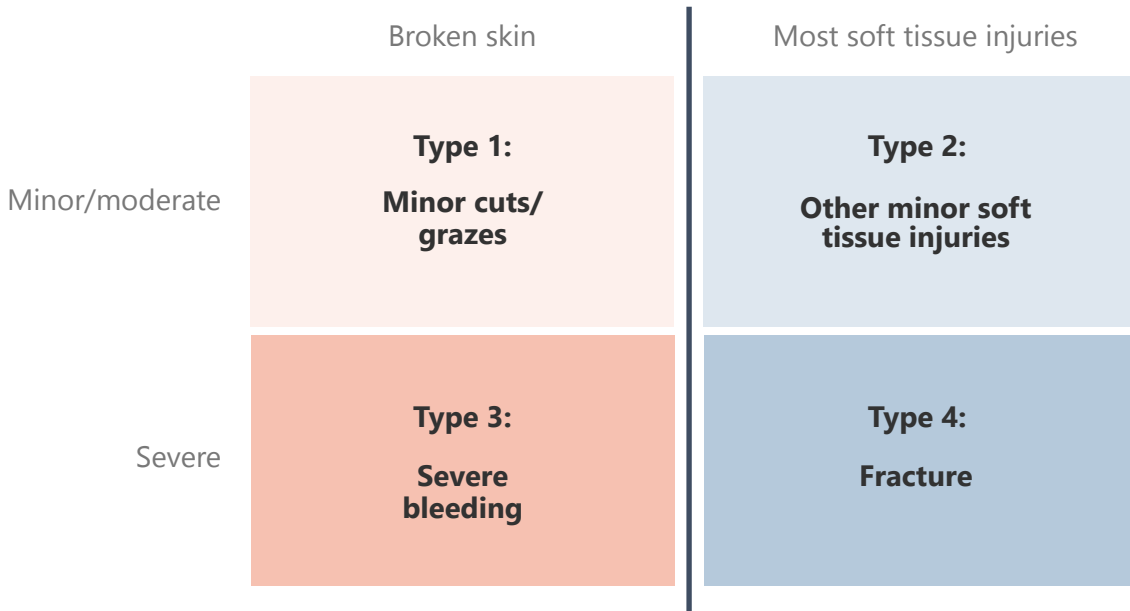


Figure 7: Four basic injury types based on severity and symptotoms

2.2.4 Treatment steps

With basic four injury types determined, the recommended treatment steps for all treatment are listed below. According to the Orange Cross's first aid guide [9], one noteworthy step ahead of all these treatments is that they should judge if they need medical help by calling 112 and make sure they are safe or the casualty they are helping is safe. This step should also be included in the instruction too.

1 Minor and moderate soft tissue

The RICE method is one of the universal treatments for soft tissue injuries according to **Figure 8**. It consists of four steps: rise, ice, compression and elevation [10]:

RICE

Rest



Compress



Ice



Elevate



Figure 8: RICE method

Rise: stop moving. Further movement or weight-bearing can aggravate an injury or increase inflammation and swelling.

Ice: to reduce blood flow, inflammation and relieve pain. Effective in the first 48 hours, 10-20 mins per hour.

Compression: apply appropriate pressure on an injured part using an elastic bandage to reduce swelling in the inflammatory process.

Elevation: elevate the injured part of the body above the heart level to reduce swelling and pain by providing a path for draining fluid back to the heart.

This method, or its alternatives, provides a systematic and helpful solution for soft tissue injuries. However, a study pointed out that evidence is insufficient to prove applying ice and compress are effective, and excessive use of ice can cause delay healing because of the reduction of blood flow [11]. Intermittent ice application of 10 minutes is most effective in reducing the temperature of tissues and avoiding side effects and possible further injury [12]. To effectively and safely apply the treatment, it's important to inform the users when, and how long they should use ice.

2 Fracture

The first aid treatment for a fracture is to fix the broken bone with hard material or a sling. The use of a triangular bandage or a SAM splint is a common way of treating a fracture.

Steps [13]:

- Stop moving of the injured part (they should stop bleeding if it's an open fracture)
- Padding around for the injured part.
- Use sling or splint to support or fix the injured part. (apply ice if needed)

According to the orange cross [9], the casualty is also recommended to apply ice in the early stage of injury to relieve pain. Padding, like a towel or washcloth, should be placed between the skin and the ice pack to prevent direct contact.

3 Cuts and grazes (laceration)

The cuts and grazes are minor injuries that are not life-threatening but still have a chance of infection. That's why disinfection measurements are important in bleeding treatment steps, especially in wilderness with way more unknown sources of infection than in cities. A cut by a dirty rusty nail on hand is more likely to get infected than a cut with a clean knife on the upper thigh [14].

Steps [15]:

- Wear sterile gloves if have
- Apply pressure on the wound to stop bleeding with gauze or compress
- Raise the injured part

- Clean the wound with water or non-alcohol wipes.
- Apply dressing or plasters based on the size of the wound.

4 Severe bleeding

A large amount of bleeding requires different treatment than cuts and grazes. Every second matters under this situation that the casualty can experience shock and die because of excessive bleeding.

Steps [16]:

Remove the cloth and wear a glove (don't raise or remove the injured leg)

Lie down

Use a bandage to apply direct pressure on the wound to stop bleeding.

if there is an object in the wound, don't remove it. Use a bandage to apply pressure on either side to reduce the bleeding.

If blood comes through the bandage, don't replace or remove the bandage. Apply the second layer of bandage on top.

Press the casualty's finger to check if it's too tight. If the colour doesn't return within 2 seconds, then it is too tight.

A tourniquet is another medical supply applying strong pressure around the arm or leg. It stops or reduces bleeding by squeezing the blood vessels. The tourniquet is out of scope because it should be used only for trained people like first responders [17]. An improper application could cause permanent damage to muscles, nerves, and blood vessels [18].

The treatment steps are **specific information that should be included in instructions**, and will be converted into concise and easily hands-on graphics for users as a part of information improvement design of the project.

The treatment steps also show **the direct medical supplies (Figure 9)** for treatments. Some have requirements for their quantities in case the injuries are too severe to be well treated such as bandages.

Medical Supplies to apply treatment directly

Define
Treatment steps for instructions

Conclusion
Direct supplies for treatment



Gloves

Provide body substance isolation to protect rescuer from contacting blood borne pathogens from patient.



Gauzes

Control bleeding and absorbing bodily fluids from wounds.



Antiseptic wipes

Destroy microorganism growth and clean wounds prior to applying a bandage



Plasters

Cover open wounds and control bleeding wounds



Bandages (at least 2)

Control bleeding and absorbing bodily fluids from wounds. Cover antibiotic and antiseptics that have been applied to wounds.



Instant cold compress

Reduce swelling and relieve pain as part of RICE method.



Splint

Support and protecting broken bones.

Figure 9: Medical supply list for treatment

2.3 User analysis

2.3.1 Introduction

The user analysis chapter starts with an analysis of a questionnaire about first aid knowledge. Instructions of the first aid kit are proved to be necessary for a product when most of the people are confident yet lack first aid knowledge or experience. Most importantly, two representative outdoor sports are selected from sports list in 2.1.2 to create scenarios using observation and interview respectively. They provide useful conclusions and considerations for following idea development and selection. The last part studies how the differences of sports types mentioned in 2.1.2, high speed sports and low speed sport, influence the supply selection. The capacity of the most common carrying tool, a backpack, will limit the first aid kit size and two versions will be developed.

2.3.2 Questionnaire

A questionnaire (**Appendix B**) was spread among a group of, in total 64, educated people in the university to investigate how much first

aid experience and knowledge they have. The following pie charts illustrate the result of the questionnaire (**Figure 10**).

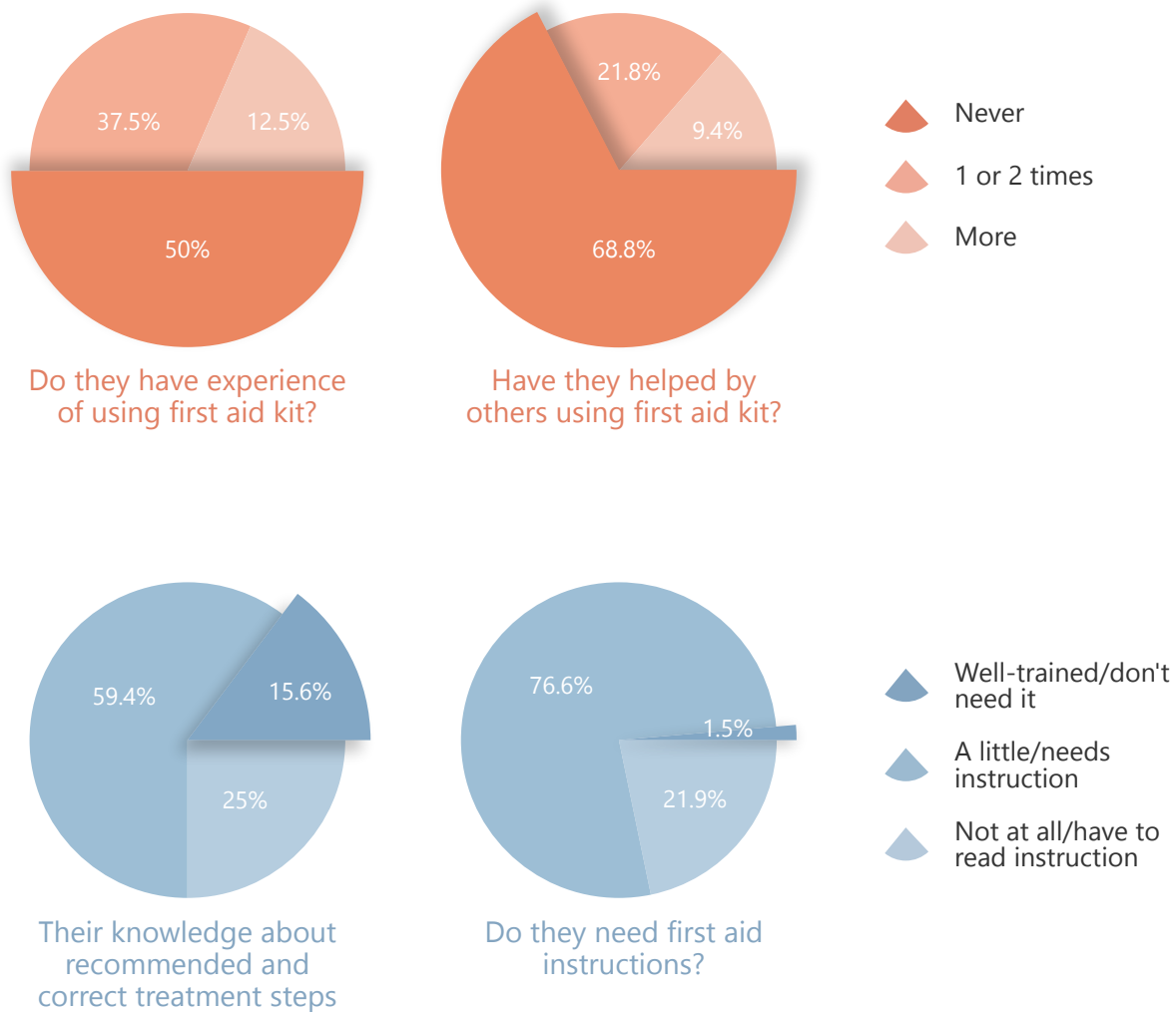


Figure 10: Questionnaire results

A conclusion can be drawn from the pie charts that most of them don't have experience in using first aid kit or helped by others with a first aid kit. Most of them have a little knowledge about first aid but have no idea what are the recommended scientific and appropriate treatment steps. **A proper guiding is necessary from a first aid kit for those who are not medical practitioners.**

During the interview with a first aid responder in PMB (**Appendix C**), he mentioned part of his job was to keep students safe, and needed to receive first aid training every year in X tudelft. One attribute of first aid is the low frequency of use which may cause fading of first knowledge from mind. **The importance of proper guidance is proved even for those who have received first training before.**

Conclusion
Necessity of instructions

2.3.3 Scenarios

Two scenarios are created to provide an overview for the design and illustrate the process from getting injured to receiving medical help. They include the information of the place where an injury happens, the accessibility of external help from others and the actual behaviour about what they've done as well as what they should do according to the Orange Cross guideline [9]. The scenario includes the potential interactions between the 'actor' and first aid kit under certain circumstances [19], from which takeaways show the specific problems and opportunities accordingly.

Two scenarios show one type of injury respectively, but all sports injuries with different severity can also happen in both scenarios.

Scenario 1: snowboarding (Video viewing) [20] Figure 11

What is snowboarding?

Started in the 1960s in the US, snowboarding is a winter outdoor sport and became an official Olympic game event in 1998 [21]. Players stand on a board with two feet attached and descend on a snow-covered slope [22], in a public ski resort or woods.

Risks

The circumstances of snowboarding injuries can result from collisions with other riders, collisions with stationary objects (tree, pole, snowmaking machine), risky actions (aerial manoeuvre), and snow conditions [23].

Data

- Snowboarding is a sport that is easy to get injured, especially for new riders. It is riskier than skiing [23].
- **Sprain and fracture** are the most commonly seen injuries, followed by contusions, lacerations, dislocations and concussions.
- **Upper extremity injuries are more common** than lower extremity injuries. 20% of all injuries and **50% of the fracture happened on wrists** [24].



Figure 11: Scenario 1 snowboarding

Scenario 2: kitesurfing (Interview) (Appendix D)

Figure 12

What is kite surfing?

Kitesurfing (or kiteboarding) is an extreme sport on open water starting from the effort of using wind as power in the last few centuries [25]. Essentially, modern kitesurfing uses a kite connected to a harness wrapping on the waist through flying lines. Riders fix their feet on a board and control the kite with a steering bar to do tricks and jumps.

Risks:

The wind is the power driving kite fly but can also be dangerous for riders. The kite can be out of control because of the wrong estimate about the wind and sudden change of weather (**Appendix C**). Besides, hitting each other, rope tangling, bad landing, going too far into the water and unknown seafloor all make the sport a riskier activity than other contact sports[26].

Data [29]:

- **Cuts and abrasions** are the highest among all injuries (25.4%), followed by contusions (19.4%), muscle sprains (17.5%) and muscle sprains (10.2%).
- Foot and ankle are the most common injuries (31.8%), followed by the knee (14.2%), and hand and wrist (10.2%).



Figure 12: Scenario 2 kitesurfing

Conclusion from scenarios

Playing along: In the first scenario, the man got hit on a tree without any witness and only found another player when he tried to move for a few minutes. Players are likely to be at a distance from the rest because of the high speed and large sporting area even when they go together with friends. If injured severely under this circumstance like a fracture, the first thing they need to do is to **call for help from 112** [9]. **It is also important to ask for help from other players** in this snowfield because a person loses his judgement under the influence of pain and panic. Others are able to apply the treatment to the back or face where are hard to see or reach by the casualty himself.

Conclusion

Importance of asking help from others first

The opportunity of designing for one-hand use of medical supplies: A similar collision can happen in the first scenario on the upper extremities which accounts for a large proportion of all injuries according to the collected data. According to a symptom study in **2.2.3**, the injured upper extremity is likely to lose its normal functions or feelings which makes two-hand application of treatment impossible. They have to apply themselves with a single hand when waiting for the arrival of medical help. However, none of the medical supplies in all first aid kits are designed for single-hands manipulation. The scenario described here is the worst but possible situation exposing the problem of current first aid kit application in outdoor sports. In this project, **one-hand use of the first aid kit will be one of the main focuses** and a solution will be developed for quicker and easier use under this circumstance.

Conclusion

Main focus 1: easily treat injuries of upper extremity alone

The influence of water and weather: Kitesurfing has the features of a few outdoor sports on open water or uses wind as power. In the second scenario, the injury can happen in the water where the players are cut by unseen seashells in the water or break their leg because of a bad landing. They have to first swim to the beach and then apply the treatment. The first aid kit will be in **a wet environment with strong wind** which influences the use of applying. A papery instruction can be soaked and destroyed. The design should find a way to provide a **stable treatment environment** even under the influences of water and wind.

Conclusion

Influence of weather and water

2.3.4 Bring a first aid kit for outdoor sports

Backpack as carrying tool

Some outdoor sports have transportations, such as a bike for mountain biking, to fix the first aid kit on their bikes. But for the rest, transportation is only used to reach the destination instead of being a part of sports so it's not suitable for all outdoor sports. Among all sports gears or accessories, **a backpack is the most widely used storing tool** for almost all people to take items outdoors and is accessible at any time. They carry one throughout the whole sport or the backpack will not be far away from them because of other valued items (ID cards, money, water, equipment, etc.).

Various backpack storage space

The concluded basic outdoor sports map

in chapter 2.1.2 categorized them into two main types, high speed and low speed sports, by looking at the power use. **The backpacks design for them has obvious differences in capacity** as shown in Figure 13. Backpacks of low speed sports using body strength to move have relatively lower capacity, from a few litres to around 15 litres, while high speed sports have backpacks mostly more than 20 litres [27], some up to 50- 150 litres because of special sports gears. Users should select a suitable first aid kit for easier carrying. For example, a first aid kit designed for indoor space (8L) is not suitable for low-capacity backpacks (7L) in order to leave more space for other items. Therefore the supplies are determined by looking into the frequent injuries of high and low speed sports.

Define

Backpack is a good choice to put a first aid kit

Conclusion

Design for two types of sports respectively



Figure 13: Storing space comparison

Different frequent injuries between two kinds of sports

Low speed sports such as running and orienteering require minimum influence from extra weight. To be included in these low-capacity backpacks, only necessary medical supplies should be included in the first aid kit. According to a study published in 2020, ankle sprain is the only acute type of injury among all five most common running-related injuries while the rest are overuse injuries [28]. The further injuries had a very low number of cases such as stress fracture, which shows no pain in the very beginning and will only be detected afterwards [29]. Therefore, **medical supplies for normal**

fractures (severe break instead of minor cracks like stress fracture) are less necessary to be included in order to reduce the size.

On the contrary, the backpacks designed for sports like snowboarding have a much larger capacity. Data collected in **2.3.3** of two high speed outdoor sports are more risky than low speed ones. Players are more likely to experience acute sports injuries than over-use ones and they have **a much rate of severe injuries like fracture**. In addition to the medical supplies for low speed sports, the first aid kit should also provide a splint to treat fracture.

Define

The difference of injuries between two types of sports

Conclusion

Small version has no splint

Category 1 respond: Life-threatening

Time critical life-threatening event needing immediate intervention and/or resuscitation.

Category 2 respond: Emergency

an emergency or a potentially serious condition that may require rapid assessment, urgent on-scene intervention and/or urgent transport.

Category 3 respond: Urgent

They are problems (not immediately life-threatening) that need treatment to relieve suffering (e.g. pain control) and transport or clinical assessment and management at the scene.

Category 4 respond: Non-urgent

incidents that are not urgent but need assessment (face-to-face or telephone), and possibly transport, within a clinically appropriate timeframe.

