EEWA

Efficient washing

PRODUCT REPORT

Master thesis project
MSc02, Industrial Design
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Title page

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Abstract

This master thesis project focuses on personal hygiene and how to efficiently wash yourself, with a focus on biking commuters and crowded family bathrooms. The project was initiated as a submission to the 2016/2017 Jumpthegap contest, where emphasis has been on sustainability and the future of the bathroom space. Today up to 74 % of Danish people shower six or more times each week, which results in the natural oils and bacteria on the skin being washed away too often, causing an increased risk of infections and dry skin. The project resulted in the product called EEWA, which can be used as a substitute for half these daily showers. It provides a gentler and more efficient washing of the body by focusing on cleaning the essential body areas; the armpits and the crotch.

Ida Schütt Madsen

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Introduction

Water is one of the most important resources, and crucial to maintaining life on earth, but as all other resources there is a limitation. In fact, only 3 % of the water on earth is fresh and of those, 2.5 % is frozen, leaving only 0.5 % of liquid fresh water. Therefore, it is crucial to reduce the human-induced water consumption (UNESCO, 2003)

74 % of Danish people shower six or more times a week (b.dk, 2009), mainly due to habit and not necessity. This is a habit that needs to be dealt with to lower the water consumption. Currently, many products deal with reducing water consumption, as for example water saving thermostats and shower head saving up to 53.33 % water (Bolius.dk, 2016). However, only a few products attempt to prevent people from showering, even though this would be the way to go to make a real difference in lowering water consumption drastically.

This project aims to create an alternative solution to the daily shower, only focusing on washing the essential body areas; the armpits and the crotch. It tries to break down the physical constraints of the bathroom by making a portable solution that can be brought and used anywhere. Even in places with no access to water. It provides the user with the possibility of getting a more sustainable life style, saving both water, money and time.

EEWA

Efficient washing

EEWA is the portable washing solution used for everyday hygiene of armpits and crotch. It contains a water reservoir making it possible to use anywhere, even in places with no access to water. This makes it ideal for people on-the-go or as a way of solving the bathroom puzzle many families face every morning.

A pump moves a mix of water and a mild cleaning agent from the water reservoir to the washing surface at the top, making the user able to wipe off sweat and bacteria. This leaves the user with a feeling of being clean and ready for the coming day, the important client meeting, or after a strenuous bike ride.


EEWA

Problems and values

Problems

Values

Showering too much

Up to 74 % shower at least six times a week. This is huge waste of resources, both in terms of water, which has environmental consequences, and for your personal economy.

Saving resources

Reducing the number of showers results in savings in terms of water, which causes savings in terms of money. Both benefitting the environment and the private economy.

Hygiene equals bathroom

Today most hygiene related activities take place in the bathroom. This can create challenges, when the bathroom is occupied or when you are not near a bathroom.

Portable

EEWA's size and materials makes it both portable and durable, allowing you to wash yourself anywhere in the house or on-the-go.

Using too much soap

Soaping up daily removes the natural oils and bacteria on the skin. Natural oils and bacteria helps keeping the skin healthy and moisturised and a too frequent removal of these will dry out the skin, increasing the risk of skin infections.

Benefits the skin

EEWA uses a so-called soapless soap, which is a Syndet that helps preserve the skins natural pH and keeps the skin moisturised.

Sweaty and smelly

Arriving at work all sweaty from the bike ride might cause some people to stop taking the bike to work. This can lead them to take the car or public transportation emitting more CO2 and thereby becoming less environmentally friendly.

Confidence

EEWA does not just kill the bacteria causing unpleasant body odour as deodorants do, it wipes off both bacteria and sweat liquids, leaving the skin clean and without a sticky feeling. This leaves you with the confidence to conquer the day ahead.

Use scenario

1. Remove bottom cap

Remove the bottom cap by turning it to acccess the water reservoir.

2. Fill with soap

Dispense one pump of the syndet soap into the water reservoir.

3. Fill with water

Fill the water reservoir with water until full.

4. Remove top cap

Remove the top cap to access the washing surface area.

5. Attach washing surface

Attach the washing surface by pressing the tongue on the washing surface into the groove on the device.

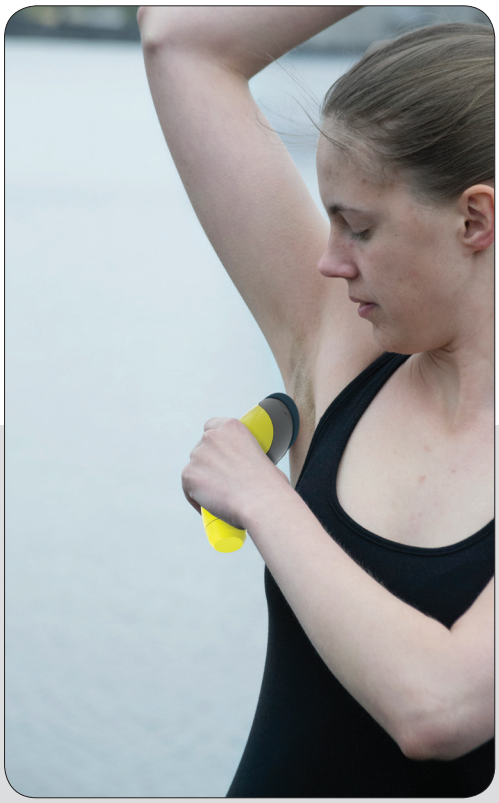
6. Activate the device

Push the activation button to activate the device.

Use scenario

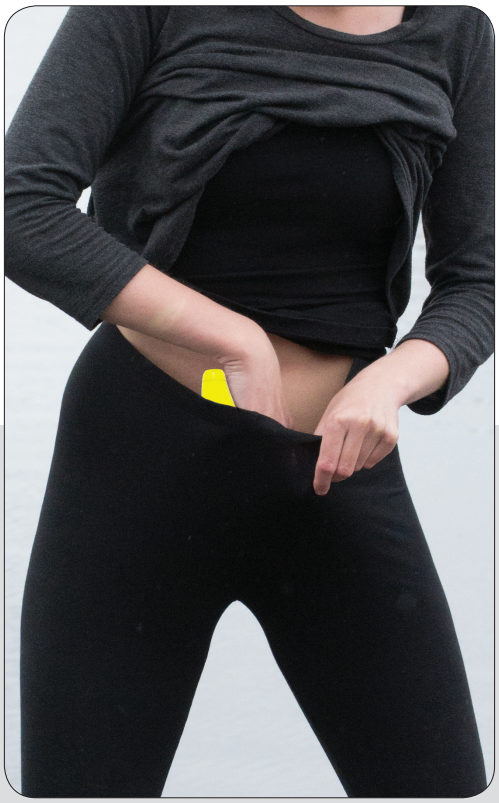
7. Activate the device

The LED around the activation button lights up to indicate activation



8. Use in armpits

Wipe sweat and dead skin cells from the armpits.



9. Use in crotch

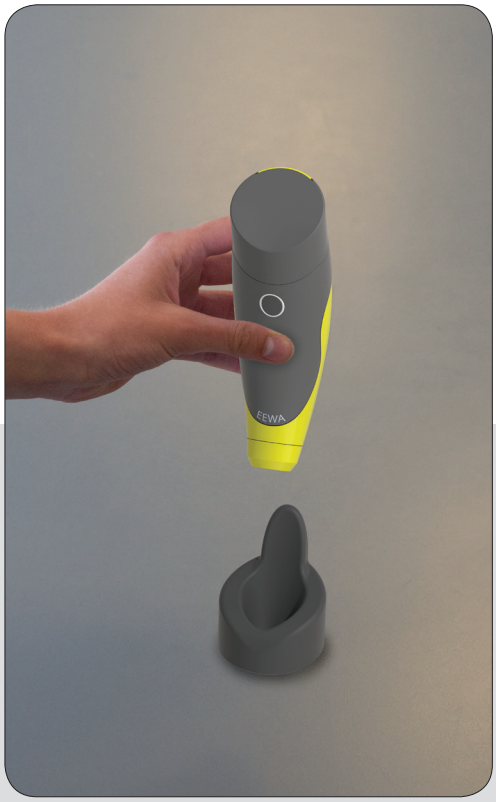
Wipe sweat and dead skin cells from the crotch.

10. Remove used washing surface

Remove the used washing surface by pulling it off from the top.

11. Put on the top cap

Put on the top cap to cover the washing surface area.



12. Place EEWA back in the dock

Place EEWA in the dock and leave it to the next user.

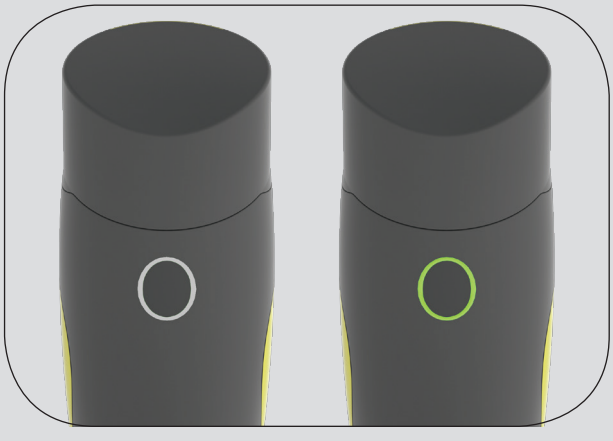
Functionality

Charging

EEWA needs to be charges every few months. Charging in done by plugging in a micro usb on the back of EEWA. The usb is covered by rubber to prevent water getting in.

Activation indication

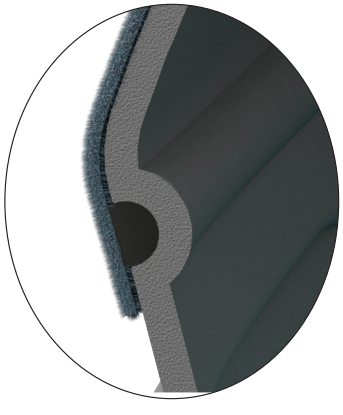
When EEWA is not activated the LED around the activation button is not lit, and will look white. When the activation button is pushed, the LED will light up in green for the two seconds it is activated.

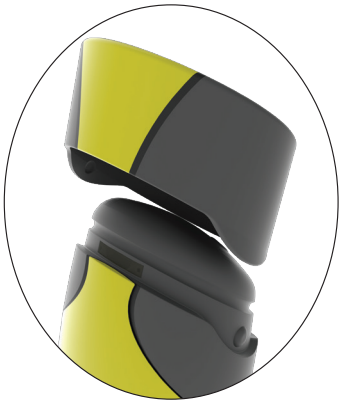


EEWA not activated EEWA activated

Attaching washing surface

Displayed as a section view, where the grey area is the plastic shell, the black is the rubber cord stitched inside the blue washing surface. The rubber cord acts as a tongue that fits into the groove around the top area of EEWA.





Cap

The cap is used to protect the washing surface, and to make it easy to bring EEWA in for example a bag. It is attached using a click mechanism placed on the sides.

Power indication

When EEWA's battery is running low the LED placed around the activation button lights up in red. When it is charging, the LED will pulsate in green, and light up in constant green when EEWA is fully charged.

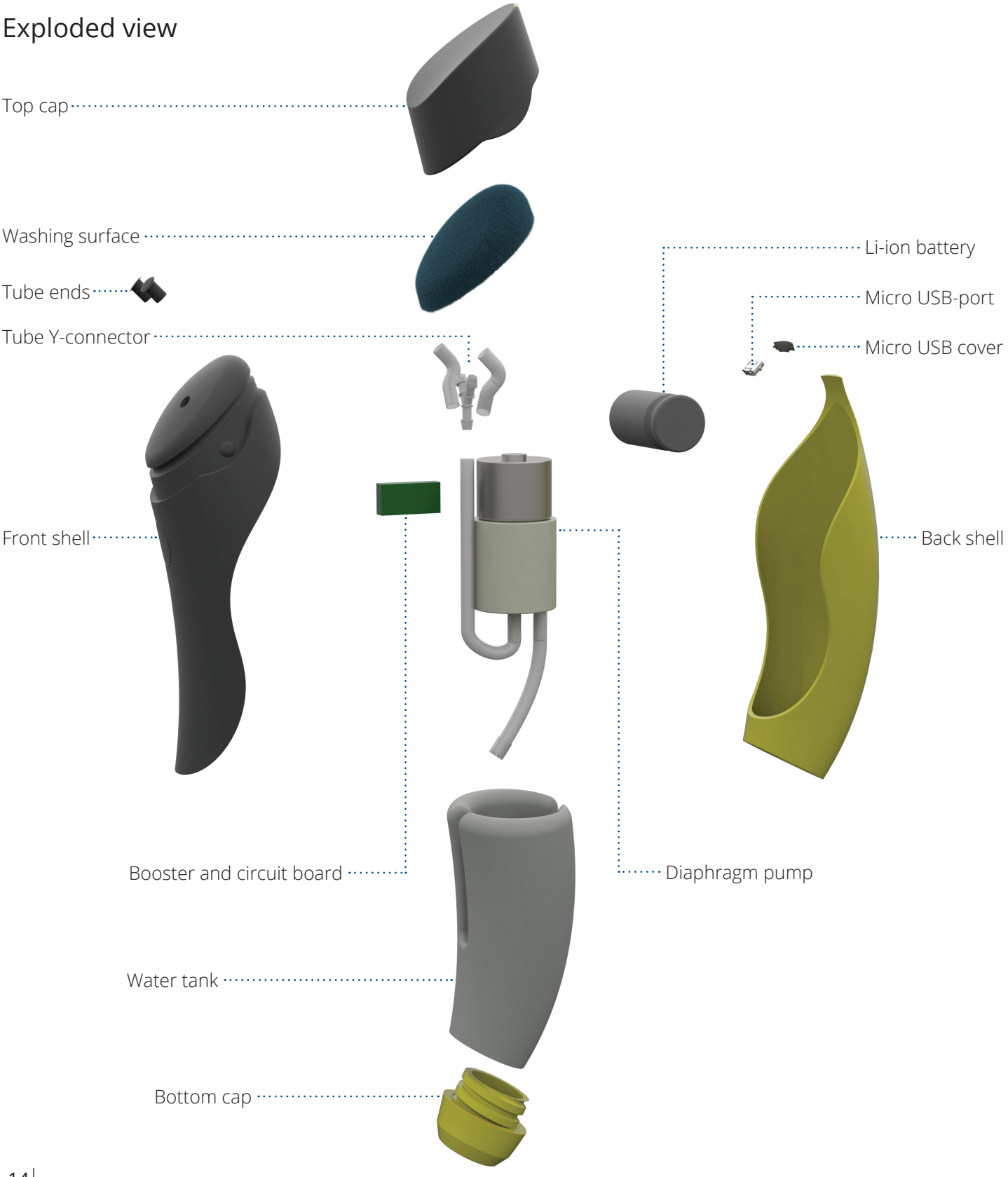
Battery low | Battery charging | Battery charged

Refilling

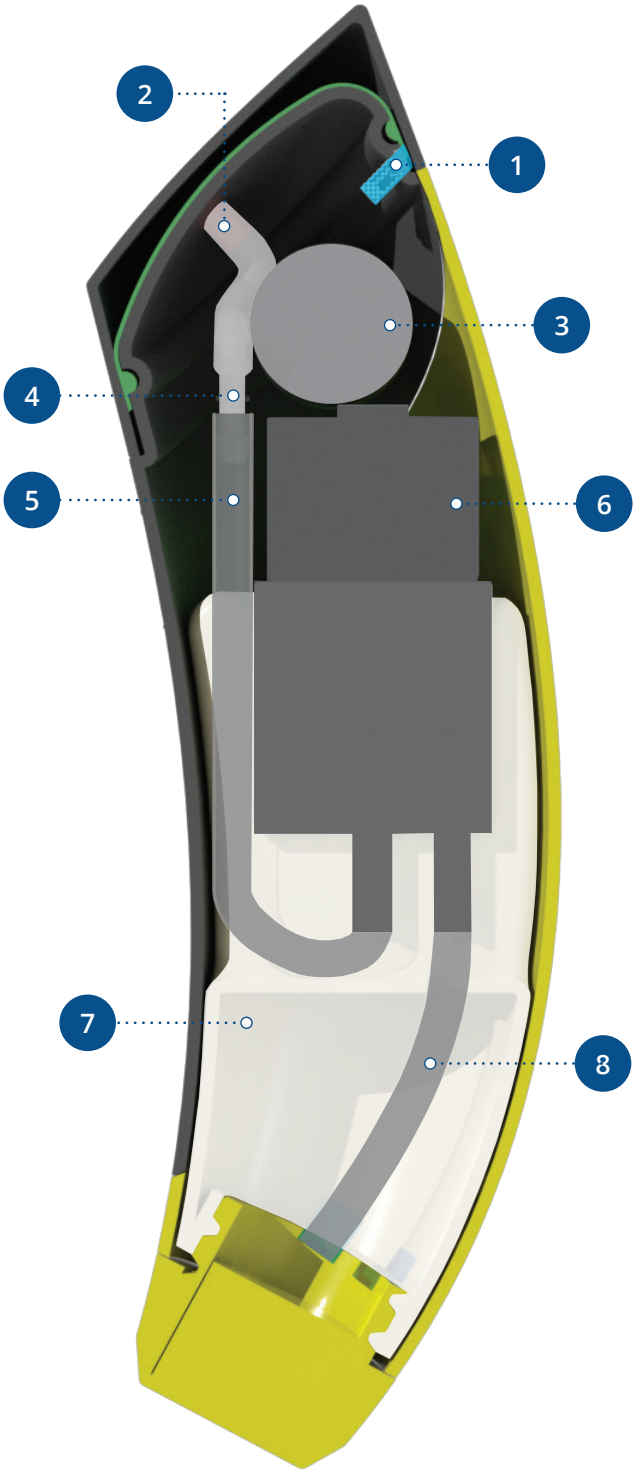
EEWA's water reservoir is accessed through the bottom cap. The bottom cap is screwed directly into the water tank, ensuring a water tight fit.

