etaren

- A HAND SANITIZING DEVICE

PRODUCT REPORT

Master thesis project

Spring 2018

MSc04-ID01 Aalborg University

PURE HANDS

ANE ØSTERGÅRD JOHANSEN

JULIA MANDRUP

ABSTRACT

Dette projekt omhandler designet af en ny håndspritsdispenser til danske hjemmesygeplejersker. Den nye dispenser er designet ud fra research omkring god håndhygiejne, observationer og interviews med hjemmesygeplejersker samt flere forskellige tests med modeller, som tilsammen har givet et gennemarbejdet produkt. Produktet består af en dispenser med en gel beholder og en aktiveringsdel. Dispenseren er placeret på en magnet klips, som er placeret i halsudskæringen på den t-shirt, som hjemmesygeplejersken bærer indenunder en uniformskjorte. Beholderen med alkohol gel indeholder nok gel til en halv arbejdsdag, og ved hjælp af et gevind i beholderen, som passer ned i et gevind i aktiveringsdelen, kan beholderen let udskiftes til en ny. Aktiveringen minder meget om det klassiske pumpe system, der ses på sæbedispensere, men på denne dispenser skal der blot trykkes ind fra siden. Ved at trykke knappen helt i bund vil der komme 3 ml gel ud, som er den anbefalede mængde for at dræbe 99,9 % af bakterierne på hænderne. Den rette mængde alkohol gel samt den øgede tilgængelighed gør at produktet skaber de bedste rammer for at hjemmesygeplejerskerne afspritter korrekt og nok gange i løbet af dagen.

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CO SUPERVISOR	Poul Kyvsgaard
PAGES	22

ANE ØSTERGÅRD JOHANSEN

JULIA MANDRUP

INTRO

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Two home nurses from the municipality were observed in how they disinfected hands through different treatments at patients' home and inside a wound clinique. The hand hygiene was not optimal because they did not use the right amount of gel or the recommended 30 seconds to kill the bacteria on the hands.

The world faces a fast evolving problem with multiresistant bacteria, and WHO (World Health Organization) estimates that in 2050 400 million people will die because of them. Therefore, it is more important than ever not to spread these bacteria. The product is designed for the home nurses, but it has great potential to be used by many more health personal and even spread to other non-health areas.

READING GUIDE

It is recommended to read the material in following order

- Product report
- Process report + Appendix
- Technical drawings

The process report is divided into six phases that follows the process more or less chronologically

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Throughout the material the term home nurse is used and this refers to an educated nurse who is working in the patient's home rather than in a hospital (Danish = Hjemmesygeplejerske).

In the process report some of the conclusions will be illustrated with triangles in different colors like below.

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FOUNDATION FOR PROBLEM

The antibiotics development cannot keep up with the multiresistant bacteria
(Hansen, M. B., et. al., 2017)

The municipality of Silkeborg states they can save 14 mio. DKK every year with better hand hygiene
(Daugård, 2015)

In 2050 a person will die every third second from multiresistant bacteria - 400 mio. from 2018 to 2050
(Hansen, M. B., et. al., 2017)

REGULATIONS FOR HAND HYGIENE

- 3 ml
- 30 seconds
- Before clean actions
- After unclean actions
- Between glove change
- After washing hands
- Before treatment
- After treatment

MISMATCH

PERCEPTIONS FROM HOME NURSES

- The hands feel clean
- Look clean
- Has disinfected at least a few times per visit
- Own opinion on when the hands are dirty and what is an unclean action

ETAREN - OPTIMAL HAND HYGIENE

Etaren is the new portable gel dispenser for home nurses. Etaren helps the home nurses achieve optimal hand hygiene by giving the right dosage of 3 ml 85% ethanol gel, so they will disinfect their hands for 30 seconds.
The home nurses have easy access to Etaren during their work because it is placed on the chest close to the other equipment like the pen, watch and pupil light that they use. By controlling the dosage and giving easy access, the home nurses have great opportunity to achieve optimal hand hygiene with Etaren. The home nurses will be more motivated to disinfect their hands correct, because Etaren is more integrated in their workflow.

Ill. 8.1 - Etaren in context

2.940 home nurses in Denmark

5.880 containers each work day

CONTEXT

In Denmark there are 98 municipalities with minimum two departments for home nurses in each municipality. In each department there are about 15 home nurses. This means that there are 2.940 home nurses in Denmark that can use the product. This also means that the municipalities will need 5.880 containers of 120 ml gel each work day when using Etaren.

A typical work day for a home nurse starts with a meeting at the department. Afterwards she gets a list of patients she has to visit and treatment for the day. She checks if she needs to find extra suppliances to bring. She finds a car and start driving up to the first patient for the day. Here she finds the needed suppliances at the patient's home often inside a closet inside a wound box.

The context can vary a lot. Most of the patients are elderly, who also have help with cleaning their home by social and health assistants/helpers, but some homes are very dirty and unhygienic according to the homenurses. Depending on the task that the home nurses have to do, they will need to use what the surroundings can offer. When treating wound the home nurses have to wear an apron to protect the uniform which covers all pockets, where the existing product Ceduren is stored.

The nurse will put all the used suppliances in a trash bag, that she gets rid of outside the patient's home.

TARGET GROUP

The chosen target group is home nurses wearing uniform. They work home at patients and have to treat them in different work environments. The patients are not always the same, and can be young as elderly persons. The suppliances the home nurses use for treatment are mainly at the patients' home. Home nurses have limit work space at the patients and little time to treat them. Transport between patients is by car.

"I USE 10-20 SECONDS TO DISINFECT."
Home nurse, 32 years old

"I USE ABOUT ONE BOTTLE (120 ML) PER WEEK."
Home nurse, 37 years old

"IF I CHANGE GLOVES, I DO NOT DISINFECT EVERYTIME IF I HAVE NOT HANDLED ANYTHING UNCLEAN. I AM JUST BUSY."
Home nurse, 55 years old

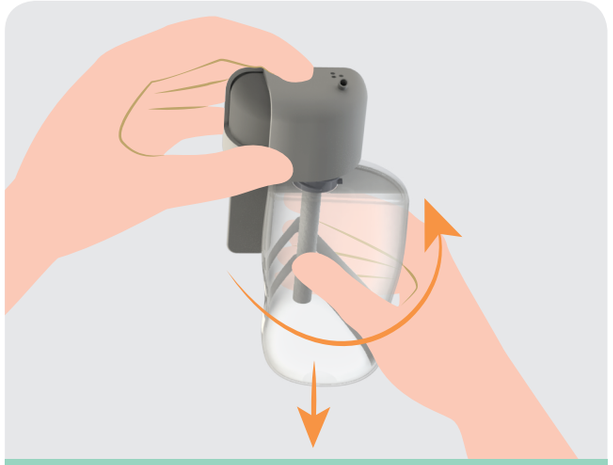
"I HOPE, THAT I DO IT ENOUGH. BUT I DO NOT DISINFECT IN 30 SECONDS EVERY TIME, AND THE AMOUNT OF GEL VARIES, TOO."
Home nurse, 35 years old

Ill. 9.1 - Home nurses

1

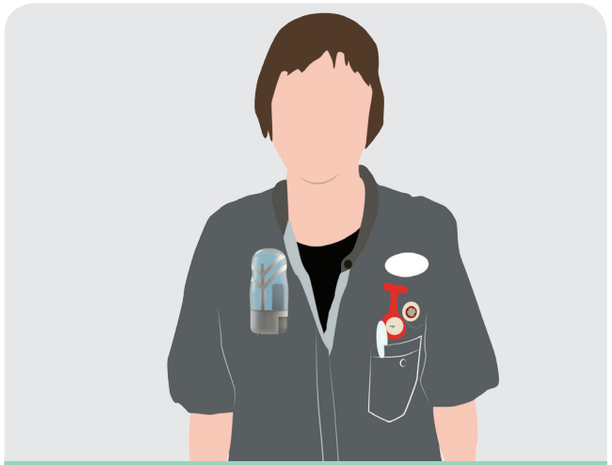
Ill. 10.1 - Attach magnet clip on t-shirt underneath the uniform shirt

2



Ill. 10.2 - Take off the empty container from the day before

5



Ill. 10.3 - Put it outside the shirt

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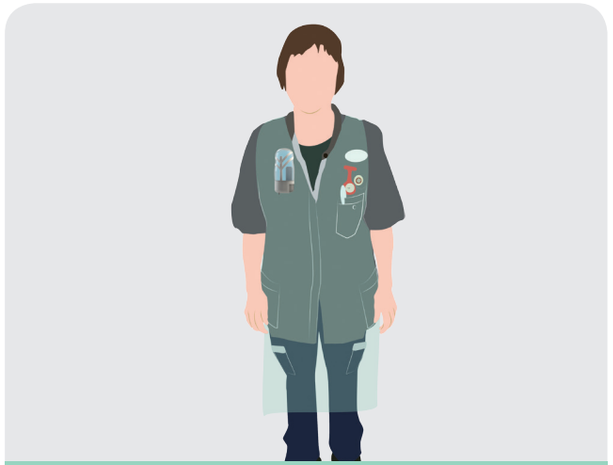
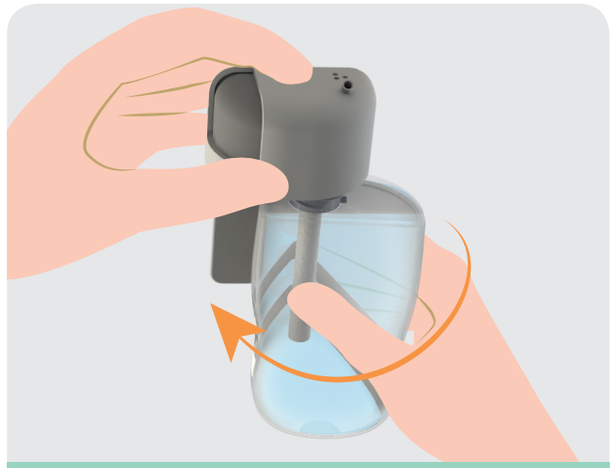


Ill. 10.4 - Wearing a apon, take Etaren outside the apon

3

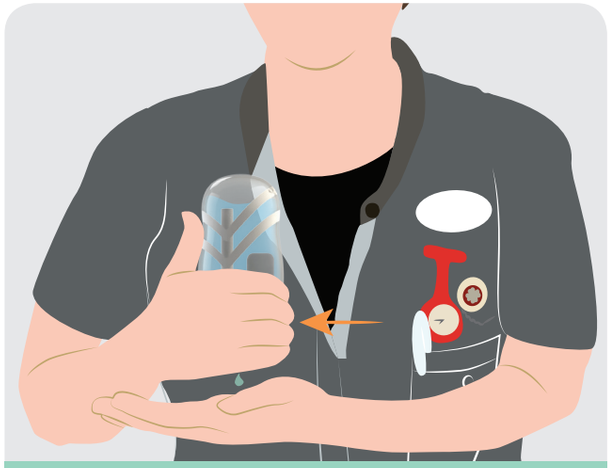
Ill. 11.1 - Pull off the sealing from the new container

4



Ill. 11.2 - Screw it on the activation until it says *click*

7

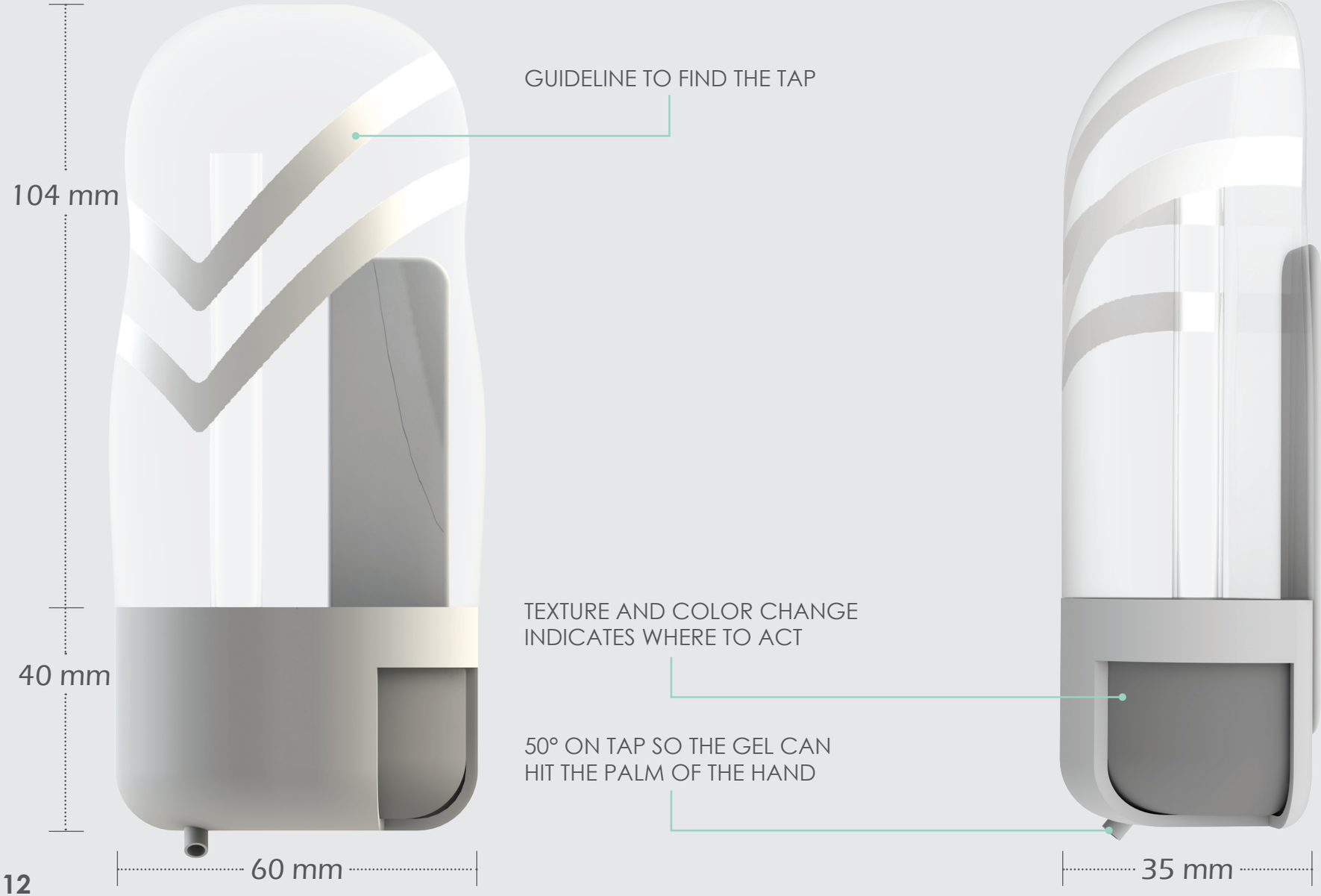


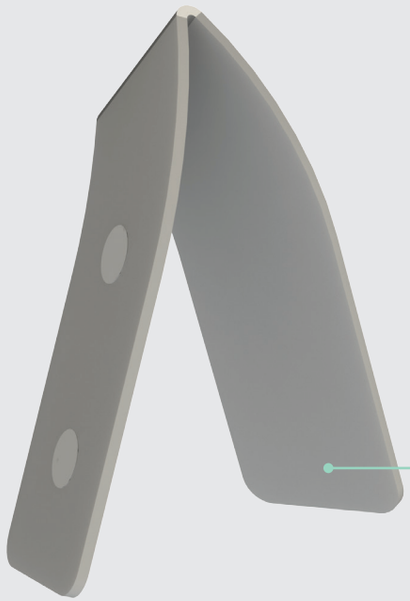
Ill. 11.3 - Squeeze to get gel

8

Ill. 11.4 - Disinfect hands

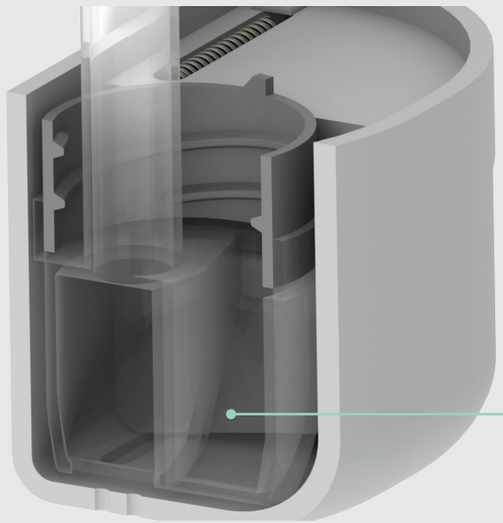
ETAREN'S SPECIAL FEATURES





REPLACABLE CONTAINER WITH
120 ML 85 % ETHANOL GEL

SUITABLE FOR ALL UNIFORMS



3 ML DOSAGE CONTROL

FEEDBACK & FEEDFORWARD

There is no delay in squeezing the activation to the gel comes out of the tap until it hits the palm of the hand.

When squeezing the activation the reaction can be felt by the gel hits the hand palm. When the dispensation is done, no more gel is dispensed into the hand palm. It is naturally that squeezing an object together some kind of visible material/liquid comes out from a hole - like a ketchup tube.

The action and reaction do not act at the same location. Squeezing the activation on the side and dispensing the gel underneath the activation.

If the home nurse is in a hurry the dynamics are high and the action might be quick which results in a uncontrolled dispensation. The home nurse can reflect in this interaction so she might think she needs to take some extra seconds to dispense the gel.

The dynamics of both action and reaction is unified - a smooth movement by squeezing the activation result in a slowly/controlled dispensation likewise a hard squeeze result in a quick/uncontrolled dispensation.

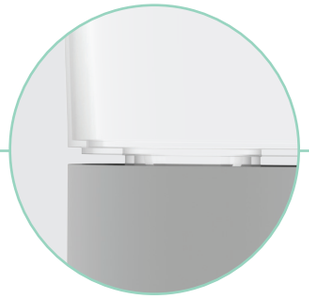
The action of squeezing the activation is a horizontal push and reaction of dispensing gel is vertical.

KEEP AN EYE ON THE GEL

The container is see-through so the home nurse knows when it is time to change the container.

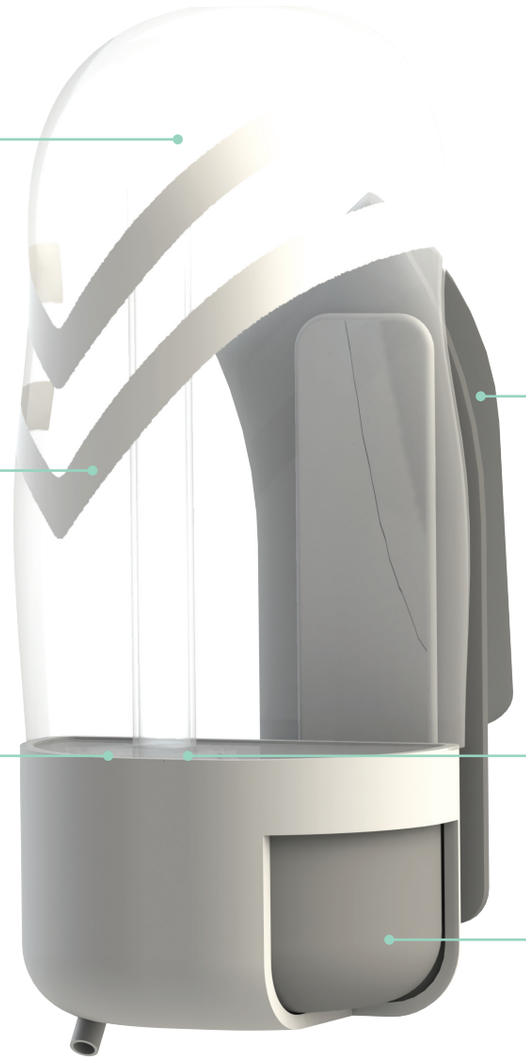
GUIDELINE

Etaren tells the home nurse where the gel comes out with the guideline. This also helps the home nurse knows which side is the front of the container.



THE PERFECT FIT

The container will give a click sound when it is screwed into place, because the shell has a small edge that overlaps with the container. The threads on the container and in the activation furthermore has small spikes that will meet when the container is screwed into place.



THE MAGNETIC CLIP

The clip contains two strong magnets that will easily connect with the steel parts in the clip and on the back plate on the device.

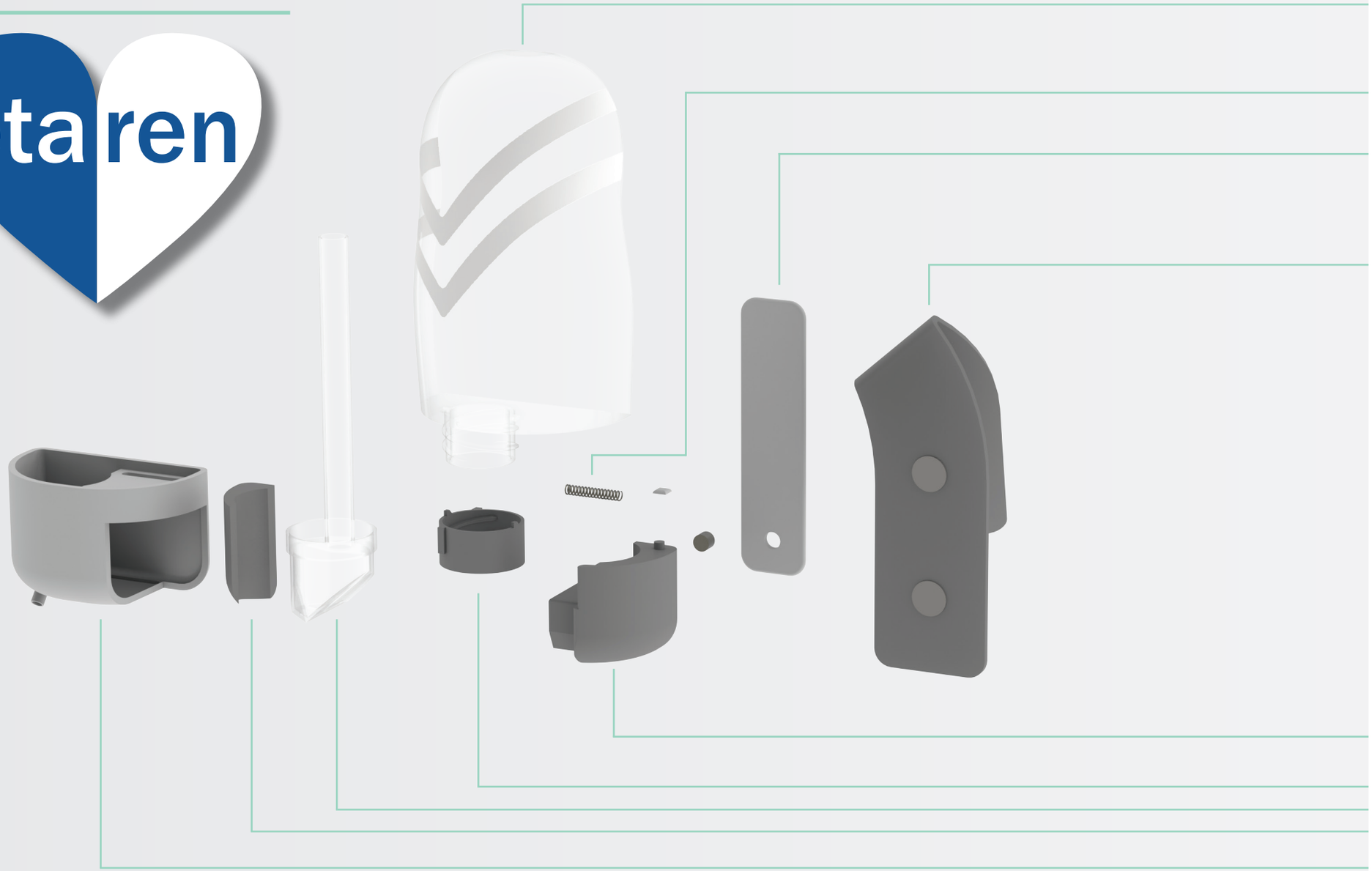
THE THREAD

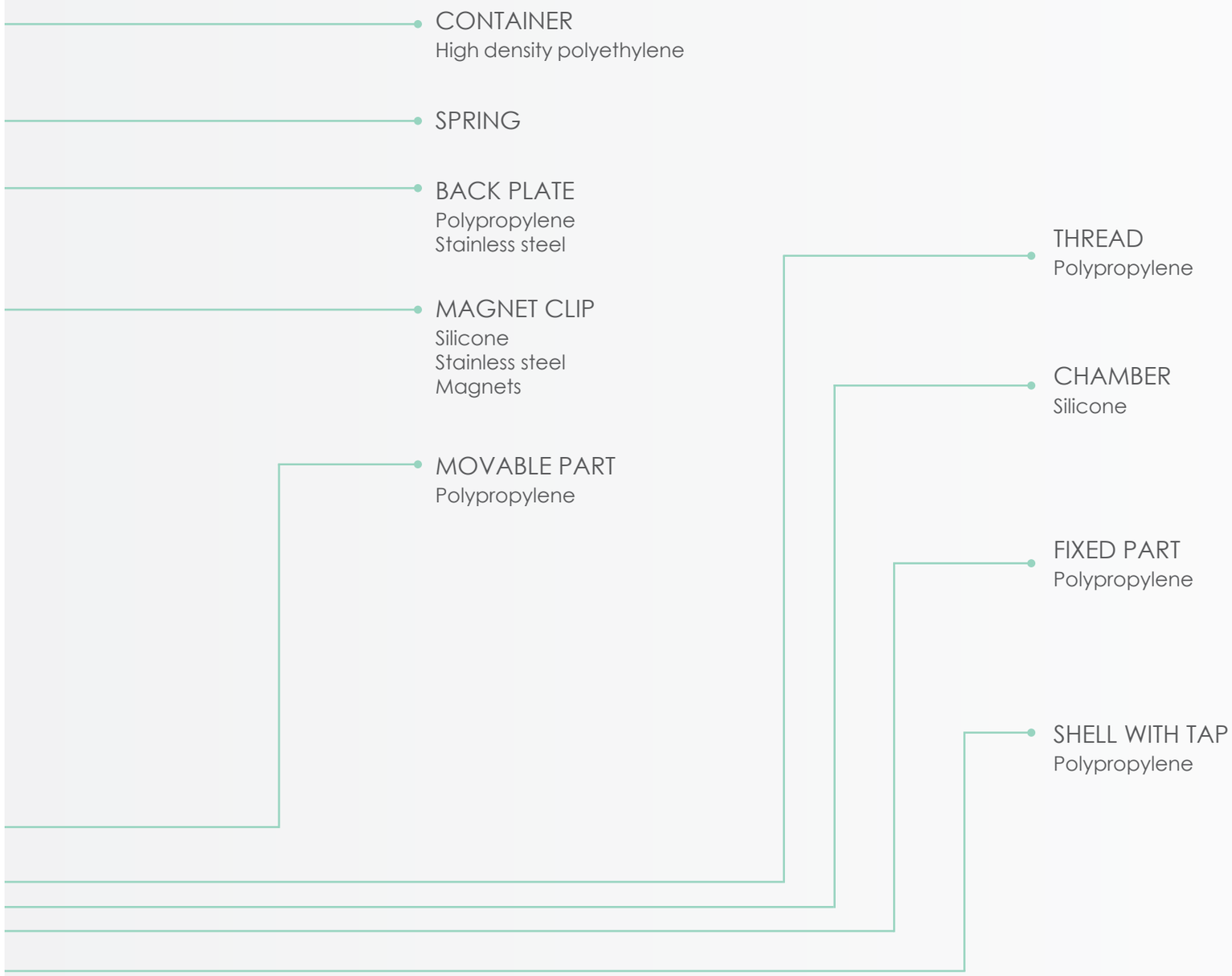
The container and the activation part each has a thread that fits into each other. This makes it intuitive for the home nurse when connecting the two parts.

THE BUTTON

Etaren has a clear color indication where to push to get gel. The button also has a texture that does not make the fingers slip when pushing.

CONSTRUCTION OF ETAREN



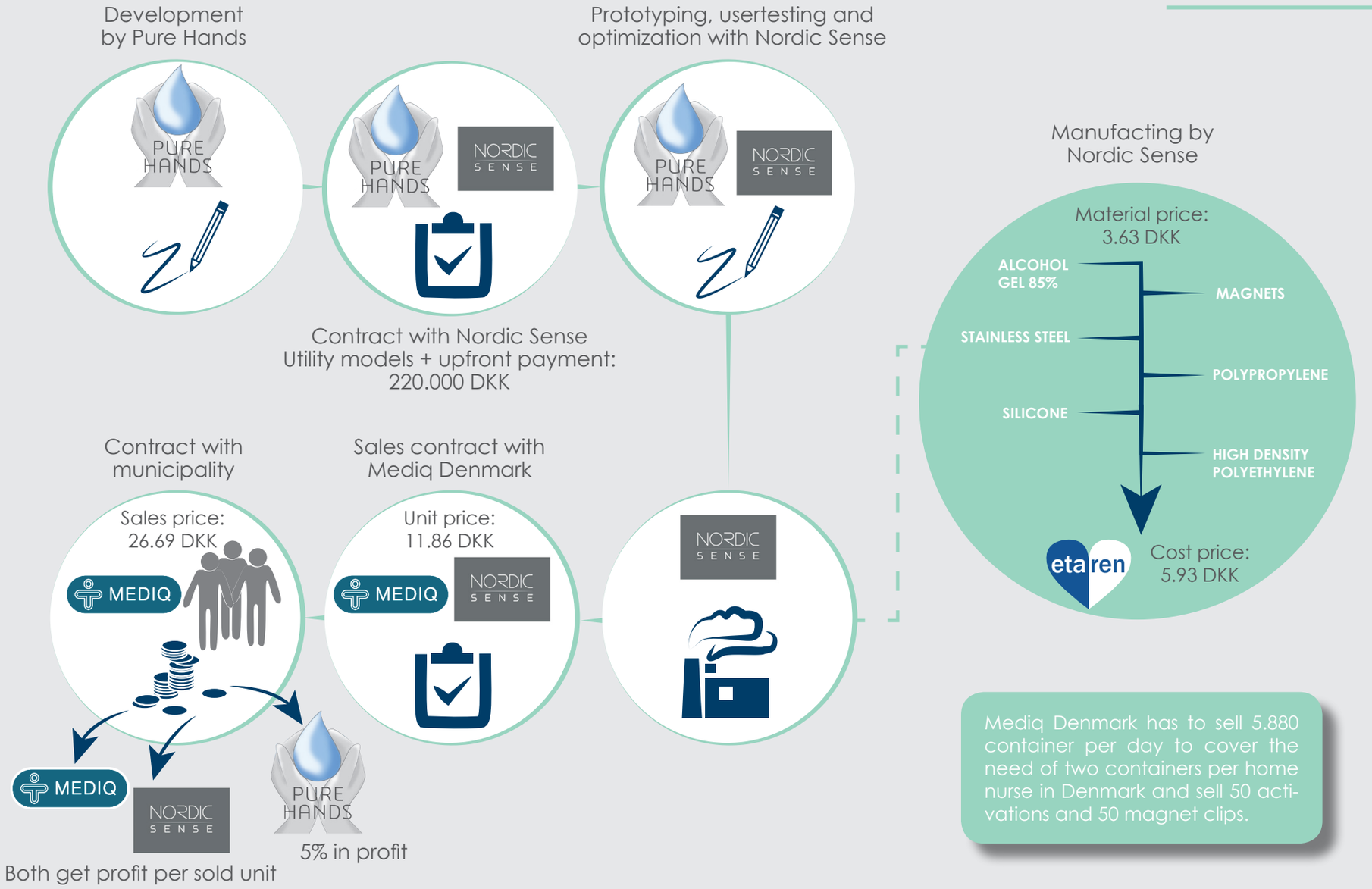

CONTAINER
High density polyethylene
SPRING
BACK PLATE
Polypropylene
Stainless steel
MAGNET CLIP
Silicone
Stainless steel
Magnets
MOVABLE PART
Polypropylene
THREAD
Polypropylene
CHAMBER
Silicone
FIXED PART
Polypropylene
SHELL WITH TAP
Polypropylene

PARTNERS

Pure Hands is a startup company established in 2018. They have developed a new product to optimize hand hygiene for home nurses by providing correct disinfection. Pure Hands wants to reduce the overall cost in the health sector by making disinfection more accessible when working as a home nurse. The product is convenient and trustworthy, because it gives the right guidance to kill 99.9% of the bacteria on the hands. Pure Hands also provide motivation to do hand hygiene because the product secures a correct hand disinfection.

