

APPENDIX

INTEGRATED PRODUCT DESIGN MASTER THESIS

ZHIYU SHI

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Appendix A: Sports list

Types of sports

Team sports	Individual sports	Partner sports	Extreme sports
American Football	Alpine & Cross Country Skiing	Badminton	BASE Jumping
Athletics	Archery	Diving	Bobsleigh
Australian Rules Football	Arm Wrestling	Figure Skating	BMX
Baseball	Athletic Track and Field	Golf	Climbing
Basketball	Badminton (Singles)	Table Tennis	Free Climbing
Bobsleigh	Biathlon	Tennis	Free running
Cricket	Bodyboarding	Trampolining	Freestyle skiing
Gaelic Football	Body Building	Volleyball	Gliding
Handball	Bowling		Ice Climbing
Hockey	Bowls		Ice Cross
Hurling	Boxing		Ice Diving
Ice Hockey	Canoeing		Ironman events
Korfball	Chess		Kayaking
Lacrosse	Chess Boxing		Luge
Netball	Croquet		Mountain Boarding
Polo	Cycling		Mountain Climbing
Rowing	Darts		Paragliding
Rugby Union	Diving (Singles)		Parkour
Rugby League	Draughts		Rock Climbing
Rounders	Downhill Skiing		Scuba diving
Roller Hockey	Duathlon		Ski Jumping
Roller Derby	Fencing		Skeleton
Soccer/Association Football	Golf		Trail running
Softball	Gymnastics		Skateboarding
Swimming	Horse Riding		Skydiving
Ultimate Frisbee	Jet Skiing		Water Skiing
Underwater Football	Judo		
Volleyball	Kayaking		
Water Polo	Mixed Martial Arts		
	Motor sports (Auto & Bike)		
	Orienteering		
	Powerlifting		
	Tennis		
	Rodeo		
	Rollerblading		
	Rock Climbing		
	Skateboarding		
	Skating (figure)		
	Sport Climbing		
	Snooker		
	Snowboarding		
	Squash		
	Surfing		
	Swimming		
	Table Tennis (singles)		
	Trampolining		
	Triathlon		

Appendix B: Questionnaire

First Aid Kit Design for Outdoor Sports

Opening Statement for sports injury first aid kit design:

You are being invited to participate in a research study titled First aid kit design for sports injury. This study is being done by Zhiyu SHI from the faculty of Industrial Design Engineering, TU Delft.

The purpose of this research study is to know the necessity of a quick and proper guiding for medical supply use, and will take you approximately 2 minutes to complete. The data will be used for the design basis only.

Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to omit any question.

We believe there are no known risks associated with this research study; however, as with any online related activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by collecting answers for very basic questions and making the survey anonymous. The data will not be shared.

Contact information:

*Required

1. Q1. Which country are you from? *

2. Q2. Your gender *

Mark only one oval.

- ☐ Male
- ☐ Female
- ☐ Prefer not to say

3. Q3. What's your age? *

Mark only one oval.

- ☐ 2-12
- ☐ 13-18
- ☐ 19-24
- ☐ 25-44
- ☐ 44-64
- ☐ Other: _____

4. Q4. How often do you do sports? (per week) *

Mark only one oval.

- | | 1 | 2 | 3 | 4 | 5 | |
|-------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------|
| Never | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Almost every day |

5. Q5. How important do you think it is to prevent injuries during sporting? *

Mark only one oval.

- | | 1 | 2 | 3 | 4 | 5 | |
|---------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|---|
| I don't really care | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | I pay attention to it throughout the sporting |

6. Q6. Have you ever got injured when doing sports? (e.g. sprain, contusion, bleeding, fracture...) *

Mark only one oval.

- ☐ Never
- ☐ Only 1-2 times
- ☐ Quite a few times
- ☐ Other: _____

First aid kit type-A: dealing with very common injuries such as small cuts, abrasions, and minor burns.



7. Q7. Have you used first aid kit before? *

Mark only one oval.

- ☐ Never
- ☐ Yes, but only 1-2 times
- ☐ I've used for quite a few times
- ☐ Other: _____

8. Q8. Have you helped by others using first aid kit? *

Mark only one oval.

- ☐ Never
- ☐ Yes, but only 1-2 times
- ☐ Quite a few times
- ☐ Other: _____

9. Q9. How much do you know about steps of dealing with acute minor sports injury emergencies? *Minor injuries: can be painful, but they don't threaten your life, mobility or long-term survival. (e.g. Sprains and muscle strain, contusion). *

Mark only one oval.

- ☐ Not at all
- ☐ A little
- ☐ I know a lot
- ☐ I'm well trained
- ☐ Other: _____

10. Q10. Are you capable of using first aid kit to properly handle acute minor injuries without first aid guide? *

Mark only one oval.

- ☐ Not at all
- ☐ Not sure, maybe I can do it with first aid guide
- ☐ Only need a little assistance of first aid guide
- ☐ I'm confident in doing it without first aid guide
- ☐ Other: _____

11. Do you have any thing to add?

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Appendix C: Interview with a first aid responder in PMB

Interview Kevin Gielisse

K: Kevin Gielisse

Z: Zhiyu SHI

Z

My graduate project project is to develop a first aid kit for outdoor sports. I had a few interviews on some students who love to do other sports and create scenario. Now i'm gonna find some information how to use the first aid kits and any problems in using them. So start with the first question. So your job and what do you usually do in the PMB?

K

My job is a I'm a non-teaching educator. What that means is i'm an employee of the uh, PMB shop. The workshop and students like yourself. When this whole situation is over or before the situation, it was custom that customary that all the students that need to help or need the tools to assist them with their projects for the classes here. And they would be able to come here and either ask for help or ask for tools that they can use here. Yeah, that's and my job is then to provide that and provide instructions or just insights to help them.

Z

Yeah, that's a useful information. Then what injuries do you usually see and help?

K

Just to go get back, it's also our job to keep them safe here. If we do our job, right? Ha. Safety is a big. That's why we do instructions. And that's why we always ask more things about what you're gonna do. What do you need. Usually at that time, we get an understanding if the person in question has thought about it before it just dives into a project at first and then. She comes out together and injuries ... I have not seen yet any yet. I'm working here for a year. Now. This year is not very uh crowded here, but ii know that there's a there has been some accidents in the past, but yes,

Z

Also you can share something details for of that. When you heard any..

K

A year before PMB worked at the facility management and actually the only emergencies that we were called in for was sort of heat, stroke or stress strokes, and um, stress fainting.

Yeah, fainting. I don't know what's stressful.

Z

Fainting. Okay.

K

It's like fainting because the stress is too high and the body just shot down. I don't know the best out. Either eating to little drinking, too. Just not drinking at all. I'm just stressing over.

Z

It's mostly like a mental problem.

K

Yeah. So it's a mental problem and your body will fix it by going. No, no more.

Z

Okay. And then, if you, for example, that's great. If you see, anyone got a wound or cut. What do you gonna do for this kind of situation?

K

Well the like you just called the accidents, like the really big accidents. We don't have that a lot, but we do have like a minor, minor cuts in fingers or in arms or someone is not being enough attention on the work that they do and they have a small. It's just it's only bleeding, not by much, it doesn't need stitches. It doesn't need a gluing or it's we call it a (plaster in Dutch) here. It's like just a piece of tape to put over cut to, make sure the skin is pressed to each other like.

Z

I know that's kind of like butterfly plaster.

K

Yeah that's the one pasta. We don't call it a butterfly open in the dutch. It's another bird. It's a tale. Tail, bandage, and we have.

Z

You're like, you just mentioned the stitches. It's not small cuts. So do you do stitches?

K

It's like when you have got this deeper than the first layer of skin and blood is coming out at a no, not alarming rate, but enough that a bandage will not fix it, then you have to help the skin fix itself. The incision is large enough for the skin to peel open, you don't have a stomach that's gonna travel, right? You have the skin that's gonna go open, and then you have to make sure

that it's pressed against to each other. So then you put it, bend over it. So they stay together and.

Z
I used like a plaster, like, but butterfly passed the other stage is doing yourself. That's right. It's gonna happen in the hospital, but not here, right?

K
Yeah, so we'll put the plaster over it. And then if it's deep enough that we don't, trust it, that's gonna fix itself. Then we'll say this is good for now, but go see a doctor or hospital or go to the hospital to have it fixed. That's basically our job as a safety officer. We'll do the first eight, but like if it's larger than we can handle that we'll call an ambulance. Or if it's something we can handle until a certain point, then we'll do that. And then we'll say, okay, for the rest of your medical care, you have to go to the hospital or a doctor. Depends on the urge of the... Like we are in the first aid kit, there's a variety of bandages to help get you to the hospital. Like calling an ambulance in the Netherlands is expensive. My parents, they got an accident and they uh paid 500 euros, almost up to \$600 for one ambulance, right, For 5k. so it's 5 kilometers to the hospital and they went with the two of them in one ambulance and they, paid each almost six hundred euros. Okay, so that's why we say if you don't need an ambulance, just drive to the ambulance yourself to the hospital yourself or take a take a cab or public terms. So it's like it's a gushing out, then we'll call ambulance because this is not gonna be enough for us to stop it for a long enough time that you can go to the so. If it's a life threatening or it's in that direction of the call 112. which is also here as TU Delft, we need to inform our bikers like, the G4 security. We have security team that's from the outside. It's not TU Delft. It's G4S for like in the number for and then as so it's g for security, security, yeah.

Z
This is team for handling...

K
They open the buildings, they close them off, they do the closing rounds, make sure that everybody is out. They assist us with getting the ambulance to somewhere in the TU Delft campus. Making sure that we got all the help we need. That's that's why we call them also and

then they'll call an ambulance.

Z
All right. So you almost answer the part of my next question, like medical supplies you most use, like most frequently. It's a bandage, right? It's bandage and plaster... That's always that nice to have a look at. (plaster dispenser)

K
Usually this is hanging like this.

Z
Mostly plaster.

K
Yeah, just bandages. Then you can why i'm not gonna do it. It's but you take it out and then the one side of the band is already uncovered. So you can apply it yourself and then take the other one on the side of...

Z
Loading of the plaster. So you take one, the next will be...

K
No, it's all what i'm just gonna do it. Like this is one, and then you take it out and you can see one side is already, and then you can just. There you go.

Z
Then this one is wasted.

K
You have enough, okay. Over the research, right? Yeah. Self quick is it? It's called it's really quick.

Z
And like one-hand-use is also my problem. So it's 4 year. It's probably my design. Yeah, I found this problem, so i'm gonna design for one-hand-use outdoor. This is probably a good example for my design.

K
So when you talk about outdoors like going hiking in like that or mountain biking so one hand use for a ticket, it's pretty awesome.

Z
You can still probably go along. Far away from your friends or family members.

K
It's cool to go with friends or with someone, but if you want to go along this, mhm. Also they have something at your disposal to make sure you're okay. Like you are injured with one hand, you have to use another hand. So using one hand, taking your backpack off, taking it out. You've got a lot on your head.

Z
What are included in the current first aid case in PMB.

K
I think primarily it's this. And then we have uh faculty wide or TU Delft wide. So first response officers.

Z
Do you know what's include in the kit?

K
I can get back.

Z
It would be nice. Thank you so much.

K
It's a little bit about so this is like all the necessary things to through the first aid. And then this is also equipped with a safety vessel. People can recognize you and it has some gloves in it, but I think this is almost to.

Z
Yeah, this is like a compress to absorb the blood.

K
Or to close a wound that don't want any filth in there. Here we have scissors to cut to repose if we need to remove them. Large bandages. This is what I was talking about. Those types of things. There are just three but you also have them with a wider and then they got into the middle. Otherwise you're gonna if you're gonna peel them off, you're gonna tear open your wound again.

Z
They have a different design, but similar function.

K
Then we have a case of life (mouse barrier).

Z
Yeah, if you're gonna the breath air into another people's mouse.

K
So you don't touch the other person's mouth, but... and then there's sterilizing tools, this is.

Some I think they called flyers.

Z
Tweezers. And safety pins yeah, I saw very typical medical supply in first aid kits. Very typical.

K
And um. Some additions to you normally find in a because we have aa lot of students here. We have. No, that's not what I thought it was. We have gloves. Like for me, I have a small cuts all over. Just working with my hands it's nothing serious, but if it's open or I scratches it open, and I touch someone others' blood. Then you have a chance of infection. So that's why we always wearing gloves. which may be interesting of you. Have you been on the trail? Not more gloves and an isolation blanket.

Z
Blanket keep your body warm yeah oh, okay? Yeah, these are all typical supplies.

K
Another one. And then. Oh yeah. It's just instructions. Instructions.

Z
May I see the instructions? Because it's also a part of my design.

K
Check this. This is all that's in there.

Z
Like designing instruction is also part of my design. So quickly gets Information to how to apply correct treatment, like that. That's just so providing some this one is a instruction?

K
Yeah, it's like a small list of basic things and what you're gonna do about the injuries. Anything we need to check that because we have extensive training.

Z
You are trained?

K
Every year, we do a course on the x Sports, where train nationals come train us to make sure that we know the the basics.

Z
Make sure you don't forget the basic rules of applying, right?

K
So just basic things like this is the situation.

What are you going to do? Like? Are you gonna start calling ambulance. Just that says.

Z
BHV I know the Dutch emergency officer. This is provided by BHV?

K
Yeah this is provided by uh, the safety team.

Z
Okay, that's good to know.

K
Which are upstairs. Like not all the time now because they have uh like work at home type of basis right now, but they do work upstairs.

Z
Really complete bag of the first aid.

K
Notebook to if you have someone in front of you and you're thinking about calling an ambulance because persons as well, then you can note some things that you don't forget like...

Z
Like personal Information.

K
Yeah, exactly. Normally we have the G4S guys take those Information for us because then we can focus on providing the medical care. But for instance, someone passed out like came through and then still is not responding very well. Then you can ask a friend what country he is living in or basic things that some questions you can ask to make sure that the cognitive part of the brain is working.

Z
Yeah, that's a good one, a notebook might be useful.

K
Especially when you're on your own outdoors and someone comes to aid you, and you're not (a stranger) that there's a card in there. This is where I'm born or ask me these questions if I don't ask them correctly, make sure I have a oh here it is tape. This is in the bag.

Z
I think I saw the orange cross. It seems I have seen this kit somewhere on some websites. Right? So they just put everything together and make a box of it. That's all.

K
Yeah. And this then like on these steps, it hangs on the wall for easy access, just grab it, push a lid, just small um. And then you can take off. This is better because you can wear it on your back when you're going through the building, instead of walking through doors and through with the big case.

Z
My design will probably a portable one. What like you can carry everywhere like include in your bag...

K
Exactly or just hanging underneath with the easy removal. It was one hand exactly. Very curious now. Can't wait for you to search prototype.

Z
Still a lot of weeks go. I finished 4 weeks. Now it's the start of the 5th week, still. You never see any injury yet. So next, have you helped yourself?

K
Yeah yeah. Most of the times it's just small cuts minor enough just look at it. If it's bleeding too much, then i'll put a bandage over it, otherwise it's...Just making sure you don't bleed all over the plate. That's like, yeah. I've a very high pain level so, or low pain level, I don't know, why yeah. Usually I don't even feel it and then i'll go back to my place (and then you realize), OH!

Z
Yeah, this maybe happens when you get cut by a really sharp...

K
Yeah, exactly. Or it happens really fast and you're focusing on something else and you're... yeah.

Z
The last question, have you encountered any problem in using the first aid kit, for example, like accessibility or in special situations or problems of any medical supplies in it.

K
No. Because the problems that you have is like speed, but the speed is uh reduced by the packaging of the materials of the slides, which is necessary, because of the sterile function of the packaging. Like each bag is a wrapped individually. And as long as it's in the bag and the bag is not open, it's sterile. You can take it out with your gloves on. You can put it on a cut or a wound. And it's sterile. You don't have to worry about the infections coming from the...Other

than that, like this one is easy to open with one, because this is where you're going for, right? Really is the open, but then this (plastic barrier of two halves of kit), this is really difficult like this is it's easy, but there's a room for improvement. I don't know something with a push button to help move this clip out or something like that.

Z
What is this glass for? Like?

K
Oh it's just a separation. Otherwise, you open this, and then everything that's in here will come follow. But it's if you have like a backpack, you don't have that issue. But then you have the issue of opening it one on that, which is difficult. This one has a large uh zippers, which is easy.

Z
If you have for a large bag, it is easy. for small one, maybe not, because it's really light.

K
The radius of the curves are okay, but like if these are like, you may facing some more difficult to, to close like.

Z
Yeah, also the problem of putting them back and put it back to the the backpack. Yeah, it's also maybe a problem.

K
Yeah. Because if you only have one hand and you're gonna care for it. It's not like going to be able to use your hand after that. So you have to put it away and get back with one hand right.

Z
Yeah.

K
In the most extreme case of the broken system.

Usually they some extreme weather they may come across that's snowing. If they do some sports outdoors and you slip and you grip (like snowboarding) or something like that.

K
Anything else? No. No, I think there's a there's already been a lot of um enhancements being built into these things. Like these things are really easy to open. And I think the issue for you or the challenge for you is to make it so one hand operable and easy to reach and put away.

Z
That's my goal to improve the using experience. That's pretty much it. Thank you for your participating in my interview.

Appendix D: Interview with a kitesurfing enthusiast

Interview Anna Moonen

A: Anna Moonen

Z: Zhiyu SHI

A

Yeah It's very exciting there. It's happening a lot of the time, a strong wind. So.

Z

Yeah, I see you know.

A

Some time and stuff. So I like that. It's also a very social sport. It's there are a lot of people that are doing it, talking about it on the beach. And if so, the community around is also very nice.

Z

Community. And when do you usually do these sports? And how often I mean.

A

I think we go like now we want to go every week, but we have to wait for good winds. Um and unfortunately, in the summer there isn't that good wind. So it's mostly when it's a little bit cooler in spring and in fall.

Z

You mean in the spring and summer?

A

No, not in the summer, the wind isn't very good. That's a real pity when it goes, when the hot weather is arriving.

Z

Yeah, that's probably not so good to do this.

A

No. So most you want to go every week, but I think it's fair to say that we go once in two weeks or, something.

Z

What about the winter? Cuz I see a lot of strong wind here in Netherlands. That is good time to do kite surfing?

A

Yeah it is, but when it's about 2 ° or something, then we stop because it's freezing your arms. You have to be alert because when you get an accident with guys and you're always laying in the water, yes. Very dangerous. When you're laying there for a lot of time to get it. What's the

word for that? That's always danger with that kind of weather. More careful for that one in school.

Z

Yeah, that's good to know. Where do you usually do kite surfing?

A

We usually go to Den Haag, the sommer scopes in the neighborhood of behave. It's a little bit. They made there in a nice pool. Something like that because they want to fill up the beach with a lot of the sand. They're having a big project there and there's, yeah like a little lake on the beach, and that's more safe to guys there, because you don't have to taking accounts where the wind is coming from, because the wind can't blow you until into the sea. We go there a lot because it's safe.

Z

Is that the secured with like a medical staff or medical supplies around that place.

A

No, it's just beach environment. So there's nothing.

Z

No buildings, no...

A

No, there's one kite school over there. It's like 10 mins walk from there. Maybe they have some, I hope so they have some medical equipment but, there's nothing. So when there's an injury, something like that, you will see that they will call the coast cars .

Z

Uhm, so they will like call 112 then.

A

Yeah, you have a problem.

Z

Yeah, may I know the name of the place again? Because I couldn't spell it.

A

Yeah, it goes the close the sand. Kijkduin. When you Google it, De Sandmotor that's the project that they build the crazy Dutch people to get more sent on the beach. Something like that. Um why it's, a little lake over. That's if you more

a few of why? It's nice.

Z
Thanks. And then like what transportation do you usually take to get there?

A
Uh the car.

Z
The car.

A
Most go with car and then we have to walk a little bit to go.

Z
So you when you get there, usually don't have any transportation, around you?

A
No, we mostly walk.

Z
okay. You ride bike?

A
Yes. But I don't do it with kitesurfing from because you have a lot of equipment. It's mostly windy. So where you go by bike, I can have a kite work and stuff. I'm not very handy with it to be honest.

Z
Yeah. And then like how many people do usually go with?

A
I mostly go with four people. Like that. We have a big group of people that are living here and want to go Guide surfing. So we always in the group. So sometimes we have to meet up with a lot of people in the arrive at the beach.

Z
You usually play with them and have fun together.

A
Yeah, because you have to have one people at all times to go catching with you because it's handy to pull the the kites up in the air. You always have someone that assisting in you with that, that makes it very social in a way. Have to help. Other people in the beach. So I never Go alone.

Z
Yeah. What do you usually prepare for the sports like, what do you bring to to there?

A
To go kitesurfing, I have a winter wet suit. When it's cold, I'm not very big fan of cold so. I mostly wear gloves and shoes also made from material and take another wind jackets with me to go for the walk.

Z
Do you mean the glove?

A
Gloves yeah. Yeah. And I got my kite equipment, so that the kite, the board and the harness that goes around your waist. And that's all with big bags.

Z
Yeah, so like I saw someone like steering under the wind and move very fast. So this kind of equipment really bulky I can imagine.

A
Yeah, so we got that or Anderson, they made a lot of handy travel bags, I guess, great for carrying everything. And I don't know. I'm most and some water. Always take that and it's, maybe in the trend of safety things in our harness. Mostly people have a little knife. Since we're... okay, I will grab it. I can explain it better.

Z
Yeah, of course. That's always like.

A
Yeah, so this is what you're wearing around your waist. I don't maybe you already saw it sometimes. Uh but, it's in France, there's a lot of safety devices in this stuff as well, but i've. This one thing, I didn't notice what it's about until you someone said it. In here, there's a little knife. You can pull out when you are having trouble with the lines. Get stuck in there that, you can cut the lights. That's always something I check before I go on to the water left. This and the safety equipment is all said before. It can be scary when the wind is going crazy. And.

Z
Yeah, you cannot predict what kind of weather will be in the next second. Yeah, do you like it? And to make sure if you get rid of the...

A
Safety systems. One is, yeah, you can lose your bars. So that's the thing you're a grip on. You lose your bar and you can pull one rope. Then you can't get loose from you, then you can pull other. Then the whole kite is gone. And you have the knife for when you're really tricked in some wires and. This could get them loose.

Z
Yeah, that's quite useful information for the safety, excuse and you mentioned like wind is a kind of risk. The factors could happen. Uh and what kind of other risk factors have you seen.

A
I think the most risk are there other people around you. That is always a risk. You have to take care of where people there. And it's really...

Z
You mean hit each other like.

A
They're not really clear rules on kite surfing like you have rules that you have to take care of the people that are downwind from you. But there. Yeah, it's a little bit like when you go on the ski piece or something, everybody is doing, this thing and. You see some nasty accidents and other thing risk is that the winds the wind falls down and get hurt. When this is and then yeah, then it's complete chaotic because then everybody is struggling. And I think the other risk is now most skaters are going on to the sea. I don't see the bottom. Are we good well in the Netherlands. I got a friend, for example, that did a big jump loses this board and land in the water and it was silly. It was very shallow. He broke his leg because of that. So I think that's maybe also in risk that you're not completely sure about what's underneath you. I think that's maybe one of the biggest accidents have solved that. Sometimes people just land on the land instead of the water and can be pretty hard then.

Z
Yeah, I can imagine this always be risky for these kinds of high speed sports.

A
Yeah, it is. Yeah and also, over water can be very hard when you go with high speed. So I think that's the risks. Yeah, that are the most like the risk for injury.

Z
And then the you actually answer the part, my next question, have you got injured or witness a injury when doing kite surfing?

A
I never get real injured. I get one time I accidentally flew my kite in someone else's kite. And that could be also very nasty because then everything is tangled up and you get dragged along the beach. But I got some Bruce is another set. Um and, I think I heard a lot the most horror stories I heard about people jumping and not

landing well and then breaking bones. You said because you're in the water and there's a lot of panic because the water...

Z
So it's why they jump because the kite is tangled together.

A
No it's not. They just want to do great stands.

Z
Okay.

A
Want to make big jumps so I think that's one most accents and a lot of people have I got it as well the first time that the bottom of the sea has a lot of seashells. So when you go without shoes, or sometimes you grip your hand along the bottom. And I got a lot of cuts, not really deep, but a lot of little cuts from ...

Z
Yeah, that's my first aid kit will help. Yeah, exactly. You can bring like a kit that may help for these injuries.

A
I didn't think it is as well, but when you mentioned your question about where's the first point you can get to when you get injured. I didn't really know because. I never asked me the question, but I think it's a real shame that we don't have like little kits with us or something when yeah, you can also you have a lot of horror stories about people losing ears because of the kitelines. I didn't see myself but you got a lot of horror stories and I think that is something that could be very to have a first aid kit when someone loses ear or have a really bad cuts from seashells or kitelines.

Z
You mentioned, you heard about one broke its leg because of bad landing. What did he do? Or how was he helped by others?

A
Yeah he. Yeah, he was just laying in the in the water. A lot of people saw him dive down and you saw that the kite was doing weird things. There were a lot of people on the beach already yelling, because my god watch out for this guy because it's not going well. Then he was just laying in the water and just real sad. And some people, we're going to him with their kites and then help them up. This there and wait to the coast cars. Got a man there. You got medical attention and put him on a stretcher itself and

he can go to the hospital.

Z

They just uh like, I can imagine it's just help him to go to the beach.

A

Yeah. They could equipment lost.

Z

Have a rest call 112. And wait for help. Yeah, and then.

A

Yeah. And then the coast cars came. Yeah, those real bad because it was really cold as well, because you're just laying in the water for a lot of time. And so he was really cold. So they like the blinking blanket, like a with one blanket around ...

Z

The blanket to keep the temperature, to maintain the body temperature?

A

Yeah exactly, they took their way to your school soon. What you said.
END.