Define

The respond times for non-life threatening cases

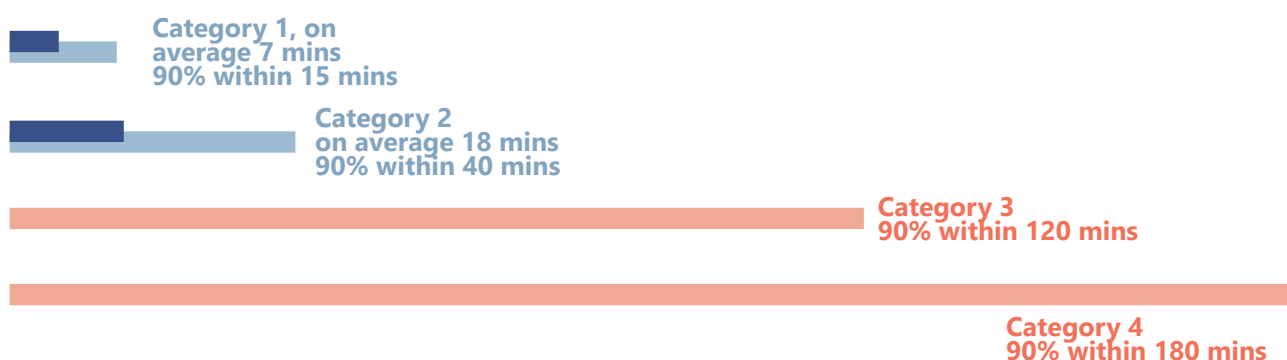


Figure 14: ambulance respond time

Emergency respond time and numbers of cold compress

The ambulance response time is categorized by NHS England into four response types as shown in **Figure 14**. Response times of non life-threatening injuries (**category 3 & 4**) can vary from more than 40 to 180 mins [30], and can be longer because of the longer distance far from the city. Recommended application of ice in **2.2.4** requires 10- 20 min per hour. However, considering the large size of ice packs, the

number of instant cold compresses should be at least 2 for high speed sports in case of response time exceeding 1 hour. For low speed sports, the importance of pain relief for every hour is low compared to size limitation.

The differences between two types of outdoor sports lead to the different selection of "MUST have" supply. In the ideation phase, two first aid kits should be developed. The final decision on medical supply will be summarized in **2.4.5**.

Conclusion

2 Ice packs in large version, 1 in small version

2.4 Current first aid product evaluation

2.4.1 Introduction

The last chapter in the discovery phase shows collected information about available first aid kits in the market. A first aid responder working in PMB showed two typical models of first aid kits designed for working places during an interview. The design doesn't fit the requirement of the dilemma in **2.3.3**, nor other portable first aid kits available in the current market.

The comparison of supply lists of a few models shows their problems of necessary supplies in treating sports injuries and fit outdoor sports context. However, the inclusion of other indirect tools for treatment are good examples to learn and select from according to the scenarios conclusions.

In the end, an existing product is evaluated involving the whole using process from opening to finishing treatment which is recorded.

Problems mentioned in the above chapter are detailed during the evaluation into each supply and step to help create a list of requirements.

2.4.2 The current first aid kit and standards

An overview of current available first aid kits on the market are listed in **Figure 15**. They belong to two representative first aid kit retailers: CarePlus (focus on portable first aid kit) and EHBO-koffer (provide first aid kits for working places in the Netherlands). The supplies themselves have no difference whether it is portable for outdoor use

or those for working places. The supplies and their quantities are adjusted based on different use purposes and number of users. To decide what should be eventually included in the first aid kit, the regulations of the first aid kit should be checked.



Figure 15: Current first aid kits

In the Netherlands, **there are no specific regulations about the first aid kit categories** or what medical supplies are mandatory to be included in them according to the biggest first aid retailer, EHBO-koffer [31]. Retailers provide workplaces or sell first aid kits based on the first aid guidelines of Orange Cross (Nederlandse Richtlijnen) and adjust the contents. The guidelines were developed by the Orange Cross and the Dutch Red Cross with the cooperation of the NIBHV in 2016, providing recommendations for almost all injuries based on scientific

evidence or available practical knowledge [9].

EHBO-koffer provides first aid kits for workplaces, schools and individuals in the Netherlands, Belgium and Germany, and has a wide range of them designed to meet different purposes [32]. EHBO-koffer is also one of the first aid kit suppliers for TU Delft. During the interview with Kevin Gielisse (**Appendix C**), one of the staff working in PMB, he showed a first aid box and a first aid backpack from EHBO-koffer (**Figure 16 & 17**).

Define
No regulations for first aid kit



Figure 16: A first aid kit in PMB [33]



Figure 17: A first aid backpack in PMB

BHV-koffer Orange Cross is a typical first aid kit sold on their website with a similar box as the rest. It is obvious that **the first aid kit and bag only serve as containers** of medical supplies. They also have large sizes due to the less necessary for space saving and higher quantities of medical supplies. These characteristics

determine that they are only suitable for working places with a large number of people or first aiders around all the time. **They don't meet the requirements** of single-hand use or light-weight needs for outdoor sports with fewer people.

2.4.3 Supply comparison of current first aid kits

By Looking into their first aid kits for sports, their checklist shows all medical supplies included, and can be used as a reference to choose my supplies into a "SHOULD have" list. Here supplies of two sports first aid kits from EHBO-koffer

and two from CarePlus are listed to show their decision making and differences between each other. Some are not for outdoor spots, but can still be used for comparison. **Figure 18** has an overview of what is included and what is not.

Medical supplies included in the current first aid kits

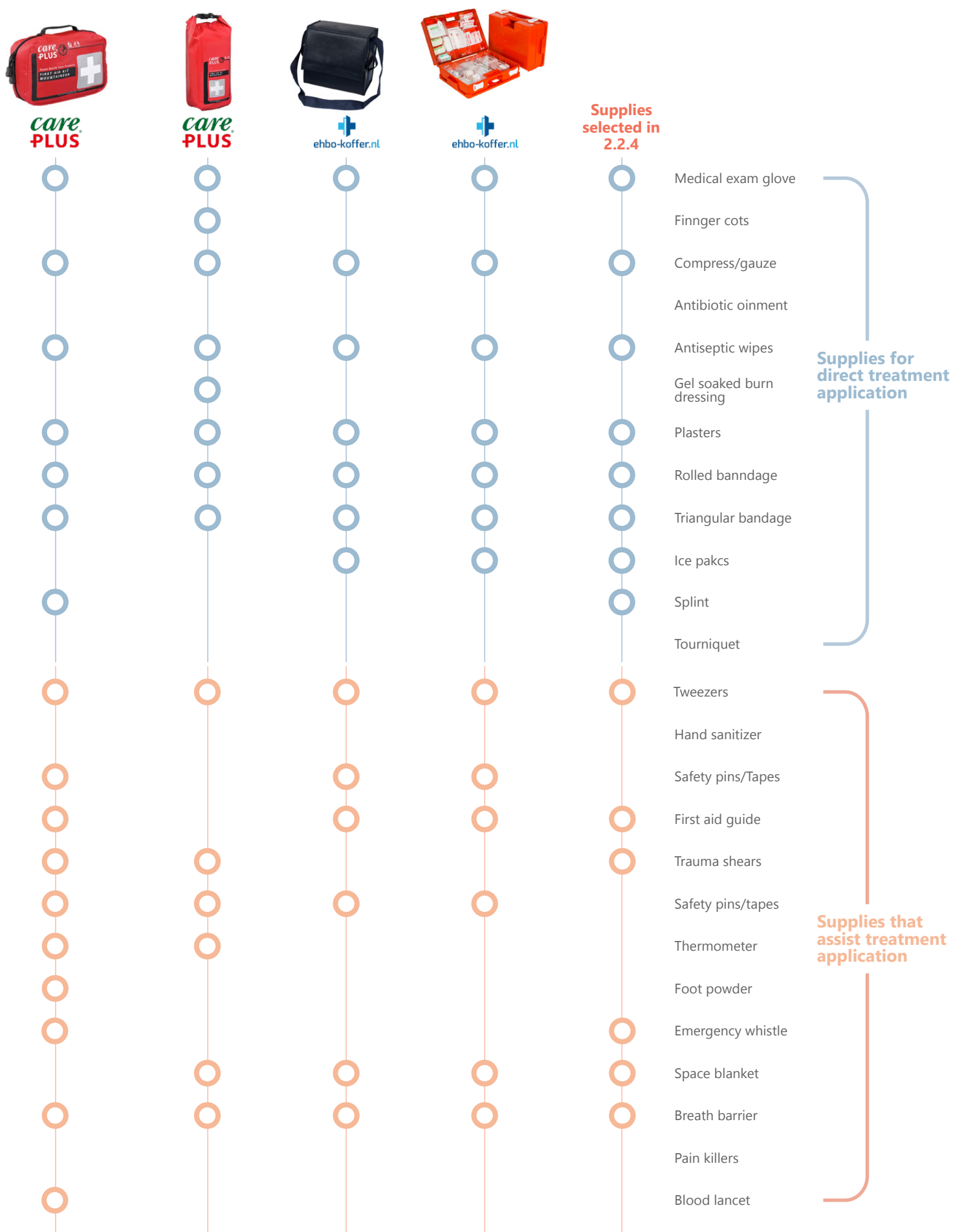


Figure 18: Medical supplies included in current first aid kits

The “SHOULD have” list includes supplies that assist the treatment apply but the treatment still works without them. They are not the core supplies for saving lives, but could be useful under a few circumstances. (**Figure 19**)

Conclusion
What indirect supplies are useful



1. Space Blanket:

According to **2.1.2**, a space blanket is useful to keep body temperature in a cold environment waiting for first aid responders, or for severe injuries like losing too much blood. It is suitable for high-speed outdoor sports which have a higher risk of severe injuries.



2 breath barrier:

creating a sanitary barrier between patient and rescuer's mouth during CPR and rescue breathing. People are still able to apply CPR without mouth barrier. Therefore it is not as important as the rest.



3 trauma shear:

effective in cutting clothes, branches or even thin metal sheets in emergency settings. Usually used when severe injuries with objects in the wound result from strong collision. It is suitable for high-speed outdoor sports which have a higher risk of severe injuries.



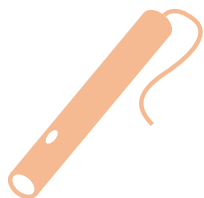
4 trauma shear:

effective in cutting clothes, branches or even thin metal sheets in emergency settings. Usually used when severe injuries with objects in the wound result from strong collision. It is suitable for high-speed outdoor sports which have a higher risk of severe injuries.



5 first aid guide:

2.3.2 The questionnaire result shows a first aid guide is one of the MUST have supplies.



6 Emergency whistle:



according to conclusions from **2.3.3** scenarios, asking help is the first thing the casualty should do, and an emergency whistle is a useful indirect supply to draw others' attention even at a long distance. So it is also included as one of the MUST have supplies.

Conclusion
Whistle is one of the "MUST have"s

Figure 19: Medical supplies assist the treatment application

2.4.4 Similar products selection

Before determining the final supplies, some decisions have to be made between some supplies with similar functions in order to decrease the size. (Figure 20)

	Function	Weight	Size	Can it be used by one hand	Reusable	Cost	Which body part?
	Designed for immobilizing bone and soft tissue injuries in emergency settings	16 g	8.2X8.5X10.7 cm	Yes, and needs bandage to fix it	Yes	€ 9	Almost all
	Triangular bandages can be used as large dressings, as slings to support a limb, or to secure a dressing in place.	125 g	9X5.5X2.5 cm	Really hard to apply alone	No	< 1€	Mostly for arms, and need training to apply to the rest.

Much better Better Worse

Figure 20: Comparison between SAM splint and triangular bandage [34] [35]

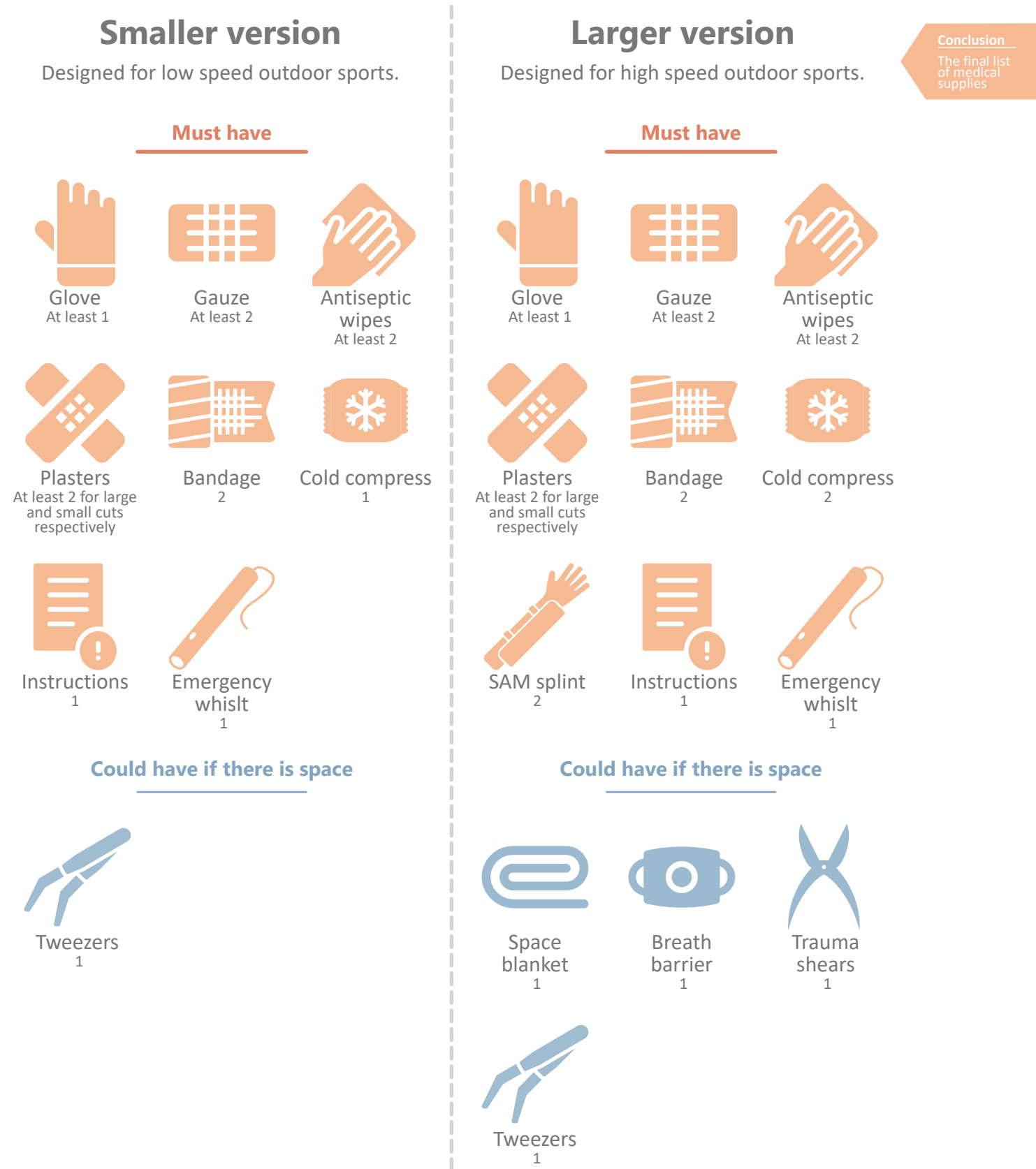
The SAM splint is **convenient to be folded and applied on a fractured part with only one hand and is reusable**. The only disadvantage of this product is its large size. But thanks to the thin aluminium sheet, it is possible to be included in the first aid kit somehow. The triangular bandage is another product to

fix the fractured part but extremely difficult to be used by one hand to make a node behind the neck [36]. Compared to the SAM splint, a triangular bandage is soft with less protection from impact, and has overlap in function as a bandage. It will only be included when SAM splint is impossible.

Conclusion
SAM splint is a better choice than triangular bandage for fractures

2.4.5 Summarize the list of final medical supplies

The final medical supplies list are the summary of chapter 2.2.4, 2.3.4 and 2.4.3. (Figure 21)



2.4.6 Product using process and User experience

CarePlus is a retailer selling a few different portable first aid kits for mountaineers, adventurers or families. The design of these first aid kits are similar, a first aid bag with an adjusted series of medical supplies. A CarePlus family first aid kit is used here to evaluate and detail the problem found in the previous chapter, in terms of accessing, opening and use of supplies.

One problem is the single-hand use of a first aid kit when an upper extremity is injured. The evaluation of the product will firstly focus on the situation. **Another problem of current product first aid kits is found in this chapter in terms of information**, which eventually optimize the efficiency by solving it. Some steps are necessary to be improved to provide a top clear first aid kit in front of its users and have fewer disturbances. The process of understanding the application steps and where to find the needed supplies are important in order to achieve the goal. **The evaluation is conducted by following the actual steps of use.** They are listed in **Figure 22**:

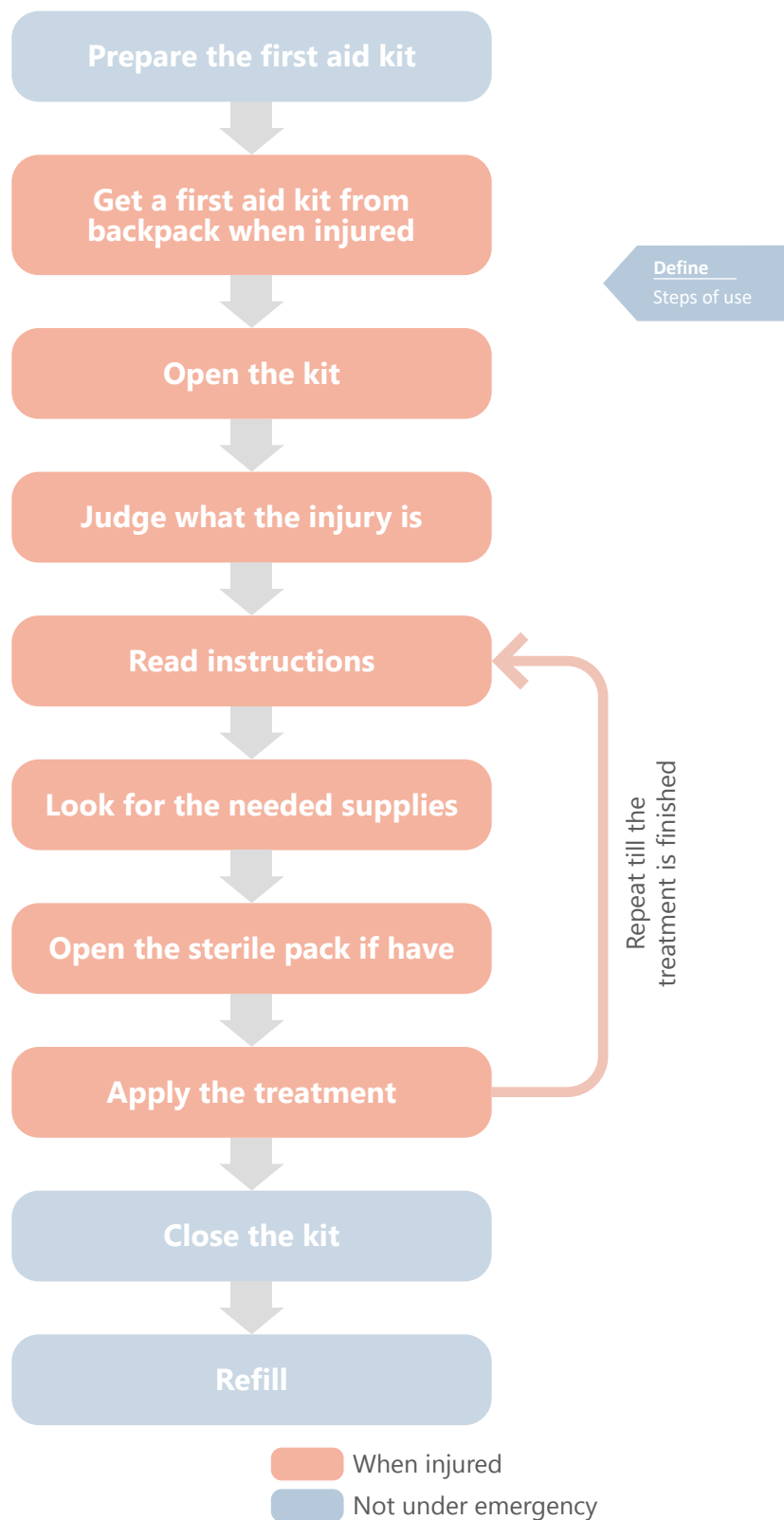


Figure 22: First aid use process

1. Prepare the first aid kit and looking for it when getting injured

The key to improve the efficiency in the first step is to get the first aid kit as quickly as possible. That's why the first aid kit for workplaces should be accessible within 30 seconds [37]. Getting a first aid kit involves **three main steps: to be aware that it exists from outside of the backpack, where it is and access it**. The users, its owner or the people around, should firstly know there is a first aid kit inside, then an effective first aid can happen. The first aid kit should be easily found and accessed is also important to improve the efficiency. If a long time is spent, the golden chance is wasted because of improper design. The CarePlus home first aid kit has eye-catching colour (**Figure 23**) to draw attention, but can't be noticed from outside of the backpack. Therefore, **the design of the first aid kit should achieve the fooling functions: be noticed from outside of backpack, easily known where it is and quickly accessible**.



