EXHUME

EXPLORE - EXPERIENCE - EXCEL

Battery driven portable **pressure washer for mountain bike cleaning.**

MSc04-ID6
MAY 2023

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Master Thesis
Aalborg University

PRODUCTREPORT

TITLE PAGE

TITLE Exhume
PROJECT START February 1, 2023
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PROJECT TEAM Ma4-ID6
MAIN SUPERVISOR Christian Tollestrup
CO-SUPERVISOR Lars Rosgaard Jensen
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ABSTRACT

This project is the industrial design master thesis consisting of the product Exhume. The project has roots in existing knowledge of mountain bikers and their wish to clean their bikes near the trail, before returning home. Several mountain bikers have contributed throughout the process to the success of the development of Exhume. Currently the mountain bikers have to bring inadequate cleaning equipment that ends up scattered all over or wait to clean the bike until returning home, when they've gotten tired and cold. With a dramatic rise of mountain bikers in the aftermath of Covid, the need for such a product is larger than ever.

Exhume intends to solve the aforementioned issues of cleaning a mountain bike by the trail while trying to become a part of the arms race that rages within the mountain biking world in regards to equipment and accessories.

This product report intends to show off the final design of Exhume, which is made on the basis of the work presented in the attached process report. The product report focuses on presenting the features, use, business and production of Exhume.

TABLE OF CONTENT

MOUNTAIN BIKING

Mountain biking has seen a steady increase in popularity over the last 15 years, and it is a seemingly continuing trend. In the United States 40 million people partake in mountain biking each year and it is increasing over time. (IMBA Canada, 2018) A key reason is that the feeling of being free and testing your skills to the limit, riding in and sensing the nature is a feeling that more and more people seek. It was ballooned by the Covid-19 pandemic, driving more people to enjoy the outdoors from being isolated for so long, resulting in a 92% increase in full-suspension mountain bike sales, expected to increase a further ten over the coming five years. (Sloss, 2021)

Mountain biking is a hobby that almost anyone can pick up and the possibilities are endless. The price that is paid for the mountain bike and gear can be adapted to each person's situation, as the market is so wide and mountain bikes are offered in all price ranges. However, the average mountain biker is estimated to spend around 8,300-10,300 DKK every year on gear and accessories alone. (Ballin, 2016)

For a lot of mountain bikers challenging their skills and the trails is a key motivator. That is also a reason why they tend to spend a lot of money on newer and better gear, to maximise their performance. The other aspect is the fashion aspect, in that they want to show off that they have the coolest equipment. And the coolest gear is often the newest and most technologically advanced things that can save the riders a little weight or improve their experience overall.

THE PROBLEM

Time consuming

There are, however, less enjoyable parts to taking the mountain bike to the trail for a few runs, namely the cleaning afterwards. The cleaning is a necessary step in order to keep the mountain bike in tuned condition for riding. Riding an unkept mountain bike is not enjoyable and could potentially be dangerous, and repairing it can be expensive.

Straining positions

Cleaning a mountain bike is a bothersome and straining job when doing it by hand and brush. After soaking the bike with a garden hose, the physical labour with a brush starts. This work leads to some straining working positions, when the rider has to hold the bike with one hand to keep it standing, while scrubbing away with the brush on the lower parts of the bike. The same applies when the bike is being dried afterwards.

Messy

Because the different parts aren't equally dirty and some are more sensitive, some parts are cleaned with different brushes. Likewise you don't want to scrub the bike with a dirty brush and water, so the space can be filled with a couple of buckets, different brushes, different cloths, the cleaning detergent as well as the garden hose. This tends to just be scattered around, resulting in a messy unorganised workspace.

Dark and tired

Cleaning the bike after the ride takes time, and since there are no real options for cleaning the bike by the trail, the rider will have to do it at home. This gives time for the sweaty clothes to get cold and the tiredness to set in on the drive home, removing all inclination to clean the mountain bike. This is naturally worse in the colder seasons, where you don't want to be standing outside in wet clothes for 15+ minutes. In addition it will also become dark before they get home from the ride.

Dirty car

The problem begins even before the mountain biker drives home. Many mountain bikers tend to put their precious bikes inside the car, rather than hanging it on the back. Hanging the bike on the back of the car leaves it more susceptible to damage and dirt from the drive home. While a relatively low risk, it is not a risk many want to take with their expensive bike. This means that they need to take precautions and cover the back in towels and be careful, otherwise the inside of the car will become dirty instead.

EXHUME

Exhume is the solution to this problem. It is a portable pressure washer solution that the mountain biker can bring with them to the trail to take care of the cleaning on the spot.
With a built-in bike stand and pressure washing ability, the bike can quickly and efficiently be washed down, removing most of the dirt that has settled on the bike. The soap spray and brush can be used to loosen the most tenacious grime up. Lastly, drying the bike over with the cloth afterwards ensures that the mechanical parts and suspension will be kept free of limescale and run smoothly.

THE CLEANING SCENARIO

Taking it out of the car

Taking Exhume out from the car can be done easily either by lifting in the gun handle itself alone or supporting on the bottom of the water tank which doubles as a secondary handle.

Mounting the bike stand

Exhume includes a bike stand that becomes a part of the shape when it is not in use. The bike stand is released easily by a latch on the side of the water tank. The bike is placed on the bike stand by the rear wheel hub, making the bike stand and keeping all parts accessible for cleaning.
When packing up, the water tank can be slid back over the bike stand, clicking it back in place with the latch, for a hands free operation.

Accessible tools

When Exhume is placed beside the bike and opened, it becomes fully prepared for cleaning the bike. Besides the gun itself, all the other equipment becomes freely accessible to grab from the top of the water tank and ready to use. By having dedicated spaces for each component it cuts down on the mess that otherwise can be created on the ground.

Cleaning the bike

With the bike placed on the bike stand it is super easy to use Exhume to clean the bike. Simply pulling the gun out and extending the hose to the desired length makes for a hassle-free experience. The different nozzles can be used to adjust the spray for different parts of the bike after preference. The brush and soap can easily be used to the liking of the mountain biker, and in the end the cloth can be used to dry off the sensitive parts or the entire bike.

THE GUN

The battery placed at the bottom of the gun delivers 20V with a capacity of 2 Ah. This is enough to ensure at least the required 15 minutes of continuous pressure washing, enough for 3 complete bike washes.
The battery is detachable for easy charging at home.

The handle has a TPE coating for a comfortable and secure grip. Because the handle of the gun is also the handle on the water tank, there is a switch close to the handle, locking the trigger to enable lifting.
The front of the gun is designed to be used as a secondary handle, when the cleaning calls for that little bit of extra precision.

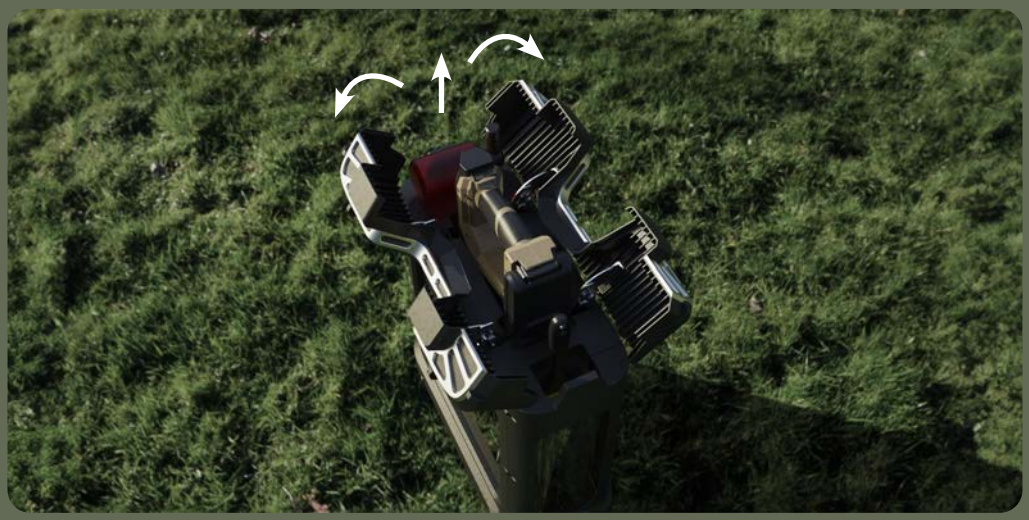
SPECIFICATIONS

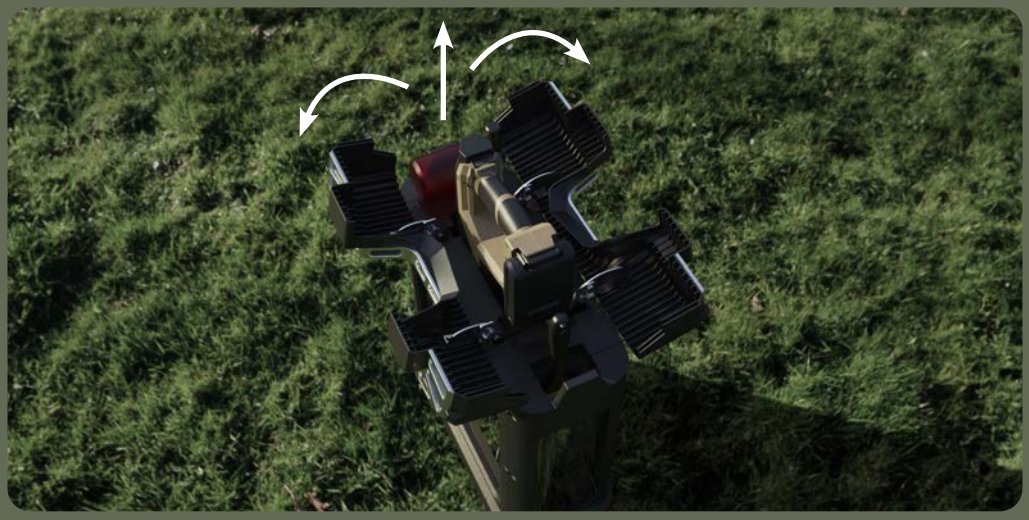
- Weight 1.2 kg
- Nozzle switch
  - 15 deg
  - 25 deg
  - Upwards
  - Foam nozzle
- Lockable trigger
- 25 bar water jet
- <90 dB
- Detachable battery
- Soft grip

The gun has four different nozzles that can be switched freely between depending on use and preference.
A 15 degree spray angle, 25 degree spray angle and a 45 degrees upward spraying nozzle.
It is also possible to attach a soap dispender to the nozzle, making it easy to cover the bike.

FEELING

Opening





The water tank is opened and the gun released by pushing the handle downwards. This releases a mechanism, making the top of the water tank open by itself, while raising the gun, presenting it and the rest of the tools needed for cleaning.
The opening consists of the two lid parts that will fold out revealing the contents. This makes for an unexpected feature that the mountain biker can proudly show off.

Bike stand

The bike stand is simple but very practical. It sits as a part of the water tank, and is easily released and placed by opening the latch on the side of the water tank.
When the mountain biker seemingly pulls the bike stand out of nowhere, they suddenly have an extra accessory that improves their cleaning experience. This is sure to surprise the neighbouring riders, making them wish to have one themselves.

Spool

The hose is attached with an automatic reel making the packing up that bit easier. When cleaning you simply pull the hose out to the needed length.
When finished cleaning and it is time to pack up again, the hose is reeled in by simply pulling slightly to release the automatic reel. The automatic mechanism makes packing up effortless, as the last thing you want before driving home is fighting with rolling up the hose.

AESTHETICS

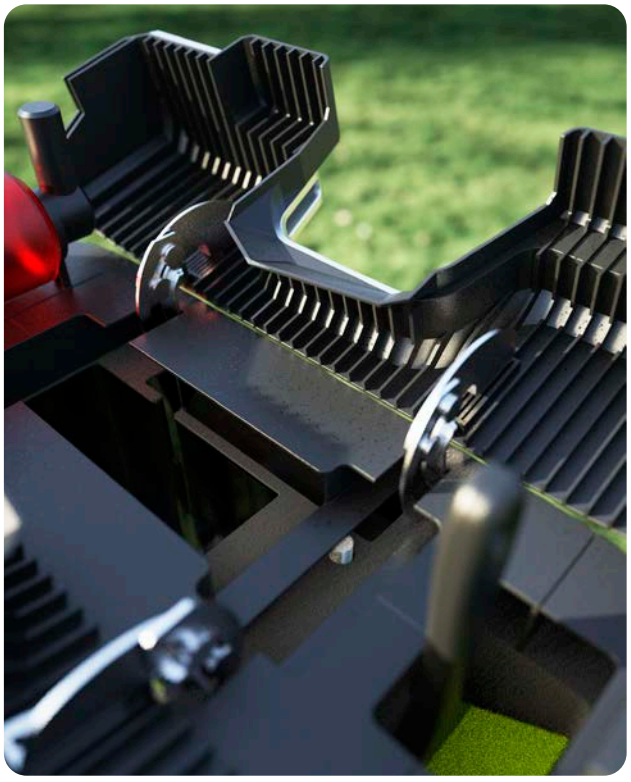
The water tank is designed with a durable aesthetic, as a protective frame guarding the valuable contents. The surface finish of the water tank gives it a naturally durable look, as well as a nice surface texture. Likewise, scratches and the like will be more concealed.

The small knobs around the top and bottom of Exhume function as small bumpers and make Exhume appear more durable.

Along the top of the lid is a metal detail adding a design detail that mimics details of a mountain bike. This simultaneously indicates that the top is strong, to ensure the user that it is safe to lift in the handle or drop it.

Other than the functional aspect of being able to monitor the water level, the transparent walls serve an aesthetic purpose. This draw links to the mechanical parts of the mountain bike, which is one of the prevalent parts of the bikes. By exposing parts of the mechanics inside, it gives a transparency of the product.

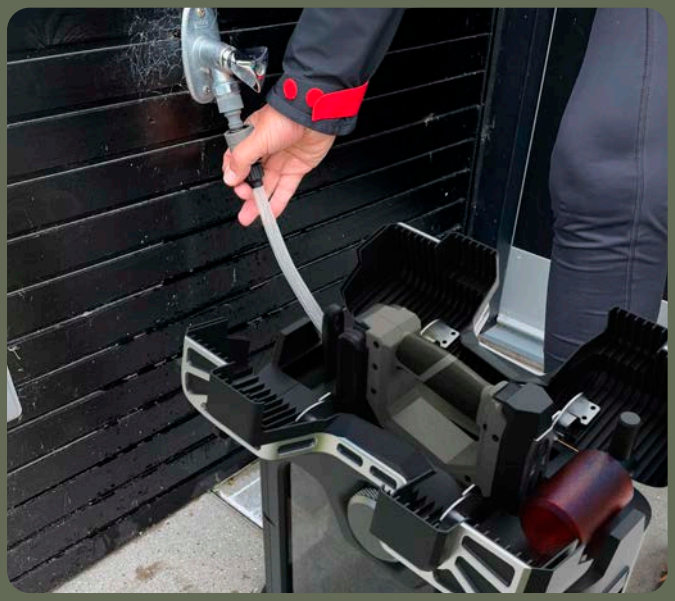
The colours are chosen to resemble other sturdy and durable products. The dark colours are likewise less visibly susceptible to small scratches and dirt.



The hinges for the lids are oversized on purpose to give a reassuring look, that it has the strength to carry a full water tank. Likewise the lids have slats to strengthen the lid, ensuring it is strong enough to lift the full tank.

The bike stand finishes off the overall shape of Exhume. Other than that it is designed to look sturdy and steady to make the user feel safe placing the bike on it.

OUTSIDE THE CLEANING



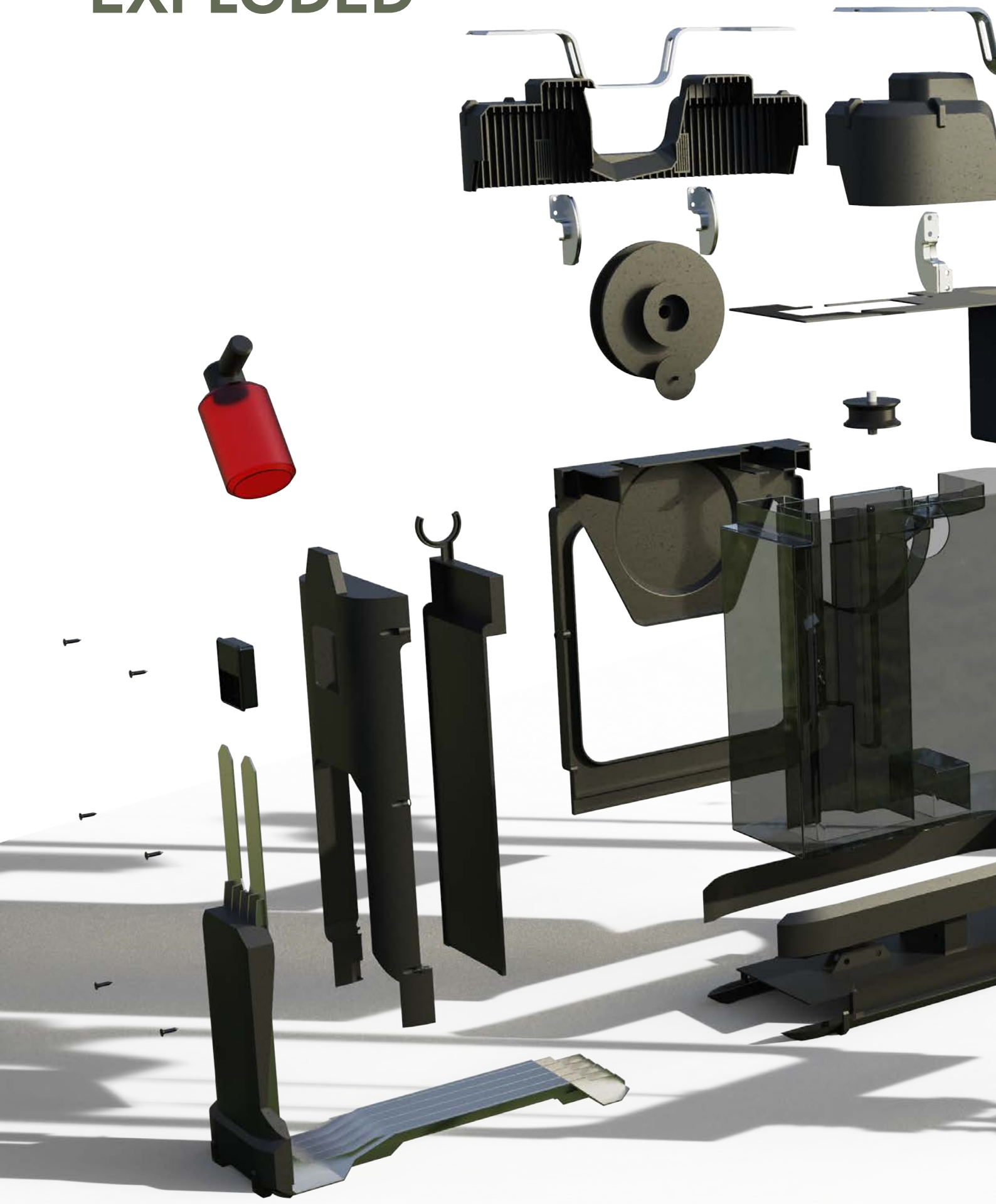
Exhume is useful for both house and apartment residents as it is possible to fill from both indoor and outdoor faucets. The hose can be disconnected from the gun and attached to a garden faucet to refill the water tank. The other way is to remove the cap on the front of the water tank, and place it under the sink faucet to fill it.

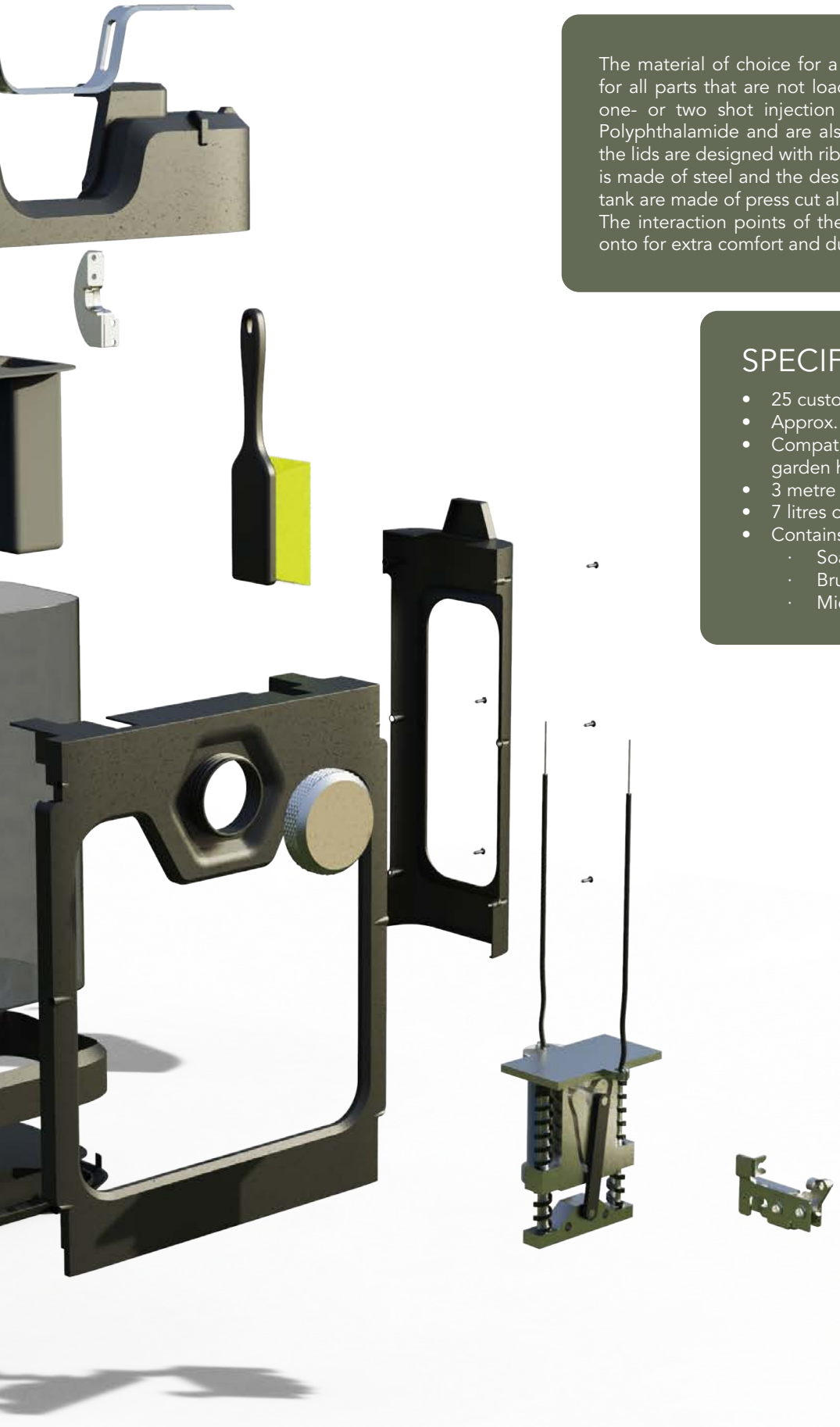
When transported in the car Exhume can be laid on the backside, or placed upright and secured with a rope to the car's mounting points.
The cap is placed high enough, that it is above the water both when Exhume stands and is laying on the back.