Appendix E - Idea selection process

Marks for important information



The decision that has to be made before selecting idea.

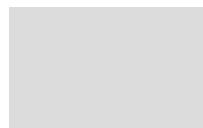


Important selected idea for each parameter.

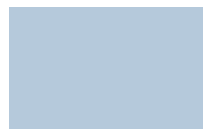
Ranked judgement for criteria



Good. The idea works and has no obvious defect.



Acceptable. The idea is not the best choice because of a certain reason, but can still work.



Bad. The idea is not a good choice compared to the rest.

1 Select space management

Why first choose space management?

Space management is the core of the first aid kit design, and significantly influences the dimensions, size and use of the kit. How these supplies are placed will influence the rest of the idea selection, such as how the glove is put on and how to transmit the reaction force, etc. There is also a preferred selection when placed inside and outside of the bag based on its dimensions. It will be shown on the selection part.

Consideration:

To take advantage of space and make the first aid kit as small as possible, there are mainly three ways of placing supplies found during the ideation phase: 1 laying flat, 2 slim, and 3 upright.

What to fulfil in the requirement list?

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 a larger one for snowboarding).

2.4 The first aid MUST include supplies for basic treatment, for lighter backpacks: 1 glove, 2 gauzes, 3 antiseptic wipes, a few plasters (at least 4 normal and at least 2 large ones), 2 bandages, 1 ice pack.

2.5 The first aid MUST include the following supplies for bigger backpacks: 2 gloves, 2 gauzes, 4 antiseptic wipes, a few plasters (6 normal ones and 3 large ones), 2 bandages, 2 ice packs and 1 SAM splint (or triangular bandage if SAM splint is impossible). If there is extra space, a larger version should include a space blanket, a breath barrier and a trauma shear.

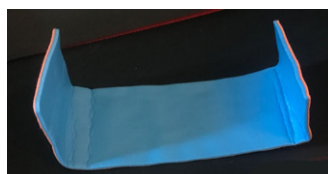
2.6 The volume of the light version should not exceed 1.5L (based on the size of supplies).

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

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

Why is the SAM splint placed in this way?

In the research report part, the comparison of the SAM splint and triangular bandage shows the SAM splint can be used with only one hand and has no big difference in size. SAM splint is the better choice and the triangular bandage will only be considered if SAM splint is impossible. During the ideation phase, I found a new way of placing SAM splints and compared it with the traditional way, method 2. Method 1 of placing the SAM splint is way better than method 2.



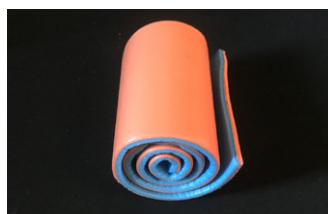
Method 1, unrolled

Pros

- + Only add very little thickness to the kit
- + Very easy to flatten it and ready to apply.

Cons

- Requires users to take it out from the side when it is located underneath a lot of other supplies.



Method 2: rolled or folded

- + Easy to take out

- Add more to the length of the kit
- It takes time to unroll it with one hand and then apply.



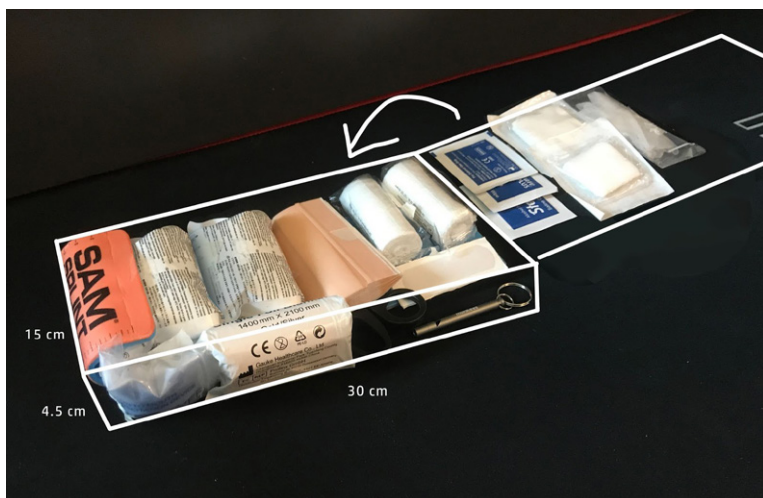
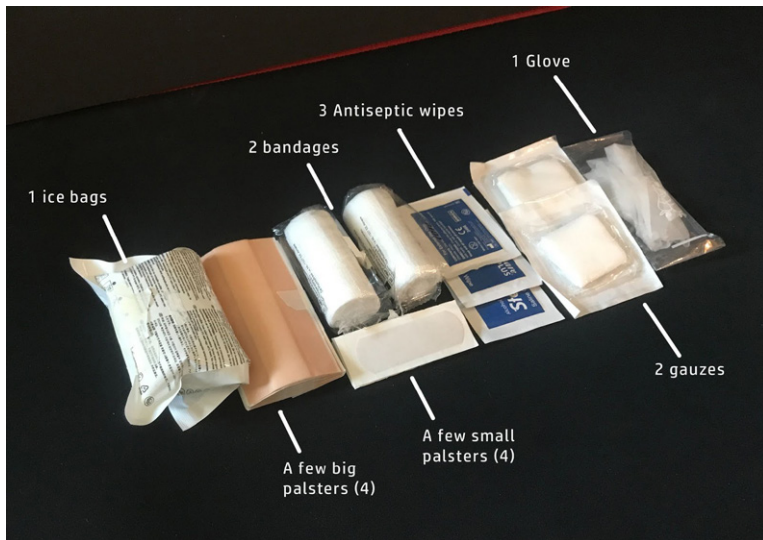
SAM splint
Method 1

Ideas



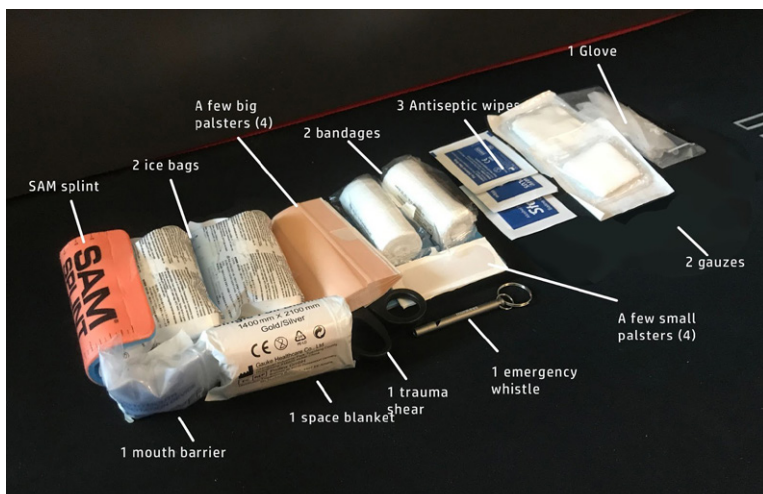
Idea 1: supplies laying flat

Small version: 20.5cm X 12.5cm X 4 cm, 1.025L.



Idea 1: supplies laying flat

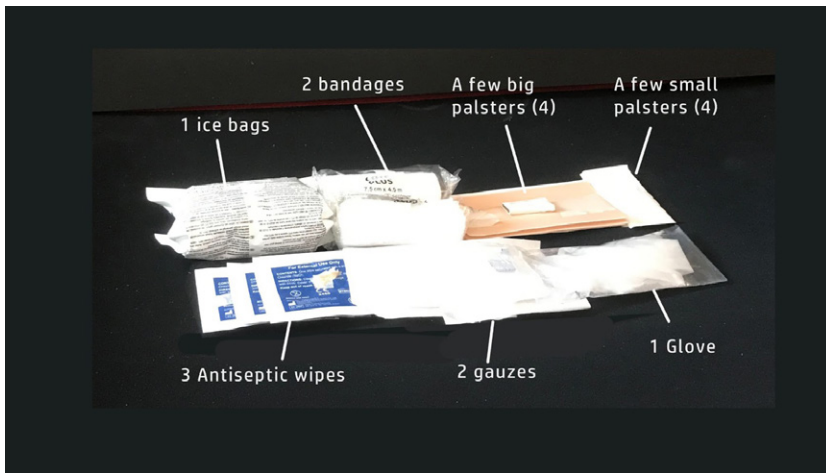
Bigger version: 30cm X 15cm X 4.5cm, 2.025 L.





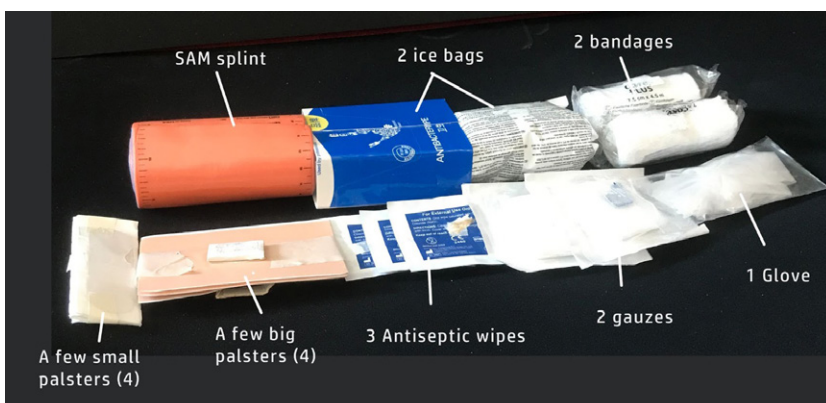
Idea 2: Slim

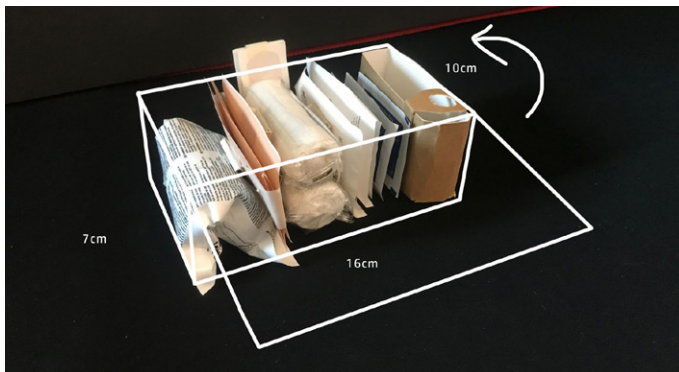
Small version: 33.5cm X 7cm X 4cm, 0.938 L.



Idea 2: Slim

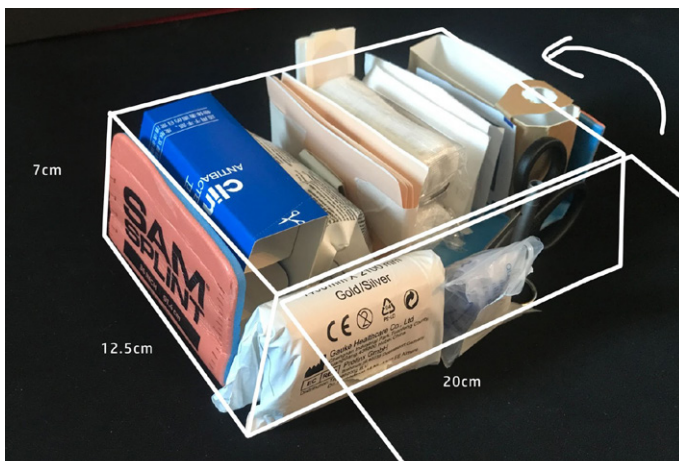
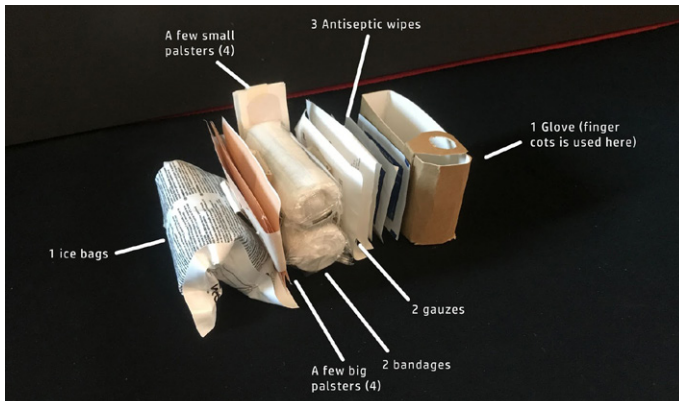
Longer version: 38.5cm X 7cm X 4cm, 2L (without the rest of tools)





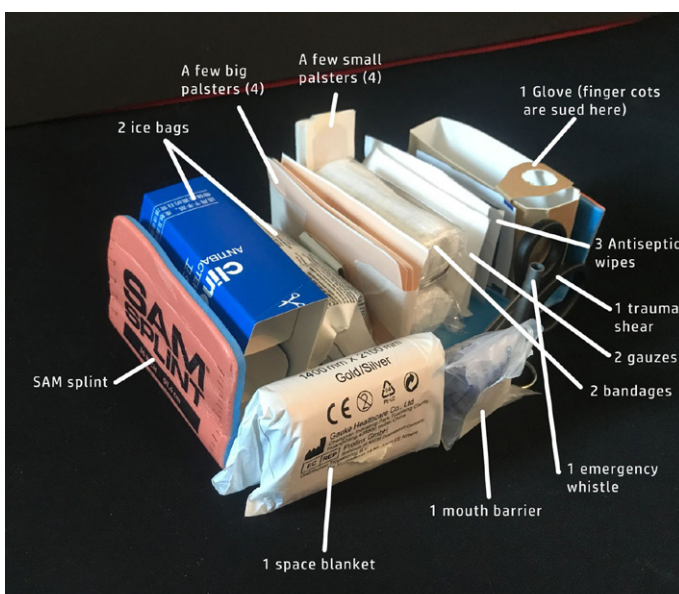
Idea 3: supplies placed upright

Small version: 16.5cm x 10cm x 7cm, 1.12 L.



Idea 3: supplies placed upright

Larger version: 20.5 x 12.5 x 7 cm, 1.75L



Inside or outside?

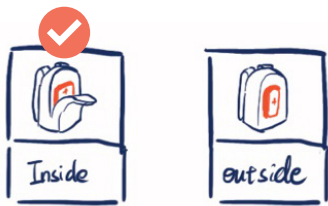
With all three possible solutions for space management, placing inside or outside of the backpack is important and helps to select ideas from this part.

Requirements:

- Noticeability
 - Accessibility
 - Fit all backpacks
- Convenient for all kinds of behaviours of outdoor sports players.

Result: place inside of the bag and is taken out when needed.
Based on the discussion with the outdoor enthusiast of kitesurfing, placing a first aid kit outside is not a good idea because she always brings bulky equipment with her and ties them on the back of the bag. There is no space for her to put a first aid kit. Since the frequency of first aid kit use is really low, it shouldn't influence the normal use of other equipment (less disturbance). Therefore, placing outside of the bag will not be selected due to its inconvenience to some of the sports players.
Placing inside the backpack is a better way to fit the requirements of as many users as possible.

	Pros	Cons
Inside of backpack	<div><ul style="list-style-type: none">- Can fit all backpacks- absolutely safe for players</div>	<div><ul style="list-style-type: none">- Not to be seen as easily as placed outside. Needs something else to remind the user.- Two more step to access (open and take the backpack)</div>
Outside of backpack	<div><ul style="list-style-type: none">- Really easy to be seen and accessed when an emergency happens.</div>	<div><ul style="list-style-type: none">- Has a requirement for the pocket/straps outside of the backpack, some even don't have them outside (cannot fit all supplies).- Has a conflict with other equipment tied outside of the bag (snowboards/surfing boards, ...) and ends up placed inside again.- can be a potential threat when hitting or tangling with an object</div>



Location
Inside

Idea 1, 2, or 3

As the following Figure X shows the comparison of relative volumes between backpack and three ideas.

Compared to idea 2, 1 can be opened along its length so that reaction force is easily transmitted. Compared to idea 3, 1 is long enough and has a larger area on top to be easier noticed and accessed when placed inside. Idea 1 is the better choice among the three ideas.

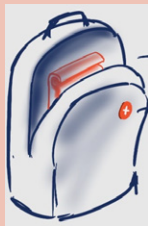


Pros

Cons

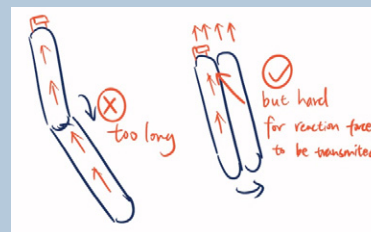
Idea 1

- long enough to be noticed and access in the bag
- Large area on the top to be easily noticed.



Idea 2

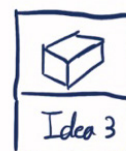
- long enough to be noticed and access in the bag



- Not suitable to be opened along its long axis, which makes it longer than the arm and hard to get supplies.
- Not suitable to be opened along its long axis, not easy for reaction force to be well transmitted when being used.

Idea 3

- short and compacted, can be covered by other objects in the backpack, hard to be noticed.



Space
management
Idea 1

2 How to draw attention from outside of the backpack

Design consideration

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.

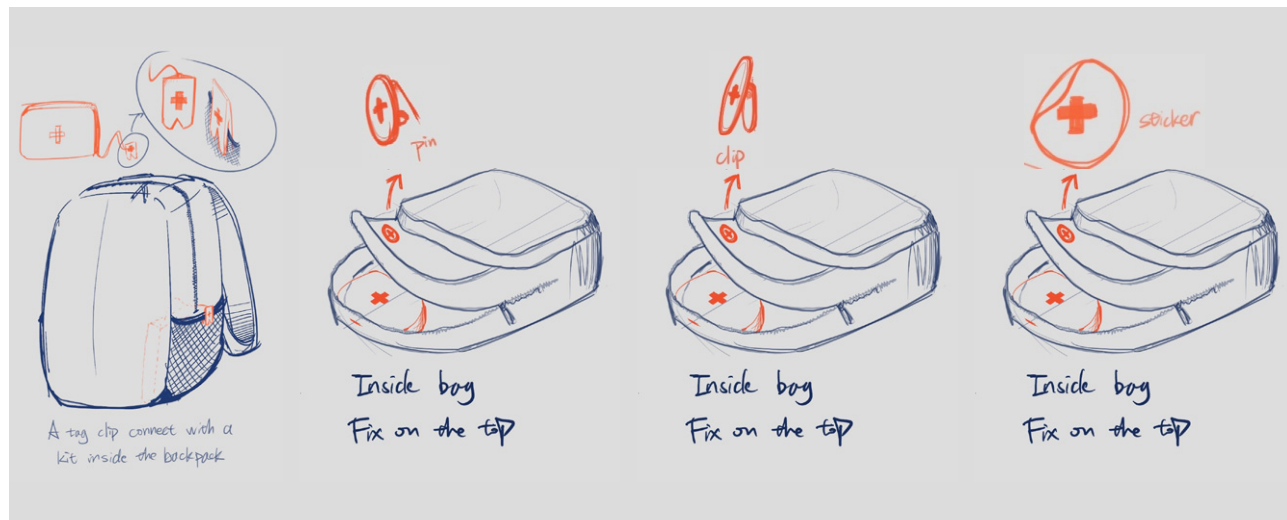
What to fulfil in the requirement list?

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

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

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

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



Idea 1

Idea 2

Idea 3

Idea 4

Idea 1: Kit connects with a clip that is located outside of the bag and clip on the edge of a pocket.

Idea 2: A pin attached to the outer surface.

Idea 3: A clip attached to the outer surface.

Idea 4: A sticker attached to the outer surface.

Criteria:

1 Durability: Can the design attach for a long time on a backpack and reusable?

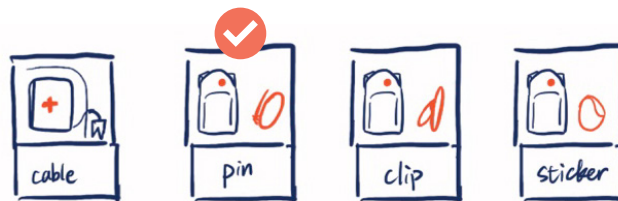
2 Stability: Does the design have a risk of falling off and getting lost?

3 Independent: Will the design influence the normal use of the backpack? Or force users to change their habits?

4 Convenience: is the design convenient to be prepared before departure?

	Durability	Stability	Independent	Convenience
Idea 1	Yes. hard component and usable.	No. won't get lost with a cable connected but can fall off.	Influence the use of the zipper.	Very convenient
Idea 2	Yes. hard component and usable.	No. tight connection.	No influence	Very convenient
Idea 3	Yes. hard component and usable.	Yes. It can fall off due to external force	No influence	Very convenient
Idea 4	No. can fade or fall off under the influence of water. And not reusable.	No.	No influence	Very convenient

By comparing four ideas, idea 2, using a pin, is the best idea.



Draw
attention
Idea 2

3 How to provide a reaction force while in use

Design consideration

When placing inside the backpack is decided, reaction force provided by the first aid kit is 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.

3.2 What to fulfil in the requirement list:

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



Idea 1

Idea 2

Idea 3

Idea 4

Idea 1: A kit hook on a pocket/handle.

Idea 2: Connected with a clip, reaction force provided by the clip.

Idea 3: Soft straps to fix on the backpack or other ropes outside.

Idea 4: Using magnets

Criteria:

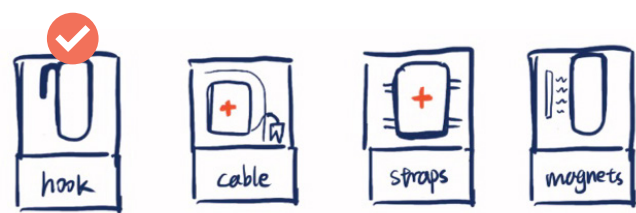
1 Stability: Is the design stable enough to provide reaction force?

2 Quick rule: Does the design cause extra steps?

3 One hand use: Can the design be used with one hand and fix on a backpack?

	Stability	Quick rule	One hand use
Idea 1	Yes. with a hard plastic hook.	No, very quick with only one step.	Yes. easy to hook.
Idea 2	No. The Clip may not be strong enough, and the cable in between is flexible.	No, very quick with no step.	Yes.
Idea 3	Yes. Tied straps are strong enough to hold the kit stably.	Yes. require users to tie themselves.	Hard to tie on the backpack with one hand.
Idea 4	Yes, with extremely strong magnets.	Yes. requires another piece of magnets to be placed on the other side of the material.	No. hard for one hand to separate two strong magnets.

By comparing four ideas, idea 1, using a hook, is the best idea.

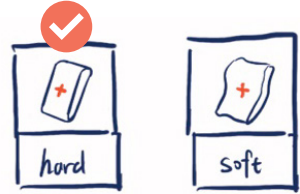


Reaction force
Idea 1

4 Hard shell or soft kit

	Stability	Quick rule
Hardshell	<ul style="list-style-type: none"> - Good protection to the supplies. - Is waterproof itself - Plastic components and structure achieve a “one-click” opening, friendly to on-hand opening. - Better transmit the reaction force with hard material. 	<ul style="list-style-type: none"> - Placing inside the backpack may not need extra protection from hardshell.
Soft kit	<ul style="list-style-type: none"> - More flexible with space because all supplies can be compressed a lot. - Soft material causes no damage to other objects in the backpack. 	<ul style="list-style-type: none"> - Needs waterproof material - Requires - Fabric may be flexible for reaction force.

Hardshell is a better choice because of its better performance in waterproof, one-hand opening and reaction force.



Hard or soft
Hard

5 The opening ways of first aid kit

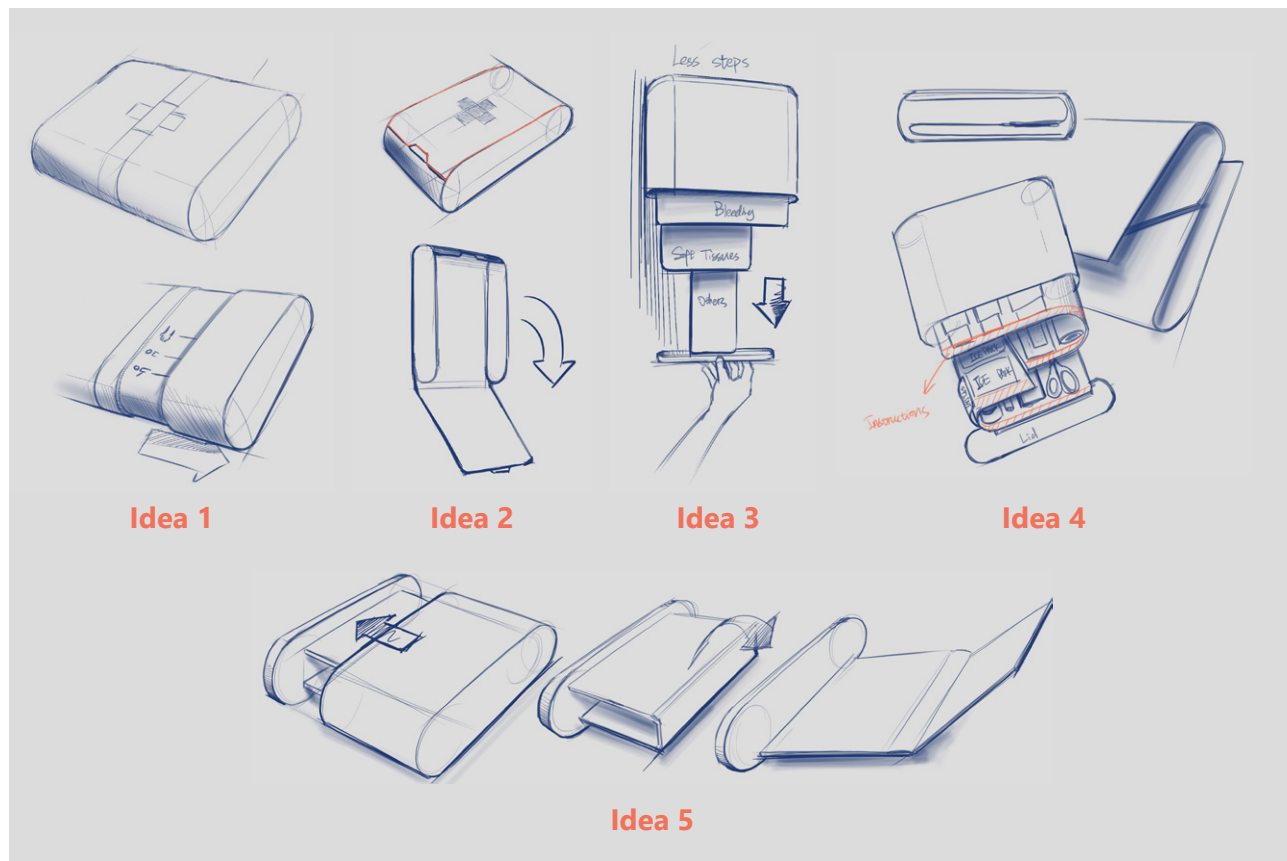
Design consideration:

When a hardshell is decided to be used in first aid kit design, some ideas suitable for hardshell are compared according to the criteria in this step.