Nordic Sense is a Danish company which has existed since 1982. They develop, design and manufacture products for personal care. (Nordicsense.dk3, n.d.)
Their products are allergy friendly and environment friendly. The products are in high quality which Nordic Sense clarify as uniformly products and products that follow trends in expression, form and function.
Nordic Sense makes sure that their manufacturing is environment friendly with solar power cells and separation of waste. (Nordicsense.dk2, n.d.)
Nordic Sense offers close cooperation with their users, customers and partners when developing and testing products to secure an optimal result. (Nordicsense.dk1, n.d.)
Nordic Sense manufactures the disinfection bottles and the gel the home nurses are using today.

Mediq Group is a global distributor of medical equipment in the health sector in 13 european countries. Since 1979 Mediq Danmark has delivered products for hospitals, nursing homes, home nursing, clinics etc. Some municipalities in Denmark have a contract with Mediq Denmark to provide products. They want to be the leading collaborator when it comes to strengthen the Danish citizens' health. They provide effective products and guidance to use them. (Mediqdanmark.dk, n.d.)
Mediq Danmark supports non profit foundations because they want to joint the responsibility for the world we are living in. (Mediqdanmark.dk, 2018)



Mediq Denmark has to sell 5.880 container per day to cover the need of two containers per home nurse in Denmark and sell 50 activations and 50 magnet clips.

etaren

- Helps you perform perfect hand hygiene

PURE HANDS

NORDIC SENSE

MEDIQ

etaren

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PROCESS REPORT

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Ill. 3.1

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New insight ▲

Needs more investigation ◀

Discarded hypothesis ▼

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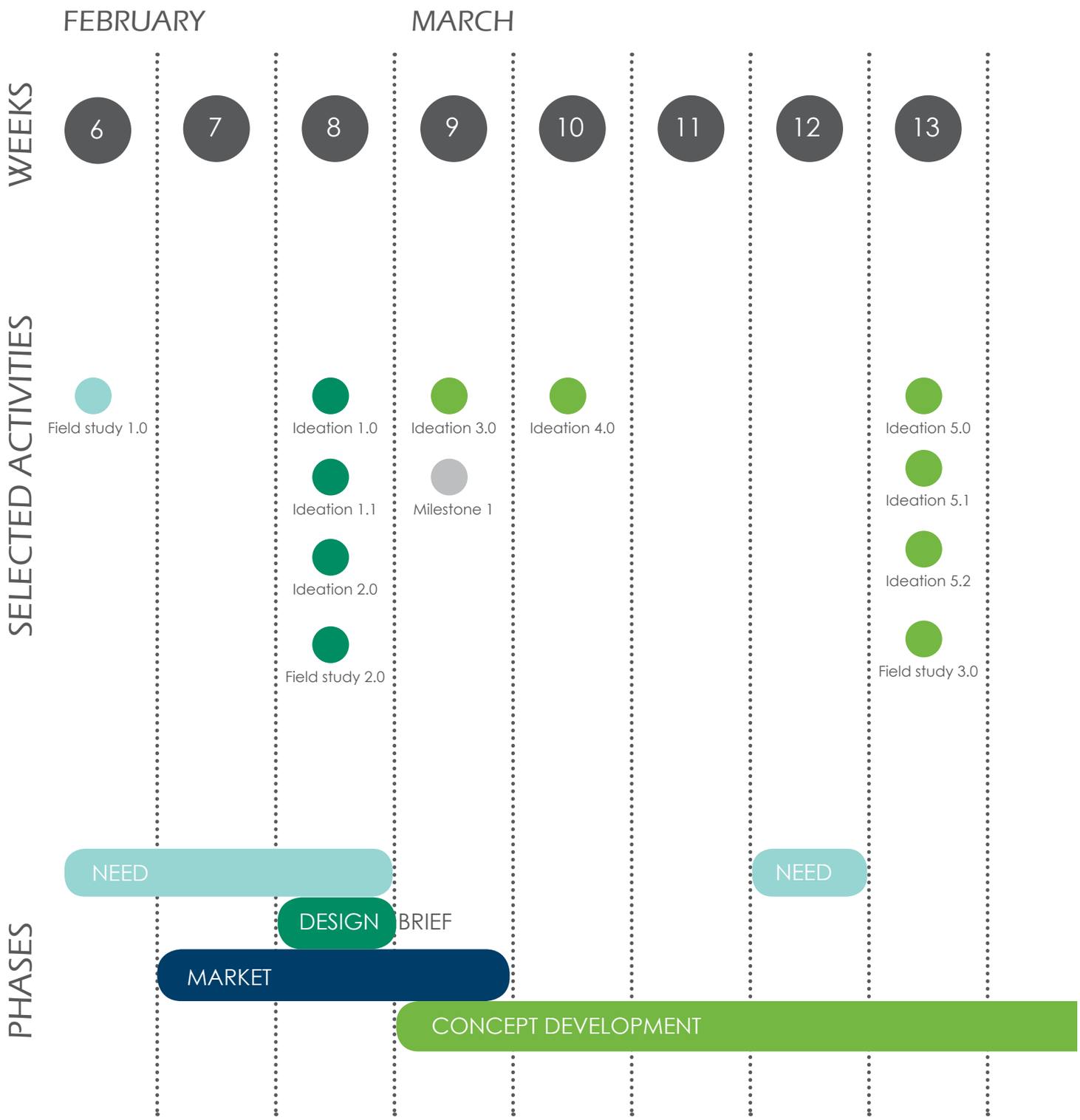
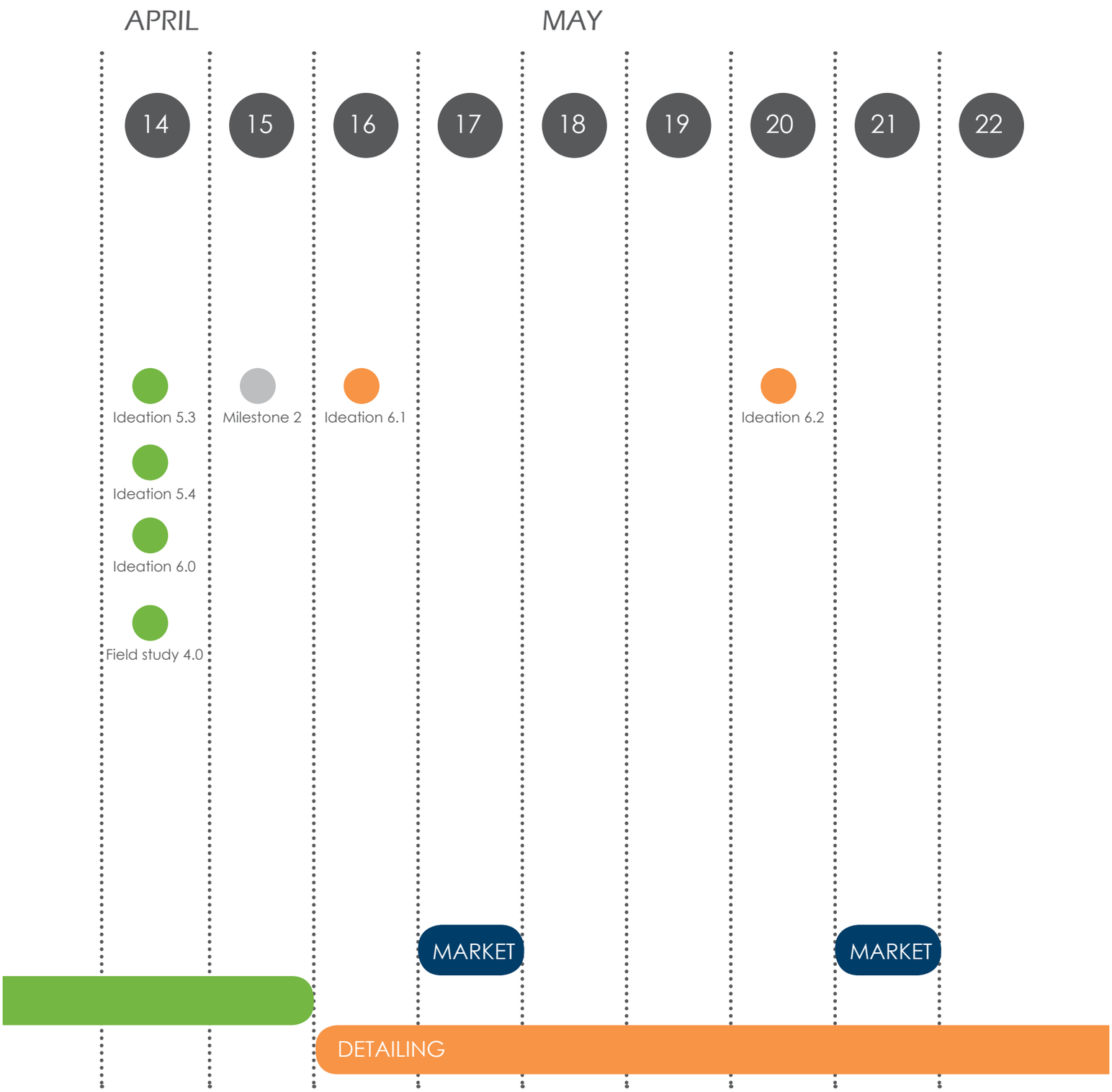
PROCESS TRACKING

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MARKET
DETAILING

01. NEED

INTRO

This phase covers most of the research done on the topic along with the first field study, where important information were gathered that made the basis for the project. The phase includes the regulations for good hand hygiene, but also investigates why the home nurses are not performing correct hand hygiene. This is done through interviews and an anonymous survey. The phase ends in a mapping of what the core problem is.

FOUNDATION FOR THE PROJECT

The microorganisms that are found in the environment and on the health staff are the direct cause of infections from the health department (including homecare). The amount of microorganisms on hands increases linear over time, if hand hygiene is not performed correct. The bacteria can survive from minutes to hours on the hands. This is also the reason why for example MRSA can be spread from the hospital to private homes. (Holt, Ilan and Kristensen, 2017)

Today, more people die from multiresistant bacteria than from traffic accidents. WHO (World Health Organization) believes that multiresistant bacteria will be the biggest threat to humans in 2050, where 400 million people will have died because of them. (Hansen, M. B., et. al. 2017)

Another problem is that the nurses are not thoroughly trained in hand hygiene. They do not get enough knowledge that is designated for this purpose anymore and that worries Jette Holt, who is a nurse with speciality in infections. She believes that antibiotic resistant microorganisms are the big issue. It is very important to control the spreading of these, because they are very hard to treat. Therefore it is more important than ever, that the nurses have clean hands when treating patients. (Kjeldsen, 2017)
The elderly generation is growing and in 20 years there will be 1.165.000 danes above 70 that uses the health section twice as much as the danes that are 50 years old. This means that more danes will be in risk of getting a hospital infection and thereby treated with antibiotics and may evolve antibiotic resistant bacteria. (Hansen, M. B., et. al. 2017)
In an investigation from 1987 it is stated which factors can motivate the staff to perform correct hand hygiene. A factor that will demotivate the staff is that they lack the knowledge of the current regulations and they also lack the recognition for doing it correct. If they are too busy, they will not prioritize the hygiene. A motivating factor is easy access and good hand products to use afterwards. This can be lotion, nice and clean towels, hand sanitizer with skin care in it etc. The staff will avoid cleaning their hands if the hands are damaged from it. A good role model is also a motivating factor. (Junker, L., Meyer, M. and Wolff, C., 2004)

Easy access is a motivating factor to disinfect correctly. ▲

Multiresistant bacteria are a growing issue in the world. ▲

Nurses do not perform correct and enough hand hygiene. ◀

Patients are not just infected in the hospitals. ◀

There will be more elderly above 70 years old in 20 years. ▲

WHAT IS GOOD HAND HYGIENE?

Good hand hygiene is more than just disinfecting the hands. The health staff should avoid wearing any jewelry, have short and clean nails, not have long fake nails or bracelets or watches on the wrists. The arms from the elbows and down must be free.
By using hand sanitizer the number of bacteria are reduced compared to washing the hands with soap. (Junker, Meyer and Wolff, 2004)

In order to have clean hands, the hands need to be free of cuts/wounds, cracks and basically need to be as smooth and healthy as possible, so the bacteria cannot hide anywhere. (Ehlert, 2005)

The skin has two layers where bacteria can be. There is the permanent layer that lies deep within the skin and there is the superficial layer. The superficial layer of bacteria can easily be removed by washing or disinfecting the hands, but it is also here that most infections in hospitals appear from. (Junker, Meyer and Wolff, 2004)

When a patient is infected the following is present (Ill. 9.1):

- Microorganisms
- Reservoir (the host, can be human, organic material, dust, dirt)
- Contamination exit (blood, slime, skin)
- Contamination path (contact, airborn)
- Contamination entrance (broken skin, broken mucosa)
- Contamination receiver (weakened immune system)

There needs to be a good base for having clean hands = smooth, healthy hands. ▲

They must not wear anything that can hold bacteria including long sleeves. ▲

The superficial bacteria can be removed with hand sanitizer. ▲

If the hands have sores where the bacteria can hide, the disinfecting is not going to be efficient. ▲

Some bacteria cannot be removed with hand sanitizer. ◀

Ill. 9.1

HYGIENE REGULATIONS

When working with nursing in contact with sick patients, it is important to follow regulations for hygiene. Microorganisms like bacteria and virus can get spread between patients and staff through the staff's hands and uniform. These can be harmless to the staff, but serious to the vulnerable patients.
Using the accurate hygiene regulation will reduce the spread of bacteria and virus. (Elbæk, 2014)

Hygiene for hands should be executed

- Before clean procedures (an action which purpose is to prevent transfering pathogenic microorganisms from staff to citizen. The risk of transferring the microorganism is limited, but acceptable.)
- After unclean procedures (an action with a rick of transferring pathogenic microorganisms from the citizen to the staff.)
- Before and after use of one pair of gloves
- After hand wash
- Before and after nurse-, treatment- and examination tasks

(Kristensen, Lund and Holt, 2013)

There is evidence that hand hygiene with disinfection with alcohol (70-85%) is faster and more effective to kill microorganisms than water and soap.
Alcohol does not have a toxic effect on skin, but after repetition the skin can get dry and irritated. Therefore glycerol is often added to the sanitizer for hands to limit the effects. An interview with a home nurse is conducted, and she mentioned that the glycerol creates a layer on the hands and they feel unclean, so the home nurse tries to wash her hands.

Hand hygiene with disinfection should be executed with an amount of sanitizer, so the hands are moisted in minimum 30 seconds.The recommended amount is 3 ml. (Holt, Ilan and Kristensen, 2017)

The container with hand sanitizer is portable and often placed on the uniform. The container is placed so it cannot be infected, but with easy access during tasks. The sanitizer container is considered unclean if it gets refilled without being cleaned. Containers which are carried on the user will be seen as unclean together with the storage pocket. (Holt, Ilan and Kristensen, 2017)
If the placement of the hand sanitizer container is easy accessible during the task, the use will be increased. (Kristensen, Lund and Holt, 2013)

The tradition to inform users about hand hygiene has been through a written or orally version. But an article written by professionals in the health sector, states that they have the experience that this information will get "lost" between all the information the home nurses get during work. They want an innovative method to inform and remind the users about hand hygiene. (Hansen, M. B., et. al., 2017)

Hand condition	Hand wash	Hand disinfection	Note
Visible clean and dry		X	
Visible unclean	X	X	After hand wash: hand disinfection is always needed on dry hands.
Visible wet	X	X	After hand wash: hand disinfection is always needed on dry hands.

Ill. 10.1 - Method and criterias of hand hygiene can be executed by hand disinfection and hand wash.

Ill. 11.1 - Illustration of how to disinfect hands.

WHAT ARE THE CONSEQUENCES OF POOR HAND HYGIENE?

One consequence of bad hygiene is that the vulnerable patients can get very sick from the bacteria, because their immune system is already weakened. In the flu season the elderly citizens (65+) are most exposed to contamination. The elderly with chronic lung diseases, heart diseases and/or diabetes are in the high-risk group. (Hjalsted, et. al., 2012)

It is estimated that over 12.000 elderly (60+) every year has an airways disease/cold that result in them needing assistance with their daily life; shopping, cooking and laundry washing. (Hjalsted, et. al., 2012)

Poor hand hygiene in hospitals cost 3.265 lives every year. Several hygiene experts agree that the problem lies in the poor hand hygiene and lack of wash of the hands and use of alcohol gel. Studies show that only 50 percent of the staff perform correct hand hygiene. (Nielsen, 2007)

Studies show that the health staff has not improved on maintaining a good hand hygiene in the last 20 years. (Junker, Meyer and Wolff, 2004)
According to Elaine Larson (1988) there is a connection between poor hand hygiene and infections.

Microorganisms are present everywhere; on bed sheets, on patients, clinical equipment, furnitures etc. When the microorganisms are in small numbers they are often not that harmful, but when the are in big numbers or especially dangerous the human body cannot fight them and infections occur.
When the patient has an infection the microorganisms are present in very big numbers.
(Ehlert, 2005)

There is a link between poor hand hygiene and infections. ▲

Nurses/staff do not follow the regulations. ◀

Infections on vulnerable patients can be fatal. ▲

There is a link between poor hand hygiene and infections. ▲

FIELD STUDY 1.0

In the first field study (W8) a home nurse from the municipality of Jammerbugt was followed during three visits at three different patients' homes. The home nurse was given a full bottle of sanitizer in the morning, so it could be documented how much she used for three visits. The home nurse was aware that the observation was about her sanitizing habits and this may have affected the result.

During the visit it was documented how many times she disinfected and for how long she did it each time.

In the field study a lot of other things were documented which gave the basis for many of the sections in this phase.
The uniform and the equipment she used were some of the things that were interesting to see. The context at each patient was also very different and so was the tasks she performed during a day.

Number of disinfections	**7-10 per visit**
Time for each disinfection	**4-30 seconds**

Ill. 12.1 - A section view of the uniform of a home nurse with focus on her equipment in the front pocket.

OBSERVED PROBLEMS

DOSAGE PROBLEM

- There is no validation of the right amount of dosis
- They use the wrong dosage

STORAGE PROBLEM

- There is not enough alcohol gel in a bottle for one workday
- They have the bottle in the pocket
- The work area is limited

STERILITY PROBLEM

- The bottle must be sealed/closed after use
- The bottle will be infected if it is placed somewhere unclean
- The bottle is unhygienic

BEHAVIOUR PROBLEM

- The nurses do not have time to clean their hands correct
- The glycerin in the gel creates a layer on the skin, that is uncomfortable
- The alcohol ruins the skin on the hands
- They forget to disinfect

VISCOSITY PROBLEM

- The 3 ml gel is hard to keep on the hands without dropping some

Current disinfection bottle used in observed context.

Ill. 12.2 - The ceduren sanitizer.

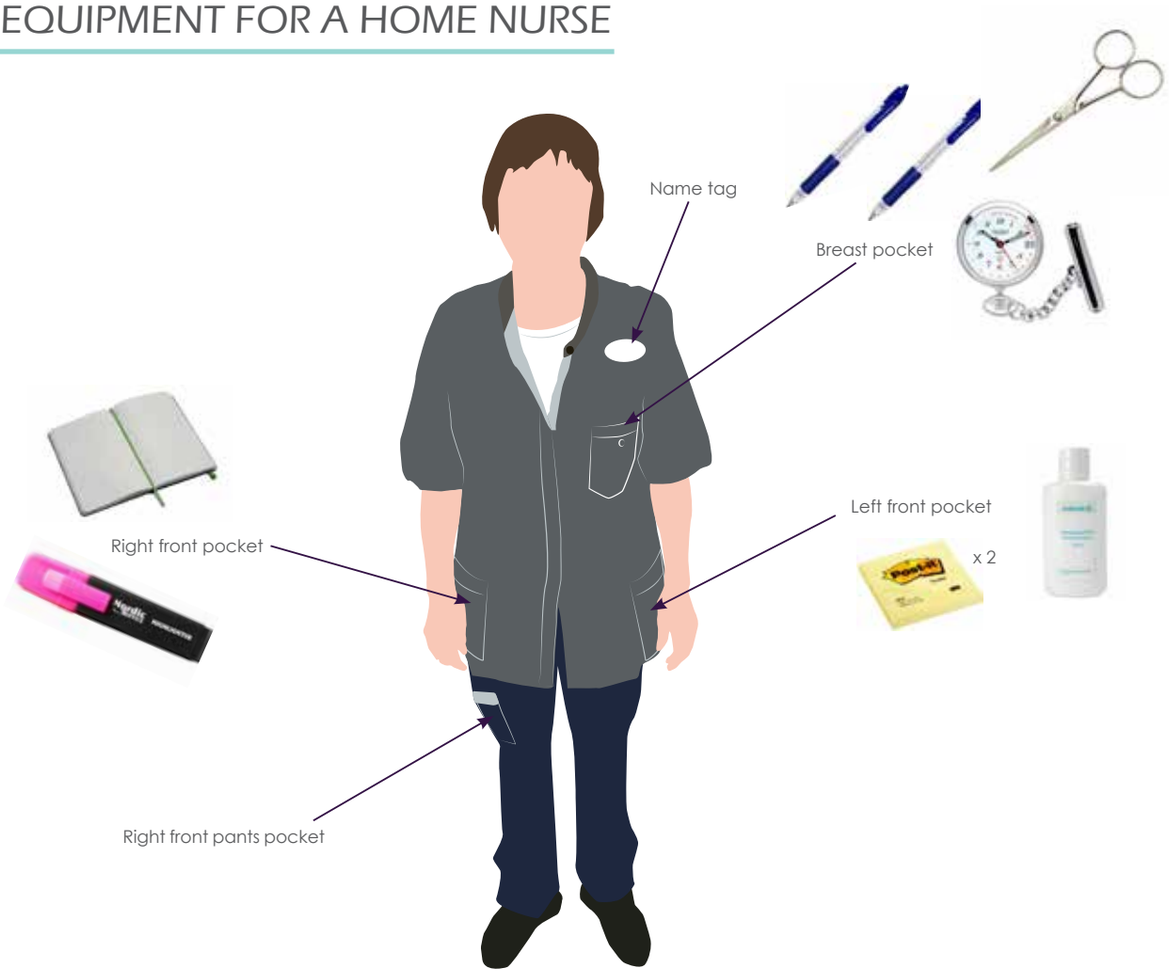
THE UNIFORMS

Textiles can be a reservoir to microorganisms and can be a reason to spread them between the home nurse and patient. Therefore the staff need to wear clothes with short sleeves. If they wear clothes with sleeves, it can be infected when treating the patient, remove sleeve during the treatment or when washing hands and pulling the sleeves back again. (Kristensen, Lund and Holt, 2013)

The home nurse changes into a clean uniform in the beginning of a workday, but also if it gets visible unclean. Hand hygiene needs to be done before handling with clean textiles.
In the municipality of Jammerbugt the home nurses get an uniform distributed. In the municipality of Gentofte the home nurses are wearing their own clothes because the municipality states there is no scientific reason that the microorganisms get less spread when wearing uniforms. It also has an economic effect because the municipality reduces the budget with 4.3 mio DKK. (Gentofte.lokalavisen.dk, 2011)
If the patient needs treatment from a very aggressive bacteria (fx. MRSA) the home nurse has to wear a coverall, gloves, glasses and a mask. This will limit the access to the pockets on the uniform. If the treatment is very unclean (fx. wound) the home nurse wears a plastic apron. (Blok et al., 2015)

From field study 1.0 an observation of the uniform was conducted. The uniform contains a shirt with short sleeves, a t-shirt, pants and a jacket. The shirt has one pocket on the chest, and two front pockets. The pants contains two front pockets and one side pocket and back pockets. The uniform is used different ways from personal preferences.

EQUIPMENT FOR A HOME NURSE



Ill. 13.1 - The uniform

SURVEY

To get a better understanding of how the home nurses work and what habits they have a survey was given to them. The survey consisted of a number of questions regarding their disinfecting habits. The home nurses already knew that Pure Hands would investigate if they disinfected enough and this might have affected the result, but the home nurses were still honest in their answers and admitted that they disinfected wrongly.
The survey can be found in worksheet 10 and some selected questions can be seen below.
The survey was answered by ten home nurses in the municipality of Jammerbugt and they were between 27 and 62 years old. Their experience in their positions were between newly employed to 20 years. In the department there were a mixture of permanent employees and substitutes.
The hypothesis was that the home nurses do not disinfect the recommended times or spend enough time on it each day.

HOW OFTEN DO YOU TAKE A NEW BOTTLE OF HAND SANITIZER?

"Around every 2 weeks"

"Around 1 per week"

"1-2 per week"

"Around every 4-5 days - maybe 1 time per week."

"... I know that I use too little."

According to the calculations on page 17 the home nurses need at least one bottle of sanitizer per day. This does not reflect the actual use in the department where they have used 306 bottles in two years (W86). This means that one home nurse have used 1.6 bottles per month.

FOR HOW LONG DO YOU DISINFECT EVERYTIME?

"15-20 seconds"

"5-10 seconds"

"Around 30 seconds"

"10-15 seconds"

"Around 15"

"Until the sanitizer gets dry. I do not take time."

"5-60 secs"

The home nurses are not disinfecting for the recommended 30 seconds. One question in the survey was if they knew for how long they should be disinfecting. All of the home nurses answered 30 seconds or more. This shows that the problem lies somewhere else. Some of the home nurses stated that they were too busy to disinfect.

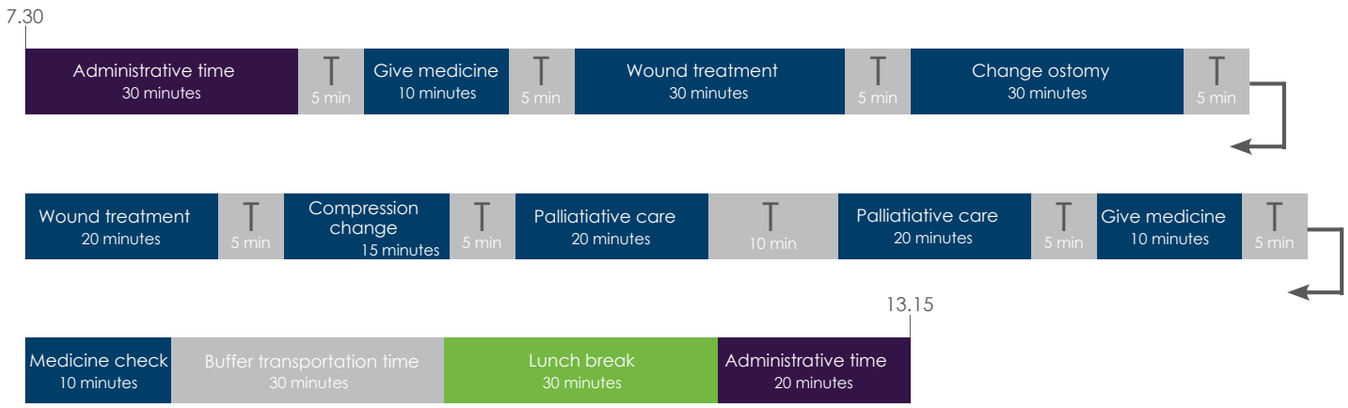
The survey confirmed the hypothesis that the home nurses are not disinfecting correctly. They do not have the time, accessibility or they simply use too little gel. The home nurses did not try to hide that they do not do it correctly. Maybe they are not that concerned with the problem when they do not see the consequences directly.
Through the survey there were a lot of mismatches between the answers from the same persons. For example there was a home nurse who took a new bottle of sanitizer once every two weeks, but still said that she uses 30 seconds to disinfect. This means that she is not disinfecting enough times each day.

The home nurses do not use enough time on each disinfection ▲

The home nurses know that they should disinfect for 30 seconds ▲

On average a home nurse only uses 1.6 bottles per month ▲

A WORK DAY FOR A HOME NURSE



T = Transportation

Ill. 14.1 - A short work day for a nurse.

EXAMPLE OF A WOUND TREATMENT

- **Disinfects hands 10 seconds**
- Finds equipment box
- Gets water in a disposable cup
- Puts equipment on the lid of the box
- **Disinfects hands 6 seconds**
- Put on apron
- **Disinfects hands 12 seconds**
- Puts on gloves
- Removes bandages/band-aids on both legs
- Cleans with water
- Takes gloves off
- **Disinfects hands 17 seconds**
- Puts on new gloves
- Puts on band-aids and use a scissor to cut
- Takes gloves off
- **Disinfects hands 10 seconds**
- Puts tape on the lid of the equipment box
- Puts cotton and bandages on patient
- Seals with the tape pieces
- **Disinfects hands 5 seconds**
- Changes to the other leg
- Puts more tape pieces on the lid
- Puts cotton and bandages on the leg
- Seals with tape
- **Disinfects hands 6 seconds**
- Takes the apron off
- Puts socks on the patient's feet
- **Disinfects hands 11 seconds**
- Throws away the scissors in a special box
- Packs the equipment in the box
- Disinfects the lid of the equipment box
- Takes out the trash
- **Disinfects hands 19 seconds**

Ill. 14.2 - A home nurse from Jammerbugt municipality in her uniform.

CALCULATION WHEN USING THE ALCOHOL GEL (W18)

FACTS

120 ml total in one container
3 ml used per time
40 times in one container

EXAMPLE 1

In the survey one home nurse substitute answered she has 4-8 visits per day and she takes a new hand sanitizer per 14 day and she disinfects for 30 seconds per time.

6 visits
7 times per visit
42 times in total
126 ml used (short day)
1,05 bottles of hand sanitizers per day

EXAMPLE 2

Many answered they have 10-15 visits per day and they do not know when they take a new hand sanitizer and two home nurses answered 1-2 container per week. They disinfect in 5-20 seconds per time.

12 visits
9 times per visit
108 times in total
324 ml used (long day)
2,7 bottles of hand sanitizers per day

THE CONTEXT

To get to the context the home nurses drive in a company car or their own car. They wear a uniform and bring a bottle of sanitizing gel.
The context the nurses are working in are the patients' home. Therefore the context can vary a lot. Most of the patients are elderly, who also have help with cleaning their home, but some homes are very dirty and unhygienic according to the home nurses. Depending on the task that the home nurses have to do, they will need to use what the surroundings can offer. This can be that a patient has a bed, they can lie on when the nurse is changing a bandage or an ostomy. If the patient has trouble moving around, the nurse will have to perform the task on the patient where they are. When the legs are the infected parts, a way to lift the legs is best for the nurse's work situation.
The nurse uses a box with the suppliance in it, that has been placed at the patient's home, so they do not have to bring a lot of stuff with them, and so they avoid using the same suppliances for all the patients.
The nurse will put all the used suppliances in a trash bag, that she gets rid of outside the patient's home.

Ill. 15.1 - An example of a Danish home where the nursing will happen.

Ill. 15.2 - Another example of the context where the care will happen. The sick person might just put their leg up on the table and the nurse will change the bandage.

▲ **The only item that they use at all the patients' homes are the alcohol gel bottle**

▲ **They wear the same uniform all day and eat lunch in it as well**

Context will vary, but the nurses will create the best work situation ▲

There is a suppliance box at each patient's home ▲

THE CORE PROBLEM

The core problem was identified based on the regulations and the perceptions from the home nurses that was found in the research and field study.

REGULATIONS		PERCEPTION
In the pocket of the uniform, but avoid touching the pocket. Protected from bacteria.	STORAGE	In the pocket of the pants or shirt.
Gel or liquid. Dispensed in the hand.	DISPENSING	Wants to control the tempo.
3 ml	DOSAGE	Wants to control the amount. The hands cannot be wet for too long.
30 seconds	TIME	Until it is vaporized. (Between 4-30 seconds)
Correct followed procedure.	CLEAN HANDS	The hands feel clean. Look clean. Has disinfected at least a few times per visit. Own opinion on when the hands are dirty and what is an unclean action.
Enough disinfecting: Before clean actions After unclean actions Between glove change After washing hands Before treatment After treatment	MISMATCH	

Has own perception on when they should desinfect.

They choose when they want to disinfect.

Do they do it for themselves or for the patient?

COPING STRATEGIES

The existing solutions only handle the way the gel is dispensed, access and dosage (W13). The problems which do not have solutions are focused around the nurses' behaviour.

CONTENT

- The alcohol ruins the skin on the hands when used a lot (coping strategy: no or less disinfection)
- The alcohol gel creates a layer on the skin, that is uncomfortable (coping strategy: avoid using it too much)

PLANNING AND EXECUTION

- They forget to disinfect (coping strategy: no disinfection)
- The nurses do not have time to clean their hands correct (coping strategy: 4 seconds or skip).