Figure 23: CarePlus home first aid kit

2. Opening the kit

CarePlus home first aid kit uses a zipper as the opening way, which is possible to be opened with one hand without being fixed (takes 8 seconds in the evaluation) (**Figure 24**). **It can be improved to be more convenient and effortless in a simple way**. To achieve the function of function, **the first aid kit should be fixed**. The second problem found in step 2 is **hard to quickly find the needed medical supplies**. For those who purchase the kit and open it the first time, the locations of all supplies should be shown to users. CarePlus home first aid kit stacks

all supplies in three transparent bags and needs to take everything out to search for the needed one (**Figure 25**). They should see the instructions first and then decide if they are going to use it or not.



Figure 24: Use only one hand to open the first aid kit



Figure 25: What's inside the first aid kit

Conclusion

Main focus 2:
Improvement
of information

3. The way of using the instruction

A folded papery instruction (**Figure 26**) is possible but inconvenient to unfold with one hand too. The treatment steps are complete but very basic, and with too many languages besides. **It can be improved to be more intuitive and well-organized.**

A wet environment or even light wind is not friendly for papery instruction according to conclusions in **2.2.3**. A papery instruction will get wet and cannot be reused next time. **It is likely to be blown away by strong winds.** Therefore, the instruction should be fixed on the first aid kit.

An untrained user uses instructions to know the steps and what supply they need. After finishing one step, they will go back to check the next step and repeat a few times. For quicker and easier looking for the needed supplies, **the treatment steps should lead to the supplies in every step** so that users have a quick overview of what they will probably need for the whole treatment.



Figure 26: Use only one hand to open the instructions

4 Use one hand to open the sterile packs

Gloves, antiseptic wipes, gauzes, plasters and bandages have an extra package to make sure they are sterile before applying. **They should be easily opened and reloaded.** During the evaluation, opening the sterile packs is possible

only when the other side of the supplies are fixed by shoes or teeth (**Figure 27**). The key to one-hand use is to simulate the function of the other hand which is **fixing them on the first aid kit**. A reaction force should also be exerted on the kit to ensure that the kit wouldn't move either.



Figure 27: Use only one hand to open the sterile packs

5 Use one hand to apply the treatment

Similar to the sterile packs, a way to fix the supplies from one side should be developed to make the application convenient for the arm-injured user. The specific supplies that needed to be developed are **gloves and bandages**. (**Figure 28**).

Putting on gloves with one hand is almost impossible. The strong friction force between the inner surface and hands stops the process from being smooth and quick. The design should provide a way to fix the glove for **easier wearing and eject**.

The dressing should be applied right on the wounds to stop bleeding when using the bandage. Using a bandage with one hand will cause sliding of the dressing. The new application of one hand should **fix the dressing right on the wound and then wrap a bandage on the arm.**



Figure 28: Use only one hand to put on gloves and apply bandages

The product evaluation detailed the design problem within use steps, and will be listed as requirements in the define stage.

3

DEFINE

3.1 Design focus conclusion

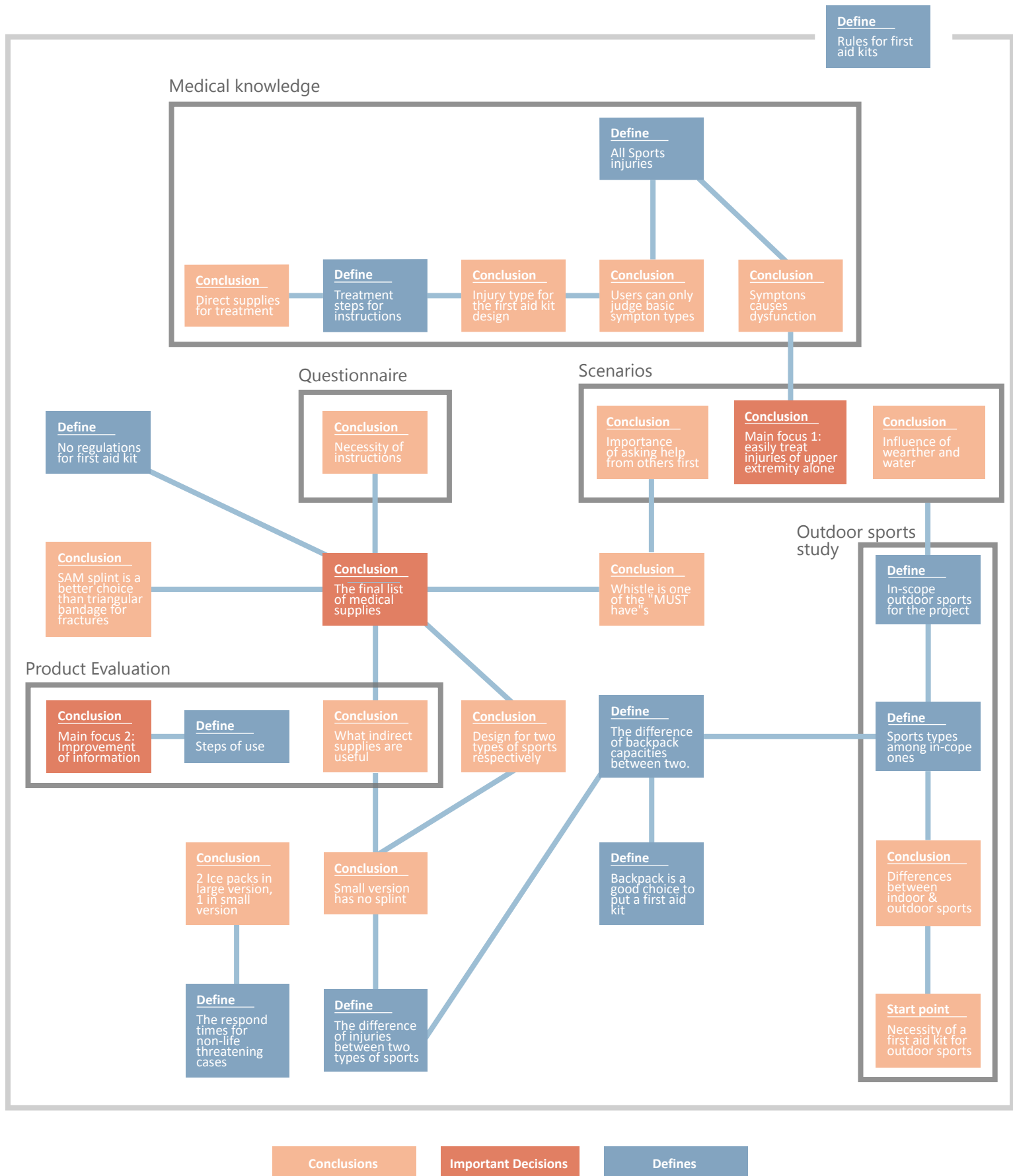


Figure 29: Defines and conclusions in Discover part

Figure 29 is an overview of all defines and conclusions in the Discover part. The basic rules on the top right defines what the design should follow. Outdoor sports and medical knowledge gives background of the first aid kit design. Two main design focuses are drawn from scenario analysis and current product evaluation. All their conclusions help select what medical supplies should be included and their quantities. These conclusions are limitations or design targets to be developed in idea generation. In this conclusion overview, those whose results are used in the next few chapters are connected with lines. From the previous research, there are some most important design focuses guiding the next part of project stage.

possible. On the other hand, their positions should follow the use sequence of supplies for easier and quicker use.

Design focus 1: Design a first aid kit for easy one-hand use

The analysis in the scenario part in **2.2.3** reveals the first design focus under a specific condition: How to conveniently and quickly apply treatment alone when one hand/arm is dysfunctional because of injuries. In the following ideation stage, ideas will be generated to achieve the target that all the supplies should be conveniently and quickly accessible and used with one hand. The requirement list in the next part shows more detailed design purposes for every supply.

Design focus 2: Optimized information design for a better user guidance

Found in **2.4.6**, the second design focus for the following design stages is guiding users better with more efficient information design of first aid kit. The problem is not only for the instructions, but the medical supply arrangement and sterile packs design. They should provide the most important and efficient information to the users in emergencies throughout the use process of a first aid kit. The requirement list shows details of information design based on research and design thinking.

Other important design decisions:

Treatment steps: as fundamental medical knowledge (**2.2.4**), the treatment steps are important information to guide users. In the following design process, they will be converted into intuitive illustrations on instructions to show users how the treatment is applied.

Final supply list: research conclusions in many chapters help to select the most necessary medical supplies that should be included in two versions of the first aid kits (**2.4.5**). On one hand, they should be well arranged to take advantage of space, making the first aid kit as small as

3.2 List of requirements

Requirements

1 The easy way of accessing first aid kit

Resources

1.1 Users should be aware of the existence of a first aid kit in the backpack at any time.

2.4.6 Step 1 Prepare the first aid kit and looking for it when getting injured.

1.2 Users should know the position of first aid kit relative to the backpack.

2.4.6 Step 1 Prepare the first aid kit and looking for it when getting injured.

1.3 Users should be able to get the first aid kit within 30 seconds.

2.4.6 Step 1 Prepare the first aid kit and looking for it when getting injured.

1.4 The access requirements should be applicable to the owner and others around him.

2.4.6 Step 1 Prepare the first aid kit and looking for it when getting injured.

2 The first aid itself and content

2.1 A light version and a bigger version should be provided to fit the different requirements of outdoor sports (e.g., small capacity for running and larger one for snowboarding).

2.2.2 What are the target outdoor activities?
The conclusion of outdoor sports types.

2.2 The first aid should firstly have a space for writing personal information.

Design thinking
Write the personal information (e.g. name/person to contact in emergencies/phone numbers/bloodtype/...) of the casualty under emergency and communicate with first aid responders in case of loss of consciousness like shock.

2.3 The first aid should include an emergency whistle.

2.3.3 Scenario conclusions
The importance of asking help from others prior to any treatment application.
2.4.3 Supply comparison of current first aid kits.
Find the emergency whistle is included in certain first aid kits
2.4.5 Summarize the list of final medical supplies.

2.4 Define the supplies and their corresponding treatments

Glove	Keep hands clean before touching the wound
Gauze	Stop bleeding
Antiseptic wipes	Cleansing wounds prior to applying a bandage
Plasters (large and small ones)	Cover open wounds
Bandages	Control bleeding, apply dressing to the wound
Instant cold compress	Reduce swelling and relieve pain
SAM splint	Support and protect broken bones
Instructions	Provide instruction for proper use of first aid supplies
Emergency whistle	Drawing attention and asking for help
Space blanket	Maintain body temperature
Breath barrier	Create a sanitary barrier during CPR
Trauma shear	Removing clothes under emergency
Tweezers	Remove tiny objects from wounds

2.5 The first aid MUST include supplies for basic treatment, for lighter backpacks: Instructions, glove, at least 2 gauzes, at least 2 antiseptic wipes, at least plasters (2 normal and 2 large ones), 2 bandages, 1 instant cold compress.

2.2.4 Treatment steps
Conclusions of direct medical supplies for treatment.
2.3.4 Bring a first aid kit for outdoor sports
Conclusion about splint and ice packs
2.4.5 Summarize the list of final medical supplies.

2.6 The first aid MUST include following supplies for bigger backpacks: Instructions , glove, at least 2 gauzes, at least 2 antiseptic wipes, at least 2 plasters (2 normal ones and 2 large ones), 2 bandages, 2 instant cold compresses and 1 SAM splint (or triangular bandage if SAM splint is impossible).
If there is extra space, larger version should include a space blanket, a breath barrier and a trauma shear.

2.2.4 Treatment steps
Conclusions of direct medical supplies for treatment.
2.3.4 Bring a first aid kit for outdoor sports
Conclusion about splint and ice packs
2.4.3 Comparison of current first aid kits
The selection of supplies that not for direct application.
2.4.4 Similar products selection
Choose SAM splint
2.4.5 Summarize the list of final medical supplies.

2.7 The volume of the light version should not exceed 1.5L (based on the size of supplies).

2.3.4 Bring a first aid kit for outdoor sports
Size comparison
4.1.2 Select Space management
Done during discover phase.

2.8 The volume of the big version should not exceed 2.8L.

2.3.4 Bring a first aid kit for outdoor sports
Size comparison
4.1.2 Select Space management
Done during discover phase.

3 Use of first aid kit – information

3.1 Users should see the instruction first after opening the kit.

2.3.2 Questionnaire
The necessity of instructions for everyone.
2.4.6
Step 2 Open the kit.
Design thinking

3.2 Users should be able to choose if they decided to use the instruction or not if they are well-trained.

2.3.2 Questionnaire
Some well-trained people don't need instructions.
Design thinking.

3.3 Users should see all supplies once the kit is opened.

2.4.6 Step 2 Open the kit.
Design thinking: The most efficient way of providing as much information as possible.

3.4 Instruction should show the needed supplies for every step and show where they are.

2.4.6 Step 3 The way of using the instruction
Design thinking: The most efficient way to lead users to supplies.

3.5 The information for every single supply should show the name and basic functions.

2.4.6 Step 4 Use one hand to open the sterile packs.
The current supplies already show the name and basic functions. The good design should be retained in my design too.

3.6 The sequence of the supplies should follow the treatment steps.

2.2.4 Treatment steps
Design thinking
The best way to find the needed supplies a based on the treatment, and help to organize.

4 Information on instructions

4.1 Instruction should firstly show the basic rule of first aid (checking the place is safe, call 112 before applying the treatment if needed).

2.24 Treatment steps
Orange Cross: The first step of the most injuries is to check and call 112 if needed.
2.2.2 First aid and first aid kit rules
Check the place is safe or call 112 before saving people.

4.2 Instruction should include the main 4 types of treatment and their steps: Cuts and grazes, severe bleeding, RICE method, fracture.

2.2.3 Sports injuries
Concluded basic types of injuries.

4.3 Instruction should be intuitive to be understood as quick as possible.

2.4.6 Step 3 The way of using the instruction

5 Use of first aid kit

5.1 The first aid kit should be able to open with one hand easily.

2.3.3 Scenario conclusions: Main focus 1
2.4.6 Step 2 Open the kit.

5.2 All sterile pack should be easily opened by one hand (Gloves, gauzes, wipes, plasters and bandages)

2.3.3 Scenario conclusions: Main focus 1
2.4.6 Step 4 Use one hand to open the sterile packs
These supplies have sterile packs.

5.3 All supplies should be easily taken out with only one hand.

2.3.3 Scenario conclusions: Main focus 1
2.4.6 Step 4 Use one hand to open the sterile packs
The next step of opening sterile packs.

5.4 One-hand use should be developed for opening instruction, wearing gloves, bandages, plasters.

2.3.3 Scenario conclusions: Main focus 1
2.4.6
Step 5 "use one hand to apply the treatment"
These two are impossible to use without the other hand and should be improved.

5.5 The first aid kit should be fixed while using it in order to provide reaction force.

2.3.3 Scenario conclusions: Main focus 1
2.4.6
Step 2 Open the kit.
The principle of single hand use.

5.6 The first aid kit should fix supplies on it and provide reaction force to simulate the function of the other hand.

2.3.3 Scenario conclusions: Main focus 1
2.4.6 Step 4 Use one hand to open the sterile packs
The principle of single hand use.

5.7 The instruction should be used under the influence of water and weather, and be stable so that the user can see it clearly.

2.3.3 Scenario conclusions
Influence from weather and water
2.4.6
Step 3 The way of using the instruction

6 The rest of requirements (secondary)

6.1 Medical supplies should be easily reloaded.

2.4.6 Step 4 Use one hand to open the sterile packs
Design thinking: after use or during preparation.

6.2 The components should be as few as possible.

Design thinking: The least steps mean quicker application and more convenient use.

4

DEVELOP

4.1 Idea Generation

4.1.1 Introduction

The idea selection part follows the rules of the morphological chart method and consists of several independent parameters (**Figure 30**). For each parameter there are possible idea or options created for selection. Based on the criteria, the best idea will be selected and a complete concept will be shown at last as the result of the best idea combination for further development. The judgement of an idea will be ranked as good, acceptable and bad. The detailed selection can be found in **Appendix E**.

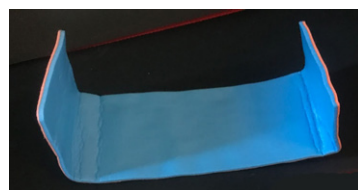
Parameters	Problem to be solved
Space management	How to make full use of space to include desired medical supplies and list them following the treatment steps?
Draw attention	How to make the first aid kit noticeable to people around and quickly understand the existence of the kit inside the owner's backpack.
Fix on a backpack	How to stably fix the first aid kit on a backpack, providing reaction force for the following treatment steps?
Kit opening	How to open the kit quickly and easily with only one hand?
Instructions	How the instructions assist users to use the medical supplies in a proper way? Where should it be and how is it used?
Sterile packs	How to design easily opened sterile packs which make medical supplies quickly accessible with only one hand?
Glove	How to develop a new way to help users putting on glove with only one hand?
Bandages	How to apply bandages with only one hand?

Figure 30: Parameters of morphological chart

4.1.2 Ideation Process

This part shows the most essential part of the ideation process, which aims to provide and select the most promising solution for each parameter. These possible solutions have their own pictograms for a morphological chart and show a clear road which ones are chosen.

The ideation process started with space management. Where the first aid kit is when not in use and how to arrange all supplies to make full use of space inside the kit are primary problems to be solved. The first aid kit should be put inside of the backpack according to the users (**Figure 32**). Three ways of placing supplies were generated during ideation. The first idea, laying supplies flat, was selected because of least disadvantages (**Figure 33**). There are two ways to place a SAM splint. Method 1 requires one less step to use, so it is better than the method 2 (**Figure 31**).



Method 1, unrolled



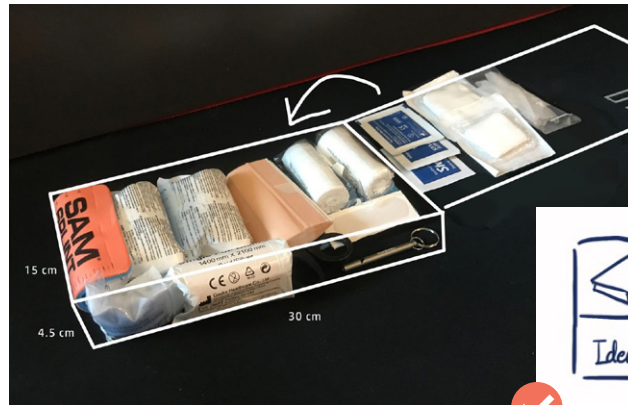
Method 2: rolled or folded



Figure 31: Two ways of placing SAM splint



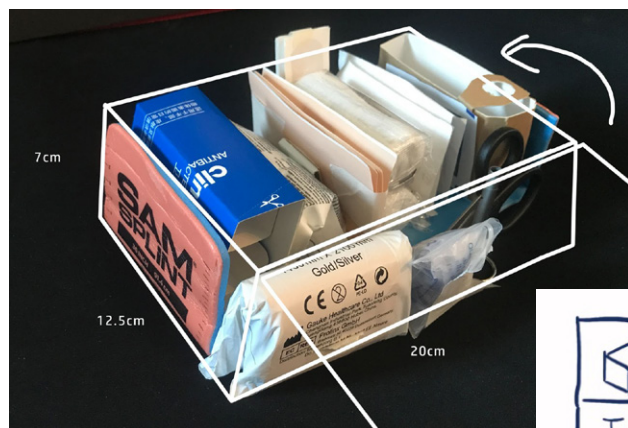
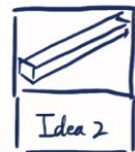
Figure 32: Put first aid kit inside or outside of the backpack



Idea 1, lying flat



Idea 2, slim kit



Idea 3, placed upright



Figure 33: Put first aid kit inside or outside of the backpack

When placing inside the backpack is decided, ideas to draw the attention of both owner and the people around should be focused. In this step, the “accessory” attached to the backpack is the key to draw attention and has a few options to select from. The Pin is selected (**Figure 34**).