What to fulfil in the requirement list:

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

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



Idea 1: Open the lid for supplies located on one side. Other supplies are loaded on the other side and have to open another lid. The information shows on the box.

Idea 2: Open the kit with a rotational lid.

Idea 3: Open the lid and pull out the three layers. The lid serves as a handle so there is only one step.

Idea 4: B10: A rolled multiple-layer carrier or supplies which can be pulled out and show all supplies.

Idea 5: Open the big lid, unfold the board on all supplies.

Criteria:

1 Quick look: Can the user see all supplies once the kit is opened?

2 One-hand use: Is the kit possible to be opened with one hand easily?

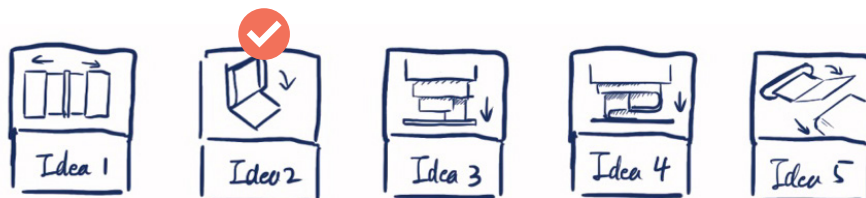
3 Reaction force: Is the kit able to well transmit the reaction force from the hook along the direction of opening?

4 Quick use: How many steps does it take from unlocking to fully opening?

5 Less disturbance: Will the opening ways influence the use of supplies?

	Quick look	One-hand use	Reaction force	Quick use	Less disturbance
Idea 1	No. Need to open the other side to see the rest	Yes.	No. Because supplies on two side require reaction force from two directions	2 to fully open it.	Yes. The hard shell on top of supplies influences their use.
Idea 2	Yes.	Yes.	Yes.	1	No
Idea 3	Yes.	Yes.	Yes.	1	No
Idea 4	Yes.	Yes.	Yes.	1	Yes. The hardshell on top of supplies influences their use.
Idea 5	Yes.	Yes.	Yes.	2	No

Idea 3 requires a thicker shell and more space on the structure to achieve the sliding function, which causes worse performance on space management. Therefore idea 2 is the simplest but the best to fulfil all requirements.



Opening
Idea 2

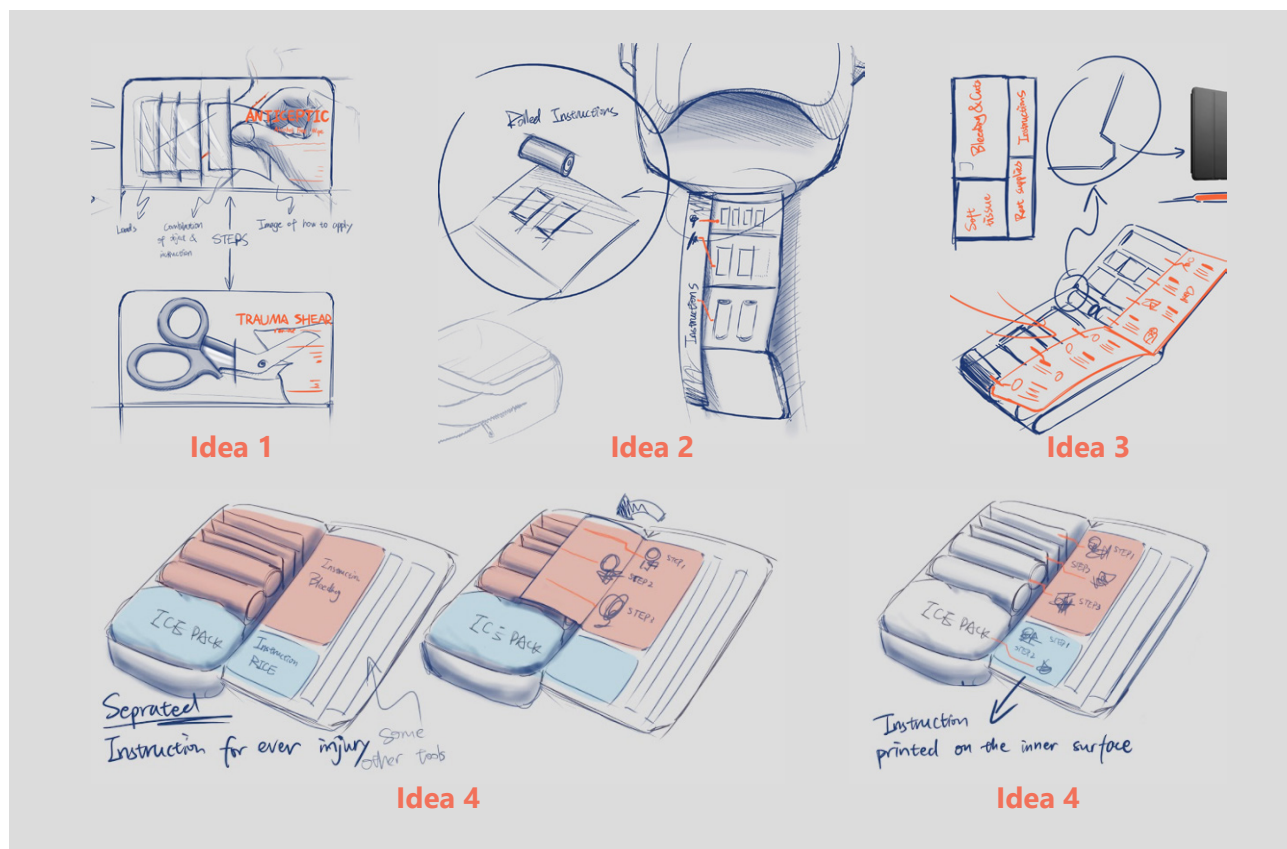
6 Where is the first aid guide

Design consideration:

Instruction is the first thing users should see once the kit is opened. They can then choose to look at the instruction or directly apply the treatment themselves.

What to fulfil in the requirement list:

- 3.1 Users should see the instruction first after opening the kit.
- 3.2 Users should be able to choose if they decided to open the instruction or not if they are well-trained.
- 3.4 Instruction should show the needed supplies for steps and shown where they are.
- 5.4 One-hand use should be developed for opening instruction, ...
- 4.2 Instruction should include the main 4 types of treatment and their steps: Cuts and grazes, severe bleeding, RICE method, fracture.
- 4.3 Instruction should be intuitive to be understood as quickly as possible.
- *(Graphic design part will be finished after the physical design is decided)



Idea 1: Combine the physical supplies with graphic instructions which illustrate how to use them.

Idea 2: A rolled instruction with eye-catching colour, from the top.

Idea 3: A folded instruction with eye-catching colour, folded from the top.

Idea 4: Folded separated instructions for bleeding and soft tissues respectively, folded on one side.

Idea 5: Printed instruction on the inner surface of the kit.

Criteria:

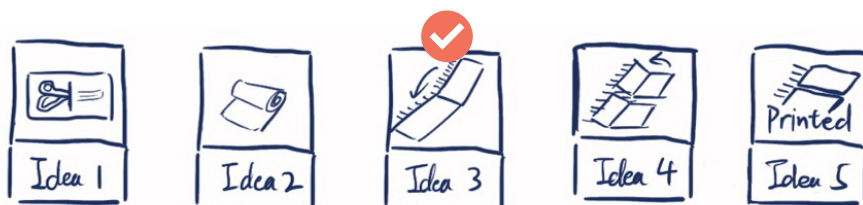
1 Eye-catching: How eye-catching is the instruction?

2 Space management: Does the idea require extra space for the first aid kit?

3 Feasibility: Is the idea possible to be used according to the selection of ideas of previous steps?

	Eye-catching	Space management	Feasibility
Idea 1	Very eye-catching	Requires more space for instruction	Not suitable for the previous selection, The combination influences the use of supplies.
Idea 2	Acceptable	Requires part of the space on the lid	Yes.
Idea 3	Very eye-catching with a large area of instruction	Requires part of the space on the lid	Yes
Idea 4	Very eye-catching with a large area of instruction	Requires part of the space on the lid	There is almost no space on the side. Since the idea 3 and 4 are similar. Therefore 3 will be better than 4.enough to print so much information.
Idea 5	Very eye-catching with a large area of instruction	Requires space on the lid, which can be used to place supplies.	When a few types of supplies are placed on the lid, space will not be enough to print so much information.

Idea 3 is the best among all 5 ideas while idea 2 is also not as good as idea 3, which can be considered as an alternative when idea 3 is impossible.



Instructions
Idea 3

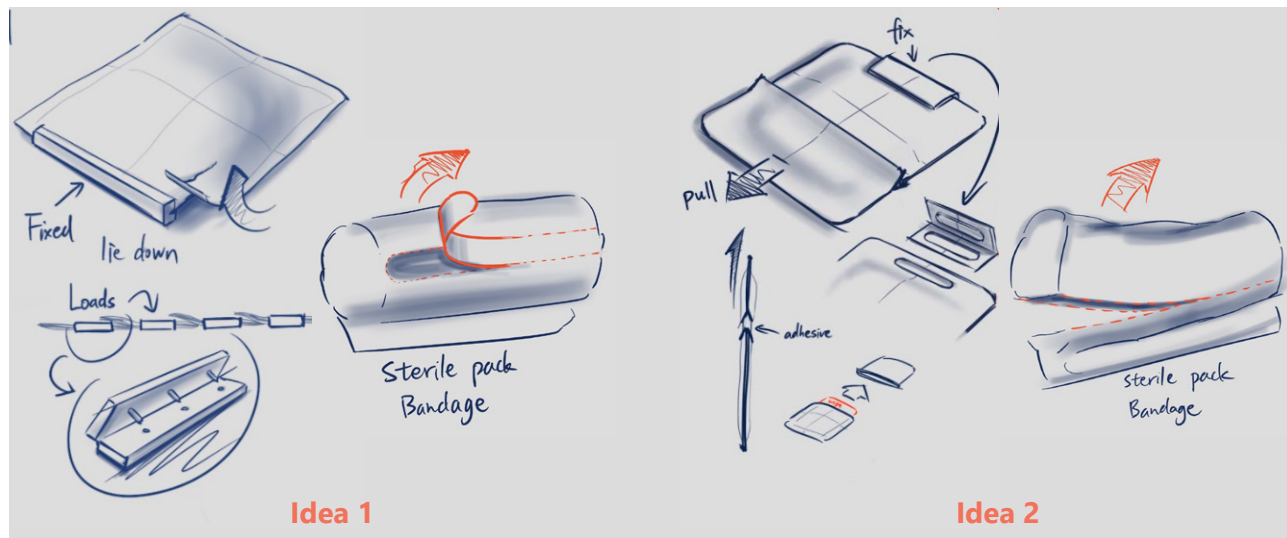
7-1 How to open the sterile pack

Design consideration:

Both of the ideas work. There are some little differences that help to select.

What to fulfil in the requirement list:

- 5.2 All sterile pack should be easily opened by one hand (Gloves, gauzes, wipes and bandages)
- 5.3 All supplies should be easily taken out with only one hand.
- 3.5 The information for every single supply should show the name and basic functions. (Graphic design part will be finished after the physical design is decided)
- 5.6 The first aid kit should fix supplies on it and provide reaction force to simulate the function of the other hand.



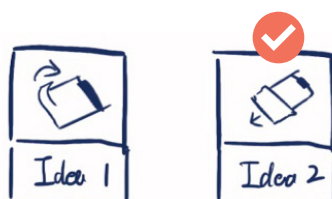
Idea 1: All supplies are fixed by a hard structure at the right bottom (bandages and wipe as examples). Users tear a part of the sterile pack and open it.
 Idea 2: Users open it by lifting half of the packaging. Two halves are glued together. This idea is also possible for placing flat or upright.

Criteria:

- 1 Convenience 1: Does it require extra space for fingers to hold it?
- 2 Convenience 2: Does it fully open the sterile pack and won't require a second operation?
- 3 Material use: how big the plastic component should be?

	Eye-catching	Space management	Feasibility
Idea 1	Yes. The user needs to put fingers underneath to hold it. Not convenient for a hard shell below.	It is easy to just open a small part, and then need to continue tearing to open it	Needs longer material.
Idea 2	Can easily lift one side and hold it.	Fully open it.	Only a little material is enough.

Idea 2 is the better idea.



Sterile packs 1
Idea 2

7-2 How to open the sterile pack

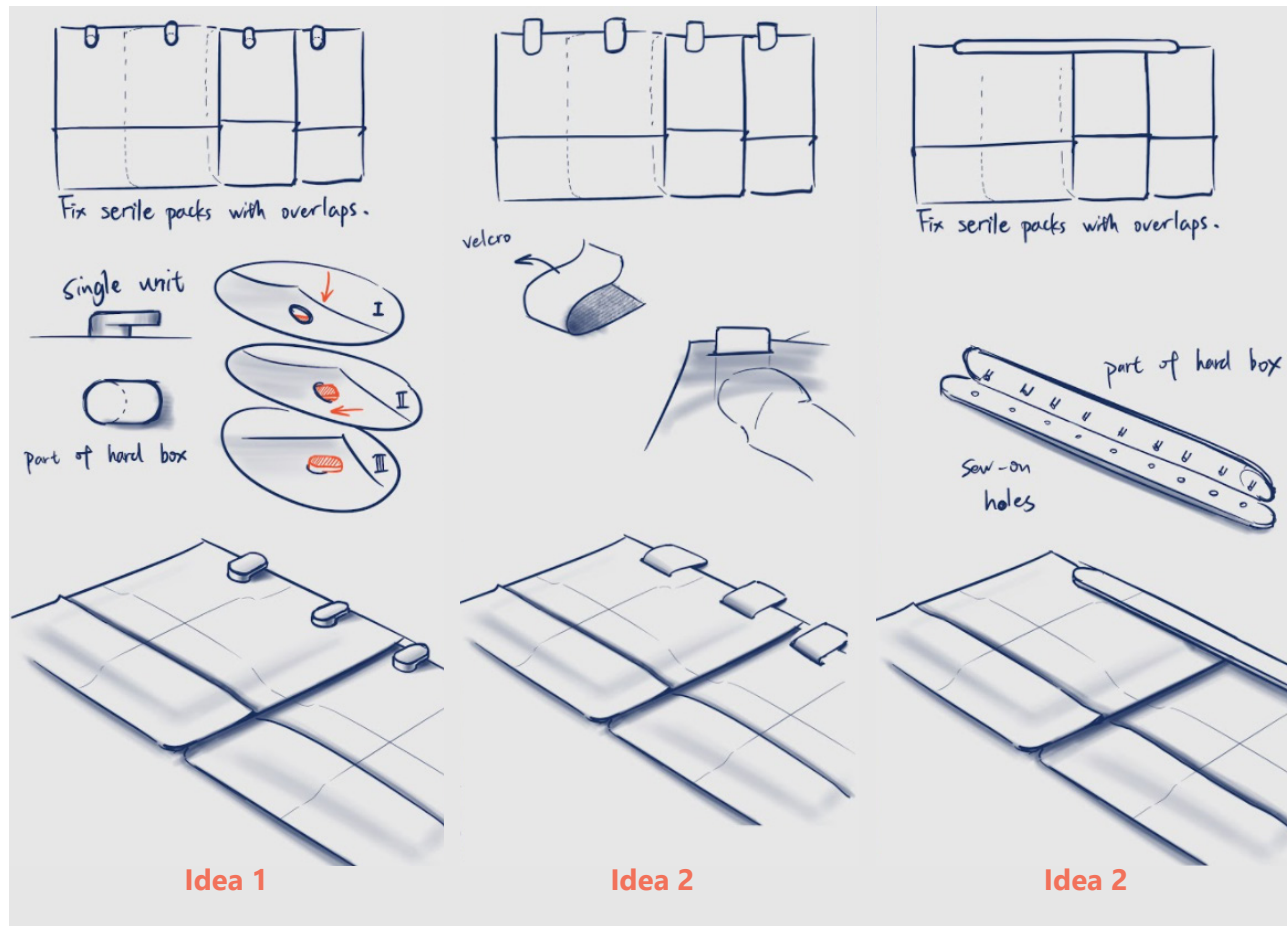
Design consideration:

When the idea of 7-1 is decided, this part is a more specific design about the sterile pack fixation. Three ideas in this part start from how they are fixed using reusable structure or material to achieve the function.

What to fulfil in the requirement list:

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

6.1 Medical supplies should be easily reloaded.



Idea 1: standard units which are part of the hard box. Sketch shows how sterile packs are fixed and reloaded

Idea 2: velcro straps

Idea 3: A long plastic component fixes sterile packs by puncturing them.

Criteria:

1 Reaction force: Does the idea fix strike tight to provide reaction force?

2 Reload: Is the idea convenient for users to reload (align and reload)?

3 Component: Does the idea require extra component, structure, connection to achieve the function?

4 Fixation: will the sterile pack fall down inside the kit?

	Durability	Stability	Independent	Convenience
Idea 1	Yes.	Easy to reload. (1 step)	No, as a part of the hard box	No
Idea 2	Yes.	Users have to get every velcro straps through the holes on sterile packs, which is slow compared to the idea 1. (way more steps).	Requires extra connection with the hard box.	No
Idea 3	Yes.	Easy to reload. (3 steps: open, align, close)	Requires a rotational structure (or structure like snap-fit) to achieve the function.	No

Idea 1 is the better idea.



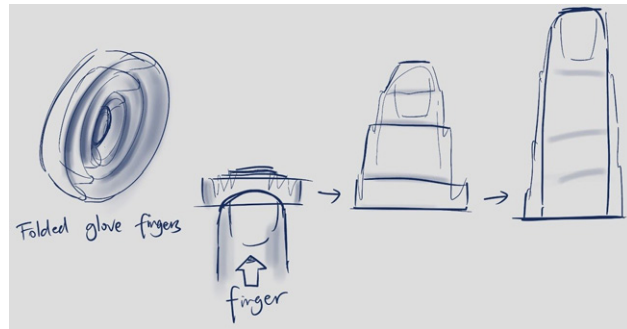
Sterile packs 2
Idea 1

8 Put on glove with only one hand

Design consideration:

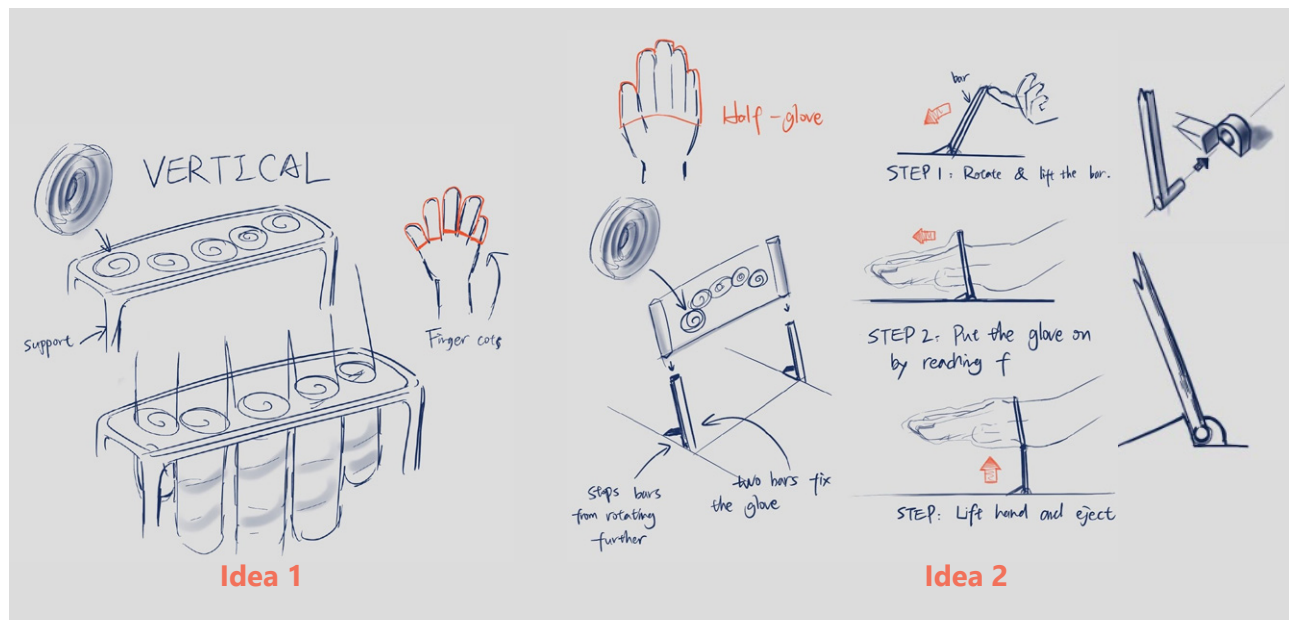
One of the problems of having trouble putting on the glove with one hand is that it doesn't have a reaction force. Another problem is that the friction between hands and gloves is too strong, especially the palm and the back of the hand where a large surface is contacting the inner surface of the glove.

The principle of the solution is to avoid contact with the palm and back of the hand. The glove only provides fingers with hygienic covers (half glove or 5 finger cots). Another advantage of the design is to allow fingers to contact the fingertip of the glove first and then unfold the glove/finger cots as shown in the following figure. All finger parts of the glove will be folded as shown on the left.



What to fulfil in the requirement list:

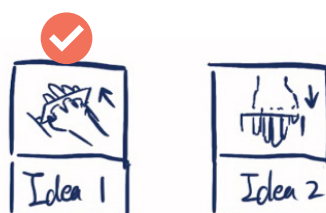
5.4 One-hand use should be developed for ..., wearing gloves, ...



Idea 1: The idea is a half-glove folded inside a sterile pack. The user lifts the glove by rotating the bar, opening the strike pack, reaching forward to put on the glove and eject by lifting the hand.

Idea 2: The second idea is putting on finger cots (not connected with each other) vertically. Similar to the first one, the idea uses the same folded finger parts but not connected, which are finger cots. Support is needed here to fix them.

These two ideas are similar ideas designed for vertical and horizontal placement of gloves respectively. As decisions made previously, idea 1 is more feasible.



Glove use
Idea 1

9 Apply bandage with only one hand

What to fulfil in the requirement list:

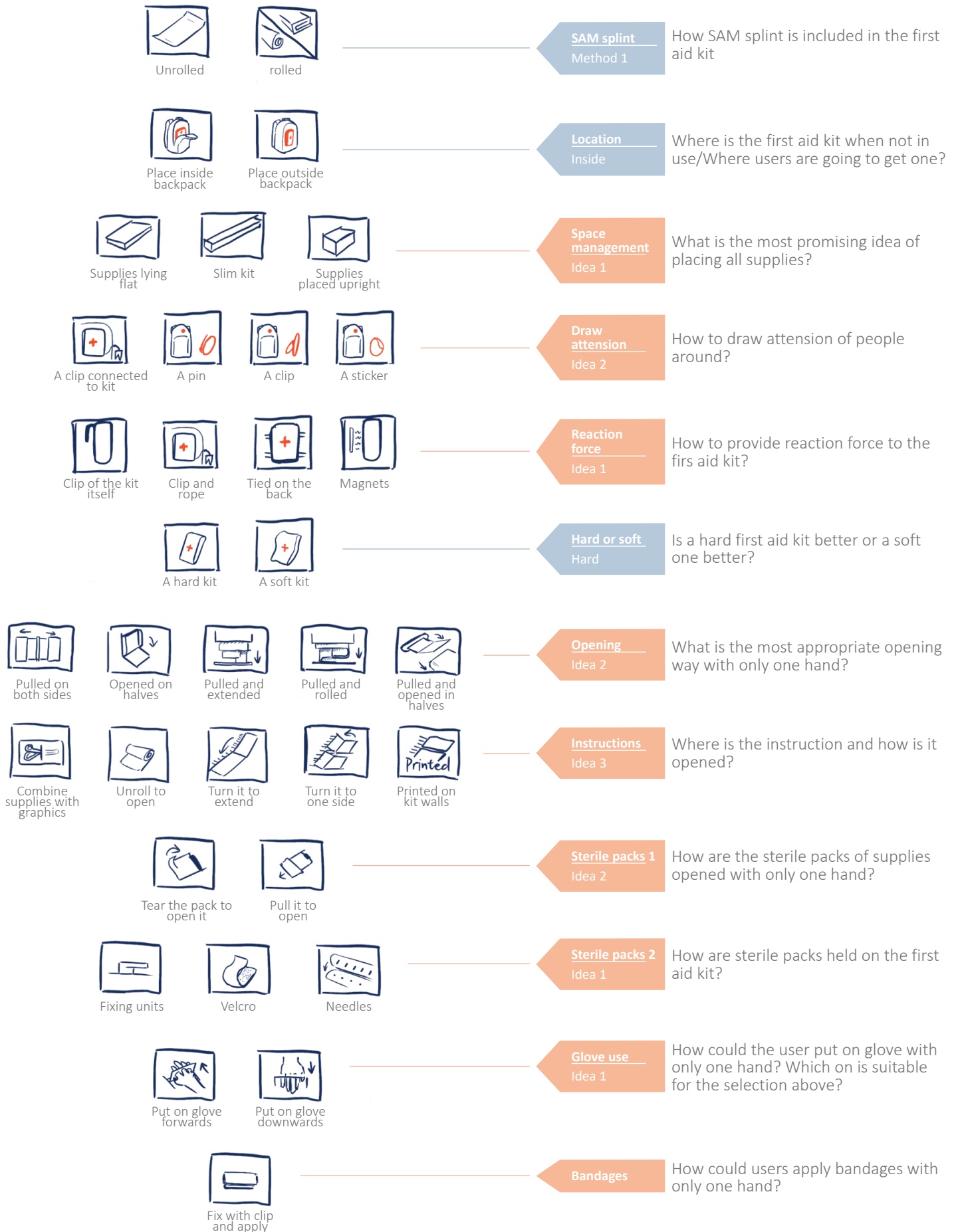
5.4 One-hand use should be developed for ...,
applying bandages, ...