Construction

Exploded view



Section cut



1. Micro USB
2. Tube ends
3. Battery
4. Tube Y-connector
5. Tube connecting pump with Y-connector
6. Diaphragm pump
7. Water reservoir
8. Tube connecting pump with water reservoir

Buying EEWA

Buying options

EEWA starter package

1x	EEWA washing device
1 x	EEWA docking station
4 x	Washing surfaces (cloth)
4 x	Washing surfaces (sponge)
1 x	100 ml syndet soap
1 x	Charging cable
1 x	Washing bag

499 DKK

Additional

10 x	Washing surfaces (cloth)

79 DKK

10 x	Washing surfaces (sponge)

89 DKK

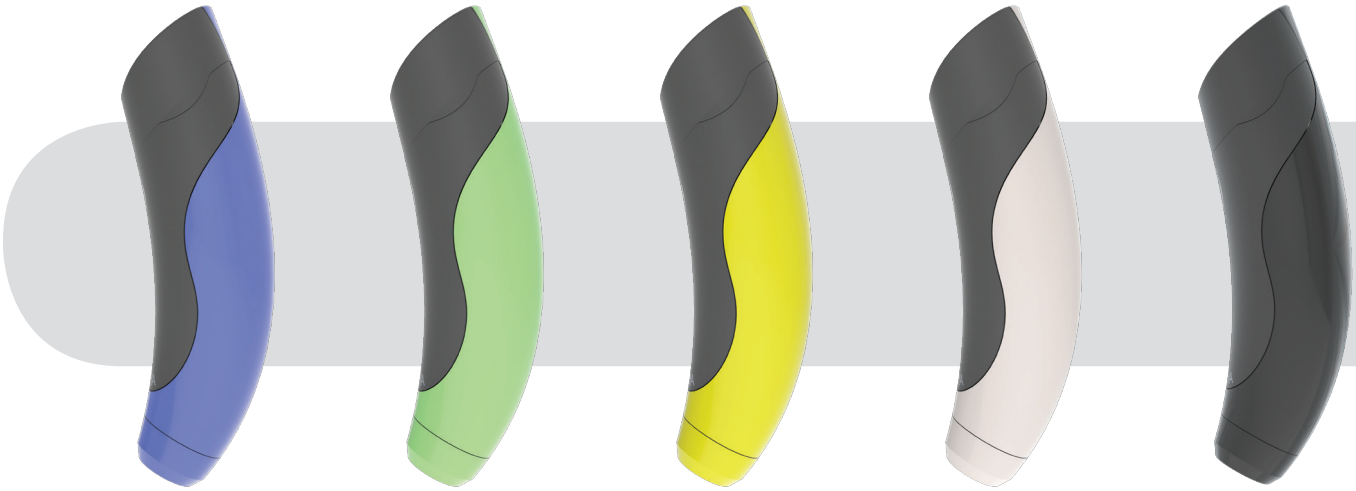
1 x	100 ml syndet soap

49 DKK

EEWA can be bought in stores like Matas, Salling and Magasin as a kind of lifestyle product.

It can be bought as a starter package as seen below, which contains all necessary elements to start using it. Beside from this additional washing surfaces and soap can be bought, as it will be required to renew the washing surfaces occasionally, and soap will need to be refilled. Over time it could be considered to develop a subscription service, where washing surfaces and soap is send directly to the user with a certain time interval. However, this is not going to be implemented during the first year of sales.

EEWA is sold in a range of different colour combinations accommodating the users' wishes.




EEWA
499 DKK

Business plan

Product price

The business plan is based only on asset sales of starter packages, which means that sales of additional washing surfaces and soap is not a part of the budget and breakeven analysis. The product cost of 147 DKK is based on material costs, component costs and salary to production and assembly employees. The team takes 50% in contribution, which is deemed reasonable. The product is sold through a wholesaler, which distributes it to retail stores. This results in a product price of 499 DKK including VAT.

Cumulative cash flow

Cash outflow

The cash outflow includes investment and variable costs. The investment contains the costs seen in the investment table. The variable costs are calculated from the amount of sold units indicated in the budget table and the product cost, which includes the below-mentioned areas.

Cash inflow

The cash inflow includes all money earned by the company. The turnover is the amount of money that the company gets from selling a number of units to the wholesaler. The sales price is fixed, but the number of sold units is increasing during the three years as the market is expanded to include Sweden on the third year and Germany on the fourth, as can be seen in the budget table. The contribution is the amount of money left when the variable costs have been subtracted from the turnover.

Break even

The break even point is reached when there is the same distance between the turnover and contribution graphs and the zero line and variable costs graph. As seen on the chart, this point is reached after two years and one month, including one year of development.

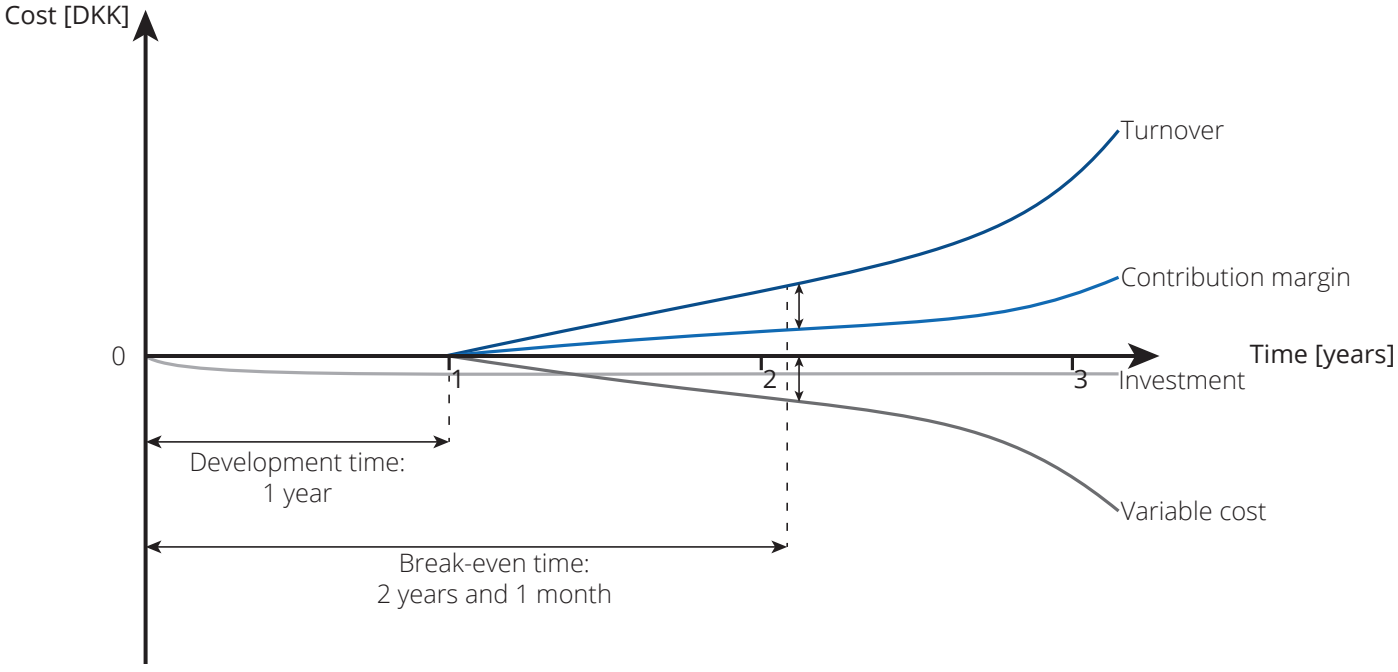
Investment

Development salary	475,000 DKK
Prototypes and user testing	100,000 DKK
Travelling	50,000 DKK
Consultants	100,000 DKK
Website development	100,000 DKK
Tooling costs	500,000 DKK
Buffer	100,000 DKK
Total	1,425,000 DKK

Product cost calculation

Sales price, retail store (incl. VAT)		499	DKK
VAT	25%	99	DKK
Sales price, retail store (excl. VAT)		398	DKK
Contribution, retail store	50%	133	DKK
Sales price, whole saler		265	DKK
Contribution, whole saler	20%	44	DKK
Sales price, company		221	DKK
Contribution, company	50%	74	DKK
Product cost		147	DKK

Cumulative cash flow



Budget

	Year 2	Year 3	Year 4
Parts sold	19,127	41,505	202,760
Turnover	4,227,440	9,173,257	44,813,440
Variable cost	2,818,293	6,115,504	29,875,627
Contribution	1,490,147	3,057,752	14,937,813

Break-even

Investment	-1,425,000	-15,853
Contribution	1,490,147	3,057,752
Return	-15,853	3,041,899

Use EEWA Everywhere


BREEZE 32

EEWA

ARKITEKTUR & DESIGN

EEWA

Efficient washing

PROCESS REPORT

Master thesis project
MSc02, Industrial Design
Aalborg University, May 2017

Ida Schütt Madsen
Kenneth Randløv

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Abstract

This master thesis project focuses on personal hygiene and how to efficiently wash yourself, with a focus on biking commuters and crowded family bathrooms. The project was initiated as a submission to the 2016/2017 Jumpthegap contest, where emphasis has been on sustainability and the future of the bathroom space. Today up to 74 % of Danish people shower six or more times each week, which results in the natural oils and bacteria on the skin being washed away too often, causing an increased risk of infections and dry skin. The project resulted in the product called EEWA, which can be used as a substitute for half these daily showers. It provides a gentler and more efficient washing of the body by focusing on cleaning the essential body areas; the armpits and the crotch.

Preface

This project was developed by group 10 on the fourth semester master at Industrial Design on Aalborg University. The group consist of two people; Kenneth Randløv and Ida Schütt Madsen. It is a 30 ECTS master thesis project developed over a period from February to June.

The project had its point of origin in the design competition Jumpthegap. The project started with a focus on sustainability, and ended up with the focus of trying to change people's washing behaviour today by providing a portable alternative to the regular shower.

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Introduction

Water is one of the most important resources, and crucial to maintaining life on earth, but as all other resources there is a limitation. In fact, only 3 % of the water on earth is fresh and of those, 2.5 % is frozen, leaving only 0.5 % of liquid fresh water. Therefore, it is crucial to reduce the human-induced water consumption (UNESCO, 2003)

74 % of Danish people shower six or more times a week (www.b.dk, 2009), mainly due to habit and not necessity. This is a habit that needs to be dealt with to lower the water consumption. Currently, many products deal with reducing water consumption, as for example water saving thermostats and shower head saving up to XX % (XX, 20XX). However, only a few products attempt to prevent people from showering, even though this would be the way to go to make a real difference in lowering water consumption drastically.

This project aims to create an alternative solution to the daily shower, only focusing on washing the essential body areas; the armpits and the crotch. It tries to break down the physical constraints of the bathroom by making a portable solution that can be brought and used anywhere. Even in places with no access to water. It provides the user with the possibility of getting a more sustainable life style, saving both water, money and time.

Reading guide

This report is the process report describing the process of the project. In addition, a product report is handed in describing the product, along with a technical drawing folder containing technical drawings of the different parts. An appendix is handed in on a USB-stick, and is in the form of worksheets that have been completed throughout the process. Each worksheet is in PDF-format, and in the folder called "Additional worksheets", additional information concerning the worksheets can be found as for example excel-sheets containing calculations. Worksheets are referenced as WS XX. All references for externally found figures can be seem in a list in the back of the report. For all external references the Harvard methodology is used.

The report is divided into six phases; framing, ideation, reframing, concept development, product development and finalising. Each phase is started with one page containing a short description of the content. Each phase is divided into different sections, a green box indicating a section output. The process has been iterative between the different phases. However, it is displayed as a linear process in the report.

The final concept will be referred to as three parts:

- Device = The product the user uses to wash him-/herself
- Docking station = The holder where the device is placed when being at home
- Storage unit = A part used for storing clean washing surfaces

Timeline

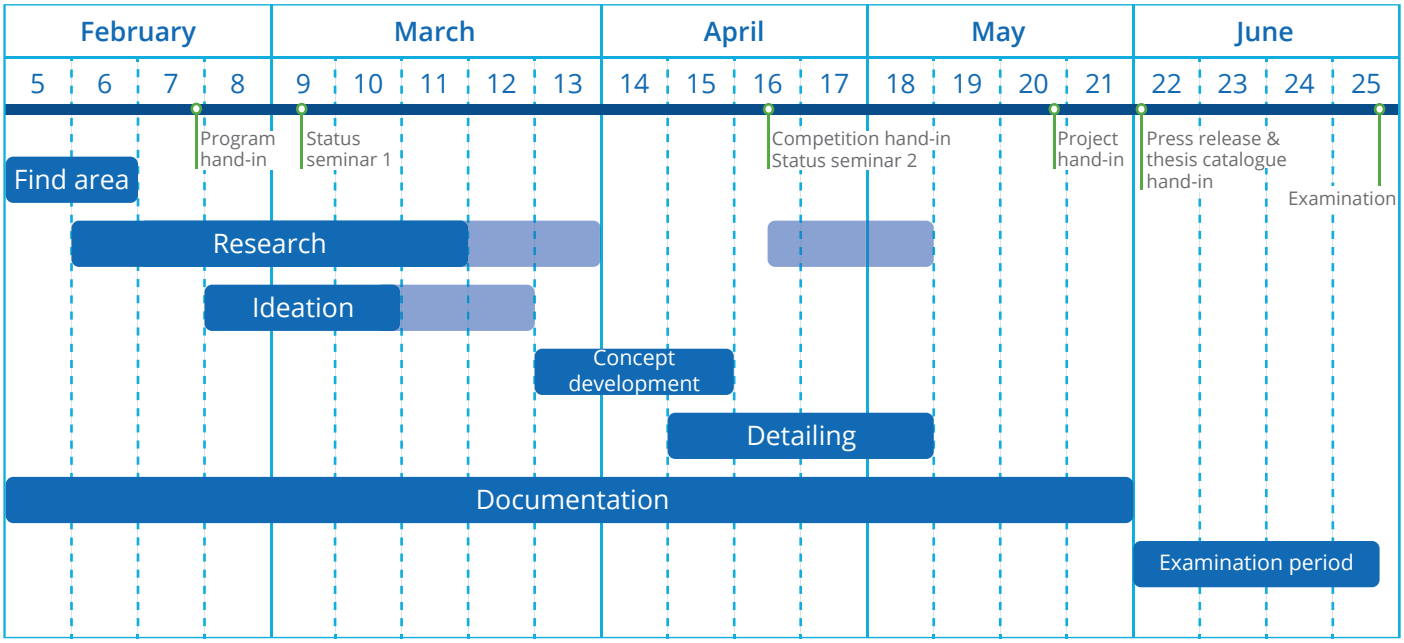


Fig. 1: Time table for the project

Framing

The framing phase consist of the initial research, which leads to the initial frame. It contains the research into designing for a competition along with the process of finding a focus area. Relevant research within this area is performed along with an analysis of the market. The phase is wrapped up with the initial frame containing problem identification, mission and criteria.

Fig. 2: Framing

Design competition

Before starting the master thesis project, the team decided to base the project on a design competition, which ended up being Jumpthegap. To get a basic understanding of the competition, research into Roca that is the company behind the competition and what it takes to win, was initiated.

Jumpthegap

Jumpthegap is an international design competition promoted by the sanitary company Roca. The competition has existed since 2004 and occurs every other year. With an age limit of 35 years for the participants, it is aimed at young designers and architects, as well as students. The competition is about designing innovative and sustainable concepts for the future bathroom space. (Jumpthegap - Roca, 2017)

Fig. 3: W+W from Roca

Roca

Roca is a large international company that produces sanitary products. They are present in 135 countries, and has more than 20,000 employees worldwide. (Uk.roca.com, 2017)
Roca's product portfolio consists of a wide array of different sanitary products like toilets, sinks, bathtubs, and a range of different brassware (Uk.roca.com, 2017). Sustainability is of great importance to Roca. This is reflected in their development of several eco-friendly technologies that are used in their products as the flush-free urinal, cold start tap (Fig. 4), and W+W (Fig. 3) (Uk.roca.com, 2017). In 2008, the Eco-Roca project was developed with the purpose of creating a more sustainable production process with the goals of reducing the CO2 emission and to manage a waste-free industrial process (Uk.roca.com, 2017). Aside from the efforts to make their products and production processes more sustainable, Roca is also the founder and main promoter of the We Are Water Foundation. The foundation has two main goals; to promote awareness for creating a new culture for water, and to carry out actions to counter the negative effects of the lack of water resources. (We Are Water, 2017)

Fig. 4: Cold start tap from Roca

Fig. 5: Cold start tap from Roca

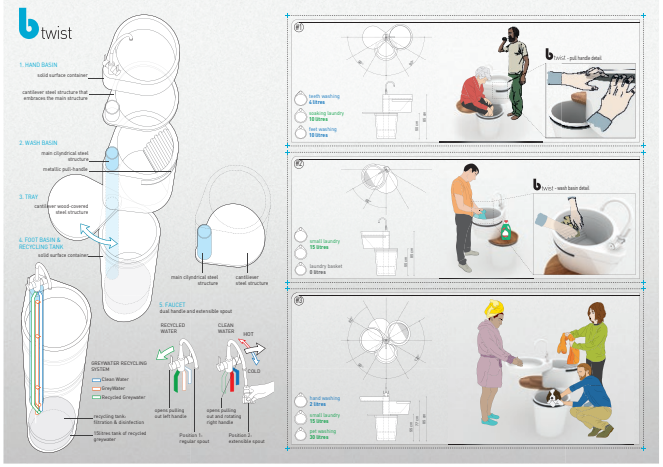


Fig. 6: [ARIA]² winning project in the Jumpthegap student category 2014/15
Fig. 7: btwist winning project in the Jumpthegap professional category 2014/15

Fig. 8: Plura winner of the sustainability prize 2014/15

Previous winning project

To get an overview of what it takes to win a competition like Jumpthegap, previous winning projects were reviewed. The complete investigation can be found in WS03. As the structure of the competition was changed from one to three winning projects and because the winning projects have changed in focus over time, only the three winning projects from the last competition were evaluated. The winning projects were compared to find patterns.

Winning project of Jumpthegap 2014/2015 (student category)

[ARIA]² is a shower that both soaks and dry the user. It uses vaporized water to clean the user, which reduces the water usage to 2.5 L/5 minutes compared to 25 L/5 minutes in a regular shower. After the shower the user is dried using air. (Fig. 6) (Jumpthegap - Roca, 2017)

Winning project of Jumpthegap 2014/2015 (sustainability prize)

PLURA is a sink where a foot-pedal is used to activate the tap to ensure a lower water consumption. There is a two-part plug, where the user can choose if the water should be collected in a bucket to be reused, or if it should just be lead down the drain. (Fig. 8) (Jumpthegap - Roca, 2017)

Winning project of Jumpthegap 2014/2015 (professional prize)

b-twist is a bathroom device combining three different sizes of wash basins. The basins can be moved so they can all be used for different purposes at the same time to save space in the bathroom. The lower bowl also consists of a grey water recycling tank, to make reusing of the water possible. (Fig. 7) (Jumpthegap - Roca, 2017)

Output

Both Jumpthegap, and Roca put a lot of emphasis on sustainability in terms of saving water, which is highly reflected in the past three winning projects. The winning projects from 2014/2015 put an emphasis on how people perceive the way of using for example a sink, as PLURA's use of a foot-pedal, or taking a shower as [ARIA]²'s use of vaporized water for showering. This along with one of the main goals for the We Are Water Foundation; "to promote awareness to create a new culture for water" could indicate a willingness to change the way people perceive the use of water. This will be used as a focus in the project.