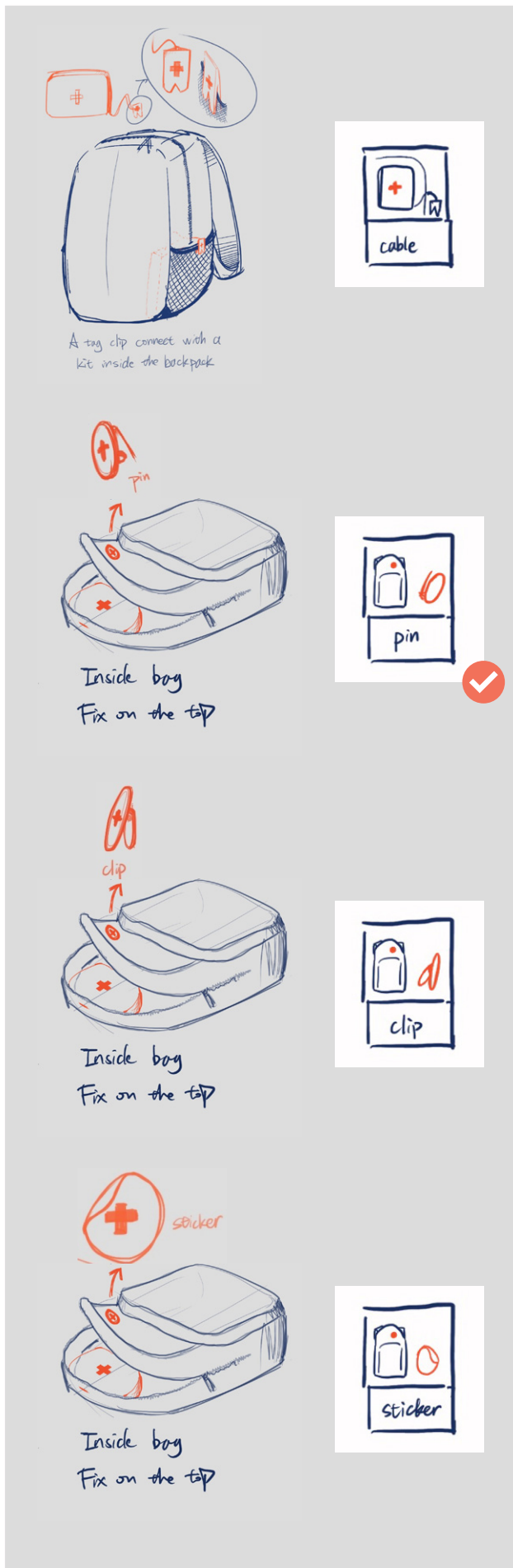


Figure 34: Ideas for drawing attentions

Reaction force provided by the first aid kit is the most important for single-hand use. The function requires the kit to be firmly fixed on the backpack when applying treatment. Ideas in this step are different ways of fixing them on a backpack while in use. The hook is selected since it is the quickest way with the least steps (**Figure 35**). A hard kit is better than a soft kit to transmit the force. (**Figure 36**) How to open the kit is the next step after fixing the kit on the backpack. Here the simplest opening way is selected. (**Figure 37**)



Figure 35: Ideas for providing reaction force

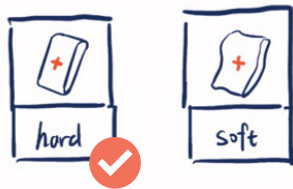


Figure 36: Select between a hard or soft kit

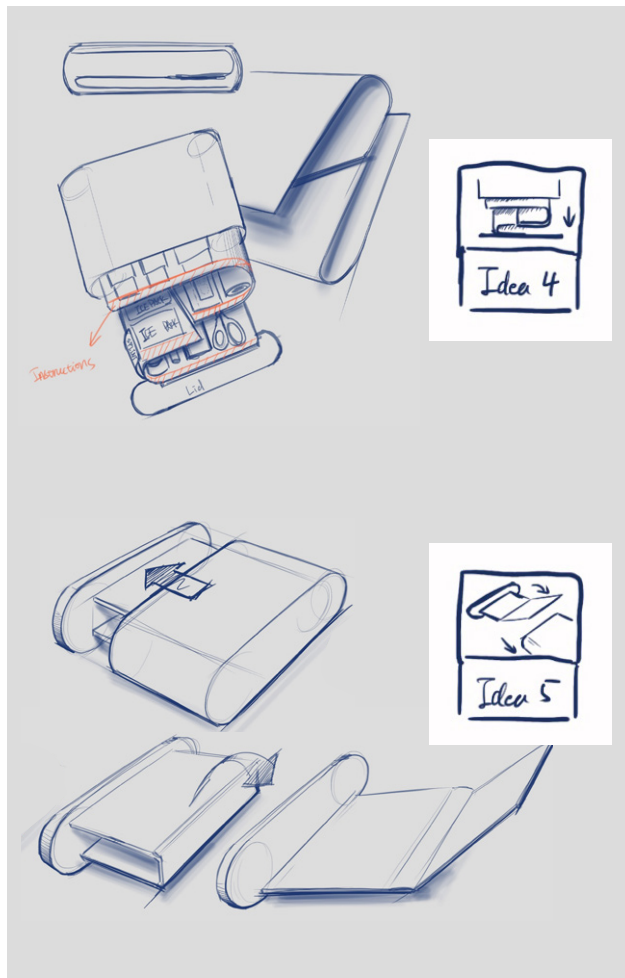


Figure 37: How the first aid kit is opened

Instruction is the first thing users should see once the kit is opened and should be connected to the kit so that they won't be blown away by wind. Users then choose to look at the instruction or directly apply the treatment themselves. Ideas in this part solve where to place the instructions and how the treatment steps are shown. Instruction unfolded from the top is the current best idea according to the comparison. (**Figure 38**)

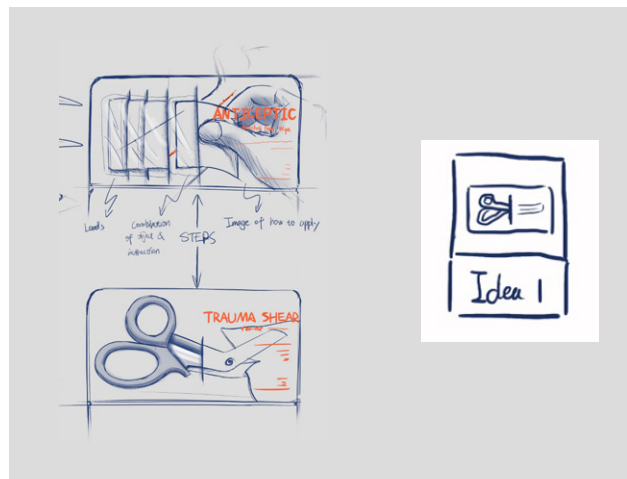
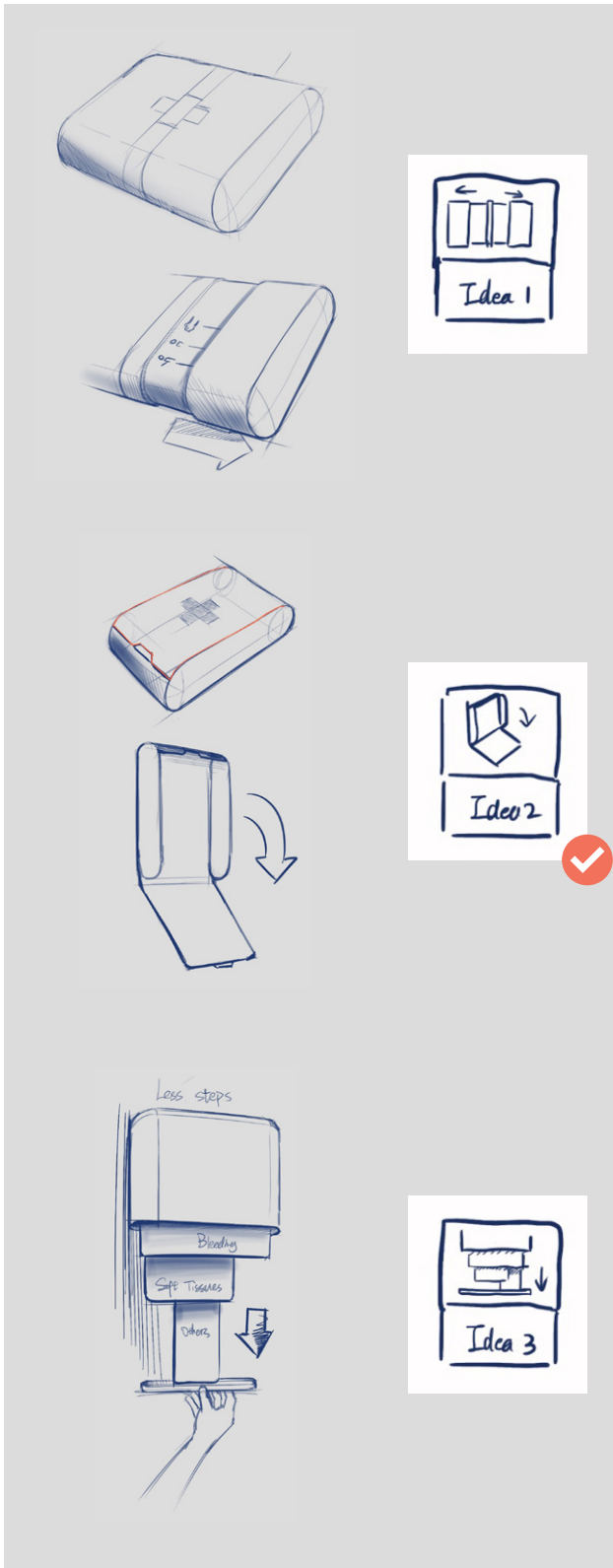




Figure 38: Instructions

Pulling sterile packs in one direction to open them is a convenient way for one hand only and is better than the first one (Figure 39). More detailed design, an fixing unit system, is generated to achieve the target. (Figure 40)

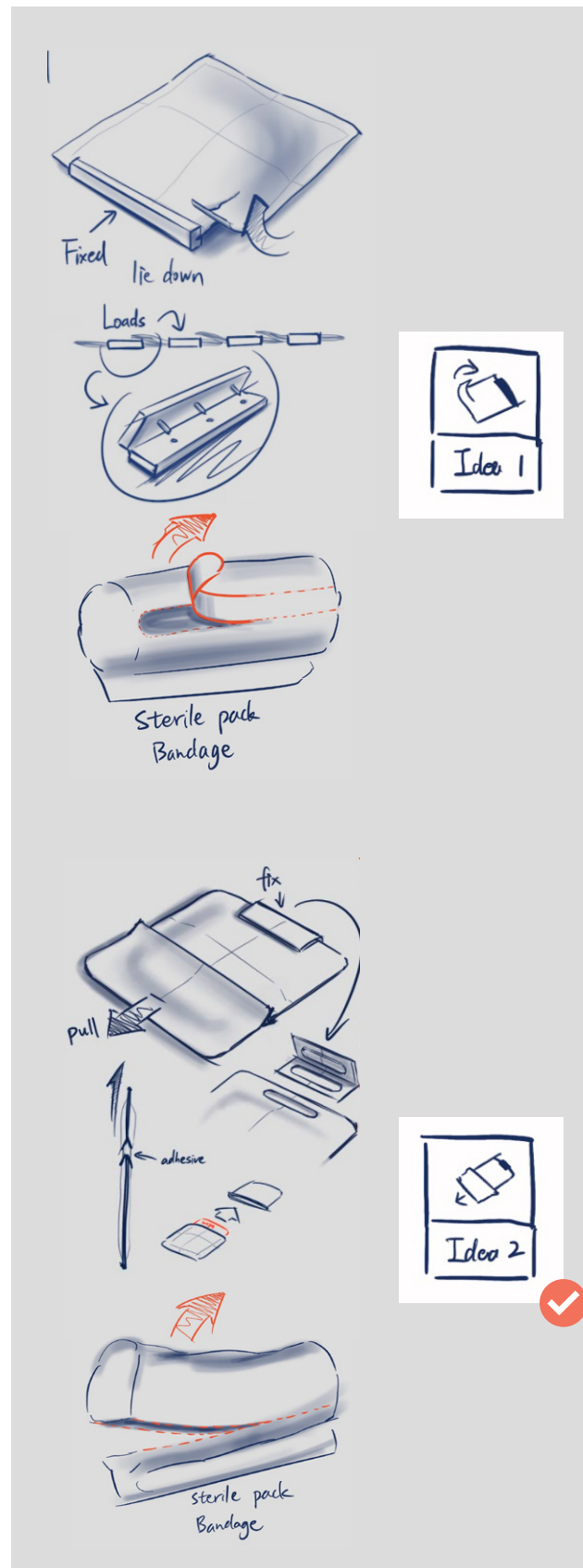


Figure 39: How sterile is open with only one hand

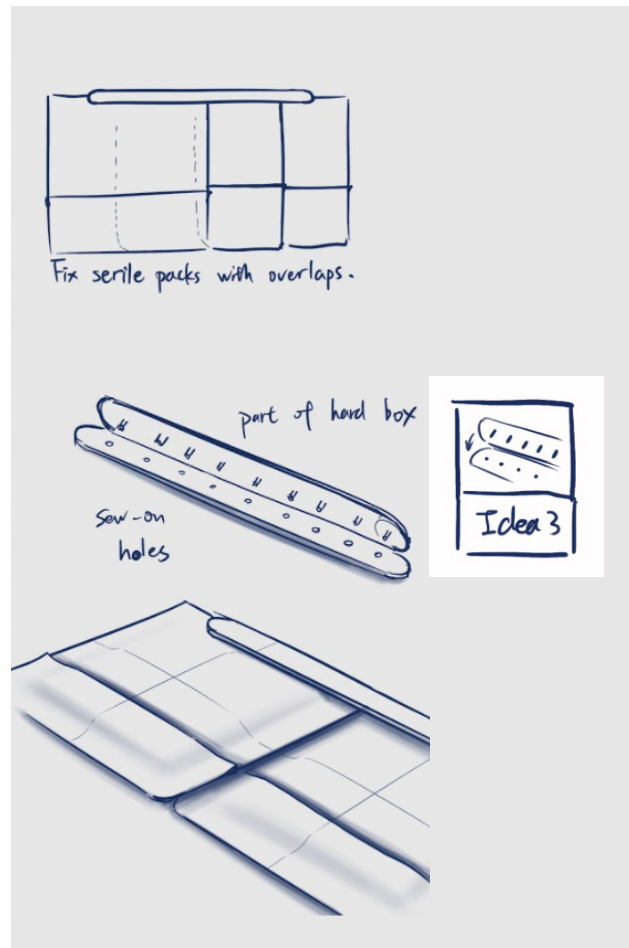
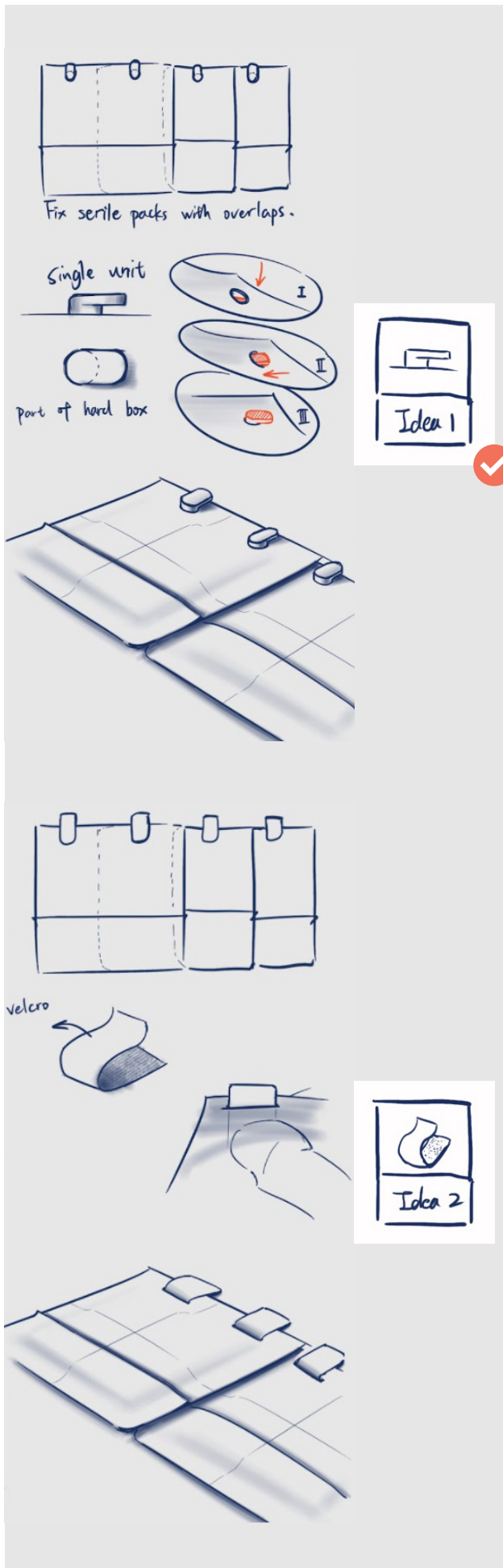


Figure 40: More detailed design for sterile pack system

Putting on gloves is the most challenging problem to be solved. The principle of the solution is to fold gloves (only fingers) (**Figure 41**), which allow fingers to contact the fingertip of the glove first and then unfold. Only the second idea fits the choice in space management. (**Figure 42**)