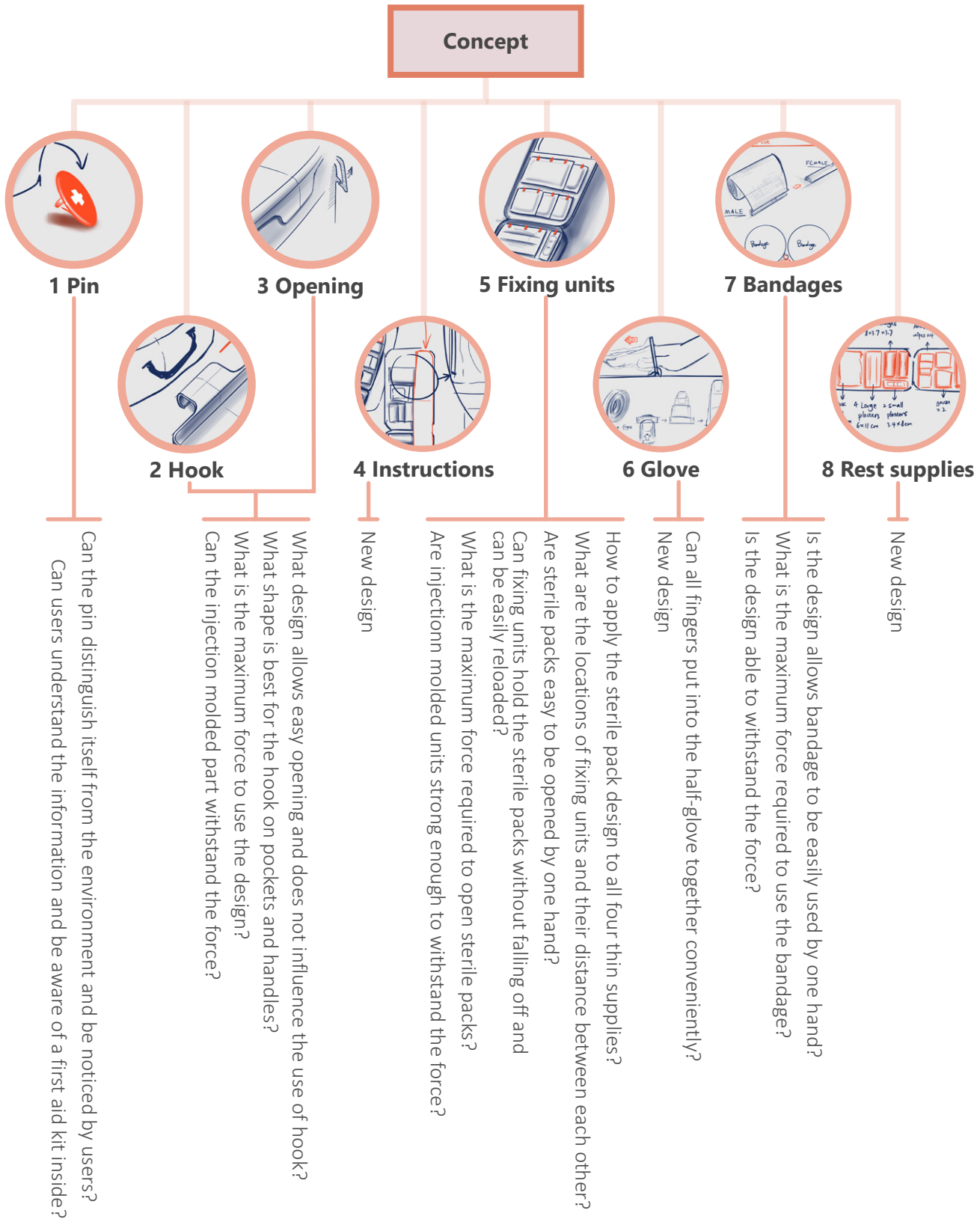
Idea: The idea is to connect the bandage with a "male structure", which connects to the "female structure" so that one end of the bandage can be fixed. After applying dressing on the wound and wrapping the other end, the "male structure" will be taken out and help to fix the bandage on the arm as a clip.



Morphological Chart



Appendix F - Concept test iterations





Part 1: Design of the PIN

Research question 1:

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

Test plan:

1. List pictures of outdoor sports, showing the environment around.
2. Compare the color existing in the locations of outdoor sports and the color of the PIN.

What to make:

1. List pictures of outdoor sports environment.
2. List of colours of these pictures.
3. Pictures of the PIN.

Result:



Figure 1: Colours of environmental and the PIN

Conclusion/analysis:

1. According to the pictures and experiences, highly saturated, **light orange is rare (or no) in nature**, especially in the location of outdoor sports. This colour usually appears on the product, and allow users to notice it at a distance because the colour **distinguishes the pin from the environment** and stand out.
2. Another finding from the pictures is that highly saturated colours are widely used on other products too. The purpose is similar to the PIN: drawing attention from humans.



Part 1: Design of the PIN

Research question 2:

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

Test plan:

1. Find a few fellow students.
2. Ask them if they can get what the PIN means at the same time.
3. Discuss the design.

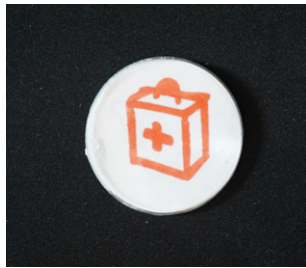
What to make:

1. Two designs of a PIN
2. Put the PIN on a backpack



1

A PIN with a simple white cross on it.



2

A PIN with a first aid kit illustration on it.

Result:

1. Misunderstanding: The first aid logo (first aid cross) is better than the logo of a kit. The logo should express the meaning clearly and precisely, otherwise it will cause misunderstanding. The logo of a kit was taken as a grocery bag during the test.
2. The symbol itself may also cause unclear meanings. To make the PIN express the meaning more clearly, the combination of a symbol (first aid cross) and text (first aid) is better (as shown in the figure).

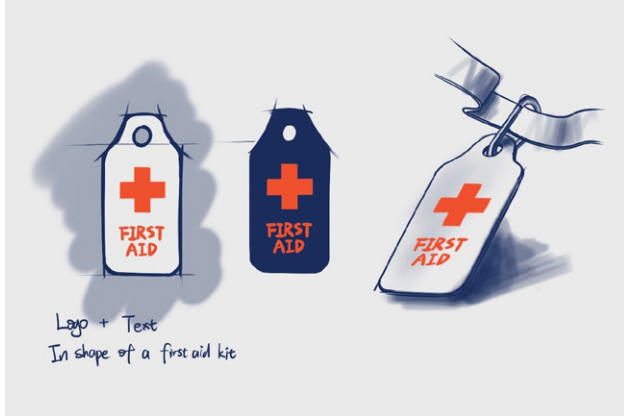
Conclusion/analysis:

Option 2 is selected.



Part 1: Design of the PIN

New design



Sketch of new design PIN



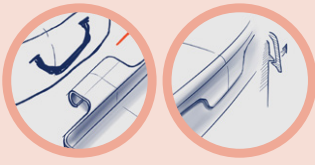
Final design PIN

Final design:
PIN



Final design PIN

The new design uses a combination of a logo (first aid cross) and text (first aid). And its shape is changed to similar to the outline of the first aid kit, more iconic and unique.



Part 2 & 3: Design of the Hook and opening

Test 1

Research question 1 & 2:

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

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

Hook and opening ways are not independent from each other, so they are tested together.

Test plan:

1. The aim of the first test about hook and the opening way is to use simple material (cardboard, glued) and have an overview about what are the proper dimensions and show if the prototype works.

2. Simply test if the hook can hook on the handle of a backpack and can be easily opened as sketches.

What to make:

Use the cardboard to make the body of the first aid kit, rotatable axis, hook, and very basic shape of the opening structure (The opening structure is currently impossible to be simulated by cardboard). The following figures show the finished first prototype of the hook.

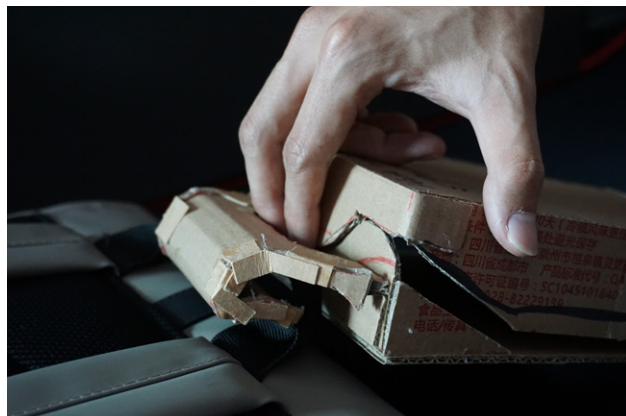


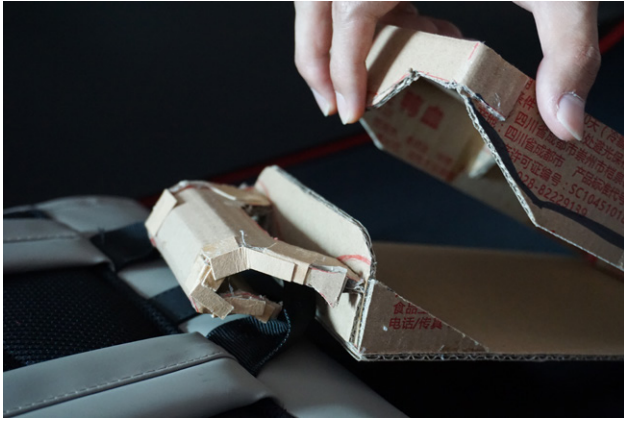
Cardboard prototype of hook and kit body

Test & Result:



Hook on backpack





Opening

Conclusion/analysis:

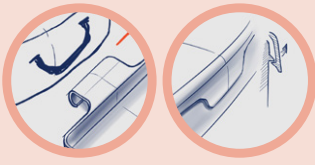
Hook function:

Because of the cardboard strength, **the function of the hook cannot be achieved**, which can only serve as a look-like prototype. The second test should achieve the function with other materials.

Opening:

The opening of the kit is simulated well for further tests, which are convenient and smooth. But there are some changes that have to be made:

1. The surface of the opening structure should be curved, for easier grasp.
2. There is not enough room for fingers according to the current dimensions.
3. The shape of the structure can be improved as easily to touch and distinguish from the rest of the structure (use shape/graphic design language to tell users here is the right place to open the kit).



Part 2 & 3: Design of the Hook and opening

Test 2

Research question 1 & 2:

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

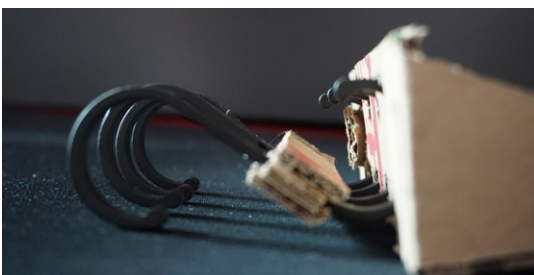
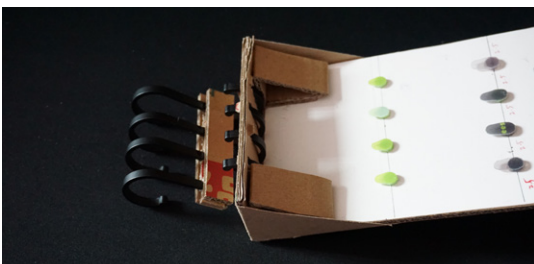
What design allows easy opening and does not influence the use of hook?

Test plan:

1. The aim of the second test is to achieve the function of the hook to prove that it can steadily hook on a backpack and provide reaction force.
2. Make a similar kit body with cardboard as the first test but use stronger material to make a hook.
3. Test the hook with a backpack and conclude for the further test.

What to make:

1. Make a similar kit body with cardboard.
2. Use steel hooks and connect with cardboard kit.



Steel hook and the second prototype made of steel hooks

Test & Result:



Hook on backpack

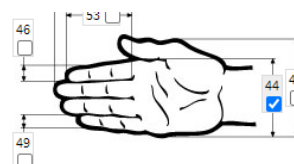
Conclusion/analysis:

Hook function:

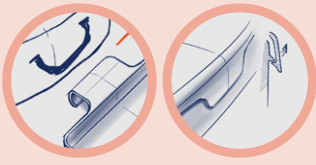
The prototype (hook) is much stronger than the first one and **successfully simulated the basic function of the design**. (The real structure should be tested using plastic).

The dimension is also good as expected. Since the handles and pockets are for the hand to reach in, they must be wider than hand width. The design of the hook should be as small as 5% of the hand width in order to fit all the handles of the backpack. According to the ergonomic data of Dutch adults, the 5% hand width is $85 \cdot 0.95 = 78.35\text{mm}$. **The hook width should not be larger than 78mm.**

populations	Dutch adults 20–60, mixed		Dutch adults 60+, mixed	
	mean	sd	mean	sd
Hand width (without thumb) (mm)	85	7	85	6



Hand width data of dutch adults from DINEN



Part 2 & 3: Design of the Hook and opening

Test 3

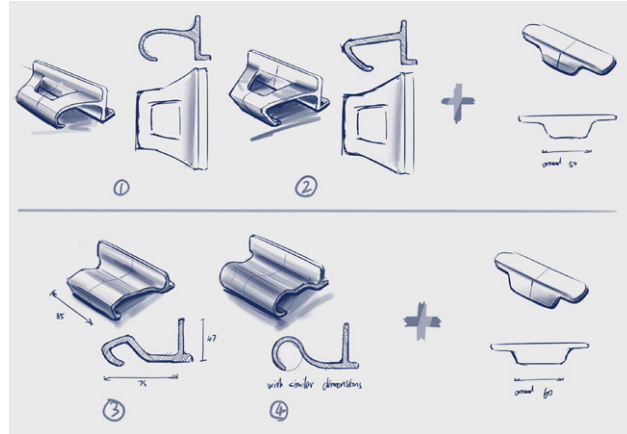
Research question 1 & 2:

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

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

Test plan:

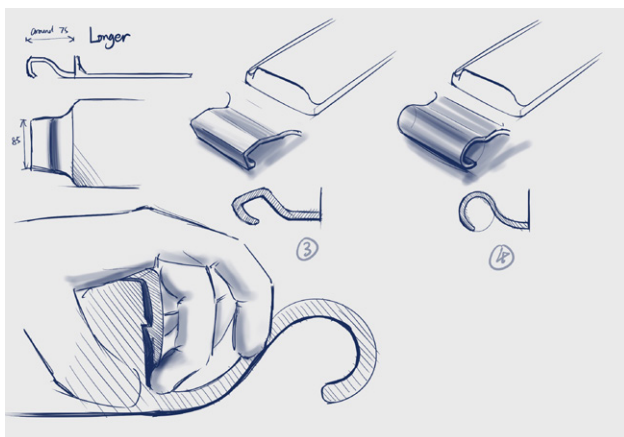
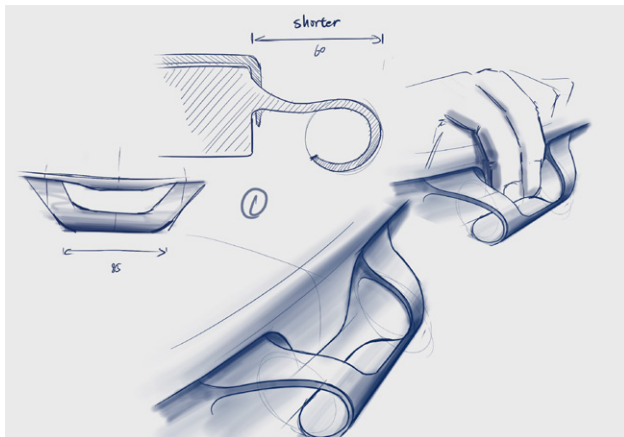
1. This test is to test and select an idea from current options and get feedback to improve the design for the hook on and opening way.
2. Based on the cardboard mockup (dimensions), Develop a few possible hooks and opening designs (making sure they can be used easily don't influence each other) (explore different shapes of the hook, allowing them to fit pockets and handles).
3. Build 3D models.
4. 3D print them.
5. self-test and invite fellow students to test, discuss, write down their comments, take photos and select the best one.



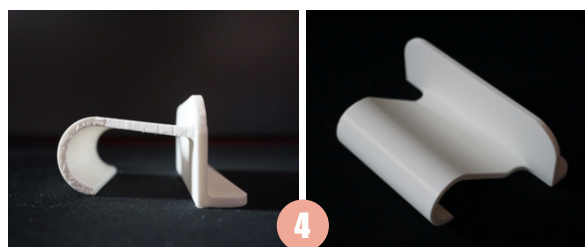
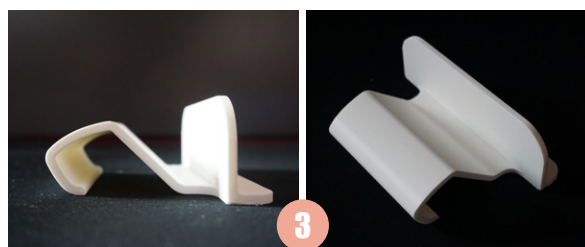
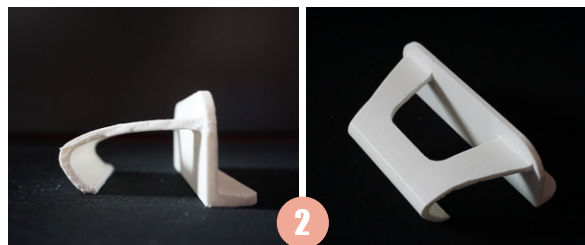
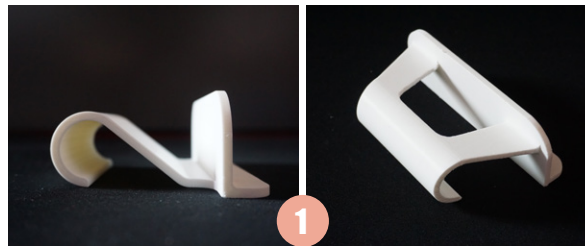
Sketches of 4 options to be modeled and printed

What to make:

1. A few sketches.
2. Only model the front part of the kit with Solidworks. 3D print them.
3. Test with 3D printed parts (combined with cardboard kit).



Sketches of opening and hook design



Four 3D printed options

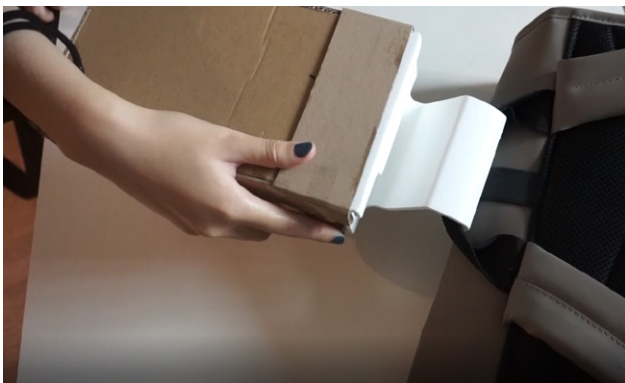


How 3D printed part connected to cardboard mock-up

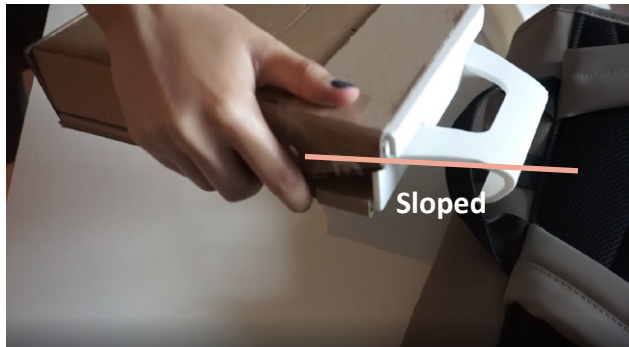


Opening test of option 3

Test & Result:



Hook test of option 3



Hook test of option 2



Opening test of option 2



Close the kit with palm

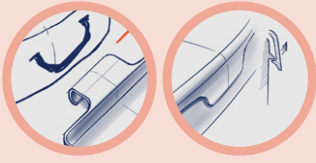
Conclusion/Analysis:

Start from No. 1 and 2. Improve the shape to make it easier to hook on than the current design. reduce sharp edges, and fit the shape of backpack handles.

Discussion takeaways:

1. Sloped shapes (No. 1 and 2) are better because they are easier to hook on. The shape is the key to influencing how quick the user can hook on their backpacks.
2. The sharp edges cause a little trouble on hooking.
3. Round or other shapes of the curve make no difference, in speed or experience.
4. Hollowed (1 and 2) hook is better. Fingers can reach through the hole to the bottom, and close it with palm. The design of No. 3 and 4 felt like the kit is not fully closed. 5. The opening way is OK.

Test video: <https://youtu.be/2fMSqlgdtEg>



Part 2 & 3: Design of the Hook and opening

Test 4

Research question 1 & 2:

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

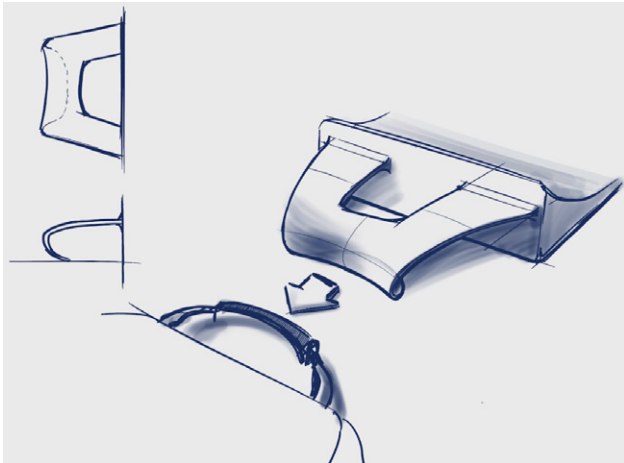
What design allows easy opening and does not influence the use of hook?

Test plan:

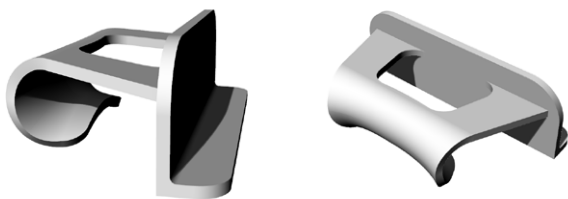
1. This test is to test if the new design can be easily hooked on (easier than the previous designs, and fit most of the handles/pockets). 2. Build 3D model and 3D print it. 3. Find different backpacks, try the different handles of them. To see if the design can be easily hooked on.

What to make:

1. Sketches of the new design
2. Build model and 3D print it.



Sketches of the new hook design



Modeled and 3D printed hook



Connect with cardboard mock-up

Test & Result:



Wide handle
+ previous hook

1st try

Wide handle
+ New hook

4th try

Test with thin and short Nylon handle



Narrow handle
+ new hook

3rd try



Narrow handle
+ new hook

3rd try



Narrow handle
+ previous hook

1st try



Narrow handle
+ previous hook

2nd try



Test with thin and long Nylon handle



Leather handle
+ new hook

2nd try



Leather handle
+ new hook

2nd try



Test with thin and long Nylon handle

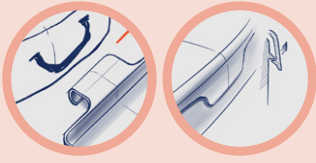
Test video: <https://youtu.be/U2-YwPBwoxY>

Conclusion/analysis:

One finding of the test is that there is no big difference between the previous design and the new design, without sharp edges. They all can be easily hooked on. The only difference from the video is when the user tries to unhook. At this moment sharp edges might make the operation a little bit slower but didn't cause big trouble to the product use.

Another finding of the test is that a wider hook is also possible to hook on a narrow handle. Users need to hook one side first and let the other go in (As shown in the pictures of narrow handle tests).

The third handle (in the video) is harder to hook on because of a much wider leather cover than the rest of the backpacks. The new design can achieve the function but has a risk of fall off. The dimensions of the new design should be adjusted.