Focus area

The focus defined by Jumpthegap was the bathroom space, which gave the project an overall focus. However, a narrower focus was required. Due to Jumpthegap's great focus on sustainability in terms of saving water, the water consumption of an average family was investigated in search for potential focus areas.

In 2015, the average water consumption per capita per year in Denmark was 38.8 m^3. The water is used for different purposes, which can be seen on Chart 1. The most water consuming activities are the ones taking place in the bathroom with shower and personal hygiene as the most consuming (36%) and toilet flushing as the second most consuming (27%). (Videncenter and Gregersen, 2017) However, as most households have two-flush toilets, using 2-6 litres of water per flush the total water consumption within this area decrease. According to a survey by hofor.dk, (2015), showering and personal hygiene account for 48 % of water consumption in households with two-flush toilets.

As the shower and personal hygiene area was the most water consuming, it was seen as the area with the most potential in increasing sustainability by reducing the water consumption. Even though showering and personal hygiene was put into one category, the team assume that showering is the area using most of the 36-48%. Therefore, the shower was chosen as the overall area for the project.

In order to break down the overall area, and define the focus of the project even more, the activities that take place in both bathtubs and showers were investigated to search for problems or potentials.

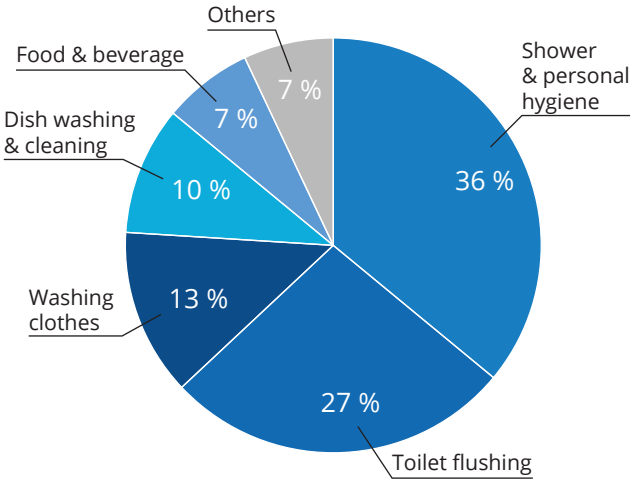


Chart 1: The distribution of water consumption in different activities (Videnscenter and Gregersen, 2017)

Output:
In the end, the focus area was chosen based on personal interest and sustainability potential. The chosen focus area was to create the efficient way of washing yourself. The word efficiency is defined as avoiding a waste of time, effort or resources, resources in this case being both money and water (Vocabulary.com, 2017). The efficient way of washing yourself is aimed at rethinking the way people wash themselves and providing an alternative to taking a shower by only focusing on washing the areas of the body that are most important for the daily hygiene.

Design driven innovation

Design driven innovation is characterised by proposing radical new meanings instead of answering to the market pull from customer needs. The design driven innovation aims to change how people perceive a certain product group (Verganti, 2009). As seen at the 2017 ISH Water Fair [WS23] radical innovations in the bathroom space are sparse and far apart. The goal of the efficient wash project is to challenge the costumer's and industry's perception of how personal hygiene could be performed.

Designing a different meaning also requires people to change or alter their current behaviour. Looking at environmental behaviour change, Steg and Vlek (2009) presents a framework for encouraging pro-environmental behaviour [WS10], and states that designing eco-friendly products that reduces consumption looks great on paper, but there is a tendency that the consumption growth overtakes the savings. To change behaviour, there need to be an extensive and visible benefit in terms of resources, effort and social approval. The issue with social behaviour is that the social norm towards showering needs to be altered for the social approval to be changed. Some people have a personal moral obligation towards the environment, which makes it easy for them to adapt to new behaviours if it benefits the environment, while others are convinced by saving money or time. The daily shower is often a deeply rooted habit in people's everyday life. This combined with their affection for using the shower as a sanctuary needs to be taken into consideration, when creating a concept as people do not want to be robbed from their daily sanctuary.

Fig. 9: Shower heads with integrated chroma therapy

Fig. 10: A fixed and a hand-held shower head

Fig. 11: Bathroom with wooden floor

Bathroom trends

Visit to bathroom stores

To get an insight into the current bathroom trends several bathroom stores in Aalborg were visited for observations in the showrooms, and short talks with the staff [WS08].

The visited stores were a combination of dedicated bathroom stores and combined kitchen and bathroom stores. In the combined stores the bathroom played a small role, where mostly cabinets with an integrated sink and a mirror above were displayed. When asking a sales woman working in Invita about the low priority of the bathroom, she said it is because they mainly sell kitchens. The cabinet doors they sell are the same in both the kitchen and the bathroom, so they mainly use the bathroom cabinets as additional sales when selling a kitchen.

In the dedicated bathroom stores it became clear that the two-part shower solution with both a fixed shower head in the top and a hand-held shower head was currently the most popular (Fig. 10). This was also confirmed by a sales woman in Nordjysk Bad og Idé Center, who said that they almost only sell this solution. Aside from this, the sales woman said that bathtubs are still popular, however, they are mostly bought by families with children. She also indicated that in her opinion future products should be easy to clean, and touch-free, as that is what the customers currently demand.
The desktop research indicated that the current trends are bringing nature into the bathroom by mixing natural materials with other bathroom materials. The bathroom is still a place of sanctuary, but with a focus where the entire bathroom does not need to be luxurious (Invita Køkkener A/S, 2016). An employee at Flisekompagniet confirmed the nature trend by stating that the look of wood and terrazzo are gaining popularity compared to the rough concrete look [WS 08]. (Fig. 11).

ISH Water Fair

Subsequently the ISH Water Fair in Frankfurt was visited. It is a five-day fair showcasing sustainable and innovative bathroom solutions. The objective of visiting the fair was to check for current and future trends, to get inspired, and to discover new opportunities [WS23].

Some of the trends spotted at the fair included a use of buttons instead of the usual knob in the shower (Fig. 13). Light was also seen as a part of the bathroom furniture, like in the mirror or behind cabinets, besides from this chroma therapy was also widely used in showers to set a mood (Fig. 9). The trend seen in the bathroom stores with large fixed showerheads was also present, but now even larger and called rain showers, where the shower head is integrated into the ceiling, and has vast

Fig. 12: The Comfortable Bathroom
Fig. 13: A shower controlled by a button

Fig. 14: The Healthy Bathroom
Fig. 15: The Fashion Bathroom is built for different stages in life.

showering options (Fig. 5).

One of the fair stands was called "Pop Up My Bathroom" and was an area concerned with trends. At the stand eight bathroom trends were displayed, all within the megatrend 'Individualisation; A bathroom that fits like a glove'. All eight trends showcased a possible way of customising the bathroom to fit each user's needs. Three examples are The Comfortable Bathroom that is built to be used at the moment, but not throughout the whole life (Fig. 12), The Healthy Bathroom is specialised for the active lifestyle (Fig. 14), and the Fashion Bathroom is focused on making a feel-good space you enjoy spending time in (Fig. 15).

During the fair several lectures were held. The team participated in a few of these regarding trends. Especially one of them provided great learnings. The lecture was called "What will be trending after the fads?" where possible future trends were discussed. The main learnings were that the bathroom is becoming more like the living room, where the bathroom is switching from being very private to very open, like having an open bathroom in the bedroom, and the importance of thinking about the elderly generation when designing for the future bathroom. The possible merging of the bathroom and bedroom is comparable to the merging of the kitchen and living room which benefitted both rooms.

Output

The visits to the bathroom stores gave a good initial idea of the current trends on the market, along with current demands from the customers; it should be easy to clean and it should be touch-free. It also provided some knowledge of the materials that are currently trending in the bathroom.

The visit to the ISH Water Fair confirmed the trends seen in the bathroom stores, and took them to extremes with for example the large rain showers. The main outcome from the fair was the megatrend Individualisation and how it influences the bathroom. Along with the transformation from the closed private bathroom towards a more open environment, where distinct bathroom borders are less significant.

Fig. 16: Image showing the embarrassment of body odour

Body odour

Body odour is the unpleasant smell that the body gives off. Sweat by itself is odourless, the unpleasant odour is caused by bacteria that breakdown sweat into acids. Body odour is most likely to occur in the crotch, armpits, genitals, pubic hair, and anus. (Nordqvist, 2017) An investigation was initiated to search for alternatives to washing yourself with water. The focus of the investigation was finding ways of preventing or reducing body odour, and ways of killing the bacteria causing the odour.

There are several ways to either prevent or reduce body odour. One of the most well-known is antiperspirant that uses aluminium salts to create a coating, which prevent you from sweating (Thefactsabout.co.uk, 2017). Several natural ways to reduce body odour also exist. Baking soda can be used to absorb moisture and keep the skin dry (Home Remedies For Life, 2015). Both lemon juice and apple cider vinegar can be used to reduce body odour, mainly due to their high acidity, which reduces the pH-level of the body, making it inhospitable for bacteria (Home Remedies For Life, 2016)

Several ways of killig bacteria exist as well. UV-light can be used, however, this would not be desirable to use on the skin, as too much exposure can cause skin cancer (World Health Organization, n.d.). The most common way of killing bacteria is using alcohol. Alcohol is used in both anti-bacterial gel for disinfecting hands and deodorants. Regular soap does not kill bacteria, it just helps remove them from the skin. Bacteria stick to the oil on the skin, and soap helps break down this oil, and remove the bacteria. (Today I Found Out, 2015)

> *Washing hands with soap and water is the best way to get rid of germs in most situations*
> - (Centers for Disease Control and Prevention, 2017)

Output

A good possibility is to kill the bacteria, which is a good way of solving the problem, but which might also result in some of the good bacteria being killed. As UV-light causes cancer this possibility was discarded. Alcohol is a possibility that is already being used in many different applications. However, it dries out the skin which is not healthy over longer periods of time. Therefore, the combination of water and soap was decided to be the most ideal.

Washing of yourself

Current washing habits

For many people the shower is a daily ritual and a deeply rooted habit. A study carried out by Sentio Research for Newspaq in 2009 showed that around half of the Danish people shower six to seven times a week, and a fourth shower even more than that (Chart 2) (www.b.dk, 2009). This is confirmed by a more recent study, carried out by YouGov for Søndagsavisen, which show that 54% of Danish people shower once a day (Søndagsavisen, 2016).
The average length of a shower varies depending on the source of the data. This could be due to the extended use of questionnaires to gather this type of data. As stated by Hilde Hendrickx, a behavioural scientist, the use of questionnaires can yield a problem:

> *The problem with that [red. questionnaires] is that people do not often have a very good insight into their behaviour because it is a habit and they may not be very aware of what they are actually doing.*
> - Hilde Hendrickx, behavioural scientist (BBC News, 2011)

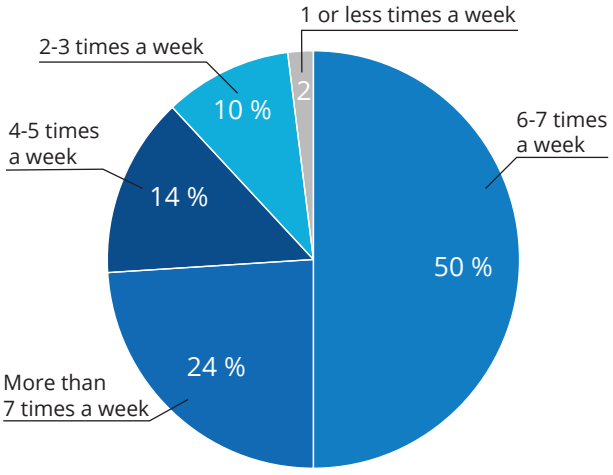


Chart 2: The distribution of how often people shower (www.b.dk, 2009)

A study carried out by manufacturer Unilever in 2011 used dataloggers attached to the showers to gain trustworthy insights into shower length. This study indicated that the average length of a shower is eight minutes, which equals a water consumption of 62 litres of hot water. Based on this data it would cost an average British family around 416 £ a year. (BBC News, 2011)

How often should you shower?

The Danish Health Authority does not have any guidelines concerning how often people should shower, and experts in dermatology and hygiene are divided on the issue. In an article from Videnskab.dk, 2013 three experts state their opinions on how frequently people need to shower:

Leif Percival Andersen from the infection hygienic unit at Copenhagen University Hospital says that only a few people need to shower more than once a day, unless they do physical labour. Showering too much, especially if you use soap every time, increases the chance of the skin becoming more susceptible to infections like staphylococcus.

Microbiologist Mogens Kilian state that there are no health-related reasons to shower at all. We live in harmony with the bacteria on the skin and they have many benefits we cannot live without. Even so, Kilian underline the importance of washing your hands frequently to avoid the spreading of diseases.

Jørgen Serup, professor and chief physician at the dermatology ward, Bispebjerg hospital, recommends to take a daily shower lasting three to five minutes while rubbing your skin with your hands. Use mild soap to wash the armpits and crotch every day and only soap up the entire body once or twice a week.

Output
All experts agree that there is no universal bathing recipe, but it depends on each person's work environment, physical labour, skin sensitivity and active lifestyle. They all agree that there is an excessive use of soap which makes the skin more susceptible to skin diseases.

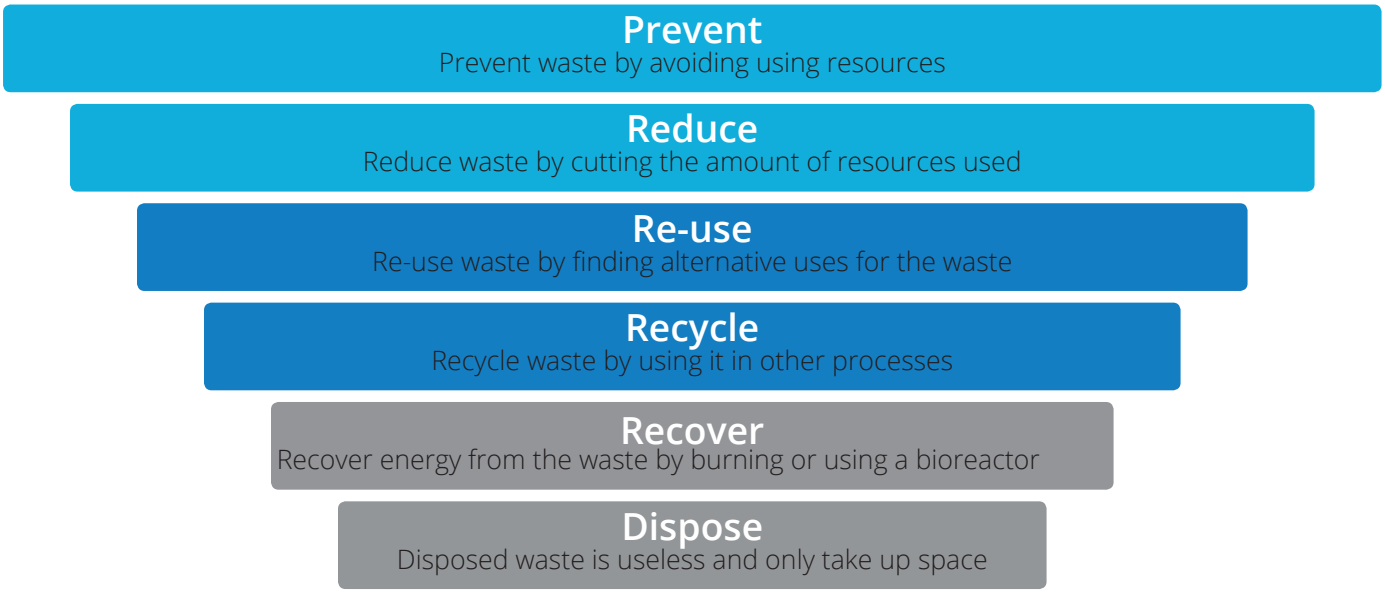


Fig. 17: The waste hierarchy

Market analysis

How to handle waste is a governmental issue as much as it is a personal one. The waste hierarchy (Fig. 17) is a combination of the European Union model and the framework from the City of Gold Coast in Australia (Ec.europa.eu, 2017). It displays the different ways of managing waste and ranks it after what is best for the environment. (Goldcoast.qld.gov.au, n.d.)

In this project water waste is the main focus. The waste hierarchy displays the different ways of reducing waste, the best way being prevent in the top, and the worst way being dispose in the bottom. In the bathroom, this should be accomplished by developing a product that prevents people from using a large amount of water.
The previous behaviour research indicates an aim for making a product that prevent unnecessary waste of water. To figure out if this was the best category to focus on, a market analysis was made based on the products currently on the market within the top three categories.

Prevent water waste

Spiky

The spikes inflate after four minutes of showering "pushing" you out of the shower (Fig. 18). It is only a concept, not a product on the market. (Inhabitat.com, 2015)

HYDRAO

A shower head that changes colour depending on how much water is used (Fig. 20). (Hydrao.fr, 2017)

Reduce water waste

GROHE EcoJoy

Grohe has a line of water saving products. In the shower they offer multiple different shower heads and thermostats to help conserve water (Fig. 21). (Grohe.com, n.d.)

Nebia

Nebia uses mist instead of a steady stream of water (Fig. 19). It claims to reduce water consumption by 70 %. (Nebia.com, 2017)

Home Depot

Home Depot are an American home improvement supplier. On their website they offer 277 different shower heads from 19 different brands with the "Water Sense" label, which indicates that it is a water saving shower head. (Homedepot.com, 2017)

Reuse waste water

Cullector

Cullector makes it possible to collect all the water being spend before finding the right temperature in the shower (Fig. 22).

Fig. 18: Spiky
Fig. 19: Nebia
Fig. 20: Hydrao
Fig. 21: Grohe Ecojoy
Fig. 22: Cullector

The collected water is afterwards being led back into the shower stream to be reused. (Cullector Water Saving Showers, 2017)

Output

The market research reveals that there is a huge number of products aimed at reducing water consumption. The products are being produced by a wide array of different brands creating both water reducing shower heads and thermostats. There are only a few products within the prevent and re-use categories.