CONCLUSION ON PHASE

The foundation for the problem lies in trying to prevent to spread the multiresistant bacteria. This is a growing issue and the antibiotics evolvement cannot keep up.
This phase has discovered what the core problem is; the mismatch between the regulations and the home nurse's perception.
A big problem is also the lack of time. The home nurses have to disinfect many times each day and for 30 seconds every time. This takes valuable time from the patient care.
Most of the home nurses know all the regulations on the area, but have many excuses not to follow them.
According to calculations the home nurses should use at least one bottle per day if they have ten visits and right now they are using 1.6 bottles per month.

02. DESIGN BRIEF

INTRO

The design brief contains the frame for the project along with the first ideations, another field study where mock-ups were tested of the concepts. The phase ends in the initial demands that the subsequent ideations followed until the direction were changed.

VISION

TO CREATE **OPTIMAL HYGIENIC CONDITIONS** *FOR TREATING PATIENTS IN THEIR HOME.*

MISSION

DESIGNING AN **EASY ACCESIBLE** *DEVICE THAT GIVES THE* **RIGHT DOSAGE**, *AND HEREBY MAKING SURE THAT THE DISINFECTION IS* **PERFORMED CORRECTLY**.

PROBLEM STATEMENT

HOW CAN A HAND SANITIZING CONTAINER BE DESIGNED SO IT ENHANCES THE HOME NURSE'S WORKFLOW, ALONG WITH MAKING SURE THAT THE DISINFECTION IS DONE CORRECTLY?

PERSONAS

Two fictive personas were created based on the survey and interviews with the home nurses.

Ill. 21.1 - Persona number one; Helle, who is working in a municipality as a home nurse.

Ill. 21.2 - Persona number two; Betinna, who previously has worked in a hospital, but now also works in a municipality as a home nurse.

HELLE

53 years, is married and has three grown up children. When she was newly qualified she worked at a hospital in three years, but she did not feel this was the right workplace for her. Therefore she has been working as a full time home nurse for almost 20 years.

She uses hand hygiene to achieve clean hands during a treatment at a patient and avoiding infection in the wounds.

She tries to make the hygiene action be a part of her work flow by placing the container near the work situation, but she is aware it can cause infection of the container.

"In the pocket, in the windowsill, on table → but is not happy about it because I do not know if it is clean."

When disinfection she uses 5-10 seconds every time, and she knows she uses too little amount of hand sanitizer. She does not have count when she needs a new container, she just take a new one when the old is empty.

"If I change gloves, I do not disinfect everytime if I have not handled anything unclean. I am just busy."

Time pressure is a big barrier for keeping Helle from achieving good hand hygiene. Another barrier is the alcohol in the hand sanitizer which makes her hands very dry, and it can be painful putting it on. She also feels the hands are dirty because the hand sanitizer creates a layer on the hands, and she tries to wash them.

BETINNA

32 years, lives with her boyfriend and they have a 2 year old boy. She has worked in a hospital for 8 years, but now she wants new challenges and started as a home nurse in the municipality 2 month ago, but with reduced hours.

She uses the hand hygiene to reduce infections at the patient and avoid spreading diseases from patient to patient.

"I have it in mind that I must disinfect when I go from one task to another. For example from unclean to clean."

In her work flow she always places the container in her right pocket, and if she by mistake places it in another place, she cannot find it when working. When she disinfects during work she is insecure on her habits.

"I hope, that I do it enough. But I do not disinfect for 30 seconds every time, and the amount of gel varies, too."

She uses one container per 14 days, which tells she does not use the right amount every time she disinfects or she does not disinfect enough times per patient.

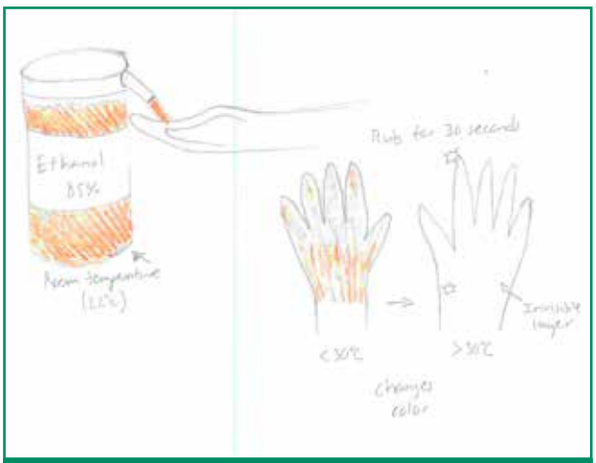
A barrier that keeps her from achieving good hand hygiene in 30 seconds is that her hands are wet in too much time so she cannot get her gloves on and continue the treatment. This will cause time pressure in the work flow.

IDEATION 1.0

The first ideation (W24) was very open and focused on the observed problems from the field study.
The idea was that it identified solutions that could be used later on to create concepts.

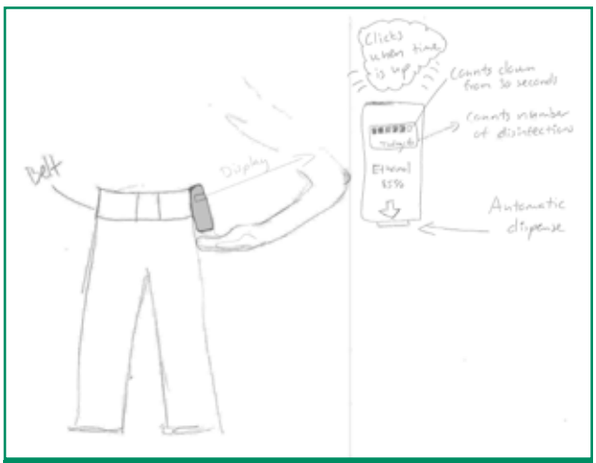
Sketch on the observed problems
- Dosage problem
- Storage problem
- Sterility problem
- Behavior problem
- Viscosity problem
- Use inspirations from other fields

Behaviour problem



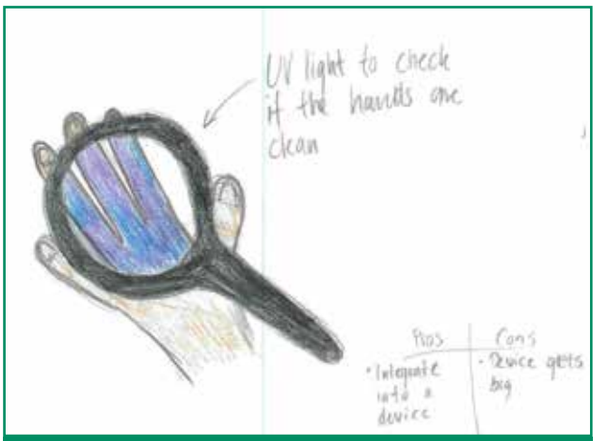
Ill. 22.1 - An idea where the gel has an additive chemical that will turn the hands a color until it has vaporized.

Behaviour problem



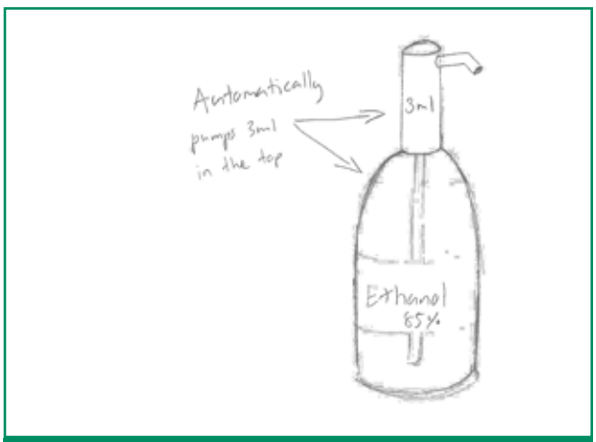
Ill. 22.2 - An automatic belt device with an indicator on a small screen that counts down the 30 seconds and also tracks number of disinfections.

Dosage problem



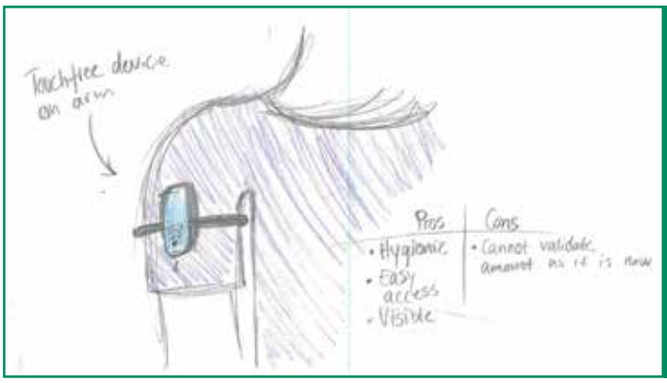
Ill. 22.3 - An idea where an additive in the gel makes the bacteria light up when viewed under ultraviolet light.

Dosage problem



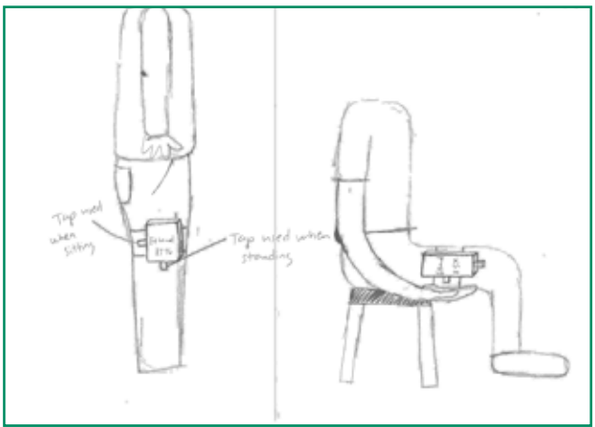
Ill. 22.4 - A pump where 3 ml is pumped to the top and then out, so the dosage is controlled.

Sterility problem



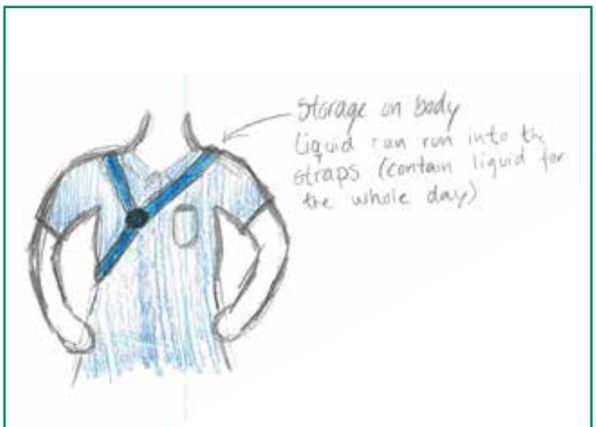
Ill. 23.1 - A touch free device that is placed on the arm. It is easy accessible.

Storage problem



Ill. 23.2 - A device placed on the thigh. The device has two taps, so it can be used when standing and sitting down.

Storage problem



Ill. 23.3 - A wearable device that is placed around the body and thereby always accessible. There is gel in the straps as well, so the weight is distributed.

The ideas were evaluated on the demands 2.0 (W12), which were still quite open. Some ideas were clearly not working, but it was good to think of every solution.
The ideas were grouped in five groups; wearable, control of disposing, reminder, something separate and protection of the tap.
Within these groups the ideas were evaluated based on the demands. Four concepts remained.

1. Wearable on the chest + 3 ml dosage control
2. Wearable in belt + protection of tap + display
3. Color at room temperature (needs more research)
4. UV light check (needs more research)

However, concept number three and four were reconsidered since there were some difficulties with these. For the gel to change color some extra chemicals need to be added and this can cause an unwanted allergic reaction. UV light cannot be seen in daylight. Fluor needs to be added to the gel, and this is very hard to wash off again. Fluor is bad for the environment. (Krogh et al., nd)

CONCEPT 1

Wearable on the chest + 3 ml dosage control

CONCEPT 2

Wearable in belt + protection of tap + display

TARGET GROUP

The chosen target group is home nurses wearing uniform. They work home at patients and have to treat them in different work environments. The patients are not always the same, and can be all ages. The suppliances the home nurses use for treatment are mainly at the patients' home. Home nurses have limited work space at the patients and little time to treat them. Transport between patients is by car.

Home nurses wearing uniform

Work in patient's home

Various work environments

Various patients

Limited time to treat patients

Limited work space

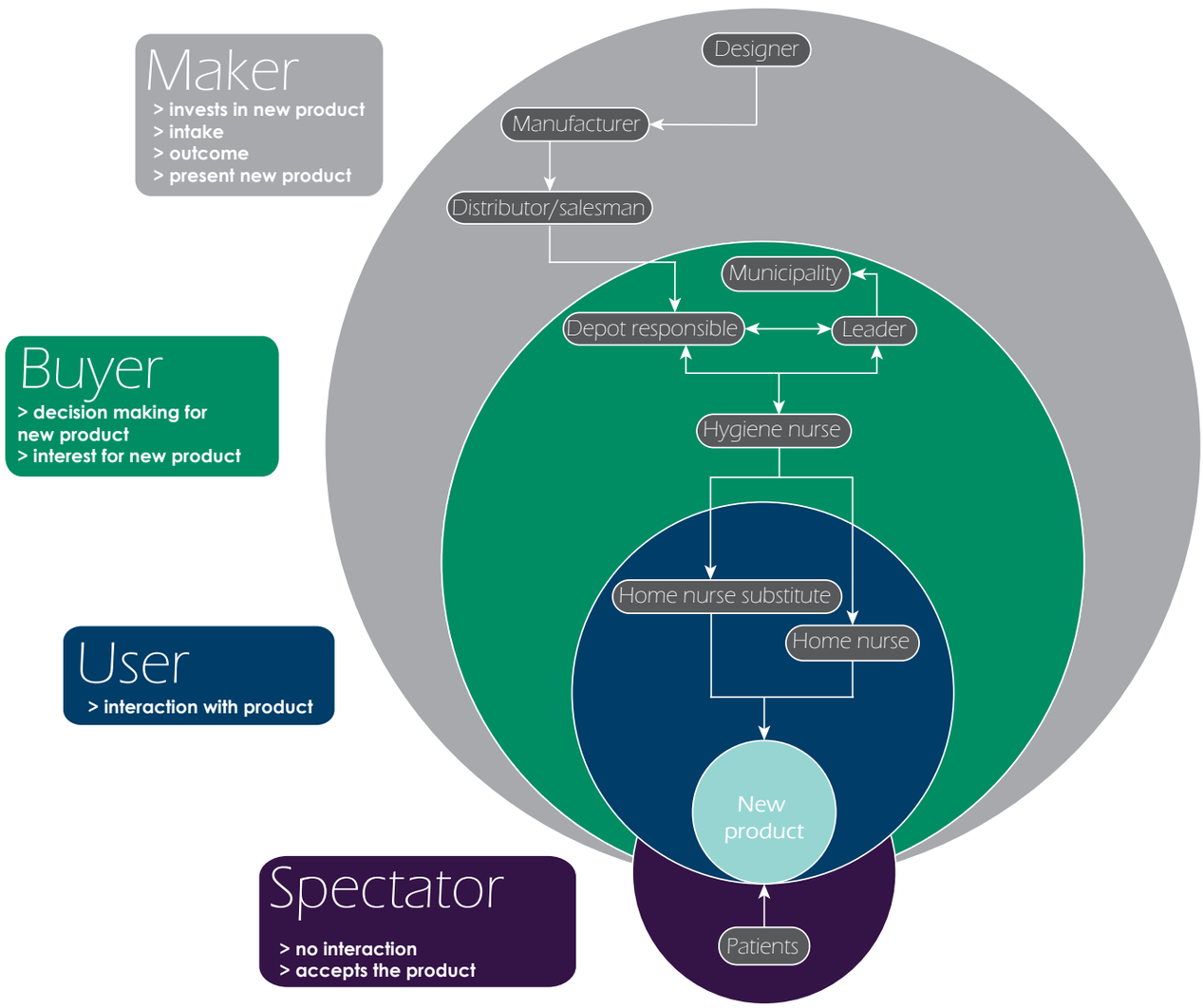
Transport by car

Ill. 24.1 - An illustration of the target group wearing their uniforms.

STAKEHOLDERS

From an interview with the depot responsible the different stakeholders are mapped (W36) to find out how many are in contact with the product. The stakeholder map is divided into different circles. In the outer ring there are all the people who are in relation to make/manufacture the product. In circle number two is the buyer of the product and in number three is the user.

To implement a new product a salesman will visit the depot responsible and in cooperation with the hygiene nurse they approve the new product. The leader has to approve the budget and the municipality pays for the investment.
The hygiene nurse informs the nurses about the new product (via email).
The patients do not interact with the product, but they have to accept the product and that the home nurses are using it in their homes.

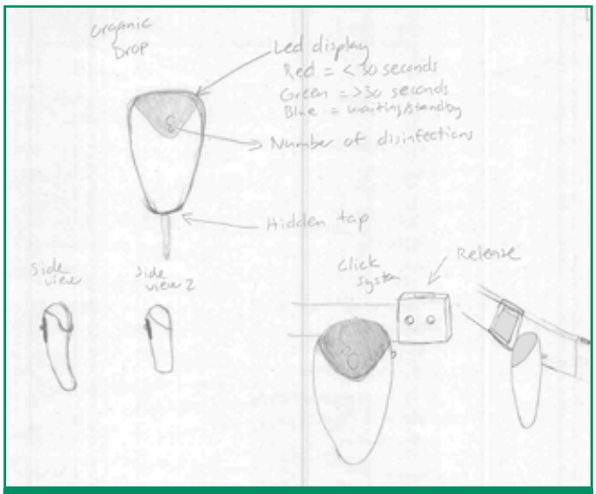


Ill. 25.1 - The stakeholders

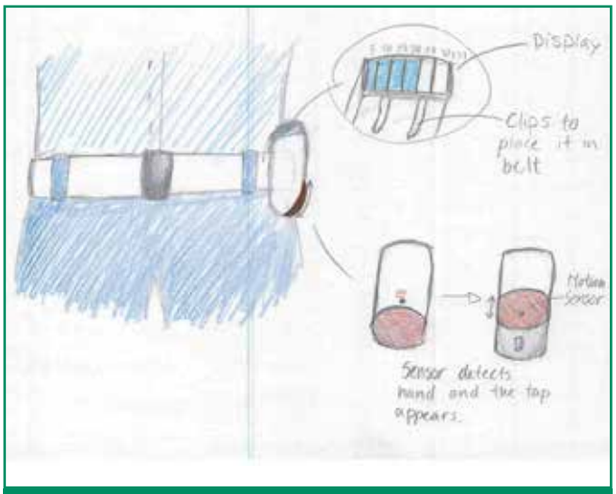
IDEATION 1.1

New ideation (W25) based on ideation 1.0. The two concepts being sketched on were the wearable on the chest combined with a dosage control, and the wearable in a belt combined with a display and protection of the tap.

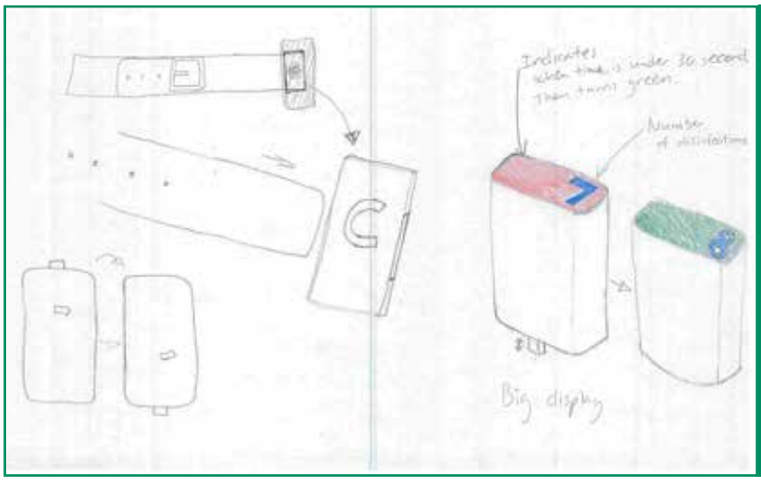
CONCEPT 2



Ill. 26.1 - An idea for the belt concept where an indicator on top counts number of disinfections and shows different colors.



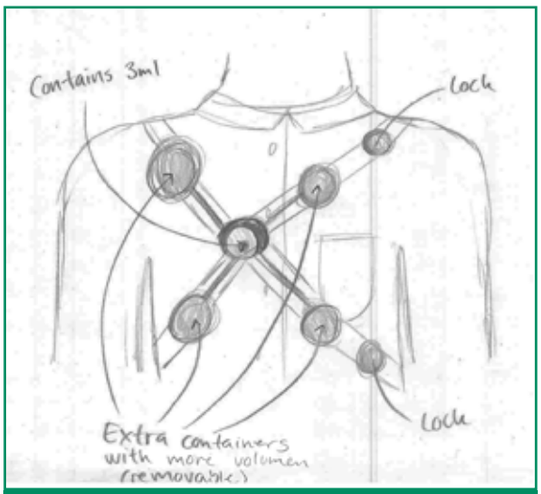
Ill. 26.2 - A concept placed in a belt where the tap is hidden and a display on top counts down from 30 seconds.



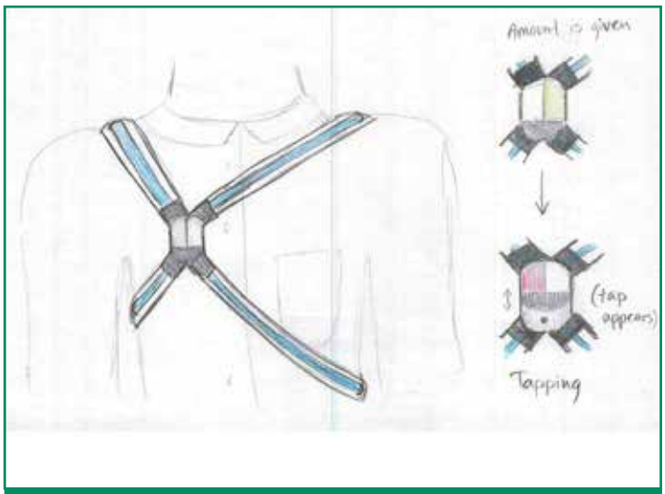
Ill. 26.3 - A concept that is mounted on a belt by turning it in the path. A colored display shows when the home nurse has disinfected for 30 seconds while counting the disinfections.

THE BELT CONCEPT SHALL

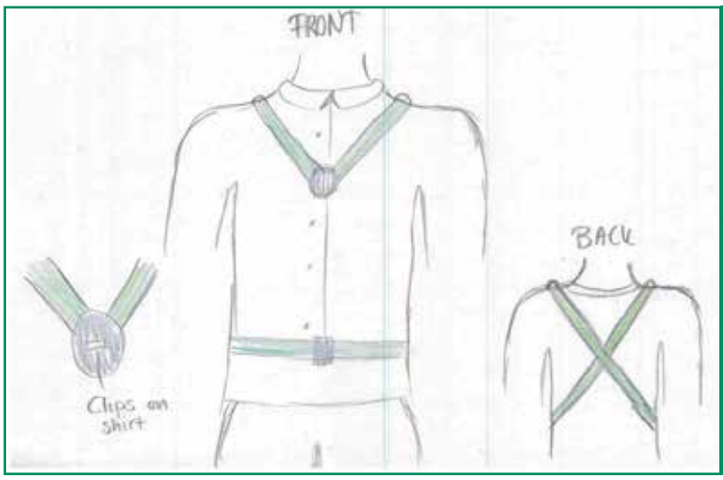
- **Include the belt**
- **Have an organic shape**
- **There should be a display on top**
- **The display shall change color**
- **The tap will be hidden**
- **Must be on the outside of the shirt**
- **The way the container is fastened to the belt must be developed**



Ill. 27.1 - A version of the chest concept where small containers of gel is placed in a harness.



Ill. 27.2 - A hidden tap that appears when the hand is moved below it.



Ill. 27.3 - An idea for the chest where the device is clipped on the shirt and fastened around the waist.

THE CHEST CONCEPT SHALL

- **Have visible gel**
- **Gel inside the straps**
- **Strapped around the torso**
- **The device contains 3 ml gel**
- **The straps will be closed with for example velcro, buttons, click system, bra closure or be one size**

The concepts were hard to detail because there were a number of unknown factors like the size and shape of the uniforms. Feedback from the home nurses were needed to get an idea if the directions were good. The concepts needed to be made into models to get a better understanding of them.

TESTING THE PLACEMENT

The placement is optimal at the middle (Ill. 28.1) and top of the torso (Ill. 28.3), these solutions gave the best naturally workflow because they were easy to reach. The device will affect the work when it is placed in the bottom (Ill. 28.2) - The movement will be awkward when reaching for it during work. When reaching for the device in the bottom of the torso the arm gets more twisted which it not a good repetitive movement when working. The rest of the test can be found in worksheet 26.

Ill. 28.1 - The middle of the torso is easy to reach and gives a natural workflow.

Ill. 28.2 - The movement of the arm when reaching the bottom part of the torso gives an akward hand position.

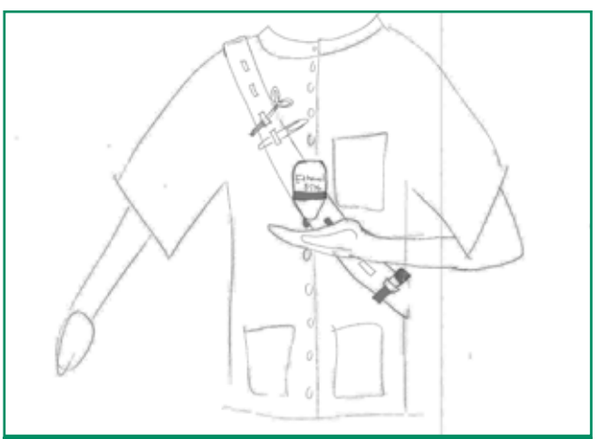
Ill. 28.3 - The top of the torso is easy to reach and when placed to one of the sides it is not in the way.

IDEATION 2.0

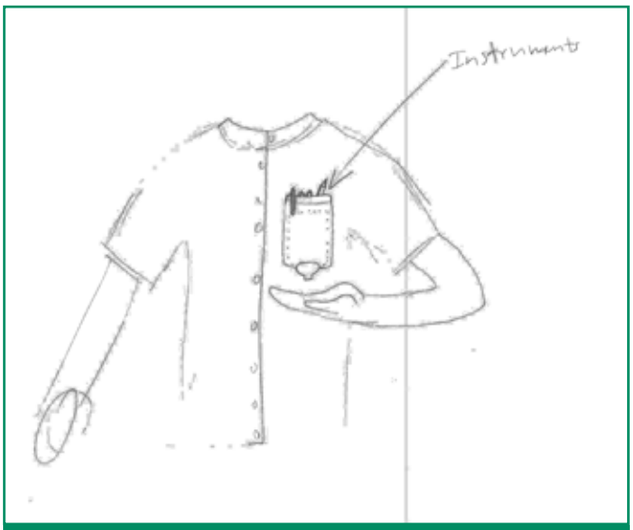
This ideation (W27) was created to spread out the ideas. Five focus areas were chosen to give inspiration and an open one for the other ideas.

- Dentist
- Handyman
- Archaeologist
- Diving equipment
- Military equipment or firefighter
- (Freestyle)

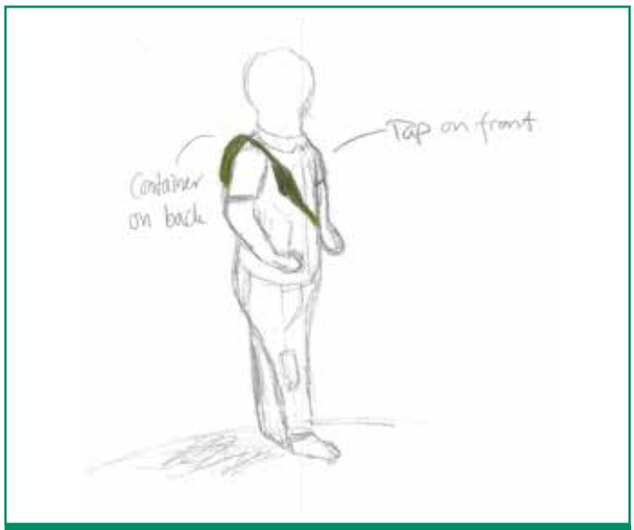
Ill. 28.4 - A concept inspired by a dentist where the product is wrapped around the body like a snake.



Ill. 28.5 - Also a concept inspired by a dentist where all the home nurse's equipment is placed in the concept instead of in the pockets.



Ill. 29.1 - A concept where the container of gel is placed in the front pocket of the uniform.



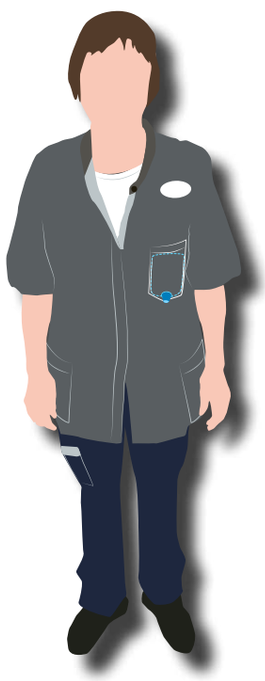
Ill. 29.2 - A concept inspired by a diver, where the home nurse has a big container on the back and a tap in front for easy access.

The chosen areas were very similar, because the focus was on belts and ways to store the equipment. Some ideas were not going to work according to the work regulations. The ideas were also very similar to the ones from ideation 1.0 and 1.1. It was difficult to find new places to place the container, that did not limit the workflow of the home nurse.

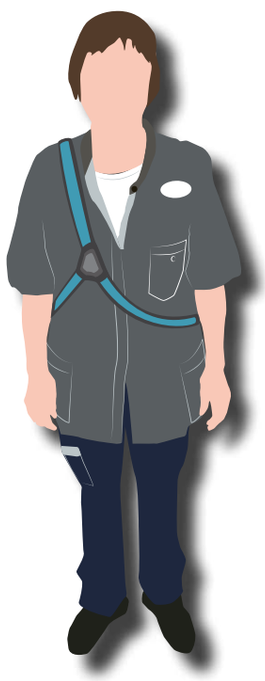
A new concept was chosen from the ideation, where the container is placed inside the chest pocket (Ill. 29.1) and a tap comes out of a small hole in the pocket.

Next step was to make physical models of the three concepts and present them for the users and get feedback.

BELT CONCEPT



POCKET CONCEPT



CHEST CONCEPT

FIELD STUDY 2.0

In field study 2.0 (W23) the three concepts were presented with mock-ups (W28, W29, W30).

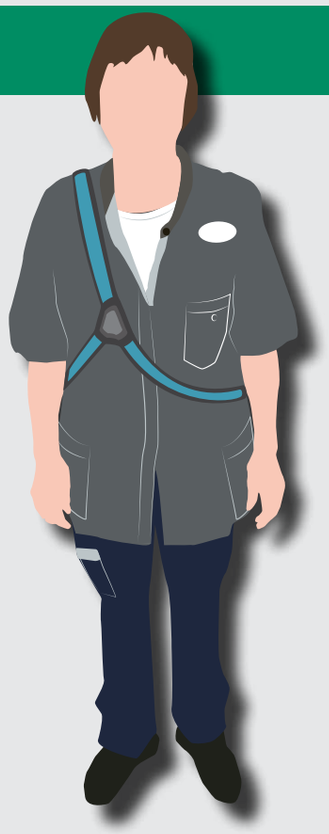
BELT CONCEPT

Ill. 30.1

Ill. 30.2

FEEDBACK

- It covers minimum one pocket.
- It might be too big when sitting down.
- It would be smart to have a new container each day.
- Good idea with countdown display (30 seconds), but not count number of disinfections.
- It should be small so it does not affect their work.
- Can cause a problem when going out and in of car.



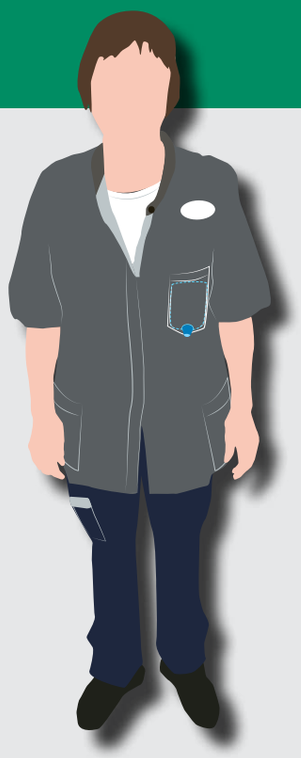
CHEST CONCEPT

Ill. 30.3

Ill. 30.4

FEEDBACK

- When working it is easy to have it in this position.
- It needs to be fasten to the shirt.
- What about when wearing a jacket?
- Could it be a one-time solution for each day?
- A new thing in their habits.
- The shape should be different, so it does not stick out.