Part 2 & 3: Design of the Hook and opening

Test 5

Research question 1 & 2:

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

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

Test plan:

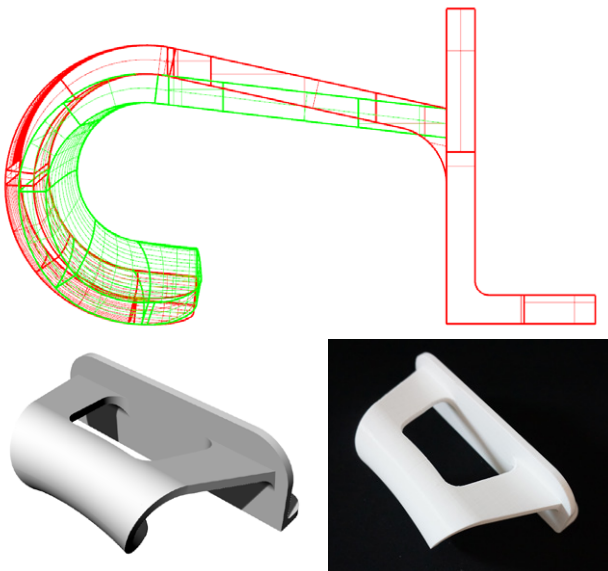
1. This test is an extra test to find out if changed dimensions are good for the thicker handles like the third handle in the last test.
2. Make a similar hook with changed dimensions as the last design.
3. 3D print it and test again.

What to make:

1. Sketches of the new design
2. Build model and 3D print it.



Hook on



Hook model with adjusted dimensions

Conclusion/analysis:

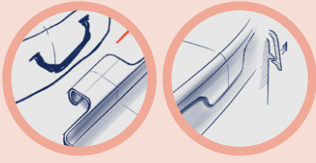
The design is good for hooking on the handle 3. And the new design should be the final design.

Final design:
Hook/opening

Test & Result:



Hook on with the help of hands



Part 2 & 3: Design of the Hook and opening

Research question 3:

What is the maximum force and can the injection molded part withstand the force?

Test plan:

1. Find out what is the maximum force.
2. Select the most appropriate plastic material for the product by looking into the required properties. Find the limit conditions of the material that should not be exceeded.
2. Use the digital model in the previous test (3D printed model)
3. Apply the material to the model. Conduct simulation in SolidWorks.
4. analysis the results of Von Mises stress and displacement.

What to make:

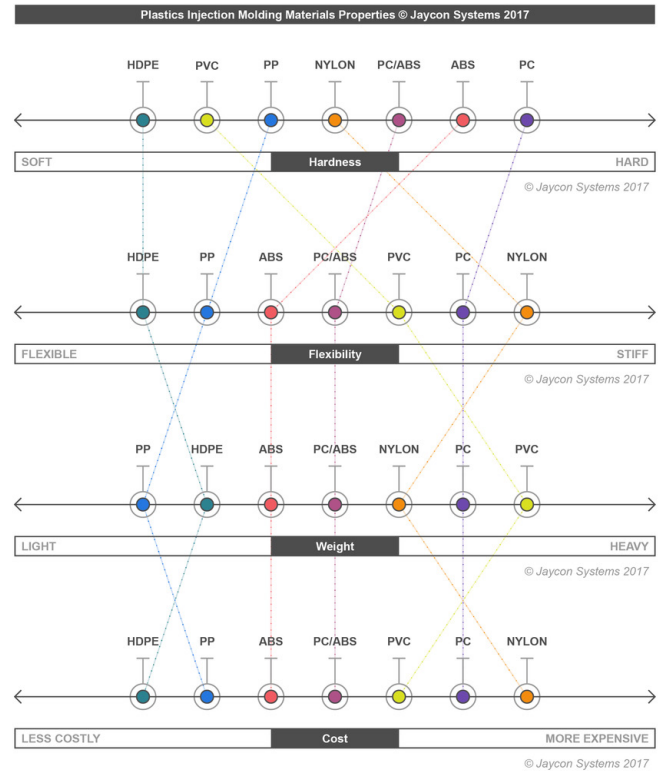
1. Material options and table of their properties.
2. The stress-strain graph of material.
3. The last digital model of the hook and SolidWorks simulation function.

Test - material selection and limit stress

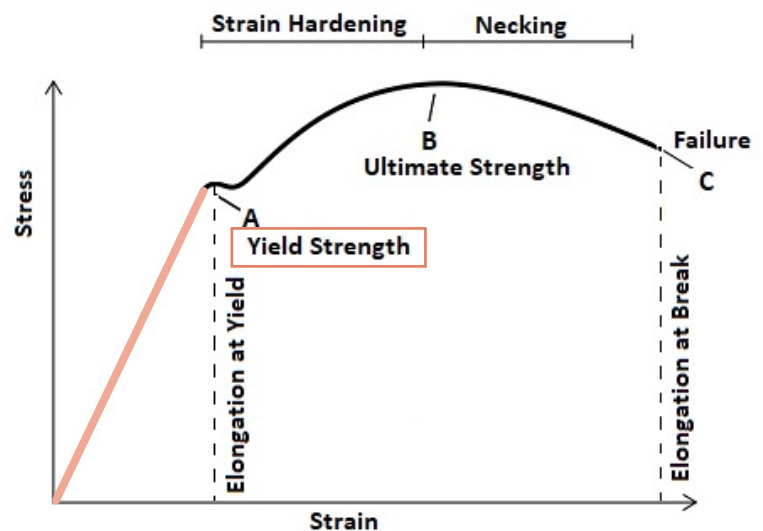
A graph from Jaycon System intuitively present the property comparison from most widely used 6 plastic materials for injection molding (Figure X) [1]. Among properties of these materials, there are 3 requirements to be fulfilled:

1. The material should be stiff enough to withstand the force. (Since the properties in this graph is not quantified, stiffness will be test and analysed when other two properties are determined)
2. The material should not be too heavy, reducing the burden for users to carry.
3. The manufacturing cost of the material should not be too high.

After removing the two heaviest (PC/PVC) and most costly (PC/NYLON) plastics, ABS or PC/ABS (a balanced blend of ABS and PC) are the most stiff materials among the rest. Since PC/ABS is mostly used for electronics enclosures, ABS is the most appropriate material for the product. According to the stress-strain graph (Figure X), all the material is elongated under stress. In the beginning, the elongation is proportional to stress (elastic deformation) before the plastic deformation happens, within which the material can still go back to its original form. The boundary of the stress is yield strength. All the simulated stress results should not exceed the yield strength of ABS, which is 4.48×10^7 Pa (44.8MPa) (Figure X) [2].



Plastic properties comparison

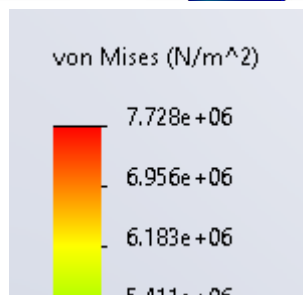
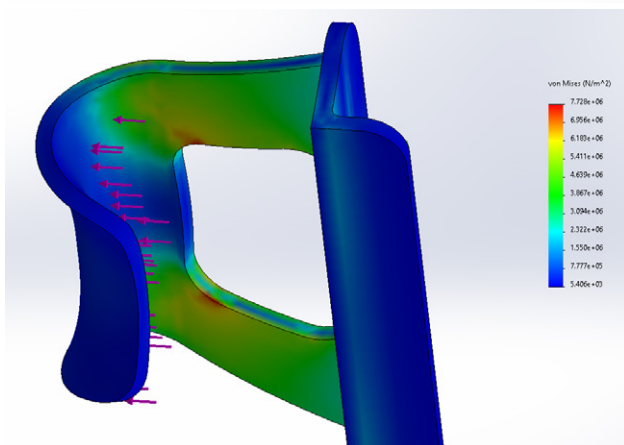
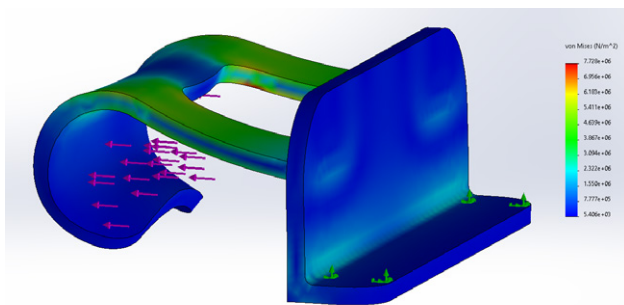


Stress-strain graph of materials

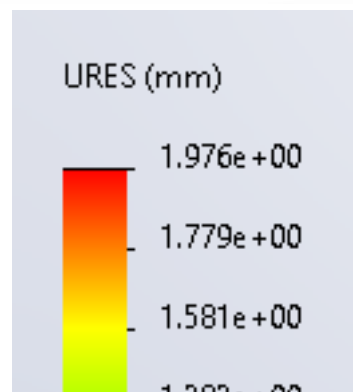
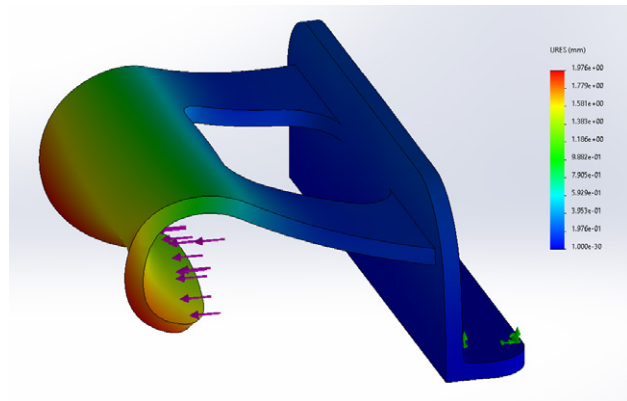
Scan&Solve Material File Source: www.custompartnet.com/materials/ Material Description	Default Failure Criterion	Density (kg/m ³)	Elastic Modulus (Pa)	Poisson Ratio	Yield Strength (Pa)	Tensile Strength (Pa)	Compressive Strength (Pa)
ABS	VonMises	1049	2.4e+09	0.35	4.48e+07	0	0
Acetal Copolymer	VonMises	1400	2.6e+09	0.35	6.0e+07	0	0
Acetal Homopolymer	VonMises	1420	3.1e+09	0.35	7.6e+07	0	0
Bakelite	CoulombMohr	1400	8.3e+09	0.24	0	48e+06	207e+06
PC	VonMises	1201	2.3e+09	0.35	6.2e+07	6.4e+07	6.96e+07
PC (10% glass filler)	VonMises	1259	4.0e+09	0.35	6.68e+07	6.89e+07	9.72e+07
PC (20% glass filler)	VonMises	1329	5.7e+09	0.35	7.86e+07	9.38e+07	1.1e+08
PC (30% glass filler)	VonMises	1420	8.41e+09	0.35	1.2e+08	1.2e+08	1.48e+08
PC (40% glass filler)	VonMises	1489	1.03e+10	0.35	1.3e+08	1.5e+08	1.4e+08
PC/ABS blend	VonMises	1149	2.5e+09	0.35	5.47e+07	0	0
Nylon 6	VonMises	1121	1.9e+09	0.35	6.24e+07	0	0
Nylon 66	VonMises	1121	2.1e+09	0.35	6.36e+07	0	0
Nylon 11	VonMises	1030	9.58e+08	0.35	3.55e+07	0	0
Nylon 12	VonMises	1041	1.1e+09	0.35	3.92e+07	0	0
LDPE	VonMises	922	2.1e+08	0.35	1.08e+07	0	0
HDPE	VonMises	955	9.1e+08	0.35	2.52e+07	0	0
Polypropylene	VonMises	910	1.3e+09	0.45	3.31e+07	0	0

Property data of plastics

Test & Result - SolidWorks stress and displacement simulation



Stress simulation result



Displacement simulation result

Conclusion/analysis:

The maximum stress doesn't exceed the yield stress of ABS, and way smaller. There is a 1.9mm displacement at back, which is ok.



Part 4: Instructions

Information optimization

Information hierarchy

Starting from the treatment steps in 2.2.4, the information included in the instruction can be listed as below (Figure X). The illustrations are place to each treatment steps.

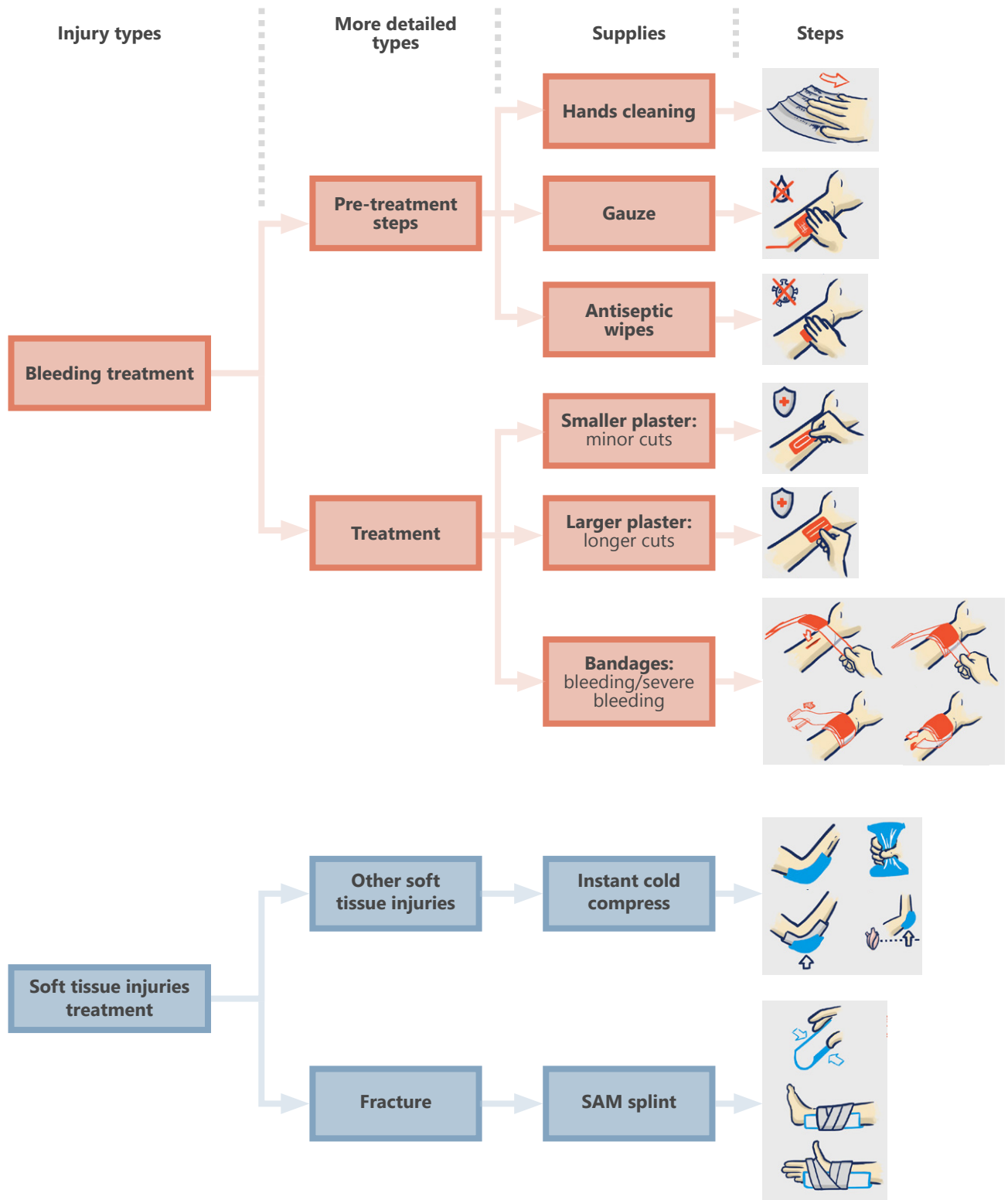
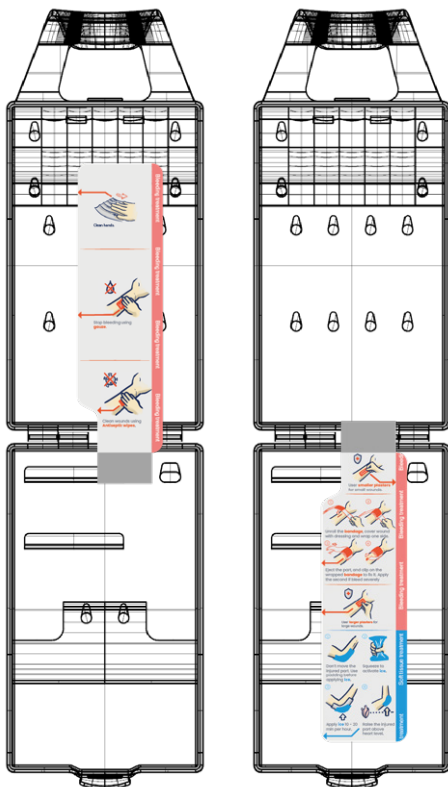
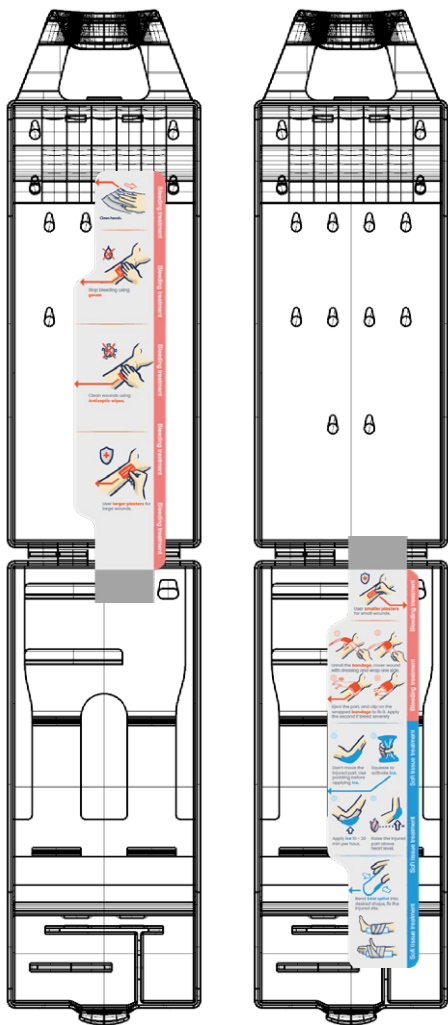
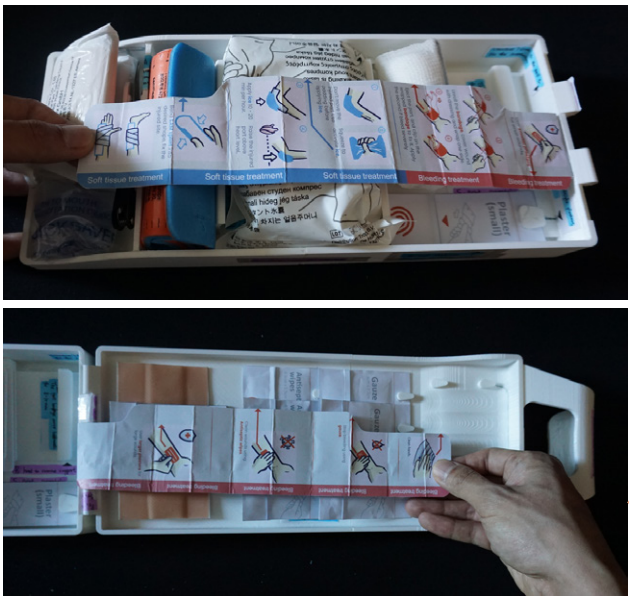


Figure 4: Outdoor sports types

Instructions design



Instruction placed on 2D models



Instruction placed on 2D models

Final design:
Instructions



Part 5: Fixing Units

Research question 1:

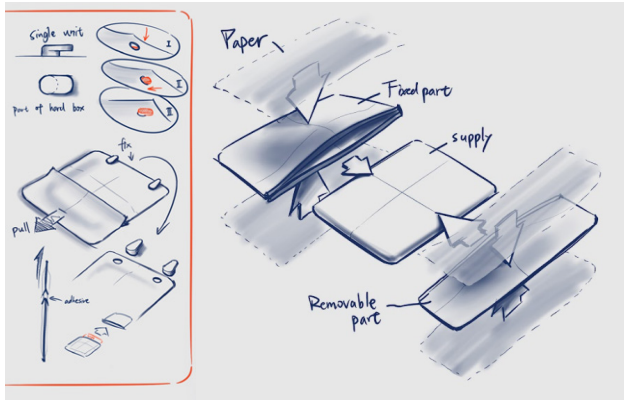
How to apply the sterile pack design to all four thin supplies? (Gauze, wipes, two plasters)

Test plan:

1. Study the design of current plaster dispenser refill pack, QuickFix
2. Make the similar design with simple materials: paper, tapes.
3. Cut the paper into proper dimensions to fully cover all four supplies.
4. Use tape to stick paper with each other. In this way the industrial manufacturing of QuickFix plaster is simulated.
5. Adjust until dimensions all fit.

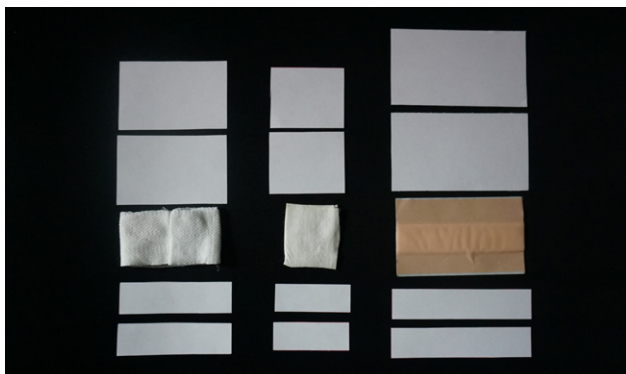
What to make:

Paper as sterile pack, with layers on the top and the bottom to cover the products, sealed in a proper thickness. There are mainly two parts of the pack, fixed part stays with fixing units, and removable part which can be removed by fingers (Figure X). They are connected by tape to simulate that they are sealed by machine (same technology as QuickFix plaster and is proved to be workable).

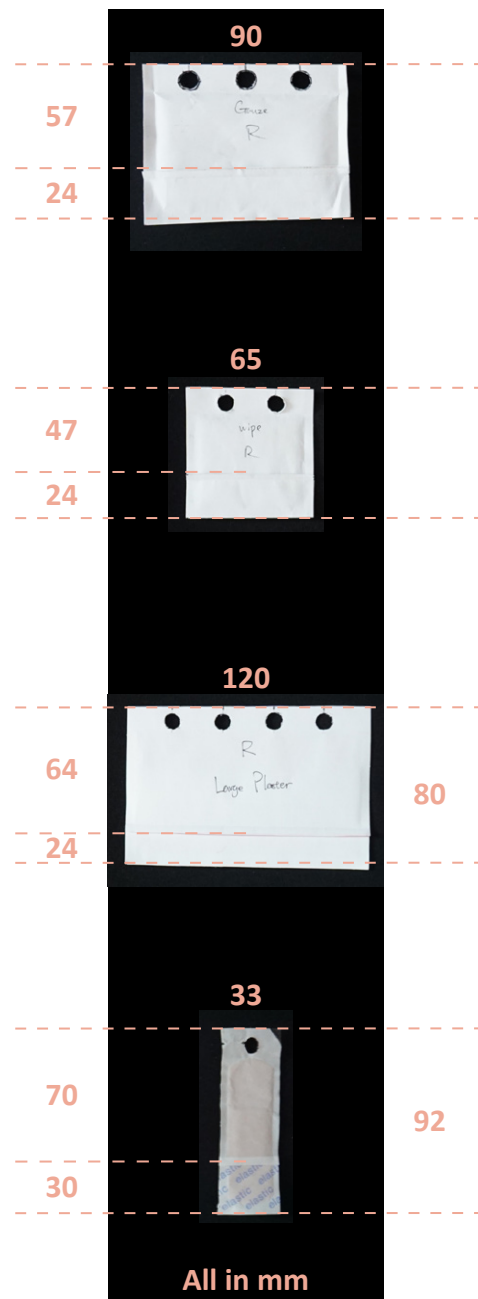
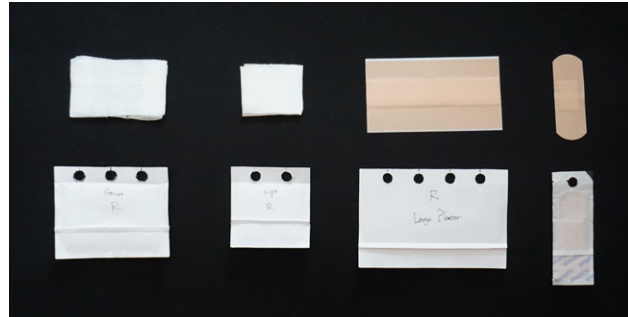


Sketched plan of making sterile packs

Test & Result:



Papers and supplies



All paper dimensions to make sterile packs

The dimensions of fixed and removable parts are list on the left of each picture.

4 mm are left for these two parts to stick to each other with tape, similar to the design of the QuickFix plasters. Therefore the sum of the number on the left is always 8mm longer.

13 cm are left for holes.

Conclusion/analysis:

The design of the sterile packs is workable to cover all four thin supplies: Gauze, wipes, two plasters. The dimensions of the sterile packs (including those to make them) are determined in this test.