It is clear that the reduce category is a red ocean and both the reuse and prevent categories are blue oceans, if using Blue Ocean Strategy terminology. However, as the prevent category is the one creating the biggest environmental improvement, this seems to be the best market to aim for.

Problem identification

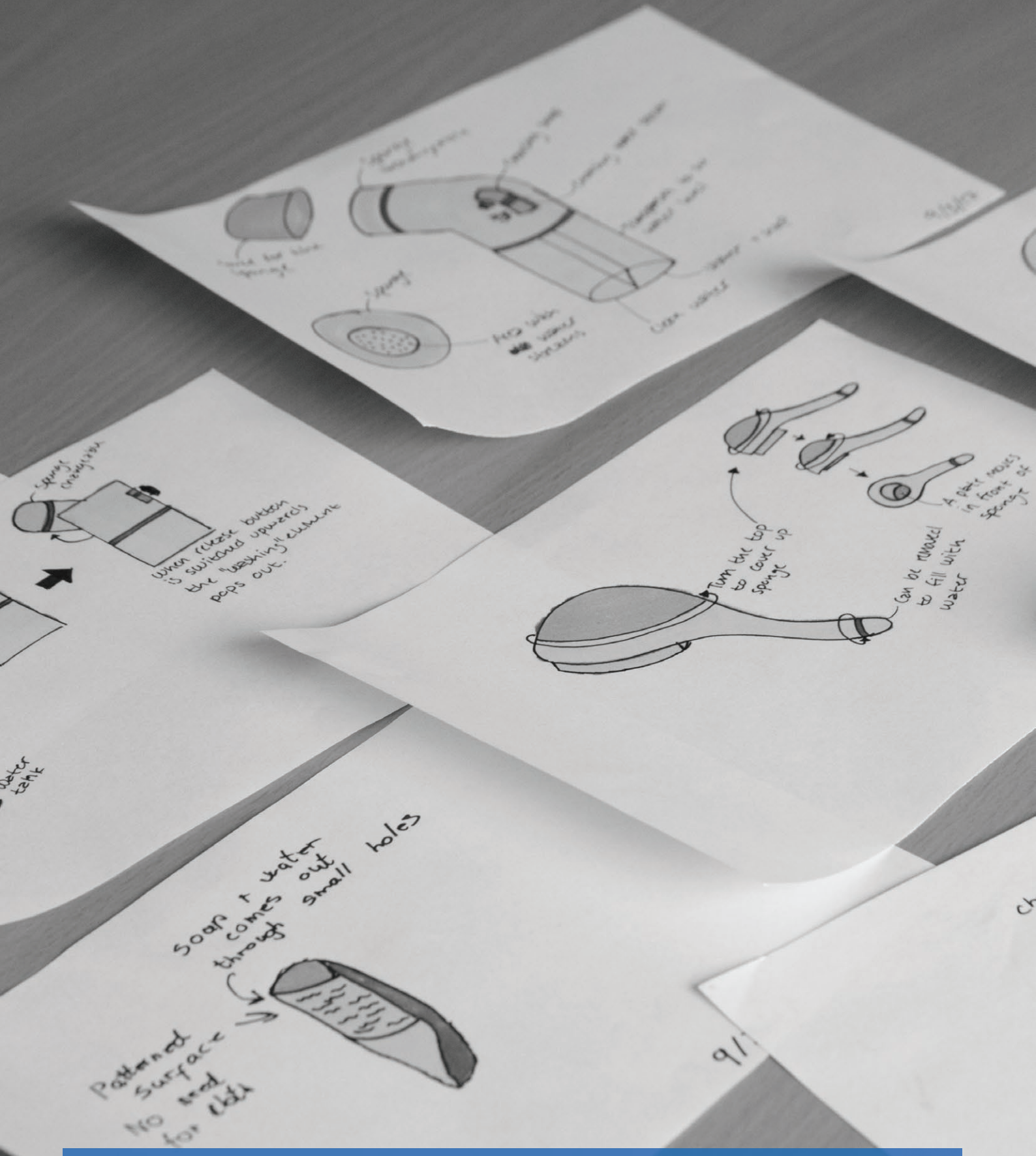
Problem	Consequence
Most people shower 6 or more times every week, which for most are too often.	A waste of water, which causes a waste of money.
Many uses the shower as a relaxing break from the everyday life, and as a way to get some private time.	A waste of water, which causes a waste of money.
For most people the daily shower is more a habit than a necessity.	A waste of water, which causes a waste of money.
Most people wash their bodies with soap every time they shower, which is too much compared to what is necessary.	The skin becomes dry, and more susceptible to skin diseases.

Mission

To avoid a waste of shower water by providing an alternative efficient way of washing, encouraging a pro-environmental behaviour.

Criteria 1.0

Criteria	Source of criteria
1. Should clean the three critical body-areas (feet, armpits and crotch)	1. Washing of yourself
2. Should use less than 50% of 7.75 liters of water per minute, which is used for an average shower	2. Washing of yourself
3. Should be a substitute for the daily shower	3. Washing of yourself
4. Should be a supplement to the overall hygiene	4. Washing of yourself
5. Should indicate how much resources the user save	5. Changing behaviour [WS10]
6. Should be easy to clean	6. Current trends



Ideation

This phase contains the initial ideation process consisting of three rounds of ideation. Each round of ideation contains a description of the approach, output and selected sketches that display some of the points in the outputs.

Fig. 23: Ideation

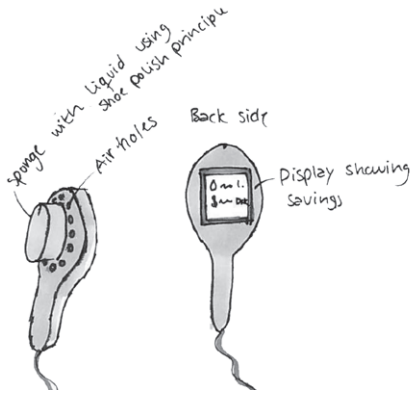


Fig. 24: Idea with sponge for washing and air holes for drying

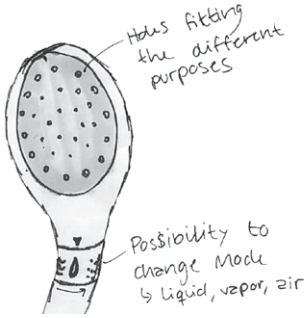


Fig. 25: A shower head that can be switched between shower and efficient washing mode

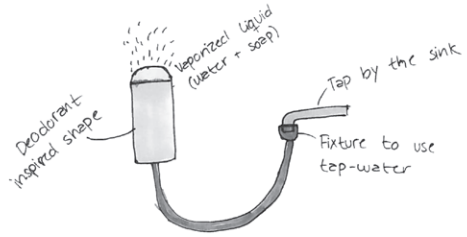


Fig. 26: An idea with a washing device being attached to the tap by the sink

Fig. 27: An idea with the shower solution becoming increasingly colder

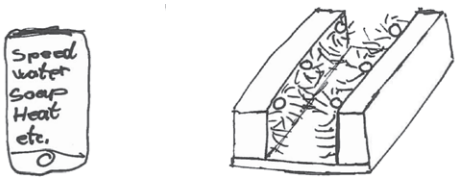


Fig. 28: Washing station for the feet including a smart phone app

Ideation 1

The first round of ideation was made with the purpose of creating a range of different ideas. To force thinking in different directions, the methods of systematic sketching, and forced relationships were used. The five categories used for the systematic sketching were based on previous research and analyses. Each category consisted of some principles, below displayed after each category:

- **Washing area:** body and feet
- **Savings indication:** display, app, sound and light
- **Size: portable:** fit inside shower and fit outside shower
- **Cleaning method:** wipe, liquid and powder
- **Drying:** air, towel and heat

The principles were numbered, and three were randomly picked for each person in each of the sketching rounds that lasted for five minutes.
The ideas were evaluated on different levels. At first, they were checked for pros and cons, which were used as identification of potentials, and areas that needed more awareness in the coming ideations. Afterwards, each idea was marked with red, yellow, or green depending on the subjectively evaluated potential, green was an idea with potential, yellow was an idea where parts of it had potential, and red ideas did not have any potential. After this evaluation, the yellow and green ideas were grouped into three overall categories based on the focus of the idea.

Output
The following potentials were found in the ideas:

- That the washing becomes increasingly colder (Fig. 27)
- Making a product to be attached to the tap by the sink (Fig. 26)
- Relatively small portable devices that can be used outside the shower stall (Fig. 24)
- Using air to create the feeling of running water on the body
- The use of something people can relate to (Fig. 25)
- The use of brushes might be good for washing feet (Fig. 28)
- Informing people about where they need to wash themselves each day

The following were the areas to be aware of:

- The solutions need to be able to clean both body and feet
- Should not tempt people to just take a shower instead of using the solution (Fig. 21)

At last the ideas were divided into three categories: air shower, automatic, and hand-held. These categories were to be the focus of the second round of ideation.

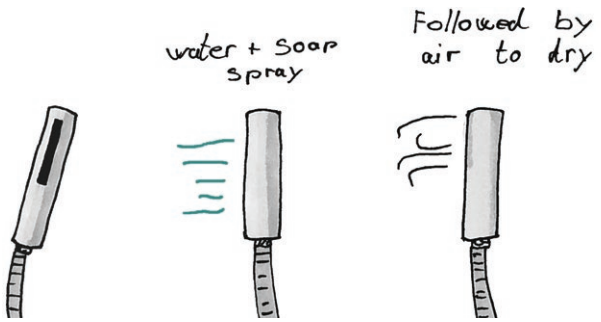


Fig. 29: Idea that sprays soapy water and dries with air afterwards

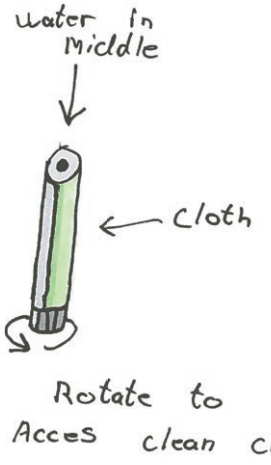


Fig. 30: Idea where a cloth rotates and is moisturised from the center

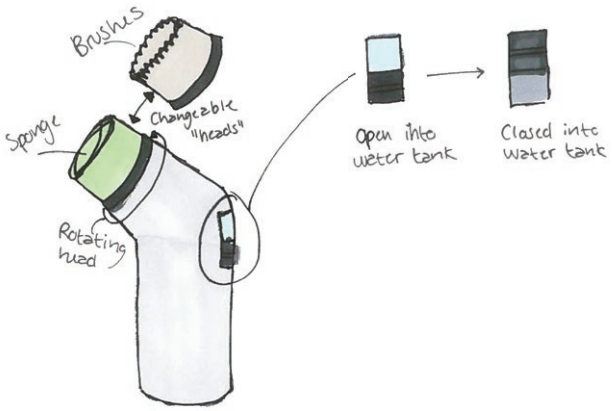


Fig. 31: Portable washing device with changeable "heads"

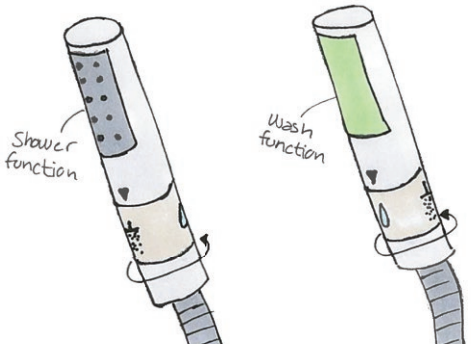


Fig. 32: A shower head that can be changed between sponge for efficient washing function and regular shower function

Ideation 2

The second round of ideation was based on the categories from the output of the first ideation. The sketches were made with the objective of digging a bit deeper, and making the sketches a bit more detailed.

Output

Air shower:

It became clear that the air shower category did not fulfill the criteria setup for the project, as it did not wash the three important areas but only might create a feeling of water running down the body. Therefore, this category was made more of a secondary thing to possibly be included in other concepts.

Handheld:

The hand-held ideas pointed in two different directions, which was a solution integrated with water, and a more independent solution that did not require any attachment to water. Therefore, the hand-held category was divided into two categories for ideation 3;

The hand-held solution could be connected to one of the current trends. The trend with a two shower head solution. The smaller one is often just used to clean the shower stall [WS 08]. This had a potential, which resulted in it being one separate category for ideation 3.

The second category was the independent hand-held solution that did not require any attachment to water.

Automatic:

The automatic shower is still something to be worked further on. The idea is to have the user doing minimum effort. The automatic aspect can be mixed with the air shower ideas for a more complete washing experience.

As the categories were not clearly defined the ideas that fit into the new categories; hand-held, second shower head and automatic, were moved to ideation 3 for evaluation.

Ideation 3

The third round of ideation was a continuation of the second round in terms of objective. It was based on the three revised categories from the output of ideation two. This ideation should end up with three concepts to indicate three different directions that the project could go in. Each of the sketching rounds lasted for 10 minutes, and there was in turn sketched on the different categories.

The ideas from both ideation two and three were evaluated by listing the potentials and challenges for each idea, and afterwards marking the ideas with red, yellow, and green to indicate the overall potential.

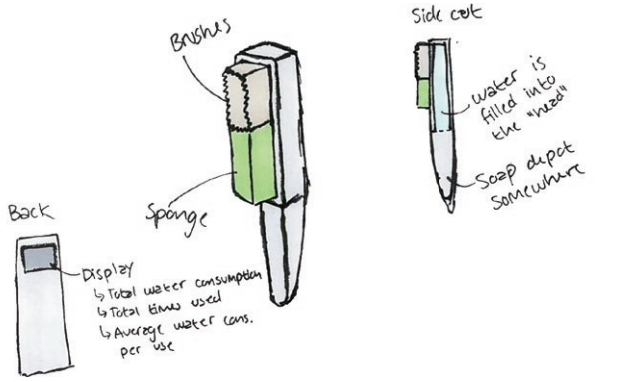


Fig. 33: Idea with brushes for washing feet in the top and a sponge for body wash in the bottom

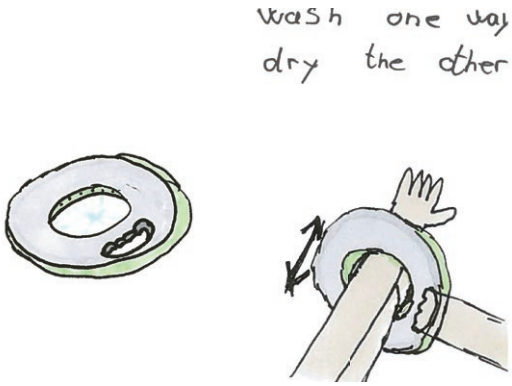


Fig. 34: Alternative idea for how to shape and use a washing device

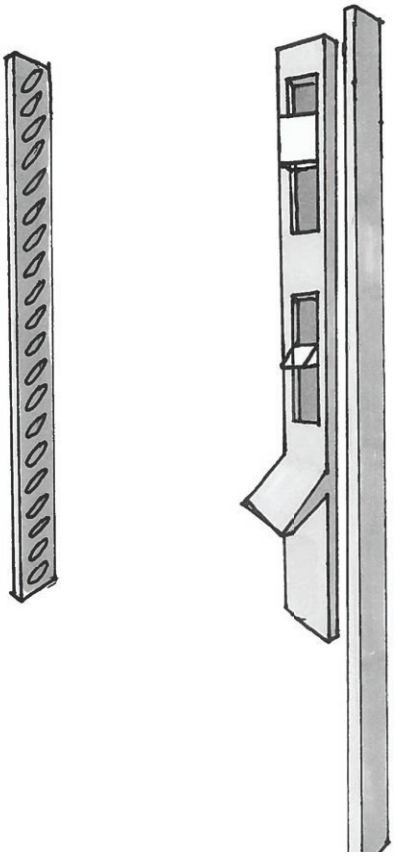


Fig. 35: Full automatic solution washing the essential body areas and dries the user with air afterwards.

Secondary shower head

Potentials

- Simple functionality (one interaction) (Fig. 34)
- The functionality as an integrated part of the shape/look
- Change of modules; e.g. sponge, brush, etc. (could also have a cleaning module for cleaning the shower stall)
- A solution that does not need to get in touch with the skin (e.g. sprays vaporized anti-bacterial liquids) (Fig. 29)

Challenges

- A general challenge within this category is that the user gets tempted to take a regular shower (Fig. 32)
- A cylindric shape might make it difficult to wash the armpits. (Fig. 28)

Hand-held

Potentials

- Rotation principle like an electric toothbrush (Fig. 31)
- Being able to change the part that is in contact with the body (Fig. 27)
- Keeping the part that is in contact with the body (for example cloth) clean
- Using area specific washing materials (e.g. sponge for armpits and crotch, and brushes for feet) (Fig. 33)
- Visible water consumption on display (Fig. 29)

Challenges

- The cylindrical shape might make it difficult to wash armpits and crotch (Fig. 30)
- If there are two types of washing materials (e.g. sponge and brushes), they must not be placed too closely together. (Fig. 29)

Automatic (Fig. 35)

Potentials

- Visible functionality
- It is better for the skin to dry it with air than with a towel

Challenges

- Might take up a lot of space
- When using air, the air needs to come from somewhere

Output

Three concepts were chosen based on which ideas fulfilled most of the potentials within each category. The chosen concept for the secondary shower head category (Fig. XX) can be changed between regular shower head mode and efficient washing mode. The hand-held concept (Fig. XX) was a device with interchangeable "heads", which in this case is the material being in contact with skin. The concept for the automatic category is a full automatic solution focused on washing feet, crotch and armpits. Afterwards it dries the user by blowing air. A decision upon in which of the directions to go needed to be made. However, this did not seem possible as the criteria did not point towards one specific direction and there were no user groups to base the decision upon. Therefore, it was decided to make a reframe of the project, to get a clearer focus with some user groups and thereby be able to make a decision.

Reframing

The reframing phase consists of a revised frame. The framing contains descriptions of two selected user groups, along with problem description, mission and a second edition of the criteria.

Fig. 36: Reframing

Fig. 37: Images for visualising the family user group

Fig. 38: Images for visualising the biking commuter user group

User groups

To get an understanding of whom the efficient wash was to be designed for, future scenarios were created for a range of possible users. These were combined to generate user groups. Future scenarios is a method used to visualise the future, based on previous research, intuition and creativity (Ideasforideas.com, 2017). The user groups generated was inspired by the scenarios created in WS33.