When moving Exhume between the house, car and cleaning spot, it can be lifted comfortably in the gun handle. The slender frame enables lifting it close to the body making it more comfortable.

The dimensions accommodate storage in regular metal shelving units in a garage or workshop or in the cupboard in an apartment with no garage space. With so many opportunities of hiding it a high 'Wife-approval-factor' is expected.

EXPLODED



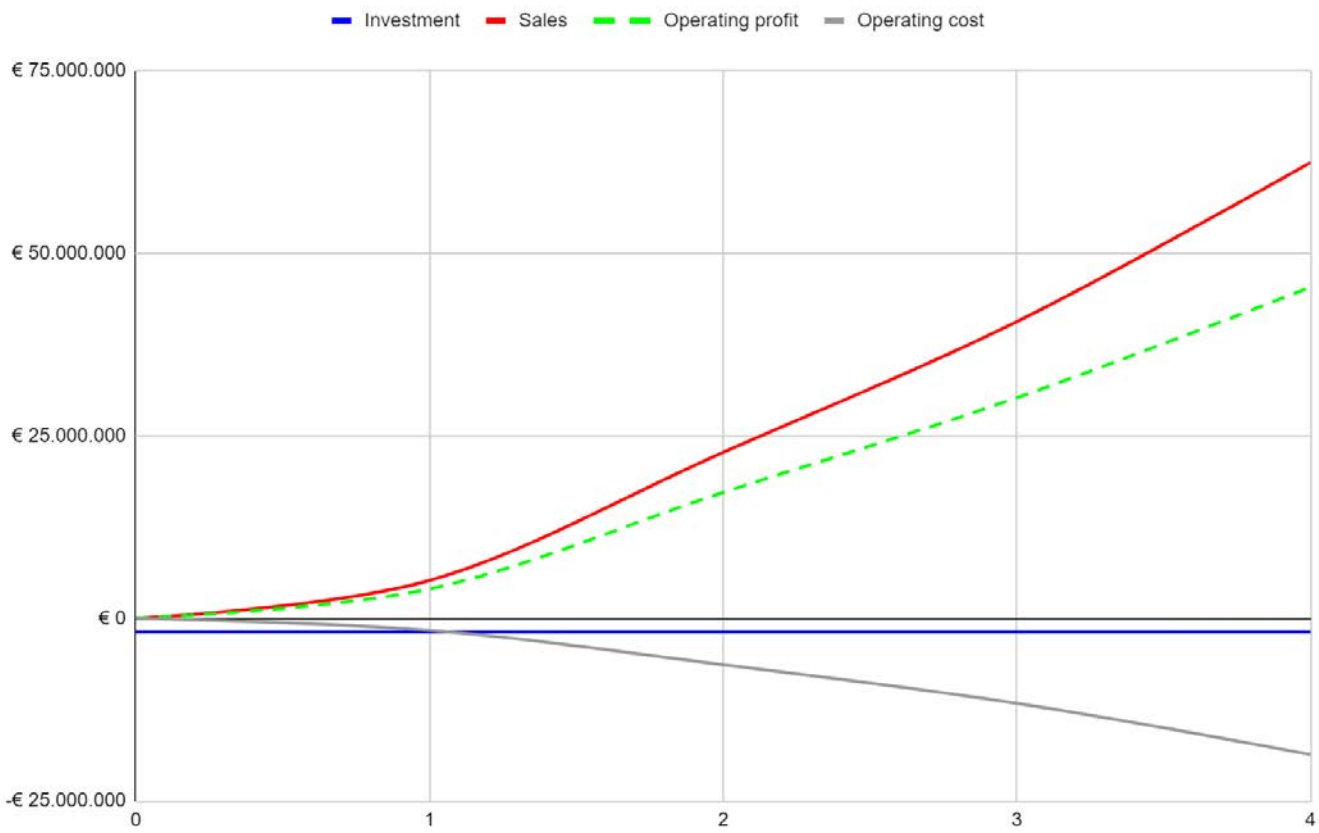


The material of choice for a product like this is polypropylene for all parts that are not load bearing. The PP parts are either one- or two shot injection moulded. The lids are made of Polyphthalamide and are also injection moulded. Furthermore the lids are designed with ribs for extra strength. The bike stand is made of steel and the design elements of the gun and water tank are made of press cut aluminium.
The interaction points of the gun has a layer of TPE moulded onto for extra comfort and durability.

SPECIFICATIONS

- 25 custom components
- Approx. 6 kg
- Compatible with regular garden hose
- 3 metre hose
- 7 litres of water capacity
- Contains the essentials
  - Soap
  - Brush
  - Microfibre cloths

IMPLEMENTATION



With an initial investment of €1.472.000 into moulds and machines and €400.000 into development, there is a need to sell products at a rapid pace. The break even time happens after 12.000 units, which is just over 60% of year one sales. With potential sales of up to 300.000 units and a sales price of €500 it is possible to gather a profit of €41.000.000 after the set period of 5 years.

Phase 1

The first step to implementing Exhume into the market is to gain some initial investments in order to further develop the product, to get it production ready. Further investments are needed for machines, moulds and an advertising campaign in order to launch the product. Here launching a Kickstarter campaign could provide a security of sales while also providing money for the production.

Phase 2

After launching the product on kickstarter it would be the aim to get the product out into mountain bike stores all over europe and north america. This would make it possible to reach a much wider audience. It would also enable the possibility of making a physical stand in the stores to show off the product, just like companies like Muc-off have had success with.

Phase 3

Since this product is made to make the user feel professional, it would complete the experience if every step from buying, through unpacking to using the product exuded the professional approach. By achieving this complete experience it is the aim to have the user perceive the product so nicely that they would recommend it to their fellow riders.

PRICE POINT

€500

Exhume has an expected sales price of €500 which is the price of a high-end pressure washer. The high price tag targets the high-income user group, where cash sits loose and expensive gear is valued highly in their mountain biking experience.

EXPLORE - EXPERIENCE - EXCEL

AALBORG
UNIVERSITY

EXHUME

PROCESSREPORT

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APPENDIX 134

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ABSTRACT

This project is the industrial design master thesis consisting of the product Exhume. The project has roots in earlier knowledge of mountain bikers and their wish to clean their bikes near the trail, before returning home. Several mountain bikers have contributed throughout the process to the success of the development of Exhume. Currently the mountain bikers have to bring inadequate cleaning equipment that ends up scattered all over or wait to clean the bike until returning home, when they've gotten tired and cold. With a dramatic rise of mountain bikers in the aftermath of Covid, the need for such a product is larger than ever.

This process report tries to present the process behind Exhume through five phases from the scoping of the project to the finalized design. Exhume intends to solve the aforementioned issues of cleaning a mountain bike by the trail while trying to become a part of the arms race that rages within the mountain biking world in regards to equipment and accessories.

READING GUIDE

This project consists of a Product Report, a Process Report, Appendix and Technical drawings. It is recommended to read the Product Report first and follow up with the Process Report for a more in depth view.
Appendix and Technical Drawings can be used as reference works in addition to the Product Report and Process Report.
The project is structured into 'phases', separated by the physical Milestone with the exception of the first. Every phase is summed up with a Design Brief while the phase introductions will include Milestone feedback to summarise where the project is moving towards and which knowledge is gained. In each design brief the demands and wishes are stated. Here som wishes will be marked with a *. The marked wishes are some that need to be defined, before they can become demands or disregarded.
Demands and wishes are indicated with a box like this in the section where they originate, are updated or are removed.

Demands
- New demand
- ~~Demand removed~~

Wishes
- New wish
- Wish in need of definition *
- ~~Wish removed~~

TABLE OF

SCOPE
01

CONCEPT
02

DEVELOPMENT
03

CONTENT

DETAILING 04

EPILOGUE 06

INTRODUCTION

The rise in popularity of mountain biking in the last fifteen years has shown many different ways of maintaining the expensive bike. Some love to clean well whereas others loathe it or even skip it. Whether you love or loathe the cleaning itself it is generally seen that there is a market for one smart solution, that is specified for mountain bikes.

Mountain bikers do all kinds of different cleaning methods, but the goal is the same; an easy way of cleaning the bike. The project started with an issue noted in an earlier project, where a low pressure cleaner was made for mountain bikers living in apartments. Research during this project showed a need for a solution that could clean the bike while by the track which has been worked upon. Further investigation shows that the reasoning for this is either to remove the most annoying dirt while still fresh and easy to handle or to be done with it before they're home and tired. The earlier project had a lot of research and an early initial concept that could be used as a foundation for further work.

The process has worked with implementing technical features, user research and -feedback and micro interactions in the specific context into one integrated product called Exhume.

With Exhume it is possible for the millions of mountain bikers around the world to clean their bikes by the trail. The cleaning consists of spraying and brushing which is an efficient cleaning process compared to their previous methods that are shown in scenarios. Furthermore Exhume speaks to the emotions of the user. This is utilized by the gun presenting itself together with a surprising opening experience that should make the user feel professional in the cleaning, like they do in mountain biking. Exhume has the sizing to clean one bike with excess water while being easily stored and transported.

Illu. 0-2

01SCOPE

In this phase, the problem will be unfolded and thereby lay out the landscape in order to choose a direction to detail. Data will be collected and initial visits/interviews will be conducted to understand the size of the problem and the meaning to the people involved.

1.1 SCOPE

Initially both directions of cleaning motorcycles and mountain bikes were explored, but it quickly became apparent that the most interesting project with better ability to work more in-depth would lie in cleaning mountain bikes. From here on, the focus will be solely on the mountain bikes.

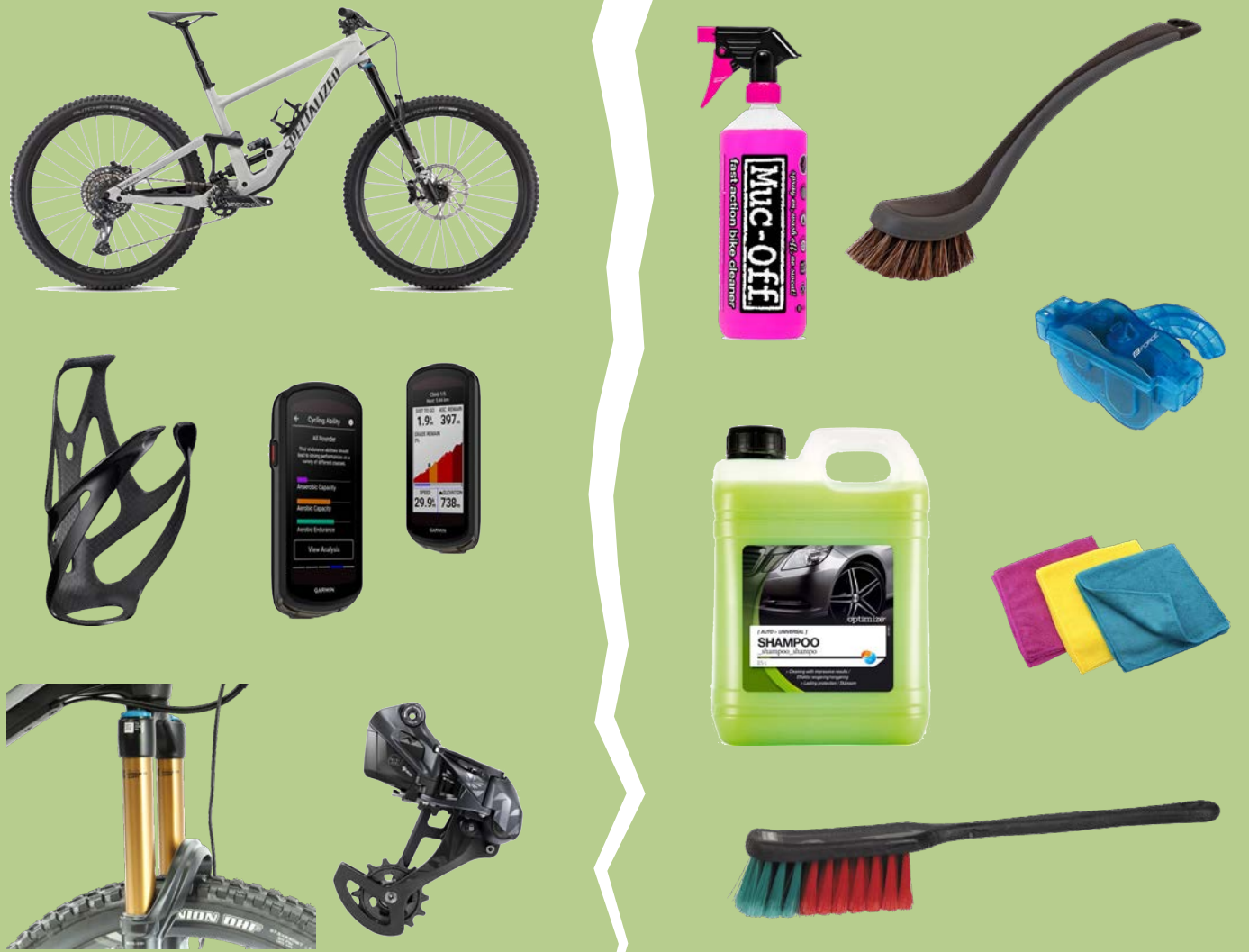
The mountain biking segment was already climbing steadily, but the outbreak of Covid-19 accelerated the tendency further. According to statistics from New York Times the sales of expensive full-suspension mountain bikes rose by 92% in 2020. (NPD Group, 2020) Furthermore the overall sales of mountain bikes expects to rise by 10% up until 2027. (Palwe, 2023) These trends are from America and are expected to be somewhat comparable to European statistics.

A big part of riding a mountain bike is the cleaning process that comes after the ride. For some the cleaning is enjoyment in taking care of their precious joy ride, while for others it is an annoying necessity. Either way it is important to take good care of the bike, so it lasts long and gives a lot of joyful times.

Mountain biking is also a hobby which includes a lot of equipment. Many mountain bikers are willing to pay large sums of money for what in reality are miniscule gains in performance. For some it's even just about having the coolest gear and showing off. But all this equipment is something that is FOR the bike, but when it comes to the cleaning process there isn't much thought put into equipment TO the bike other than 'special' detergents, brushes and chain cleaner tools. This leads into a framing, where the value lies in looking and feeling cool. The project focus is in creating a product that you just cannot live without as a mountain biker - either because of its cleaning properties or its cool factor.

Expensive gear

Cheap cleaning equipment



Illu. 1-1, Gear vs cheap equipment

1.2 PREVIOUS KNOWLEDGE

As mentioned in the introduction, this project takes inspiration from an earlier project that was made in collaboration with Nilfisk in the 7th semester. The interviews used for the old project can be seen in appendix 2. The most noticeable information taken is the following wishes:

Wishes

- Tap refill
- Easy to store
- Wife approvable
- Space optimised features

1.3 USERS

DEMOGRAPHICS

According to statistics about 80% of mountain bikers are male and 75% of mountain bikers are 24-64 years of age. Mountain bikers are statistically overrepresented by high-income households which can be seen in how their spending is. There are also plenty of low income mountain bikers, who logically do not spend as much. (Barber, 2016)

SPENDING

The price that is paid for the mountain bike and accessories can be adapted to each mountain biker's income, as mountain bikes and accessories are offered in all price ranges. However, the average mountain biker is estimated to spend around $1200-1500(8300-10300 DKK) every year on gear and accessories alone. (Ballin, n.d.)

TARGET GROUP

With this in mind it makes sense to target the product towards high-income males in the age group of 24-64. The target group is wide and ready to spend a lot on the right equipment for their situation. The product may target other audiences as well, but this target group is the main focus for this project.

Illu. 1-2, Mountain bikers

1.4 SCENARIO

By talking to different mountain bikers it was observed that there is one main difference in how their scenario of cleaning their bike plays out. This is whether they live in an apartment or a house. The ones living in houses mostly have the necessary facilities for cleaning their bike while the ones living in apartments need to utilize the cleaning facilities at a petrol station.

In order to get a detailed understanding and identify the problematic areas of the different scenarios and their problems, each scenario is investigated through acting-out and situated interviews. The "at-home" scenario is being focused on since it is believed to be the most common scenario. The scenario will now be shown along with the observed and pointed-out problems. Additional problems observed from the scenario at the petrol station will be shown afterwards.

What happens		Notes	Time
01	Preparing and packing for the trip.	• Packs his bag with tire patches, food, water and phone. • Makes space for having the bike inside the car or on the bike holder.	20-30 min
02	Drives to the track	• Typical trip is roughly 1 hour	30-60 min
03	Unpacks for the track	• Take the bike down from the bike holder or out of the car. • Applies his backpack and water.	10-15 min
04	Rides the track	• Rides for approx. 3 hours. • The bike either gets mud, dust or both on it.	Approx 180 min
05	Returning from the track	• The user packs his things • Changes clothes	5 min
06	Cleaning in place	• Uses water bottle water to get the worst off	2 min
07	Getting the bike back in the car	• Straps it on the bike holder or puts it inside the boot of the car.	10 min
08	Driving home	• Takes approx. 1 hour.	30-60 min
09	Unpacking the car	• Getting the bike out, removing towels and folding seats back up.	15-20 min
10	Prep for cleaning	• Finding hose, buckets, brushes, soap - whatever is needed.	10 min
11	Cleaning the bike	• Detailed scenario.	5-60 min
12	Packing everything up	• The cleaning equipment needs to be cleaned and put back away again. • The bike goes to storage as well.	10 min

The problematic areas of the overall scenario is summed up as follows

01 It takes 20-30 minutes to prepare the car to accommodate the bike, which could be used for cleaning instead.
02 When driving home the bike is likely to dry up even more than it otherwise would have.
03 When riding in winter time it's likely that the sun has gone down when getting home. Whereas out on the track, you are more likely to stop before you are no longer able to see anything.
04 It takes 10 minutes preparing the cleaning of the bike and 10 minutes packing up afterwards which is a long time to the effective cleaning time.

Scenario zoom - Cleaning the bike at home

01 He places the bike on a bike stand or leans it against something.

02 He rolls out a garden hose to the bike.

03 He starts off by wetting the bike to make it easier to remove the dirt.

12 And when holding the bike while reaching to the other side to scrub.

11 Some straining positions are observed when brushing the lower parts

10 If the tyres are to be cleaned he applies extra water and scrub thoroughly.

13 The brush is rinsed off with the hose.

14 The bike is then rinsed thoroughly.

15 The bike is bounced to remove excess water.

The problematic areas of the current cleaning process is summed up as follows

01 User needs to roll out a garden hose every time
02 In the winter it is most likely dark when he gets home to clean the bike.
03 He has nowhere to put the garden hose, so it is just thrown on the ground.
04 The brush bangs into the frame sometimes
05 The brush needs to go everywhere in order to get all the dirt off
06 The user has to hold on to the bike when brushing it.
07 With no lance a bit of spray back is observed
08 The working positioning are straining sometimes
09 Cleaning "the other side" is a hassle
10 When cleaning the wheels the bike needs to be rolled a bit in order to clean the wheels all the way around.

04 After a quick spray, he takes a brush from the bucket.

05 He wets the brush as well, and the nthrows the hose on the ground.

06 Muc-off is sprayed on the brush (others spray the soap directly onto the bike)

09 The wheels are cleaned with the same brush, which can be a tough task.

08 He only uses one brush, and sometimes it rams into the frame of the bike.

07 He brushes the bike, starting from the cleaner top working down to the dirtier bottom.

16 The bike is dried with a towel from top to bottom.

17 The most important parts are the mechanical parts to avoid limescale.

18 The rest of the bike is purely for aesthetic purposes and feeling that the bike is clean.

Illu. 1-3, Scenario

Demands

- Must be safe to use on a mountain bike
- Battery and water included
- Transportable in car
- Can be used with existing cleaning products
- <15 minutes cleaning
- Must contain the essentials for cleaning

Wishes

- Transportable / mobile
- Easy / fast to prepare
- Easy to use
- Minimise body strain
- Storage of other mountain bike related equipment
- Bike stand

1.5 DESIGN BRIEF

PROBLEM STATEMENT

How can the cleaning process for mountain bikes be improved through a new industrial design product?