Part 5: Fixing Units

Test 1

Research question 2:

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

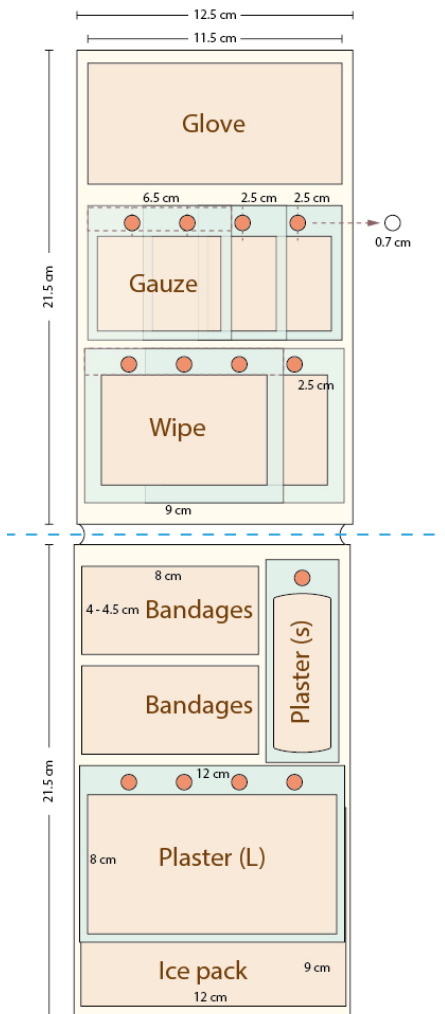
Test plan:

1. When all dimensions of sterile packs are determined, Adobe illustrator is used here to simulate the proper positions of them. Place "fixing units" to fit gauze, wipes, two types of plasters. Make the design as simple as possible.
2. The actual design will be test in the next iteration.

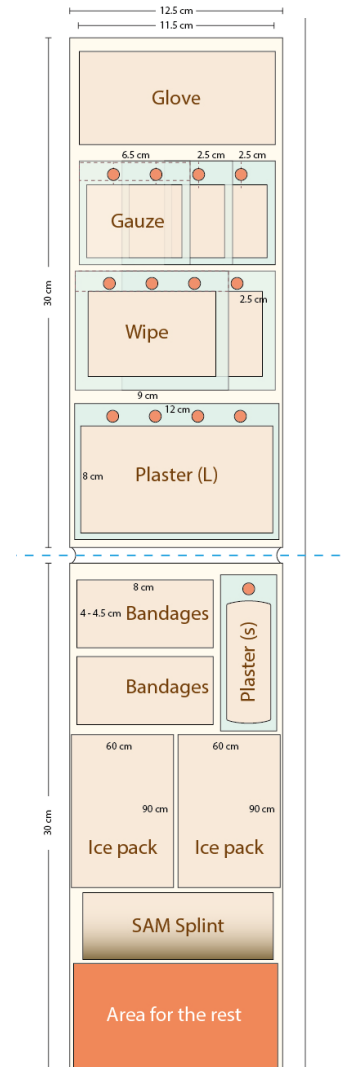
What to make:

1. Use the dimensions of the first aid kit. Use the dimensions of the previous test.
2. Make a 2D overview of supplies.

Test & Result:



2D supply overview (small version)



2D supply overview (large version)

The width left for placing main supplies is 115mm (a little smaller than kit width, 125mm, so that the supplies won't touch the walls). The units should well distribute on the sterile packs so that the force opening the pack can be well balanced. Besides, units should also well distribute to the kit. The proper distance of the fixing units are 25mm. Too long or too short will not work. 7mm is the proper diameter for the fixing units, and won't influence the rest supplies.

Conclusion/analysis:

The test is conducted to have a proper distance and place them in right positions. The fixing unit system is mapped and proved to work theoretically. It should be tested with real prototype in the following steps.



Part 5: Fixing Units

Test 2

Research question 2:

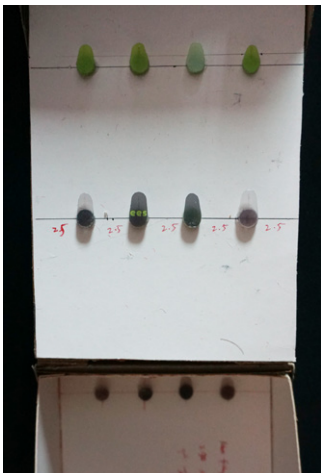
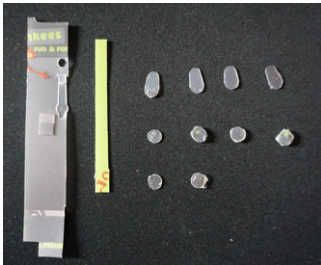
What are the locations of fixing units and their distance between each other?

Test plan:

1. Use the sterile pack mockups in the very first test, and mock up of first aid kit body in the hook test.
2. Make holes on sterile packs based the 2D supply overview.
2. Use simple material (plastic pieces and glue) to make similar design (fixing units) as in sketches.
3. Load the mockups on these fixing units, test if all packs can be properly placed on them.

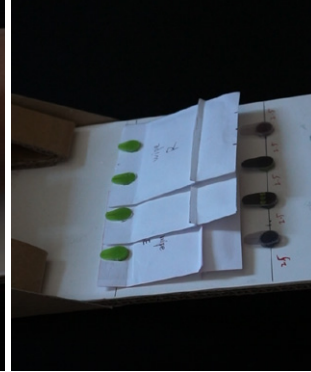
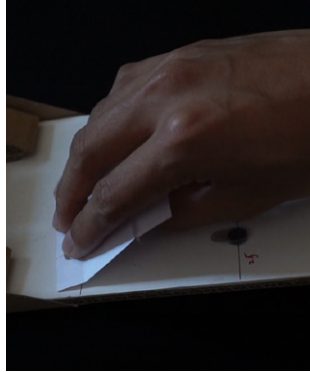
What to make:

1. Sterile packs in the very first test and cardboard first aid body in the hook test.
2. Cut the 7mm holes, with 25mm distance in between, on sterile packs according to the dimensions of 2D supply overview.
3. Use the plastic sheet, cut them into desired dimensions and glue them into the exact shape of fixing units.
3. Glue the fixing units in a designed distance (25mm) on cardboard kit.

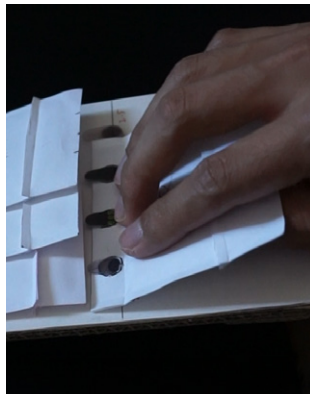


Fixing units made of plastic sheets

Test & Result:



Load test of antiseptic wipes



Load test of gauzes



Load test of large plasters

Test video: <https://youtu.be/R-KTR1NWtQM>

Conclusion/analysis:

The design and distance between the fixing units are workable for placing sterile packs and as a good result of 2D dimension map.

Because of hand-made fixing units and sterile packs, they are less accurate than manufactured products in terms of hole diameters and distances.

The problem will be solved using printed parts or papers with more accurate dimensions.



Part 5: Fixing Units

Test 1

Research question 3:

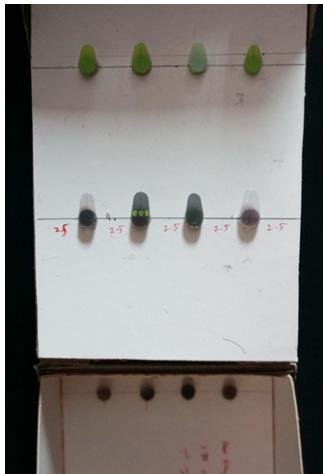
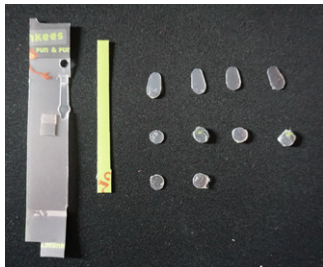
Are sterile packs easy to be opened by one hand?

Test plan:

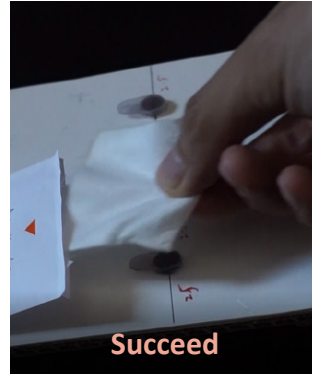
1. The first plan is to use the mockup made in the previous tests, which was expected to withstand the force: fixing units made of plastic sheets, papery sterile packs.
2. Hold one end steadily. Use one hand to open all the sterile packs.

What to make:

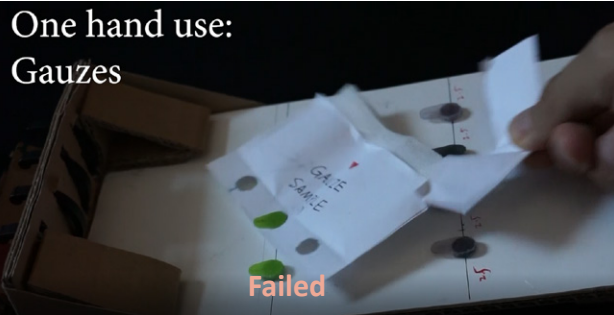
Same as the last test.



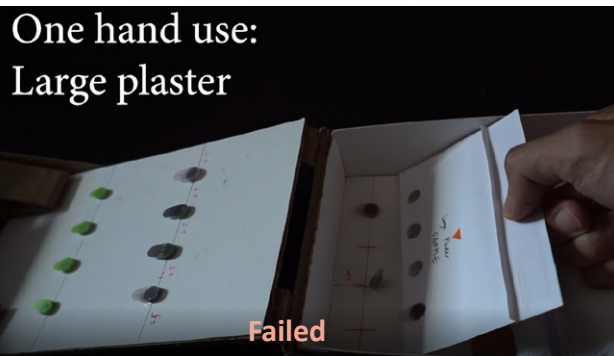
Fixing units made of plastic sheets



Pulling test of antiseptic wipes



Pulling test of gauzes



Pulling test of large plasters

Test & Result:



Test video: <https://youtu.be/R-KTR1NWtQM>

Conclusion/analysis:

The test with antiseptic wipes proved that the system works, the dimensions and the shape of the fixing units are good. But the glue is far less strong to hold the force.

According to the loading ways, gauze's and antiseptic wipes' units have maximum 2 layers of sterile packs for each of them, thus no need to be high. However sterile packs for large plasters are all placed in same fixing unit. These should leave more space for more than two layers of sterile packs (higher fixing units).

The test should be test further with 3D printed parts.



Part 5: Fixing Units

Test 2

Research question 3:

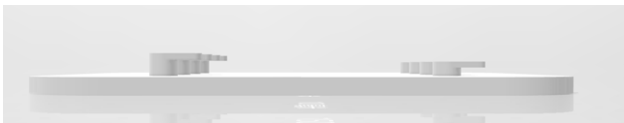
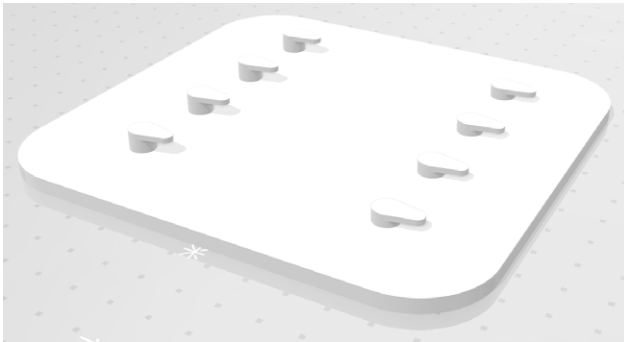
Are sterile packs easy to be opened by one hand?

Test plan:

1. The first plan is to use the mockup made in the previous tests, which was expected to withstand the force: fixing units made of plastic sheets, papery sterile packs.
2. Hold one end steadily. Use one hand to open all the sterile packs.

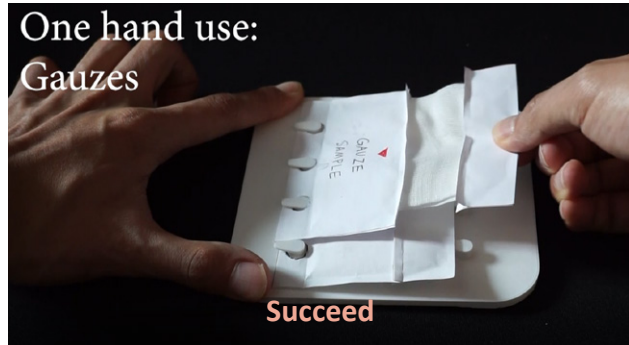
What to make:

Same as the last test.



Modeled and 3D printed fixing units

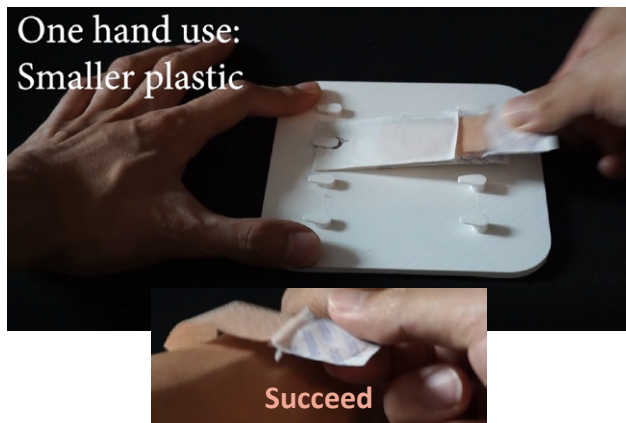
Test & Result:



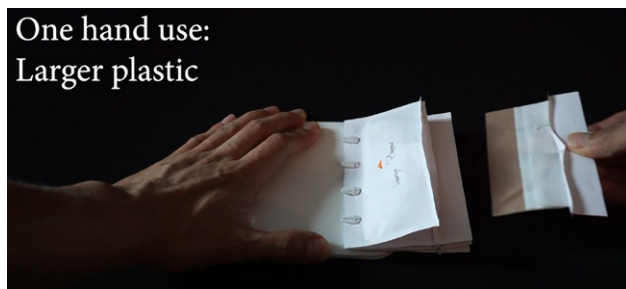
Pulling test of gauzes



Pulling test of antiseptic wipes



Pulling test of small plasters



Pulling test of large plasters

Test video: <https://youtu.be/7Esv45OI3Dc>

Conclusion/analysis:

The test with antiseptic wipes proved that the system works, the dimensions and the shape of the fixing units are good. But the glue is far less strong to hold the force.

According to the loading ways, gauze's and antiseptic wipes' units have maximum 2 layers of sterile packs for each of them, thus no need to be high. However sterile packs for large plasters are all placed in same fixing unit. These should leave more space for more than two layers of sterile packs (higher fixing units).

The test should be tested further with 3D printed parts.



Part 5: Fixing Units

Test 3

Research question 3:

Are sterile packs easy to be opened by one hand?

Test plan:

1. Design new changes to fulfil the requirement in the conclusion test 2.
2. Make mockups of these designs and test them.

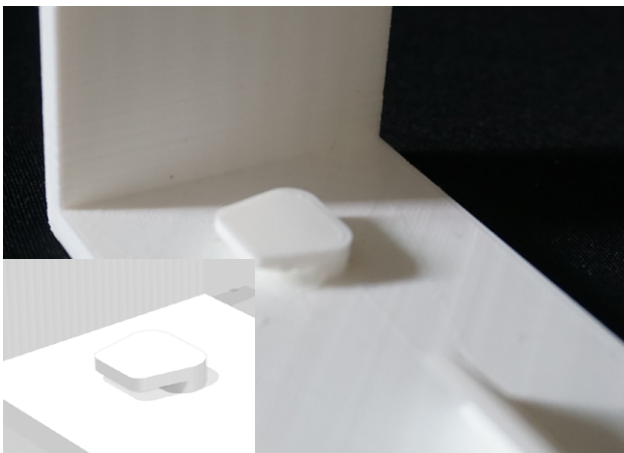
What to make:

1. New design of the sterile pack for large plaster using a similar width as antiseptic wipes, but are open on both sides.



New design of sterile pack for large plasters

2. New design for small plasters to hold its pack, making it non-rotatable. make a 3D model and print it.



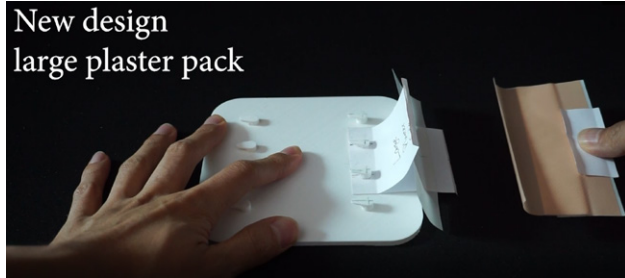
New design of fixing unit for small plasters

Test & Result:

New design large plaster pack



New design large plaster pack



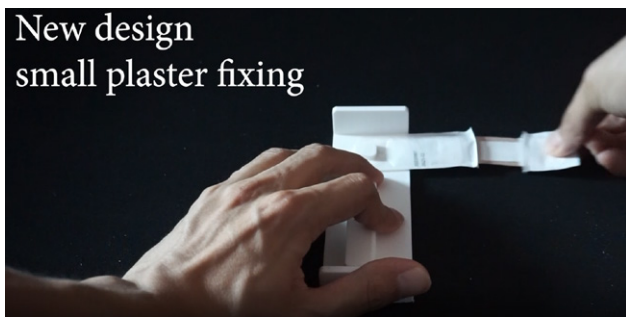
New design large plaster pack



Test of new design

New design small plaster fixing





Test of new design

Test video: <https://youtu.be/8P1amu73w4E>

Conclusion/analysis:

These changes for larger and smaller plasters are successful. They should be kept for the final design.



Part 5: Fixing Units

Research question 4:

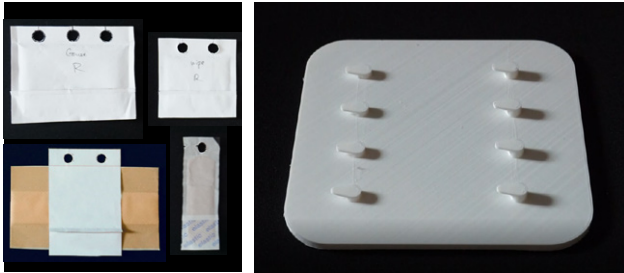
Are fixing units holding the sterile packs without falling off and can be easily reloaded?

Test plan:

Test with the mock-up above (test 2).
They should be reloaded with only one step.
They should fall off when opening or closing the kit.

What to make:

Mock-up in test 2.



Test & Result:

Test video: <https://youtu.be/7Esv45Ol3Dc>

Conclusion/analysis:

All supplies can be easily reloaded with help of their sterile packs. They won't fall off when opening or closing the kit.



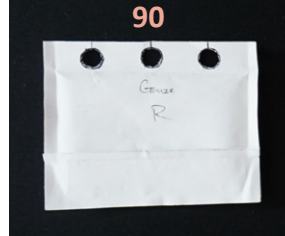
Part 5: Fixing Units

Research question 5:

What is the maximum force required to open sterile packs?

Test plan:

1. Use a force gauge to measure the force needed to open the small plaster. The plaster dispenser refill pack is the only current product and manufactured by machine. The rest 3 prototypes cannot be used for tests because they are made by hands. The only way to predict how much force they require is to measure with a current accessible product and then calculate.
2. Under the same technology, calculate the theoretical force needed for the rest 3.



34.64 N

It requires largest force to open sterile pack of gauze. To make sure the fixing unit system works safely, the result should multiply safety factor, 1.5. The largest force is **51.96N**.

Test video: <https://youtu.be/kL6MjOp2qxw>

What to make:

The tool used here is a Force gauge and the existing plaster dispenser refill pack.

Conclusion/analysis:

The maximum force the units should withstand is **52N**. The simulation should be conducted in SolidWorks to see if the real injection molded part withstand the force.

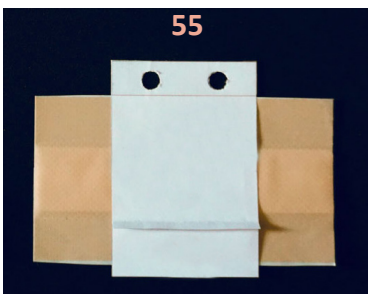
Test & Result:



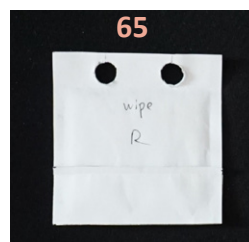
Force test using force gauge



Find the force required to open small plaster through test. **12.7N**. The rest three are made by hand. But they will be eventually manufactured with the same technology. The force is proportional to their widths. The results are as follows.



21.07 N



25.02 N



Part 5: Fixing Units

Research question 6:

Are injection molded units strong enough to withstand the force?

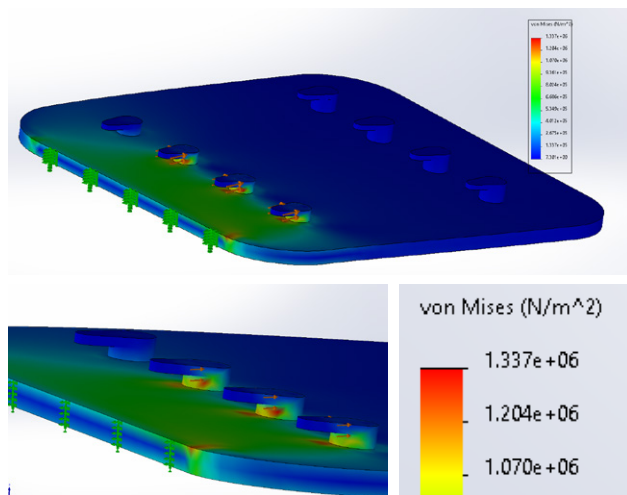
Test plan:

1. Use the digital model in the previous test (3D model in test 2).
2. Use simulation in SolidWorks. Apply material (ABS) to the model and correct load (perpendicular to the cylindrical surface of units). Record and analyse the stress/displacement result.

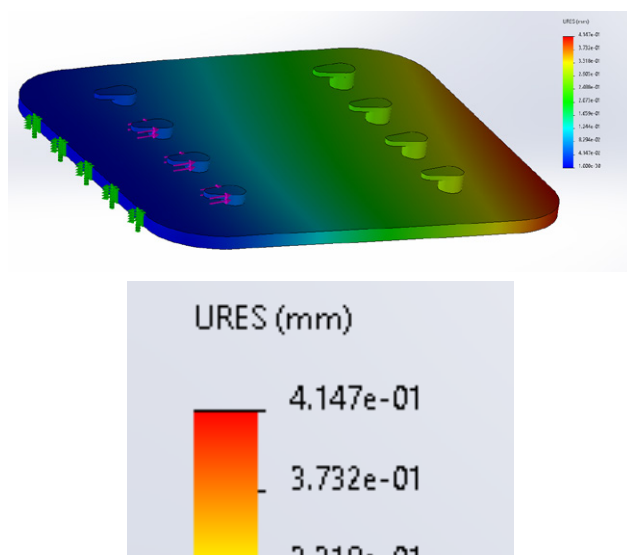
What to make:

1. 3D model in test 2.
2. SolidWorks simulation.

Test & Result:



Stress simulation result



Displacement simulation result

Conclusion/analysis:

The maximum stress doesn't exceed the yield stress of ABS. There is a 0.4mm displacement at back, which is acceptable. The design should be combined into the final product.



Part 6: Glove (hands cleaning)

Research question 1:

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

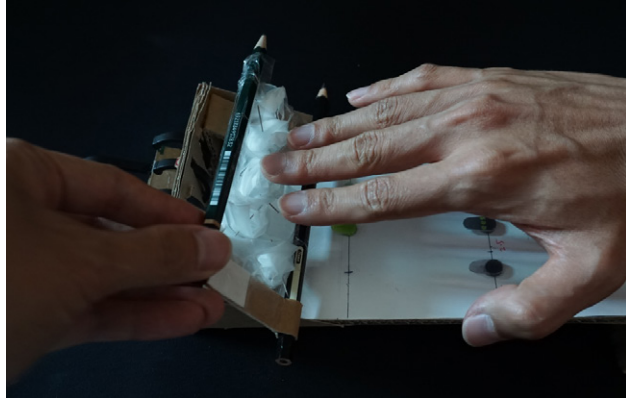
Test plan:

1. Make a mock-up of one-hand use gloves as in the sketches.
2. fix the glove (withstand the reaction force) and put fingers in.
3. record a short movie to show it works.

What to make:

A half glove with all finger parts folded like as sketched.

Use other long but stiff material (pencils) to fix the half glove.



How it is used

Test & Result:



Half glove



Half glove fixed by pencil and tape



Test: put on glove

Test video: <https://youtu.be/HNZN73034d4>

Conclusion/analysis:

It is possible to put on 5 fingers together.

Problems:

1. fingers are contacting the glove at the same time. The design should consider the lengths and positions of fingers on the hand, especially thumb. When the thumb is placed beneath the index finger, then they can touch at the same time.
2. The experience is not smooth as expected. The stiff bars on the top and on the bottom were not aligned when putting on gloves.
3. The direction of putting on the glove is stretching forward, which is opposite to the rest of the supplies. **The idea doesn't work. The design has to be changed.**

Because of force direction, the idea doesn't work. A new idea should be developed to replace it.



Part 6: Glove (hands cleaning)

New design: hands cleaning

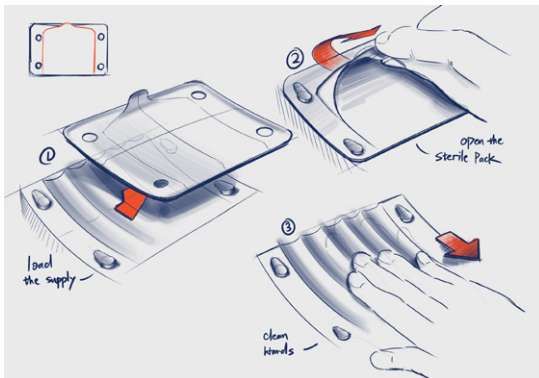
Design purpose:

1. It is almost impossible to help the user put on the glove within such a small area
The direction of putting on the glove is opposite to the reaction force. The hook cannot stop the glove from moving further.