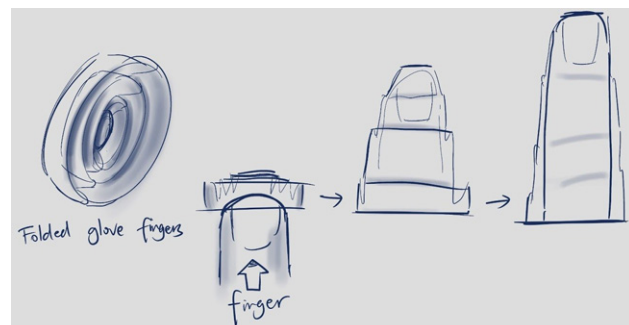


Figure 41: Principle of putting on glove with one hand

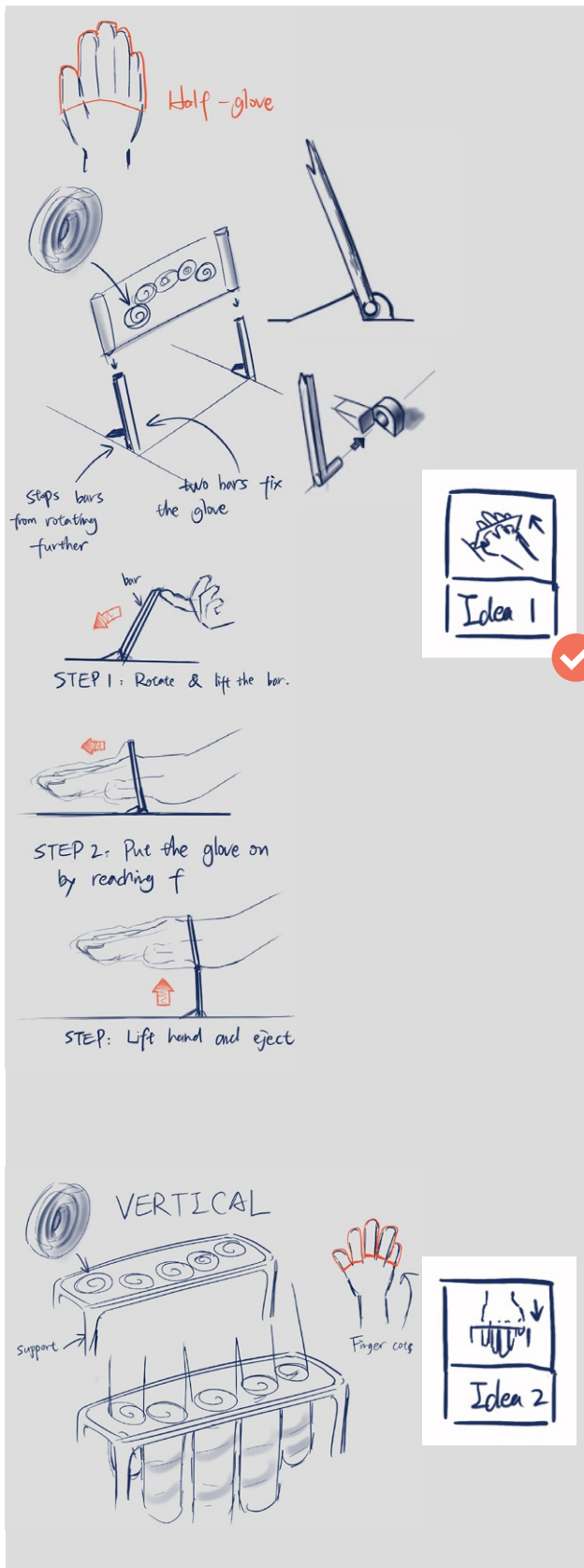


Figure 41: Putting on glove with one hand

The idea for one-hand-use bandage is to fix one end of it, allowing users to first wrap the other end on the injured site and then use a clip to fix it. (Figure 41)

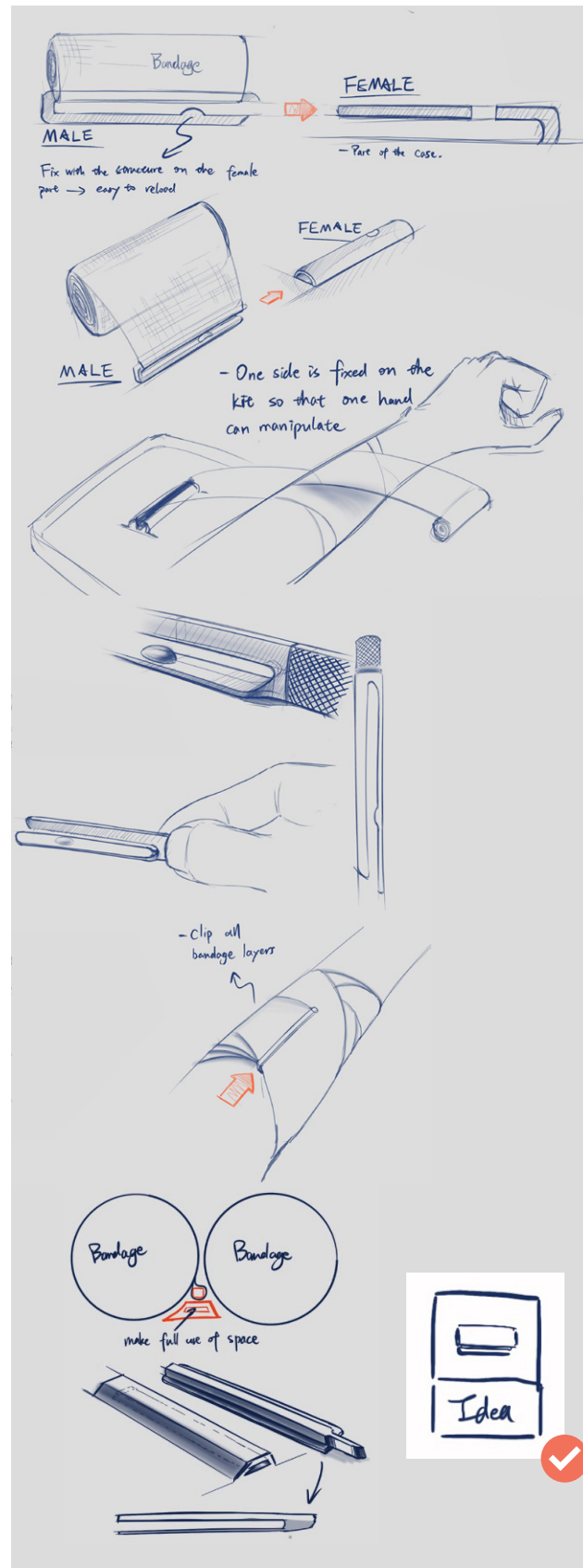


Figure 42: How to apply bandages with one hand

4.1.3 Morphological Chart

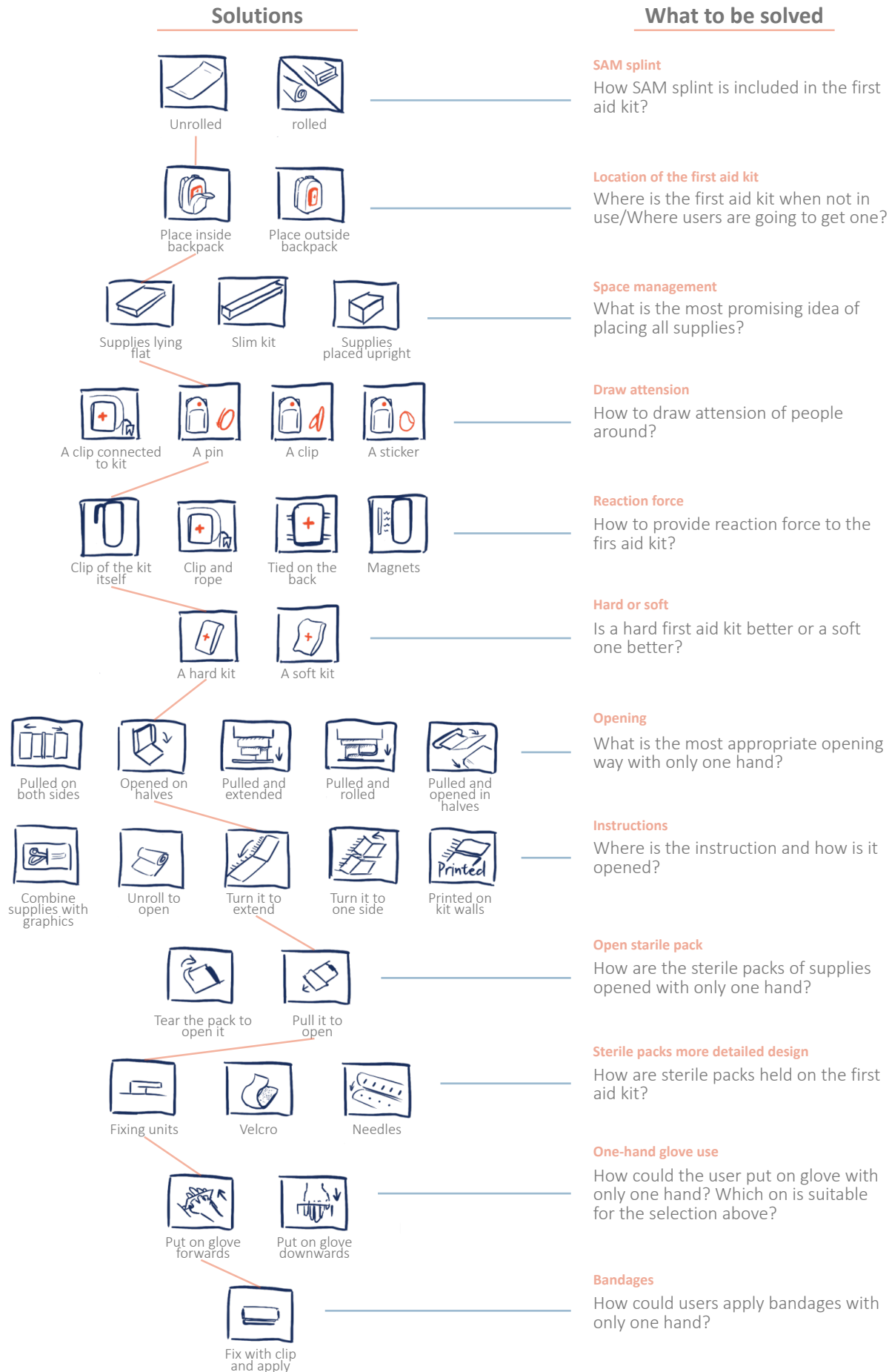


Figure 43: Morphological chart

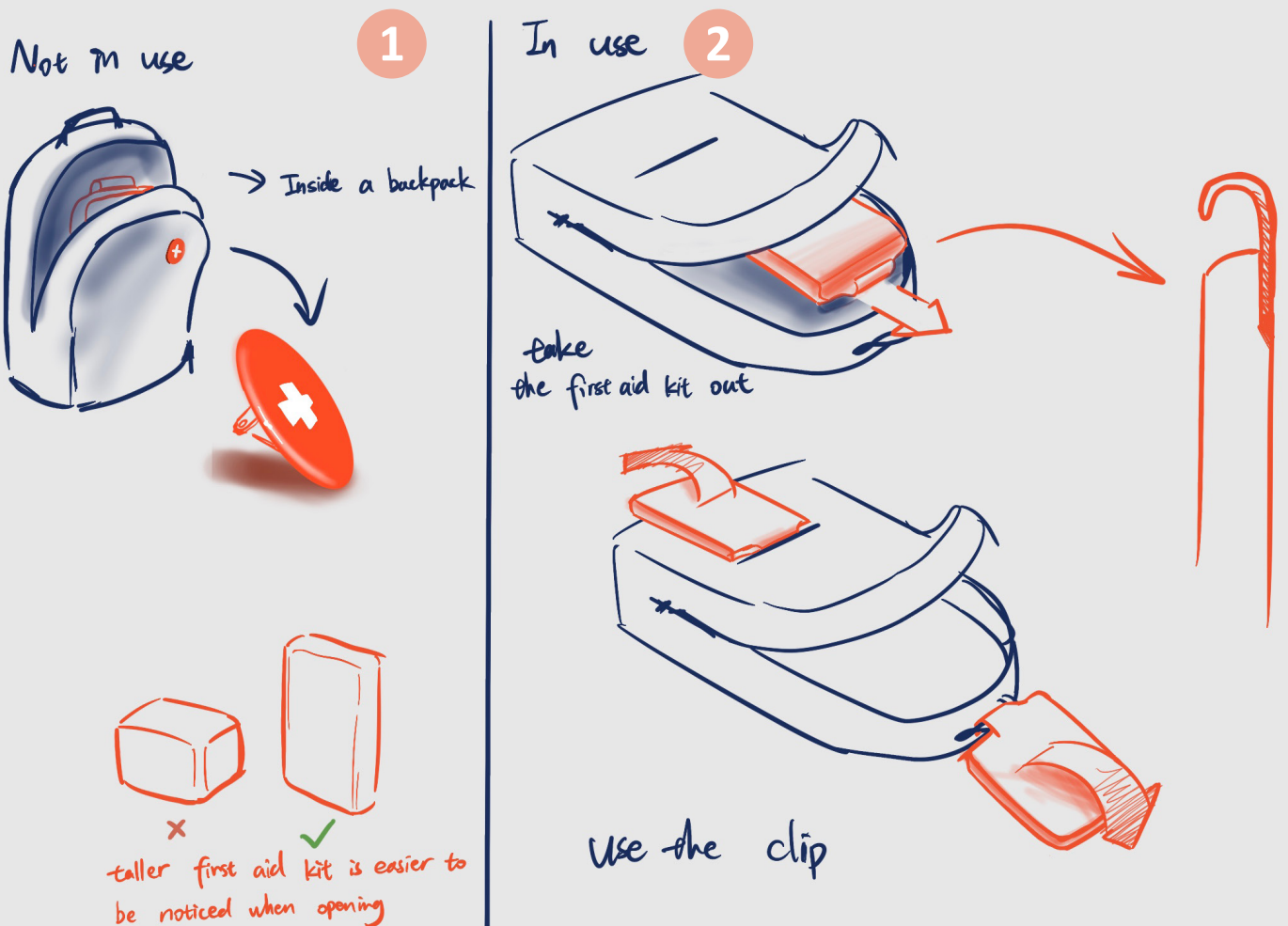
4.2 Concept

The ideas selected in parameters fulfill all requirements, and are eventually combined into a concept. They have no obvious conflict between each other in this concept, which is currently feasible for the next stage. They will be further tested with prototypes to find out if they really achieve the design target, and evolve to a physical concept.

The concept is a first aid kit brought by outdoor sports enthusiasts when they do outdoor activities, inside their backpack. A tag is bought together with the kit and hung on the backpack. People around are well informed about the existence of the first aid kit so that the treatment can be applied with medical supplies even when the casualty is unconscious.

The product provides a solution for the worst situation that operating extremity is unavailable. When one arm is dysfunctional because of

injuries, it is not only possible but convenient to use the designed first aid kit with only one hand. Use process designed into least steps, all supplies included in it are quickly and easily accessible or usable without the help of another hand. With this first aid kit users are able to apply treatment themselves for all body sites. The information shown to the users under emergency is well organized. All medical supplies are seen once the first aid kit is opened, which are also listed based on the treatment steps. The instruction fixed on the first aid kit has illustrations for every treatment step. The use experience throughout the treatment application is improved by showing the most important information hierarchically, including illustrations and supply themselves. The design details are shown below.



1 A pin with eye-catching color located outside of the backpack drawing the attention of both the owner and people around. They will all be aware that there is a first aid kit inside the backpack for emergencies.

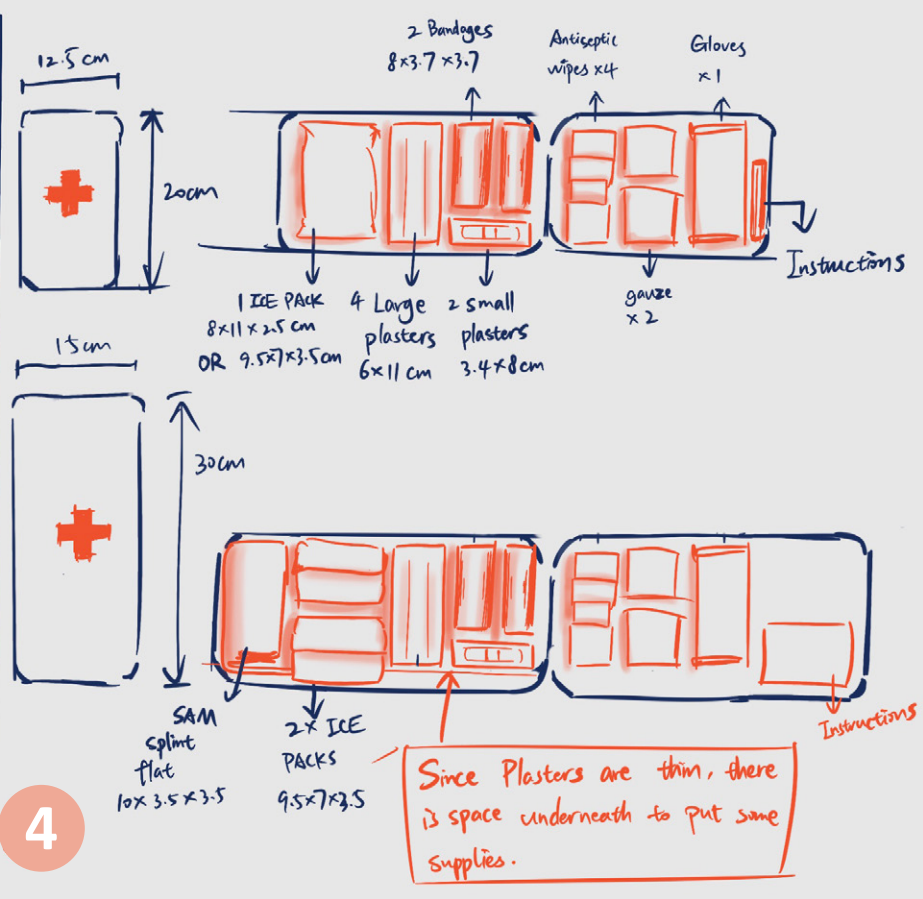
2 Users take out the first aid kit from their backpack when an injury happens. The hook on top of the kit serves as fixation providing reaction force. It can be hooked on the pocket or handle of a backpack, flexible in use.



3

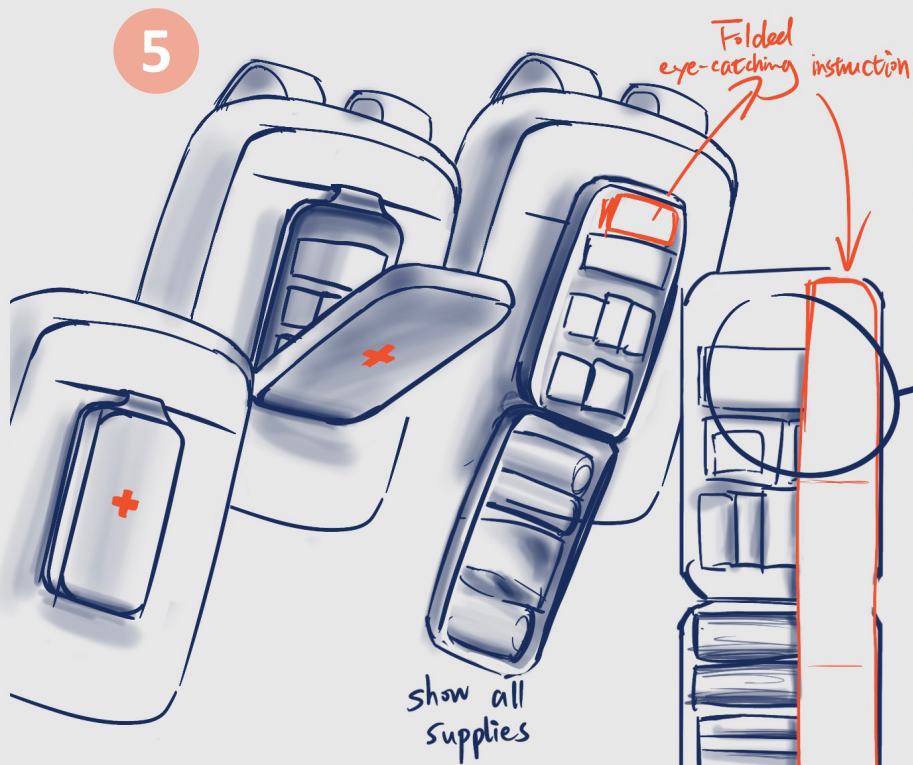
3 Pockets and handles are the best places for a first aid kit to hook on, and are all wider than hand width in order to reach in. Therefore the width of the hook is similar to hand width.