VISION

Maintaining the good driving experience through easy cleaning of the bike

TARGET MARKET

Mountain bike enthusiasts who want a way to clean their bike easily and effortlessly, while maintaining control and a sense of accomplishment.

GENERAL REQUIREMENTS

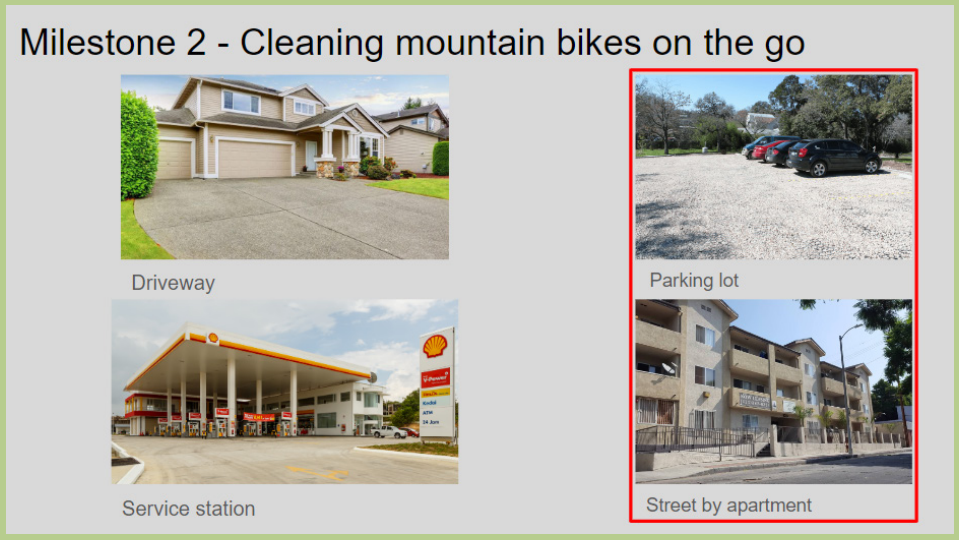
		Section
01	Must be safe to use on a mountain bike	1.4
02	Battery and water included	1.4
03	Transportable in car	1.4
04	Can be used with existing cleaning products	1.4
05	<15 minutes cleaning	1.4
06	Must contain the essentials for cleaning	1.4

WISHES

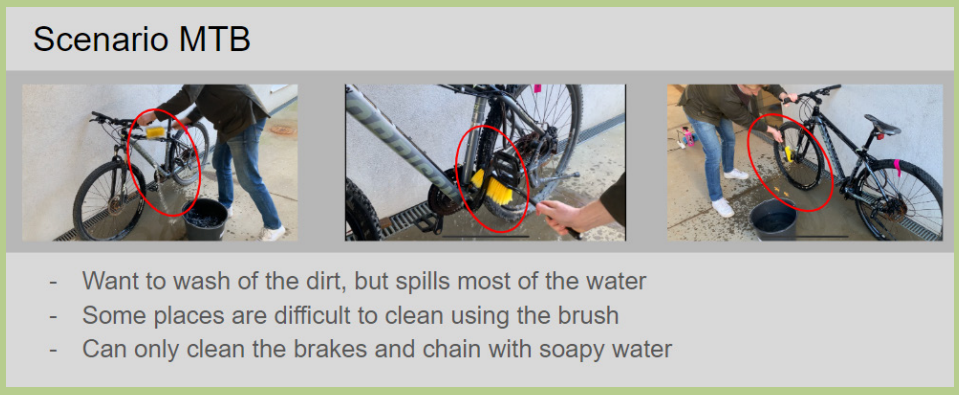
		Section
01	Easy to store	1.2
02	Wife approvable	1.2
03	Space optimised features	1.2
04	Tap refill	1.2
05	Minimise body strain	1.4
06	Bike stand	1.4
07	Storage of other MTB related equipment	1.4
08	Transportable / mobile	1.4
09	Easy to use	1.4
10	Easy/ fast to prepare	1.4

Presented at milestone

The milestone can be summed up by the group presenting where the mountain bikes are intended to be cleaned.



The scenario of cleaning the bike regularly and with pressure washers is presented.



And the initial solution space is shown. This is to be developed throughout the project.

Illu. 1-4, Milestone 2 presentation

02CONCEPT

In the first phase work has been put into gaining knowledge upon the cleaning process of mountain bikes and the struggles hereof by looking into previous research and defining different scenarios for which to focus this project.
The initial scoping of the mountain bike cleaning still poses some questions. The previous research has been focused on people living in apartments, but due to the amount of money that is seemingly spent on gear and bikes in an endless arms race, the possibility of expanding the target group is going to be checked. This means that expanding the problem is not of the highest importance, but rather the coming phase will focus more on locating the sales potential and mapping the values and attraction points that are prevalent in mountain bikers.
As the project is based on the cleaning of mountain bikes, it is relevant to investigate how often the target group of gear-minded mountain bikers tend to deep clean their mountain bikes. This is going to be determined in order to find a balance between cleaning the bike enough and staging the cool gear feeling as the main selling point.
Lastly a concern is raised with whether or not the bearings and other sensitive parts will withstand the water pressure. As such an important step in the coming phase is to investigate how much pressure is needed to achieve the desired cleaning, as well as the amount of pressure that the bearing can withstand. Once these factors have been determined, a feature list will be created to compare the potential product with existing solutions.

2.1 INITIAL SKETCHING

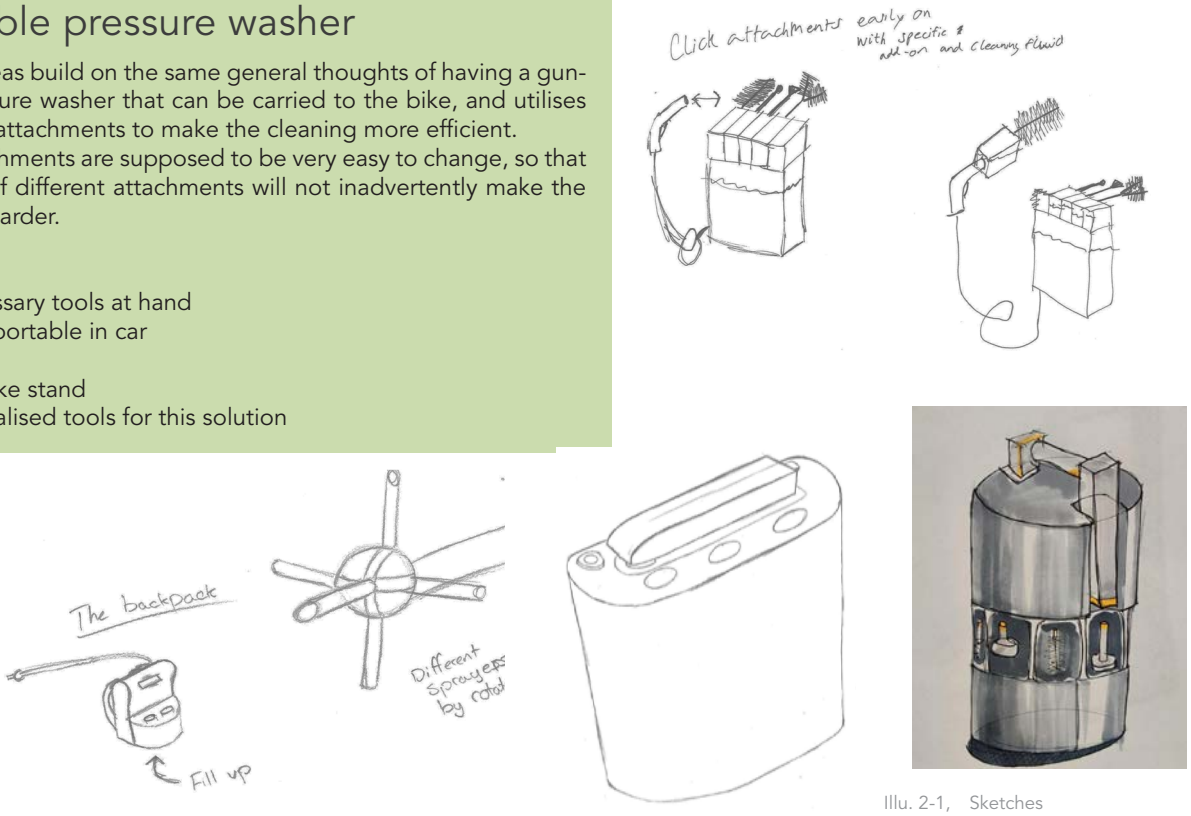
The initial ideation process is revolving around laying out the solution space, identifying different possible concept directions. To investigate the solution space, a sketching round is made. The sketches are then grouped in different themes and evaluated. The sketching round has led to three main concept directions with different focus points to be worked upon in the following process.

Portable pressure washer

These ideas build on the same general thoughts of having a gun-like pressure washer that can be carried to the bike, and utilises different attachments to make the cleaning more efficient.
The attachments are supposed to be very easy to change, so that the use of different attachments will not inadvertently make the process harder.

Pros
- Necessary tools at hand
- Transportable in car

Cons
- No bike stand
- Specialised tools for this solution



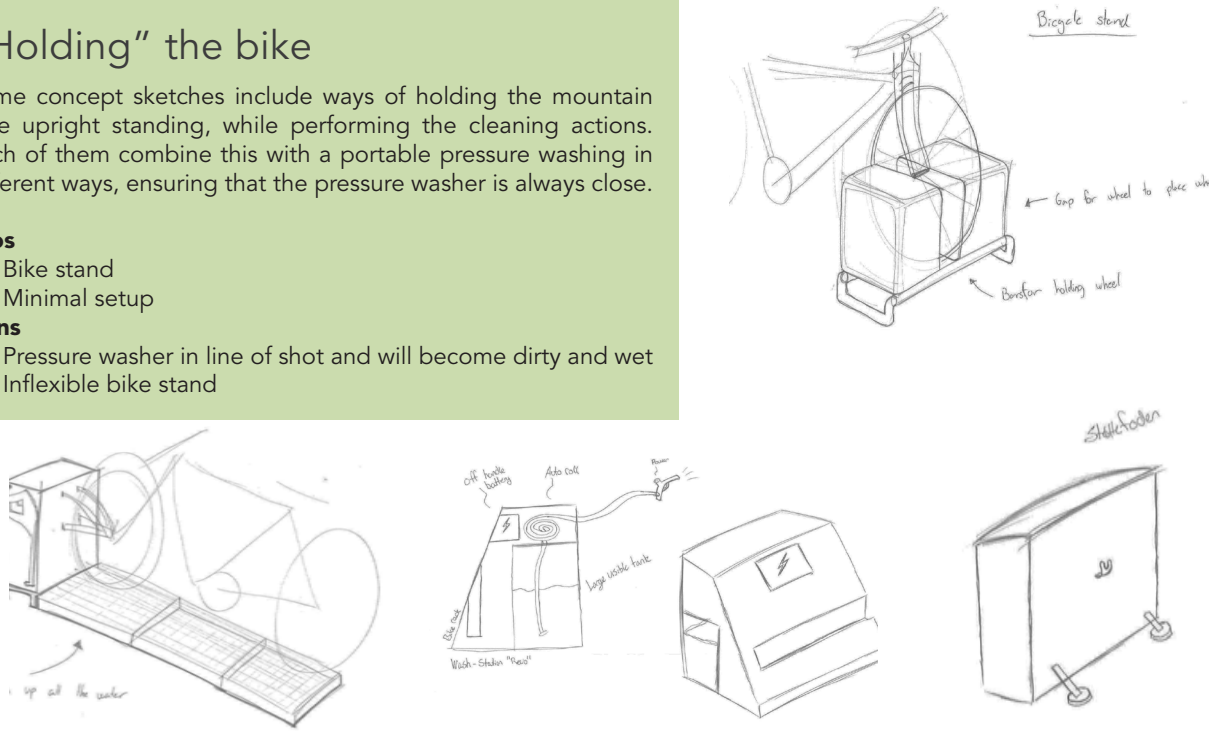
Illu. 2-1, Sketches

"Holding" the bike

Some concept sketches include ways of holding the mountain bike upright standing, while performing the cleaning actions. Each of them combine this with a portable pressure washing in different ways, ensuring that the pressure washer is always close.

Pros
- Bike stand
- Minimal setup

Cons
- Pressure washer in line of shot and will become dirty and wet
- Inflexible bike stand



Illu. 2-2, Sketches

Washing station

A completely different direction is the washing station, which would be present at the mountain bike trails, and provide cleaning facilities for the mountain bike users. The idea is that you would have the necessary cleaning equipment present at the trail, and contain the potentially environmentally harmful detergents instead of spilling it into nature.

Pros
- Gives the proper tools
- Does not affect the users prepping routine
- Always available

Cons
- Where to put it?
- Who services it?
- How is it serviced?
- Vandalism and theft?
- Do users want to pay for it?
- Modern detergents and oils for bikes are mostly eco friendly, so it's not an issue emitting in nature

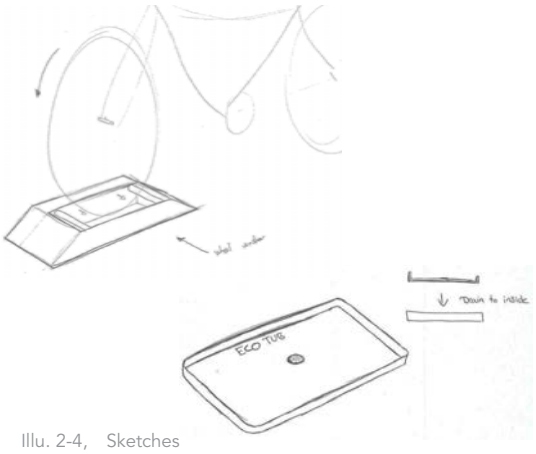
Illu. 2-3, Sketches

Others

The other notable ideas were a wheel cleaner, as this was pointed out in the initial interviews as one of the most annoying things to clean. The other is a small water collecting tub, that can be placed beneath the bike to collect water and spare the nature of detergents and potential oil wash-off.

Pros
- Specific and simple
- Good to environment

Cons
- Wheels are not necessary to clean
- Modern detergents and oils for bikes are mostly eco friendly, so it's not an issue emitting in nature



Illu. 2-4, Sketches

Conclusions

Already based on these initial ideas, some decisions can be taken. First of all, the product should be a personal tool, because the washing station at the track presents too many issues. This includes who will pay for it, who will be responsible for maintenance, the need of water and electricity sources and the inflexibility of it being a stationary solution at mountain bike trails, posing the question of what to do when you ride in other places.

The idea of incorporating a sort of bike holder in the tool is liked because it eliminates the users workaround of leaning their expensive bikes against random things. However from the sketches it is apparent that there will be issues with using the tool itself as the bike holder. It will be more susceptible to becoming wet and dirty because of the close proximity to the dirty bike, meaning the user has more to clean and dry off before driving home.

The wheel cleaner and the eco tub have the same issues, as well as being one extra piece of equipment to bring along and take out.

The pressure washer idea seems like the best option going forward, with the idea of using the pressurised water to remove dirt, and special attachments to ease the cleaning. However this still needs to be validated, and the specific demands and wishes of the users must be examined, in order to determine what features and aesthetics are necessary.

Demands
- The product should be able to be placed away from the bike when cleaning

2.2 COOL IN MOUNTAIN BIKING

With the goal of achieving a cool solution, the next objective lies in exploring what makes things cool in the mountain bike universe and what makes them want to use their money. Interviews with different bike salesmen are made because of their knowledge about the users and trends within the mountain biking world. The salesmen are asked about what equipment the bikers choose to buy and why. Additionally, it is investigated with examples of what some people choose to spend a seemingly unreasonable amount of money on. The first interview was conducted with a salesman at "Rold Skov Cykel shop". This store mainly sells high-end mountain bikes and equipment. One of the key insights provided by this salesman was two different segments/types of "cool" in the world of mountain biking. These were the "X-Game" style and the "Olympic" style.

X-Game style

He called the first one "X-Game style" because it is not all about performance, but the fact that you look cool while riding. Here he drew the reference to skiing since in X-Games they perform their stunts in more loose and chill attire, while at the Olympic games, it's in a skin-tight suit for optimal aerodynamic performance.

For the "X-Game" segment the new "Butter series" attire is trending at the moment. According to the salesman, the clothes are almost "a rude fashion statement" that is impractical for the environment. Other than it just being fashionable the cool aspect is in the fact it shows that the rider doesn't care about getting dirty while catching the eyes of any bystanders.

Illu. 2-5, X-Games style

Olympic style

For the other segment, the "Olympic games style", the performance is the main driver for purchasing. This is according to all the salesmen the largest and most prominent segment.

The performance factors are "a faster bike", "better handling" and "a smoother ride". For the people in this segment a seemingly small performance increase is worth an unproportionally large amount of money. This information was provided through examples of some of the components.

Illu. 2-6, Olympic style

A faster bike

- Lighter components

Better handling

- Stiffness of key components
- Lighter wheel rims
- Grippier tires

A smooth ride

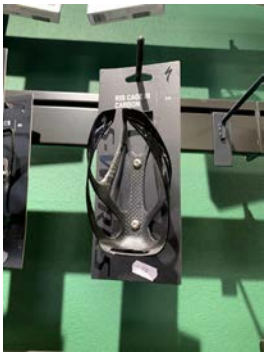
- Smoother suspension
- More points of suspension

Price and performance comparison

Bottle holders

Plastic bottle holder		Carbon fibre bottle holder
159 DKK	vs	550 DKK
33 g		24 g

Essentially saving 9 gram will cost 391 DKK, amounting to a decrease in weight of 27% with an increased price of 245%.
In addition to the slight performance increase, a large appeal is the look, as the salesman said that carbon fibre look sells.



Illu. 2-7, Bottle holders

Handle bars

Aluminium handle bar		Carbon fibre handlebar
500 DKK	vs	1399 DKK
270 g		167 g

Meaning that for 899 DKK you can save 103 gram, which is a 179% increased price for 38% decreased weight.
The salesman mentions the lower heat conductivity as an extra slight performance feature of the carbon fibre. However he also mentions this is not a big deal, as this is mostly circumvented by gloves and grips anyway.

Illu. 2-8, Handle bars

Shoes

Nylon outsole shoe		Carbon fibre outsole shoe
1400 DKK	vs	3500 DKK
357 g		270 g
6.0 stiffness index		13.0 stiffness index

In terms of the shoes, there is obviously the weight, as well as the other things, but the stiffness is very important for the performance.
A 150% increase in price can then afford a 24% decrease in weight, but with a large increase in the stiffness as well.

Illu. 2-9, Mountain biek shoes

As seen in the examples, the slight decrease in weight makes people willing to spend extra money on the components. According to the salesman from Rold Skov Cykelshop, another factor of people spending the extra money is also the carbon fibre look and the fact that when you buy an expensive bike, you tend also to buy the best equipment for it.

Another aspect for users choosing to buy much more expensive products is if it contains a new type of feature. This is a new type of suspension for gravel bikes that comes with a premium price. The suspension according to the salesman is not that drastically improved to defend the price. Another example of a feature that is a quality of life improvement is the electronic gear shifter, illu. 2-10, which offers no large performance increase for its price. But there is wide agreement that once you try it, you won't want to go back to the mechanical gear shifter.

Illu. 2-10, Innovative suspensions and gear

Wishes

- A user experience relating to the mtb lifestyle
- Give a feeling of performance increase and professionalism

2.3 INITIAL VALUES

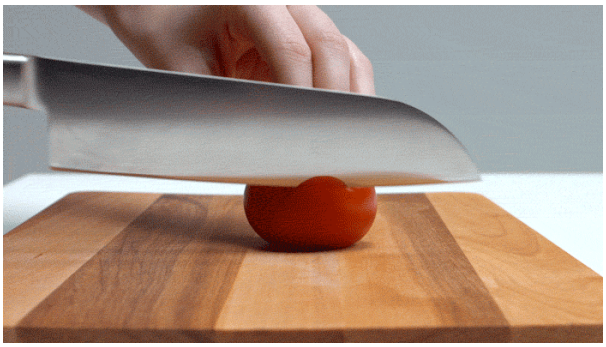
The initial steps of defining which features would be included in the product was to investigate potential values before interviews and feedback creates a narrow sightedness in the process. That is, what values should this product bring to the users, and what kind of feelings should they feel when using it. This is done by brainstorming values and feelings, that are described in a sentence and with an accompanying picture. The brainstorm was divided in the feeling of using it and the feeling of holding the gun. The feeling and values were eventually discussed, creating a mutual understanding of the aim. The values were separated into three groups, the ones that are on target, the ones that are partly on target, and the ones that miss the target. The first two groups were to be used as reference for future work, while the latter was discarded. Analysing the values that were decided upon, the values are summed up as:

Using the product should make the user feel prepared and cool, like the hitman and a cowboy from a western.

Illu. 2-11, Hitman

Illu. 2-12, Western Cowboy

The use should be effortless and satisfying like cutting with a good sharp knife and seeing the difference when dirty furniture is being cleaned.