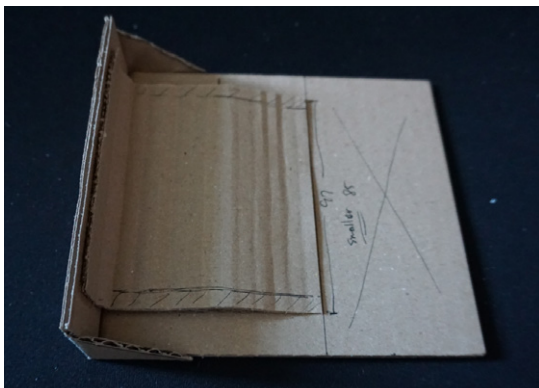
2. Find an alternative to achieve the same function when the first idea is not possible.
The first step of all bleeding treatment steps is to keep the touching area clean between hands and the wound. To achieve the same goal, the idea can be switched from putting on gloves (isolate dirty hands from wounds) to clean hands/fingers (disinfect the touching area). The alternative should also be possible to be used by one hand.

New design for hands cleaning:

The idea is to develop a supply of 75% alcohol wipes inside the sterile packs. With the help of the sunken surfaces, fingers are fully contacting with the alcohol wipe. In this way the most areas of palm are fully disinfected. The design uses a similar design as fixing units. It has its own sterile pack and can be opened as sketches.



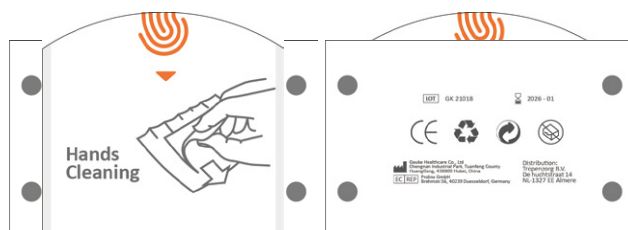
Idea sketches



Cardboard model



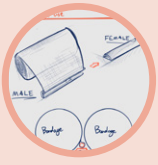
3D printed model



Sterile pack design

Final design:
Hands cleaning

Test video: <https://youtu.be/BsG9yXAKNMM>



Part 7: Bandages for one-hand use

Test 1

Research question 1:

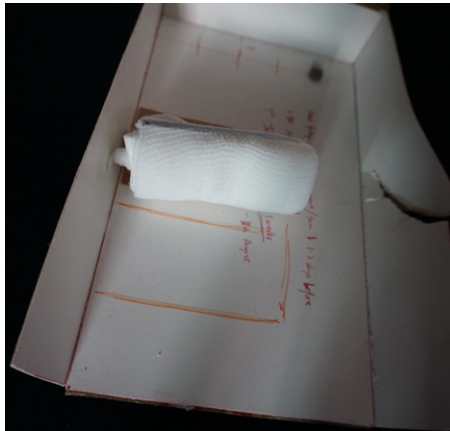
Is the design allows bandage to be easily used by one hand?

Test plan:

1. Make a simple prototype with cardboard as in the sketches.
2. Test the prototype and conclude. Find details that can be improved to make the experience better.

What to make:

1. Cardboard male and female structure.
2. Connect the bandage with the male part.



Cardboard model of one-hand bandage use

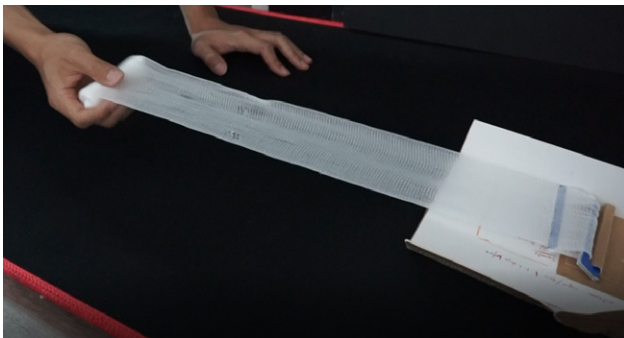


2. Apply the dressing right with the wound. And apply on it.



3. Wrap one end of the bandage.
It doesn't need any fixing structure here to hold this end because of the adhesiveness of the bandage itself.

Test & Result:



1. (open the sterile pack) pull out the bandage
Users have to stay far from the kit because one end is too long. Can be solved by moving the dressing clover to the kit end.



4. Eject the clip
The clip is ejected laterally which has almost no space and **will be limited by the wall** of the kit. It should be changed to ejecting upwards or forwards.



5. Wrap the other end, and clip on the wrapped bandage.

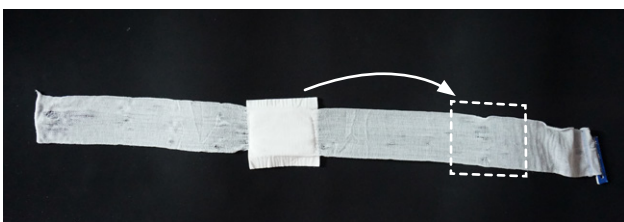
The clip works fine but in order to improve the experience, the male part can be designed **much thinner** so that it can be easier to clip on.

Test video: <https://youtu.be/3NLEZ6rYB3I>

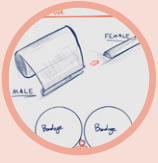
Conclusion/analysis:

The changes have to be made for the next iteration:

1. The dressing on the bandage should be moved closer to the kit.
2. Change the way of ejecting the clip to upwards or forwards.
3. Make the clip thinner.



Move the dressing



Part 7: Bandages for one-hand use

Test 2

Research question 1:

Is the design allows bandage to be easily used by one hand?

Test plan:

1. The second test for the improvement for step one- decrease the length of the clip end.
2. Test again with the same cardboard mock-up and bandage with moved dressing.

3. The third advantage of this change is that the other end is wrapped for more rounds. This way allows the bandage held more steadily on arm due to its own adhesiveness.

Test video: <https://youtu.be/gcnfXxpLZpE>

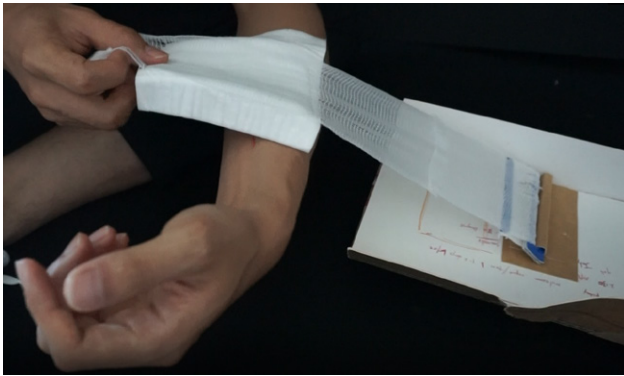
What to make:

The dressing on the bandage should be moved closer to the kit.

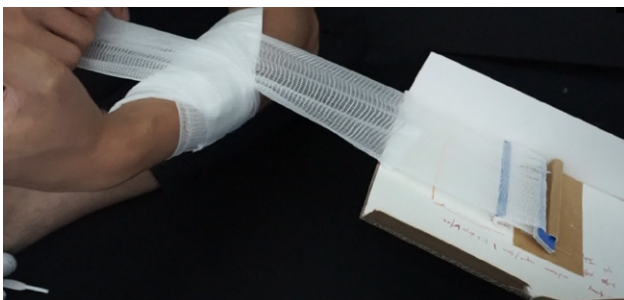
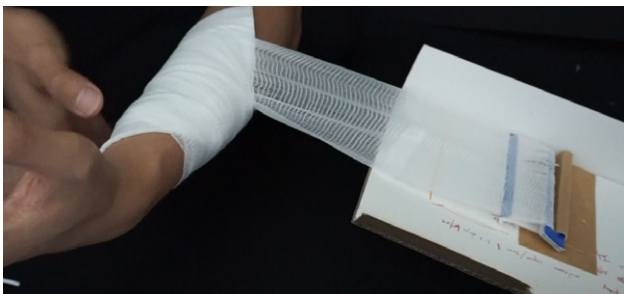
Conclusion/analysis:

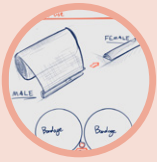
The change is successful.

Result:



1. By moving the dressing closer to the kit. The distance between the user and the kit is significantly shortened. It is more convenient to eject the clip.
2. Another advantage of this change is that the user can apply the dressing much quicker than the initial design, which means a quicker stop of bleeding.





Part 7: Bandages for one-hand use

Test 3

Research question 1:

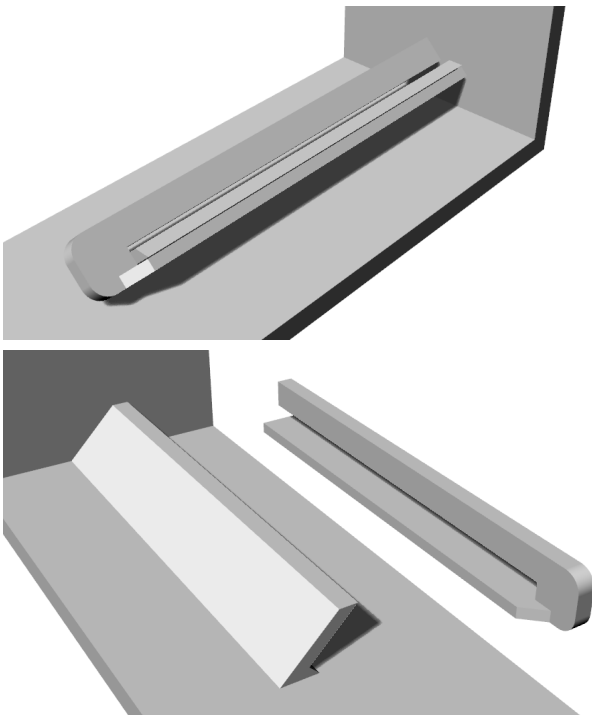
Is the design allows bandage to be easily used by one hand?

Test plan:

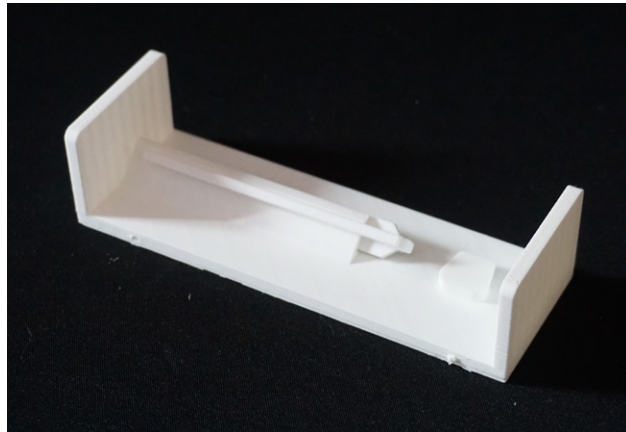
1. This test is for improvement 2 & 3 in test 1: Change the way of ejecting the clip to upwards or forwards, and make the clip thinner.
2. Make a model of the new design and 3D print it.
3. Test again with the printed part.

What to make:

The new design of male and female parts.



Digital model



The clip is ejected upwards.

Test & Result:

The new design was too weak to be tested.

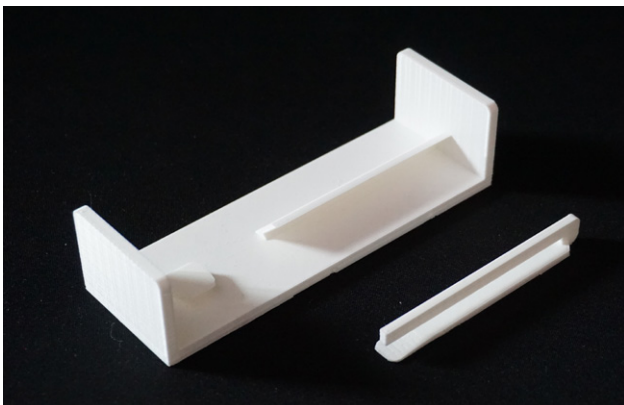
Conclusion/analysis:

The design is **too weak to withstand the force**, the test cannot be done.

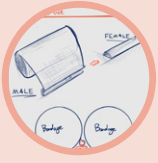
The structure with an open-end cannot hold the strong force.

The 45-degree structure allows the clip very easy to slide off.

The design of the next iteration should strong enough to hold onto the kit.



Thinner clip and even thinner in the front, for more convenient use.



Part 7: Bandages for one-hand use

Test 4

Research question 1:

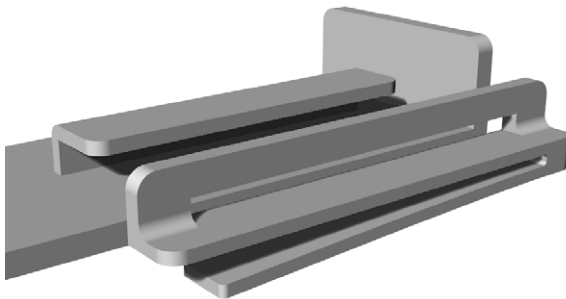
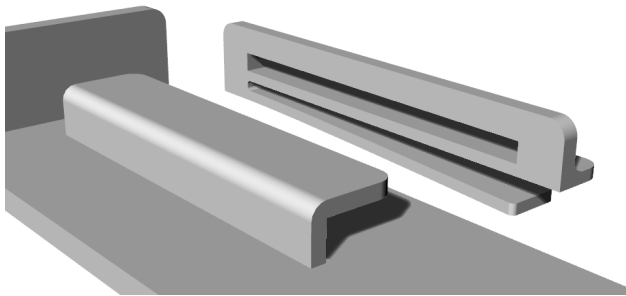
Is the design allows bandage to be easily used by one hand?

Test plan:

1. According to the problems listed previously, change the design.
2. Make a model, 3D print it and do the test again.

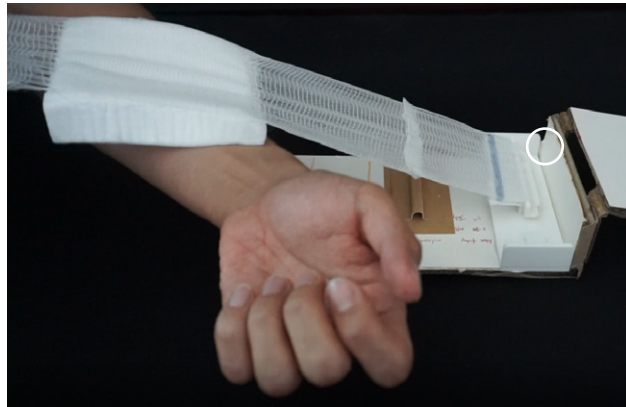
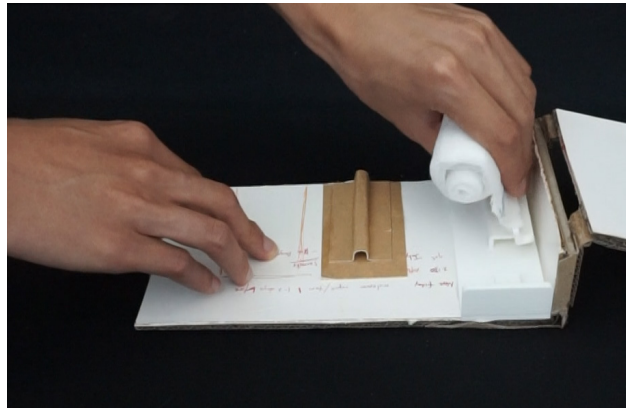
What to make:

The new design of male and female parts.

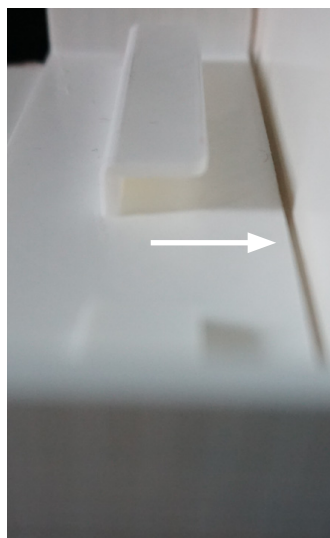


Digital model

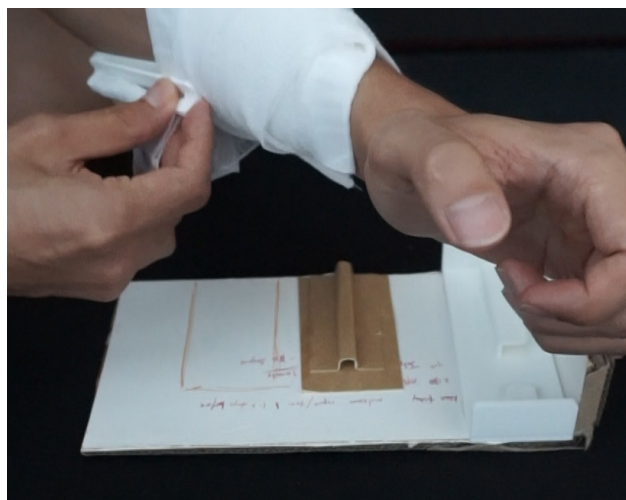
Test & Result:

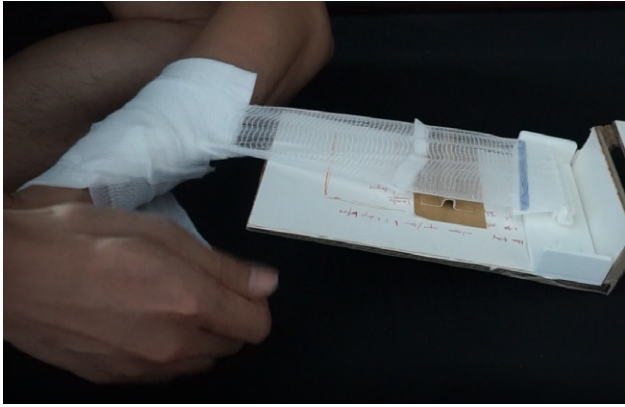


The design requires a little space between the design and wall. The bandage can be placed here to save space, instead of place a bandage on the other side.



No open end anymore, now the clip will be ejected forwards.



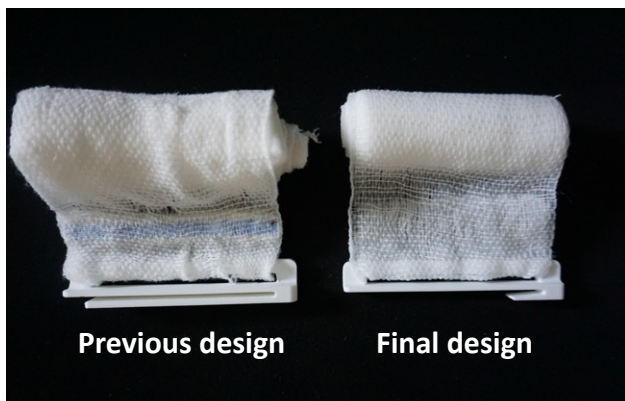


Wrap and apply the clip

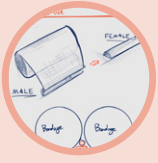
Test video: <https://youtu.be/OR7BV28enVU>

Conclusion/analysis:

The new design solved the problems, and was working quite well. There is a new finding during the following tests that a shorter clip provides quicker fixing. The change has been applied to the design as shown below. The clip is combined into the final product.



Final design:
Bandages



Part 7: Bandages for one-hand use

Research question 2:

What is the maximum force required to use the bandage?

Test plan:

1. Use the same prototype (bandage only) above, and connect the clip with a force gauge.
2. Use bandage 3 times, use a camera to record the force number on the force gauge throughout the test.
3. Use film editing software to see the maximum force frame by frame.

Conclusion/analysis:

The maximum force that clip should withstand is 6 newtons.

What to make:

Bandage and a force gauge.

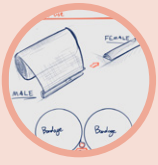
Test & Result:



Instant force 4.1 N
Max force: 3.5-4 N

The peak force is more than 4 newtons. But the most frequent largest force is between 3.5 to 4 newtons. Therefore the force that the clip should withstand is $4 \times 1.5 = 6$ newtons.

Test video: <https://youtu.be/mKDk4rQL71o>



Part 7: Bandages for one-hand use

Research question 3:

Is the design able to withstand the force?

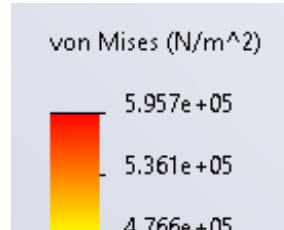
Test plan:

1. Use the digital model in test 4.
2. Use simulation in SolidWorks. Apply material (ABS) to the model and correct load (perpendicular to the cylindrical surface of units). Record and analyse the stress/displacement result.

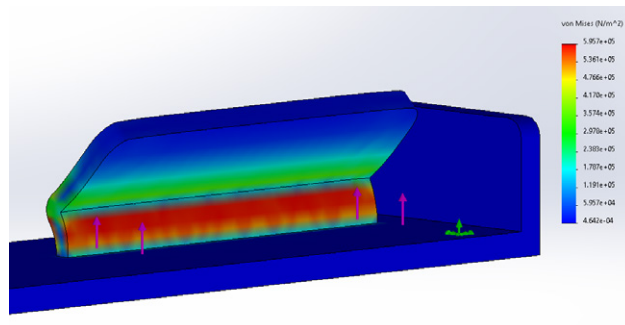
What to make:

1. 3D model in test 2.
2. SolidWorks simulation.

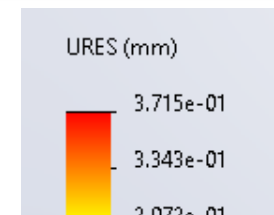
Test & Result:



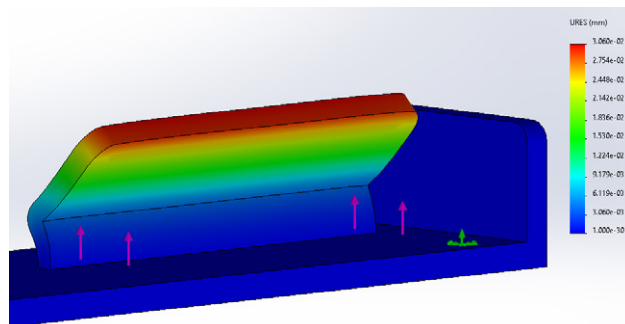
Displacement simulation result: Clip



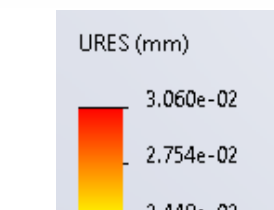
Stress simulation result: kit structure



Stress simulation result: Clip

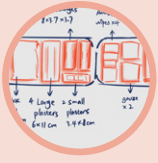


Displacement simulation result: kit structure



Conclusion/analysis:

The maximum stress doesn't exceed the yield stress of ABS.



Part 8: Rest of supplies

Structure design

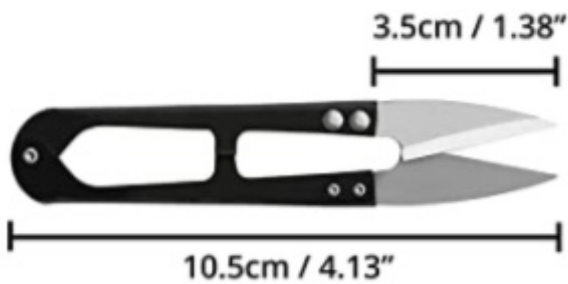
From trauma shear to sewing trimming scissors:

According to space management, the trauma shear is way too large to be included since there are no smaller trauma shears in the market. The item is changed to sewing trimming scissors.:

1. Trimming scissors has a similar function as trauma shear. The tool is designed for dressmaking and can be used to remove the cloth when injured and cut supplies.
2. Sewing trimming scissors (ST scissors) have a way smaller size than trauma shears.



Trauma shear

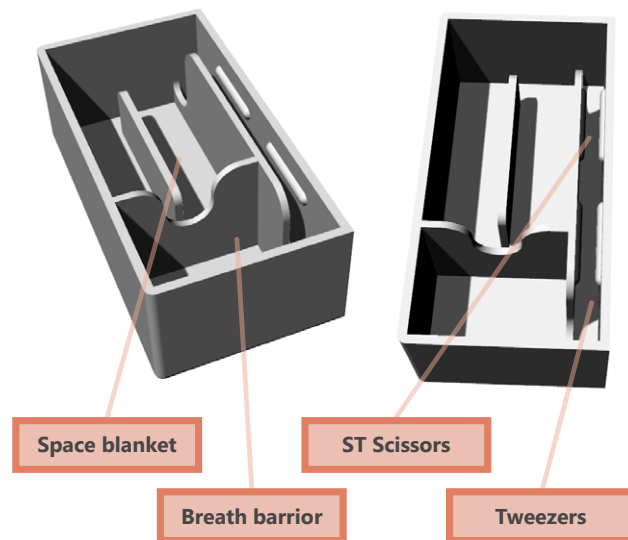


Sewing trimming scissors (ST scissors)

Space design for rest of the supplies:

Design the space and structure for the rest of the supplies: Tailors scissors, tweezers, space blanket, and breath barrier. The functions to be achieved are: make sure they can be easily got by one hand, and make sure they won't fall out when opening and closing the kit. The design will be included in the final product.