4 Second part shows the dimensions of two versions of the first aid kit and the layout of all supplies inside them.



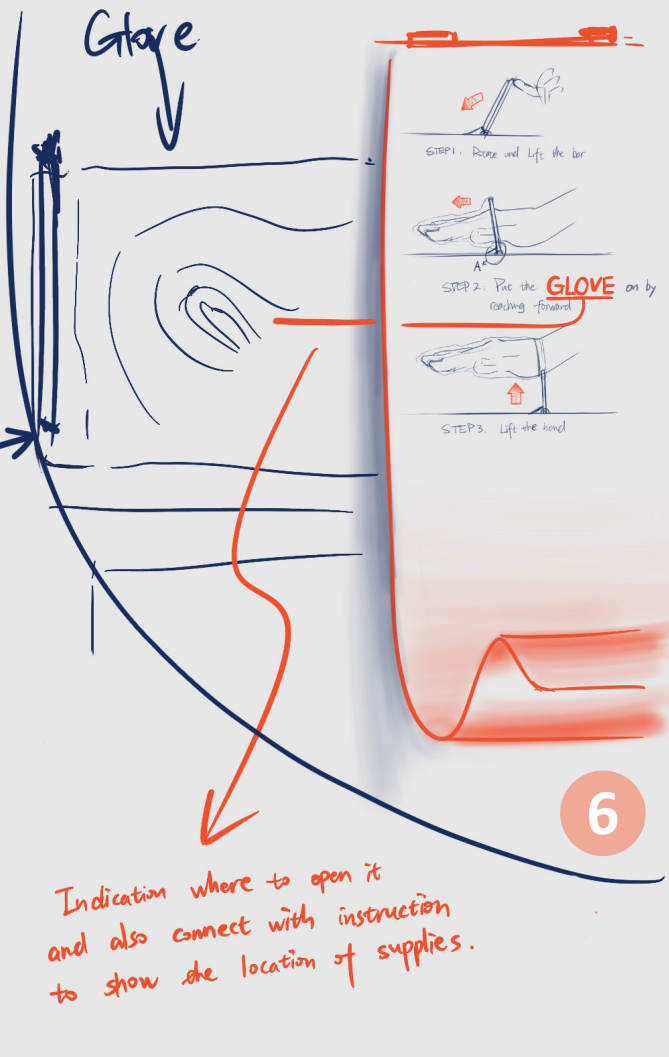
4

5

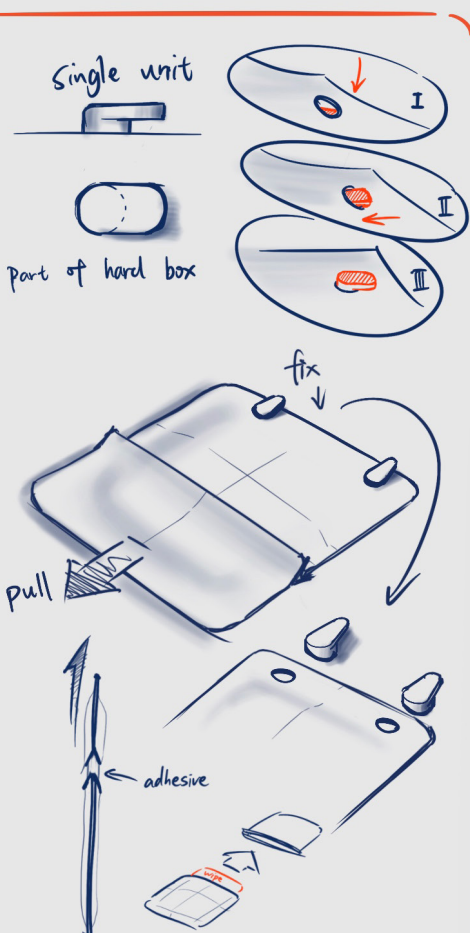


5 The first aid kit is a hard box and opened in a simple way as shown in the sketch. The user will quickly and clearly see all supplies once opened.

6 An instruction with eye-catching color is placed at the top of all supplies so that the user notices it first after opening. It can be unfolded to see the treatment steps, and the corresponding supplies. The name of the supplies are connected with the opening indicator on the sterile pack, in this way users know where to find the supply and where to open the sterile pack.

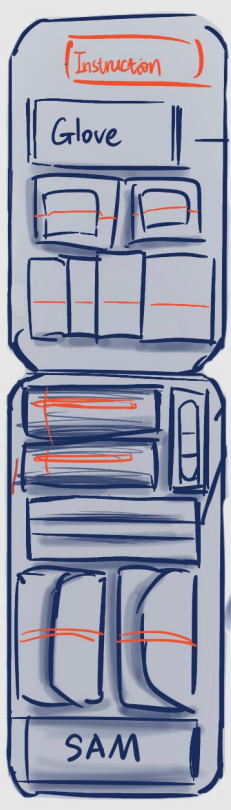


6



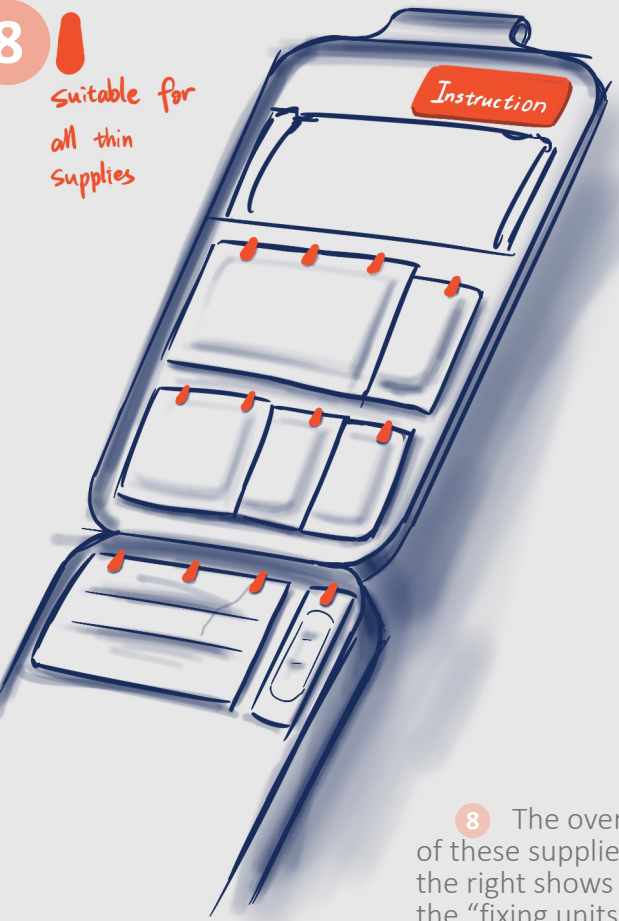
7

7 The sterile packs of wipes, gauzes, and plasters are opened as shown in the sketch, as well as how to reload.



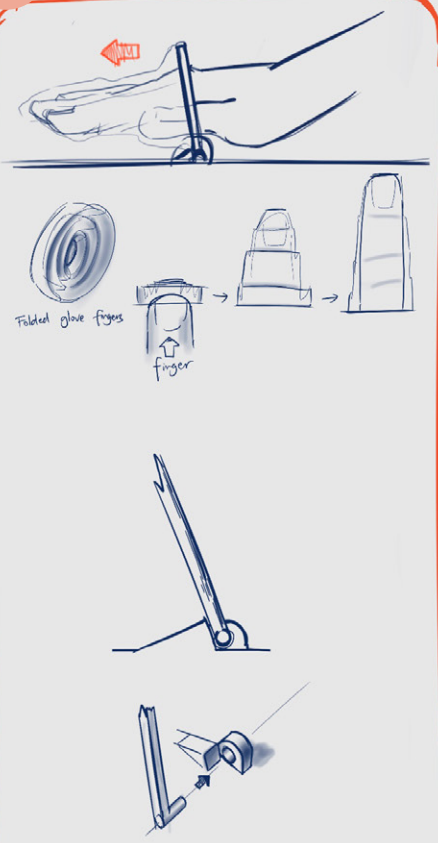
8

suitable for all thin supplies



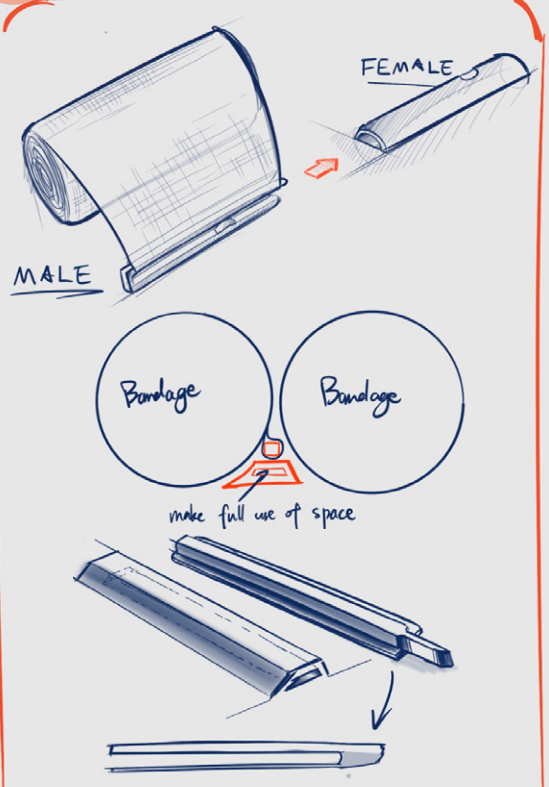
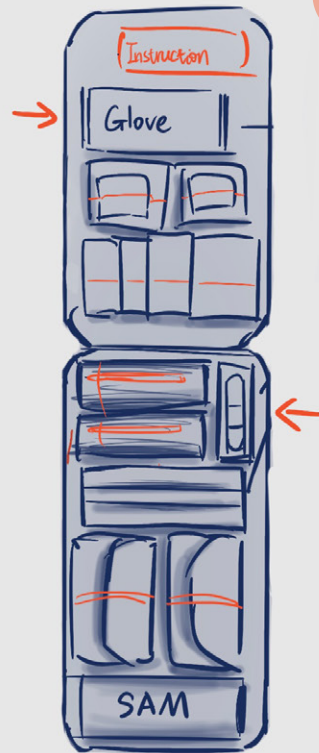
8 The overview of these supplies on the right shows how the "fixing units" are located inside of the first aid kit.

9 glove use



9 How to use the glove with one hand.

10 Bandage use



10 How to use the bandage with one hand and fix it with plastic structure: a male and a female component. The female is part of the box.

4.3 Concept validation and test iterations

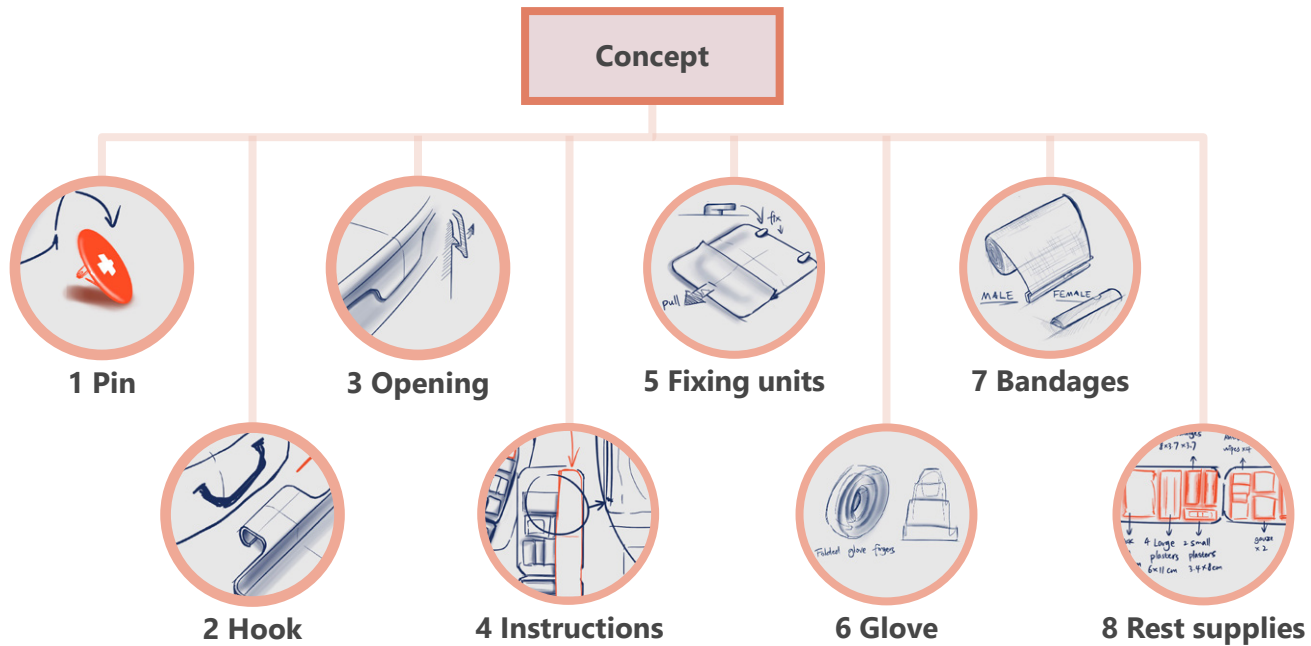


Figure 44: Concept testing themes

To make a sketched concept a realistic product, the strategy used after the midterm is to divide the concept into several independent parts again and test them separately, as shown in **Figure 44**. Each part has a few iterations, from simple cardboard prototypes to 3D printed parts, to solve the problems during embodiment until the part is good enough to be combined into the final design. For each theme there are questions to be answered to validate the concept. They are listed as follows.

1 Pin (tag):

Can the pin distinguish itself from the environment and be noticed by users?

Can users understand the information and be aware of a first aid kit inside?

2 Hook & 3 kit opening:

What design allows easy opening and does not influence the use of a hook?

What shape is best for the hook on pockets and handles?

What is the maximum force to use the design?

Can the injection molded part withstand the force?

4 Instructions:

Treatment steps information hierarchy and

design.

5 Fixing unit system:

How to apply the sterile pack design to all four thin supplies?

What are the locations of fixing units and their distance between each other?

Are sterile packs easy to open with one hand?

Can fixing units hold the sterile packs without

falling off and can be easily reloaded?

What is the maximum force required to open sterile packs?

Are injection molded units strong enough to withstand the force?

6 One-hand-use glove:

Can all fingers put into the half-glove together conveniently?

7 One-hand-use bandages:

Does the design allow bandages to be easily used by one hand?

What is the maximum force required to use the bandage?

Is the design able to withstand the force?

8 Rest supplies:

How to include the rest of the supplies in the first aid kit?

How to make them accessible by one hand too?

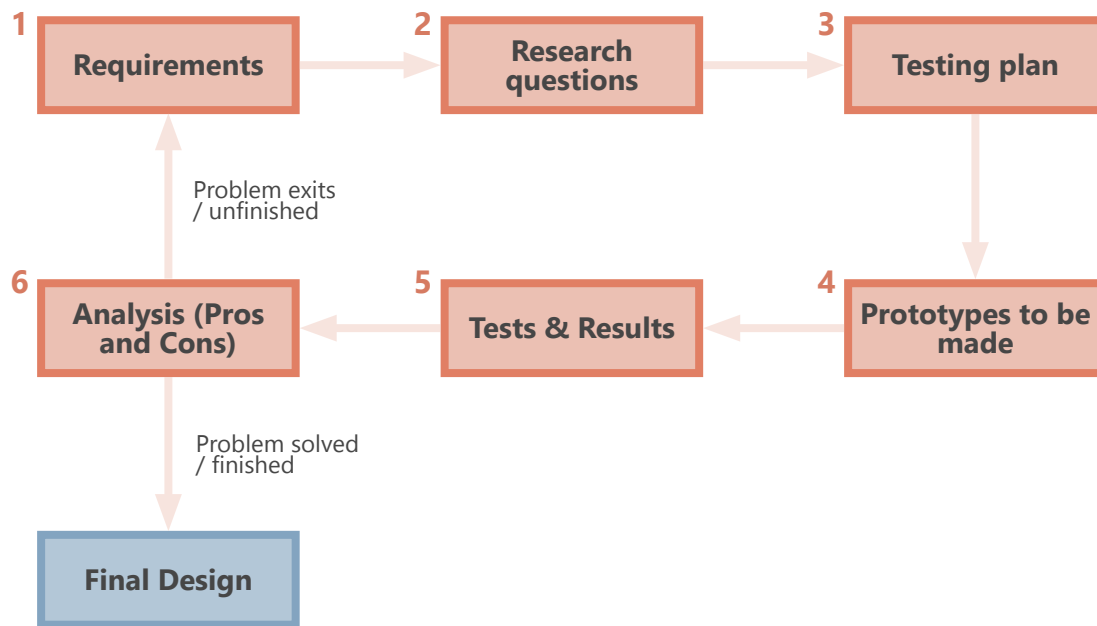


Figure 45: Testing loop

The iterations use the method shown in **Figure 45**: define the target, make prototypes, discover problems, conclude the test and guide the next iteration.

1 Requirements:

The requirements come from the list of requirements, or generated from new design thinking have to be achieved. They guide the tests of each part.

2 Research questions:

The specific and unclear questions to be answered by conducting a few tests.

3 Testing plan:

The plan for the following testing involves what to make, what tool to use and how to test.

4 Prototypes to be made:

Specifically what prototype should be made. How will the prototype be like, and their material, way of making and tools?

5 Tests & results:

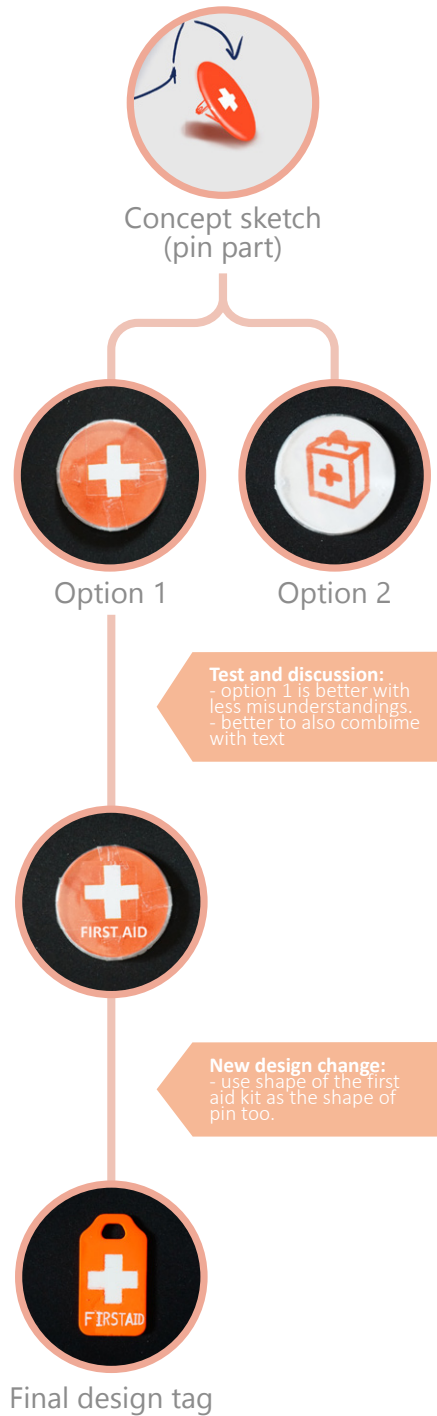
Conduct the test, record them in different manners.