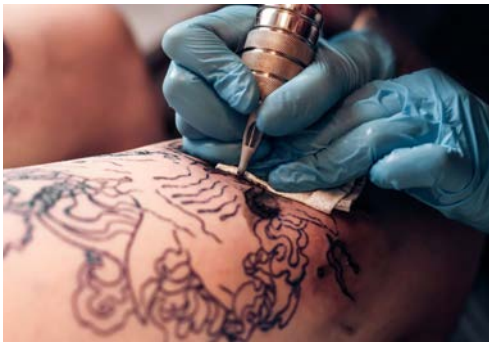


Illu. 2-13, Knife cutting

Illu. 2-14, Cleaning couch

Lastly, the user should feel a sense of mastering their tool and controlling a cool machine, like a tattoo master with his pen or a pilot flying an aircraft.

Illu. 2-15, Cockpit



Illu. 2-16, Tattooing

The optimal situation is that it is so easy and enjoyable, that if the neighbour asks about it, you should be able to have surplus energy to say "I got you" and demonstrate on their bike, even after cleaning your own.

The values shown here are not presented to users and therefore not verified. The values presented in this section are used as inspiration for future sketching and the final values, that are determined later in the project.

2.4 FEATURES

FEATURE INTERVIEWS

Following the determination of values, a list is constructed with the intention to locate potential features to include in the product that would be suitable for the situation, and provide the right values. These potential features come from a brainstorm and the knowledge from the earlier project.

- Air blower
- Nozzle switch
- Bike stand
- Brush attachment
- Flow/pressure modifier
- Remaining water observation
- Kitchen sink refill
- Storage room
- No Limescale
- Soap dispenser (foam)
- Chain cleaner

In order to narrow these down, and eliminate excess features, interviews were conducted with mountain bikers. The interviews were conducted with the interviewees quickly demonstrating how they clean their mountain bike currently. This was done to be able to both observe the current process, and to be able to ask elaborating questions to their process.
This was followed by a trial with a low pressure washer, with any equipment they would like, in order to see and ask what they would like to use. This was supplemented by questions with the goal of identifying the needs and wishes that the users had in terms of features and what has to be included in the design.

In terms of the equipment used when cleaning the mountain bike, the general way of doing it was to wet the bike with a garden hose, apply soap, scrub the dirty parts with a brush, rinse off the soap again and then finally drying the bike with a cloth. The steps of this process can be seen in illu 2-17.
There are however differences in the exact approach to it. This varies slightly, from brushes used, to how the soap is applied, to how nitty gritty the brushing is done and to how much effort is put into drying the bike. Some of these habits are from convenience more than a conscious choice, e.g. one saying they use a regular dish washing brush because that was just what they had, and then it was cheap to get a new one. He did however have two, one with finer hair, for the delicate parts and the paint job, and one with more rough hairs, which was used for the cassette and chain as this grime requires something harsher.

Even though there was a difference in how thoroughly the bikes were dried off, there was no doubt that the mechanical surfaces of the dampers and the like is necessary to dry to avoid limescale messing with the functionality. As there are differences in how meticulous the mountain bikers are when cleaning their bike, further tests of the current solutions are to be made to help define how clean is 'clean enough'. This includes identifying where the current solutions do well and where they don't do well, with the goal of identifying new problems these solutions create, and by that define the solution space further.

Illu. 2-17, User tests

Demands
- 4-5 litres of water capacity per bike

Wishes
- Should be able to clean two bikes

2.5 TESTING PRESSURE WASHERS

In this still quite early stage of the project, it is necessary to test if the users are interested in using a low pressure washer solution. To do this a cheap solution from Grouw is bought and tested against the 'dedicated bike washer' from Muc-off. This is also done to identify problems with the current pressure washer solutions.

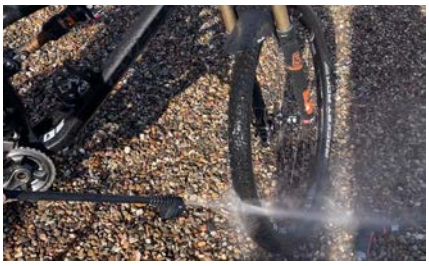
Grouw

The Grouw washer is tested on Jens and Svend cleaning their bikes and giving their feedback on the product, while relating the experience to their usual cleaning routine.

Firstly Jens tries out the different nozzles figuring what is the best for him, which is the **25 degree nozzle**. He also likes the **upward nozzle** to clean the chain and cassette.

He found it to be extremely **effective and quick** at removing the dirt left on the bike. But it is observed that he holds on to the lance towards the nozzle for control.

He notes that he normally would not clean the tires, but with this solution he would. It would add value to him to do it, because the cleaner the bike, the better it rides, but with a brush he cannot be bothered.



The length of the lance is 700 mm, which Svend finds to be way too long. He wants to be **closer to the bike** and have **more precision** in the cleaning action.

Jens uses the foam sprayer and does not like it. It **sprays way too much soap** and half misses the bike. Also the amount of water needed to get it off again is too much. **Svend dilutes the soap** beforehand to save it. He likes the idea of the foam sprayer but **lacks control.**

Illu. 2-18, Testing Grouw pressure washer

Muc-Off

With the information from the Grouw solution in mind, the Muc-Off cleaner is assembled and tested within the group first and with Jens afterwards.

It is noted that it makes **a lot of noise** compared to the Grouw and a **pressure that is unnecessary** for the task at hand. This amount of noise is too obnoxious for the trail. The comment about noise also relates to the use of the **air blower which is disregarded** as a feature from this point.

It contains a lot of different parts that need to be assembled and it is **difficult to change the nozzles**.

Furthermore **the lance is even longer** than the Grouw, which is really not ideal.

Because the pump is placed before the hose, **the hose has to be stiffer**, which compromises its mobility during use and when packing it up.

As an additional note it is annoying that all of the **interaction points are located low**, but on the positive side they are mostly **clearly marked** with the distinct pink colour. The hose roll-up is placed at 30 cm height, which is decided to be the lowest allowable interaction point.

Illu. 2-19, Testing Muc-Off pressure washer

- During the interview both Jens and Svend state that chain cleaners are bad and unnecessary. A toothbrush works great and there is no need to change this.
- The inclusion of a nozzle switch makes the flow/pressure modifier feature redundant.
- The users are fine with using a cloth to remove excess water and avoid limescale on the bike.

Based on the feedback from the test persons regarding the use of the low pressure washers, it is clear that a solution like this is something they would like, but it has some issues that are essential to fix for it to be a viable solution. This process has led to new wishes and demands that are defining for the concept sketching round in the next section.

Demands

- 20-30 bar water pressure
- No louder than existing solutions*
- No interaction under 300 mm

Wishes

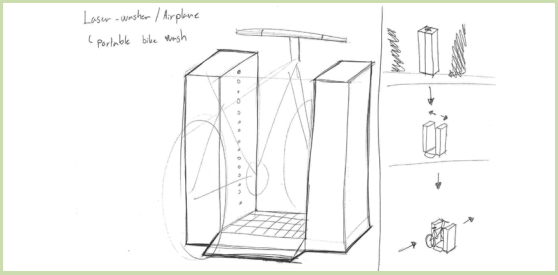
- Appropriate lance length *
- Rollable hose
- Different spray angles*
- ~~Minimise body strain~~

2.6 CONCEPT DEVELOPMENT SKETCHES

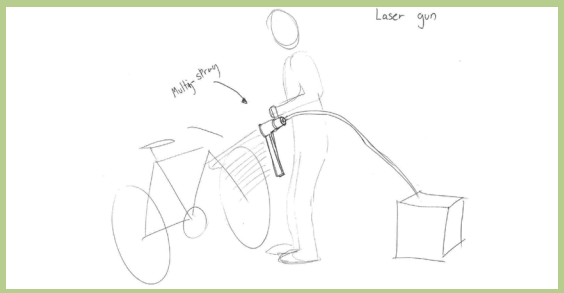
With the wishes and demands made up until this point it is necessary to investigate the solution space further. The objective is to create two or three concepts that can be made into brochures and shown to potential users for feedback. The intention for the feedback is to get knowledge about how the user would like to interact with the product and what they hook upon. To get this feedback the sketching round has parameters that define three vastly different concepts. This round refers back to the values presented in section 2.3.

The first idea is a bike stand / wheel wash. It has some interesting prospects in its semi-automatic functionality, but it has also been decided earlier that wheel cleaning is not a major necessity in mountain bike cleaning.

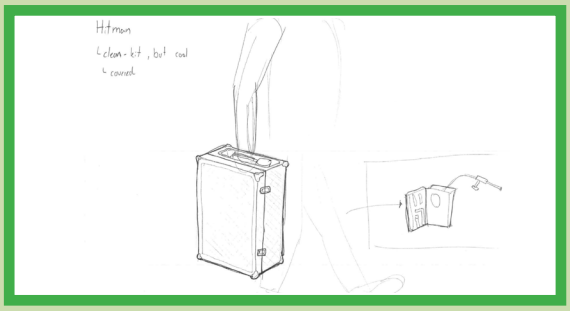
As a development of the first concept shown in this section a portable bike wash is presented. The bike is pushed through and the cleaning happens automatically. This is too automatic and interferes with some users' wish to 'take care of their bike' for which reason the idea is discarded. Furthermore it is extremely complex to a simple problem and it does not seem portable but more like a home product.



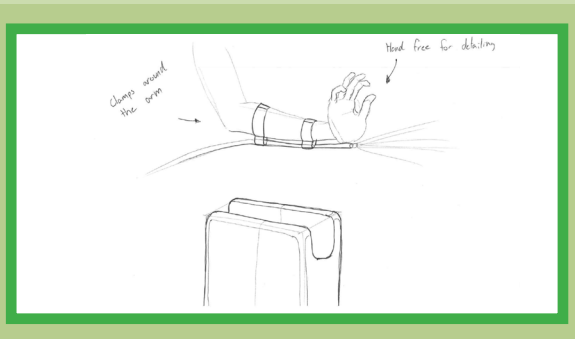
The next sketch is a handheld gun that has a very wide spray, that is able to clean the whole bike in one or two swoops. The ability to have such a wide spray to quickly clean the bike is interesting and as stated in section 2.5 it is necessary to find the right spraying angles. However, wasting water by not always hitting the bike seems counterproductive.



The fourth sketch works with having a toolbox that looks protected and important when lifted like a briefcase. When opened all the necessary tools are presented. It should have a feeling of walking around with a gun ready to go like a hitman, which is a value from section 2.3. This concept is chosen for further work.



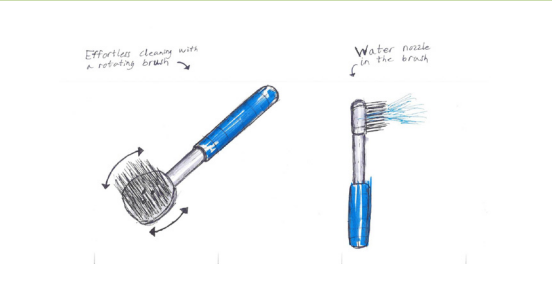
The next sketch works with a superhero feeling. This is done by copying the spider-man move and mounting the sprayer on the body. It also provides accessibility for both hands when cleaning. The concept is chosen for further work due to its radical approach to which feedback is needed.



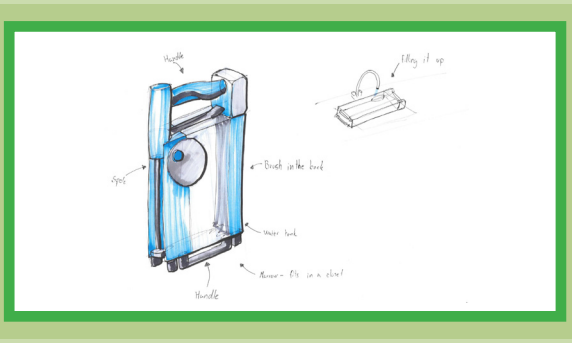
Illu. 2-20, Concept development sketches

This concept is a more traditional take on the issue. It is disregarded as being too stationary and difficult to lift, but the free placed gun is nice and used for future reference.

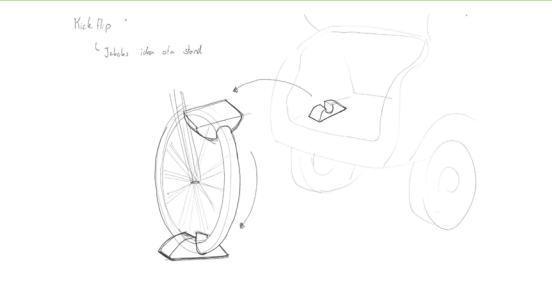
A new brush with inspiration from electric toothbrushes in its rotation and with water flowing through. It leads to questions for the interviews regarding the brush and its use. How often and which demands do the users have to the preferred brush.



This, concept eight, works with the free gun from the sixth concept while being slimmer and more integrated into a single unit. This is refillable by tab, which is a wish from the earlier made project. This concept is chosen for further work due to its integrated gun and simple shape.

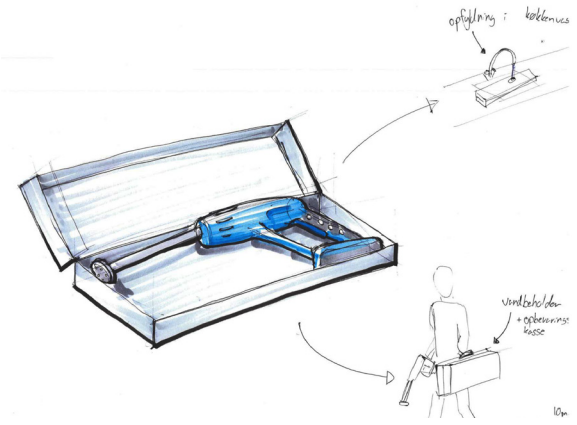


As a bike stand is discussed it is also interesting to see how this could be implemented in an interesting way. Here is a solution which is easy to mount on top of the wheel followed by the lifting of the wheel. Gravity and inertia will make the bike stand stop at the bottom and the bike can be placed steadily on the ground.



Illu. 2-21, Concept development sketches

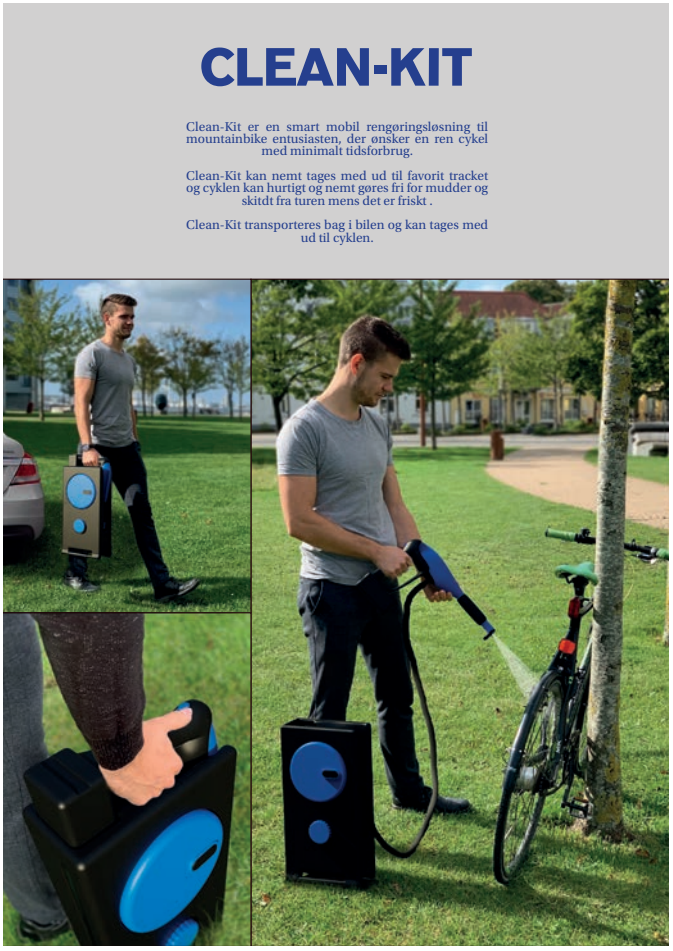
With a lot of concepts created it is possible to choose three very different directions to the user. An example of how the hitman toolbox could be developed is initiated. As is the development of concepts five and eight for the creation of brochures for interviews in the next section.



Illu. 2-22, Further development

2.7 CONCEPT DEVELOPMENT

The three concepts 'Clean-Kit', 'Clean-Hit', 'Clean-Fit' are shown to get an initial response to the three project directions. The three directions are made based on the values in section 2.3. Clean-Kit intends to show a mobile solution that is taken from the car to the bike. Clean Hit intends to stay in the car during cleaning, just pulling out the gun, as well as having a 'toolbox' with all the necessary equipment. Clean-Fit is to be mounted on the arm to have a superhero-feeling and control of the cleaning process. The objective is to know something about what kind of experience the user would like when cleaning.



Illu. 2-23, Clean-Kit

Illu. 2-24, Clean-Hit

Illu. 2-25, Clean-Fit

Clean-Kit is preferred by the users due to its overall mobility and flexibility. For Clean-Hit it is annoying to put it in a packed car and the hose will interfere with the bike rack on the car. It is also noted that it seems weird to use in the winter, because you won't be able to close the boot without the car getting cold. Also boots are very different in dimensions, so it might be annoying if the boot is low and our solution should deal with different types of boots.

Clean-Kit can be stationary in the car, if the hose is long enough and there is no bike rack, so it is a bonus it could have both features. Clean-Fit is just a no-go as all mobility is removed from both hand and body when the solution is mounted on the body. Does a middle aged man want to stand in lycra in a parking-lot and look like spider-man? Not according to our test subjects.

Additionally it is added that a test person has previous experiences with a low pressure washer from Lomax. From this experience it is noted that a product like this can be too heavy for easy use and that the battery must be removable, otherwise you forget to charge it and it quickly becomes a glorified bucket. On the other hand it is important to include enough water to not feel under pressure when cleaning the bike.
It is added that when it is cold, about 6 degrees, it has to be quicker than 15 minutes. Any longer and the user will be too cold and skip the cleaning altogether. He adds that targeting this hobby segment it may be important to differentiate from the competition. This could be by making it dedicated to mountain bikes, because other solutions are more 'all-round' like the Grouw, and don't quite succeed at any task and this target group could be ready to pay a lot for something with the real mountain bike spirit. Regarding the addition of features, it is noted that the foam sprayer is a nice to have feature but if implemented nicely it would be used frequently.

To sum up it is important for the users to have a solution that just works easily. It must not be a hassle to use whether they use a car mounted bike rack or have the car in the back of the car. It can by no means be attached to the body, as this limits their movement and generally it should not be limiting. Furthermore it is important for them to not look weird or out of place when using the product in the specific context. Having developed and shown these three concepts and gotten feedback has given new knowledge, wishes and demands. The next step will be looking into existing solutions and how they compare to the feedback from the users in this section, with the intention of locating where and how a new cleaning solution should differentiate itself to be successful in this context.

Demands
- Removable battery
- Efficiency of cleaning must be equal to or better than current solutions

Wishes
- Visually relating to a mountain bike context
- Appropriate hose length*
- Plenty of water*
- Foam sprayer
- Lightweight*
- 80% clean bike*
- Different positions for different boots*

2.8 MARKET ANALYSIS

To expand the understanding of current cleaning solutions for mountain bikes, a market analysis into these is made with the intention of identifying and learning from the pros and cons of these solutions. The knowledge is to be followed by a diagram placing the current solutions, which should indicate how a new solution can differentiate from competition. The analysis is based on desktop research, with each of the competing products being evaluated based on a mix of the feature set, reviews and what is indicated on the images. In addition knowledge about current solutions and the use hereof comes from self-made user tests. The data presented in this section has been collected continuously from the very early process and until now where it is presented.

In terms of the pressure washers, there are regular pressure washers, like the Nilfisk and Muc-Off, that are connected to power and water supply, battery driven pressure washers that suck water from any water source and lastly the all included pressure washers with battery and water tank.

Muc-off pressure washer
Pros
- Designed for bicycles
- Strong brand
- Soap dispenser har dilution adjustment

Cons
- Corded, both power and water
- Detach nozzle to change spray

Nilfisk C100.7-5
Pros
- Lots of power

Cons
- Only high power setting
- Corded
- Spray adjustment is done by physically de-/attaching nozzles
- Designed for outdoor surface cleaning, with bikes as a secondary

Worx Hydroshot
Pros
- Changes spray angle on nozzle
- Battery driven
- Can attach bottle for true cordless experience

Cons
- Spray change is far away at the end of lance.