Family

Peter is a 40 years old real estate agent who is married to Charlotte, who is the co-owner of a closet company. Together they have three children; two teenage daughters in the age of 14 and 17, and a boy in the age of 6. They live a busy life, and especially in the morning it is a puzzle to get everything done in time with the teenagers wanting a daily shower, and the youngest needing help to get ready.

Peter and Charlotte feel like they have tried many different things to solve the morning bathroom puzzle, but it seems impossible to get it to run smoothly. Thus, Peter and Charlotte need to wake up an hour prior to the kids to get ready for work, which makes them exhausted and irritable during the day.

Biking commuter

Alex is a 28 years old single girl working as a professor at the university. The university is located 10 km from where she lives, which she sees as an acceptable distance for biking. She enjoys her morning bike rides to work, and the afternoon bike rides back home. The only problem is that she bikes uphill all the way to work, which results in her being sweaty when she arrives. Therefore, she always brings an extra shirt, and a deodorant to minimise unpleasant body odour. Despite this she still feels a bit sticky in her armpits and in her crotch, which makes her feel unpresentable towards her students and co-workers.

Problem identification

Problem	Consequences
Families	
The daughters in the family take long daily showers	Waste of water and money. There is less time on the bathroom for the other family members
There are many people that need to use the bathroom for different purposes in the morning.	The parents need to wake up early to have the necessary time on the bathroom.
Taking daily showers with out it being necessary.	Removing the natural oils from the skin resulting in the skin drying out, and becoming more susceptible to skin diseases.
Biking commuter	
Not feeling presentable due to sweat or odour	Lack of confidence, don't want to take the bike/public transportation.
Using deodorant or perfume to cover or remove body odour	Feeling sticky and dirty, even though the unpleasant body odour has been covered or removed

Mission

To eliminate the physical constrains of the bathroom, by providing a solution to efficiently wash yourself wherever, saving both time and resources.

Criteria 2.0

Criteria	Source of criteria
1. Should clean the two critical body-areas (armpits and crotch)	1. Washing of yourself
2. Should be a substitute for the daily shower	2. Washing of yourself
3. Should be a supplement to the overall hygiene	3. Washing of yourself
4. Should be easy to clean	4. Current trends
5. Should be able to be used by different people	5. User group (family)
6. Should be faster to use than an average shower of eight minutes	6. User group (family)
7. Should be portable	7. User group (biking commuter)
8. Should fit into a backpack	8. User group (biking commuter)
9. Should contain soap	9. Body odour
10. Should contain a maximum of 100 ml. of water	10. ?
11. Should use less than 100 ml. of water per wash	11. ?
12. The washing device should be wireless	12. ?

Changes from original frame

The new frame changed the focus of the project slightly. Previously the main focus had been sustainability and getting people to change their showering behaviour to benefit the environment. Moving forward, the sustainability aspect was still a focus in the project, but more as a focus being in the background while the needs of the user groups, as saving time in the morning and feeling presentable at work became the main foci. The new focus caused a criterion to be removed. It was the criterion regarding the concept being able to display the amount of saved resources, as this was based on the behaviour change research, which had been discarded as a focus.

Due to one of the user groups being a biking commuter the concept needed to be portable. This concluded which of the directions from ideation 3 the project needed to follow; the hand-held. Regarding this it was decided to discard the focus on being able to wash feet. This focus had been challenging to implement in the previous ideations, and additional research indicated that the feet not necessarily requires daily washing.

Concept development

The concept development phase covers the steps made from the reframe and until a concept was chosen. It contains an additional round of ideation and two rounds of idiom testing, resulting in the final decision of an idiom to be used for the concept.

Fig. 39: Concept development

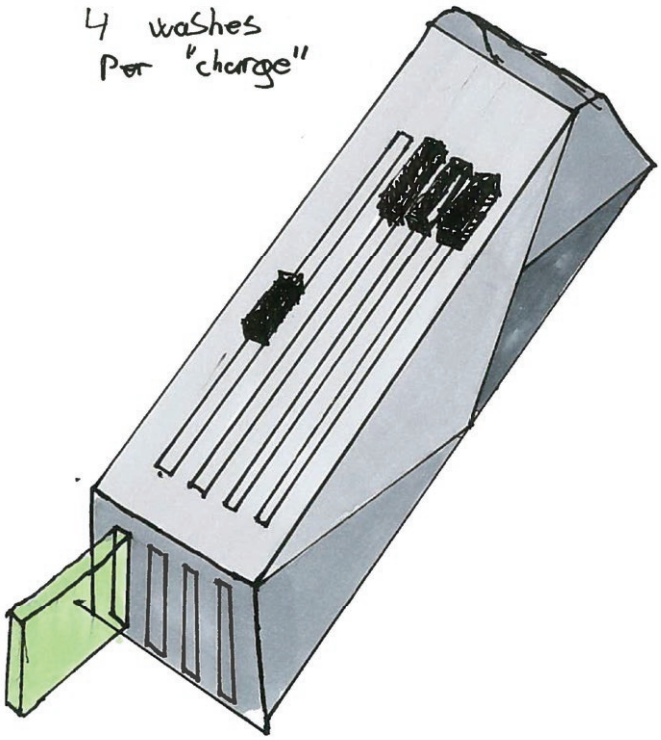


Fig. 40: Idea with four washing surfaces that can be slid out and used separately before changing them all

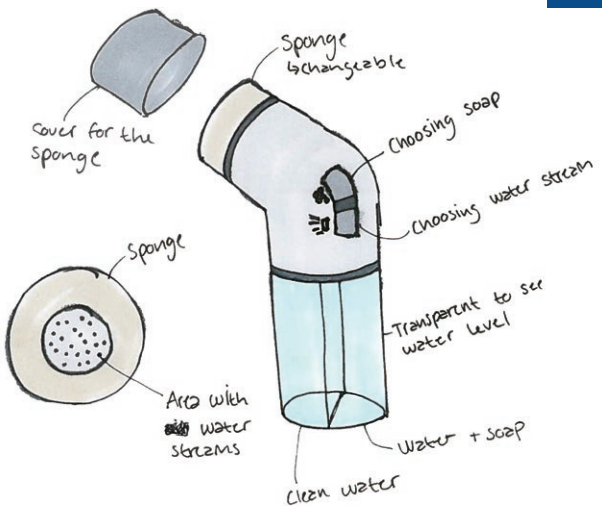


Fig. 41: Idea with a sponge for washing, an area with water streams for rinsing and separate water and soapy water reservoirs.

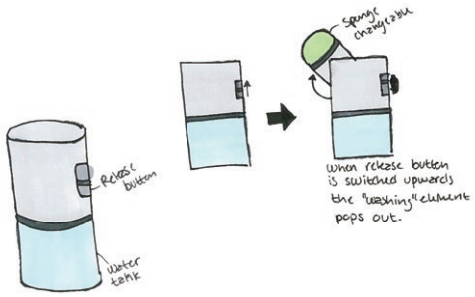


Fig. 42: Idea with a pop-up washing surface

Ideation 4

The fourth round of ideation was the first ideation within the new frame. The method of use related stimuli was used to inspiration for new ideas, shapes, and functions. The stimuli images were focused on hand-held, portable products and concepts and products handling liquids. Each sketching round lasted for 15 minutes.

The ideas were evaluated based on the criteria. However, it was not deemed possible to use all criteria for evaluation. Criterion 6 (page XX) was implicit in all ideas and therefore not used for evaluation. The criteria 4, 10 and 11 (page XX) required more developed ideas to be able to use them for evaluation.

Output

After this round of ideation, it became clear that it did not bring much value to the project to keep ideating. The ideas did not develop enough from round to round, resulting in the project moving forward in a slow pace. Therefore, it was decided to try and take a new approach using CAD and 3D-printing to create physical models.

Fig. 43: The six models used for testing in the first round of idiom testing

Idiom testing

Round 1

As the ideation did not seem to lead to the choosing of one specific concept, it was decided to make several physical models to use in an act it out session. This was done by making different shapes in CAD, some based on previous concepts, asome based on thoughts of nice to hold or use for washing armpits and the crotch, and some made to try and think out of the box (Fig. 45). Six shapes were modelled and 3D-printed afterwards (Fig. 43).

Seven fellow students tested the models by acting out how it would be to use them. They were told where the washing surface was placed, and asked to evaluate the models based on how it felt to hold them in the hand, how it felt to use them in the armpit, and how they imagined it would feel to use them in the crotch. The complete results of the testing can be seen in WS41.

Output

The testing of the models gave some new interesting insights into what was needed to create the optimal shape of the product. The following potentials were taken from this testing into the next round of idiom modelling.

- Having a 360° washing surface (Skinny lamp)
- Handle with a flat area where either the thump or the forefinger can rest, which creates a feeling of having it under control (Slender man)
- Slender washing surface, which makes it easier to be used for the crotch (Slender man)
- Having an “inside” and “outside” washing surface for different purposes (Sleek)
- Having the possibility to use it without holding the handle. For example, not holding the handle when using it in the armpit, and using the handle when using it for the crotch (Whale)
- The washing surface has a shape that is similar to the armpit, in order to make it fit inside an armpit (Whale)
- An angle between handle and washing surface (Priva 2.0)
- Can stand on a table (Priva 2.0)

Round 2

The second round had the objective of choosing one idiom to be used as the starting point when developing the functionalities of the product. The idiom testing aimed at combining as many of the points from the output of the first round into each of the models. This resulted in three different models that were 3D-printed, and tested (Fig. 46 and Fig. 47). Six fellow students tested the three models under the same conditions as the tests in the first round. However, this time

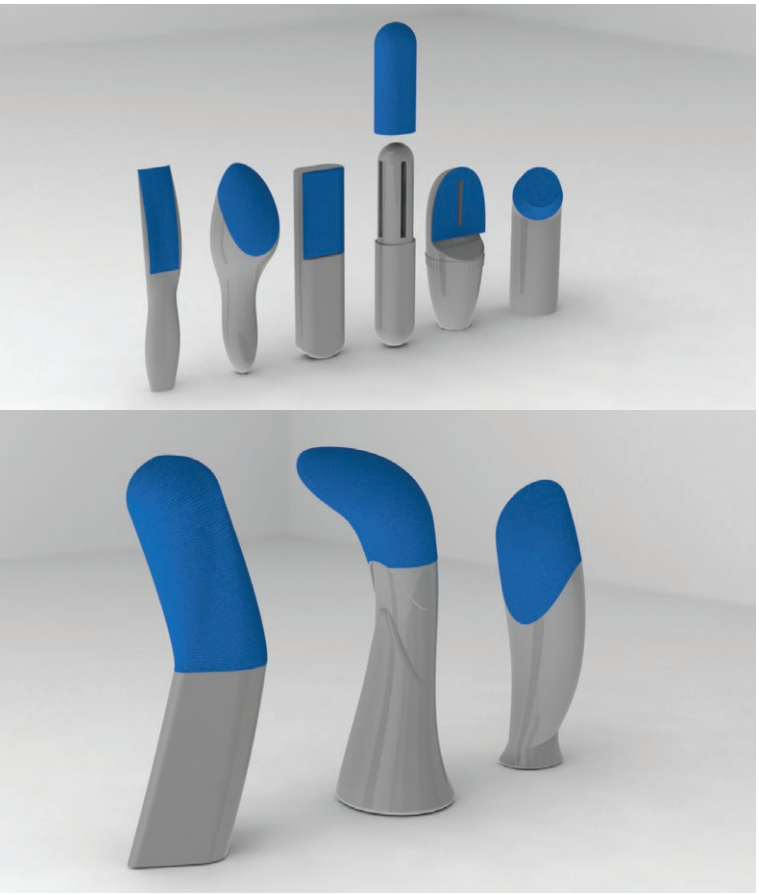


Fig. 44: The six models from round one with indications of washing surfaces
Fig. 45: The three models from round two with indications of washing surfaces

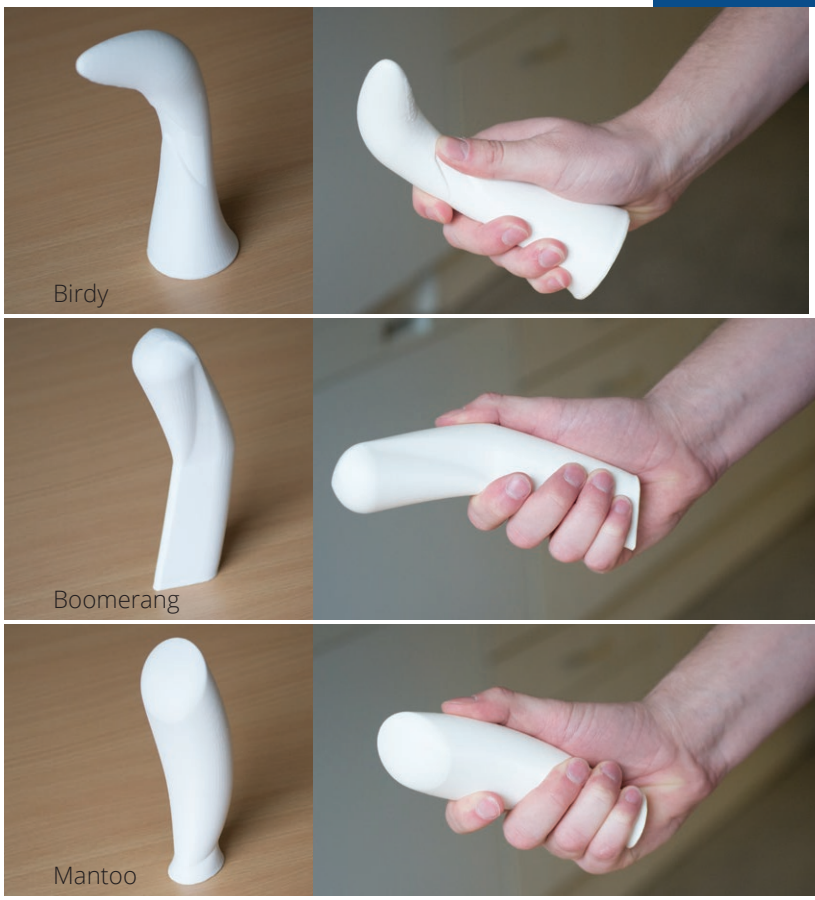


Fig. 46: The three models used for idiom testing in the second round

they were also asked to rank the models based on which they liked the most and how it felt holding and using it. The ranking was from one to three, where one was the one they found to be best, and three was the one they found worst. The complete results of the testing can be seen in WS41.

Output

The average ranking of the models was as follows:

1. Mantoo = 1.6
2. Birdy = 2
3. Boomerang = 2.4

The comments from the participants indicated that most of them liked the washing surface of Mantoo the best. However, they missed the steeper angle between handle and washing surface, which was present in both Birdy and Boomerang, and they also said that Mantoo's washing surface might be a bit too small.

Based on the rankings and the comments Mantoo was chosen as the idiom to be used in the coming process of developing the functionality.

Fig. 47: One test participant during the testing of Birdy

Product development

This phase describes the process from concept idea to final product concept. It contains a generic use scenario, requirements, several investigations into soap, functional solution principles, different aspects of the washing surface, the hand-in for Jumpthegap, a competitor analysis and the aesthetic work of defining a visual expression. It also contains more technical aspects of choosing a water pump, a battery, a charging method and materials and production. It is finalised with a description of the business aspects of the project.

Fig. 48: Product development

Use scenario

Before starting the product development an overview of how the team intended the device to function was needed. This could be used to clarify undefined aspects of the functionality, and get an alignment within the team regarding the aim of how to use the product. To do this a generic use scenarios was set up covering the main use of the device within both the user groups. In the scenario, the column to the right describes the different steps in the use of the product, the blue boxes resemble the steps that are defined and the grey boxes resembles the steps that are to be defined. The green boxes in the column to the left describes what needed to be clarified for the grey boxes to become fully defined.

Output

It became clear that much clarification was still needed before having a fully defined use scenario. The specific areas that need clarification were the following:

- How is washing surface cleaned and attached?
- How often should the water reservoir be filled?
- Does the device use electricity?
- Is there space for storage of dirty washing surfaces in the docking station?

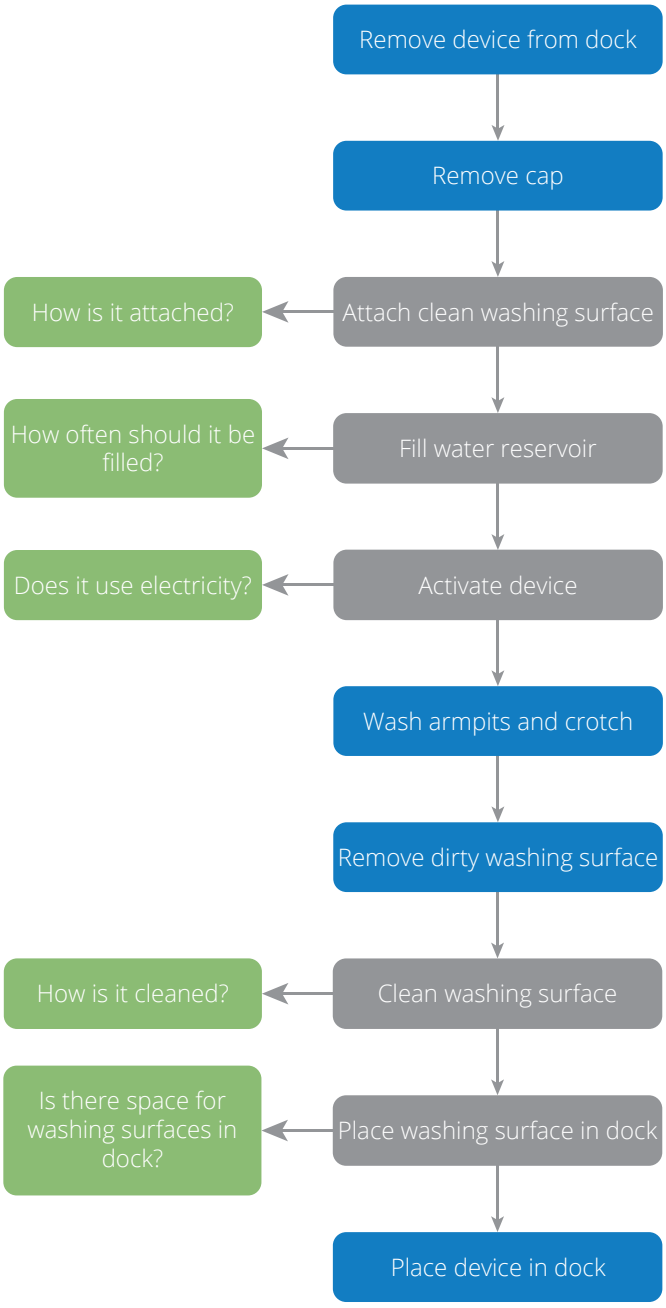


Fig. 49: Generic use scenario

Requirements

Quantitative

Requirement	How it is evaluated
1. Different people should be able to use the device	1. Each person should be able to use a different washing surface than the person before
2. The device should be able to remove sweat from the armpits and crotch	2. The washing surface should be used to wipe off sweat from the armpits and crotch
3. Should be able to remove odour from the armpits and crotch	3. The bacteria in the armpits and crotch should be killed or removed
4. When full (water, soap, charged) the device should be fully functional without access to a bathroom	
5. Should be faster to use than an average shower of eight minutes	
6. Should be portable in terms of size	6. Metaphor seen below (Fig. 50)

Qualitative

Requirement	How is it evaluated
1. Should be a supplement to the daily hygiene.	1. Can be used on an everyday basis
2. Should be easy to clean	

Fig. 50: Metaphor for portable size

Portable

Metaphor: 500 ml plastic water bottle with water

- Should be held in one hand
- Should weigh under 500 grams.
- Should be smaller than 240 mm in height
- Should be smaller than 60 mm in diameter

Water

Moving water

As the washing surface is the topmost part of the device, water needs to travel upwards to moisture it. To find the best way of moving the water upwards, an investigation into different solution principles was initiated. Six different solution principles were found with a combination of manual and automatic solutions, and some with the possibility of being both. The complete investigation of solution principles can be seen in WS42.
The solution principles were evaluated based on the wish for the team to know the exact amount of water being dosed for each use, along with the user having as easy an interaction with the device as possible. In this case, easy is evaluated as having as few interaction as possible.