POCKET CONCEPT

Ill. 31.1

FEEDBACK

- The chest pocket is small in some uniforms, but can be placed in another pocket.
- Will the tap get infected?
- It can point downwards or outwards.
- The best solution, but it has to be flexible.
- If it is placed inside a pant pocket it would be difficult to reach when standing.

EVALUATION

It might just be a question of getting used to this extra equipment.

It can be integrated into their work day and work procedures.

They are used to doing things a certain way.

How big is the container with all the electronics inside?

Maybe reevaluate if it should contain 200-250 ml alcohol gel.

The benefit of having an external device is that it does not have to fit a certain uniform.

The pocket concept is not universal enough and is discarded.

BODY ZONES

In order to find out which body areas are free when working, and thereby a possible place for the container to be fastened, the body zones are mapped (W60).
There were a number of things to consider; the jacket the home nurses are wearing between the visits, the apron they are wearing when dealing with wounds, and when they are sitting down and driving a car.

Ill. 32.1 - The see-through apron the home nurses are wearing (left) and an example of a jacket they wear between visits.

Ill. 32.2 - Free areas are the knees.

Ill. 32.3 - Free areas are the upper arms and the torso.

Ill. 32.4 - Free areas are the upper arms.

Ill. 33.1 - Free areas are torso and the upper arms.

Ill. 33.2 - Free areas are the upper arms and the torso.

Ill. 33.3 - Free areas are the upper arms.

Ill. 33.4 - No free areas that are easy reachable when wearing a jacket.

Ill. 33.5 - The torso becomes free and accessible when wearing an open jacket.

CONCLUSION

The upper arms and shoulders are free when they are not wearing a jacket.
It is important for the home nurse to disinfect her hands when wearing an apron, because it happens when treating the patient.
They probably have the apron on for a longer period of time than the jacket.
They already have their gel bottle inside the jacket in their uniform pocket, so it will not be a problem with space underneath the jacket. They also have their pen-equipment in the chest pocket underneath the jacket.
The neck is somewhat accessible, but not visible and there could be a danger of choking and feeling like a dog with a collar on.
The feet and knees are not accessible when standing, so it will not be used.
The lower arms need to be free all the time. The jacket actually prevents this.

The upper arms are accessible with and without the apron on. ▲

The apron is the most important thing to consider, because it is where the patient care is happening ▲

INITIAL DEMANDS

The conclusion on this phase ended with the initial demands (W33) for the product. The demands are very generel, as the direction and concept were not chosen yet.

DEMANDS FOR CONTENT

Gel: Alcohol 80-85% (v/v) (= 74-80% (w/w)
Dosage is 3 ml
Must rub in for 30 seconds
Must contain some water
Must contain a skincare element (fx. glycerol 1-3%)
Cannot be in spray form
Must make the hands clean (eliminate 99,9 % of the bacteria)
Must contain an element that makes it undrinkable (isopropanol or denatoiumbenzorat)

DEMANDS FOR CONTAINER

Dosing the wanted amount of sanitizer without splash or contamination from the environment
A sticker to tell the user it is the sanitizer
The container must be secured to the body
The container must not prevent the user from doing their work

DEMANDS FOR DISPLAY

Indicates when 30 seconds has passed
Visible in daylight and in darkness
Can be easily sterilized
Visible when working
Integrated part of the container

WISHES FOR THE EXPERIENCE (BEHAVIOUR)

Flow in the work procedure

Reminding them to disinfect

Encourage them to disinfect correct

WISHES FOR DOSAGE

Only possible to give the right dosage (3 ml)

The dosage must be touch free

Only give gel when the user wants it

WISHES FOR STORAGE

Can contain enough gel for an entire work day

Container should be placed so the user has easy access during a task

WISHES FOR STERILITY

Must not be stored in unhygienic environment

Must be touch free

Must not require touch after disinfection

Container can be sterilized after use

Container must be sterilized, if refilled

03. MARKET

INTRO

The market for the hand sanitizers were explored by looking at existing products, but also looking at products within the same area for example soap dispensers. The findings were used to find the market potential for the new product. This phase also presents the partners that Pure Hands will work with to launch the product and the business model canvas is build on the cooperation with these partners. Furthermore it was investigated what all of these infections caused by bad hand hygiene costs the society to estimate how much money can be saved on the problem,

COMPETING PRODUCTS

The market of sanitizers were explored to see what products were out there. The products were investigated and the positive and negative things were found for each product. The full research can be seen in worksheets 9 and 13.

Yellowone Handsafe	+	-
 Ill. 36. 1 - Wearable dispenser placed in pocket of uniform	• Designed to have in a pocket • Convenient • Portable • Hand powered	• Does not give 3 ml in two pushes like stated • Not refillable • Not enough disinfecting gel for 1 workday (only 75 ml) • Can only be placed in a pocket • Hard to place in the pocket without pressing • The angle of the spray is not good • The pocket needs to be the right size

Ceduren	+	–
 Ill. 37.1 - Current solution	• Small • Portable • Hand powered	• Not handsfree • Not refillable • Time consuming • Not enough disinfecting gel for 1 workday (120 ml) • The bottle gets infected • No dosage control • Opens by pushing down a lid and squeezing the gel out

Pump dispenser	+	–
 Ill. 37.2 - A pump	• Portable • Hand powered • Dosage control • Disposable	• The pump can contain bacteria • Needs to stand on a stable place • If it is not pressed all the way down the dosage will be wrong • Harder to use with one hand

Handsfree walldispenser	+	–
 Ill. 37.3 - A touch free walldispenser.	• Hands free • Hygienic • Visible • Intuitive • Refillable	• Foam is not as effective as gel or liquid • Non portable • Hard to know if the correct dosage is used • User might touch it • Uses batteries

There is different solutions for different situations. The dosage control is important so the user knows that they are disinfecting the hands correctly. The positive things from the products that are taken from this are:

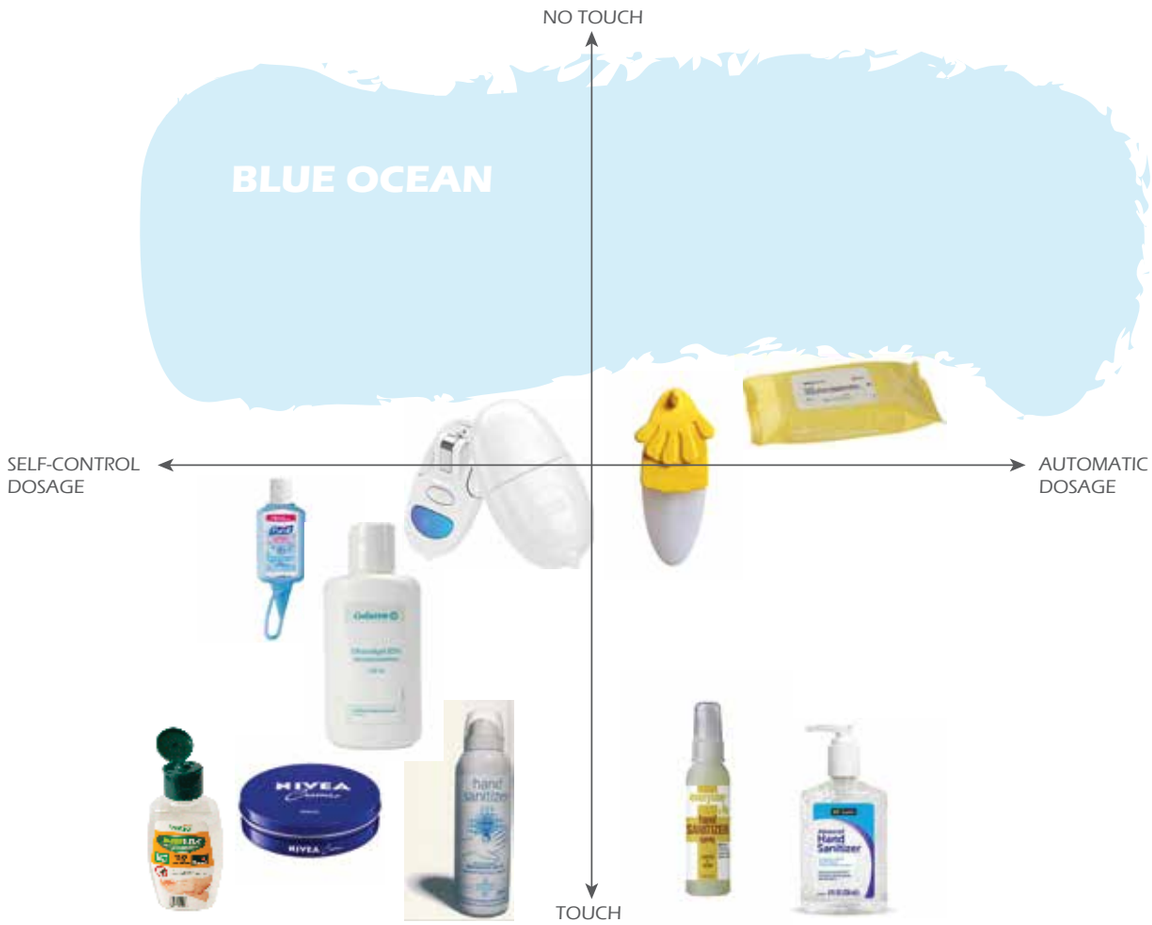
- Dosage control
- No lid that needs to come off
- Handsfree/elbow served
- Precise spray

It will make sense to look into the competing products again when the concept has been chosen.

The analysis made the foundation for the blue ocean canvas (W13).

MARKET POTENTIAL

Based on the research and findings the market potential was in designing a device that was touch free and had automatic dosage (Ill. 38.1) while still being portable. The products on the market lacked the dosage control. Even though the YellowOne Handsafe claimed to have a dosage control of 1.5 ml per push, it was not correct. One push gives less than 1 ml and therefore it cannot be trusted to give the right dosage.



Ill. 38.1 - An illustration of the market potential space within the competing products.

THE PARTNERS

To be able to get into this market some partners were needed for Pure Hands. It was estimated that it would be difficult to go against Nordic Sense and Mediq Denmark who are the manufacturer and distributor of the current solution "Ceduren". Therefore the two were chosen as partners. Mediq Denmark is the salesman in the setup and they already have a contract with at least one municipality. Nordic Sense will be able to help with the development of a future product and get it ready for the market. They have knowledge about production that can be valuable to Pure Hands.

PURE HANDS

Pure Hands is a startup company established in 2018. They have developed a new product to optimize hand hygiene for home nurses by providing correct disinfection. Pure Hands wants to reduce the overall cost in the health sector by making disinfection more accessible when working as a home nurse. The product is convenient and trustworthy, because it gives the right guidance to kill 99.9% of the bacteria on the hands. Pure Hands also provide motivation to do hand hygiene because the product secures a correct hand disinfection.

Ill. 39.1

NORDIC SENSE A/S

Nordic Sense is a Danish company which has existed since 1982. They develop, design and manufacture products for personal care. (Nordicsense.dk3, n.d.)
Their products are allergy friendly and environment friendly. The products are in high quality which Nordic Sense clarify as uniformly products and products that follow trends in expression, form and function.
Nordic Sense makes sure that their manufacturing is environment friendly with solar power cells and separation of waste. (Nordicsense.dk2, n.d.)
Nordic Sense offers close cooperation with their users, customers and partners when developing and testing products to secure an optimal result. (Nordicsense.dk1, n.d.)
Nordic Sense manufactures the disinfection bottles and the gel the home nurses are using today.

Ill. 39.2

MEDIQ DANMARK

Mediq Group is a global distributor of medical equipment in the health sector in 13 european countries. Since 1979 Mediq Danmark has delivered products for hospitals, nursing homes, home nursing, clinics etc. Some municipalities in Denmark have a contract with Mediq Denmark to provide products. They want to be the leading collaborator when it comes to strengthen the Danish citizens' health. They provide effective products and guidance to use them. (Mediqdanmark.dk, n.d.)
Mediq Danmark supports non profit foundations because they want to joint the responsibility for the world we are living in. (Mediqdanmark.dk, 2018)

Ill. 39.3

THE BUSINESS MODEL CANVAS

The business model canvas is made for Pure Hands and the relationship to the manufacturer Nordic Sense. Nordic Sense is a key partner for Pure Hands.
Nordic Sense will be assisting with the prototypes and the optimization of the product with their knowledge within the field along with their production equipment. All the business model canvases can be seen in worksheet 91.

DESIGNED FOR: PURE HANDS

KEY PARTNERS

Nordic Sense A/S

KEY ACTIVITIES

Problem solving

Development

KEY RESOURCES

Core knowledge

VALUE PROPOSITION

Compliance with standards

Development

Improvement

Competitive solution

CUSTOMER RELATIONSHIP

A tested solution

CHANNELS

Contract

CUSTOMER SEGMENTS

Nordic Sense A/S

COST STRUCTURE

Development time and prototyping

Usertesting

Optimization

REVENUE STREAMS

Monthly salary

Profit per sold unit

VALUE PROPOSITION

Pure hands offer a compliance of the standard regulations on the area of hand disinfection. They furthermore offer development and improvements that continue after the product is on the market. Finally they offer a competitive solution.

THE CUSTOMER SEGMENTS

Nordic Sense is a key partner, but also a customer, because Pure Hands are going to sell the solution and their competences to them. Nordic Sense will sell the product to Mediq Danmark, who is then going to sell the product to the municipalities.

CUSTOMER RELATIONSHIP

Pure Hands' relationship to Nordic Sense is that Pure Hands are presenting a tested solution that they can work together on to develop. This will be through a contract.

KEY RESOURCES

Pure Hands' finest resource is the knowledge gained in the project and from the user tests, interviews, survey and research.

REVENUE STREAM

Nordic Sense will pay Pure Hands a monthly salary from the contract is signed to the product is launched on the market. For every sold unit Pure Hands will get 5 percent in profit.

CONCLUSION

The business model canvas is "Plan A" where the contract with Nordic Sense is the way into the market. Nordic Sense already has a contract with Mediq Danmark and they are selling to the municipalities, where Mediq Danmark has a contract. They do not have a big profit, but they have a four year contract with the municipalities. Mediq Danmark does not have any innovative products, but they do have competitive products since they could have made that contract. The innovative product is what Pure Hands can offer.

WHAT DOES BAD HAND HYGIENE COST THE SOCIETY?

Bad hygiene has a high cost for each municipality, and that is Pure Hands task to reduce the cost by developing the new sanitizer. The outcome of implementing the new sanitizer to a municipality can be shown with the amount of money spend on infections.

A report from the municipality of Silkeborg estimates that they can save 14 mio. DKK in Silkeborg with better hand hygiene. (Daugård, 2015) The municipality of Silkeborg has 92.024 citizens. (Da.wikipedia.org, 2018)
Taking the 14 mio divided on 92.024 citizens the municipality can save 152 DKK on each citizen. The municipality of Copenhagen has the largest amount of citizens in Denmark with 613.288 citizens. (Da.wikipedia.org, 2018) This municipality can then save 93 mio DKK.
It cost the municipality for example 66.500 DKK to treat one patient with MRSA that has a long disease period. In average it costs 20.000 DKK per patient who is infected by MRSA in a normal disease period. (Arbo Frederiksen, 2017)

All municipalities in Denmark uses lots of money on treating patients with infections, therefore they can save money on implementing a better hand hygiene. The money saved can be a result on implementing a new sanitizer.

THE MULTIRESISTANT BACTERIA

The number of ill people caused by multiresistant bacteria has increased and it is one of the biggest threat to the society - especially to the weak and elderly citizens.
The Danish health minister says that there needs to be more knowledge in how the bacteria are getting spread between people.
The Danish government suggests that Statens Serum Institute gets 8 millions extra in 2018 together with the 500 millions they already get to develop the medicine and antibiotics. In 2021 the institute will get 16 millions extra. (sum.dk, 2017)

14 million DKK

..can be saved in the municipality of Silkeborg if the hand hygiene is improved.

93 million DKK

..can be saved in the municipality of Copenhagen if the hand hygiene is improved.

20.000 DKK

..does it cost to treat one patient with MRSA.

"It is not acceptable, that our citizens get ill by multiresistant bacteria. We have to take the threat seriously and therefore, with our welfare reserve, we want to prioritize, to eliminate the threat against us"

Danish health minister Ellen Trane Nørby

CONCLUSION ON PHASE

The market phase made the initial business case for the project. It was important to know which competing products were out there and what they could solve. The market potential lies in designing a touch free device that automatically dispenses the gel, but is still portable. The way to get this device into the market is by partnering up with Nordic Sense (manufacture) and Mediq Denmark (distributor) and thereby make the society save a lot of money.

04. CONCEPT DEVELOPMENT

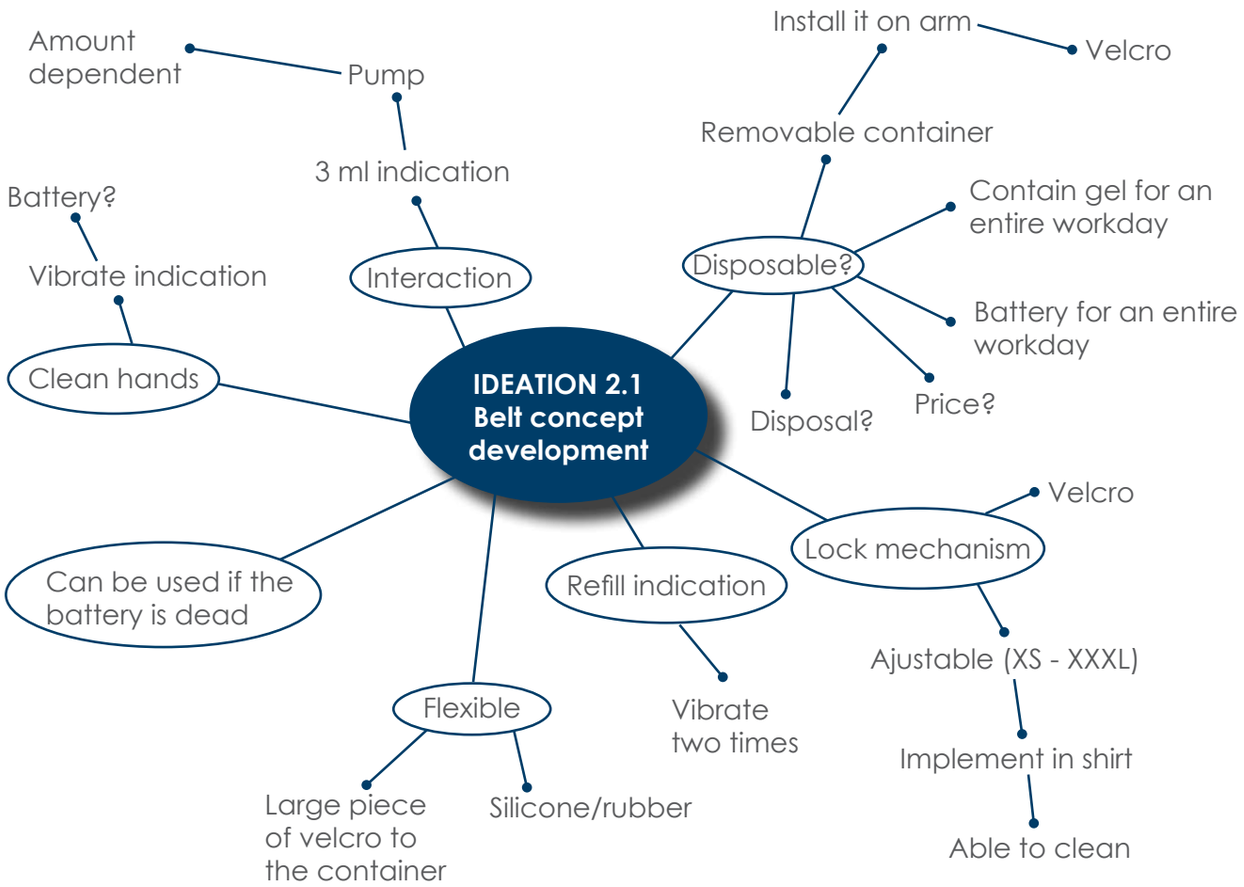
INTRO

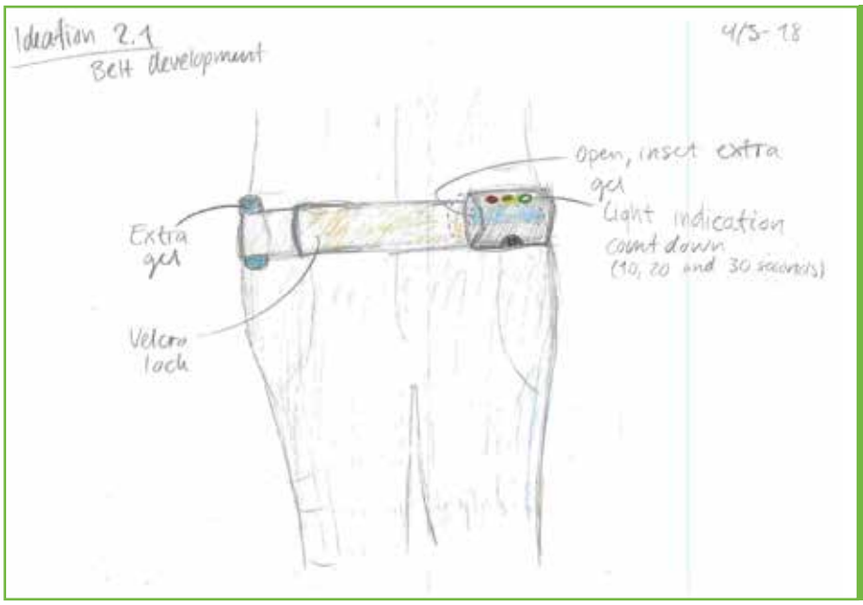
The concept development phase contains nine ideations that lead to chosing the final concept. The direction is changed a few times during this phase. The two concepts; the belt concept and the chest concept are both tested with multiple mock-ups and with the home nurses and finally one concept is chosen. The phase ends in the final criteria for the product.

IDEATION 2.1

Ideation 2.1 and 3.0 explores how to add extra value to the concepts by integrating more functions. The solution space was also explored. The complete mind maps can be found in worksheets 41 and 42. This is only the chosen functionalities.

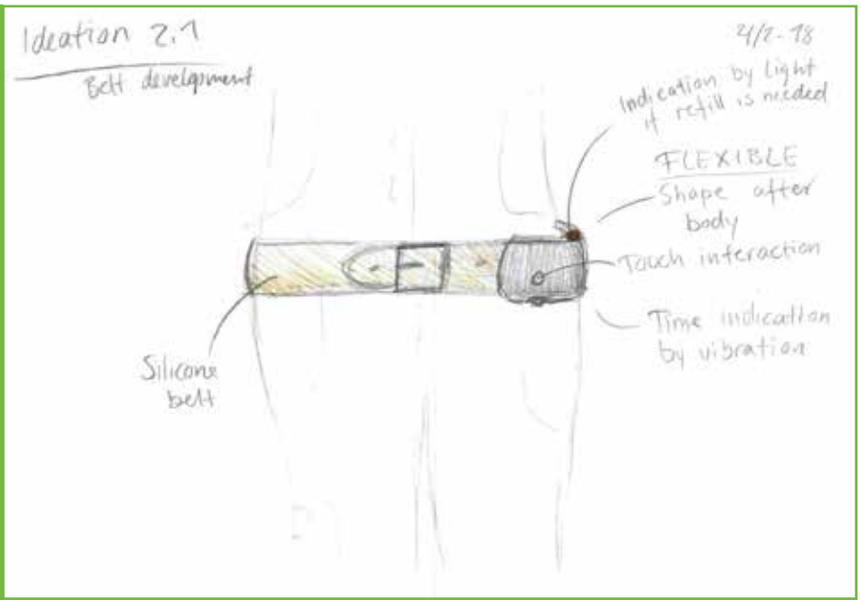
BELT CONCEPT DEVELOPMENT





Ill. 45.1 - An idea where extra cartons of gel is stored in the belt. There is a light indications that goes from red to yellow to green when 30 seconds has passed.

Ill. 45.2 - A silicone belt where the container is also flexible and forms around the body. The device has touch interaction and a vibration that tells the user, that 30 seconds has passed.



- ▲ **The container has to shape around the hip**
- ▲ **Flexible or soft material used for the belt**
- ▲ **Easy adjustment with velcro**
- ▶ **Light is difficult to see when the placement is at the hip**

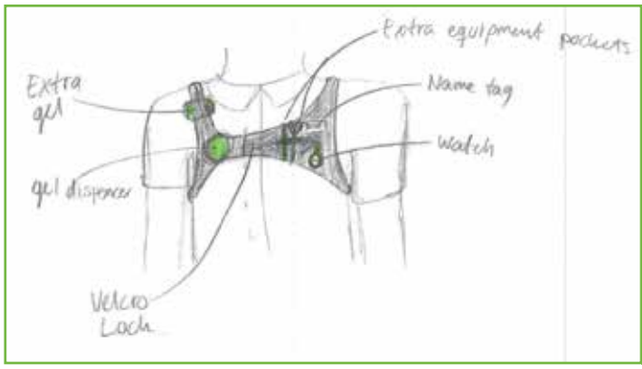
Vibration for indication is discrete and usable ▲
- **When the container is almost empty**
- **When 3 ml have passed**
- **When the hands are clean**

Disposable and contains gel for a entire workday ▲

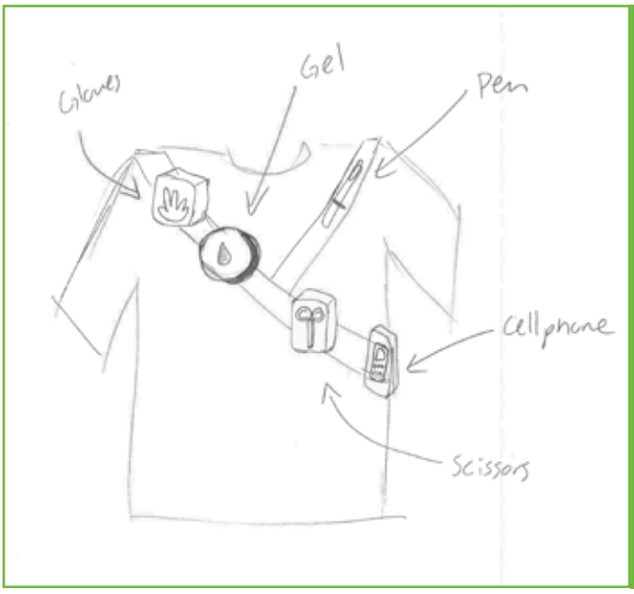
Container is movable so it can be placed on the arm ◀

IDEATION 3.0

CHEST CONCEPT DEVELOPMENT

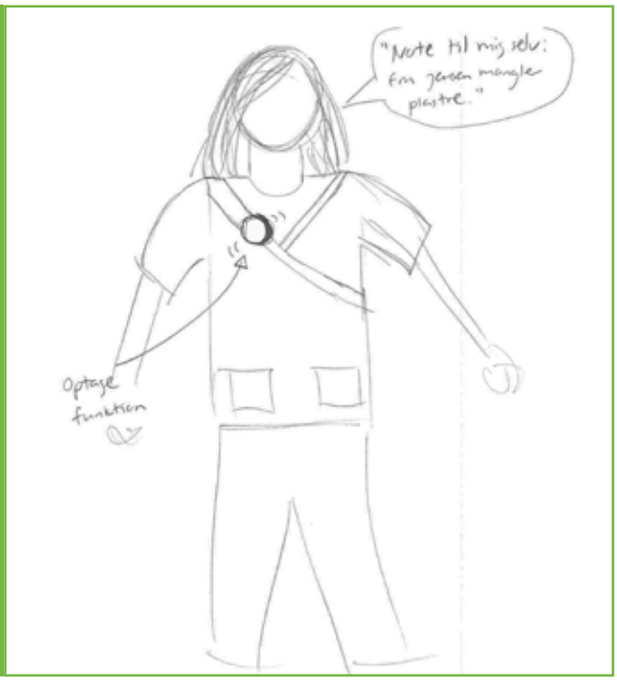


Ill. 46.1 - An idea inspired by a weapon west where all the equipment the home nurse needs is stored in. It closes with velcro and has a symmetric design. It also has extra cartons of gel.



Ill. 47.1 - Another solution where all the equipment will be placed in the new wearable part. It includes a small box for the scissors the home nurse is bringing.

Ill. 47.2 - An idea where the home nurse can use the gel device to record notes for herself instead of bringing a note book. This is to eliminate some of the stuff in the pockets and adding extra value for the home nurse.



▲ **Personal device to store other equipment like name tag, watch etc.**

▶ **Light indication:**
- **When the container is almost empty**
- **When 30 seconds have passed**
- **When the battery is getting low**

▶ **Double activation (touch + sensor)**

Some kind of buckle to close it ◀

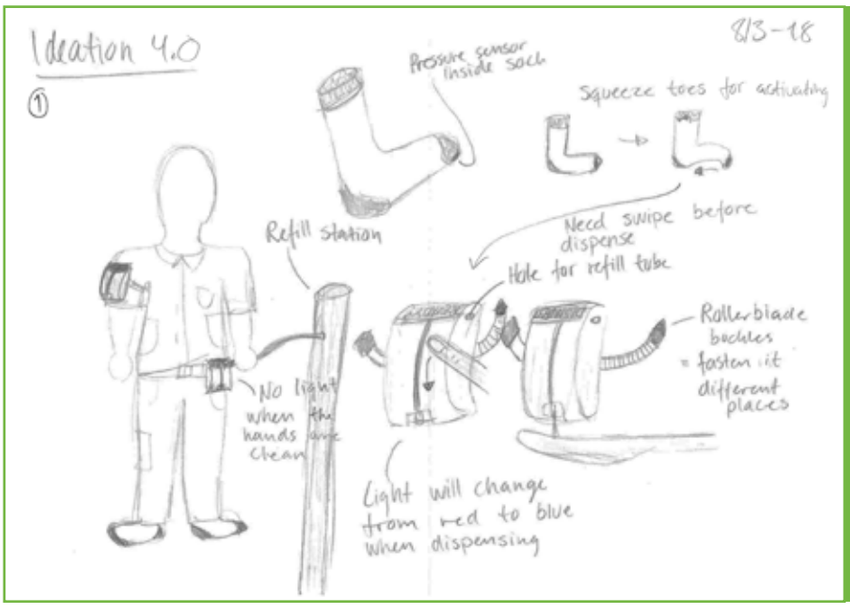
Container is refillable and has to be cleaned with the uniform ▲

Must not emphasize the breasts ◀

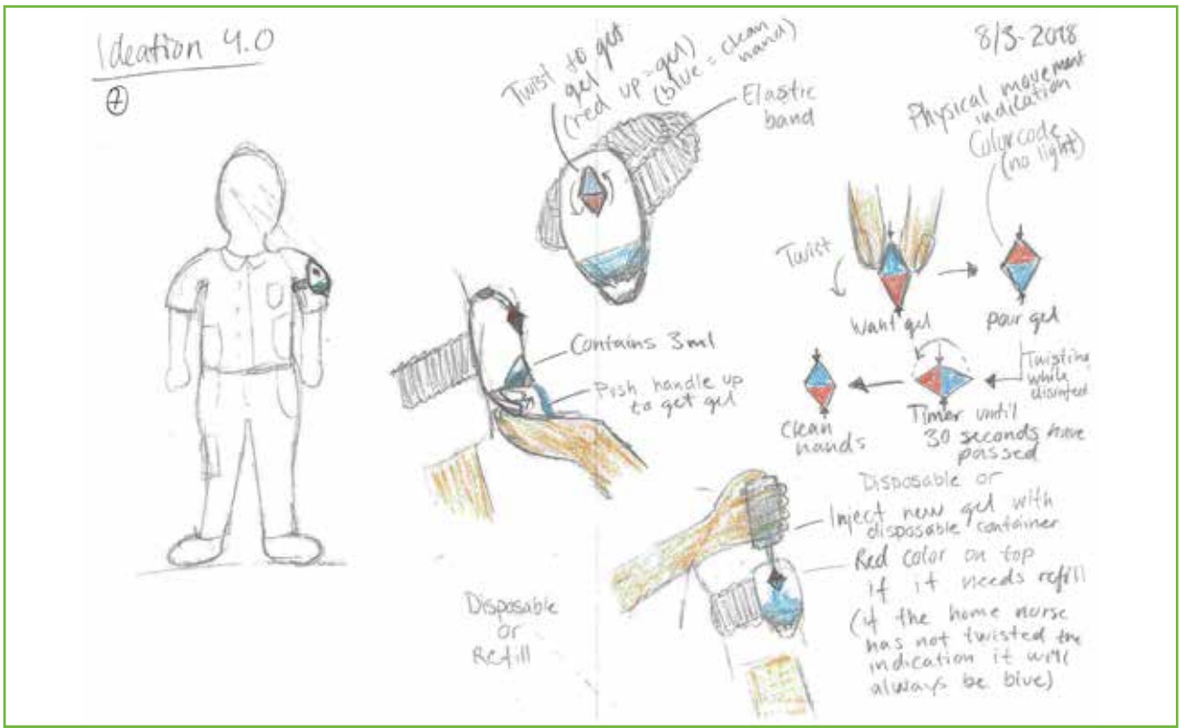
IDEATION 4.0

The purpose of ideation 4.0 (W44) was to combine the solution principles found in worksheet 43, where all the functions were investigated. In ideation 4.0 the selected functions were:

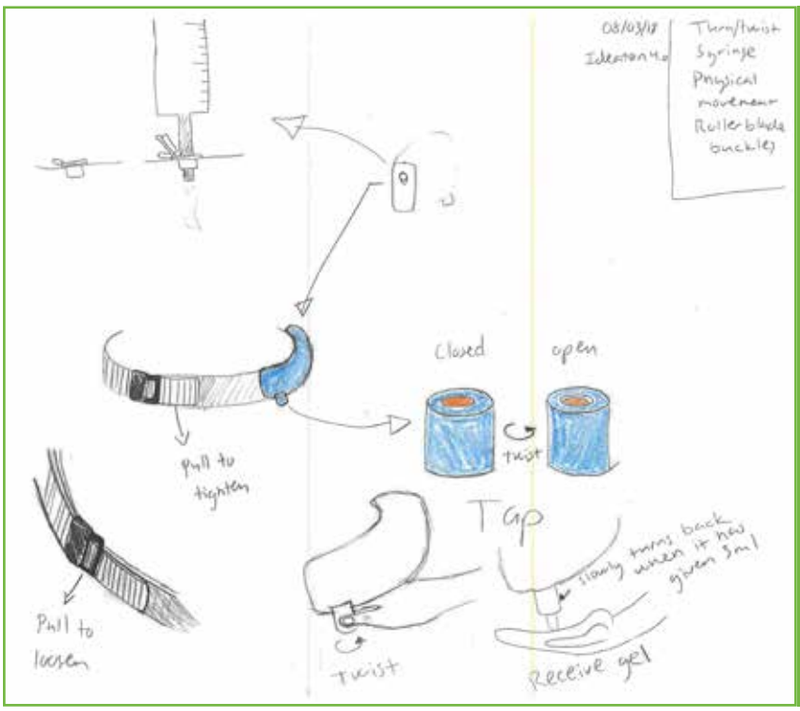
- Control of dosage
- Activation
- Refill or Disposable
- Indication
- No start when unwanted
- Adjustable in size



Ill. 48.1 - An idea where one activation is placed in the sock and the other on the device, where the user will slide to get gel. The device can be moved from the belt to the arm. The device will light up when activated with the foot.