6 Analyze:

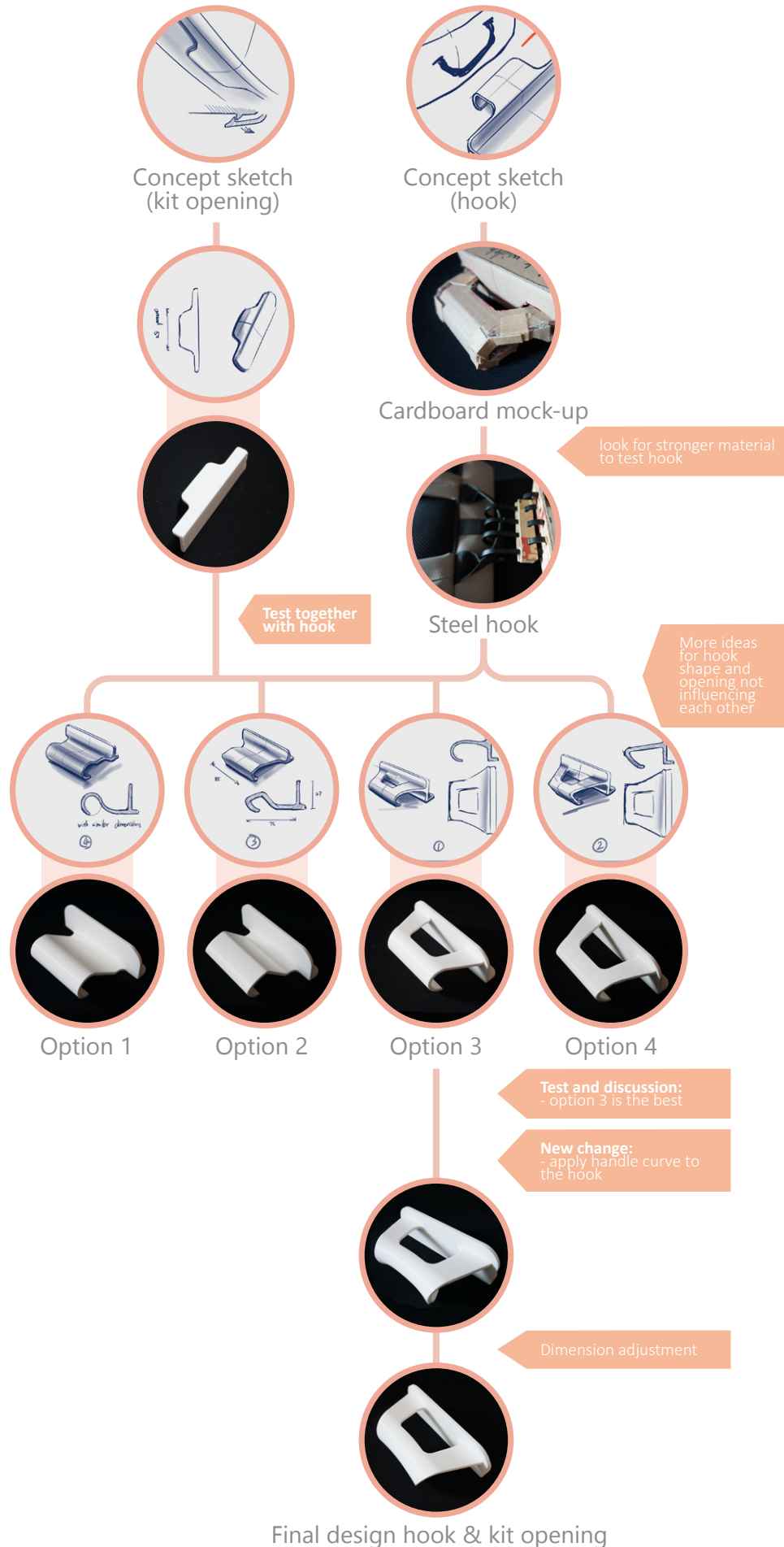
is that answer the research question? what are the pros and cons discovered from the test? Are there any new issues popping up? Is this design good for the final concept? what new requirements show be listed?

The complete test process can be found in **Appendix F**.

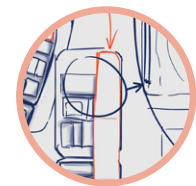
1 Pin(tag)



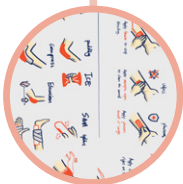
2 Hook & 3 kit opening



4 Instructions



Concept sketch
(Instructions)

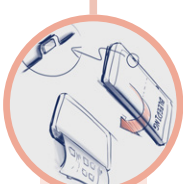


Drawing
Illustrations

Arrange all illustrations

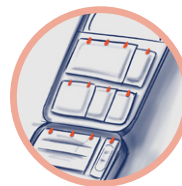


Test and discussion:
- change to a bigger
one which has more
advantages than the last



Final design instructions

5 Fixing unit system



Concept sketch
(Fixing unit system)



Cardboard mock-up
fixing units

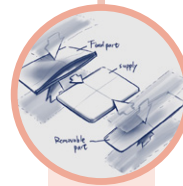


3D printed part is
stronger to be tested

Higher units for large and
small plasters



change the shape of
smaller plaster unit to
make it non rotatable.



Cardboard mock-up
fixing units



Change the pack of large
plaster, which requires
much less force to open.



Design of sterile packs,
showing the most
important information
on the front side



Final design sterile packs

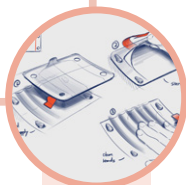
6 Put on glove with one hand



Concept sketch (glove)



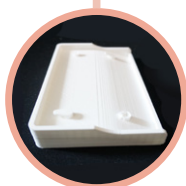
The idea is hard to achieve because of force direction. An alternative is found.



New idea aims for hands cleaning. And how it is opened is designed too.

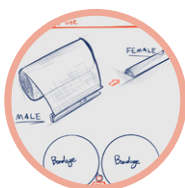


Cardboard mock-up



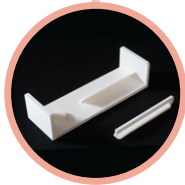
Final design for hands cleaning

7 Bandages



Move the dressing closer to the first aid kit

Change the direction how the plastic part is ejected

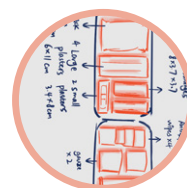


Change the design to withstand force



Final design one-hand-use bandages

8 Rest supplies



Trauma shear is changed to sewing trimming scissors



Final design to be combined

Iterations Overview

The complete test process can be found in Appendix F.

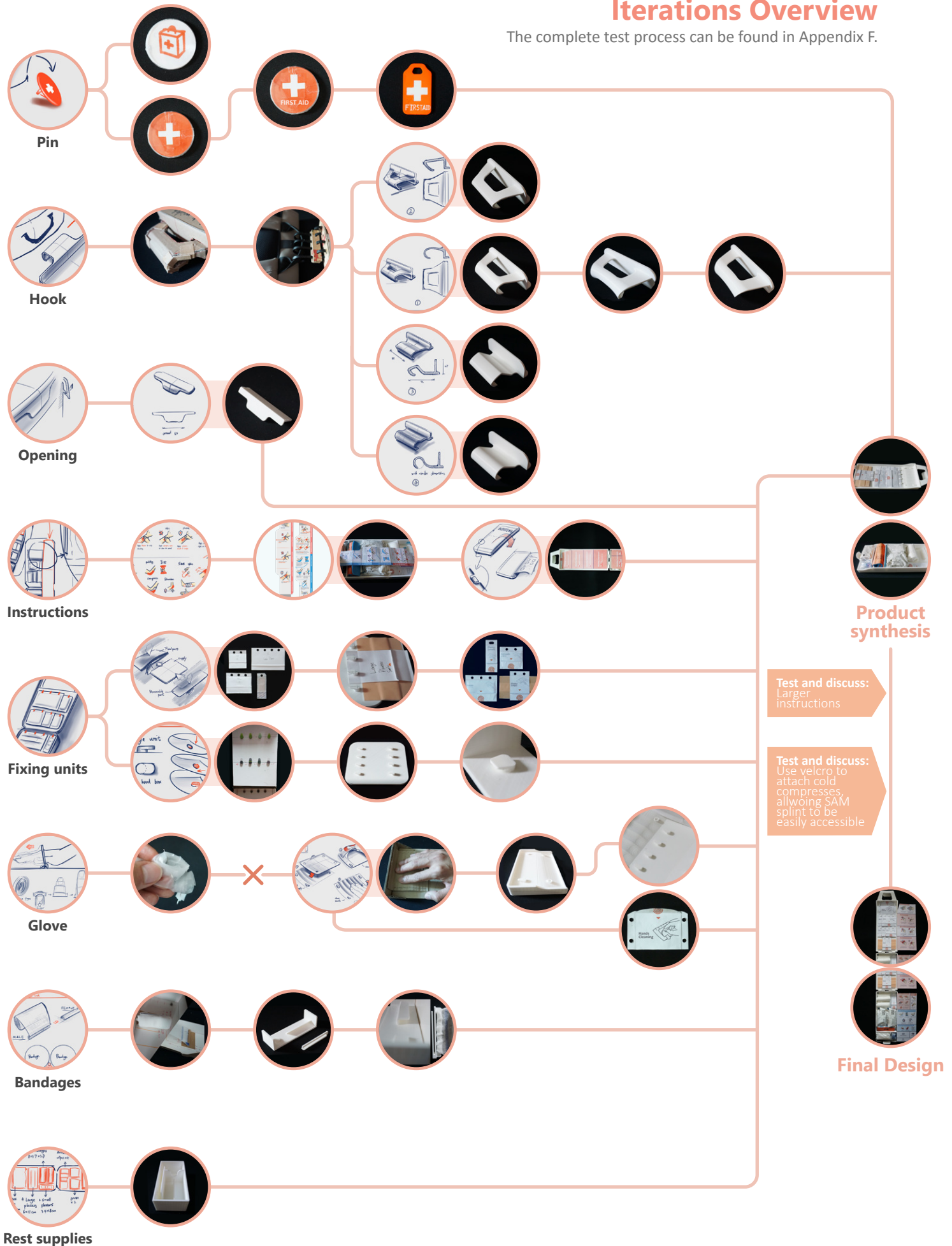


Figure 46: Testing iterations roadmap

4.4 Final Design

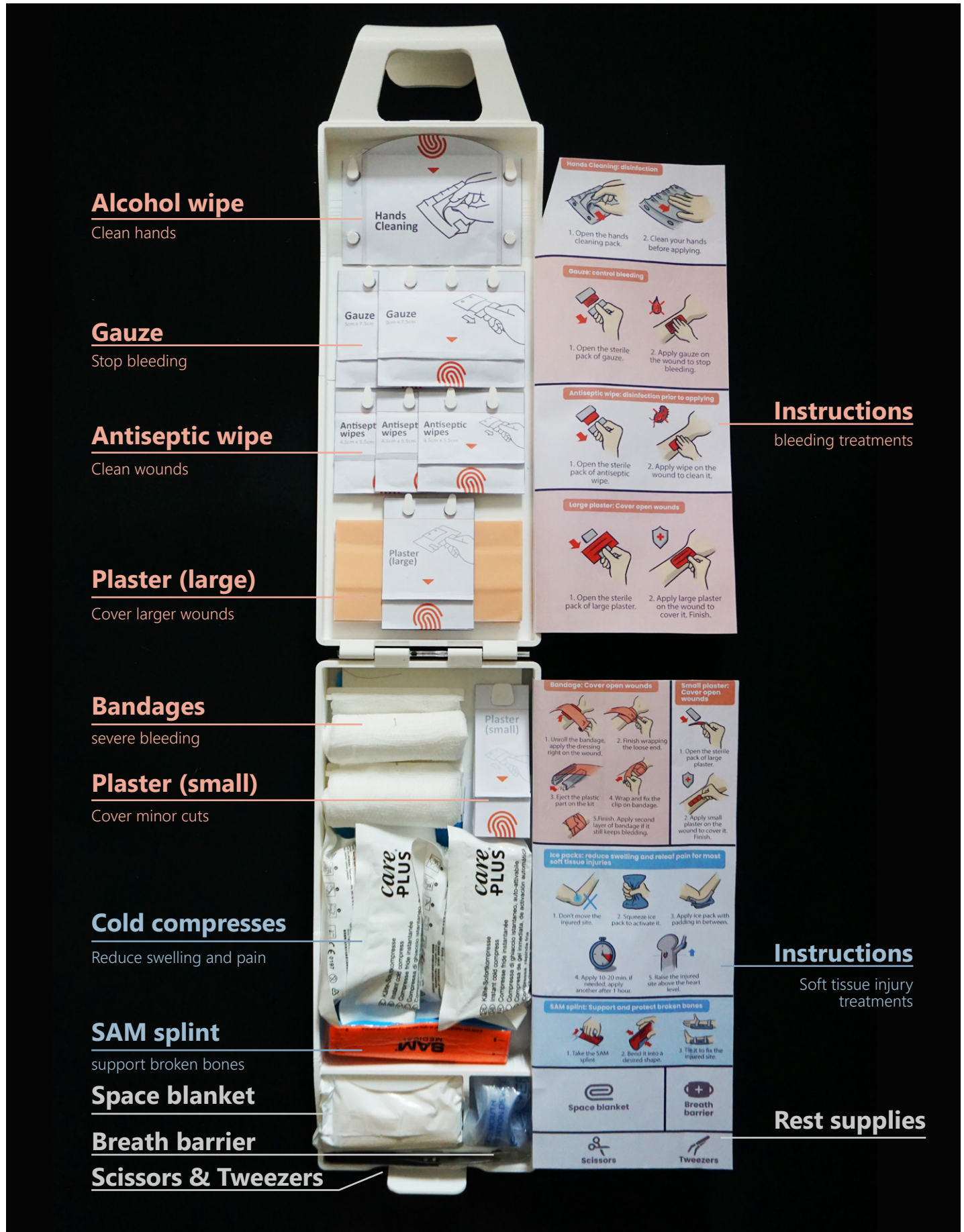


Figure 47: Final design

The sketched concept becomes a physical and workable prototype in the end (**Figure 47**). Most of the ideas in concepts are accomplished, while some are proved impossible and substituted with new designs.

The final design of the project (proof of concept) is first aid kits (a larger version and a smaller version for high and low speed outdoor sports respectively, **Figure 48**) designed for outdoor sports, and allows the users to quickly and easily apply treatment alone even when one arm is dysfunctional. Kit opening, instructions unfolding, sterile packs using and treatment applying of some supplies are all designed for conveniently used by only one hand. The first aid kit provides basic protection for users and covers the worst situation. Moreover, Users are able to see the most important information for treatment applications under emergencies. The product, with the well arranged hierarchical information, is guiding users what steps they are recommended to do and how to do them. The design aims to use least components and steps to achieve the function of one-hand use, and optimize the information to improve the use efficiency.



Figure 48: larger version and smaller version

4.4.1 A first aid kit designed for one-hand use

The final design comes after the first attempt of the product synthesis. All adjustments and improvements found in the previous iterations are accomplished in this version. The final 3D printed prototype achieves almost all the expected design goals and is functioning quite smoothly.

Hook act as the injured arm

The hook is the core of the one-hand-use design. All actions to finish the whole process of the treatment (opening, pulling, wrapping) requires one hand to fix the object and the other to operate. The hook serves as the first hand, fixing the first aid kit steadily on a backpack (**Figure 49**). All one-hand actions towards the users are possible thanks to the function of the hook. In this way the needed supplies themselves are separated from the kit body by pulling. According to the concept validation process, the hook on the final design fits has appropriate dimensions to hook on almost all backpack handles. Users can also hook on pockets, shoulder strips, or any other similar object found near them.



Figure 49: Hook design

Easily accessible and apply

Inspired by plaster dispensers, I applied the similar technology to the rest of all thin medical supplies: hands cleaning tissue, gauzes, antiseptic wipes, small plasters and large plasters (**Figure 50**). The fixing unit system on the main kit body holds these supplies tightly through holes in their sterile packs. The combination of plastic structure and papery packs allows one-step access to supplies, no need to open sterile packs and then take the supply out. It saves time under emergency and improves user experience, making the whole application process smooth.



Figure 50: One-hand-use sterile packs design

The use of bandages was also designed for one-hand use. A rigid plastic part (clip) holds one end of the bandage on the kit so that the rest of the septs can be easily done, when reaction force is transmitted from the hook to the clip.

The rest of the supplies are well organized based on space management and final adjustment (**Figure 51** are separated by velcro straps. The idea was brought in the last step and went quite well. Soft velcro straps allow smooth ejection of SAM splint and in the meanwhile fix the cold



Figure 51: Final design on lower kit body

compresses. Moreover, indirect supplies (space blanket, breath barrier, sewing trimming scissors and tweezers) are placed at the end of the first aid. They can be accessed with one hand too. As a secondary requirement, the development stops here when it works fine.

4.4.2 Improved efficiency by optimized information design

The design of the information is also organized and optimized to improve the efficiency of use.

The instructions, sterile packs of thin supplies, and the pin was designed to convey the most essential information to users at different stages.

Information design: PIN

The purpose of pin (tag) design is to draw the attention of users around the casualty and tell them the existence of a first aid kit inside a backpack. An eye-catching colour, light and highly saturated orange, can well distinguish the tag itself from the environment and easily be noticed by people around (**Figure 52**).



Figure 52: Pin (tag) design

Information design: instructions

Helpful advice from participants of user tests was adopted to improve the design of instructions. The final design is a kit-sized instruction showing information from both sides. The information hierarchy shows from the basic type (bleeding or other soft tissue injuries divided by two colours) to application steps, and then into more detailed apply ways. Users will first see the basic

injury types and judge what they are going to treat. And then flip over the instructions (**Figure 55**), look at more detailed information where the medical supplies are presented on the left (**Figure 53 & 54**). The design clarifies the treatment step to step and leads users to find what they really need. It creates communication between the product and the users, making the one-hand use steps more explicit.