Filling water reservoir

The user would need access to the device's water reservoir to be able to fill it. The access should not compromise the shape of the device.

Output
Both manual and automatic solution principles provided the possibility of controlling the amount of water being dosed for each use. However, an automatic pump was chosen as it secured a single interaction to activate the product.
It was decided to place the point of access to the water reservoir in the bottom of the device. The bottom was made into a cap, which could be removed in order to fill the device with water.

Soap

Soap type

To efficiently wash yourself and remove body odour, sweat and dead skin cells, some sort of cleansing agent is needed. The skin is sensitive to change and reacts poorly to variations in pH. Human skin commonly has a pH value in the range 4.5 to 6.5. Traditional soap has a pH value of 9 or 10 which is a drastic change in pH. To avoid skin irritation and dryness, it is recommended to use milder cleaning alternatives with a neutral or slightly acidic pH value (Pascoe, 2013). Lipid free cleansers and syndets are both neutral types of cleansers. Lipid free cleansers also apply a thin layer of film to help keep the skin moisturised, but needs to be wiped off afterwards. Syndet is short for synthetic detergent, and is recommended for sensitive skin. Commercially syndets are known as "soap-less soaps". (Stephenson Personal Care, 2014). Syndets also has the added benefit of containing more moisturisers and humectants than regular soap. Humectants are a type of moisturiser that absorbs moisture in the air and applies it to the skin (Pander, 2017).

> *Transmission electron microscopy has demonstrated that skin washed with synthetic detergents has shown well-preserved lipid and protein regions compared to significant damage to both after washing with soap. The relatively high free fatty acid content of synthetic detergent bars provide a moisturizing benefit that help to maintain skin hydration*
> - (Mukhopadyay, 2011)

Dispensing of soap

The two headlines when discussing how the soap should be dispensed was whether the soap and water were to be kept separated or mixed prior to pumping it onto the washing surface [WS63]. In WS52 different solution principles were explored on how to dispense the soap into the water stream. A key factor when deciding was to keep user interaction to a minimum. This could be achieved by mixing the soap and the water directly in the water reservoir or by adding another pump for the soap.

Output
Adding a second pump to dispense soap, could compromise the visual expression of the device, as one pump to move the water is already in place. To allow for more idiom freedom, mixing the soap and water directly in the water tank was chosen.
Using a controlled amount of a syndet type cleanser with moisturising and humectants ingredients would allow the water and syndet mix to be used to wash yourself without having to rinse afterwards. The pH value equal to the skin and the added moisturisers will keep the skin healthy and well in contrast to regular soap which strips all natural oils from the skin leaving it dry. However, mixing the soap and water comes with the risk of people either using too much syndet or using a wrong kind of soap. To assist the users to use the right amount of syndet, a soap dispenser, dispensing the correct amount of syndet on each push is provided.

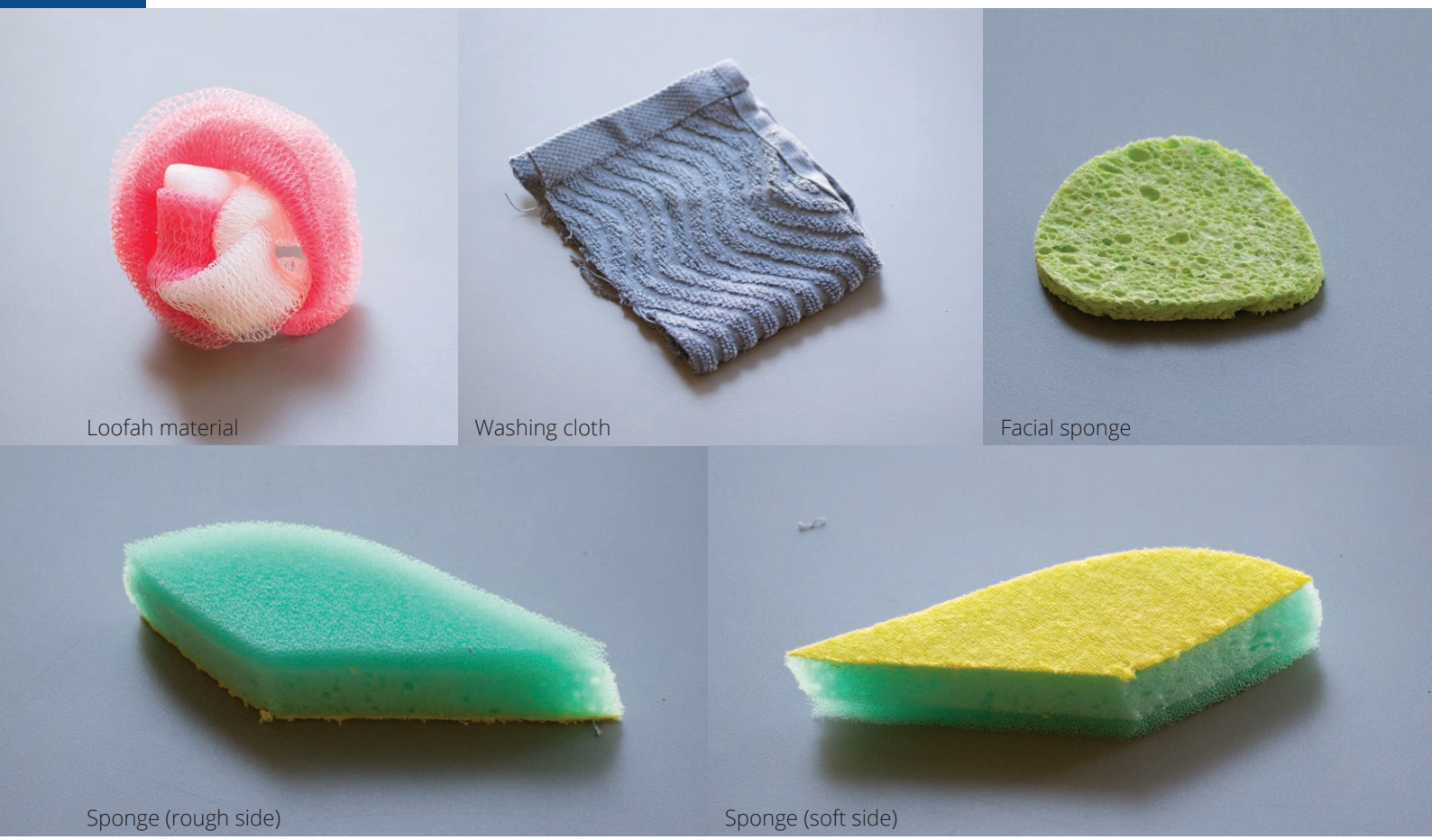


Fig. 51: Samples of the different materials used for testing

Washing surface

Cleaning washing surface

As reusability of the washing surface was of high priority due to the focus on sustainability, an investigation into keeping the washing surface clean was initiated. The aim was to kill bacteria on the washing surface inside the device or docking station, to keep it clean between uses. Some of the data from the previous investigation into killing bacteria [WS17] was used in this investigation [WS46].

A range of different ways of killing bacteria were investigated; UV-light, alcohol, electricity and ozone. Especially UV-light was considered a good way of killing the bacteria as no human contact was needed, and therefore there would be no risk of the light harming the user. Beside from the UV-light being implemented in the device or docking station, it was also considered a possibility to just wash the washing surfaces in the washing machine between uses to eliminate the bacteria.

As it was deemed possible to kill the bacteria or minimise their growth, it was also deemed possible to reuse the washing surface. This raised a concern regarding whether the users would want to reuse it or not. To validate this, a questionnaire was created. The respondents were fellow students who were presented with the question; Which of the degrees of reusability would you prefer if you were going to use our product? They were presented with the following scenarios, where a washing cloth was used as the washing surface material, to make it relatable for the respondents:

1. Reusable: UV-light is used to kill the bacteria on the washing cloth between each use, making it reusable for a few times before washing it in the washing machine.
2. Reusable: The washing cloth is washed in the washing machine between each use.
3. Disposable: Every time a washing cloth has been used it is thrown out and replaced by a new washing surface for each use.

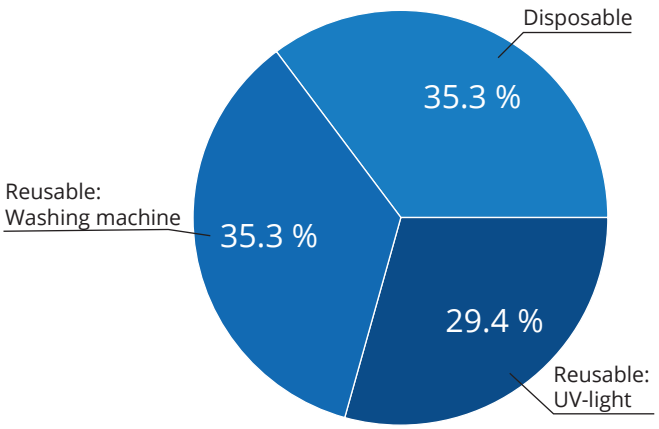


Chart 3: Results from the questionnaire regarding reusing the washing surface

Armpits					
Gender	Sponge (rough side)	Sponge (soft side)	Facial pad	Washing cloth	Loofah material
Female avg.	5.0	2.8	1.8	1.8	3.8
Male avg.	4.0	2.5	2.8	2.0	3.8
Total avg.	4.5	2.6	2.3	1.9	3.8

Crotch					
Gender	Sponge (rough side)	Sponge (soft side)	Facial pad	Washing cloth	Loofah material
Female avg.	4.8	2.3	1.3	2.5	4.3
Male avg.	3.8	2.3	2.5	2.3	4.3
Total avg.	4.3	2.3	1.9	2.4	4.3

Table 1: Test results from the testing of different types of washing surfaces

Fig. 52: A plastic bag using the tongue and groove principle

Washing surface material

Alongside the investigation of how to keep the washing surface clean, a research into which materials the washing surfaces should be made of was initiated. Five materials were used (Fig. 51), and fellow students were given a sample of each to be tested at home. They were told to moisture each sample and then use it in both armpits and crotch, then they ranked the samples based on how good they felt to use in both places, where one was the best and five was the worst.

Eight fellow students, and their boy-/girlfriends tested the samples. The result of the tests can be seen in Table 1, and all the testing material can be found in WS48.

Attaching washing surface

Attaching the washing surfaces is a central part of the usability of the product. As the washing surfaces are meant to be changed frequently it was important that the method used to fasten them to the device itself, was going to be simple. Several different methods for changeable solutions were explored, which can be seen in WS54.

Output

As 64.7% of the participants in the questionnaire (Chart 3) wanted to reuse the washing surfaces either by cleaning it with UV-light or by washing it in the washing machine, it was decided to reuse them. The team found that it would not be worth it to implement UV-light, which would add cost and take up space inside the device or docking station. Therefore, the second scenario, where the washing surface is washed in the washing machine between each use was chosen. Comments suggested that the washing surface could be rinsed with water after each use, and thereby be reused a couple of times before being washed, which is also a possibility in this scenario. Because the washing surfaces are to be changed frequently it was decided to with the principle of tongue and groove, which is used in for example Zip-lock bags (Fig. 52). Making a groove around the top of the device itself and applying a tongue on the inside of the washing surface enables the washing surface to be attached and kept in place. The washing surface is removed by pulling it until it lets go from the device.

As seen in Table 1, there was a difference in what material the genders preferred. The female participants overall liked the facial pad the best, while the male participants liked the washing cloth the best. Both the facial pad and the washing cloth was chosen as materials to be used for the washing surface to accommodate the preferences of both genders.

Fig. 53: A rendering of the product handed in to Jumpthegap

Hand-in for Jumpthegap

The hand-in for Jumpthegap was approximately one month prior to the final hand-in of the project. This meant that it was necessary to have the first draft of a finished product ready. The aim for this hand-in was to have the visuals of the product finalised and having the defined functionality of the product, and the components needed to accommodate this functionality. The main component being a water pump [WS49].

Output

After hand-in the device was 3D-printed to test how the shape felt. It had been necessary to make it bigger, especially in the bottom to make space for the water pump. It became clear when seeing the physical model that the new size gave it an unfortunate visual expression and made it uncomfortable to hold. To change the size a different pump was needed. (Page 35).

As there had not been put much effort into developing the docking station and the storage unit, spending more time on developing these was needed. (Page 38).

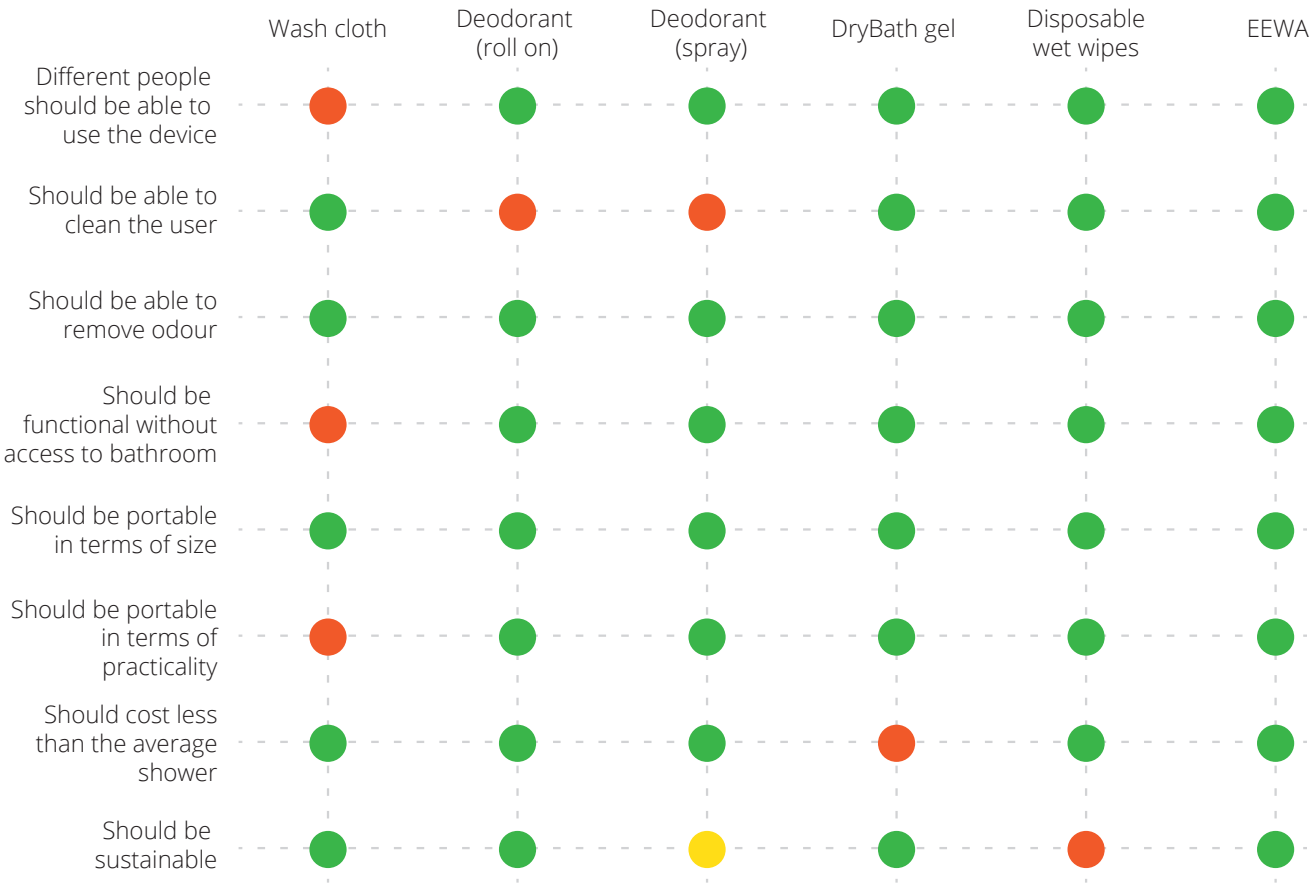


Table 2: Competitor analysis

Competitor analysis

As it was not possible to find other solutions exactly like the product on the market, it was decided to try and consider the current competitors regarding a quick washing of the body. The competitor analysis was also made with the purpose of clarifying how the product differentiate from current solutions. Six current solutions were set up and evaluated on eight different parameters, which were taken from the requirements (Table 2). The complete analysis can be seen in WS58. A green dot means that the parameter is fulfilled, a red dot means that it is not fulfilled. A yellow dot means a third possibility, which is specified differently for the specific parameters.