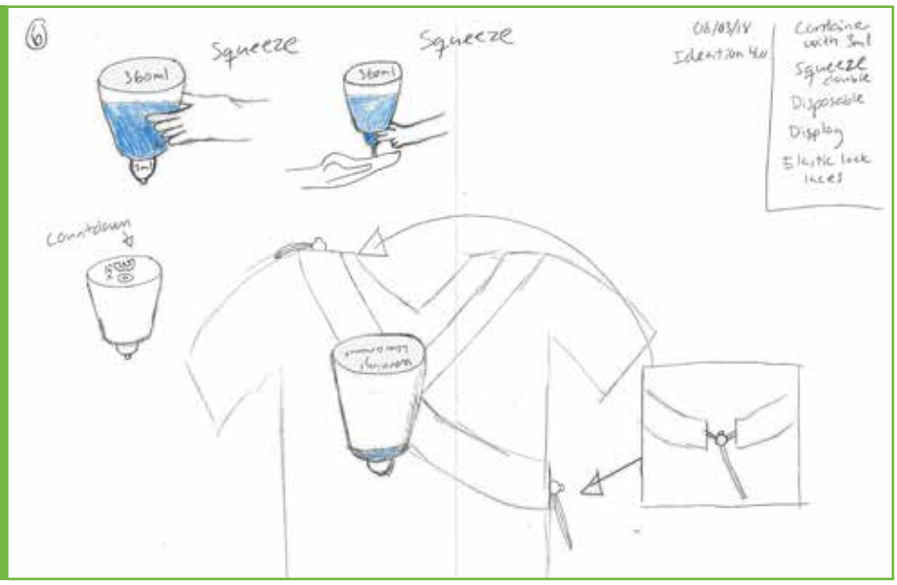


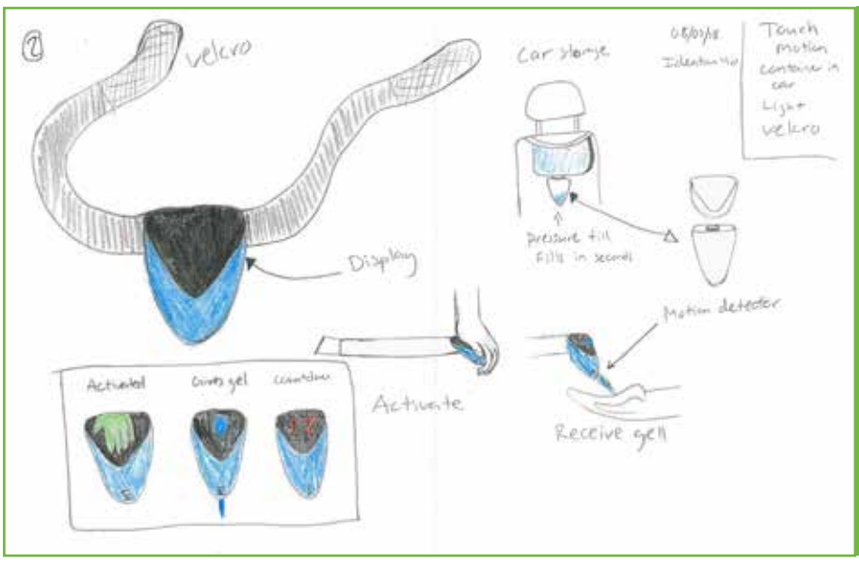
Ill. 48.2 - A concept inspired by a egg timer where the user will turn a button first and then push a handle to get the gel. The egg timer button also functions as a countdown for the 30 seconds. The device is placed on the arm and can either be disposable or refilled.



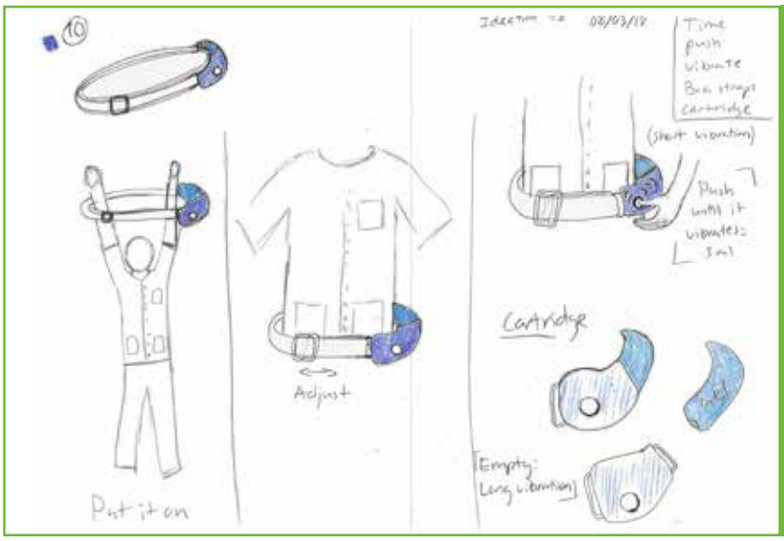
Ill. 49.1 - A concept with a tap that has to be twisted before it opens - like on a drinking bottle for sports. The device is placed in a belt that has a rollerblade buckle to close it. The container will be filled with a syringe. The tap automatically closes by slowly turning back when the gel is disposed.

Ill. 49.2 - A concept with a double activation where the user first squeezes the big container and then the small container to get the 3 ml of gel. The device is placed on the chest wearable part, that closes with lock laces and can be adjusted.





Ill. 49.3 - A concept placed around the hips that closes with velcro. The device also has double activation where the hand needs to be placed over the screen before the motion sensor below can registre the hand and give gel. The screen also has a countdown.



Ill. 50.1 - This idea is meant to be put on over the head and can be adjusted like a bra strap. The device has a button that needs to be pushed until it vibrates and then it gives 3 ml of gel. The device has a changable cartridge and it gives a long vibration when it is empty.

From all of the ideas from this ideation the best solution principles where chosen and gathered to three different concepts:

CONCEPT 1.1 - PUSH & VIBRATE

Bra strap and closing
Belt placement
Cartridge refill
Moveable to upper arm - how?
Vibrate to indicate (different vibration patterns)

- Time
- Empty

CONCEPT 2.1 - SQUEEZE SQUEEZE

Changing light
Visible gel
Chest placement
Moveable to upper arm - how?
Refill in car
Lock laces

CONCEPT 1.2 - KITCHEN TIMER/EGG

Velcro closing
Belt placement
Safety lock refill (like lighter)
Vibrate to indicate 30 seconds and empty
Egg timer inside
Moveable to upper arm - how?

By using the solution principles found by Tjalve (2003) the sketches got more detailed in the interaction when putting it on and adjust the size, activating the device and refilling it etc. Next step was to create mockups to illustrate the principles for each concept. The three concepts were created by mixing solutions from sketches which gave a more final concept.

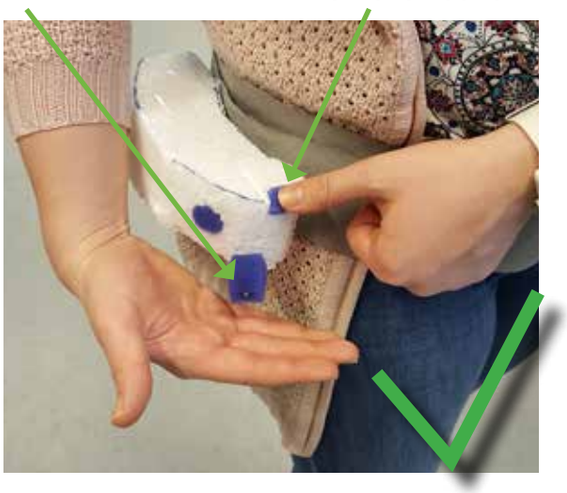
MOCK-UPS AND TESTS

Mock-ups were made of the concepts to test various things. Some of the things that were tested were the placement of the activation for the belt concept, the activation for the chest concept, the mounting for the chest concept and the size of the container for the chest concept.

Through the tests with the belt concept it became clear that concept 1.2 Egg timer would not be possible to have on the arm, because two hands were needed to get gel. The tests can be seen in worksheets 45, 46, 47 and the evaluation in worksheet 53.

THE BELT CONCEPT

Ill. 51.1 - The belt concept mock-up was made in flamingo and contained gel enough for a whole work day (360 ml). The belt was closed with a bikini buckle.

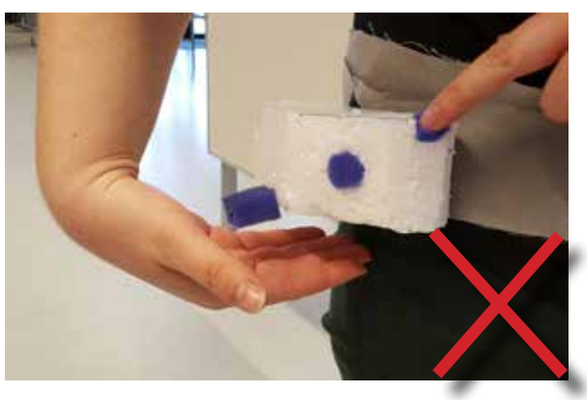


Ill. 51.2 - The activation and the tap is close to eachother and visible for the user. Both arms are in comfortable positions.

On the arm

Ill. 51.3 - The activation works on the arm where only one hand can be used to activate and receive gel.

Ill. 51.4 - The tap is too far away from the activation. The shoulder is very twisted before the user can reach the button.



Ill. 51.5 - The right arm is in a very akward position to reach the gel. There is a lot of pressure on the velcro when pushing with a finger.

THE CHEST CONCEPT

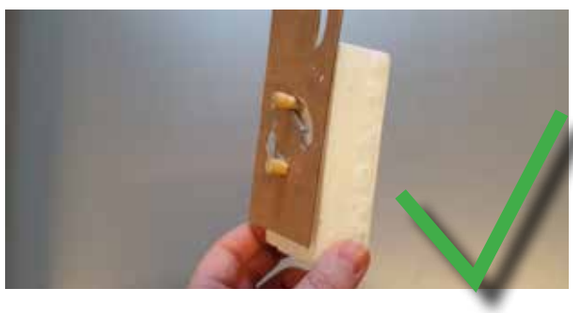
SQUEEZE TEST

Ill. 52.1 - The interaction is based on a squeeze on the big container and then the small that contains 3 ml.

Ill. 52.2 - The squeeze is most comfortable from this angle, because the elbows can relax and it creates no awkward positions for the arms.

MOUNTING TEST

Ill. 52.3 - The mounting was tested with a linear and a rotating mount. The rotating mount created the best illusion of that the container was mounted tightly and would not fall of.



Ill. 52.4 - The mounted container in a rotating mount.

CONTAINER VOLUME TEST

Ill. 52.5 - The different volumes of the container.

Ill. 52.6 - Very big container that gets in the way of the work. The arm gets twice as thick when placed there.

Ill. 52.7 - Good size for the chest. It is not in the way. Also a good size on the arm. It follows the arm.

MORE TESTS

ANGLE OF TAP

To find the optimal angle the gel comes out, a test was conducted. The test consisted of a syringe with 3 ml gel and a cardboard with angles with an interval of 10° from 0° to 90°. The full test can be found in worksheet 49.

#	Degree [°]	Comments
1	90	Rotation in torso - awkward position to get gel. Hard to reach and see where the tap is placed.
2	80	Same as in test 1
3	70 ✓	Good angle for the beam of gel into the palm.
4	60 ✓	Same as in test 3
5	50 ✓	Same as in test 3
6	40 ✓	Same as in test 3
7	30	The position of hand is moved to the front of the torso.
8	20	Same as in test 7
9	10	The hand needs to be curved to catch the beam of gel. The beam is almost vertically.
10	0	The beam is too vertical.

Ill. 53.1 - The hand that holds the cardboard does not illustrate the position when using a concept. It is only the right hand that illustrate the position when dispensing.

The tap with an angle of >80° is difficult to reach with the palm. From 70° to 40° the beam of gel is easy to catch with the palm. In angle 30° and 20° the position of the hand is more ergonomic because the torso has minimum rotation. When the angle is <10° the hand needs to be curved because the beam is vertical.

The test was only for one angle in 3D, so the other angle needs to be tested as well. The tests can position the tap on the concepts placed on a belt. For the chest concept the angles also need to be tested.

▲ **An angle between 20° and 30° is best suited for the belt concept**

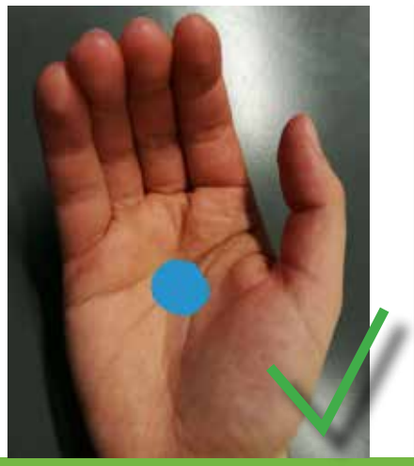
▲ **An angle from 40° to 70° is best to hit the palm of the hand**

The angle needs to be tested in the other direction and with the chest concept ◀

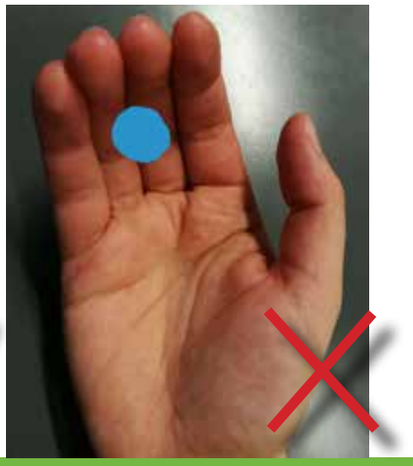
GEL IN HAND

A test was conducted to find out how the gel can be disposed the best way - in the palm or can it be disposed between the fingers? For the full test see worksheet 50.

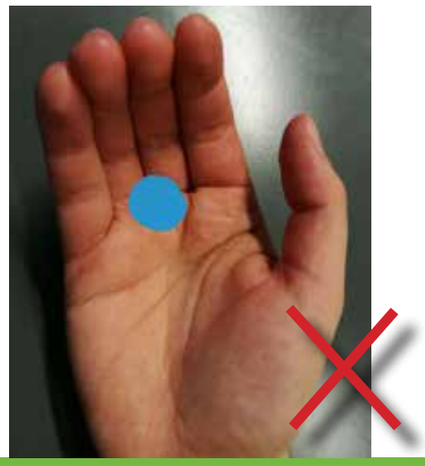
Ill. 54.1



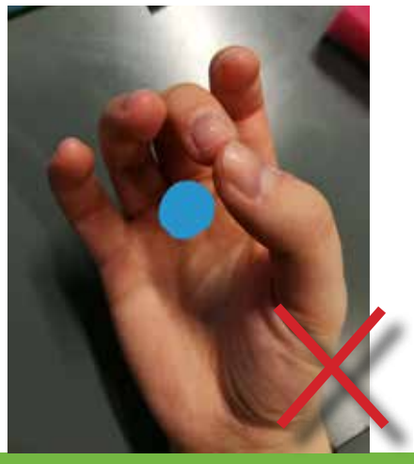
Ill. 54.2 - Control. Plenty of room for the gel in the palm. The palm creates a nice "bowl" for the gel.



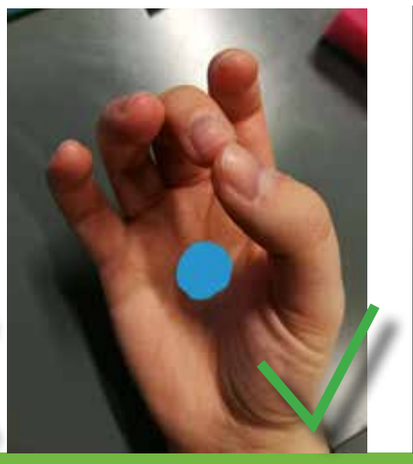
Ill. 54.3 - Must secure that the fingers are closed tightly. It slips through the fingers.



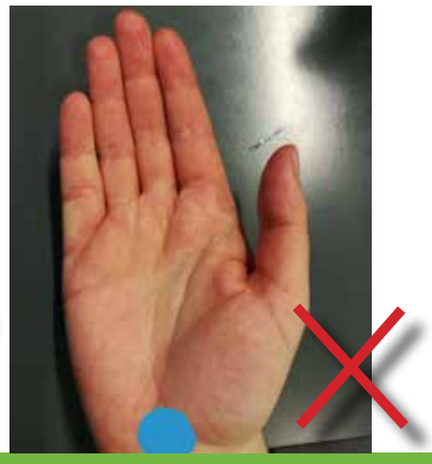
Ill. 54.4 - There is a bump where the gel is placed, so it can either go down to the fingers or into the palm. The feeling is a bit uncomfortable because the outcome is unknown.



Ill. 54.5 - Very uncomfortable. No control of the gel. It slips through the fingers.



Ill. 54.6 - Still a secure feeling because of the bowl. The fingers' position are not important, when the gel can land in the palm.



Ill. 54.7 - Uncomfortable and the gel slides to the palm but could easily slide the other way if the hand is tilted just slightly.

▲ **The palm is the best place to put the gel because it creates a small bowl.**

It takes extra effort to keep the fingers tight together. ▲

▲ **It is natural to move the gel to the other hand when the gel is secured in the palm on the first hand.**

The fingers' position when the gel is disposed in the palm is not important. ▲

FIELD STUDY 3.0

The purpose of field study 3.0 (W57) was to test all the mock-ups that were made of the two concepts. It was very important to involve the target group because they are the ones that will use and wear the products everyday. The mission was also to motivate the home nurses to disinfect more and therefore the concept must be approved by them.

CHEST CONCEPT USER 1

FEEDBACK
"Smart solution."
"Is it in the way when I put my jacket on?"
"I cannot feel that I have it on."
"Do I take it off when I put on my jacket?"
"The functionality is the most important thing."
She likes that she can place the other equipment on the concept as well.

Ill. 55.1

BELT CONCEPT USER 1

FEEDBACK
"Too big when wearing the jacket (with the placement on the side of the hip). Too big in general."
"I need to get to my phone in the right pocket. The container is blocking this. "
"Maybe I could move my phone to the other pocket."

Ill. 55.2

BELT CONCEPT USER 2

FEEDBACK
"Better for the users wearing a vest. "
"It is better for when the home nurse is sitting down and talking with the patient. "

Ill. 55.3

CHEST CONCEPT USER 3

FEEDBACK
"It does not interfere with the work. Looks a bit funny in that material and design. Needs to be in another material. "

She likes the arm solution for the clinique. It looks very professional when having it on the arm.

Ill. 56.1

BELT CONCEPT USER 3

FEEDBACK
Wants to place the belt in the waist instead of the hips. Needs to get to the phone in the pocket.
"When I am pushing a button with my unclean hands, it might be a problem."

Ill. 56.2

THE CONTAINER ON THE ARM

"Very clever for when wearing the apron. "
"Velcro is better for mounting, because it is difficult to see the mounting on the arm."
"The gel needs to come out very easily."

THE CONTAINER SIZE

Maksimum 182 ml. Not bigger.
The smaller the better. Not too thick. Better that it is wide.

Does not mind it does not follow the bodyshape. It could be a problem for women with big boobs.

▶ **Is it in the way when wearing the jacket?**

▶ **It is a problem that they cannot get to their phone in that specific pocket?**

▲ **"The functionality is the most important thing."**

▲ **The models were not precise enough for the home nurses to understand and give precise feedback on the concepts**

Arm solution could be permanent for the clinique ◀

Arm solution should have velcro or an easy mounting ◀

The solution should be discrete ◀

IDEATION 5.0

MOUNTING ON CLOTHES

Magnets

Safety pins

Clips

Velcro

Rotation mounting

Press-fasteners (trykknap)

Loop and carabine hook

Zipper

Strap that can turn into loop

around the container

Screw

Ideation 5.0 (W64) was used as inspiration for ideation 5.1 by using Tjalve (2003) to find solution principles, where the focus was how to mount a container on the body/clothes.

MOUNTING ON SKIN/BODY

Tape

Slap wrap

Velcro

"vest/t-shirt/harness" under uniform with magnets

WAYS TO GET 3 ML GEL OUT WITH ONE HAND

Squeeze into smaller container and squeeze again

Push button until it vibrates and 3 ml comes out

Push until it has given 3 ml and stops with a vibration

Pump once = 3 ml

Under pressure like a soda stream - vibrates when 3 ml has come out

The conclusion was for the wearable part and the activation:

WEARABLE PART

It must be something that does not need to be glued or sewed on the uniform, because it takes extra resources.
Three variation of the solution:

1. Clips for mounting the container on the uniform.
2. T-shirt/clothes/harness under the uniform that is tight to the body with magnets
3. Magnets to place under the uniform on the t-shirt they are already wearing

ACTIVATION

Pump once gives 3 ml. It is fast and easy to do and the gel comes out immediately. The pump automatically refills the small container with gel when released.
The pump may not be able to push all of the gel out?
The activation should not contain battery required parts.

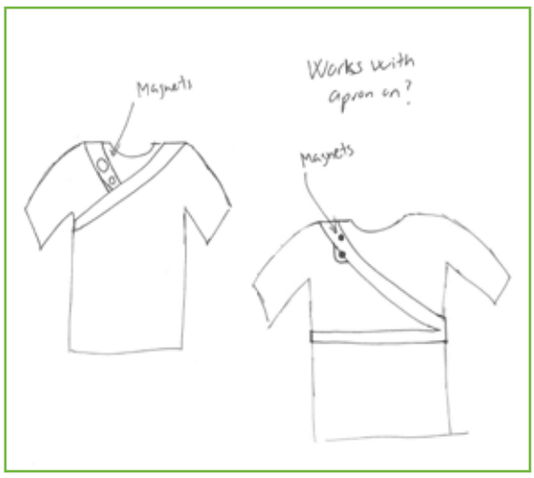
IDEATION 5.1

Building on ideation 5.0 where Tjalve was used to find solution principles, the new ideation (W65) explores the details of the three wearable solutions along with the activation of the pump.

Sketching on
- Clips for mounting the container on the uniform.
- T-shirt/clothes/harness under the uniform that is tight to the body with magnets
- Magnets to place under the uniform on the t-shirt they are already wearing
- The pump solution
- Other solutions?

The ideation resulted in two new ideas to fasten the container to the body and a new way to squeeze the 3 ml out.

FASTEN CONTAINER 1



Ill. 58.1

A harness that is worn under the shirt uniform but on the t-shirt with magnets

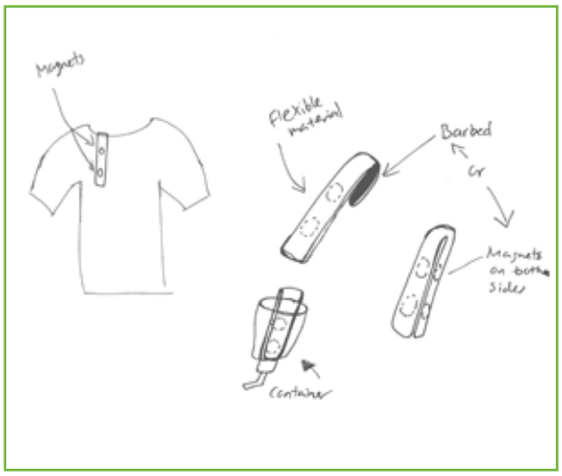
+ Not to worry about that the breasts are being highlighted

+ The mounting is easy and discrete

+ The container can be moved outside the apron and still work

- It needs to be adjusted in size and have a tight fit

FASTEN CONTAINER 2



Ill. 58.2

A clip to put on the shirt with magnets in it

+ Very easy to put on

+ No need for adjustment around the body

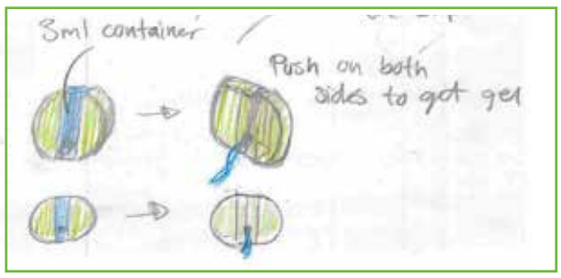
+ Can fit on the t-shirt they are already wearing

+ The container can be moved outside the apron and still work

- Cannot be adjusted in size

- Need to be flexible, but maybe it will interfere with the functionality

ACTIVATION 1



Ill. 59.1

Squeeze on both sides

+ Always gives 3 ml

+ Can be used with one hand, but not necessary

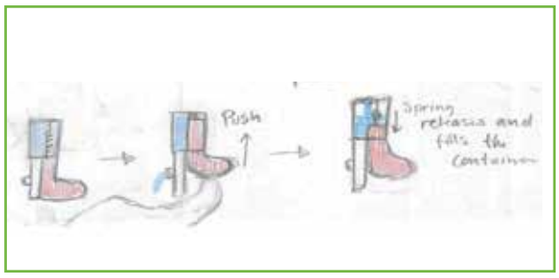
+ Can be implemented in both concepts

+ Cheap to manufacture

? Is the hand position awkward

! Needs a one way valve

ACTIVATION 2



Ill. 59.2

Push 3 ml out

+ Always gives 3 ml

+ Can be used with one hand, but not necessary

+ Can be implemented in both concepts

+ Cheap to manufacture

? Is the hand position awkward

! Needs a one way valve

? Can be made with a spring or rubber material

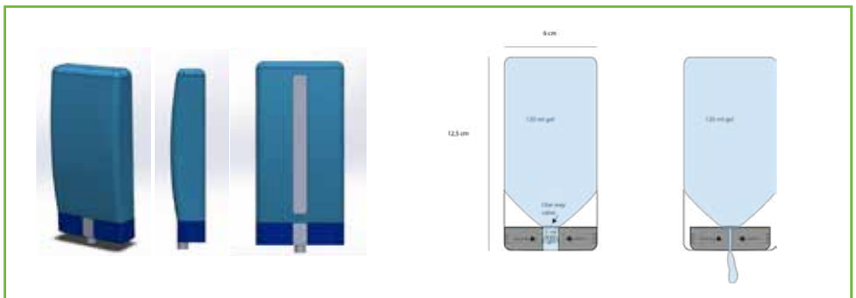
IDEATION 5.2

An ideation (W68) based on ideation 5.1 where the two concepts were chosen. The objective was to develop the two concepts more and to detail the different parts.
The concepts had to contain

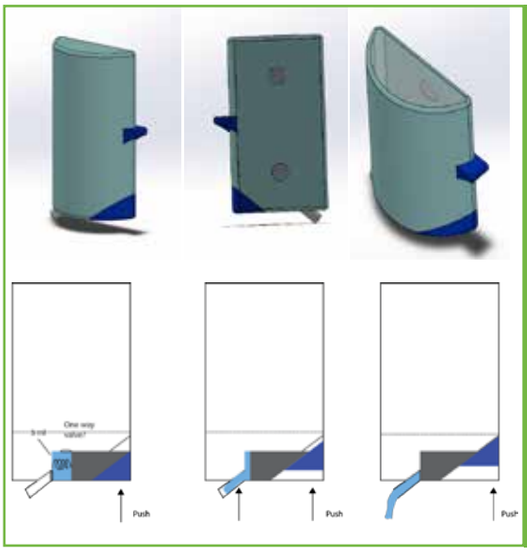
- Detailed activation
- Shape
- Mounting on home nurse
- See how much gel is left
- Materials

CONSIDERATIONS

- No small grooves where dirt/bacteria can be
- Smooth surface that is easy to clean (after wearing the apron)
- Soft edges
- Follow the body shape
- Transparent in what the use is
- Ergonomic because of the repetitive move

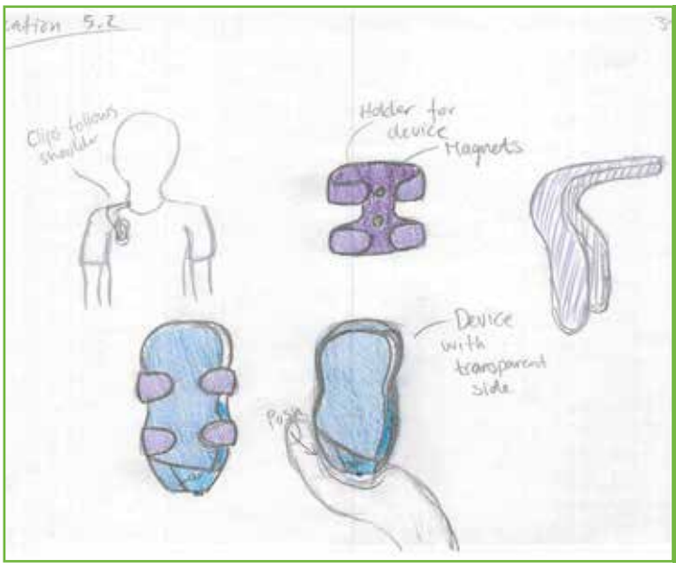


Ill. 59.3 - An idea for the container that is fastened on the clips. The activation works by squeezing in from both sides and then the gel comes out the middle.