Final design:
Rest supplies



Space management of the rest supplies



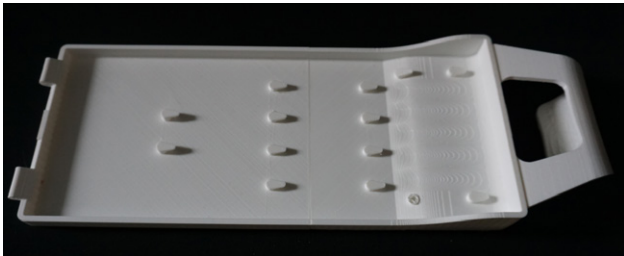
3D printed parts

Complete product

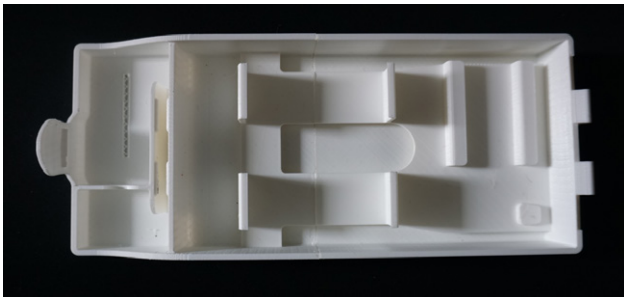
Synthesis of all separate parts

Product synthesis:

All separately tested parts are combined into a complete one in the end and were 3D printed into a more real prototype. As a first attempt, a lot of printing fails or improper designs are found on the 3D printed parts during this period. A few parts are tested fine but affect each other after being combined. Their dimensions have to be further adjusted in order to achieve the design goals and have a smooth user experience. The pictures below are photos of the product synthesis.



Combined model upper part



Combined model lower part



Combined model loaded with medical supplies

Looking for problems for the next iteration:

There are mainly three types of problems to be found:

1. Adjustment of dimensions: The space left for certain supplies are too small, around which the space of other supplies have to be adjusted. Some structures on the 3D printed part were not functioning because of the wrong dimensions. These mistakes cannot be simulated in software but needed to be found in printed parts and guide the next iteration.

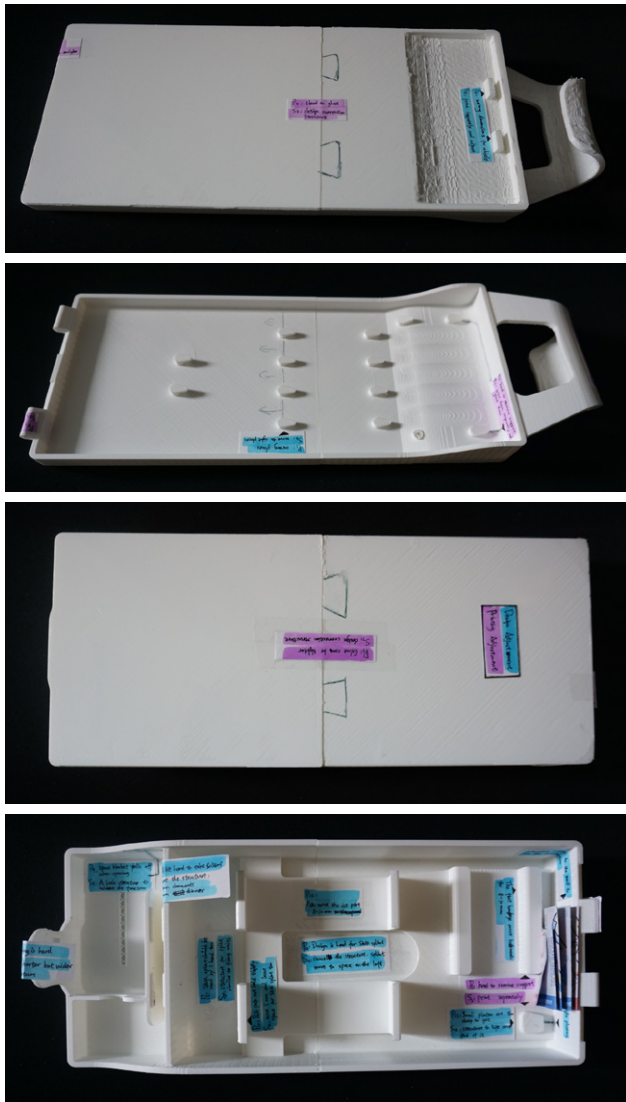
2. Printing fails/defects: Due to the limitation of 3D printers, each over-large first aid kit body has to be printed in halves. That lead to many difficulties. Small structures (fixing units for example) are easy to break when removing

the support. Some structures make support removing hard or even impossible (support between two rigid layers, support inside holes). To make a better prototype, how to print the prototype have to be changed.

3. Problems involving use/information: Tests with real users to find out the problem of design. Their advice will be considered for the next iteration.

The first two types of problems are found and labelled with stickers on the prototype (Blue for dimension adjustment, purple for Printing fails/defects).

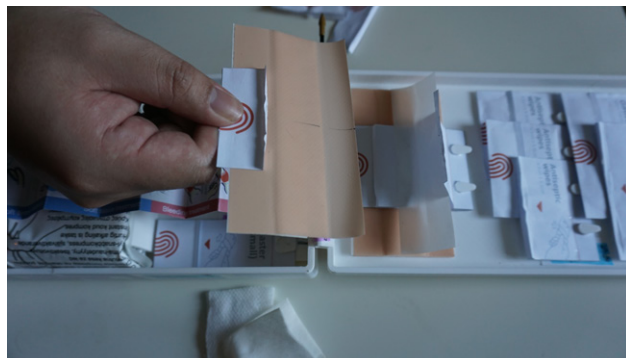
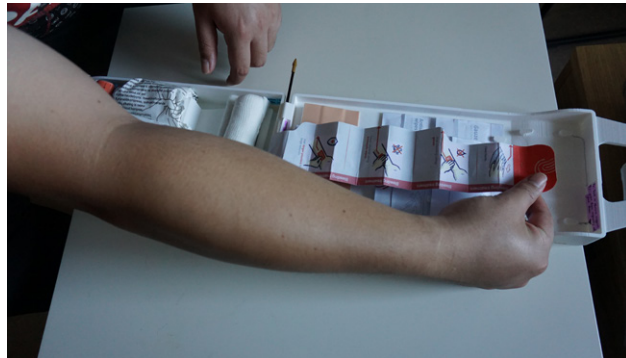
- Adjustment of dimensions
- Printing fails/defects



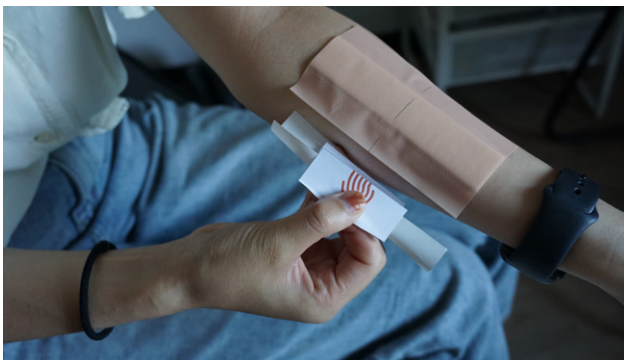
Labelled problems on kit body

User tests:

Two participants (fellow students) were invited to try the prototype and discuss how the product can be improved. The test shows the communication between the product and the user, revealing the hidden problems of the current design. Their comments during the discussion provided helpful insights for supply use and information design.



First user test photos (user A)



First user test photots (user B)



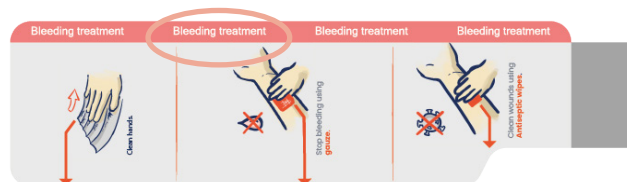
Participant A

DFI student

Problems during the first user test:



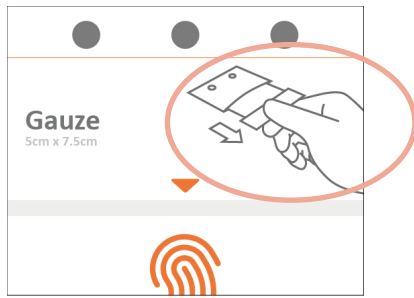
1. When the user notices and opens the instructions, they will intuitively pull it down, which means they will first see the second half of the instructions and wouldn't notice there is also information on the back (which should be the first half and should be noticed first).



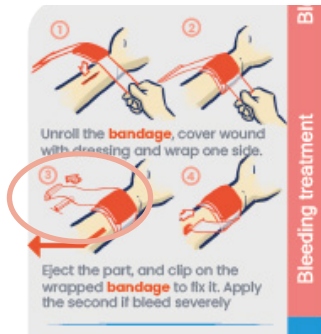
2. The sequence of steps, numbers and the different injury types are not so noticeable. (The box can be also divided according to injury types, with colours).



3. When applying the treatment, the instructions have overlap with supplies. They have to place it aside, apply one step, and put it back to look instructions again. This could repeat a few times when applying a complete treatment.



4. The illustration of sterile pack opening is useful, but it should be more noticeable.



5. The use of bandages are confusing, the information should be more clear and intuitive, especially step 3.



6. "Apply ice 10-20 min per hour" doesn't refer to two ice packs, and can lead to misunderstanding. It can be changed to "Apply an ice pack 10-20 min, if needed, apply another after 1 hour."

7. "raise injured site above the heart level" is not so clear. It can be changed to an illustration of a person raising an injured site (redpoint) above the heart level.



Participant B

IPD & SPD student

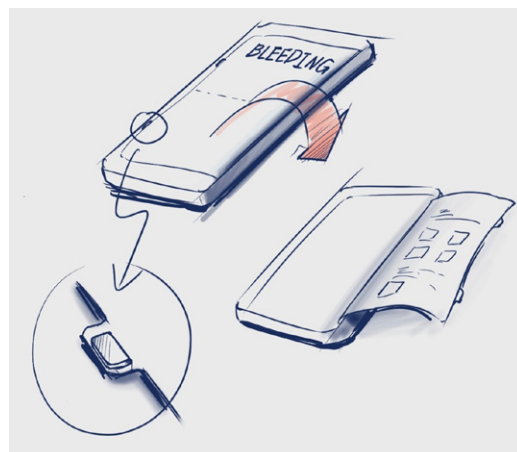
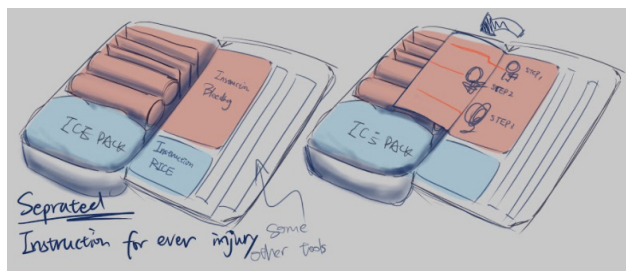
Problems during the second user test:

1. Same problems as 6 & 7 in the first test.



2. The SAM splint is hard to unroll (like mentioned in the report). If ice packs are fixed with Velcro (soft and flexible), the SAM splint can be placed under them again. It is convenient to remove cold compresses and take the SAM splint. The advice achieves the initial idea of SAM splint in the idea selection part.

The new important improvements according to user tests:

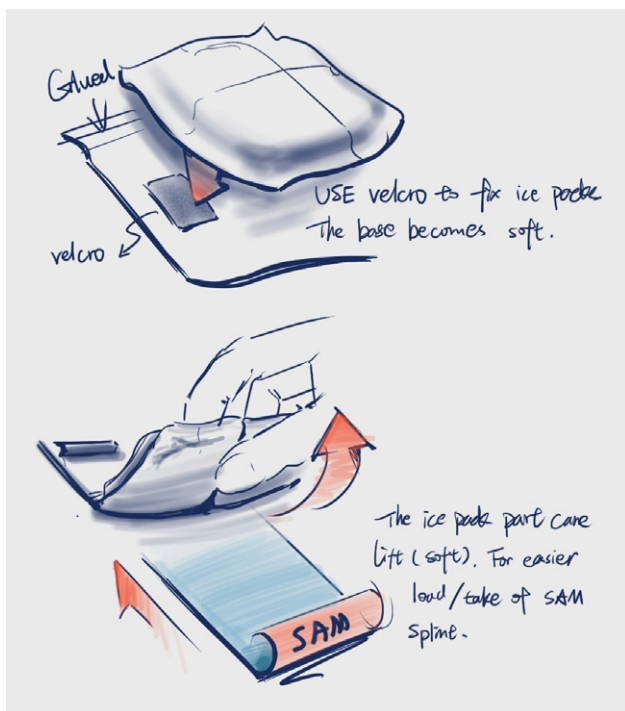


Improvement 1:

The instruction is changed similar to idea 4 during the idea selection stage. The instruction fully covers the first aid kit when it is opened and then extended.

Why the new design is better?

1. Much larger area to include more information or make it more clear.
2. The back side can be used to distinguish the basic injuries first, making the information more hierarchical.
3. Larger area also allows users to notice the instructions first, instead of other medical supplies.
4. The other side can be fixed, stopping the supplies from falling down when opening.
5. While using, the new instructions doesn't take any space inside the kit. Users are able to apply and read the instructions simultaneously.



Improvement 2:

Where the cold compresses locate is changed from rigid 3D printed board to soft velcro belt. The main problem stopping the load of SAM splint is mostly the friction caused by uneven surfaces of the 3D printed model. The improvement solves the problem by change part of the rigid board (where cold compresses locate) to soft material. In this way both SAM splint and cold compress are able to be easily taken.

These two big changes, as well as the problems of dimensions and 3D printing, will be improved in the next iteration, which is the **final design** of this project (**main report 4.4**).

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

! USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy". Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !



family name SHI 4917
initials _____ given name ZHIYU
student number 5045339
street & no. _____
zipcode & city _____
country _____
phone _____
email _____

Your master programme (only select the options that apply to you):

IDE master(s): ☒ IPD ☐ Dfl ☐ SPD

2nd non-IDE master: _____

individual programme: _____ (give date of approval)

honours programme: ☐ Honours Programme Master

specialisation / annotation: ☐ Medisign

☐ Tech. in Sustainable Design

☐ Entrepreneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair Henk Kuipers dept. / section: HCD/AED
** mentor Tessa Essers dept. / section: SDE/MD
2nd mentor _____
organisation: _____
city: _____ country: _____

comments
(optional)

⋮

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..



Second mentor only applies in case the assignment is hosted by an external organisation.



Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair Henk Kuipersdate 12 - 04 - 2021

signature

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Date:
2021.04.12
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CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: 30 ECOf which, taking the conditional requirements into account, can be part of the exam programme 30 EC

List of electives obtained before the third semester without approval of the BoE

☒ YES all 1st year master courses passed

☐ NO missing 1st year master courses are:

name J. J. de Bruindate 14 - 04 - 2021

signature

Digitally signed by J. J. de
Bruin, SPA
Date:
2021.04.14
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FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **. Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks?
- Does the composition of the supervisory team comply with the regulations and fit the assignment?

Content: ☒ APPROVED ☐ NOT APPROVEDProcedure: ☒ APPROVED ☐ NOT APPROVED

comments

name Monique von Morgendate 28 - 04 - 2021

signature

First Aid Kit Design for Sports Injuries

project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 06 - 04 - 2021

06 - 09 - 2021

end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

The inclusion of new sports events in global games over the past decades gives sports higher exposure. As a more ordinary activity, sport is a good choice for an increasing number of people to keep fit or compete. However, an injury can happen in the next second when doing outdoor activities. It is easy to get injured doing strong physical confrontation activities (basketball, football), high-intensity exercise (playground equipment, gym) or extreme sports (skateboarding, parkour). Ignoring the safety rules, lack of warming-up and accidentally hit can all cause sports injuries. In America, statistics from National Safety Council (NSC) showed that basketball had around 404 thousand injury cases while football had around 292 thousand in 2019 [1]. Exercise (with or without equipment) was found to have the highest number of injuries, 468 thousand, followed by cycling, 417 thousand [1]. In addition to activities with physical confrontation, individual sports has lower risk in getting injured but with less help. Injured in a place where no external in-time medical assistance can be reached, the situation can go wrong if they didn't prepare for an emergency at all.

The current available medical kits are designed for a specific public area or family use and are too bulky for long-distance outdoors activities [2]. Those designed for sports injuries even have similar supplies with the rest, and offers limited items for minor soft tissue injuries [3]. They are mainly used for several types of severe injuries like bleeding, burns and bone fracture [4], instead of those caused by sporting (Figure 1) [5].

The RICE method (rest, ice, compress and elevate) (Figure 2) is one of the universal but controversial measures for those muscles and soft tissue injuries. A research 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 [6]. Rest: stop moving to prevent inflammation, pain and further injury.
Ice: reducing blood flow, inflammatory and relieve pain.
Compress: reduce edematous swelling in the inflammatory process.
Elevation: reduce swelling by increase venous return of blood to the systemic circulation [7].
This method, or its alternatives, provides a systematic and helpful solution for these injuries and can potentially serve as the core of the design, by guiding users to properly apply the method. It is considered to be a first aid treatment instead of a cure, whose aim is to relieve the discomfort and potentially reduce the recovery period and long-term negative impact.

A few injury types and a specific first aid treatment can be the start to develop a product for most sports enthusiasts. The medical kit is not necessarily to be bulky and may have wider and flexible applications. This may be a step to future medical design for individuals, allowing ordinary people to apply professional treatment to themselves.

[1] <https://www.iii.org/fact-statistic/facts-statistics-sports-injuries>

[2] <https://www.ehbo-koffer.nl/product/ehbo-koffer-a/>

[3] <https://www.redcross.org/store/sports-first-aid-kit/720010.html?cgid=first-aid-supplies>

[4] <https://www.mfasco.com/blog/health-topics/what-is-a-first-aid-kit.html>

[5] https://www.physio-pedia.com/Sport_Injury_Classification#cite_ref-Verhagen_1-0

[6] Van den Bekerom, M., Struijs, P., Blankevoort, L., Welling, L., Van Dijk, C., & Kerkhoffs, G. (2012). What is the evidence for rest, ice, compression, and elevation therapy in the treatment of ankle sprains in adults? Retrieved March 19, 2021, from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3396304/>

[7] [https://en.wikipedia.org/wiki/RICE_\(medicine\)](https://en.wikipedia.org/wiki/RICE_(medicine))

[8] <https://www.inijunman.com/free-human-anatomy-illustrations>

space available for images / figures on next page

introduction (continued): space for images

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

Acute Injuries caused by sporting

Sports injuries that may be covered by first aid kit in public place

Not covered

image / figure 1: Sports injury types classified by Bruker & Khan's Clinical Sports Medicine

RICE

Rest



Ice



Compress



Elevate



image / figure 2: RICE method illustration from injurymap [8]

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

The rapid development of sports brings opportunities for ordinary people to have more choices, but also brings an increasing number of injury cases. The need for first aid measures like medical supplies is changing while first aid kits haven't been changed for years. It can be an opportunity to develop a first aid kit for sports activities, covering the most frequent injury types caused by sporting.

Another problem with the current medical kits is that they are simple combinations of different medical supplies included in a box. Injuries happening far from the city means little chance to get treatment while an easy-to-carry medical kit offers simple first-aid treatment anywhere. Medical kits can be designed with better user experience and space management to fit different sports requirements.

As the product is used for the first time, it has the responsibility to tell users how to handle it properly. A long manual costs time for users to find the corresponding information when they panic. An effective and systematic first aid treatment (RICE for example) can also be complicated and most of the users have no idea how to apply it. The conveyed information plays an important role in communication, making sure the right steps are in progress. The instruction can be concise and intuitive so that users are capable of applying the treatment as quick as possible.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

- Design a medical kit covering the most frequent or serious injuries caused by sporting;
- ... and fit the features of sports and user behaviour;
- ... and with product communication guiding users to apply a first aid treatment.

The solution is a (series of) product and also includes product-user communication as a part of the design. Firstly, the design can also be a first aid kit but designed for sports only. It will provide effective treatment for the most frequent and serious sports injuries. For example, to effectively provide medical treatment, temperature changing technologies will be applied to achieve the effect, e.g, ice bags or the thermoelectric cooler. For those severe injuries on bones, a simple and quick fixing device may be included in the kit to prevent further injuries. The kit will provide guidance for users to conduct in-time treatment before professional help arrives or provides relief from pain and discomfort if it's a minor injury.

Secondly, sports have an uncertain number of players and can happen anywhere. However, most accessible first aid kits are designed for public places with high population density and serves the purpose of saving life. Minor and moderate injuries are necessary to be covered with a wider range of use. For instance, the first aid kit can be a private and portable one to bring more convenience to users wherever they do sports.

Last but not least, the improvement of instruction for users is important to better guide users to conduct correct treatment steps in a short time. Concise and intuitive information will be conveyed through the instruction, as well as the feature of the products themselves.

The final design must comply with the guidelines of the Orange Cross. [1] [2].

[1] <https://www.ehbo-koffer.nl/inhoud-oranje-kruis-ehbo-koffer/>.

[2] https://www.hetoranjekruis.nl/media/1179/nederlandse_eerste_hulp_richtlijnen_2016_definitief.pdf

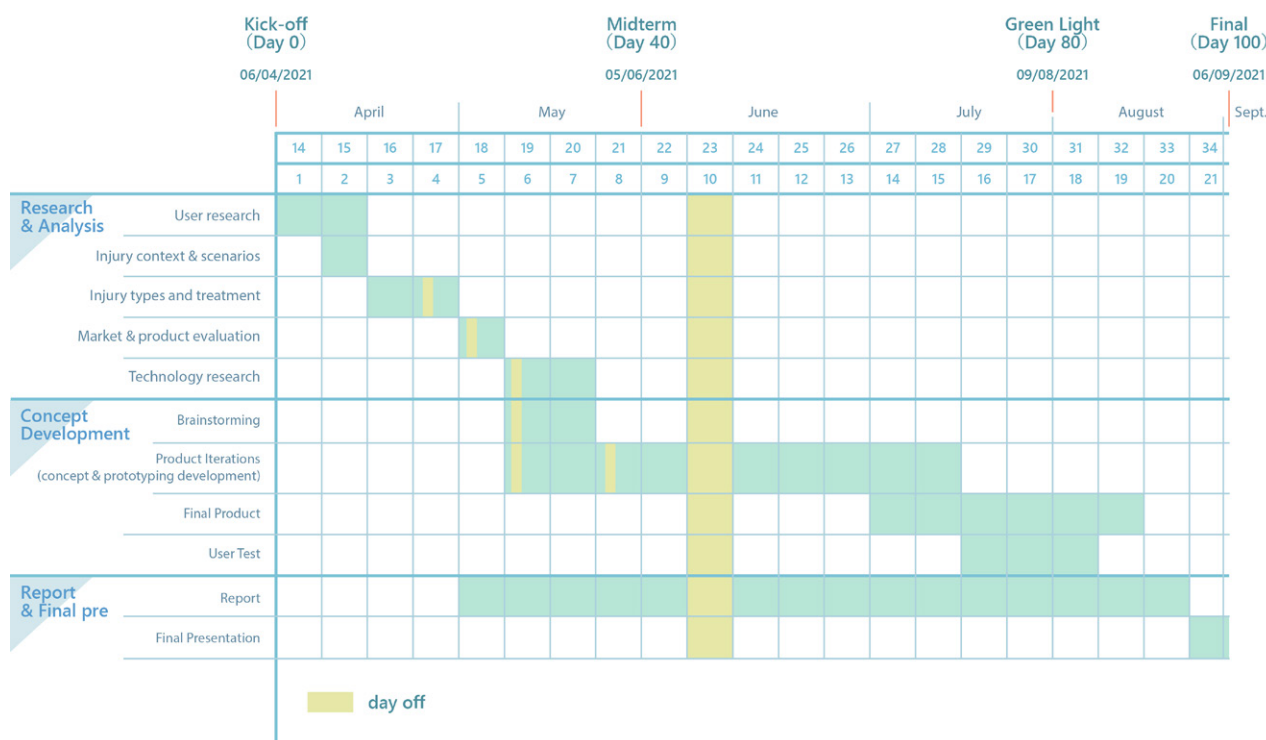
PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 6 - 4 - 2021

6 - 9 - 2021

end date



The Gantt chart shows the rough planning within 20 weeks (with 1 week off) starting from the second week of April and will end in September, from 06/04/2021 to 06/09/2021. Different design phases, research, concept development and finalizing, are all shown in the chart together with their detailed sections. The research part is more predictable and easier to be planned before the start of the project. It will focus on searching collecting the information of users (information, needs and feedback through questionnaire and interview), theories (the injury attributes, solutions, technologies), product (existing product market research and product evaluation), and user scenarios. This stage will take 4-5 weeks and will be constituted together with the ideation part.

The concept is expected to have a few versions before the final one. The following weeks will be mainly focused on concept development iteratively before and after the midterm evaluation. I plan to have a complete and feasible concept before then, and continue developing to have a physical final product until the green light meeting. User testing or simulation is also important to get to know the limitations of the design and collect feedback from participants for better improvement. It will be conducted before or after the green light meeting.

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, Stick to no more than five ambitions.

Among all stages of product design, I was quite good at presenting my ideas with enjoyable visual expressions. But relatively, my information searching and analysing capability is less satisfying compared to my other skills. How to well analyse information and use it rationally and scientifically are capabilities that I've been hoping to develop for years and is one of the reasons why I choose to continue studying at TU delft. In the past three semesters, I've learned quite a lot of knowledge in this field through commercial projects and lectures, and fully aware of the fact that information processing and communication is the basis of all good designs. The graduation project is a perfect opportunity to show the skill learning progress as a master student.

I love to do regular exercise which is a helpful activity to relieve stress and keep fit under such a hard period. That's why I'm pretty enthusiastic about sports topic which is more related to the human body than most of the projects. People can benefit a lot from regular exercises like improving body function and lowering the risk of disease. However, human body is also relatively vulnerable to the external environment that it's easy to get injured when doing sports. The aim of this human-centred project is to design for near-future medical environment, covering non-fatal injury types that are usually neglected by ordinary people. I hope my project provides sports enthusiasts with a convenient injury solution making them feel better secured.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.