Output

All the current solutions differ from the product in s parameters. It can be discussed whether it is enough that it only differs from some competitors in one parameter However, as it also focusses on some softer, not quantitively comparable parameters like being a dedicated product in this category and provides a proper wash of the essential body areas, without risking skin irritation or dryness, it is deemed to be acceptable.

Water pump type

As it was chosen to use a pump for the device, it was needed to find the best suited type of water pump.

There are two overall types of water pumps; centrifugal pumps and positive displacement pumps, and different sub-types within the both types. The initial conclusion was to use a centrifugal pump with a flow rate of 80-120 L/h [WS49]. After consulting with the technical supervisor, a second study of pumps was initiated [WS64]. The technical supervisor suggested a peristaltic or a diaphragm pump, which were the ones investigated. The focus was on finding a pump with a lower flow rate and a size that would not limit the overall shape of the device too much.

Output

A diaphragm pump with the specifications seen in Table 3 was chosen.

	Voltage [V]	Current [mA]	Power [mW]	Flow rate [ml/sec]	Size [mm]
Chosen pump	12	200	2400	4.17	Ø = 27 h = 59.5

Table 3: Specifications for the chosen diaphragm pump

This pump was chosen due to the flow rate of 4.17 ml/sec being more suitable for the product, and because it does not need to be submersed, making it possible to place it anywhere inside EEWA, giving more freedom over shape and size.

Battery

Battery type

Different types of rechargeable batteries were compared to find the most powerful battery that would still fit inside the device. The complete table of investigated batteries can be found in WS65. The batteries were compared based on the parameters voltage, current, power, size and price.

Output

The final battery was chosen to be a Li-ion battery as these are some of the most common batteries used in various rechargeable applications. The specific type of battery was a Li-ion 18350 with the specifications seen in Table 4.
The battery only being 3.7V requires the voltage to be boosted to work with the 12V pump.

	Voltage [V]	Current [mAh]	Power [mWh]	Size [mm]	Price [DKK]
Li-ion 18350	3.7	800	2960	Ø = 18.3 h = 34.6	10

Table 4: Specifications for Li-ion 18350

Battery life

An investigation into the power consumption of the internal electronic components was initiated to determine the battery life between charges. The electronic components considered in the calculation were the water pump and the booster that is needed to boost the battery voltage from 3.6V to the 12V required by the pump. Besides from the electronic components, the self-discharge of the battery and the fact that the battery should not be over discharged were considered in the calculation. The self-discharge was calculated from a 5 % discharge during the first 24 hours, and 2 % discharge every month. Besides from these 2 % discharge a month an additional 3 % was added due to the need for security circuit when using Li-ion batteries. (Batteryuniversity.com, 2017) The limit for over discharge was set to be 20% of the battery's original capacity. The full research can be seen in WS69.

Output

The battery lifetime between each charge for the two user froups can be seen in Table 5.

Biking commuter	Family
12.7 months	6.2 months

Table 5: Battery life for each of the use scenarios

As the time between each charge is above half a year in both user groups, it could be reconsidered whether it is necessary to implement charging in the docking station.

Charging method

As the device uses an electrical pump and has a battery, it needs to be able to be charged. The initial idea for charging method was to use induction charging like what is used for electrical toothbrushes. This would be implemented in the docking station making the device charge every time it was placed there.

Output

After considering the battery life it became clear that frequent charging would not be required. It was decided to integrate a micro USB plug in the device to be used for charging. This would provide some freedom in shaping the docking station as there would no longer be a requirement for it to be used for charging. On the other hand, using a micro USB plug might make it more difficult to get a good IP-rating in terms of making the charging area waterproof. However, as several waterproof Bluetooth speakers uses micro USB plugs for charging it was deemed to provide a sufficient sealing.

Visual feedback

To assist the user, feedback is needed to let the user know when the device should be charged, when it is charging, and when it is fully charged, and to let the user know when EEWA has been activated. It was decided to use an LED as feedback, as this is a well-known way of providing this type of feedback. Different ways of placing the LED was investigated (Fig. 54).

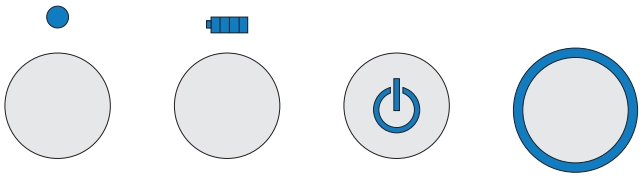


Fig. 54: Different suggestions for how to place the LED (blue) in relation to the activation button (grey)

Output

The idea where the LED is placed around the activation button was chosen due to the possibility of the user still seeing it even when pressing the activation button. The feedback displayed by the LED can be seen in Fig. 55.

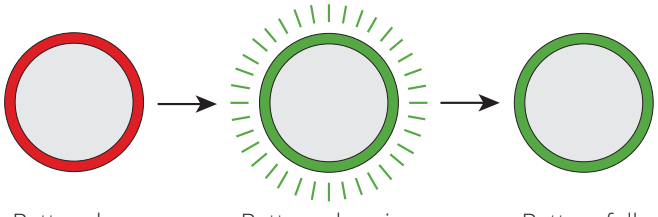


Fig. 55: The charging feedback flow of the LED

Fig. 56: Moodboard used to design the docking station

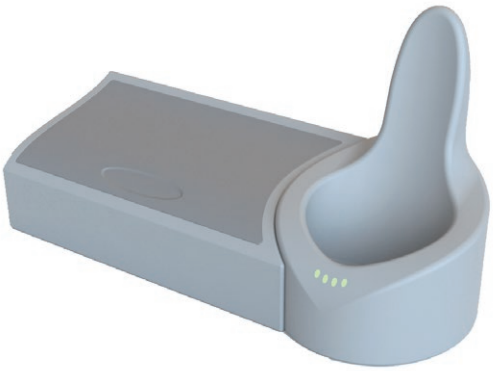


Fig. 57: Docking station and storage handed in for Jumpthegap

Fig. 58: The final docking station

Docking station and storage

As with the visual expression of the device the ideation of the docking station and storage unit was divided into two iterations. One for the competition hand-in, and one after the hand-in.

Hand-in Jumpthegap

A moodboard was used as inspiration for the first ideation of a docking station (Fig. 56). It showed different docking stations, some of them also containing storage, of other bathroom appliances. Three overall ideas concerning look and placement of storage was made, resulting in the docking station seen on Fig. 57.

Final expression

After hand-in it was decided to discard the idea of using the docking station for charging the device, as charging was not needed that often, as found in the battery life research on page 36. A second round of ideation was initiated with the main dilemma of whether the docking station and storage of washing surfaces should be combined into one unit or split into two separate entities. Having a docking station and storage in combination seemed ideal, however, the team found it difficult to create a good visual expression that fitted with the expression of the device. Several ideas were made regarding the two directions, which can be seen in WS72.

Output

Due to difficulties in making the ideal solution for storage of washing surfaces, it was decided to only create a docking station, and postpone the creation of a storage unit. The docking station itself, without storage, was based on the docking station from the hand-in, with modifications to size because of the product being smaller and the absence of charging. (Fig. 58)

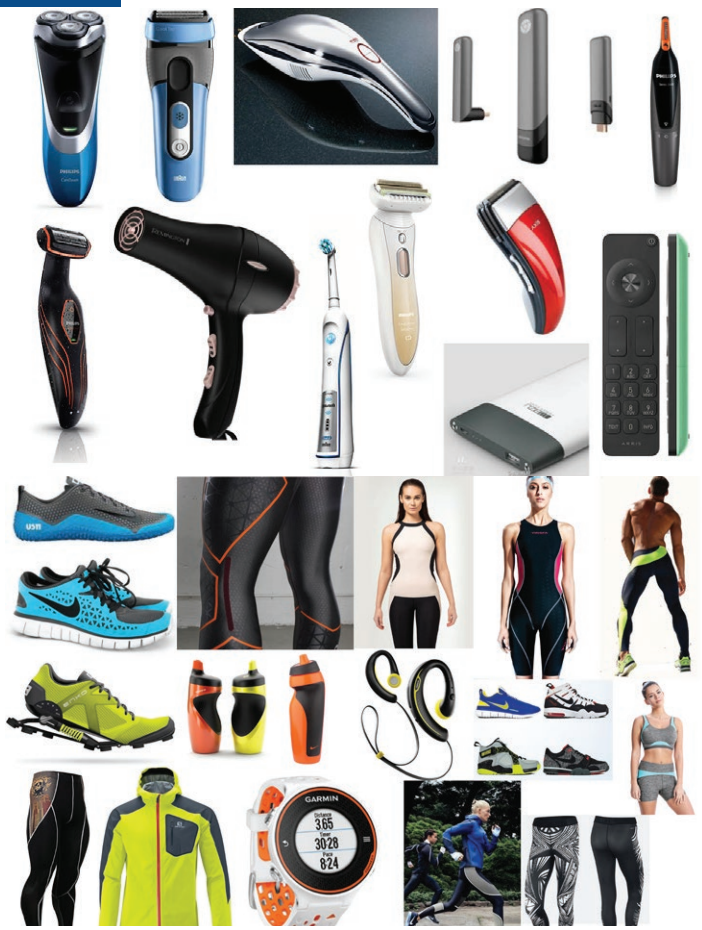


Fig. 59: The two moodboards used to create the visual expression

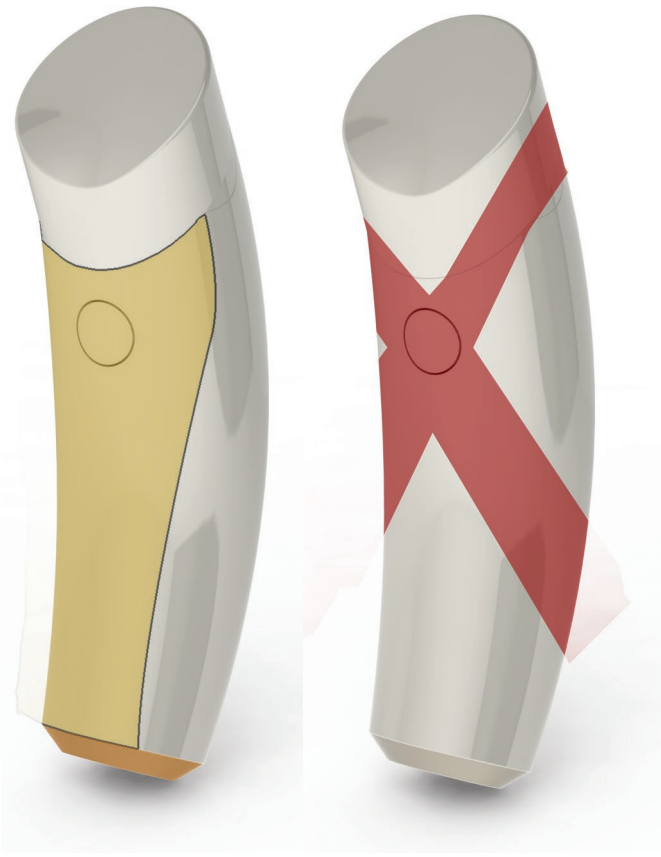


Fig. 60: Round 1 - Two different ways of using colours

Visual expression of device

The development of the visual expression was divided into two iterations. The competition hand-in and afterwards further iterations to reach the final visual expression.

Hand-in Jumpthegap

For the competition hand in a moodboard (Fig. 59 - top) served as main inspiration. The goal was to develop an expression that would stand out without being the centre of attention in the bathroom. Many bathroom items are specifically made for men or women, making these products either very masculine or feminine in expression. The goal for the hand-in was to create a product that was not aimed at a specific gender, but had some of the common features of bathroom products, like soft curves. Neutral colours were picked to accommodate both men and women. [WS57]

The result was styled with curved lines and toned down colours (Fig. 53 on page 34).

Final expression

For the competition, the focus was mainly on the bathroom and the family user group. To include the biking commuters, a second moodboard was created focused on sports equipment (Fig. 59 - bottom). Sports equipment is characterised by using bright colours and distinct thin lines to add a sense of direction. Where objects from the bathroom had long constant curves, the sports equipment allows for sharp turns and corners.
A series of different designs were created based on the moodboards. In contrast to the first round of exploring the visual expression, where two designs quickly made an impression and was developed upon, there were no clear favourites. Instead the designs were validated and evaluated based on what would function well in terms of production and assembly. [WS68]

Output
The final expression is a mix of the curved lines from the competition design, with shaper curves along with a visual connection to the cap (Fig. 64). A thin line, as seen on the sports equipment, highlights the direction and indicates the access to the water reservoir in the bottom. A brighter colour pallet is chosen for the backside to make associations to the fast on-the-go lifestyle, but with a neutral front side to contrast.

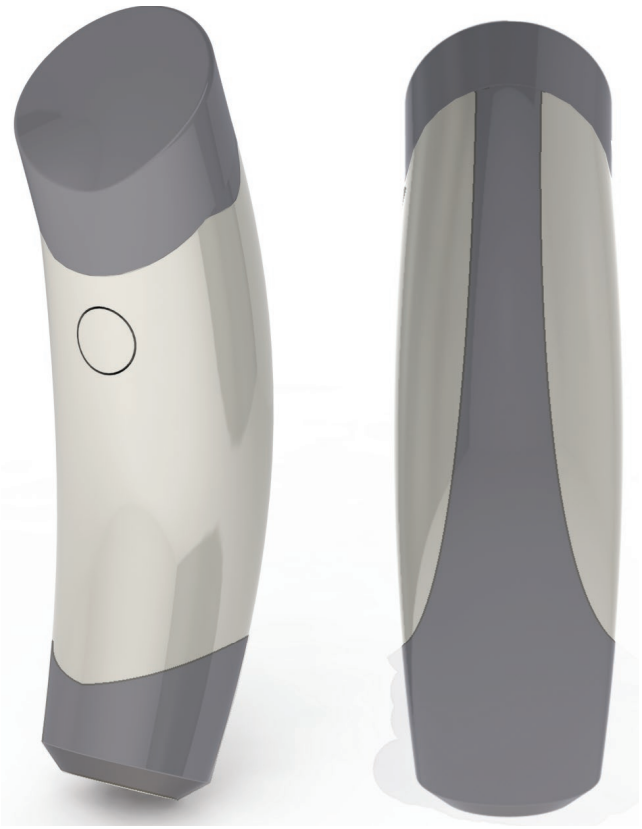


Fig. 61: Round 1 - Discrete colours used to connect the bottom and the cap

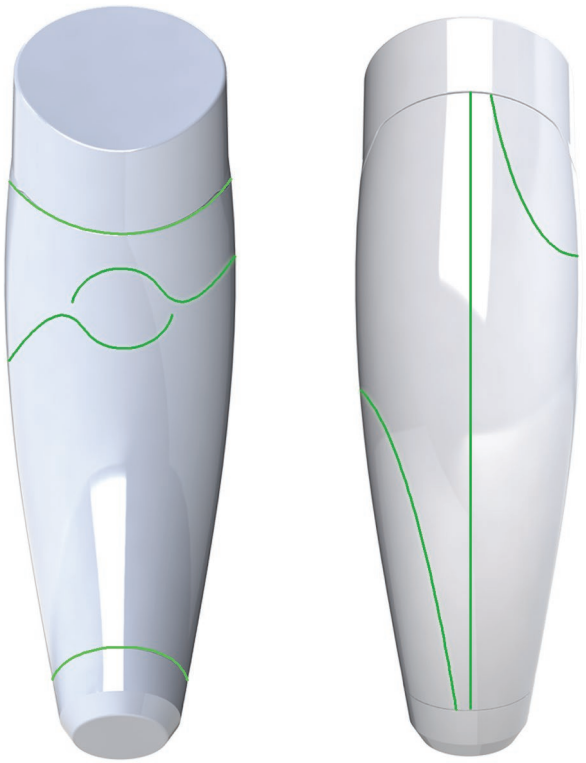


Fig. 62: Round 2 - An attempt to only use thin coloured lines

Fig. 63: Round 2 - Use of strong colours in combination with black

Fig. 64: The final visual expression of the device

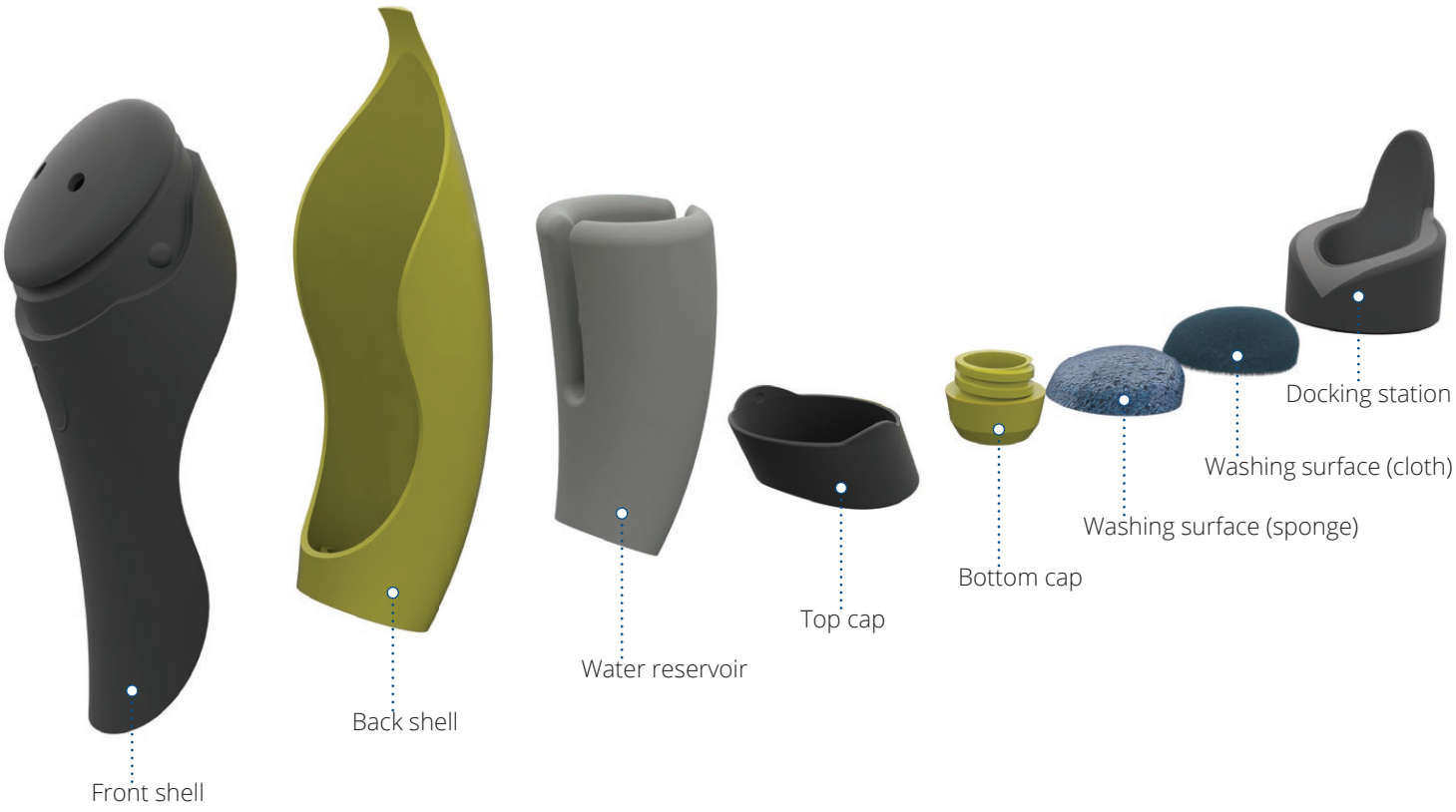


Fig. 65: Exploded view

Materials & manufacturing

Shell, top cap and bottom cap

Material

The material for the shells, top cap and bottom cap was selected based on the need for great impact strength and scratch resistance. ABS was the final choice due to it fulfilling the two requirements, along with it being easy to process, and having a reasonable price. (Lefteri, 2014)

Production

The shell is in two parts and with the top and bottom cap it is a total of four parts. They are all injection moulded due to the high precision, low cost in mass production and the possibility to manufacture complex parts. Each part has its own mould (Efunda.com, 2017)

Water container

Material

The main requirement for the water container was that it should be able to contain the water without the material absorbing it. PET was used for the water container due to it being used for plastic bottles, which bear great resemblance to this application.