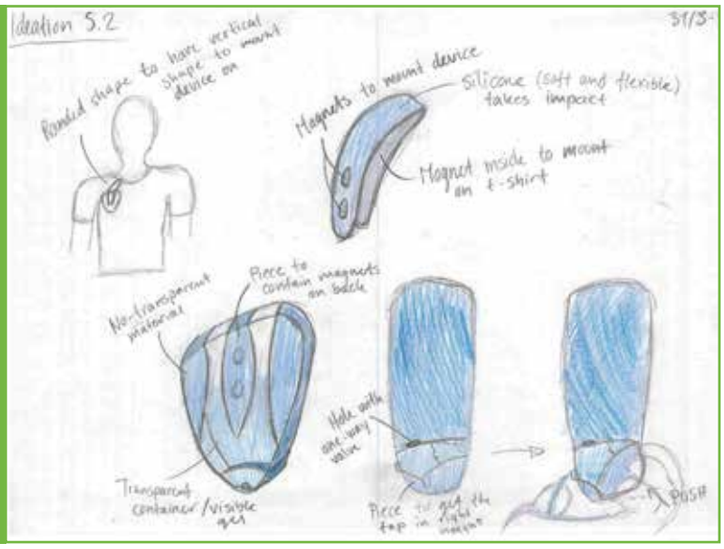
Ill. 60.1 - Another idea for the container design, but with an activaiton that is squeezed from the bottom and up. The activation parts are indicated with a dark blue color.

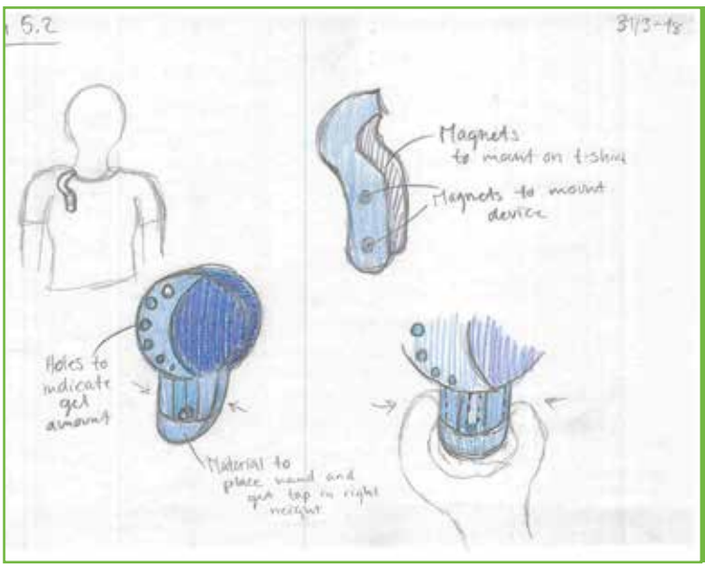
Ill. 60.2 - An idea for what the magnetic clip should look like. The clip has a lock that can be turned.



Ill. 60.3 - An idea for a holder for the container. The clip is designed so it follows the shoulder.

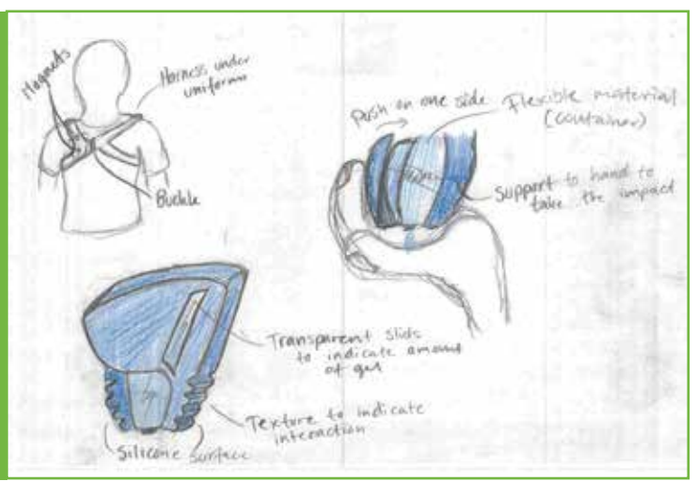
Ill. 61.1 - A design idea for the container and magnetic clip. The container is visible in some places, so the home nurse can see when the container is empty.





Ill. 61.2 - An idea for the design where the container has a circular shape with see-through holes, where it can be seen how much gel is left. The magnetic clip is shaped in an organic shape, so it follows the body more. The gel is given by squeezing on both sides of the activation.

Ill. 61.1 - An idea for the chest wearable part where the activation part is squeezed from both sides. The activation has a silicone surface. The home nurse squeezes with the fingers and the root of the hand.



▲ **The magnet clip is minimum invasive for the home nurse and therefore the best solution**

▲ **The shape of the clip should follow the body shape more and the shirt lining**

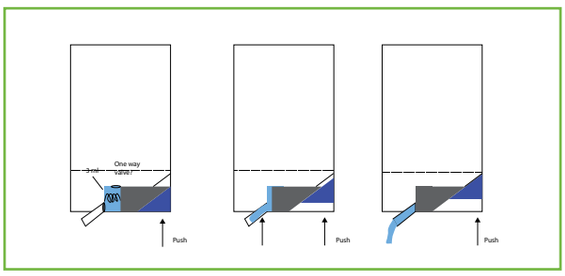
▶ **The activation needs to be tested**

The harness takes too long to put on compared to the clip ◀

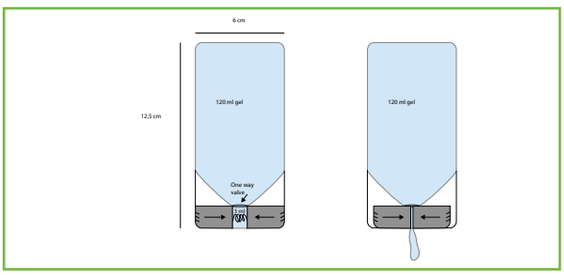
The magnet clip should be in a flexible material and not too thick ▲

ACTIVATION TEST 1

An activation test with simple mock-ups was done (W70) to test different ways to activate the device to find out how the hand should be positioned and how the activation would work. The test was based on the two activation methods illustrated below.

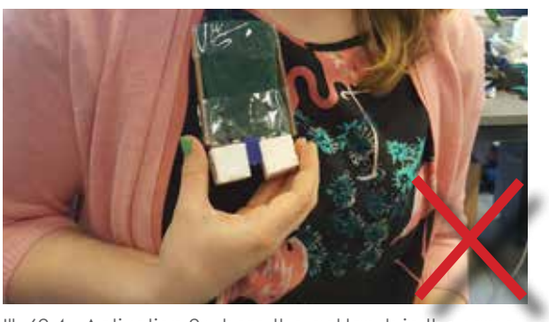


Ill. 62.1 - Activation 1 where the push is from the bottom with a triangled piece.



Ill. 62.2 - Activation 2 where the user push in from both sides

Ill. 62.3 - Activation 1. The container moves to the side when activated. The hand position of the activating hand is a little bit awkward because the hand is pushed towards the chest and the thumb needs to be placed on a edge that sticks out.



Ill. 62.4 - Activation 2 where the gel lands in the same hand that is used for the squeeze. The hand needs to be in a more angled position, before the gel lands correctly in the palm.

Ill. 62.5 - The same activation as ill. 62.4, but with two hands.
The gel lands perfectly in the palm of the bottom hand, but the upper hand is in a very awkward position.

Ill. 62.6 - Based on activation 2, but where the push only happen from one side. A finger needs to be placed on the top of the container so it stays in the right position. There is a slight twist in the elbow when the arm is placed like this.

Ill. 62.7 - Is based on ill. 62.6 that was the best solution in the test. The left arm has a comfortable bend and the other hand is used to catch the gel in the palm.

CONCLUSION

Ill. 62.7 works the best. Both hands can be used because the home nurses need to use them when disinfecting. The angle of the tap needs to be decided and tested so it is easy to hit the palm with the gel. The twist in the elbow from ill. 62.6 is removed when turning the arm this way.

CLIP DESIGN

The clip is going to be placed under the uniform shirt (W69), but on the edge of the t-shirt, that the home nurses are wearing underneath. The t-shirt is a provided part of their uniform. The clip was designed to fit most standard t-shirts and tested on Pure Hands' t-shirts. The size of the clip is based on the product's size along with previous test done on the size of a container attached to the chest/body (W45).

Ill. 63.1 - The first clip was just straight. It does not follow the shirt lining and it is not comfortable.

Ill. 63.2 - The second clip had more curves and was more comfortable, but it did not follow the shape of the container.

Ill. 63.4 - The third clip had a slight curve but it did not follow the lining of the shirt.

Ill. 63.3 - The fourth clip had a slight curve follows the lining of the shirt and has a straight piece to attach the container/holder.

Ill. 63.5 - A quick 3D sketch of the clip.

CONCLUSION

The clip is going to be curved on the top to follow the shirt's lining. The curve depend on the shirt, but the user can place it easy with the magnets and adjust it so it is not in the way. The clip will have a straight piece in the bottom where the container is attached.
The clip should be with soft edges and in a semi flexible material, so it does not add stiffness to the body. The shirt might vary and therefore the clip will have to be adjustable. The magnets is helping, because there is not only one right way to put the clip on.

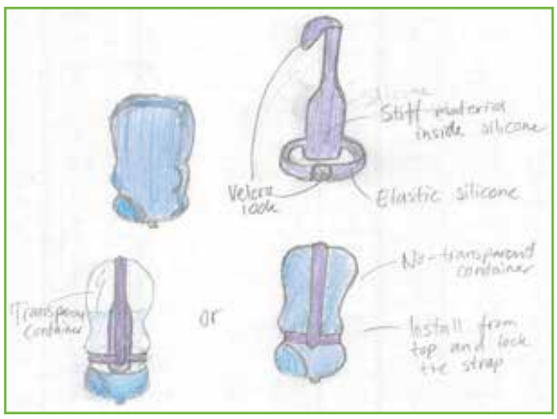
IDEATION 5.3

It was decided that the container should not contain the magnets, because it would be too expensive to manufacture when the container was going to be disposable. Ideation 5.3 (W73) was created to develop the new concept focusing on the design of the container and holder. There were some demands to the solution:

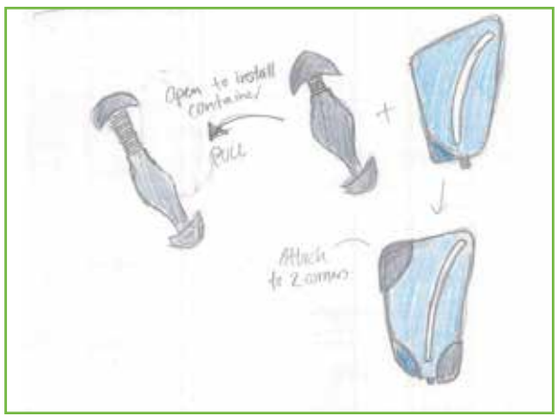
- The magnets have to be sunken so the container will stay in the right position.
- The holder must contain magnets to fasten it to the clip
- Must be easy to clean

From Worksheet 72 - holder inspiration:

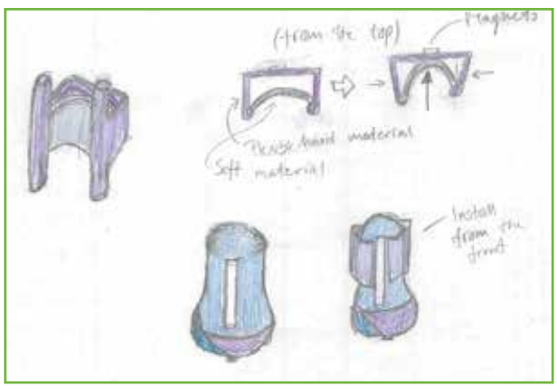
- The holder has to fasten the container from more than one side
- The holder must not interfere with the tap
- The holder and shape are dependent on each other
- The holder must contain magnets to fasten it to the magnet clip



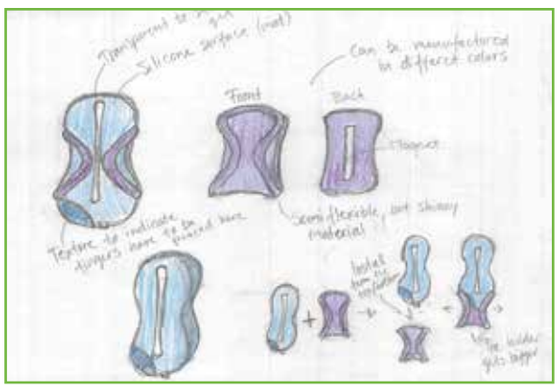
Ill. 64.1 - A solution with a velcro closing and a silicone elastic band. The container in the left corner is see-through for easy validation of the amount of gel.



Ill. 64.2 - A solution with an asymmetric lock holder.



Ill. 64.3 - A solution with an elastic lock that is very easily placed.



Ill. 64.4 - A solution with a slightly elastic but firm material where the container is popped into place.

The holder has to secure the container from the top and around it

The container should be transparent so the volume of gel is easy to validate

The holder should be in soft and flexible material, but the space on the back that contains magnets has to be hard

A symmetric holder might give a more stable experience

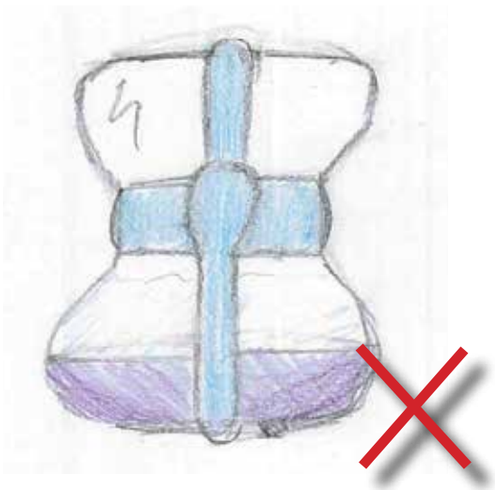
How can the strap and container compliment each other so it looks like an integrated product?

The magnets cannot be sunken, because the shirt is placed in between.

IDEATION 5.4

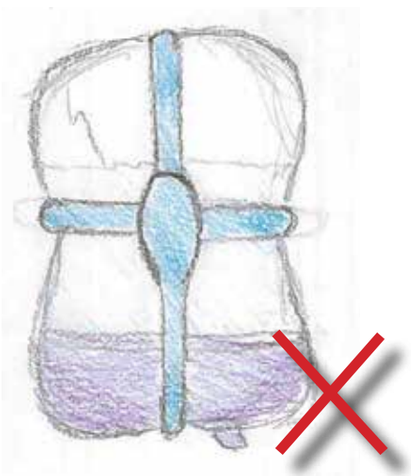
Ideation 5.4 (W75) was created to try and develop the aesthetics in the product, so the holder and the container would fit better together instead of looking like two very separate parts.

The holder also needed to be tested and developed. It was choosen to make a silicone band that went around the container - both to secure it to the holder, but also to place the magnets in.



Ill. 65.1 - The shape indicates that the bottle should be squeezed, which is not the case.

Ill. 65.2 - The shape reflects an upper body of a human, but the band is more discrete than in ill. 65.1.



Ill. 65.3 - The band around the product symbolizes a cross, that is commonly connected to medicine.

Ill. 65.4 - A soft curve that indicates the activation and a Y-band across the product.

A new ideation is needed

The container must not give a reference to a head

The interaction part needs to be an integrated solution in the shape

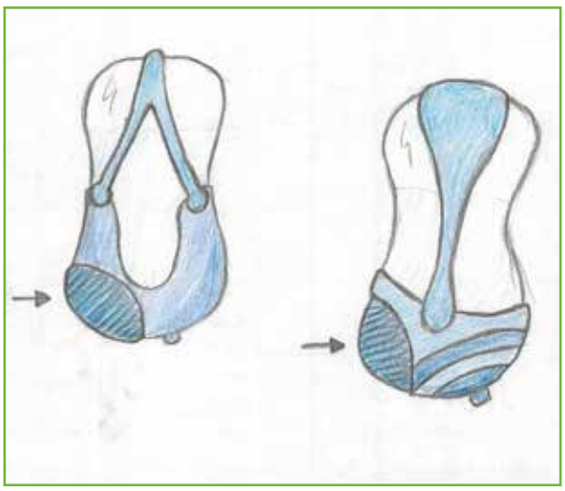
The water drop reference might not be a good inspiration

The interaction might be the best solution to get inspiration for the shape

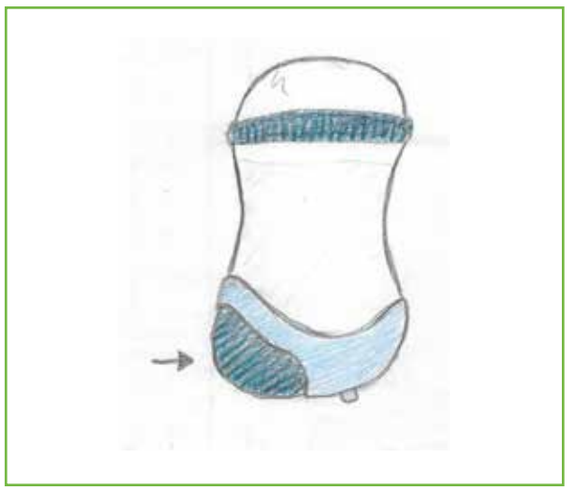
The silicone band does not look integrated in the product

IDEATION 6.0

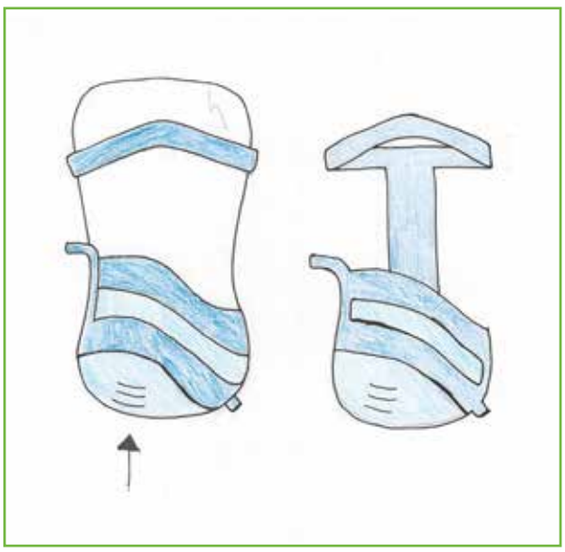
This ideation (W76) aimed at integrating the silicone band more into the product and take inspiration from waves. The activation place was also going to be clearly indicated.
The two activation ways were still both in play.



Ill. 66.1 - Two ideas for the design with the silicone band wrapped around the container. The design is inspired by waves and water drops.



Ill. 66.2 - Another idea for the design where the silicone band is more discrete but still supports the container. The button is indicated both with a darker color, but also with texture in the material.



Ill. 66.3 - An idea for the design where the push is done from underneath and a small piece of plastic sticks out on the holder, so the home nurse can use it for the counter push. The design is inspired by waves.

The silicone band was very hard to integrate and therefore a new idea came to mind, where the container is secured directly in the activation part by adding threads that fit together. This removed the need for having the silicone band. The ideas from ideation 6.0 was however, presented in field study 4.0 and feedback was given based on these.

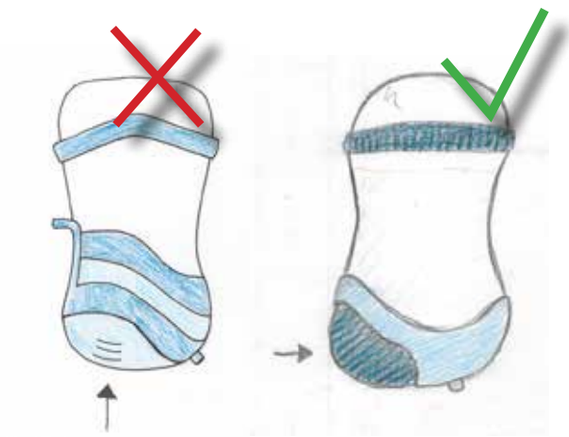
FIELD STUDY 4.0

Field study 4.0 (W77) was based on an interview with a private home nurse. The purpose was to see how the private home nursing worked, what equipment she had and to get feedback on the concept.

Ill. 67.1 - The interview setup with models and sketches. The home nurse is wearing a polo t-shirt or t-shirt with her logo on as a uniform. Her wish is to signal to the patient that she is professional, but a bit casual, so the patient would not feel sick and too much like a patient.

Ill. 67.2 - The equipment the private home nurse brings to each patient's home. In the bag was also two bottles of hand sanitizer. A big bottle with a pump that has liquid sanitizer. She places this on the table at the patient's home. She also has a small gel container, that she thought was handy at first because of the size, but the pump is easier accessible when working.

Ill. 67.3 - The private home nurse with the mock-up.



Ill. 67.4

THE CONCEPT

The squeeze from the sides is best, because it is best for the fingers. She knows many nurses with sore fingers and/or osteoarthritis, becaue they have exposed their fingers to much in their work.
The blue color and the shape with the waves are best, because it signals waves, soft values and something fluent.
She is a bit puzzled about the signal of the container, when it is placed on the chest.
The positive side: The home nurse will remember to disinfect the hands. And it signals to the patient that she is clean.
The negative side: In her field it is not always needed and might signal that the patient is sick and should feel that way. But it is very easy to take it off, when she is not going to use it.

The squeeze from the side(s) is best	◀
The placement is good	▲
The blue color and the waves are good	▲
It is very easy to take off when not needed	▲
The weight (120 ml) is not a problem	▲

FIRST EDITION CAD MODEL

The first CAD model focused on making all of the parts from the activation fit inside it. The lines in the product should be organic and symbolize waves that together with the blue color had a calming effect. The container was made in clear plastic and the guideline was sunken on the container and continued on the activation in a dark blue color. The button was also made in a dark blue to indicate that the interaction was there.

Ill. 68.1 - The container had to be screwed into the activation and therefore the activation could not go up and cover the container.

Ill. 68.2 - The container and the activation connected.

On the first CAD model the two parts were very different in looks. The activation was very wide and had a non integrated connection to the container. The activation part tried to follow the line from the container, but it did not work the intended way. The container was light because of the clear plastic, but still very wide and not very thick. This gave the activation part some restrictions in the design. The connection between the two parts and their aesthetics needed to be explored more.

DEMANDS FOR THE SANITIZER

Metric #	Need #	Metric	Imp.	Unit	Marginal value	Ideal values
1.0	5,15 *	Must contain alcohol	5	v/v	80	85
1.1	3,5,11 *	Dosage	5	ml	3	3
1.2	4,5,6*	Must contain some water	2	%	-	-
1.3	6 *	Must contain a skincare element	4	%	2	3
1.4	3,14	Eliminate bacteria	5	%	99.9	100
1.5	*	Must contain an element that makes it undrinkable	4	%	-	-
1.6	11, 18 (Online. abena.dk, 2018)	Must be in gel form	5	Viscosity	3000 mPas @ 20°C	7000 mPas @ 20°C

* From Nationale Infektionshygiejniske retningslinjer

DEMANDS FOR THE CONTAINER

Metric #	Need #	Metric	Imp.	Unit	Marginal value	Ideal values
2.0	*	Has a sticker to tell the user it is the sanitizer	2	Binary	Yes	Yes
2.1	20	The container should be secured tightly to the activation part	4	Subjective	>3	>5
2.2	1,4,11	The container shall indicate where the gel comes out	3	Subjective	>3	>5
2.3	2	Container can be sterilized after use	2	Binary	Yes	Yes
2.4	7,16	Show when container is almost empty	2	Subjective	>3	>5
2.5	W94, 7	Closed with a sealing	2	Binary	Yes	Yes
2.6	4,7, 21	Intuitive sealing	3	Subjective	>3	>5
2.7	7,17,22	The sealing must not break unintended	4	-	-	-

DEMANDS FOR MAGNETIC CLIP

Metric #	Need #	Metric	Imp.	Unit	Marginal value	Ideal values
3.0	1,4,9,10,20,21	Can be used without the uniform	4	Binary	Yes	Yes
3.1	6,10	Comfortable to wear	3	Subjective	>3	>5
3.2	10	Must not ruin the home nurse's clothes	2	Subjective	>3	>5
3.3	8,20,21	Must be able to hold the container's weight	4	Kilograms	0.130	0.150
3.4	20	Make sure that the container is placed parallel to the clip	3	Degrees	<10	0
3.5	6	Hypoallergenic	2	Binary	Yes	Yes

DEMANDS FOR MAGNETIC CLIP

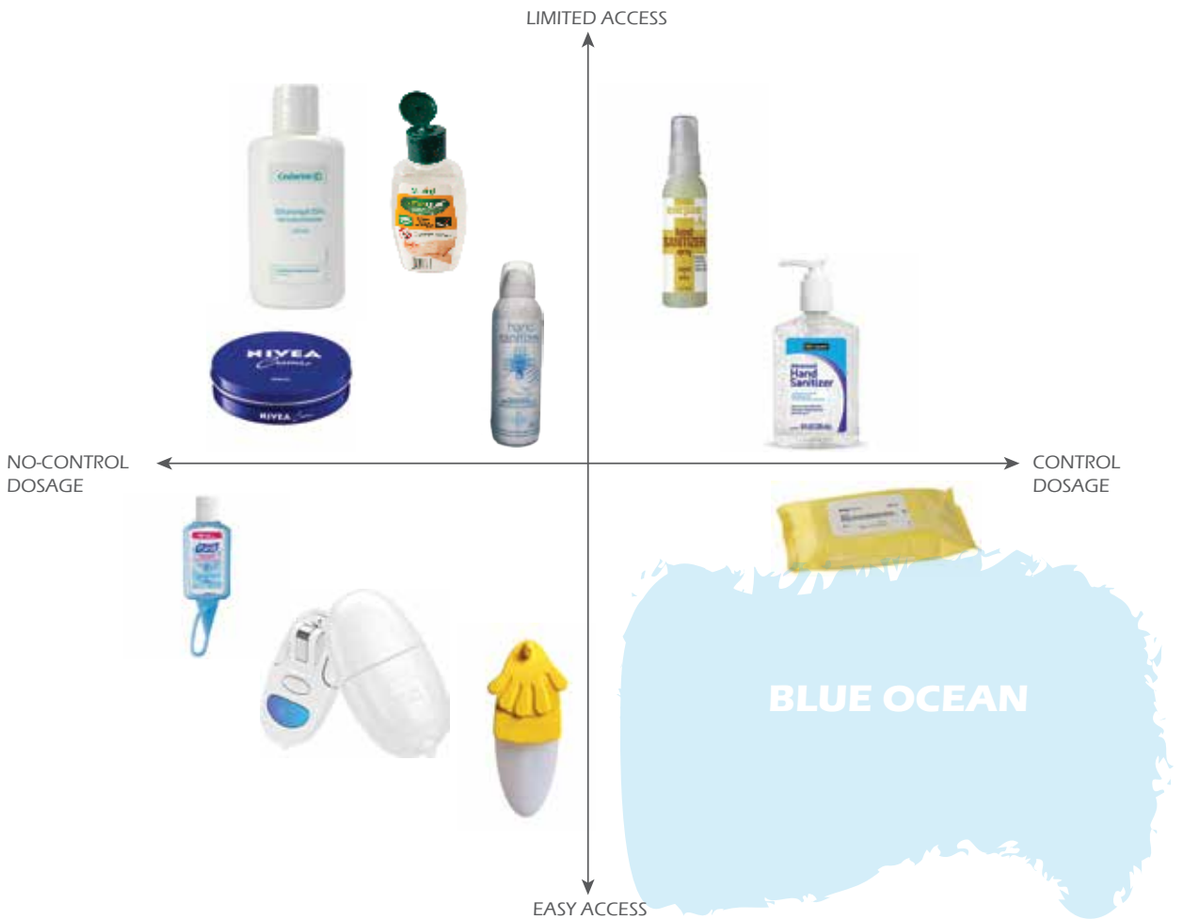
Metric #	Need #	Metric	Imp.	Unit	Marginal value	Ideal values
4.0	12	Does not overload the fingers	2	Subjective	>3	>5
4.1	4,12	There must be a good grip on the contact surface	2	COF	0.25**	0.3**
4.2	10,11,22	The activation and the container must be closely sealed together	4	Liter	-	0
4.3	1,16,21	The activation part must support the container at all times	5	Kilograms	0.12	0.13
4.4	4,10, 12, W49	The tap must be angled out from the body	3	Degrees	40	50
4.5	8,19	The shell and the container must fit together in their design	3	Subjective	>3	>5
4.6	4,7,12	There must be a tactile feed-back when placing the contain-er in the activation part	2	Binary	Yes	Yes
4.7	4,7,21	Intuitive replacement of container	3	Subjective	>3	>5

**(Albright Technologies | Silicone Molding, Medical Silicone Prototyping, Injection Molding & More, n.d.)

WISHES FOR THE EXPERIENCE (BEHAVIOUR)

Metric #	Need #	Metric	Imp.	Unit	Marginal value	Ideal values
5.0	1	Must be placed on the body	5	Binary	Yes	Yes
5.1	8	Refers to styleboard in aesthetics (W102)	2	Subjective	>3	>5
5.2	3,4,13, 18	Encourage them to disinfect correct	5	Subjective	>3	>5
5.3	W45, W57 9,20	Must have a size that fits the body	1	Subjective	>3	>5

The new direction for the project demanded a new look at the market potential. The old one on page 38 had focused on the automatic and touch-free dispensers. The market potential for the new direction was designing an easy accessible device were the dosage was correct. Therefore a new blue ocean canvas was made (W112).



Ill. 71.1 - The new market potential.

CONCLUSION ON PHASE

In this phase in ideation 5.2 the final concept was discovered. It consisted of a magnetic clip that the home nurses will wear on their t-shirt and a device that would also contain magnets, so it could be placed on the clip. The activation was tested and the best solution was chosen. The concept idea was confirmed to be a good idea at field study 4.0 and the first CAD models were made.
The project was ready to move into the detailing phase.

05. DETAILING

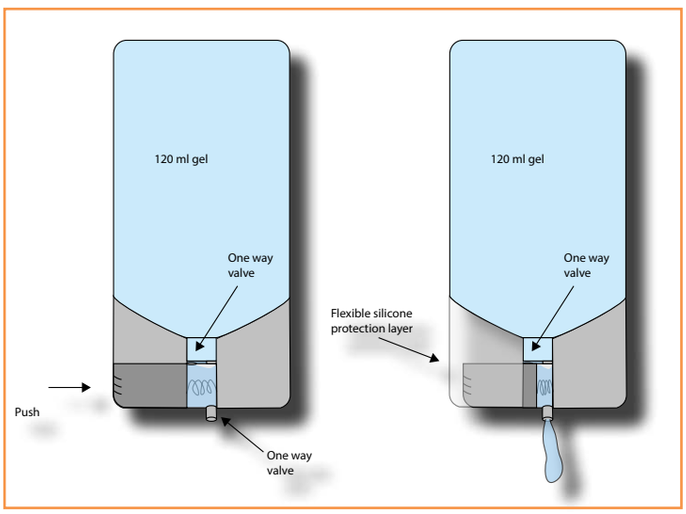
INTRO

The fifth phase is the detailing phase. It contains more tests with the activation, the thread, the sealing, pressure, chambers and guideline. All of the parts were developed after the tests.

The phase also contains the business section, where the activity plan to launch the product is presented, and finally the production of the product is described.

ACTIVATION DETAILING

The activation needed to be developed (W79) to specify how it would work. The squeeze from the side was chosen based on the feedback from field study 4.0. Based on insight from the home nurses it was discovered that their fingers are exposed to much pressure from example pushing out many pills during a day. Therefore the fingers should be spared in a new product. The activation where the push is happening from one side was chosen, because then the home nurse can use the hand root to withstand the push.



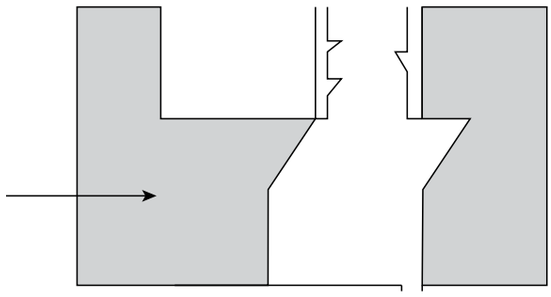
Ill. 72.1 - An illustration of the activation where the user pushes in from the side and gel comes out the bottom. A spring was added to make sure the button would be pushed back into the starting position. The spring makes it impossible to squeeze the chamber all flat, so the chamber size had to consider this.

Ill. 72.2 - A mock up of the activation. The hole for the gel cannot be placed in the middle, because the gel might be pushed up in the container instead of out.