Aqua2go GD900
Pros
- Changes spray angle on nozzle
- Battery driven
- Mounted torch

Cons
- Spray change is far away at the end of lance.
- Needs bucket of water (or similar)
- Not specifically for bikes

Bosch Fontus 18V
Pros
- Control
- Bosch battery
- Large water tank
- Long battery life

Cons
- Size
- Weight
- Loose hose
- Designed for multipurpose

Kärcher OC 3 plus
Pros
- Small size, mobile
- Can be powered/charged by auxiliary power outlet
- Water tank is detachable

Cons
- Low power
- Not specifically for bikes

Garden hose
Pros
- Most house owners have

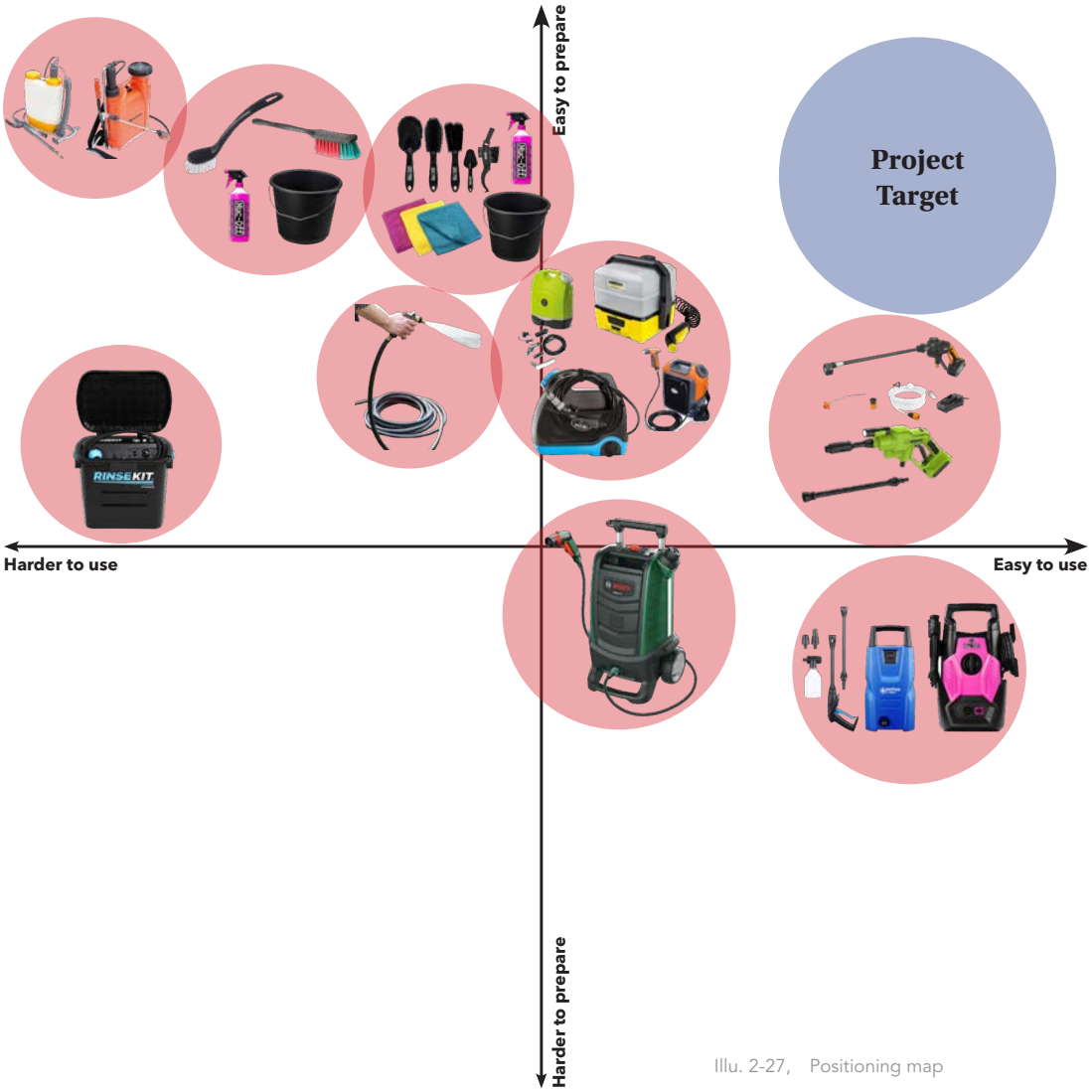
Cons
- Needs water outlet
- Low pressure
- Limited to at home in the range of outlet
- Not for bikes

The different products in this analysis have each of their positives and negatives. But generally the issues are that they are either too stationary for the scenario or they are too weak to handle the dirt. The types like Worx Hydroshot and the Aqua2Go are the closest competitors because they are portable, but they require bringing a bucket of water separately. Lastly none of these products are designed with mountain bikes in mind, so the aesthetics of the products are also pointing in different directions.

Illu. 2-26, Market analysis

The intention of this section was to sum up the knowledge gained about existing solutions and determine where and how it is possible to differentiate a new product. This was evaluated both as the pros and cons listed on the other page, as well as the positioning map below. As mentioned previously this knowledge has been gathered continuously throughout the project, and likewise the positioning map has seen several iterations throughout the process up until this point. The positioning map evaluates how easy the competing products are to prepare and use. This was started as a part of investigating the barriers to cleaning the bike, which was boiled down to the fact that it is a hassle to find and prepare all the equipment, and likewise that is a cumbersome process of actually cleaning the bike. Currently no solutions fulfil both aspects, and as such the positioning map indicates that a gap in the market can be created by developing a product that is both easy to prepare and easy to use.

In order to hit this gap in the market, the aim going forward is to learn from the pros and deal with the most essential of the cons of the competitors while keeping the positioning map in mind. However, before this data is used in a sketching round the next step is to execute a test to see if soap and brush is necessary to integrate in the sketching round afterwards.



Illu. 2-27, Positioning map

2.9 MUD TEST

The objective of this is to see if there is any difference between cleaning bikes covered in fresh mud compared to 4 hour old mud. Is it possible to do it with water only or if detergent and brush is necessary. This is tested by actually making a test bike dirty and cleaning it with and without the use of brush and detergent and with both fresh and dried mud.

Before mudding



Illu. 2-28, Bike before mudding

2 minutes after mudding

Cleaning process
It is quite easy to clean the bike with pressurised water only.



Illu. 2-29, Bike after mudding - 2 minutes

4 hours after mudding

Cleaning process
- **Just water** - It works, but it's inefficient.
- **Soap dispensed** - Is soaked for two minutes. Works fine. Very satisfying that it was quick as clearly working. Would use.
- **Muc-Off** - Is soaked for two minutes. A lot of work to cover this especially dirty bike - and it was only 1/3



Illu. 2-30, Bike after mudding - 4 hours

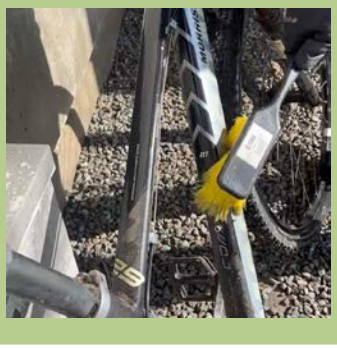
Laying down

The bike is also tested cleaned laying down with the following results after the two sides have been cleaned once, and the bike is turned over once more. It clearly shows that the bike is bad to clean laying down. It is also noticed that it is difficult to create a cleaning movement pattern, as you normally would when cleaning.


Illu. 2-31, Bike after cleaning laying down

Brush test

So far the testing has been without the inclusion of a brush. The next step is to see how a brush will affect the cleaning efficiency. The same muddy scenario is set up and the bike is made wet first, then soap applied, then brushing and finally rinsing off. The test does not clearly show if the brush is absolutely necessary. It might be convenient and useful on some occasions where the dirt and grime is exceptionally grim. For this reason it is decided to work with including a brush in the solution for now.

Illu. 2-32, Cleaning with brush

When the mud is still fresh and wet, it is quite easy to clean the bike with water only, and only 3,5-4 litres are used. For 4 hour old mud it works very efficiently when it is soaked in detergent before spraying off with water. Water alone worked but it was not efficient or pleasant to use. It was much more efficient and pleasant to use the soap dispenser than the Muc-Off sprayer.

The bike cannot be laid down during cleaning. For once it is not smart that there is no cleaning pattern. Furthermore you get a feeling of just moving dirt around and finally it is not recommended to lay a bike on its gearing so only one side is cleanable. Additionally this would create a scenario, when it is sprayed from the chain side towards the brake disc, something that is also recommended not to do, because the chain oil ruins the disc. Knowing that there may not always be an ideal tree or lamppost nearby for cleaning, it is decided to include a bike stand in the final solution.

The intention of this test was to investigate the effect of having dried mud compared to fresh. It is clear how the fresh mud is easier to handle, which confirms why it makes sense to remove the worst dirt while still fresh on the bike, which is the main thought behind cleaning the bike by the trail. With this confirmed, it was also intended to see the difference of cleaning with and without soap and brush, to determine if they are essentials in mountain bike cleaning. The soap is determined to be essential but the brush is still unknown and to be decided after user feedback in the next section

Knowing these things further concepts are working with soap integration - in the form of either space for a Muc-Off container or a soap dispenser. The concepts also include a brush, so it is possible to get feedback upon this. Generally the next step is to define some features that can define the size, weight, price and materials of the product and also determine if the brush is essential or not. It is chosen to make two mock ups of concepts and show these to potential users to get feedback.

Demands
- Bike stand
- Must contain the essentials for cleaning
  - Water, cloth and detergent

Wishes
- ~~Bike stand~~

2.10 TESTING CONCEPT MOCKUPS

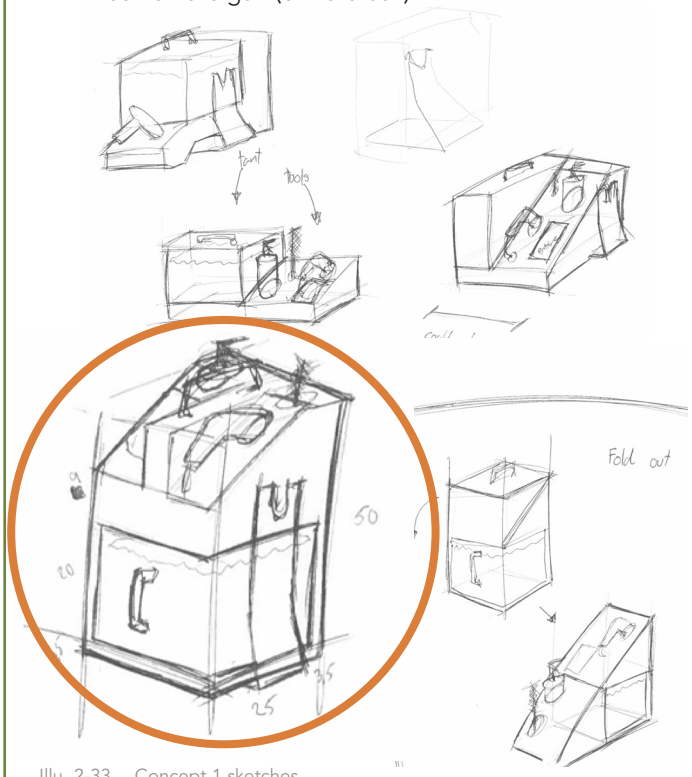
Initial sketching

In order to create the necessary mock-ups for testing, specific concepts are needed. The test should give more information on the needed features that have been discussed previously. Two concepts are wanted and defined as seen below.

The concepts are based upon the clean-kit concept and its feedback. The aim is to end up with two concepts that can be made into mock-up models taken to potential users for testing. One concept is to be contained inside the boot of the car and another that is taken out to the bike, for comparison.

Concept #1

- Placed in the car when cleaning
- With a bike stand
- Pistol (short gun- one hand)
- Battery and pump in the box
- Larger storage room
- Muc-off spray
- Brush on the gun (or no brush)



Illu. 2-33, Concept 1 sketches

The included featureset from above leads to the following sketches. The one marked out is the one chosen. The idea of this mock-up is to have it placed in the trunk of the car at all times. From here the water tank can be taken out and refilled. The battery can be taken out as well. The gun is a small one-hand-held precision tool. This is possible by having the battery, motor, pump and the water in the stationary box in the car. This concept has a separate soap sprayer with it, that can be held in the other hand. A bike stand is attached to it and can be taken out to hold the bike. Furthermore the interactions are located high up and facing the user for most ideal use.

Concept #2

- Taken out of the car when cleaning
- Without a bike stand
- Rifle (longer gun - two hands)
- Battery and pump in the gun
- Carries only the essential equipment
- Soap dispenser
- Brush in the box.

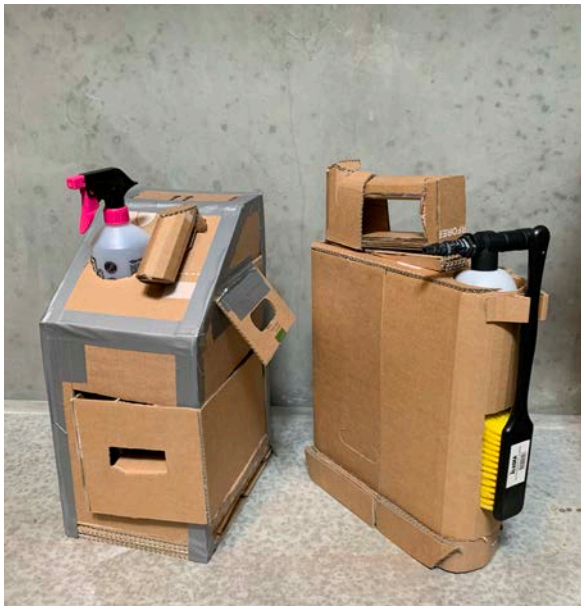
Illu. 2-34, Concept 2 sketches

The second mock-up is a more portable one. With a large two-hand-held gun with an integrated battery, motor and pump. The gun's handle acts as a handle for the whole cleaning solution, which was a wish from early on in order to minimize space needed for the overall product. The soap can be applied by attaching the dispenser to the gun. A long-shafted brush is also available on the side of the box. The box is meant to be taken out of the car each time the bike is to be cleaned and focuses on having the features easily accessible. The gun can also be attached to a normal garden hose for an unlimited water supply. Both models have around 10L of water.

The objective of this task was to create two concepts from a set of focus points that could be made into mock ups. Under the creation of the concepts there were no issues implementing the focus points as intended and therefore the task was successfully completed which leads to the next step of creating mock ups.

Mock-ups

With the mock ups made,it is possible to decide upon the must-have features through interviews with users. The full list of questions can be seen in appendix 2. The mock ups are made in full-scale and with simplified aesthetics. The models do not take weight into account. The test is made to get feedback upon features, workflow and storage of each mock up.



Illu. 2-35, Concept mockups

Concept #1

- Placed in the car when cleaning
- With a bike stand
- Pistol (short gun- one hand)
- Battery and pump in the box
- Larger storage room
- Muc-off spray
- Brush on the gun (or no brush)

Concept #2

- Taken out of the car when cleaning
- Without a bike stand
- Rifle (longer gun - two hands)
- Battery and pump in the gun
- Carries only the essential equipment
- Soap dispenser
- Brush in the box.

From concept #1 it is decided to look further into including the bike stand if it is possible. There are different opinions on whether the gun should be short (one hand) or long (two hands) as they find a small gun to have more control in the cleaning process, but at the same time does not feel powerful and durable in the same way as the bigger gun. In regards to the storage room and the soap dispenser there is not a clear answer to how it should be implemented. From earlier interviews it was noted that they preferred different soaps for personal reasons and this led to a decision to go with a soap dispenser solution rather than incorporating something from Muc-Off. Additionally it is clear however that the brush should be included and be in the box as it will be used every time according to the users. Furthermore the solution should be taken out of the car for more flexibility and it is important to have the battery and pump in the gun. This is both to be able to use it with a garden hose at home, and to put some weight and control in the gun. As a side-note they seemed to appreciate the slimmer appearance of concept #2 and stated that it has a wow effect in its features compared to the appearance. Because it is so slim and small it does not seem like it incorporates a lot of features, but the user is positively surprised.

With so different user needs in a small group of test persons, it is decided to look into the possibility of making a user-specified solution, where the specific feature-set can be customized to the buyer, in order for the user to only bring with them the features they need.

Despite being quick mock ups of cardboard the feedback gained in this test has proven to be useful. The intention was to get clear answers to which features should be implemented and how this could happen, but this was not the case. The unclear answers were likely due to the fact that it was not possible for the users to actually try these features with the presented models. The most important question to get an answer to was whether the product should be placed within or taken out of the car when in use and here a clear answer was given. This allows for further work in this direction.

Demands
- Out of car use
- Battery and pump in handle
- Must work with garden hose
- Must contain the essentials for cleaning
  - Water, cloth, detergent and brush
- Foam dispenser included

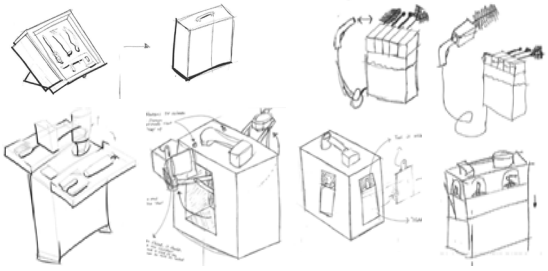
Wishes
- Wow effect to user and surroundings
- Customisable solution
- ~~Foam sprayer~~

2.11 FEATURE SKETCHING

With the knowledge that the product should be taken out of the car and the placement of the battery and pump it is decided to diverge and brainstorm on possible features with the new knowledge in mind. The new features are grouped and evaluated. Some pass and some are discarded. The objective is to have potential features that can be made into working principles in the following section.

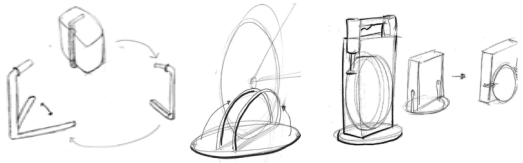
Presenting the gun and tools

The first feature is to present the gun and tools to the user. It is a feature that is expected to add to the experience and for this reason it is passed on for further work.



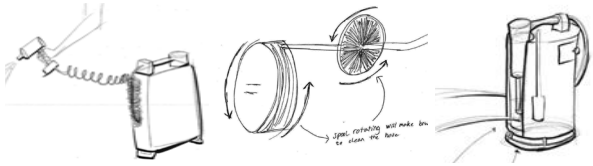
Bike stand

The bike stand is a necessity for this product and brought on. Here different ways of implementing it are shown to help give it a score in the next section.



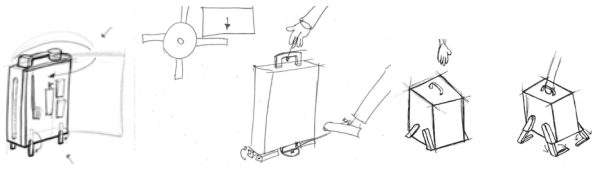
Clean hose

The issue of a dirty hose was mentioned in an interview and therefore it has been decided to sketch how potential solutions could be implemented. This is also passed for further work.



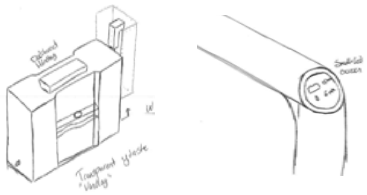
Anti-dirt stand

Another issue regarding dirt has come along during the project. Is the product a new dirty element that is to be cleaned before going back in the car and how can this be avoided. To do this, sketching of potential solutions has been made. Furthermore a test was made to confirm the issue. A test, shown in appendix 3, indicates that while tiny amounts of dirt may end up on the cleaner, it is not an issue large enough to require a smart solution.



Water indication

The feature of implementing a way of observing the remaining water status is essential and passed on for further work.



Soap dispenser

As dispensing soap has become a demand to include in some form it is necessary to include for further work.

Improving stability

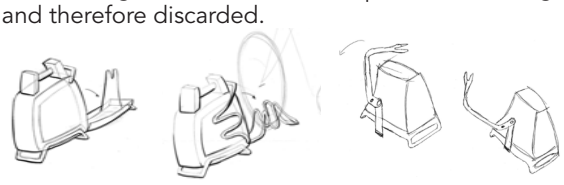
This sketch works with a fold out extension to improve stability. It is not expected to be necessary and is discarded but could be brought back if necessary later.

Flexible water storage

If issues occur having enough water, it is possible to make an expandable water storage solution. This is discarded at this point due to complexity.

Challenging the demands

At last some concepts are made that challenges the existing demands - mostly the placement of the product when cleaning. None of these concepts are valued highly and therefore discarded.



Illu. 2-36, Feature sketches

The objective of this section was to follow up on some of the earlier potential features and add new potential features to the list. The features from this list that are passed on are to be worked upon to become working principles that can be implemented in the future. All this is made to determine the feature set that is used in the detailing of the product in the next phase.

2.12 WORKING PRINCIPLE SKETCHING

With a lot of possible features to include it is decided to make a sketch round once again to create concepts with different focus points. These focus points are created to achieve a focus of making working principles in the shown concepts. The working principles open for possibilities to mix and match the features and ways of implementation as needed.

Concept 1

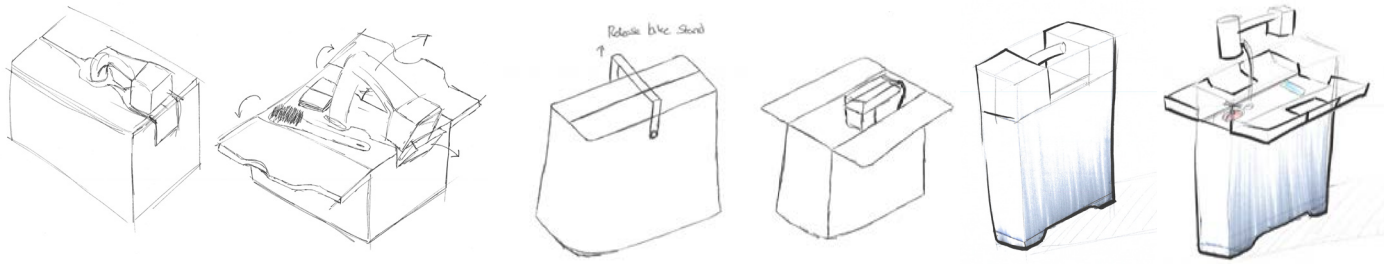
The first concept focuses on being clean looking which should enhance the transformation and give a 'wow-experience'. Furthermore all tools are hidden when not in use so the clean appearance is achieved.