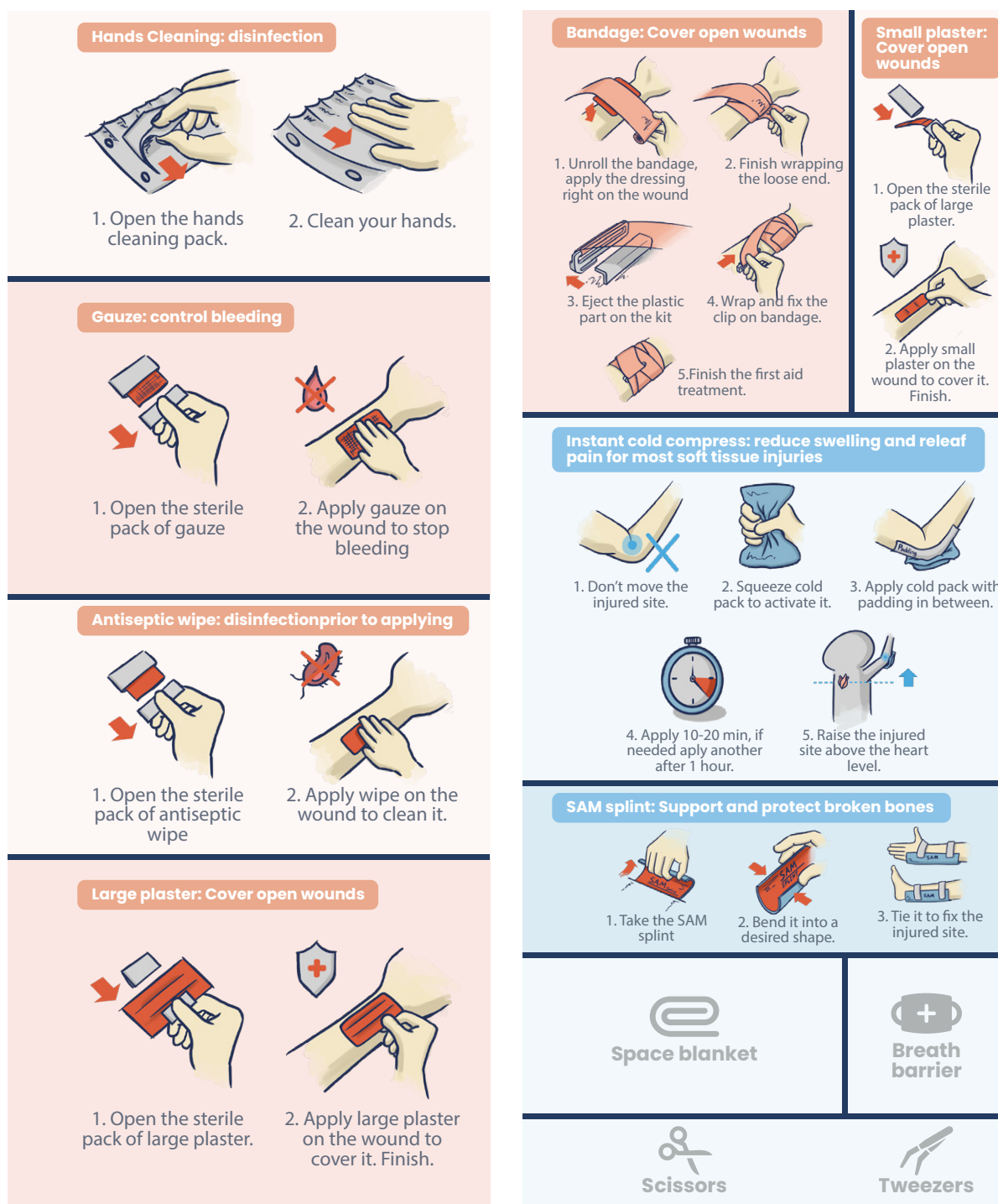


Figure 53: Instructions on upper and lower parts, front side

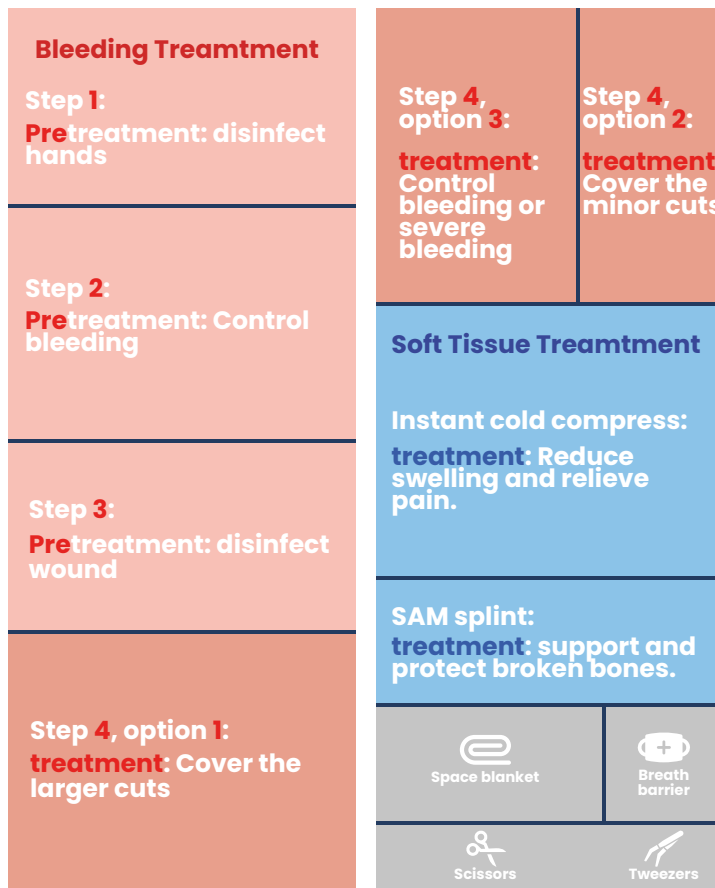


Figure 54: Instructions on upper and lower part, back side

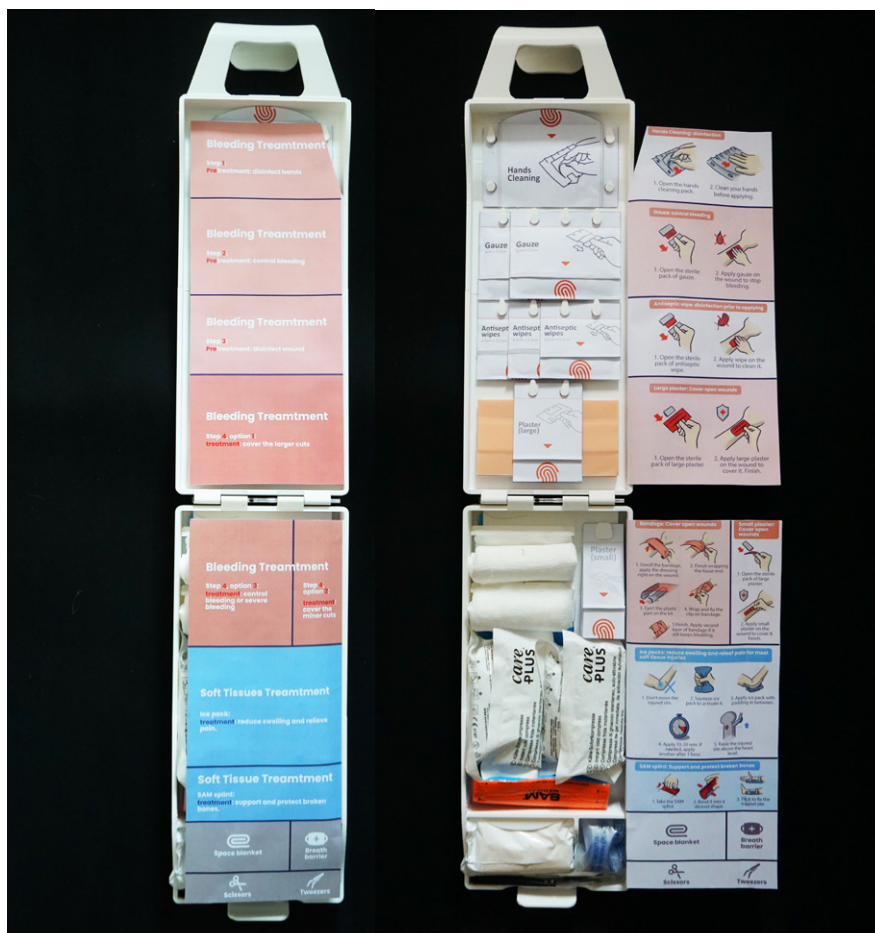


Figure 55: Instructions

Information design: Sterile packs

The design of sterile packs shows the most important information on the front side, while the less important is on the back. When injured, this way makes sure users will first see the terms that are helpful to their treatment application. The design of sterile packs takes advantage of

graphic language to tell users how to use the product. Fingerprint icons and illustrations are intuitive information that can be quickly understood. The contrast between light and dark, saturated and desaturated colours makes information design more hierarchical. (Figure 56 & 57)

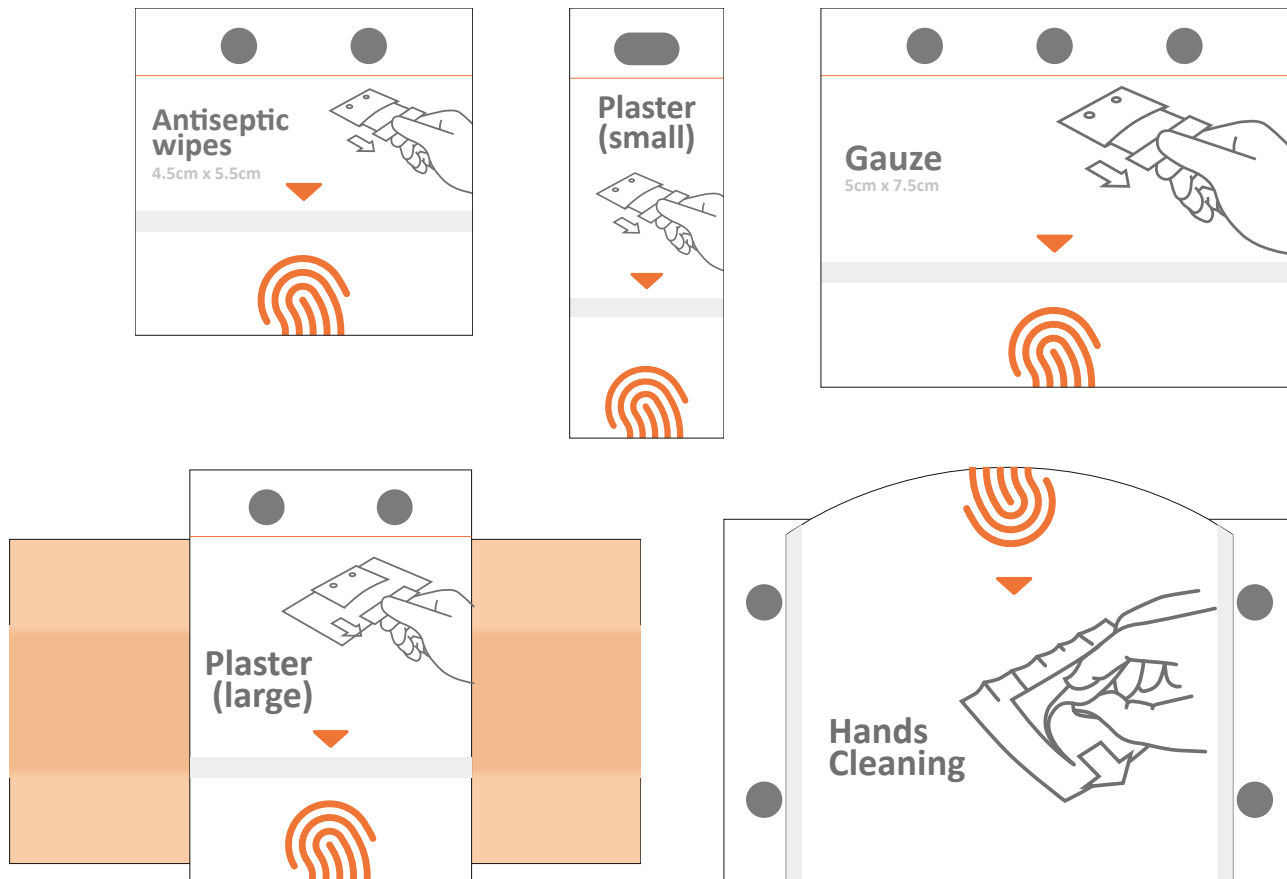


Figure 56: Sterile packs design



Figure 57: Sterile packs design on final product

Other details

Emergency whistle is placed outside of the kit where there is space for supplies. It is a special item which should be used before the rest (or even before opening the first aid kit) to ask for help from people around. **(Figure 58)**

The personal information form is in the same place which includes the basic information of the owner (name, date of birth, address, phone number) and information of a person for emergency contact (his/her number).



Figure 58: Emergency whistle and personal information form

5

DELIVER

5.1 Cost estimation

The main first aid kit body and several plastic parts will be injection molded. **Figure 59** shows the costs of making moulds, in different sizes or complexity [38]. There are mainly four plastic parts that need to be injection molded: upper kit body part, lower kit body part, bandage clip and pin. The cost of each component and their

estimated selling prices are listed in **Figure 60**, according to the information online. Their cost resources mainly come from Chinese manufacturer platform while selling prices come from EHBO-koffer, the official provider of medical supplies.

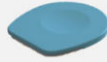
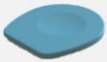
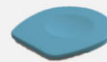


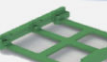



	Rapid Prototyping	Insert Tooling	High Production Tooling
Basic	 <p>\$75</p> <ul style="list-style-type: none"> Part Size: 0.75 in. x 0.5 in. x 0.06 in. Small Material Usage Objet 24 - VeroWhite Material Layer thickness - 0.0011 in. No Post Processing 	 <p>\$1,500</p> <ul style="list-style-type: none"> Part Size: 0.75 in. x 0.5 in. x 0.06 in. Flat Parting Line C1 Finish (Dull) No Undercuts Single Cavity Mold 	 <p>\$4,500</p> <ul style="list-style-type: none"> Part Size: 0.75 in. x 0.5 in. x 0.06 in. Flat Parting Line C1 Finish (Dull) No Undercuts 5 in. x 8 in. Mold Base (P20 Tool Steel)
Intermediate	 <p>\$215</p> <ul style="list-style-type: none"> Part Size: 5.65 in. x 2.55 in. x 0.76 in. VeroWhite Material Light Sanding Medium Part Volume 	 <p>\$5,000</p> <ul style="list-style-type: none"> Part Size: 1.25 in. x 1 in. x 0.18 in. A2 Finish (High Polish) Deep Internal Ribs Small Ejector Pins Sub Gated 	 <p>\$13,500</p> <ul style="list-style-type: none"> Part Size: 3.6 in. x 3.4 in. x 0.55 in. Complex Mold Seal Offs EDM Required Threaded Inserts Overmolded 8 in. x 12 in. Mold Base (P20 Tool Steel)
Advanced	 <p>\$765</p> <ul style="list-style-type: none"> Part Size: 4.15 in. x 3.54 in. x 3.54 in. Detailed Features Large Volume VeroWhite Material 	 <p>\$9,800</p> <ul style="list-style-type: none"> Part Size: 1.25 in. x 1 in. x 0.18 in. EDM Finish (Light texture) Complex Mold Seal Offs Small Features Sub Gated 	 <p>\$28,000</p> <ul style="list-style-type: none"> Part Size: 6.4 in. x 3.4 in. x 1.5 in. Stepped Parting Line Multiple Undercuts Complex Seal Offs

Figure 59: Sterile packs design on final product

Part (incl. packaging)	Amount	(Packaging) Material	Manufacturing cost		Material cost		Market price
			Cost per unit	Actual cost (in total)	Material area/volume	Actual cost (in total)	
Hands cleaning tissue	1	Waterproof seal paper	€ 0.213/bag	€ 0.007	172.4cm ² /pc	0.139m ² 85 gsm € 0.0346	€ 0.42
Gauze	2	Waterproof seal paper	€ 0.510/bag	€ 0.0102	145.8cm ² /pc		€ 0.32
Antiseptic wipe	3	Waterproof seal paper	€ 0.638/bag	€ 0.047	92.3cm ² /pc		€ 0.0525
Plaster (large)	4	Waterproof seal paper	€ 0.200/box	€ 0.08	96.8cm ² /pc		€ 0.9372
Plaster (small)	4	Waterproof seal paper	€ 0.242/box	€ 0.0097	66cm ² /pc		€ 1.067
Bandages	2		€ 0.068/roll	€ 0.136			€ 1.37
Instant cold compress	2 (1 for small)		€ 0.425/pc	€ 0.85			€ 2.82
SAM splint	1		€ 2/0.9m	€ 0.578			€ 4.09
Space blanket	1		€ 0.238/pc	€ 0.238			€ 1.67
Breath barrier	1		€ 0.191/pc	€ 0.191			€ 3.95
ST scissors	1		€ 0.051/pc	€ 0.051			€ 3.51
Tweezers	1		€ 0.014/pc	€ 0.014			€ 1.33
Pin (tag)	1	ABS	€ 3825	€ 0.383	5.629cm ³ /pc	€ 0.63/kg	€ 1.532
Upper kit body	1	ABS	€ 23800	€ 2.38	213.8cm ³ /pc	501.47cm ³	€ 9.52
Lower kit body	1	ABS	€ 23800	€ 2.38	276.2cm ³ /pc	1049kg/m ³	€ 9.52
Bandage clip	2	ABS	€ 3825	€ 0.766	2.92cm ³ /pc	€ 0.331	€ 1.532

* 10000 pieces estimated to be sold

	Manufacturing cost	Selling price
First aid kit small version		
Large version:	€ 8.486	€ 43.65
small version:	€ 6.989	€ 27.68

Figure 60: Cost estimations

5.2 User test

The test for the final prototype was mostly about whether users can be well guided by the first aid kit. It was conducted with four random participants who know nothing about the project so that the design of the tag can be tested first.

Test set-up:

1. Users are asked about their understanding and what they will do when seeing a pin and an unconscious casualty lying on the ground, without showing a product.
2. Users are asked to apply treatment themselves with only one hand, pretending

one arm is bleeding, and unable to be used. The whole process starts from hooking on a backpack, without telling users how to use it.

3. Users are asked to apply treatment themselves with only one hand, pretending one arm is sprained and fractured.
4. Observe how users use the product, where they are hesitating and using it in unexpected ways. After this, explain the design to users, discuss with them and record their comments and advice.

The noticeable observations and discussion were recorded with text as shown below.



Participant 1

- **Correct** about the meaning of the tag: There is a first aid kit inside the backpack.
- The opening way of the first supply (alcohol wipe) is different from the rest. It's better to keep them in the same way.
- She had a few seconds of **hesitating about how the sterile packs are opened**, and didn't tried in the designed way.
- She thinks it is a self-explanatory product.



Participant 2

- He guessed the tag means the owner has a specific medical condition (diabetes or asthma). He also guessed there is a first aid inside the backpack, which is also **correct**.
- The information on the instructions is good but can still cause misunderstanding. It can be improved by **adding an arrow** from top to bottom to show the sequence of all steps, giving an overview of them to users.





- The use of bandages is quite good. However, the **wrapping is blocked** because of the connection of one end, which is not so smooth and convenient.
- Participant 2 noticed the information on sterile packs and opened them quite smoothly.
- The participants had trouble understanding the **how the clip is ejected and fixed on wrapped bandage**.



Participant 3



- She was also **correct** about the tag: a first aid kit inside.
- She was also **struggling with how to open the sterile packs** and couldn't find where to pull them. She recommended to color the whole "removable area" of packs so that they can be more eye-catching.
- She had the similar problem with participant 2 that the **fixed end blocked the wrapping** to some extent. She advised that the bandage can be narrower.



Participant 4



- She was also **correct** about the first aid kit inside the backpack according to the information on the tag.
- She advised that the personal information of the owner can be written at the back of the tag, like those used in the US army.
- She thought the designed way of applying supplies is new to the users, especially those who see the product for the first time. She recommended having a linked **short movie online to teach people** how to use it.
- She questioned about the wasted material.

Conclude from user tests

All participants can well understand the meaning of the tag.

The information design proved good in this test to successfully draw the attention of people around, and inform them of the existence of a first aid kit inside a backpack. Participants can well understand the information on instructions and apply the treatment in proper order with the help of it. The disadvantages of the design mostly appear on how to provide an overview of treatment steps, and new ways of applying.

People who see the product for the first time still need time to figure out how to use it.

The same insights were drawn from the sterile pack use. Although illustrations and light-orange fingerprints icons were given, participants were not able to immediately understand. A video is a good idea to help users before departing to do sports. All supplies designed for accessibility or usable with one hand are quite successful. Participants had positive comments about the design. Only the bandages use could have further changes to improve the experience.

5.3 Limitations and recommendations

New developed way of applying treatment

To achieve the design goal of one-hand use, a few new ways of applying treatment were developed. They are proven to work well but are not easy to be understood by users, especially users who see the product for the first time. During the test, participants were struggling with applying some medical supplies, especially how to open the sterile pack and bandage application. A short movie clip can be provided online to help users quickly go through all treatment steps. Watching it during preparation is always helpful than checking instructions under emergencies.

Unfinished details

Since project time is limited. Some details of the product haven't been finished. The bandages should have their own sterile pack and include similar information (how and where to open) as the rest as shown in the concept sketches. Sewing trimming scissors was selected to replace the trauma shear. It is an existing product (a standard part) but has a defect that its blade tip is sharp, bringing risks of secondary injuries when using the first aid kit. The solution can be a new scissor with redesigned blade shape and thickness similar to trauma shears by manufacturers.

Tests cannot be conducted

The application of a new sterile pack design requires more tests to technically keep them sterile. Standards of these medical supplies should firstly be reached before they become available products on the market. These tests cannot be done within this project but in laboratories.

Explore the form

The function realization and proper guidance are the main focuses of this project. The form is not deeply explored because of limited time. For further development, form and appearance design can be the focus to make the product more attractive to the users.

5.4 Conclusion

To conclude, the project developed a new first aid kit allowing self-treatment alone when one arm is injured with optimized information design. A physical prototype as the result of the project accomplishes the requirements and can be used in the end.

The design covers the worst situation that could happen during outdoor sporting. Upper extremity injuries are common, and it costs users much more time to apply treatment with current first aid kits, or even make some steps impossible. The new design in this project was developed considering one-hand use, and allows quickly and easily treatment when one arm is dysfunctional.

To improve the use efficiency and save precious time of first aid, the use process is optimized to show the most important information to users. The first aid kit tells users what they should use for two types of injuries and guides users how to use supplies with only one hand and apply treatment properly. On the contrary, the current first aid kit only shows rough steps of treatment application and stacked medical supplies, which is unfriendly to untrained users to quickly find needed supplies.

In this project, the design goals are well achieved with a physical prototype. The further development and test, in terms of technical and appearance, are still necessary to reach technical and commercial standards of a real product.

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