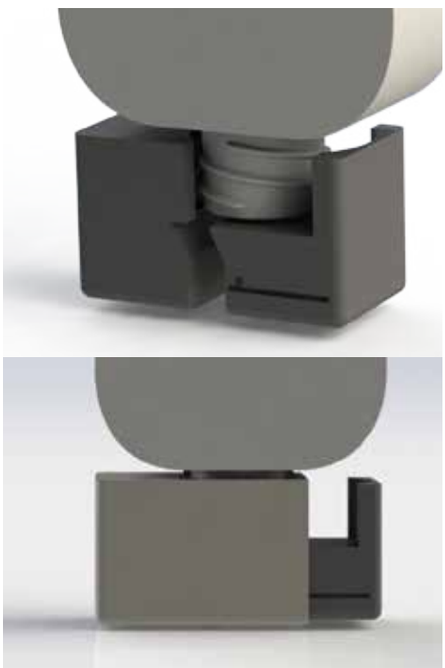
The container and the activation part needed to be sealed close together so no leakage would happen. Therefore it was decided that the container should be screwed in the activation part like a cap on a soda bottle (Ill. 73.1). For this two threads were needed.

The form of the movable part was redesigned (W80) a few times because it had to block the opening to the container but not the hole where the gel comes out. It could not be totally straight because it would not block the opening at first as it should. It should not be totally diagonal because of the same reason and the hole is placed in the wrong side when it is diagonal. So the form should be diagonal on the top and straight in the bottom (Ill. 73.2).

Ill. 73.1 - a thread on a soda bottle.



Ill. 73.2 - The grey part on the left is being pushed towards the other grey part. It blocks the hole in the top and thereby forcing the gel to come out in the bottom.



Ill. 73.4 - The parts where drawn in 3D to make sure they fit together and then they were 3D printed. The thread that the container screws into is not shown on the illustration. A shell is going to cover the parts.

Ill. 73.5 - A mock-up of the solution where the chamber is being squezzed from the side and gel comes out the bottom.

The solution was tested with a mock-up (Ill. 73.5), where the parts in the activation was 3D printet and the chamber was in silicone. The gel came out very easily when the chamber was pushed flat.
The thickness and shape of the chamber needed to be developed further to make sure that all the gel comes out.

THE MAGNETIC CLIP

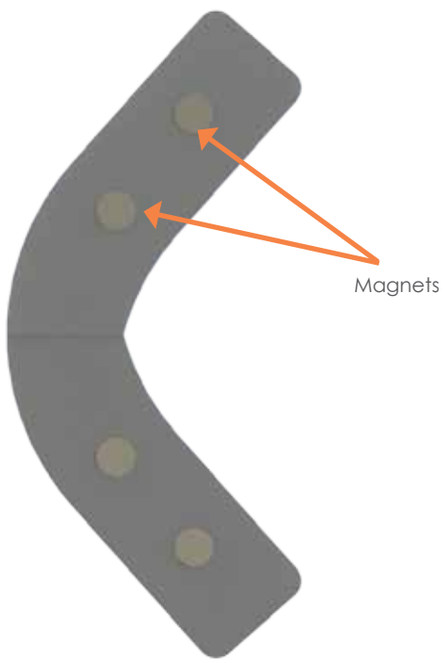
It was decided that only one side of the clip should be magnetic, but the clip should be able to be turned inside out, for when the clip is used on the other side of the t-shirt. The magnet will be more protected and this will prevent that the magnet attaches itself to a steel part in the surroundings.

Some demands were determined for the material and design

- It should feel comfortable against the skin and be hypoallergenic
- It should contain a magnet on one side and a piece of steel on the other side
- It must be able to be used without the uniform
- It must not ruin the home nurses' clothes
- The magnets must not interfere with the surroundings
- It must make sure that the container is placed correctly

After testing the stiffness of various materials and the placement of the magnets (W101) it was decided that there needed to be two vertical magnets on the clip. Furthermore it was decided that the material should be in a soft material like silicone that is flexible, but it should still have a stiffness to be able to hold the container's weight. Silicone was chosen as material for the magnetic clip.
Silicone is used in various products and there is no documentation that it is unhealthy. Silicone can be found in shampoo and makeup and can therefore be in close contact with the skin. (Paulaschoice.com, n.d.) Silicone is also used as implants in the body and in contact lenses. (En.wikipedia.org, n.d.)
Silicone is also the best material to prevent the force from a push tested in worksheet 51 and this can be transferred to fit into this context as well, where there will be an indirect push and some movement in general.

Ill. 74.1 - The folded magnetic clip that will be placed on the t-shirt. The magnets will be sunken into the silicone, but will be indicated with a color, so the home nurse knows where they are.



Ill. 74.2 - The unfolded magnetic clips. Two circles will be magnets and two will be steel. This will make sure that the magnetic clip can be used on both sides of the body. Only the two magnets will be visible/indicated. The steel pieces will not be visible.

THREAD TEST

Different threads were tested on existing products to find out the number of rotations of the cap, if the cap hits the same point on the container every time and feedback when the cap is in the right position. It is very important that there is no leakage of the gel and therefore the container needs to be closed tightly everytime. The full test can be found in worksheet 81.

Ill. 75.1 - The make-up bottle is best suited for the fast and precise way to attach the container.

The make-up bottle has good audio feedback, because the bottle has a small edge where the cap clicks on. The two spikes inside the cap hits the small spikes that are between the bottle and the thread. This gives a feedback of when to stop turning. The turn is only halfway round the bottle and is therefore faster than the others that need to be turned up to five times.

The cap can be put on two different ways. This make-up bottle's cap has no back- or frontside and therefore it does not matter which side is which. The other caps are harder to turn to the same place everytime and the lack of feedback might cause leakage of gel inside the activation part. Therefore the make-up bottle is better.

▲ **Feedback by a click sound gives an indication that the container is attached correctly**

▶ **The number of rotations has to be little, so the home nurse does not use time on attaching the container**

The edge of the make-up bottle will be used to give the click sound feedback ▲

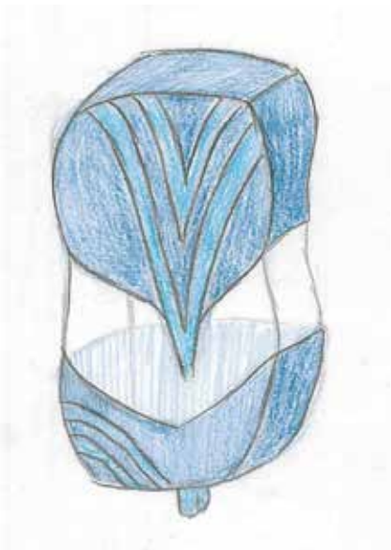
The spikes on both the bottle and the thread will be used to give feedback to the nurse for when the container is fastened ▲

IDEATION 6.1

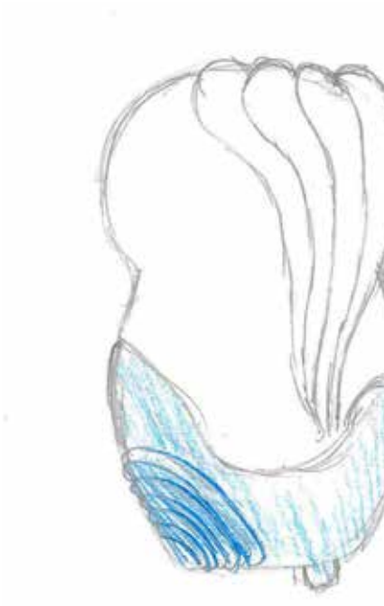
Ideation 6.1 (W83) was another small aesthetic ideation, but now the silicone band was gone and the container and the holder had to be connected in a new way - by the two threads.

A new idea with a guideline, that would show the user where the gel comes out was also tested in this ideation. From field study 4.0 the blue color was carried on and used.

Ill. 76.1 - The guideline consists of a drop design. The button where the user pushes is indicated in a darker blue color.



Ill. 76.2 - The guideline consists of arrows that points in the direction of the gel exit. The part in the middle of the product is see-through, so the user knows when the container is empty.



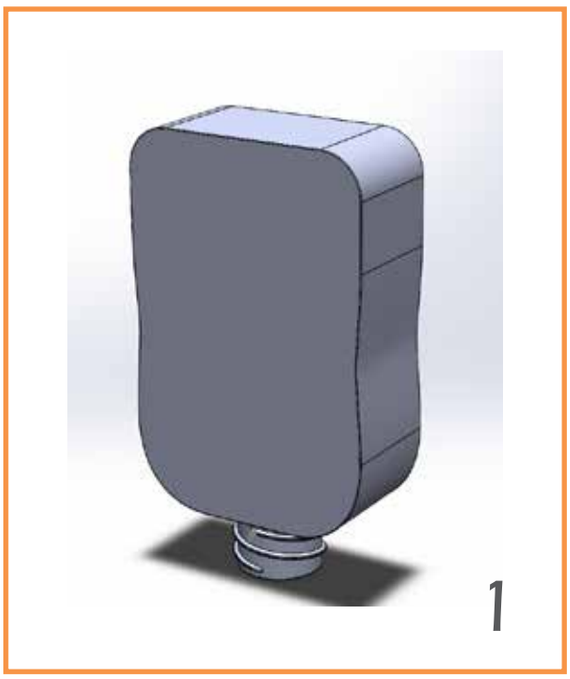
Ill. 76.3 - A more organic design of the guideline. The guideline is not that integrated into the shape of the container. Lines can be drawn to a mermaid.

The guideline has to start from the top and down, so the home nurse can place the hand easily underneath the tap.

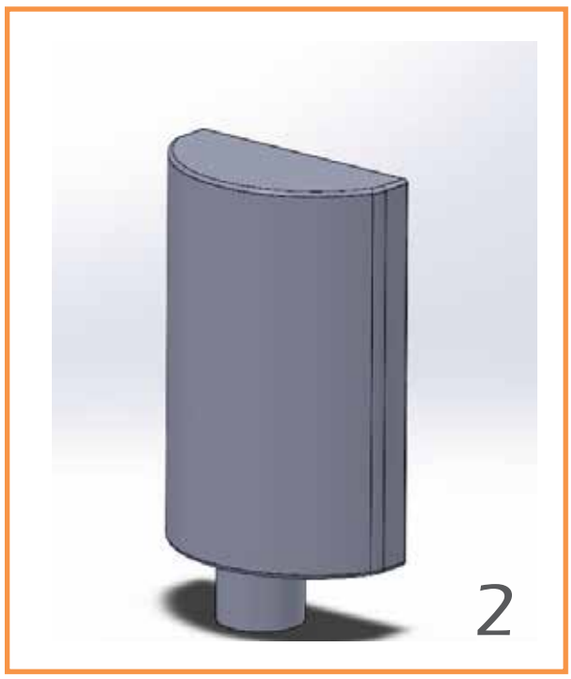
It was difficult to figure out how the shape should be, and choose a final design, when the design of the whole product was not decided yet.
The guideline had to be tested, to find out where it should start and end.

CONTAINER DESIGN

The container's shape and design was explored. The size and volume was already decided based on feedback from fieldstudy 3.0 and container size test (W45), so the only thing that was missing was the looks. The back of the container should be fairly flat, so it would follow the shape of the chest of the user.

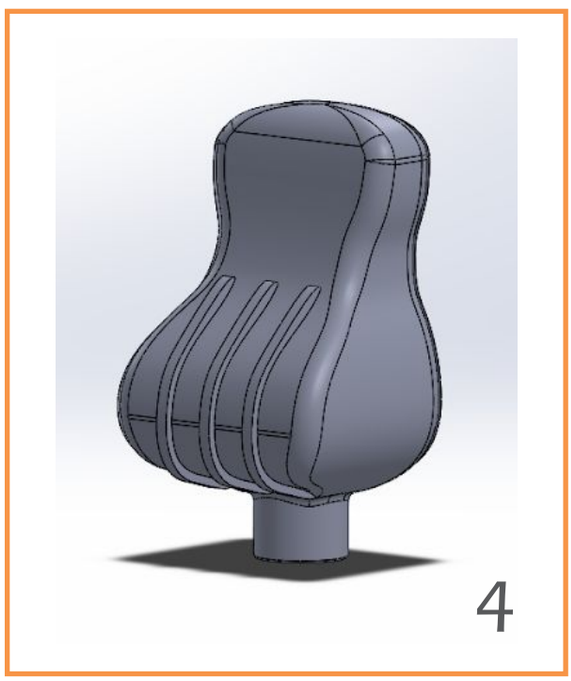


Ill. 77.1 - The first draft of the container where it is very symmetric designed. The container goes in a bit on the sides.

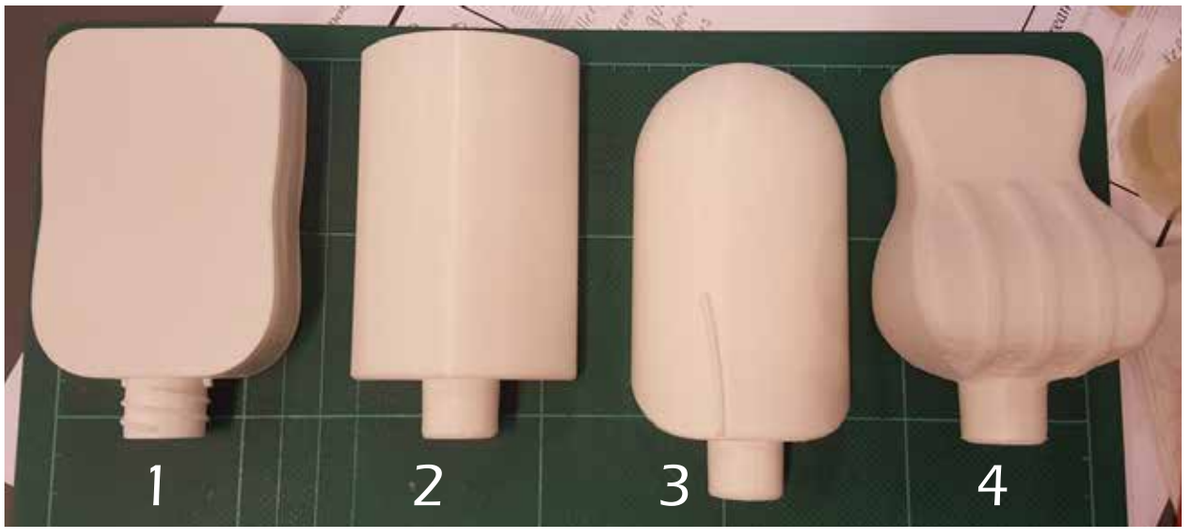


Ill. 77.2 - The second idea is that the container creates a half circle from the chest and out. This gives a very rounded feel on the part that sticks out from the chest.

Ill. 77.3 - The third idea is to have rounded edges everywhere except on the back, where it is still flat. The corners are cut off and rounded as well. A guideline that sticks out was added to test if it could be felt.



Ill. 77.4 - The fourth idea is a pear shaped container where the guidelines, that sticks out are meant to hit the palm of the hand when the user is squeezing the device.



Ill. 78.1 - The four 3D printet shapes that were tested.

TESTING THE SHAPES

The shapes were tested concerning how they felt to turn, how they felt against the chest and when squeezing the activation (W89).

Number one had very sharp edges, but could easily be turned because of the dents in both sides. It did not stick far out from the chest and felt comfortable against it.

Number two still had a sharp edge on the top, but otherwise felt comfortable to have against the chest. It was an uncomfortable shape to turn, because there was such big difference between the front and the back (flat and very round).

The third container was very comfortable to turn, because the rounded top fits perfectly inside the hand. The edges on the back needs to be softer. It works good with the activation, because a finger can be placed on the side while squeezing.

The fourth container sticks very far out from the chest and there is a big difference in the volume of the top and the bottom. It is, however quite soft and the top feels good to have in the hand. The container is way to big compared to the activation part. The guidelines do not touch the hand and do not work.

Some demands were derived from this test:

- The form needs to have a round top so it fits inside the hand rotating the container
- The form needs to have concave shape on the sides so it is easy to hold on when rotating the container
- The form needs to be convex front and a flat back
- The edge between the front and back needs to have a big radius

The third container could be adjusted a bit and then the activationpart and the container needed to fit better together.

Ill. 78.2 - The final shape of the container.

SEALING

The container is disposable and filled with gel when the home nurse receives it. Therefore it needs a way to keep the gel inside. A cap was considered (W87, W99), but it could result in wrong use. A sealing was then considered and the first initial idea was to use the turning of the container to unseal it as it went into place. Therefore this was tested using alu foil and the top of the container.
Another idea was to make a sealing that could easily be ripped off. By using the thread from the make-up bottle, the bottle would only turn 180 degrees before it would be in place. This challenged the construction of idea number one. The full test can be seen in worksheet 94.

BREAK THE SEALING WHILE TURNING

1

Ill. 79.1 - The sealing on the container.

2

Ill. 79.2 - The sticks that will cut the foil when the container is turned.

3

Ill. 79.3 - The sealing that has been cut.

RIPPING THE SEALING OFF

1

Ill. 79.4 - The sealing on the container with a small piece to grab.

2

Ill. 79.5 - The sealing when pulled off the container.

3

Ill. 79.6 - The container with a clean opening.

The solution with something cutting the sealing demands more accuracy by the home nurse, because if the pieces hit the sealing in a wrong spot the cutting fails.
There might be small pieces of the sealing that blocks the opening, so the gel cannot pass.

The pulling off solution is simple and is independent by the other part in the activation.
The home nurse has to throw out the empty container when taking a new one, therefore it is not an extra proces when throwing out the sealing.

Ill. 79.7 - The final solution for the sealing where the home nurse uses the index finger to pull off the sealing.

STYLEBOARD AND AESTHETICS

To make the final design for the product a styleboard was needed. The styleboard consisted of products that the home nurses already use and this made sure that the product would fit into their work.

THE UPSIDE DOWN CLOCK

Flexible material that is comfortable against the body (Ill. 80.1). The weight of the clock face is supported by the silicone material. The clock face is embedded in the silicone so there are no sharp edges and there is a smooth transition between the two components that otherwise have a very different density.

Ill. 80.1

PUPIL LIGHT

Clean lines from the thin end where the light comes out to the more thick middle part (Ill. 80.2) where the fingers rest and all the way to the thinner back end where the light is turned on. Clear and simple interaction with an on/off button. The fingers can rest on the metal stripe that also indicates that the light comes out from that end. Very neutral in color choice.

Ill. 80.2

THE THERMOMETER

An ergonomic shaped product (Ill. 80.3) with smooth lines and soft edges. The shape underlines where to grab the thermometer. The scan button is clearly indicated and is placed so the thumb naturally rests on it. The display is placed so the hand does not cover it and is also right next to where the measuring of temperature is happening. The underside has a silicone surface where the fingers/hand rests to give a slight friction.

Ill. 80.3

From the styleboard a number of parameters where set up for the design:

- The transitions between the different components should be smooth
- An ergonomic shape that fits the movement of the hand is good
- A material that has a slight friction is good for where the hand touches the product
- White, blue and grey colors are neutral, professional and trustworthy
- The interaction must be clear and preferable indicated with a button or icon
- Many products for nurses have a childish design (like the colorful watch) but the home nurses wish was to have a professional looking equipment that fits the elderly target group of patients

SHELL DESIGN

Based on the styleboard the shell needed to be redesigned, so the container and shell fits better together and looks like a uniform product. A selection of the ideas can be seen below. The rest can be found in worksheet 97.

Ill. 81.1 - One of the suggestions for the design. The meeting between the activation and the container has been made more discrete, but still not smooth.

Ill. 81.2 - This suggestion completely connects the two parts. The design is inspired by the make-up bottle where the cap perfectly seals the two parts together.

THE FINAL SHELL DESIGN

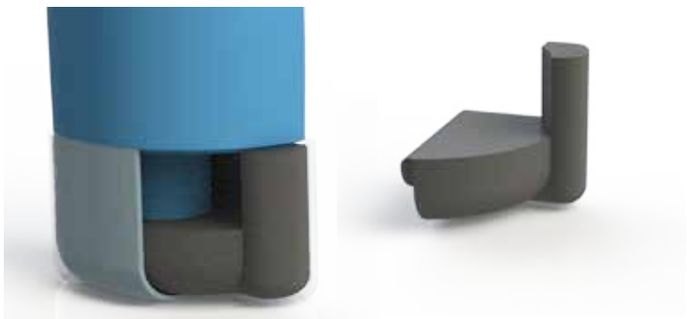
Ill. 81.3 - A render of the shell attached to the container.

Ill. 81.4 - The 3D printet container and shell attached to eachother on the left and the shell viewed from the top on the right.

The final design has the shape from ill. 81.2 and has been cut so the movable part can move in and out. The movable part now needs to be attached to the shell. The shell is only one millimeter thick and more vulnerable when it has been cut. Therefore it should be made a bit thicker.

ACTIVATION DETAILING 2

The shell design was settled and the parts inside the activation now had to be redesigned to fit the new shape (W95, W111). There was a problem with the movable part (Ill. 82.1) that had to be attached somewhere and the construction was very open on the side where the movable part was moving in and out.
This had to be solved, so a new construction was suggested where the thread in the activation was moved to the left which meant that the container had to be changed as well (Ill. 82.3). A spring was added inside the activation to make sure that the movable part would be pushed back into place (Ill. 82.2).



Ill. 82.1 - The movable and the activation before the changes.

Ill. 82.2 - A close up of the construction inside the activation.

Ill. 82.3 - The redesigned container, where the opening is moved to the left.

Ill. 82.4 - The different parts inside the activation. The spring helps the movable part (left) move back into place.

Ill. 82.5 - The whole product with the new construction inside.

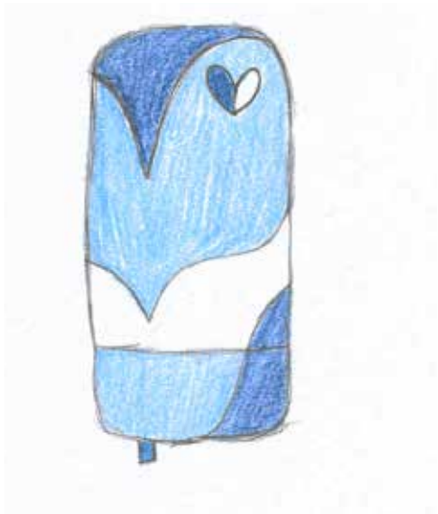
GUIDELINE & IDEATION 6.2

It was decided to make the guideline as a thin layer on top of the container. The guideline could either be in a colored plastic or the see-through while the container around it was colored. It had to be tested where to place the guideline, so the home nurse's hand would not cover it. The full test can be found in worksheet 84.

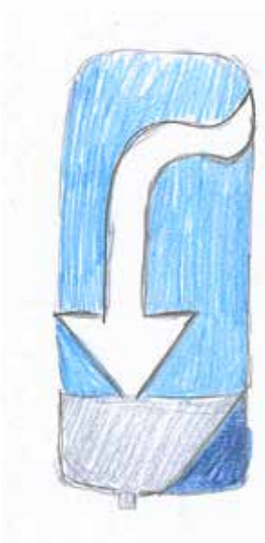
The test resulted in a quick ideation to find out how the guideline should look like on the container. The ideation can be found in worksheets 85 and 108.

Ill. 83.1 - The solution that worked, where the guideline was visible when the hand was placed on the activation.

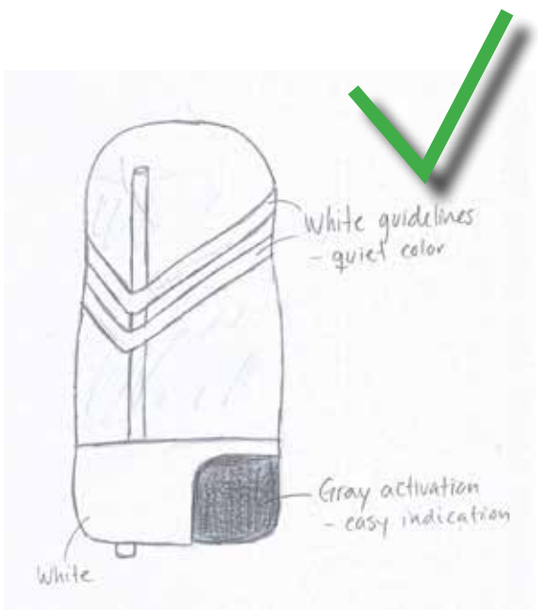
Ill. 83.2 - The guideline viewed from above.



Ill. 83.3 - An idea for the look of the guideline. The guideline takes inspiration from waves, but also symbolizes arrows to show where the gel comes out.



Ill. 83.4 - A more direct guideline where the arrow is made a bit discrete by being the part that is see-through. The blue colors are connected to water, calmness and waves.

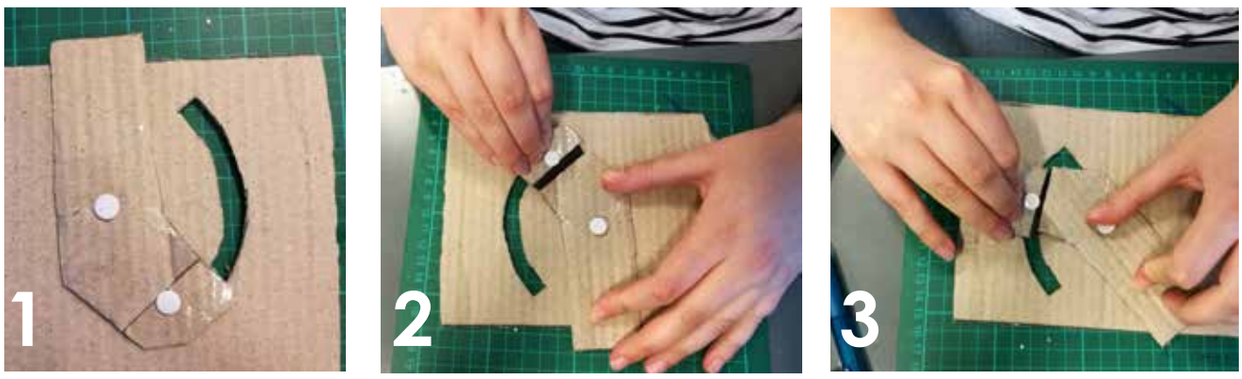


Ill. 83.5 - By looking at the styleboard again the blue colors did not fit the wanted look. The final design has white and grey colors instead that are more discrete.

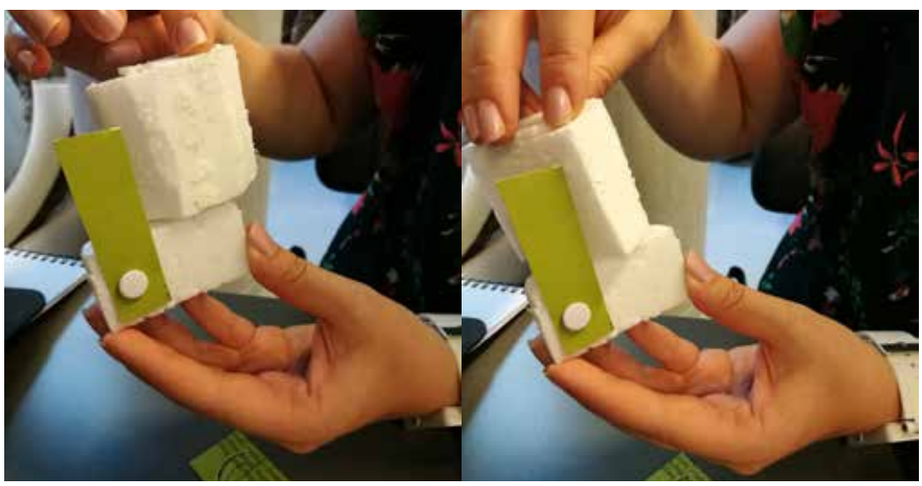
THE HOLDER ON THE BACK

The new construction found in activation detailing 2 on page 79 meant that the container's turning point was shifted to the left. This could be used in the development of the steel holder (W109) that had to be on the back to mount the device on the magnetic clip.
The first ideas for the steel holder was based on the old construction where the turn of the container was in the middle of the activation.

A demand for the holder was that it had to be fast to turn the container. Another demand was that the holder could not be removed from the shell, because the home nurses could lose the part. A demand from the first construction was also that the removing of the steel holder should be done in one movement.

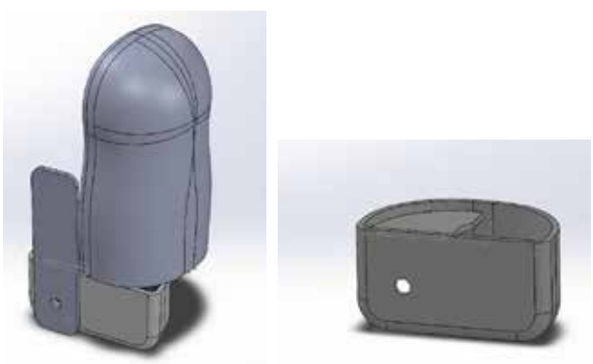


Ill. 84.1 - A solution for the steel holder, where an elastic material allows the user to pull the bottom piece into the path and turn the holder.



Ill. 84.2 - The steel holder is moved to the left and made more narrow. This allows the container to be turned without colliding with the holder.

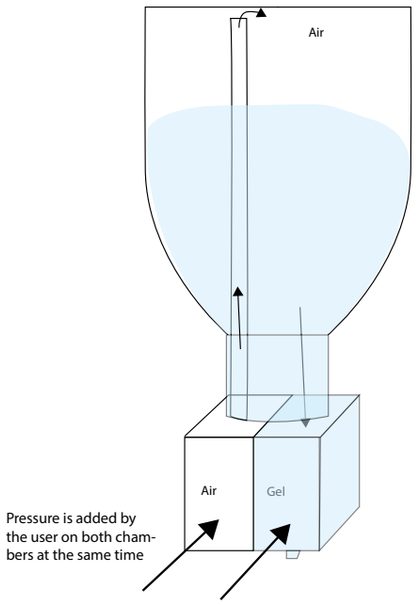
The shell had to be reconstructed with a plate that goes all the way to the left on the back, but it is still possible to push the movable part in with the fingers on the front. The construction was tested to see if the container could be turned without colliding. It worked, but the container had to be turned the other way. The steel part will also function as a stop plate, so the home nurse knows when to stop turning and a guideline for which way to turn.



Ill. 84.3 - The 3D model of the new construction with the steel part and the container being turned.

PRESSURE TESTING

The vacuum solution that was going to get the gel to flow could not be solved in a satisfying way, so a new solution had to be found. An idea where air pressure is used to push out the gel was chosen. It is commonly seen in similar products with a pump solution and therefore it can be done. In the solution an air chamber is therefore added along with a pipe that goes up to the top of the container where the air is pushed out (Ill. 85.1).
By pushing in on both chambers at the same time gel will come out in the bottom.

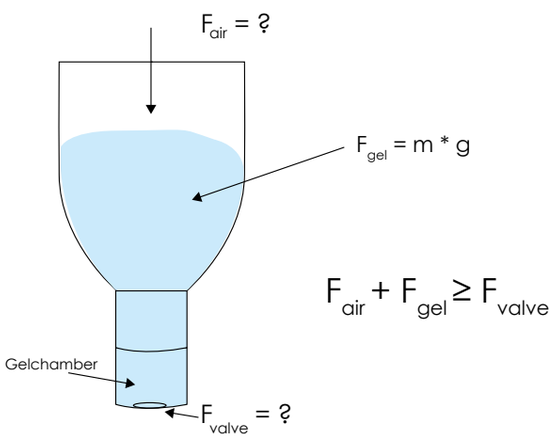


Ill. 85.1 - An illustration of the solution with two chambers and a pipe that goes up to the top of the container.

THE TEST SETUP

The test setup (Ill. 85.3) consisted of a container with ketchup that represented the gel. The container had two holes in the bottom. Here the two small chambers were connected.
The air chamber on the right with a pipe that went to the top of the container and a contra valve in the bottom, and the gel chamber on the left with a ketchup valve in the bottom. The air pressure from the container will have to be big enough to open this valve as well.