Focus

- Clean look
- Everything steered from one place
- Shell/exo skeleton
- Symmetrical

Working principles

- Inside bike stand
- Transform top
- Auto retractable hose w. Clean spray
- Hose spray out the bottom



Illu. 2-37, Concept 1 sketches

From this first concept the opening experience is decided to work upon. The way it hides the tools at first and opens up to present all the necessities is a surprise element that could be used in future design development.

Concept 2

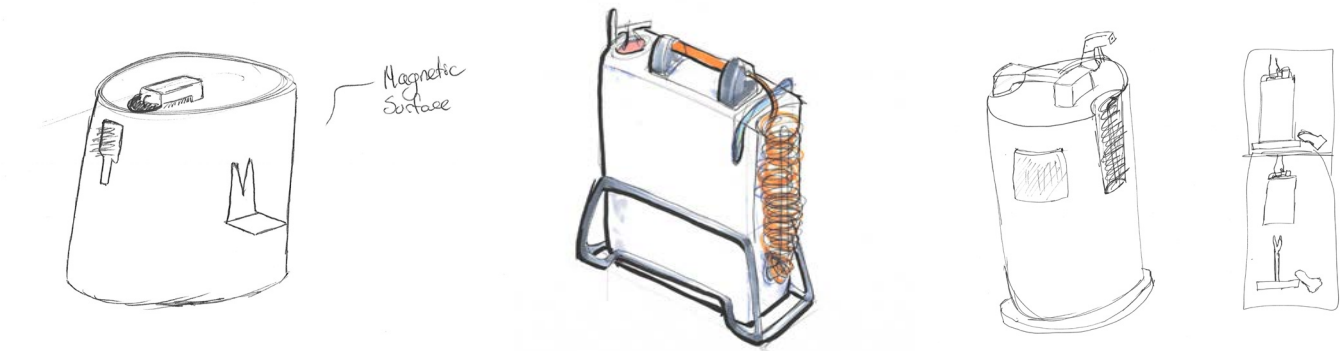
The second concept should show off the features at all times. The experience lies in telling the user that they can do anything with this solution. Just choose the right tool.

Focus

- Accessible look (tool)
- Interactions all over
- Asymmetrical

Working principles

- Outside bike stand (foot)
- Tools placed outside
- Spiral hose



Illu. 2-38, Concept 2 sketches

This concept works by showing off the tools instead of hiding them. The asymmetrical design and the outside placed bike stand is brought on for further work. So is the spiral hose, as it is a simple solution to keeping the hose somewhat clean.

Concept 3

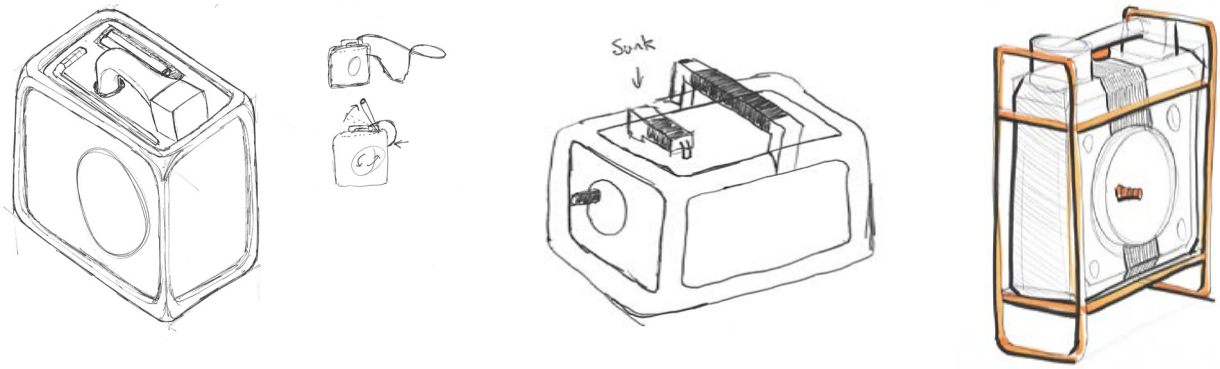
The third concept should look protected. It can be dropped or run over by the car without any fears. It is much more of a tool and should look professional and the user has to manually use all features.

Focus

- Reliable/sturdy (volvo)
- Protected components
- Construction inspired product
- Embraces dirt

Working principles

- Bumpers (tubes)
- Outside bike stand
- Physical reeling in
- Marked interaction points
- Visible spool



Illu. 2-39, Concept 3 sketches

The clearly marked interaction points of this concept are chosen for further work. So is having a more protected look but not with outside frames or bumpers, as this industrial feeling does not match the hobbyist mountain bikers.

Concept 4

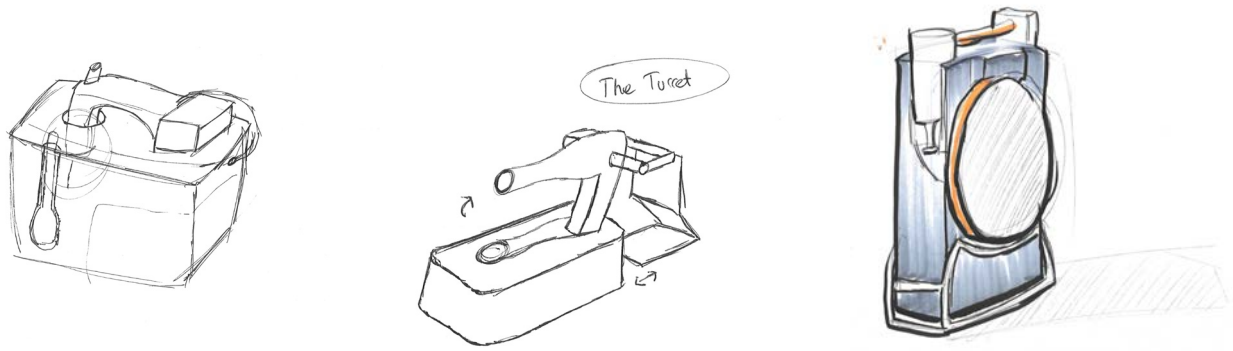
The fourth concept works towards making the cleaning feel effortless. The process is as automated as possible and the user has as few manual interactions as possible.

Focus

- Effortless
- Automatic
- Prepares next step
- Doesn't get dirty
- Small and light
- Easy to repack

Working principles

- Spool spray
- Auto reel spool
- Outside bike holder
- Sprays the spool and brush together
- Feet that doesn't get dirty and are easy to clean



Illu. 2-40, Concept 4 sketches

The preparation of this concept is interesting. Maybe it is possible in a simple way to make the product prepare the next step in some situations. The cleaning of the brush and hose is also still in contention for further work.

Concept 5

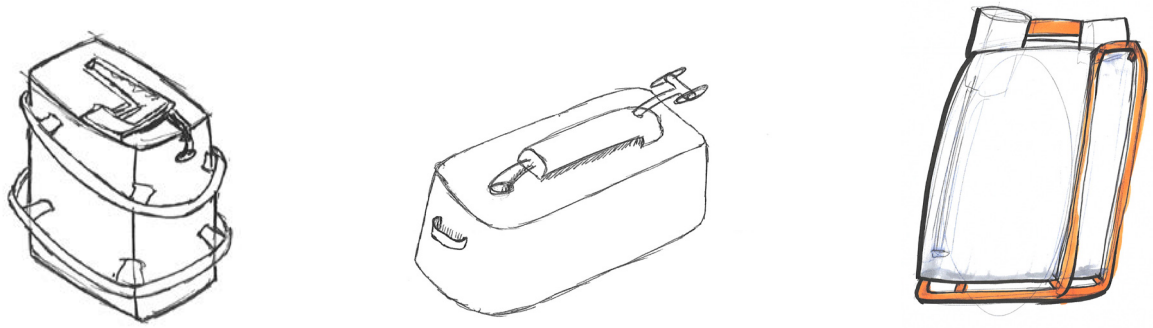
The fifth concept is for lazy people. It focuses on being small, light and simple. There are no added features and can be thrown in the car. It should be clear to use when doing the absolute minimal cleaning process.

Focus

- For lazy people
- Sometimes left in car
- Small and light
- Doesn't use
  - Soap
  - Bike stand
  - Brush
  - Cloth
- As long as the bike will work next time it is clean enough
- Thrown in car
- Simple look
- Clear interaction points

Working principles

- Gun accessible from multiple angles
- Either
  - One hand gun - hold the bike
  - Two hand gun - angle
- Doesn't use much water
- Inside spool
- Auto reel spool
- Multiple grips of water tank



Illu. 2-41, Concept 5 sketches

This fifth concept has given an idea of the product being accessible from different angles for use in a lot of different scenarios.

With a lot of possible features to include it is decided to make a sketch round once again to create concepts with different focus points. These focus points are created to achieve a focus of making working principles in the shown concepts. The working principles open for possibilities to mix and match the features and ways of implementation as needed.

The objective for this round has been to create working principles as ways of implementing features and help determine which features are possible to include in a both nice and easy way. With five different concepts and potential working principles to include in future concepts the task at hand has been accomplished. The next step in the report is evaluating how easy the features are to implement in the product, which is a task that has been made simultaneously with the task in this section.

Wishes
- Presenting the tools

2.13 INITIAL FEATURES

From the testing and supervision an opportunity appeared, that a product could be made to suit the user. By having different features that can be chosen, it is possible to create cleaning solutions to fit the specific users needs. To investigate this further, the different potential features are looked into with a focus on seeing which features are must-haves and which can be customised to the solution in a pro version and whether it is worth it. This is made simultaneously with the working principles sketch round presented previously. The sketch round is contributing with knowledge of how easy each feature can be to implement.

Initially it is outlined what the factors that can contribute to making the product 'cool' if present or 'uncool' if not present.

Cool factors	Description
Tough/resilient	It would be uncool to have a cleaner that would seem fragile. If you have to be extra cautious about the cleaner it loses some of the "cool".
Effortless	The less effort with the biggest effect seems cool since cleaning the bike is often thought of as a chore and something that is tedious to do.
To not move the problem, but to eliminate it	It is cool if you can clean your bike, but it becomes very un-cool if you move the dirt inside or onto the car instead
Fast	It is considered cool to create a faster process with fewer steps, since it, like the "effortless" factor, is considered a tedious task. Another aspect is that it is always prepared and ready
New / clean product every time / readiness	Just like the bike itself having a clean (like brand new) product every time you need it, just feels like it performs better.

Following this is an evaluation of the chosen potential features that has been investigated throughout the process so far. The evaluation builds on four parameters, the pros and cons, whether it is a base feature or an extra feature and the ease of implementation, which is made as an estimation based on the knowledge gained up to this point.
Worth noting in the evaluation is that the bike stand and auto-open storage room are both being prioritised to implement despite scoring relatively low in implementation. This is due to them being valued highly in regards to creating a cool and desirable experience for the user. These can be related to the effortless feeling and fast cleaning described above, adding cool elements to the product and scenario.

The decision on which features are differentiating, base, and pro are made in relation to how easy they are to implement and how much value they give to the user. Differentiating features are implemented because of demands in the process. Base features are easy to implement and give high value to the user. Pro features are nice-to-haves that can be implemented to improve the usability but are not necessary to have, to have a nice user experience. The valuation of this is shown as a table with pros and cons of each feature, and ranked with a grade in parenthesis.

Blue = Differentiating feature Green = Base feature Yellow = Pro feature

EASE OF IMPLEMENTATION	POTENTIAL FEATURE	PROS	CONS
1 (10)	Remaining water indication	• Allows the user to clearly see how much water is left • The user can adjust their cleaning pattern depending on the remaining water	• Requires transparent water tank
2 (9)	Nozzle switch	• Allows the user to clean with different hardnesses	• Adds a little weight to the gun
3 (9)	Foam spray	• Applies soap on the bike very fast • Can also be used on other items like a car or furniture. • If the user wants a specific brand they have the possibility • They could buy bulkier containers of soap.	• Uses water • Uses a lot of soap • Spills more soap on the ground. (could just be applied directly to the brush)
4 (6)	Retractable hose	• Takes the step of rolling the hose back away • Looks cool • Might make the hose not touch the ground	• Adds weight (200g) • Adds size • More fragile (moving parts)
5 (5)	Larger storage room	• Allows the user to have the things they otherwise also would bring in a single package. • Additional cleaning tools can be brought on the trip.	• Takes up more space • A shelf or door might add a little weight
6 (4)	Bike stand	• The user doesn't have to hold the bike. • The user doesn't need to turn the bike around.	• Added weight • Added size • The setup takes longer • Additional thing to clean before putting back into the car. • Can't hold two bikes at the same time, even though there is water for two bikes
7 (3)	Hose cleaner spray	• The hose is always clean, when it is rolled up	• The hose ends up wet and needs to dry somehow. • Maybe the whole hose can not get cleaned this way • Running out of water - problem
8 (3)	Auto-open storage room.	• The storage room that contains all the tools are protected. • Gives the box a "cleaner look" • Gives a wow-factor	• Fragile - moving parts • Not much necessity

The objective of this task was to see the implementability of the different features in correspondence with the working principle sketching round from previously. The features are ranked based on their ease of implementation and given a colour corresponding to their necessity. The differentiating features are the one stemming from demands already made, the base features are to be implemented if at all possible and the pro features are nice to have. The nice to haves are quite difficult to implement and do not give huge amounts of value, meaning that they will be disregarded. This also means that the rest of the features are either base features or differentiating, meaning that there is no reasonable possibility to implement customisation in this product at this point. The new set of features leads to some new demands.

Demands
- Retractable hose
- Remaining water indication
- Nozzle switch

Wishes
- ~~Customisable solution~~

2.14 DESIGN BRIEF

PROBLEM STATEMENT

How can the cleaning process for mountain bikes be improved through a new industrial design product?

VALUE MISSION

Maintaining the good driving experience through easy cleaning of the bike

GENERAL REQUIREMENTS

		Section
01	Must be safe to use on a mountain bike	1.4
02	Battery and water included	1.4
03	Transportable in car	1.4
04	Can be used with existing cleaning products	1.4
05	<15 minutes cleaning	1.4
06	The product should be able to be placed away from the bike when cleaning	2.1
07	4-5 litres of water capacity per bike	2.4
08	20-30 bar water pressure	2.5
09	No louder than existing solutions*	2.5
10	No interaction under 300 mm	2.5
11	Removable battery	2.7
12	Efficiency of cleaning must be equal to or better than current solutions	2.7
13	Bike stand	2.9
14	Out of car use	2.10
15	Battery and pump in handle	2.10
16	Must work with garden hose	2.10
17	Foam dispenser included	2.10
18	Must contain the essentials for cleaning *Detergent, Brush, Water, Cloth*	2.10
19	Retractable hose	2.13
20	Nozzle switch	2.13
21	Remaining water indication	2.13

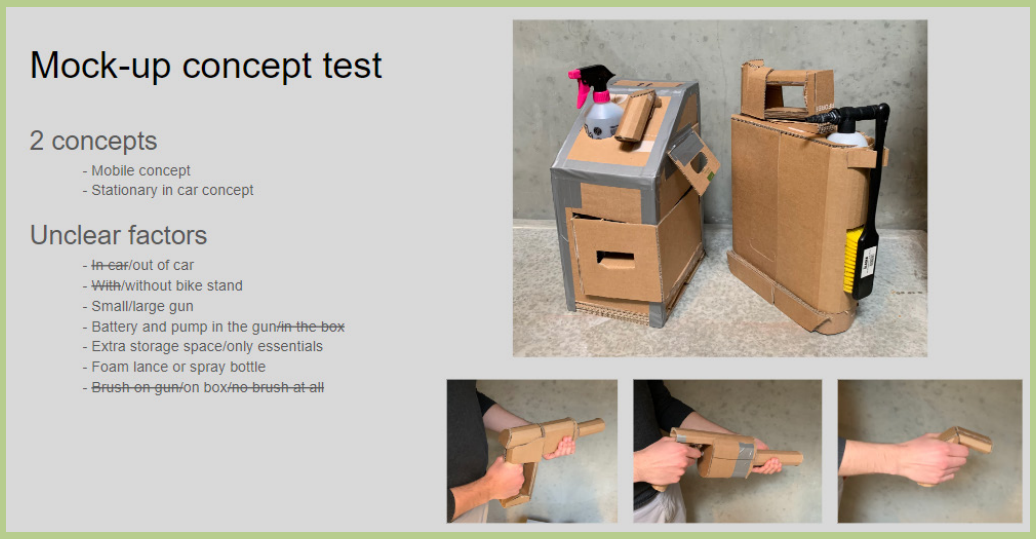
WISHES

		Section
01	Tap refill	1.2
02	Easy to store	1.2
03	Wife approvable	1.2
04	Space optimised features	1.2
05	Transportable / mobile	1.4
06	Easy to use	1.4
07	Easy / fast to prepare	1.4
08	Minimise body strain	1.4
09	Storage of other MTB related equipment	1.4
10	Give a feeling of performance increase and professionalism	2.2
11	A user experience relating to the mtb lifestyle	2.2
12	Should be able to clean two bikes	2.4
13	Appropriate lance length*	2.5
14	Different spray angles *	2.5
15	Rollable hose	2.5
16	Plenty of water *	2.7
17	80% clean bike*	2.7
18	Appropriate hose length *	2.7
19	Lightweight *	2.7
20	Visually relating to a mountain bike context	2.7
21	Different positions for different boots *	2.7
22	Wow effect to user and surroundings	2.10
23	Presenting the tools	2.12

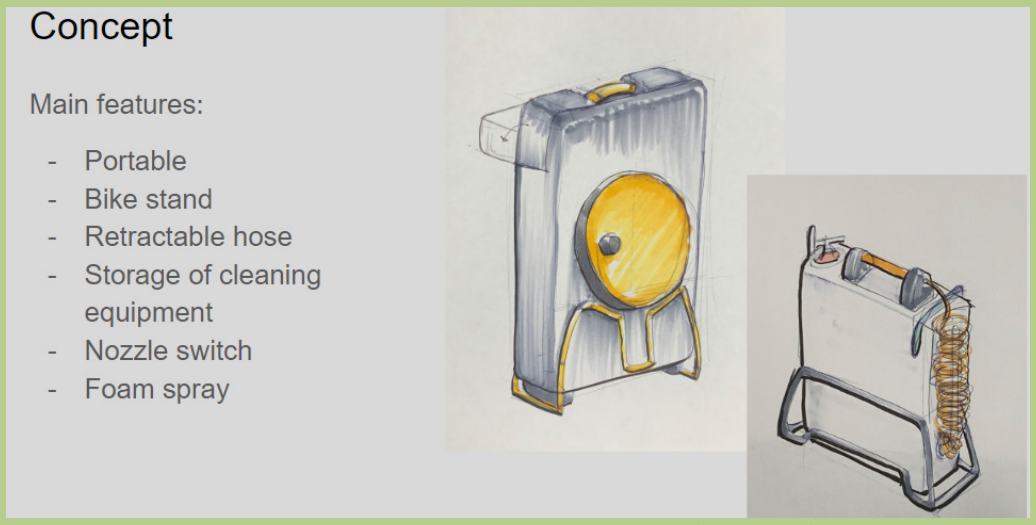
Presented at milestone

The initial new information presented at this milestone is some of the tests made, which leads to some concept development.

The concept development led to mock-up testing. Feedback which was essential for moving forward with the development.



The concept at this point was presented to look like this and with these features.



Illu. 2-42, Milestone 3 concept

03DEVELOPMENT

The second phase has focused on testing existing cleaning solutions and defining where this product can distance itself from competition and which features are to be implemented, as well as defining which of the overall concept directions to work upon. The feedback from the milestone leads to the next phase. Important steps are to be made in regards to determining the right amount of water to not feel under pressure when cleaning. It is also necessary to look further into and define what 'cool' is in this context and how it should be integrated in the product. The working principles of the last sketch round are to be used to define the user experience that is intended in this context. The experience, features and appearance should also make it clear why this product is dedicated to mountain bikes which is essential to determine in the following phase.

3.1 CLARIFYING CLEANLINESS

Based on the feedback from the milestone it shows that it is necessary to be more clear on what '80% clean' is. 80% clean is a wish coming from section 2.6, where the feedback from interviews was that it was not essential to do a full cleaning every time, but it should be clean enough to not damage the bike.

Based on previous information gathered in interviews it is necessary to do the essential cleaning. This cleaning includes removing excessive dirt and grime that may damage the bikes mechanical components or paintwork. The mud testing shows that it is possible to remove the dirt and grime with pressurized water, some detergent and a brush. The cleaning process does not include greasing parts. This is a part of maintaining the mechanical parts and it is something they would prefer to do at home when rested and with loads of tools at hand. The main part of this cleaning process is to make sure the dirt and grime does not stick to the bike, so it becomes difficult to remove later or in the worst case does damage to their precious mountain bike. This leads to a change in the wish, so 80% clean is replaced with a more understandable wish.

Illu. 3-1, Muddy drivetrain

Illu. 3-2, Bike mechanic

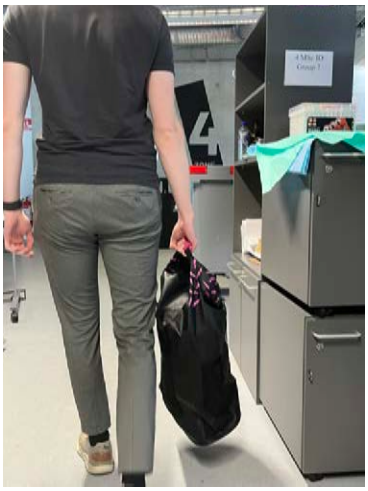
Wishes
- Remove damaging dirt and grime from frame and mechanical parts
- ~~80% clean bike*~~

3.2 MAX WEIGHT

As part of the milestone feedback, it is necessary to define how much water is enough. The previous amount of water determined was 4-5 litres per bike. After the milestone feedback this number is changed to 6-7 litres, to have a solid excess and no pressure of having to save water or skip cleaning.