Production

Injection blow moulding was chosen as the manufacturing method for the water container due to its relatively simple shape and the fast production speed.

Washing surface

Material

There are two types of washing surfaces; wash cloth and facial sponge. The materials used are cotton fabric and PVA sponge material, as this is the material currently being used. The surfaces are attached by using a tongue and groove principle, the tongue being a silicone rubber cord.

Production

The silicone rubber cord is stitched to the inside of the washing surface.

Docking station

Material

ABS was selected for the docking station due to the need of a smooth surface, and how easy it can be processed. (Lefteri, 2014)

Production

The docking station is injection moulded due to the low cost in mass production. It is made as a solid part to ensure that it has a certain weight.

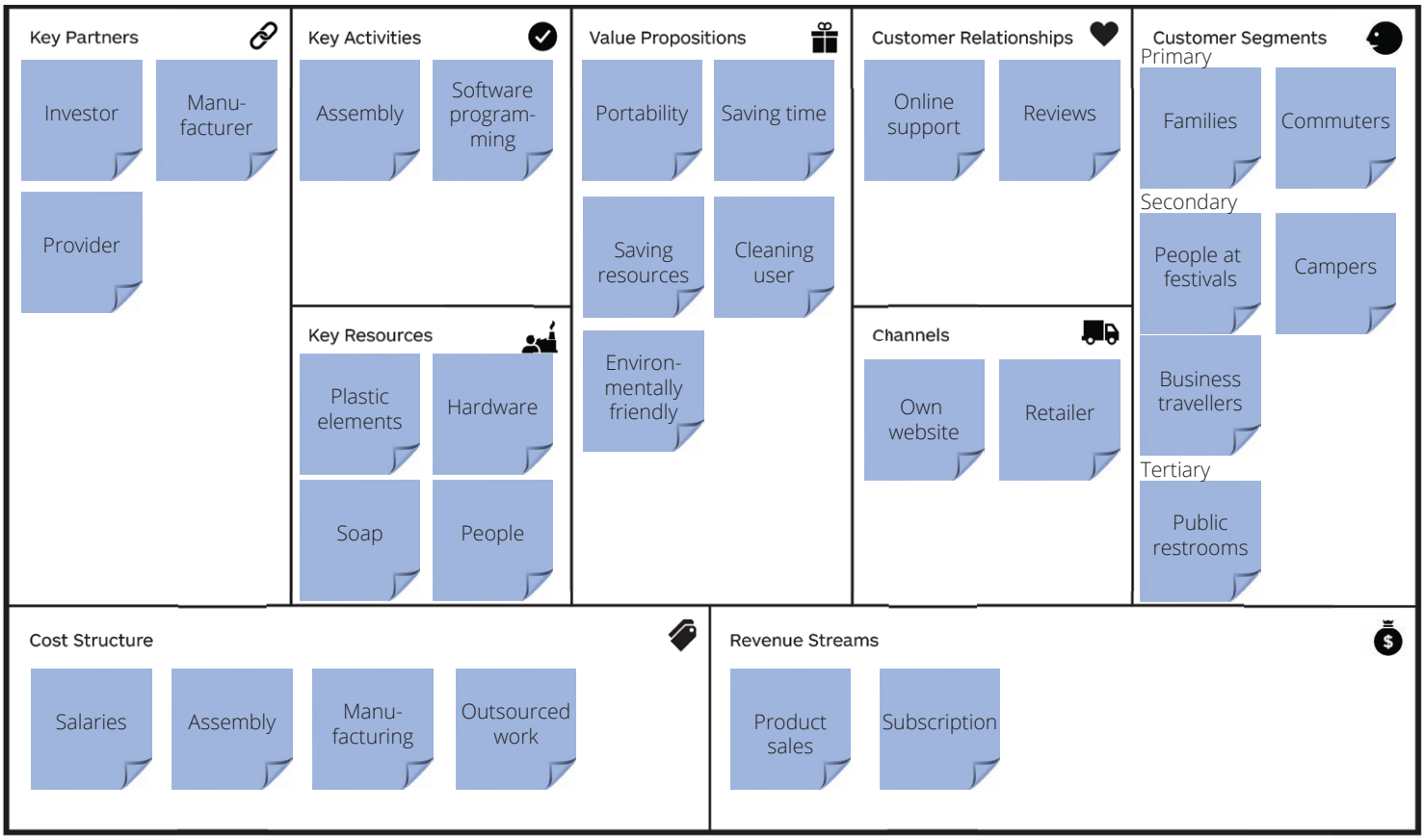


Fig. 66: Business model canvas displaying the project's business model

Business approach

To get an overview of the different aspects of the business part of the project, a business model needed to be developed. Two overall business approaches were found. Either creating a business with the team as entrepreneurs trying to make EEWA into a start-up, or with the team developing EEWA and afterwards selling the project to an established company as for example Philips or Braun. The entrepreneurial way included three possibilities:

1. Finding an investor that was willing to invest money in the project.
2. Finding an investor that was willing to invest money in the project along with spending time helping the team develop the product, by providing knowledge within areas where the team were lacking.
3. Getting the investment for the project through Kickstarter.

Several risks and advantages were found for the two overall business approaches. However, the entrepreneurial approach was selected to ensure a certain degree of freedom in the product development. The considerations for the possibilities within this approach can be seen in WS70.

The second possibility, where an investor invests money and time in the project, was selected as it seemed like the most attractive direction with the least amount of risks. This was mainly due to the knowledge that an investor might be able to provide in areas where the team do not have much knowledge, which would be beneficial to both the process and the final product. With this decided, a business model was created using the business model canvas (Fig. 66).

Product price

The investment includes the expenses for the development budget to finalise EEWA for market launch (Table 6). Some of the numbers are estimates based on knowledge from previous lectures or from desktop research, and some of the numbers are guesstimates.

The product price was the price of a starter package pack including one washing device, one docking station, one charging cable, eight washing surfaces (four of each kind), one bottle of 100 ml. syndet soap and one washing bag. It was calculated based on the material costs, the costs of internal components and salary for the production workers doing the assembly. The material costs of the plastic parts were based of the mass of the parts defined by SolidWorks and the price of each type of plastic. The cost of a cloth washing surface was based on a pack of washing cloths found in Jysk. It was estimated how many washing surfaces could be

Investment	
Development salary	475,000 DKK
Prototypes and user testing	100,000 DKK
Travelling	50,000 DKK
Consultants	100,000 DKK
Website development	100,000 DKK
Tooling costs	500,000 DKK
Buffer	100,000 DKK
Total	1,425,000 DKK

Table 6: The different costs included in the investment

Product cost	
Material costs	3.72 DKK
Soap	15 DKK
Internal components	57.21 DKK
Washing bag	3 DKK
Charging cable	3.42 DKK
Assembly	65 DKK
Total	147 DKK

Table 7: The different elements included in the product cost

made of each washing cloth, and the price of one washing cloth was estimated based on that. The price of one sponge washing surface was guesstimated to be three times bigger than the price of a washing cloth. The cost of a 100-ml. bottle of syndet soap was estimated based on the price of a 250-ml bottle divided by 2.5 and with VAT removed. The cost of both washing bag and micro USB charging cable was taken directly from prices on the internet. The cost of the internal parts was mainly based on the price of specific parts found on the internet, and the rest was a guesstimate. These prices were found with the aim of documenting as many as possible. Therefore, it is estimated that some of them are a bit too high compared to what it would cost in real life, with an initial production of 19,127 units the first year. The salary of the production workers was based on numbers given in a lecture on a previous semester, being 200 DKK/h for a blue-collar worker, and 250 DKK/h for a white-collar worker. This is if the product was to be assembled in Denmark.

This calculation results in a product cost of 147 DKK per unit (Table 7) for a starter package, which leads to a market price of 499 DKK. Besides from the starter pack it is possible to buy additional washing surfaces and soap at a price of 79 DKK for 10 cloth washing surfaces and 89 DKK for 10 sponge washing surfaces and 49 DKK for 100 ml of syndet soap. The possibility of making a subscription for both washing surfaces and soap is also considered, but will not be implemented in the beginning. It could be considered to move the production to China to make the product cheaper. This would result in a drastic decrease in the assembly cost due to a salary of 16.75 DKK for blue-collar workers and 150 DKK for white-collar workers. The product cost would be 101 DKK with a market price of 340 DKK per starter package. However, production in China would go against the sustainability aim, as transportation of products from China to Denmark would cause a high CO2 emission.

Market share

The first year of sales was focus on the primary customer segments; families and biking commuters. The market segments containing these two customer segments within three different countries were researched. The main country being Denmark, with the additional neighbouring countries Germany and Sweden.

In accordance with the previously defined user group, families with three or more children living at home were the focus. Through various statistics websites it was found that there are 120,851 Danish families (Statistikbanken.dk, 2017), 3,322,000 German families (Statista, 2015) and 217,366 Swedish families (Statistikdatabasen, 2015) meeting these requirements.
The biking commuters were defined to be people biking daily to and from a place of work or education. To find these numbers two different statistics were used. The first one was

Country	Population	Daily bikers (%)	Number of daily bikers	Biking to work (%)	Number of bikers to work
Denmark	5,676,000	32	1,816,320	46	835,507
Sweden	9,799,000	20	1,959,800	46	901,508
Germany	81,410,000	18	14,653,800	46	6,740,748

Table 8: The order in which the market segment of biking commuters has been calculated., from left to right

Country	Number of commuters	Number of families	Total number	Market share (%)	Total market share
DK	835,507	120,851	956,358	2	19,127
DK & SWE	1,737,015	338,217	2,075,232	2	41,505
DK, SWE & GER	8,477,763	1,660,217	10,137,980	2	202,760

Table 9: The order in which the market share has been calculated, from left to right

made by TNS Opinion for The Commission of Europe and indicated how many percentage of the participants that bikes daily. This was used to determine how many people in each country that bike daily based on its population. Afterwards a study in Danish transportation habits from DTU was used to determine how many of the people biking daily that due it to get to and from a place of work or education (Faktaark om cykeltransport i Danmark, 2015). The study indicates that 46% of all bike rides have the purpose of commuting to and from a place of work or education. The complete calculation of the biking commuter market segment can be seen in Table 8.

It is guesstimated that it would be possible to sell the product to 2% of the complete market segment, including both families and biking commuters. The market share was calculated for Denmark alone, for Denmark and each of the neighbouring countries Germany and Sweden and for all three countries in total. This resulted in the market shares displayed in Table 9.

Business cases

Two scenarios for business cases were made. One where the product is sold only in Denmark. The first year it is sold to 2% of the market segment, then the second year the sales are increased to 5% and the third year they are increased to 10%. The second one is where the product is sold in Denmark the first year, the second year sales are expanded to include Sweden and the third year it includes all three countries, all with a market share of 2 %. The breakeven time will be the same in both cases, which is just after the first year.

As mentioned, the product price is calculated only for a starter package. Besides from this it is also possible to buy additional washing surfaces and soap creating additional revenues. These were not included in the business cases, as there was no way of knowing how often the users want to renew their washing surfaces.

The calculations are only based on the primary customer segment. It would be possible to expand to include the secondary and tertiary customer segments over time. Also, as seen in the business model (Fig. 66) it would also be possible to make revenues by creating a subscription for new washing surfaces and soap. This is however not considered to be within the first years, but more of a thing that would create revenues in the long term.

There is no way of knowing how the market would embrace a product like this, as there does not currently exist any similar products. This was seen as the main challenge regarding the business case.

Finalising

Fig. 67: Finalising

Further work

Taking EEWA to the next level would require thorough and clinical testing of especially the washing surfaces and their lifespan, as well as contacting manufactures to get exact prices. Manufacturing of a fully functional prototype would also be of high priority, enabling user testing, as a critical area for this project is whether it is attractive for the user and if they see the point of having a product like EEWA. After user approval of the product, investors can be approached. Having the user testing and approval before approaching an investor might give the investor faith in the project, and its ability to make it on the market. Increasing the team's chances of getting an investment.

Product reflection

In general, we are satisfied with the washing device. However, there is always room for improvements. One of the areas that could be improved is the one concerning the dispensing of soap. The initial idea was to dispense a controlled amount of soap using a pump, due to us not wanting to compromise the shape of the device, it was necessary to discard the pump idea and use the simplest principle of mixing the soap and water when filling the water reservoir. This results in a situation with a critical risk of error, if the user dispenses too much soap or pours in a wrong kind of soap.
Another possible error is that nothing prevents the activation button from being pushed accidentally during transportation, in for example a bag. This could be explored further by testing how hard you would have to press the button or use the top cap to ensure that activating EEWA is not possible.

Regarding the docking station, we like the overall shape of it, even though it looks very like the one handed in for Jumpthegap. However, the fact that it is made in solid ABS is not very thought through, and it is deemed that there are better ways of manufacturing it, which will be considered between hand-in and examination.

Overall, this is a new type of product that has not yet been seen on the market. Therefore, there is no way of knowing if people will accept it as a product that solves any problems or needs. Hygienic wise we also do not know how it will be met. Therefore, some user validation is needed. We will attempt to get the needed validation before examination.

Process reflection

This thesis was written with a starting point in the design competition Jumpthegap centered around developing new bathroom solutions. The competition provided some obstructions, for example the focus on sustainability, which provided us with a direction for the project. The hand-in of the competition was one month prior to the official hand-in at the university, which forced the project forward, leading to us having a somewhat finished concept a month before hand-in. This was a great deadline, as it made it possible to evaluate the first edition of a final concept and move into a second iteration and improve the areas where the concept was lacking.

Visiting the ISH water fair in Frankfurt was a great experience, but the four days spend on the trip could have been used better. It provided some new insights especially from some of the lectures, but the overall trends and products were in large the same as we had previously seen on both the internet and in the visited bathroom stores.

The rounds of ideation mostly consisted of hand sketching. From the beginning, we knew that hand sketching was not our strong suits. The preliminary rounds consisted of rough and quick sketches which went fine, but when we were presented with the need to draw more detailed parts and complex shapes, the sketching skills fell short. This caused a lot of wasted time and frustration due to us not being able to communicate our ideas sufficiently. Another area causing frustration during the ideation phase was the lack of a clearly defined user group that could be used to evaluate the ideas. To move forward, the reframe was made creating two user groups to provide some needs for which we could design for. The user groups were based on our own thoughts of future scenarios, where the users would use a product like EEWA. They could have been explored further by basing them on real people instead of our own thoughts, mostly to have some people to use for testing concrete concept ideas.
At some point in the ideation it became clear that we could not move further if we did not do something differently. Idiom testing took over from the traditional hand sketching. It became clear that working with physical models eliminated the limitations that the hand sketching created for us. Therefore, we should have accepted out limited hand sketching skills earlier on, and instead tried to find alternatives ways of doing ideation, using for example 3D-modelling and mock ups.

Creating physical 3D shapes for the idiom testing advanced the ideation further and made it possible to test concepts on ourselves and other people. Testing a product used for washing armpits and crotch proved to be a sensitive task, which made some of the test participants a bit shy, especially regarding the crotch. It might have been better to make the participants test the concepts by themselves in the bathroom, instead of doing it in a group room surrounded by other people. Besides from this, 3D-printing takes time, which resulted in the development of a concept being delayed.

During the process the criteria made during the first phases were used to some degree, but the requirements were not really used. At least not used in the documented sense. They were always in the back of our head when developing, but were not concretely enough taken into the investigations. We were also afraid that putting down requirements would limit the solution space, as many of the solutions used was found when exploring the area in depth. We also found it difficult to quantify the requirements, and in the end, they were just postponed again and again. A solution to the wasted requirements could have been to have fewer requirements and then add to them during the product development process instead of trying to do all the requirements at once before entering the product development phase.

In some areas extensive research was made, where it was later found to be unnecessary. An example of this is the research made on UV- and ozone-cleaning of the washing surface. A lot of time was put into this, but in the end, we found that the respondents of the survey just wanted to use the washing machine for washing the washing surfaces. If this had been clarified from the beginning, time could have been saved on the extensive research.

When handing in for the competition a combined docking station and storage unit was included as a part of the project. The development of this was based on one rough ideation at time had been short, so we knew that this would need some more iterations before the final hand-in. However, we ran into two main problems; whether the storage unit was actually needed, and if it was whether it should be a separate part or combined with the docking station. These undefined problems lead us to work in circles, where we tried to work in both a combined and a separate direction without it leading to anything. A requirement would have been needed to fully define the direction, which should then have been followed by alternative ideation including less hand sketching and more 3D-modelling and use of mock ups. As the storage unit never reached a satisfying result, it was discarded for the hand-in and will be developed between hand-in and examination.

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Illustration list

Figures

Fig. 1: Own illustration
Fig. 2: Own picture
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