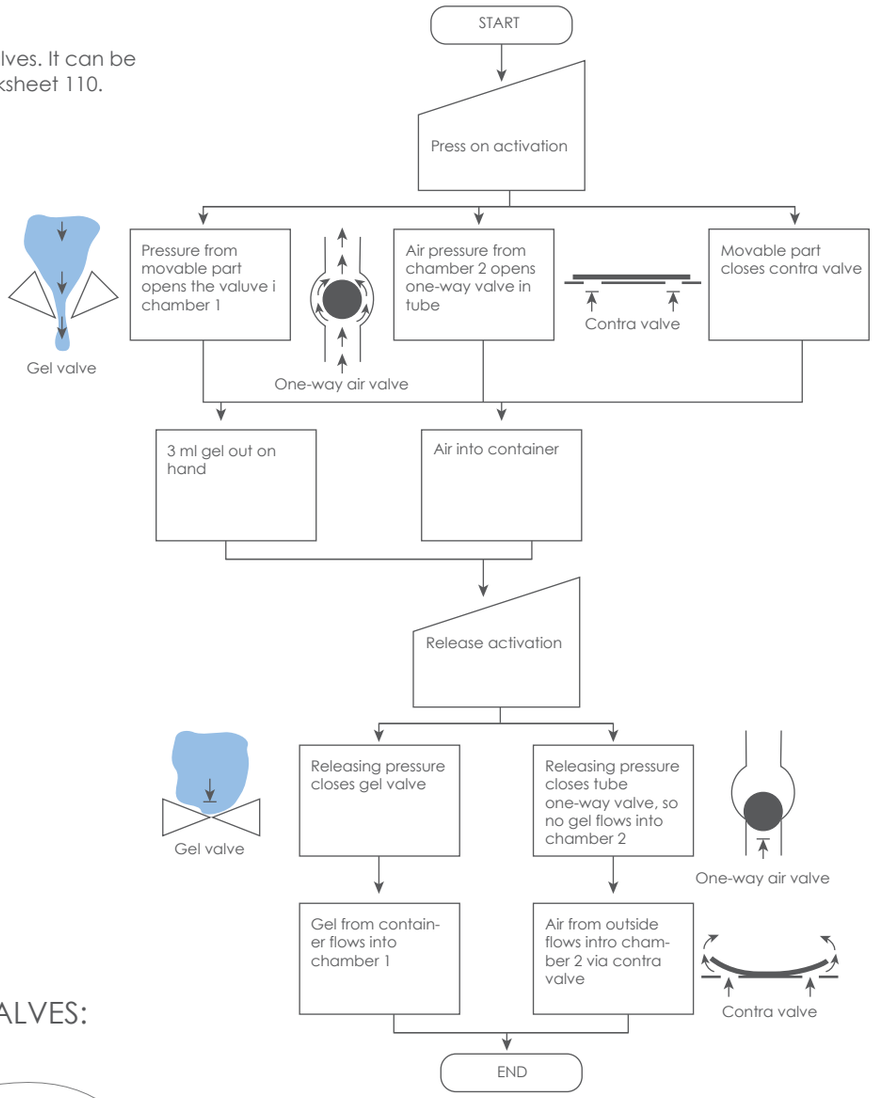
The pressure that is needed to open the valve had to be found before the air pressure could be determined (Ill. 85.2). The only known force was the gravity. The mass of the gel will change when the device is used during the day, but because the gel has a thicker viscosity than water the viscosity force will affect the system, and a constant air pressure can be used. This air pressure is something that will need to be tested with a functional prototype and this will be done in collaboration with Nordic Sense, when the product is further developed. Therefore the air chamber is decided to be the same size as the gel chamber and the air pressure can be changed.



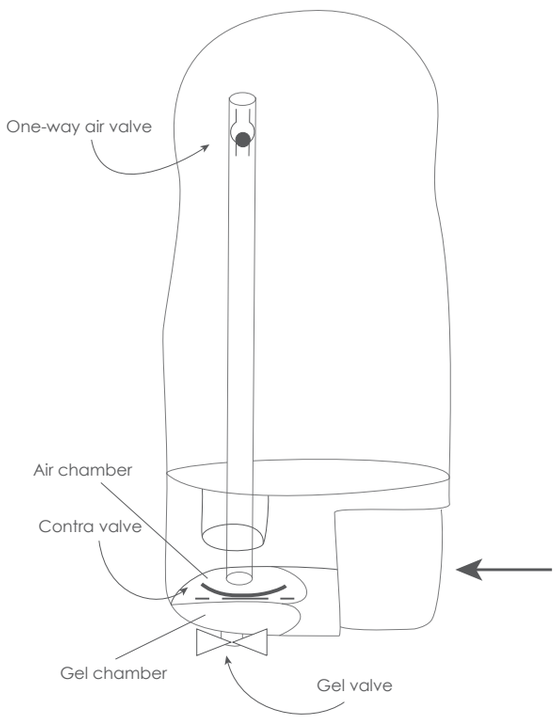
Ill. 85.2 - The forces that are in play when the gel comes out.

Ill. 85.3 - The setup where the ketchup is pushed out through the valve in the bottom of the left chamber.

Ill. 86.1 - A flowchart of the valves. It can be seen in a larger version in worksheet 110.



OVERVIEW OF THE VALVES:



Ill. 86.2

CONCLUSION

The activation with pressing on two chambers works well. Pressure on the two chambers with the movable part in the activation allows air to flow into the container and gel out of the gel chamber. Releasing the pressure allows new air into the air chamber via a contra valve. In the end of the air tube there need to be a one-way valve, so gel does not flow into the air chamber.
The tests with the functional prototype will determine how much air pressure will be needed.

The connection between the gel chamber and container is through the thread, therefore there is no need for a tube here. The air tube needs to be fastened to the air chamber, that allows the home nurse to change the container without moving the tube or connecting two separate tubes.

CHAMBER DESIGN

The new pressure solution demanded two chambers instead of one (W107). The extra chamber with air needed to be added and it was tested how the chambers would act when pressure was applied from one side.
From worksheet 96 it was discovered that a small diamond shape (Ill. 87.1) was the best solution when the chamber was squeezed. Furthermore it was concluded that

- The sides should not be straight, because when squeezing the movable part gets harder when the material is folded straight
- The chamber should have a small bottom, so minimum material is fasten to the shell
- Diagonal sides make the best fold, because the material are not squeezed together as with straight sides
- The thickness should be around 0.80 mm so it is easy to squeeze and the material does not break

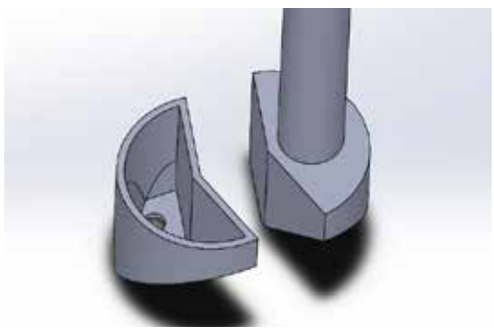
Ill. 87.1 - The optimal shape for the chamber.

Ill. 87.2 - The first design for the two chambers.

The diamond shape from the previous tests, were used and split into two chambers. The first design where both chambers had a straight wall where they intersected. This meant that the bend of the walls where impossible to control.
Therefore the walls where changed so they both had a small bend (Ill. 87.3), which meant that they would bend into eachother at excactly that bend (Ill. 87.4).

Ill. 87.3 - The new and bend walls.

Ill. 87.4 - The folding of the chambers is controlled by the bend.



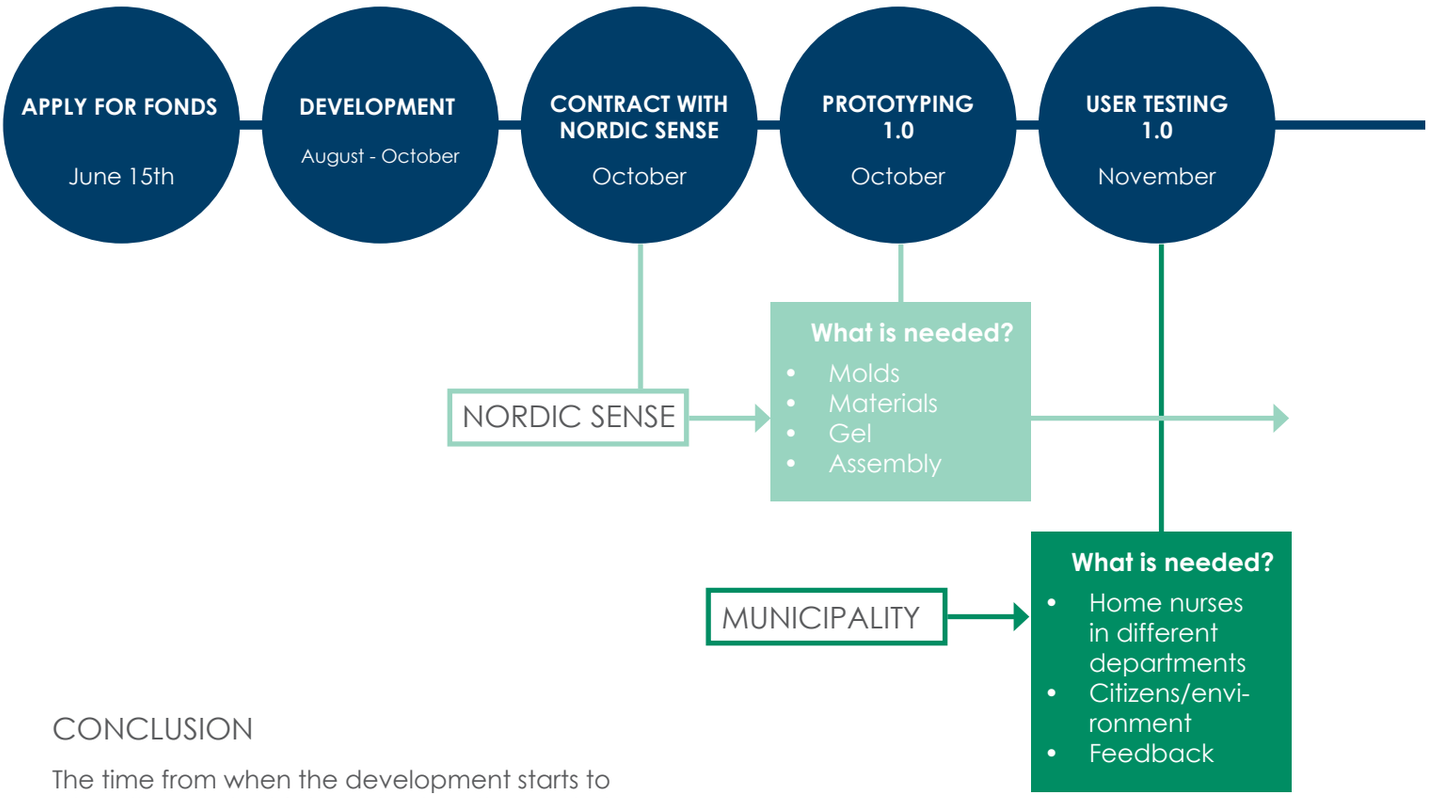
Ill. 87.5 - The two new chambers.

The final design of the two chambers were drawn in 3D (Ill. 87.5) and made sure that they fit the thread in the activation. The air chamber has an opening for the pipe. The gel chamber has a hole in the bottom and at the top.

ACTIVITY PLAN

The activity plan for how to launch the new product into the market and what partners are needed along with their tasks were made. The overall activity plan is for Pure Hands.

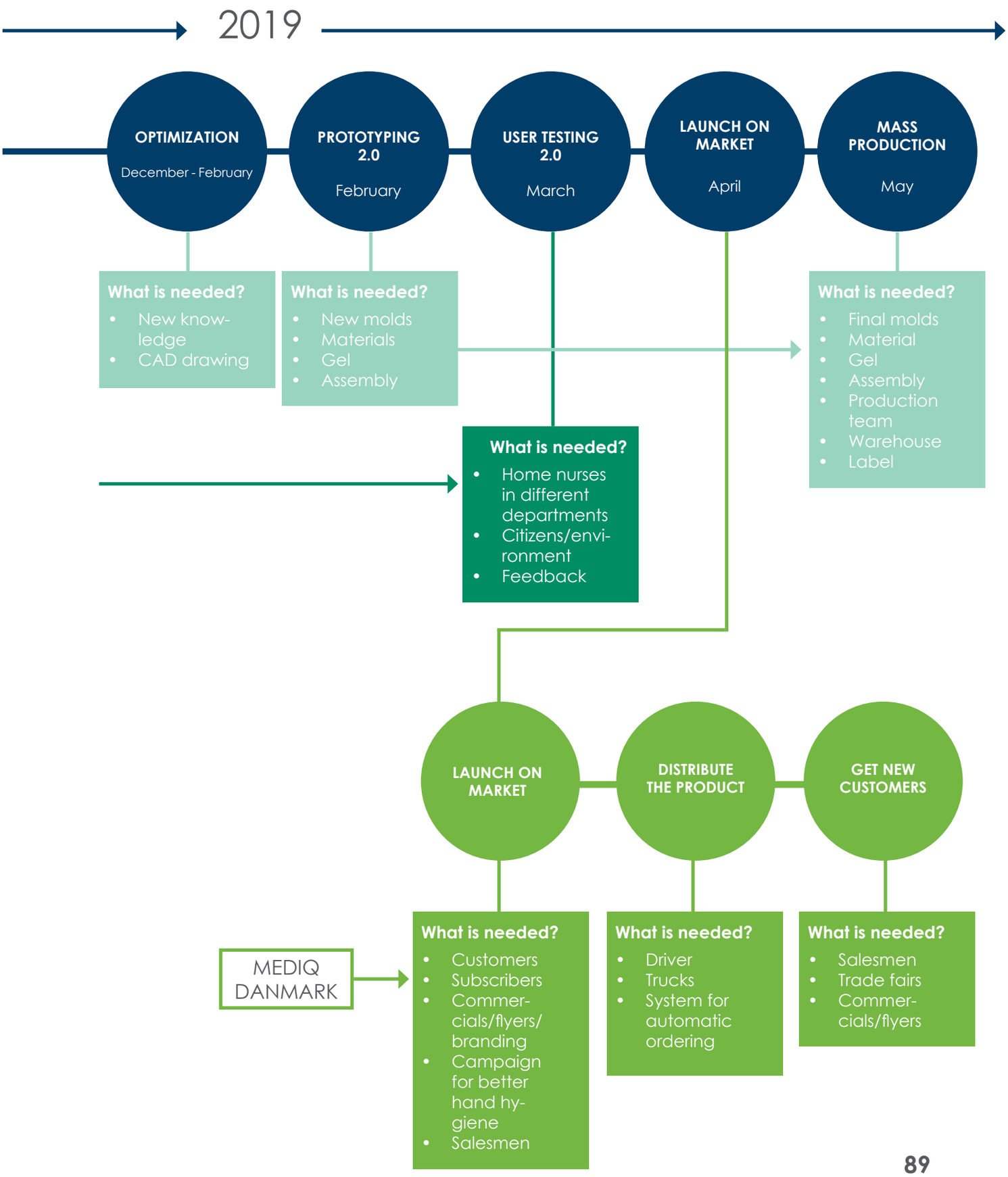
2018



CONCLUSION

The time from when the development starts to when the product is launched on the market is approximately eight months. There will be conducted two user tests with home nurses in the municipalities, so Pure Hands needs to be in contact with the municipalities. Depending on the outcome there might need to be more user tests and more optimization and this will shift the activity plan.
Nordic Sense will assist Pure Hands in the development and prototyping phases, because they have the knowledge and equipment that is needed for production. Their previous collaboration with Mediq Danmark is also a key resource for getting the new product to the right market with success.

From a previous case with a competing product; YellowOne Handsafe it has been observed that the product is not being mass produced and is not found in the hospitals like they had hoped. The final user tests were conducted but not documented on their website as promised. There might have been issues with the product in use. The hospitals have chosen not to purchase the product.


2019
OPTIMIZATION
December - February
PROTOTYPING 2.0
February
USER TESTING 2.0
March
LAUNCH ON MARKET
April
MASS PRODUCTION
May
What is needed?
New know-ledge
CAD drawing
What is needed?
New molds
Materials
Gel
Assembly
What is needed?
Final molds
Material
Gel
Assembly
Production team
Warehouse
Label
What is needed?
Home nurses in different departments
Citizens/envi-ronment
Feedback
LAUNCH ON MARKET
DISTRIBUTE THE PRODUCT
GET NEW CUSTOMERS
MEDIQ DANMARK
What is needed?
Customers
Subscribers
Commer-cials/flyers/ branding
Campaign for better hand hy-giene
Salesmen
What is needed?
Driver
Trucks
System for automatic ordering
What is needed?
Salesmen
Trade fairs
Commer-cials/flyers

NPV CALCULATION

Net present value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows over a period of time. NPV is used in capital budgeting to analyze the profitability of a projected investment or project. If the NPV is positive it means that it is a project that will give a profit by covering the costs and more. (Kurt, n.d.)
The estimated costs of starting up the business for the new hand sanitizer is illustrated using the NPV (Net Present Value) models. The full calculations can be found in worksheet 82.

PURE HANDS

Pure Hands pays for the development of the product for two months, and then make a contract with Nordic Sense, who then pay Pure Hands to develop the product further. Pure Hands get an upfront payment to cover the previous expenses, and a utility model (small patent) so only Nordic Sense has the right to sell the product. (Patent- og Varemærkestyrelsen - Rettigheder, 2016) Pure Hands does not pay any rent for location under the collaboration because Nordic Sense pays for it, so the two partners get an office at Nordic Sense's headquarter in Silkeborg.
Pure Hands gets 5% of the sales by Mediq Denmark, which gives Pure Hands a profit on 13.584,60 dkk per month after the launch of the product. With this profit the designers at Pure Hands have to take on other projects to get more money. It could be a new product for Nordic Sense, so they maintain their collaboration and expand their common knowledge.

NORDIC SENSE

Nordic Sense already has machines for injection moulding and injection blow moulding, but they have to pay for new moulds to fit the new design. The first mould is more expensive because the design of the parts are unique and the second prototyping only has small adjustments to the mould after the optimization. Nordic Sense has to manufacture 5880 container each day, so they use 16 hours every day to keep up with the needed amount. They have to manufacture 50 magnet clips and 50 activations each day, so they only use the injection moulding machines in totally 8 hours per day for this task.

MEDIQ DENMARK

Mediq Denmark is a partner to Nordic Sense where they run the sales part of the project. Mediq Denmark needs 5% of the income for branding the product and has to pay two salesmen to cover the market in Denmark. Mediq Denmark need to outsource an automatic subscription system to deliver containers to the municipalities. Mediq Denmark has a monthly outcome on 5.000 dkk to maintain the subscription system. Mediq Denmark pays the amount of units that is needed for the municipality from Nordic Sense for a price that is smaller than the sales price.

	injection moulding		injection blow moulding	
Produced	120,00	per hour	360	per hour
Sales Price	26,69	Dkk per unit		
Materials Cost	3,63	Dkk per unit		
Salary and Wage (2 persons)	208,00	Dkk per hour		
Opening hours	8,00	hours per day		
Operations cost	1,06	Dkk per unit	0,18	Dkk per unit
Cost price	5,93	dkk per unit		
Sale	5880	containers per day		
	50	clip/activation per day		
Mold	100000	dkk per mold		

Ill. 90.1 - An overview of the numbers used in the NPV.

	Time	Development	Upfront payment	Utility models (brugsmodel)	Usertesting, optimization	Profit (5% per sold unit)
Year	0					
January	1	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.
February	2	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.
March	3	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.
April	4	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.
May	5	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.
June	6	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.
July	7	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.
August	8	-33.280,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.
September	9	-33.280,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.
October	10	0,00 kr.	200.000,00 kr.	2.000,00 kr.	33.280,00 kr.	0,00 kr.
November	11	0,00 kr.	0,00 kr.	0,00 kr.	33.280,00 kr.	0,00 kr.
December	12	0,00 kr.	0,00 kr.	0,00 kr.	33.280,00 kr.	0,00 kr.
Year	1					
January	1	0,00 kr.	0,00 kr.	0,00 kr.	33.280,00 kr.	0,00 kr.
February	2	0,00 kr.	0,00 kr.	0,00 kr.	33.280,00 kr.	0,00 kr.
March	3	0,00 kr.	0,00 kr.	0,00 kr.	33.280,00 kr.	0,00 kr.
April	4	0,00 kr.	0,00 kr.	0,00 kr.	33.280,00 kr.	0,00 kr.
May	5	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
June	6	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
July	7	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
August	8	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
September	9	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
October	10	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
November	11	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
December	12	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
Year	2					
January	1	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
February	2	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
March	3	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
April	4	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
May	5	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
June	6	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
July	7	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
August	8	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
September	9	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
October	10	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
November	11	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
December	12	0,00 kr.	0,00 kr.	0,00 kr.	0,00 kr.	13.584,60 kr.
NPV=	**553.836,60 kr.**	-66.560,00 kr.	200.000,00 kr.	2.000,00 kr.	133.120,00 kr.	285.276,60 kr.

Income

163.015,20 kr. per year
13.584,60 kr. per month

Ill. 91.1 - NPV calculation for Pure Hands for the first three years.

PLAN B

Pure Hands is handling prototyping, usertestings, optimization and branding themself and outsourcing the manufacturing to another company than Nordic Sense. Pure Hands has to pay the manufacturer for the production who gets 20% extra payment for maintaining machines and so on. Pure Hands does also pay for the three moulds.
Pure Hands does not sell the same amount of units each day, so the manufacturing is not as big as well. The reason is that Pure Hands needs to draw a new contract with the municipalities that might already have a contract with Mediq Denmark, and needs to step into a market with many competitors.
To make this scenario succeed Pure Hands has to loan money or seek other partners or sponsors to invest in this project.

CONCLUSION

Plan A has the best odds because Pure Hands might get a better product in collaboration with Nordic Sense who already has knowledge and resource to optimize the design that Pure Hands has at the beginning. Nordic Sense is selling the product through Mediq Denmark who is already on the market and has contracts with municipalities in Denmark. The lowest risks for Pure Hands also lies in plan A, because all the rights are sold to Nordic Sense.

The NPV models are only estimations of the needed amount of units. If the plans need to succeed both Mediq Denmark (in plan A) and Pure Hands (in plan B) have to sell the needed amount and the home nurses have to use the needed amount of gel each day.

The new gel dispensing device consists of different components where most of them are a part of the activation. The activation is a special part in itself and is a bit complicated. The components are small and need to fit each other to get the most smooth interaction.

MAGNET CLIP

The magnet clip is made of silicone. The material is good for absorbing shocks (W51) and is very flexible. It has a soft and rubbery tactile feel, which is a good characteristic when working with contact to skin (W93). (Lefteri, 2014) To make the clip magnetic, two magnets are mounted inside the clip in one side and two stainless steel pieces are mounded inside the other side. The clip are manufactured by injection moulding where material is heated and injected into a mould and then cooled down and detached from the mould. (Lefteri, 2013) The four small pieces are placed in the mould before the silicone gets injected into it.

ACTIVATION

The activation part is mostly made of polypropylene (PP) which is the best plastic for withstanding repeated actions without shearing. (Lefteri, 2014) The material is recyclable and already used for the cap of Ceduren by Nordic Sense. The no shearing ability is good for the activation because it repeats the same action up to 180 times per workday (W18).

MOVABLE COMPONENT, FIXED PART, SHELL AND THREAD

These components are also manufactured by injection moulding in separate moulds.
Inside the shell, the contra valve is placed in the air chamber's position. The contra valve consists of small holes and a silicone piece glued to the shell to close the holes.
The movable component is attached via a path in the shell and a small piece that sticks up on the movable component where a spring is attached to get the component to the start position. Underneath there is also a path and a small piece that runs in this.
The thread is glued to the fixed part inside the shell.

THE BACK PLATE

The back plate is also made by injection moulding polypropylene. The plate has a small steel part inside, so it can be placed on the magnets in the magnetic clip. The back plate is fastened to the shell with a steel part, that can stick to the other magnet on the magnetic clip.

CHAMBERS

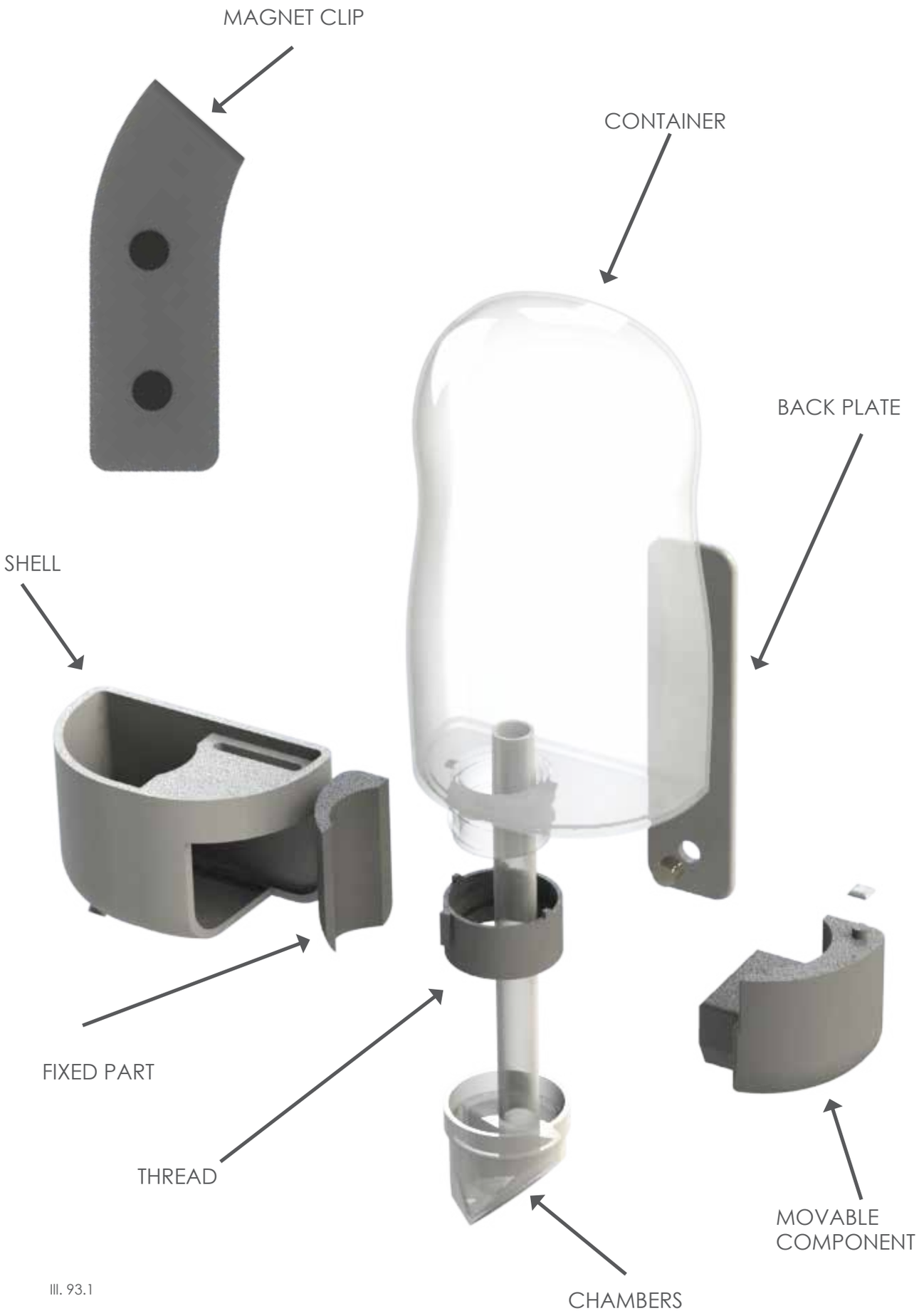
The components are made of silicone, and manufactured by using injection moulding. The tube attached to the air chamber needs to be in a more stiff material so it does not bend, so it is made of PP. In the end of the tube there is a one-way valve.

CONTAINER

The container that holds the gel is made of high density polyethylene (HDPE). Nordic Sense already uses this material to manufacture the container for Ceduren. HDPE is a tough material with low friction and low water absorption which is good characteristics for a bottle with alcohol gel inside and it has a thread to fasten it to the activation. (Lefteri, 2014) The material is recyclable, which follows Nordic Sense's environmental values and the mass production of containers.
The container is manufactured by injection blow moulding with an injection-moulded pre-form with a thread at the neck. Compressed air gets injected into the pre-form that is placed inside a mould. The air blows up the preform and forces the material against the mould that shapes the form of the container. (Lefteri, 2013) The container gets released from the mould and is ready for the next step.
The next step is to place stickers on the container to illustrate the guideline.
The sealing is glued to the top of the container thread. The sealing is manufactured by injection moulding.

Most components are made by HDPE or PP, because Nordic Sense already knows the materials' abilities and already is using these for the Ceduren bottle.
Silicone is used because it is comfortable to the skin, flexible and has a smooth tactile feel. PP is good for repeating actions and this ability is good for the activation.

Injection blow moulding has small sustainability issues which is that the pre-form is heated twice, so its energy is used twice: making the pre-form and making the container. Therefore it is important to use a tough material as HDPE for this container, so it will not fail and leak gel. No material waste and recyclable of the manufacturing method which follows Nordic Sense's environmental qualities.


MAGNET CLIP
CONTAINER
BACK PLATE
SHELL
FIXED PART
THREAD
CHAMBERS
MOVABLE
COMPONENT

Ill. 93.1

06. EPILOGUE

CONCLUSION ON PROCESS

The process of this project has lasted almost four months. During this time the home nurses have been visited four times. In the beginning it was important to find the core problem, before a new product could be designed to solve the problem about bad hand hygiene. There was already a good base from the research about how multiresistant bacteria are spreading and that we should avoid this by encouraging to perform correct hand hygiene. Through interviews and a survey it became clear that it was a behavioural problem, where the home nurses had their own perception on when they needed to disinfect and for how long. But it was also a question about forgetting and also a time issue.
This insight, combined with all the research on the topic, lead to a mission for the project that was; to design an easy accessible device that gives the right dosage, and hereby make sure that the disinfection is performed correctly. The easy accessible part has been a key feature for each of the many ideations, where new places to place the device has been explored. For a long period of time it was the belt and chest concepts that were meant to solve this in the best way. These were the places on the body where the new device made sense to place, but ultimately the belt concept was discarded because it was going to be in the way during too many activities. In ideation 5.1 the final idea with the magnetic clip was found and all of the problems with the chest concepts and how it would enhance certain body parts went away.
It was a breakthrough to have the basic idea settled and the many tests that were done afterwards made a lot more sense.
The functionality was an important factor for the home nurses as well for Pure Hands. Therefore the activation had to be solved before the aesthetics could follow. The final product still needs to be tested by the home nurses, but it is designed from all of their feedback from previous visits and the survey.

CONCLUSION ON PRODUCT

The Etaren hand sanitizer device is a simple but highly functional product, that the user can trust. All of the parts in the product are carefully picked and tested, so nothing is left for chance. User friendliness and ergonomics have been considered in the interaction design. The product is designed for the Danish home nurses, but it is an universal solution, that can easily be spread to regular nurses, other employees in the health section and even wider. It is designed to have the magnetic clip placed on a t-shirt and the device on another shirt, but it can easily be used with only one layer of clothes as well. The threads and the pump system (in this device it is sideways) are features that are well known from other places and therefore intuitive to use. The placement of the back plate is making the changing of a new container very easy, since the user does not have to remove or turn this before.

REFLECTION ON PROCESS

Throughout the process a lot of mock-ups has been made. These have been used in user testing, field studies and for testing different functionalities. It has been a great hands on approach, but it has been difficult to find the right materials or materials that were similar to the right ones. When working with liquid it has been hard to make mock-ups that did not leak and at some point we needed to make an air tight mock-up. This was almost impossible to do with the resources we had. We have been looking and seeking inspiration from many different products that we already know. This was partly because we knew how they functioned, but also because it was most likely products that the home nurses also knew how to use/wear.

In the beginning we were certain that we needed to make a product that the home nurses did not touch at all and thereby make it electrical. This resulted in many problems and a doubt from the home nurses about if they could trust that the product would not malfunction. Then they could not get any alcohol gel at all or what?
Another place we got stuck was that we wanted the home nurses to wear something around the upper torso, so the device could be placed on the chest. This was something we tried to improve on many times before we came up with the magnetic clips, that was far more discrete to wear.

The home nurses in the municipality of Jammerbugt have been the main basis for the target group and they have given us valuable feedback on our ideas. They were, however, on a tight schedule to make it to every patient, so we sometimes had to talk to them during their lunch break and they did not have time for very in depth answers, but that is why we contacted the private home nurse, who had experience from working in a hospital as well.
To get even more feedback it would have been good to get in touch with other municipalities and see how they were disinfecting, but when reading about YellowOne Handsafe, it was clear that it was a problem with the accessibility and forgetting to disinfect that were to main issues. The designer behind YellowOne Handsafe has gathered research in a hospital for several years.
From the last visit before the product was finished a long period of time had passed. Therefore the home nurses have not seen the final product, and we would like to get some feedback on it. We have scheduled a visit after the hand in.

For the final stage of the process we would have liked the home nurses to test with a prototype that works. We spend a lot of time in the end on the detailing phase and solving the last problems with the product, so we ran out of time. It is, however, the plan to test with prototypes in the near future.

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ILLUSTRATIONS

The illustrations not listed below are of own production.
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