With the new amount of water defined the next step is to look into the max weight. The first test is made by filling the Muc-Off bag with three 5 kg colli of paper. The test showed that this was way too heavy but also annoying to lift due to its size.

To get a more valid result, a model is made with a more realistic weight balance and a better handle. The test also shows how big an impact the size and handle can have. A model is made of three 5 kg colli of paper. These are taped together and given a handle to get a feeling of approximately 16 kg.
The test indicates that 16 kg is in the high end of allowable lifting weight but also that the handle and balance has a major impact on the lifting experience. The homemade model feels much lighter and easier to lift compared to the Muc-Off test. To give a slightly better experience target is put at 12 kg with the maximum allowable weight at 15 kg. It is noted that the weight should be close to the body.



Illu. 3-3, Weight test

With a target weight of 12 kg the next step is to estimate the weight of the different components as seen on illu. 3-4. Here it is estimated that to be within the target and max allowable weight, it is necessary to bring less water as this is the largest factor. Having less water has the consequence of not being able to clean two bikes in the intended detail. But this is prioritized lower than the achieving the weight target and therefore removed.

The target of the objective was to define the target and max allowable weight of the product when full of water. The decision is based on the creation of a model and how comfortable it is to lift and walk with. The model is not accurate in the feel of the handle and the center of gravity, but the results of the test are determined to be accurate enough. With this issue investigated the next step is to clarify what cool is in mountain biking. It was clear from the last milestone that there are still issues communicating what defines cool and the following section tries to deal with this before additional development of the product is achieved.

Gun	1	kg
Battery	0,5	kg
Soap disp.	0,1	kg
Roller	0,3	kg
Brush	0,2	kg
Hose	0,4	kg
Water tank	2	kg
Water	7	kg
Stand	1,5	kg
Total	13	kg

Illu. 3-4, Weight estimation

Demands
- Max 15 kg
- 6-7 litres of water capacity
- ~~4-5 litres of water capacity per bike~~

Wishes
- Target 12 kg
- Weight close to the body when lifting
- ~~Should be able to clean two bikes~~
- ~~Lightweight *~~
- ~~Plenty of water *~~

3.3 CLARIFYING COOL IN MOUNTAIN BIKING

From the milestone there was feedback stating that the presentation mentioned 'cool' a lot without actually defining it. The specifications and parameters that define the cool factor should be identified.
Contrary to initial beliefs, the aspects of risk, tracks and care for the bike are minor motivators. These are important for a few people in the biking universe but are not the main driver. There are a lot of different motivational factors for mountain biking. One of the most prominent ones is the adventure aspect of the ride. The feeling of figuratively defeating the beast and overcoming the challenge. (Taylor, 2011) Of course, the functional aspect of physical exercise is a motivator but for mountain biking specifically, it's the thrill and feeling of escapism that really hooks people. The social aspect is one of the main drives in people wanting to try out new tracks and begin with mountain biking. (Shredtrail, n.d.) The social aspect is also part of what makes them want the newest and best equipment at all times. Nobody wants to have something worse than their fellow mountain bikers.

From section 2.2 it can be understood that the products the mountain bikers are paying loads for are products that to some degree improve their performance and gets them closer to being (or feeling) professional.

The performance in this product lies in the cleaning of the bike. It should be able to do it quickly and efficiently, while being light and compact. Being professional is more of a feeling the product should communicate to the user and the surroundings. Performance and professionalism in this context are connected as professionals use equipment that is effective at the task at hand, i.e. cleaning the bike. While a new cleaning solution may not improve their abilities on the trail it can still get them closer to how the professionals work. The combination of the performance and professionalism and how this is communicated to the user and surroundings is defined as an experience, which will be discovered in the following sections. Achieving these factors should give a product which is desirable and would almost become a symbol of status within the mountain biking world.

The professional cleaning process is very important to understand and throughout the process there is a general knowledge of how professionals clean their bikes and why this method is not 1:1 implementable in the hobbyist scenario. This knowledge is finalised and unfolded in section 4.1.

3.4 INTERACTION (FEATURES)

The objective in this section is to unfold different ways of implementing a (positively) surprising opening experience. The opening experience is becoming increasingly more important as the detailing process is initiated as it is the main differentiator of this product compared to competition. Desktop research is made to find working principles of different unexpected movements to find the most fitting movement for the specific user experience.

The mechanism pops out in multiple dimensions by itself with one push. This may give a really unexpected experience that could be interesting to work upon but it is complex and difficult to interpret the movement, for which reason it does not progress.

Illu. 3-5, Folding cup holder mechanism

An unexpected experience when the doors open. A two-part unfolding movement. The two part movement is a good mix of unexpected in the specific context while also having a movement path that is easy to interpret. This idea progresses.

Illu. 3-6, Automatic folding doors

An unexpected experience when the doors open. A two-part unfolding movement. The two part movement is a good mix of unexpected in the specific context while also having a movement path that is easy to interpret. This idea progresses.

Illu. 3-7, Table with hidden features

The objective for this section has been to find different movements of the opening experience.
A lot of found movements have an element of hidden features. Another theme is something that is not necessary functionally, but is there anyway as a sort of flashy feature that shows off that it can be there even without function, it shows a kind of excess. The most prominent example being the falcon wings on the Tesla X. They didn't have to function like they do but they do, to kind of show off and do something different.

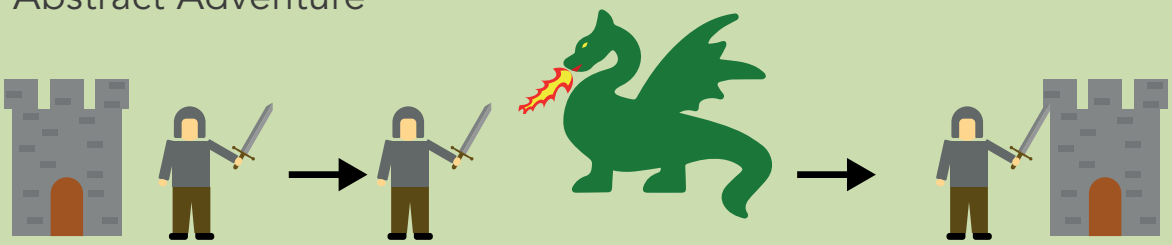
It is also necessary to look into the specific interactions. How should it look, feel, move, sound to give the right feeling of quality which fits a product like this. Here it is noted that when something really gives a nice experience, it is when something is built in a high quality and the interaction is thought through. E.g. the opening or closing of an airpod case, it is very satisfying that you can feel when it is open and closed with the magnets. And the closing of a macbook lid or a well built car door, the way it gives a good thump, where you are satisfied and can feel confident it is closed properly, and there are no rattling sounds so it doesn't sound like something is broken. The feeling that the user should get in such micro interactions is the next step to look into in section 3.5 but it will be made on the basis of existing products and the understanding hereof. With the time frame at hand and the competencies it is not possible to follow up on this in the final product other than a descriptive explanation. Before the micro interactions can be defined, it is decided to look into which overall feeling the user should get when using the product, which is made as a story.

Illu. 3-8, Airpod case

The Story

As explored in section 3.3 the main motivation for mountain bikers is the feeling of adventure. Here we can deconstruct the "adventure" and try to see if our product can be implemented into the adventure or create an adventure on its own. The method used to do this is to find a fitting adventurous story and split it into sections. Each section the main elements and features are defined and this is translated to the mountain biking experience and the features present here. At last it is also translated into the cleaning experience and how the features can be implemented to fit the adventurous storyline.

The Abstract Adventure



The top story is the story of the sword in the stone. A the left is the man with the sword and the stone alone. The sword is the weaponry the man has to defeat the evil dragon. The story follows the path of a traditional adventure, being home in the beginning, going out and overcoming the challenge and then returning home.

The Mountain Biking Adventure

Translate the sword in the stone story to mountain biking, in the second story the man has his bike. The trail is what must be defeated with the bike as the weapon. With the bike as the weapon the biker has the confidence and skill set to go defeating/overcoming the track. Here it is clear that the user wants to have the best weapon and keep it sharp for the encounters to come. This is why they will spend excess amounts of money on their "weapon".
It seems unclear how the narrative can include the bike cleaning in this scenario. Therefore a third adventure is presented.

The Adventure of Cleaning The Bike

And translating the story to the cleaning process.
In the third story (our story), the man has his cleaning gun. The dirt and grime is what must be defeated, to defend the precious and beloved bike from harm. The cleaning gun is the weapon that can be used and help the man overcome this challenge.

Illu. 3-9, Story

It is generally important to have a weapon that gives the feeling of being able to solve the task at hand. The weapon should be like a friend, a helper that gives joy and confidence in the user's skill set. Having these stories and indications towards an experience leads to the following:

- An experience for both user and surroundings
- A dedicated mountain bike tool

These considerations of how the cleaning tool should feel for the user will now be used to select and define each small interaction with the product in the following section.

Wishes

- Presenting the tools to user and surroundings

3.5 INTERACTION SCENARIO

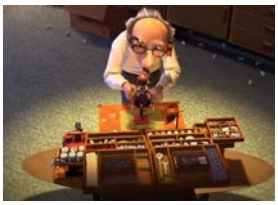
Based on the interaction visions and knowledge from the previous section, the logical next step is to map the scenario and mark each micro interaction. When this is done, it is necessary to determine how each interaction should look, feel and sound to enhance the storytelling and overall experience of the product. The highlighted interactions are shown in this section, while the full scenario can be seen in appendix 5. The pictures on the right are chosen and shown to give a common understanding of the feeling that is seeked for the specific micro interaction. Each interaction is graded from 1-10 according to how inportant they are in order to prioritise them.

Placing the bike stand - 6

The feeling of placing the bike stand on the ground should be like the pro cup stackers , who hold a stack of cups and place them precisely and fast on top of each other. It should fall nicely into place

The presentation of the gun - 10

The presentation of the product should resemble the toolbox in Toy Story 2, that transforms from a regular looking tool box to a mini saloon for the toys. Like the toy refurbisher you have everything you need readily available, giving a feeling of preparedness for any obstacles. And the unfolding just looks cool and satisfying.



Picking up the gun - 9

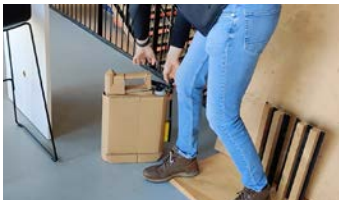
The feeling when picking the gun up from the water tank should be like a sliding a gun out of the holster on the belt.

Holding the gun and shooting - 8

The feeling of placing the gun firmly in your hands and beginning shooting should be something like swinging a heavy gun up to the other hand and starting shooting like rambo. - you feel strong enough that you can hold it with one hand/arm and still control it.

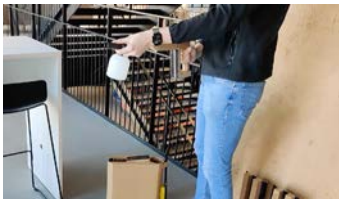
Placing the gun in the water tank - 8

The feeling of placing the gun in the "holster" again should resemble the feeling of placing an air pod on its holster. It has a magnet and sides that guide it into place and gives a satisfying snap, when it is into place.



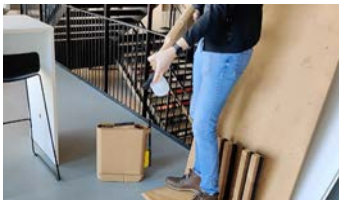
Taking the brush - 7

The feeling of taking off the brush should be the same as taking a tool off a tool board or rack. It has its dedicated place, where it fits exactly and can be taken off with a single hand. When putting it back it should also have the feeling of locking into place.



Attaching the soap dispender - 6

The feeling of attaching the soap dispenser should resemble the feeling of loading a magazine into a pistol. Or connecting a quick release hose. The click sound along with the tactile feedback of it being connected should be replicated.

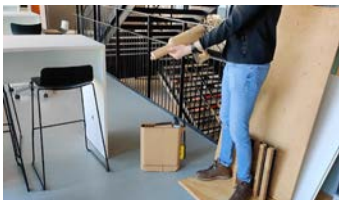


Spraying the soap - 5

It is definitely not in the interest of the user to "litter" with the soap. Therefore the soap stray should feel very controlled. This means that it should have a sharper angle than the current one, and spray less soap onto the bike. The precision and feeling should resemble the people who spray insulation in homes.

Taking the soap dispenser off - 6

This interaction should be like releasing a magazine from a rifle. The muc-off release trigger for the hose is awkwardly placed for one hand since it would require the point finger to press it down (it is way too hard), this can be seen in appendix 6. The thumb would be a much better choice.



Rinsing soap off the bike - 7

The feeling of washing off the soap should be like cleaning a window and scraping the soapy water away.

Securing the gun in the water tank - 9

It should feel secure and a tactile feeling or sound that it is locked in place, like a padlock being closed.

Removing the bike from bike stand - 2

It should feel smooth and straightforward to remove the bike from the bike stand, like a pallet jack

Picking the product up - 6

The feeling should be of stability and the handle is secure, as picking up an important briefcase, like the nuclear launch codes

Remounting the bikes stand - 7

This should feel easy and you should feel that it fits together, and it should be clear when it is in place and locked, like lego bricks snapped together

Placing the product back in the car - 7

Giving a feeling of control and not bashing it into the car.

Illu. 3-10, Interaction scenario zoom

By having dove into the micro interactions in the scenario, it has been possible to identify the most important interactions and couple them with the feeling that they should resemble which in turn leads to new demands for the product. Furthermore by ranking the importance of the interactions, it can be easier down the line to make decisions regarding compromises by relating the interactions to the feelings. It is noted how important it is to lift it from the correct height for a nice experience which leads to a wish. In the future the optimal lifting height will be determined through testing. Moving forwards with the information gathered in this section a problem slicing approach is used to accommodate the different interaction feelings.

Demands
- Upright or laid placement possibilities in the car

Wishes
- Appropriate lifting height*

3.6 CONTEXT

To get a better idea of the different environments the solution will meet, a field trip to Rold Forest is undertaken. On the main road to the forest there are seven different parking lots with relation to a mountain bike trail. The six parking lots have different types of ground, different amounts of space to deal with and different slopes. The parking lots are graded upon their easiness to deal with from a cleaning perspective. This is based upon how the waste water would be distributed on the ground surface and if there is a possibility to lean your bike up against anything nearby and how much space is available. The full test can be seen in appendix 7.


Rebild Bakker - 6

- Ggravel parking
- Grass right by the parking
- No trees, but steep hill
- Slight slope
- Little space by the car, but plenty of space beside the parking


Forest ground - 3

- Mainly dirt and stones
- Slight slope of the road
- Moderate space
- Trees for standing up the bike.


Forest parking lot - 6

- Grass and gravel
- Slightly muddy.
- No slope hence the mud
- Trees for stand the bike up
- Plenty of space


Hotel parking lot - 10

- Stone, pavement and grass hybrid.
- Moderate space.
- No slope
- Trees for leaning the bike against.


School parking lot - 10

- Asphalt
- Slight slope
- Trees for standing up the bike.
- Moderate space by parking lot, but plenty of space beside parking lot.
- Has a washing station for the bikes


Illu. 3-11, Context

Forest entrance - 4

- Dirt and sand
- Slight slope
- Both trees and steep hill for stand the bike up
- Plenty of space.

The gained information leads to new wishes for the product. With so many types of parking situations the product has to stand steady and avoid becoming excessively dirty no matter the terrain. To see how much dirt a similar solution can pick up a mud test is made. This test shows that it does not get as dirty as expected.

Wishes

- Steady on different terrains
- Avoid becoming excessively dirty

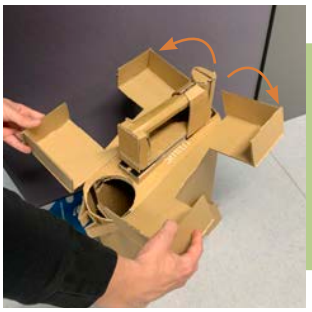
3.7 OPENING EXPERIENCE

Having looked into both the overall experience and each micro interaction, the next step is to determine the final opening experience. The opening experience should be well fitting to the different contexts that it can be placed in, so the different openings are evaluated upon how durable they look to fit in.
The original mock up is used as a water tank and a set of lids is made. The lids are moved in different patterns and each pattern is then evaluated.

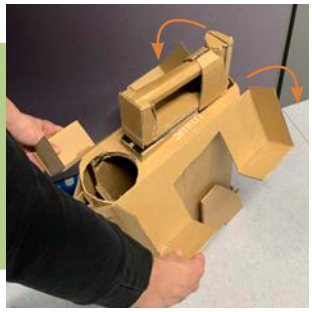
The openings are graded upon the following parameters

- Stability
- Complexity
- Durability
- Ruggedness

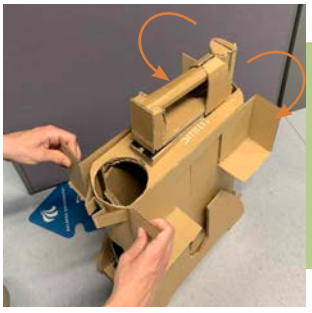
Illu. 3-12, Mockup model



Pros	Cons
• Tangible opening mechanism • Gives a great overview of the cleaning tools • Accessible tools	• Exposed shells - could feel fragile • Legs would be more likely to hit the sides



Pros	Cons
• Tangible opening mechanism • Accessible tools	• Exposed shells - could feel fragile • Legs would be more likely to hit the sides. • If the tank were to fall over the hives would be twisted in the wrong direction



Pros	Cons
• Tangible opening mechanism • Accessible tools	• Exposed shells - could feel fragile • Legs would be more likely to hit the sides. • Long actuation

Pros	Cons
• The shell would hide/protect the mechanism • The gun appears to pop-up	• Less space for ekstra tools • At least 3 arms are required for each arm to keep it horizontal

Illu. 3-13, Opening experience mockups

Pros	Cons
• Tangible mechanism • Slightly better overview of the tools	• Would be better for right handed people rather than left handed people. • Maybe not as satisfying
• Tangible mechanism	• Would take up ekstra space • Would only be curved in one direction • No additional space for tools • Would cover the handle

Illu. 3-13, Opening experience mockups

Six different openings are tested and out of those, two are chosen for further work. These are the '80 degree' and the 'out and down'. These two are animated and shown to potential users.

To fit the story of having the right tool ready and at hand it is decided to make the gun move upwards during the opening, to exaggerate the motion and present the gun. The feedback is that the 80 degree rotational opening is more predictable - in a good way. The transformation is clear when it starts and ends unlike the out and down opening. The 80 degree one seems more durable and satisfying to look at and this is therefore to be implemented in the cleaning tool. During this test it is noted how the gun in the out and down concept appears to pop-up, which is a new feature that could be added in future work.

Wishes
- Presenting the gun and tools
- ~~Presenting the tools~~

3.8 OPENING MECHANISM

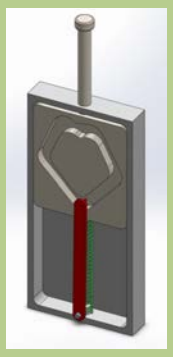
Having decided upon an opening experience the next step is trying to get the experience's movement actuated. With the battery placed in the gun, the moving will have to be a purely mechanically actuated mechanism. It is decided to look into potential mechanisms that could actuate this movement, to see if it is realistic to actuate it this way and start determining the dimensioning and placement of said mechanisms. From defining the opening experience, it is decided that the gun should be presented, meaning that a movement downwards from the lifting position should initiate a rotation in the lid and simultaneously a movement upwards in the gun.

In the work to find potential mechanisms, multiple solutions were considered. The solutions explored were using either a rotary latch with a brake line principle or a push-push mechanism, as can be seen on illu 3-14 and 3-15. The chosen solution is described below, while the rest of them can be seen in appendix 8.

Rotary latch
Similar to opening the hood of a car. Using a lever, that the user interacts with, a cable to transfer the action, and the rotary latch itself.

Illu. 3-14, Rotary latch

Push-push
The push-push mechanism is used in two places. To lock vertically and achieve rotation in the lid. Both mechanisms are actuated pushing the gun downwards.

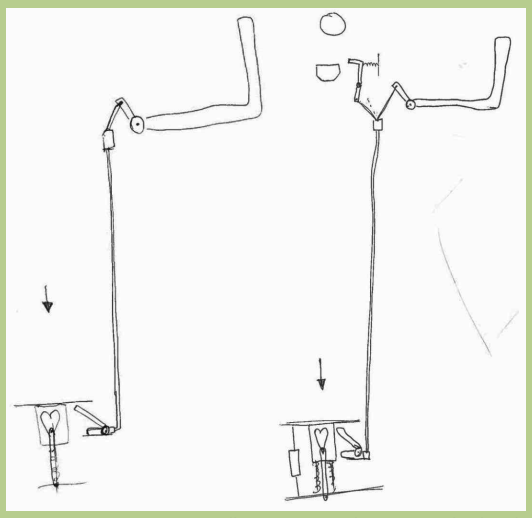


Illu. 3-15, Push-push mechanism

Initial concepts using brake line principle

This solution is a mix between push-push and brake line principles.

The push-push limits the gun to its vertical positions and allows for the actuation of the brake line which then actuates the movement of the lid and the mechanism that locks the gun vertically for lifting purpose. This is a very simple solution and is intended to develop further in phase 4.



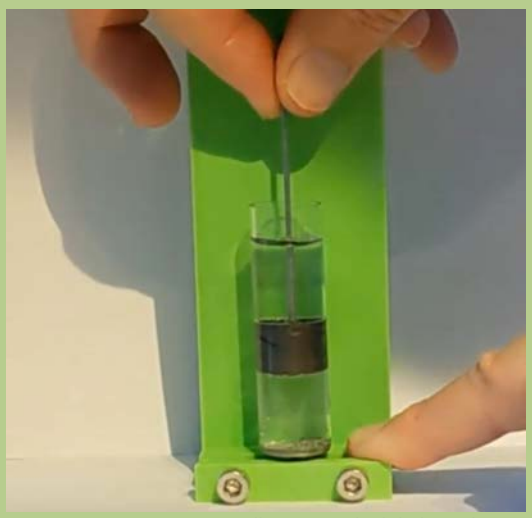
Illu. 3-16, Working principle sketch

Soft close damping

A big part of having the right experience is having a dampened movement, as an erratic movement will be interpreted as malfunctioning or under-engineered, which is a no-go for this user group.

Fluid dashpot damping is with air as the viscuous fluid is chosen for the damping of the motion. Specifically, pull damping is chosen, as this works best when the load is not too great, and the piston gets to reset all the way after movement.

These principles are brought on for further development in the future.



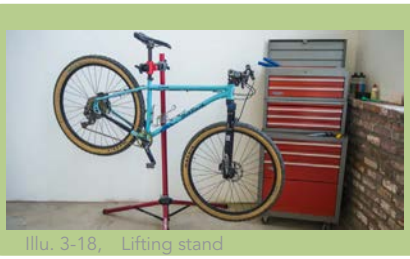
Illu. 3-17, Fluid dashpot damper

3.8 BIKE STAND AND HOSE REEL

Bike Stand

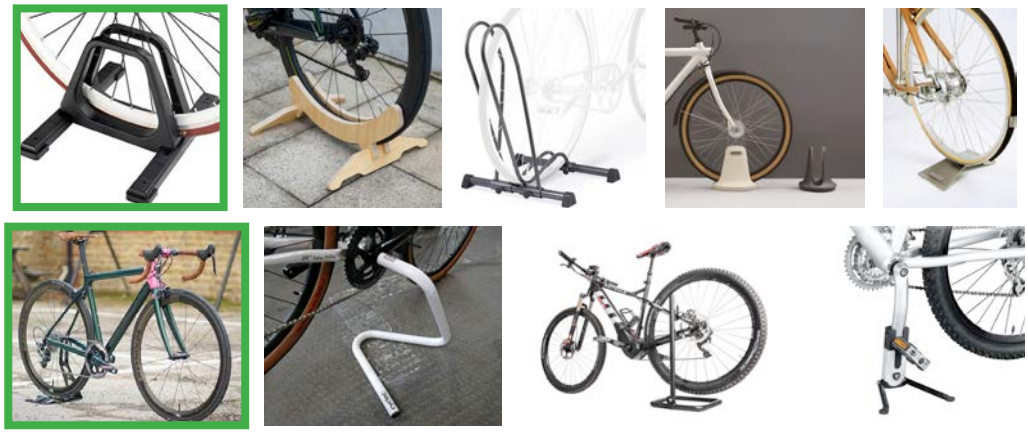
Having defined an opening experience, it is time to define which type of bike stand is ideal for this solution. In order to simplify our solution and not focus solely on the bike stand, it is wished to incorporate an already existing bike stand design if possible. This will be done by collecting all the available bike stands which are in a compact size. The number next to the category is each category's weighting. The full chart can be seen in appendix 9.

- Size (6)
- Weight (9)
- Setup (7)
- Cleanability Stand (6)
- Cleanability Bike (5)
- Style (3)
- Stability(7)



Illu. 3-18, Lifting stand

This type of stand was seen at Finn's place during the interview. While it does look really professional in its use, Finn also stated that it is not optimal to use in conditions less than perfect. A slope and a slight breeze they fall over. Furthermore they are a hassle to set up even in ideal conditions. For these reasons, this type of bike stand is disregarded early on.



Illu. 3-19, Bike stands

Of the two winners the first one is chosen because it is much simpler to implement in the solution and it is deemed easier to use in the context. This is taken into the detailing process for further work and implementation.

Wishes
- Around wheel stand

Hose Reel

Having decided upon a bike stand, the next step is looking at the hose reel. Different working principles are found with pros and cons to each.

The first solution is a retractable hose reel. It is easy to use but it will let the hose touch the ground and get dirty. It is also not the simplest solution, so it is decided to look into finding something simpler if possible.

The first of the simpler solutions is the spiral hose known from garden hoses. It is cheap, simple and well-known and could be integrated easily.

Illu. 3-20, Hoses

The third option is a flexi hose. These are quite clever but also unreliable and prone to ruptures quickly, so this solution is disregarded.

With two possible solutions it is decided to work with the spiral hose as plan a and the hose reel as plan b due to the simplicity of the spiral hose. To test the spiral hose is bought and quickly shows clear disadvantages. It unfolds fine but after just a couple of times, it won't roll back fully. For this reason the spiral hose is discarded and the hose reel is decided upon.

3.9 BIKE DESIGN AND STYLE

For the upcoming concept round the objective will be to test styles. To have the necessary knowledge to create visually fitting concepts, the following work tries to analyse styles both in the biking world and from other contexts. It leads to concepts that are shown to interviewees for feedback. The objective here is to analyse mountain bikes from different top brands. What are the styles their bikes have and how these styles are made from a functional perspective.

The Trek's larger frame appears more rugged, off-roading and heavier than the competitors. The cannondale and Scott seem lighter and smaller. The Scott and Specialized is visually the fastest in the frame shape, by being leaned backwards. The Cannondale is more horizontal and 'in control'. The Scott bike seems simpler compared to the others, which is exemplified perfectly by the rear suspension being hidden inside the frame. The Specialized and Cannondale are the visually more complex solutions whereas the Trek is showing off the rear suspension big time and really seeming powerful.

The Trek bikes have a wide range of colours, but are mostly one colour which is in contrast to the competition that does a lot of fading between neutral and colourful paints.
The Trek's colourful paint shows off the bike by being this colourful, whereas the other bikes show off the frame and brand by being more geometric and edgy in the design. They focus on looking modern and fast, which the colour fading helps with.

Trek

Cannondale

Scott

Specialized

Illu. 3-21, Mountain bikes

The research has shown that there are different ways of approaching the mountain biking target group. It can be more rugged as the Trek style, or faster and more aggressive like the Scott. The information from this research helps find inspirational images for the following style boards, which are used to create a style for the solution. The intention of making the style boards is to create different styles that can be shown to the users and get closer to which style is the most appropriate for the specific context and target group and which factors they hook upon.

To explore potential styles three style boards are made. The three style boards are used for internal use in creating new styles but also shown to the user to get feedback on which parts of the board they like and how accurately the design suggestions fit to it. Shown here are the most important features and lines used as inspiration, while the full style boards can be found in appendix 10. As with the bike analysis the objective is to find inspiration in styles for the creation of visual styles.

Sporty

The sporty style board has focus on mixing long and short straight lines with sharp angled corners with fillets. This creates a dynamic look between different surfaces, shapes and sizes, which is most noticeable on the BMC bike and the helmet.

Modern

The modern look is much softer in its lines and corners, which is well presented by the VW wall charger. It has large, soft surfaces made by not quite straight lines and large fillets in all corners. As the bench implies there are also opportunities to look into more organic shapes.

Rugged

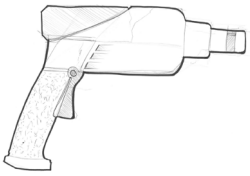
The rugged style works with rounded edges that can be dropped upon without breaking. The materials are, partly, softer and work with more broken surfaces. Assembly points are often shown and likewise the interaction points are clear.

Illu. 3-22, Style boards

3.10 STYLE CONCEPTS

The objective of this task is to get feedback upon the concepts that are made with the information and inspiration of the style boards and bike analysis. The gun and water tank styles are shown to users and the feedback should lead towards the creation of new visual styles in an iterative process. The feedback to these different styles was mixed.

1.



The first concept was not taken well, as the trigger was weird and the dimensioning was off and it reminded too much of a wheel-gun.

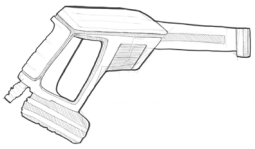
2.

The second concept was liked and seen as stable with a solid stance.

3.

The third was deemed cool with a recognisable look that could fit well into the context by being so rugged.

4.

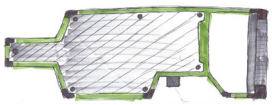


The fourth seemed too dangerous as it 'would not be allowed into an airport'.

5.

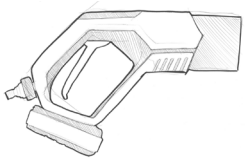
The fifth was too much like a briefcase.

6.



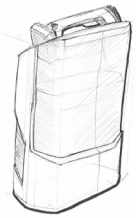
The sixth looks like a wild rifle from shooting games, which was not appreciated.

7.



The seventh was their favourite gun, as it mixed some nice lines with a still rugged look, but maybe a bit too futuristic.

8.



The eigth looks like it goes on the back and is to be carried around. It has a lot of character but does not seem as rugged as the others.

9.

Rounding off with a gun where the pump and motor is placed at the front with the battery on the top. According to potential users the appearance is valued to be too soft and a bit weird looking.

Illu. 3-23, Style sketches

Generally for the gun concepts is that they are shown with large triggers, but the users seem more interested in a two finger approach. The spiral hose concept was discussed and it was deemed a bad solution. The automatic hose reel, known from some vacuum cleaners, are understood to be a much more convenient solution.
Visually it is important to look durable in this context but with a twist of performance which leads to the removal of the style board 'modern sleek'. Features wise it was discussed to integrate an electronic nozzle switcher, which gave positive remarks. The idea was understood to be like electronic gear changers, which has become a very popular choice in recent years according to the interview in section 2.2 and appendix 4. As a final note the storage room is disregarded from the point. They would not bring more cleaning equipment in the room and only some would use it for patches, food, chain links etc. and for this reason it is evaluated to be unnecessary.

This style round was made with the intention of gaining additional knowledge of the users and how well the initial concepts fit into the context. The round gave a lot of insights but additional styles are to be made in future work to get closer to the finalised concept. The task has shown that without further boundaries the gun could have many drastically different looks. To overcome this, the next step is to place the motor, pump and battery, as this will create design boundaries for the gun.

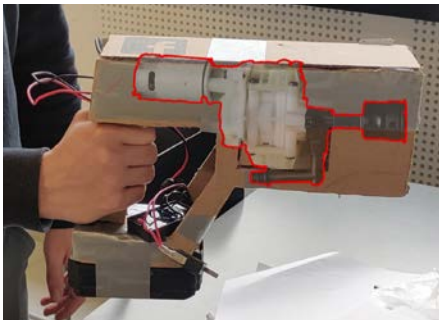
Demands
- Automatic hose reel
- ~~Retractable hose~~

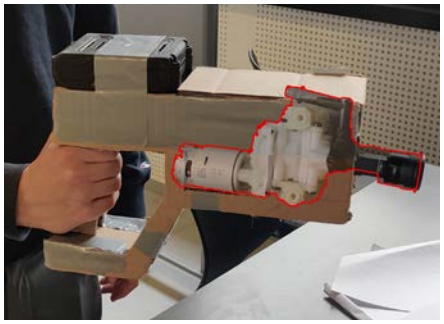
Wishes
- ~~Storage of other mountain bike related equipment~~

3.11 WEIGHT BALANCE TEST

To correctly design the gun it is important to get the feeling right. A big part of this feeling is having the right balance of weight, so it does not strain the wrist or hand. This balance is mainly controlled by the placement of the motor, pump and battery within the gun. The placement of these components are also critical to know, because they define how the gun can be shaped. The theory beforehand is that placing the motor and pump close to the hand above and the battery below the hand is the best for weight balance. This will be tested with mock-ups, where the components can be placed in different placements.

First off, a mock-up is built with cardboard. The mock-up allows for multiple configurations of the components. The two best examples of placement of motor and pump can be seen in the images below. The full test can be seen in appendix 11.





Illu. 3-24, Part placement

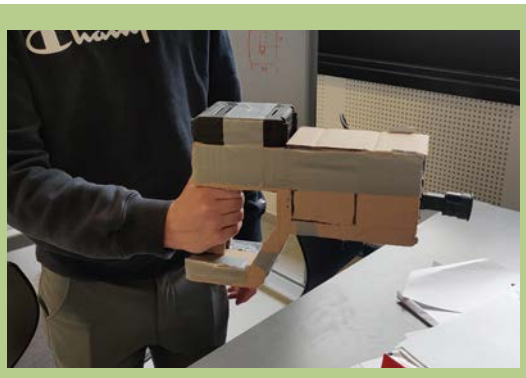
Illu. 3-25, Close weight gun

Close weight gun

The mock-up gun is configured with the close design first, and tested by team members holding it and simulating spraying a bike.
The remark about this is, that the weight balance feels good, when it is close to the hand when only using one hand to hold it.

Front heavy gun

Afterwards, the long design is configured, and tested. Instantly it was noticeable that the balance was way worse, as expected. It is noted that it makes the gun feel a lot heavier to hold and use.



Illu. 3-26, Front heavy gun

It is further noted for both, that getting close and tilting the gun sideways feels heavy and straining, and as a result you might want to use both hands in this case.
Therefore, two hand grips were attempted on both the configurations. Here it is noted that the bottom part that would be gripped should be slightly further forward on the gun, in the scale of 2-3 cm, as this will accommodate better where you naturally would grip it.

Lastly it is noted that this mock-up looks a little too massive in the front, as the narrowing is not represented. This simply supports the notion that the nozzle end should narrow down, to give a sense of direction, and lighten the look and feeling of the front end.

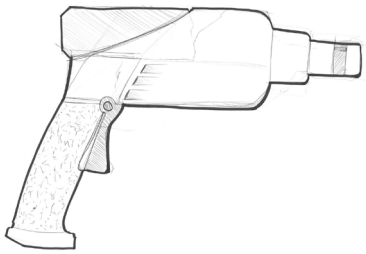
With the knowledge of the component placement, the creation of different gun designs can continue.

Demands
- Two hand grip

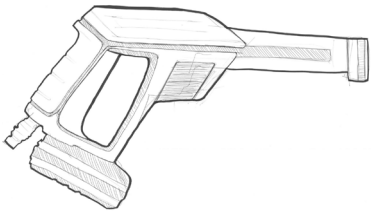
Wishes
- Weight of gun close to hand

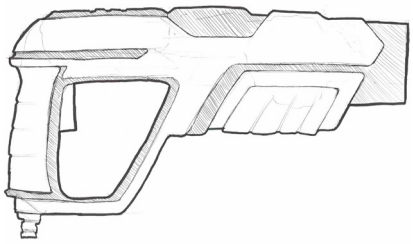
3.12 GUN DESIGN

Based on the aforementioned style boards and feedback it is possible to create a new design of the gun and water tank. The gun is presented with a basis on the placement of the pump and motor taken from a Worx Hydroshot and the battery from a Grouw low pressure washer, both components are placed with regards to the weight balance test. The first three sketches are from the previous feedback round but are shown with feedback to help define how the new gun design is made. The three initial sketches and their feedback leads to new designs that are developed through a feedback loop.

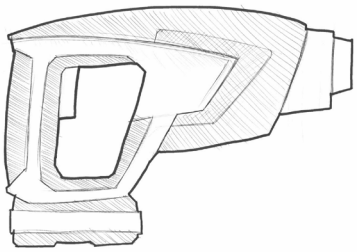


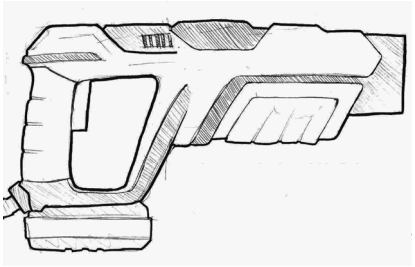
The left gun looks like a tool, but the speed stripes don't fit and the trigger is not cool. It is noted that it appears more like a wheel gun, which is not really fitting of the universe. It needs to look more rugged and durable.
The right gun is too long and dangerous, but does have some sportiness in the lines. The overall concept is well liked, if it can be shortened. Additionally the angle on the handle creates issues when trying to fit it into the water tank. It is decided to continue with this overall look paired with previous feedback.



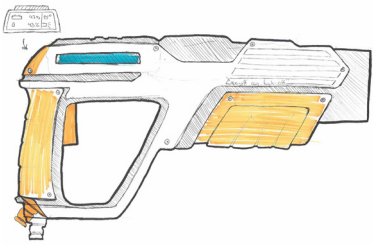


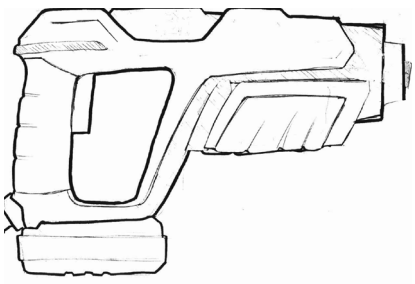
The gun on the left is a more rugged and less dangerous iteration. The clear indication of interaction points is really appreciated in this concept and should be carried on in future concepts. As this sketching is done simultaneously as the weight balance this design is quickly discarded however, due to the new demand for the weight distribution.
On the right gun, the concept is tested with a more sporty feeling, but is quickly regarded as being too 'space-blaster' or 'water gun-toy' inspired and would not fit the very serious mountain biking target group.



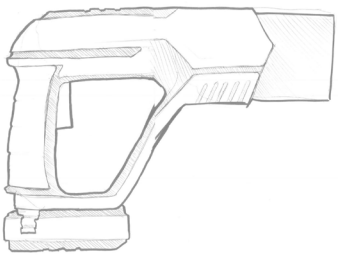


The next step builds on the previous sketch, elongating the gun again to achieve a more coherent aesthetic. This is generally appreciated, however the optimal length may be somewhere in between.
The right gun tries to add a bit more ruggedness to the surfaces and interaction colors. The four lines in the top right and the visible assembly point poses a possibility to add some different kind of ruggedness. The blue line in the top left represents that the water flowing through is visible, but this is disregarded as an unnecessary feature.





The next concept, on the left, tries with a narrower end of the barrel to give a feeling of more control in the spraying action. It was noted during the weight balance testing, that it could seem imprecise with a very wide end. The supporting handle is moved slightly forward to give a different grip and the unnecessary lines are removed as the feedback was that they cluttered the design, and that didn't align well with the water tank. This is referred to as DMG.
The last concept on the right is an attempt to make it less dramatic and simpler to figure out which design language fits the context and user group the best. This is referred to as Basic.

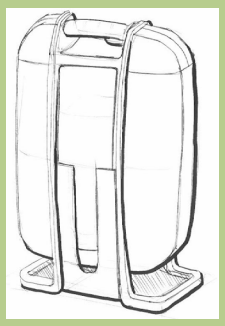


Illu. 3-27, Gun style sketches

Seeing as this drawing is two dimensional, it is decided to 3d model it when the water tank has been finished. This 3d model should give a better feeling of the overall appearance to decide if it is too futuristic in its looks and should be toned down or it is alright in relation to the water tank. However before proceeding to this, it is necessary to finish the water tank design and get feedback on both gun- and water tank design.

3.13 STYLE

As with the gun design the objective is to get feedback upon the styles created from the style boards and bike analysis. This process is initiated with feedback to the concepts shown in section 3.10. The feedback leads to new iterations to each concept. When the development is found to be adequate, the styles are rendered and shown to users in a new feedback loop.

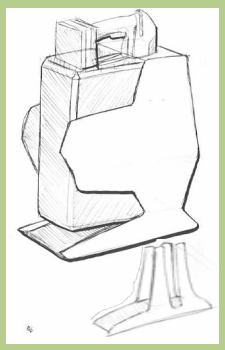


Based on the feedback to 2 in section 3.10, this concept brings the lightness of the foot together with a rail that better incorporated the bike stand, creating a floating experience.

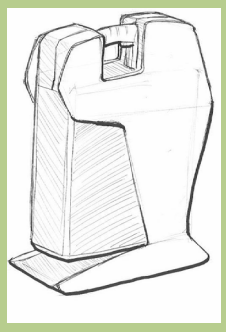
This concept works with a large transparent side slightly showing the internals and water level. The bike stand is on the outside and a part of the visual appearance. The flowing stand creates the floating look and other than the handle the gun is covered by the opening mechanism which makes it more appealing to use the gun handle to lift everything.

Based on concept 8 in section 3.10, this concept tries to fix the issues with the opening experience not being possible. It includes a two part folding top, but it is apparent that the lack of the angled top makes it seem much larger and way less dynamic. Also the two part folding is deemed too complex for the value gained.

Another iteration on concept 8 includes a slimmer top and simpler two part opening. This is more viable, but the concept becomes out of balance so the indentations are changed. It loses a lot of dynamism and becomes very tall in its looks.



This concept draws inspiration from the modern sleek and sporty outdoors, with a floating looking water tank. It is deemed as quite nice, but it resembles a bear hugging something too much. Additionally, the top does not accommodate the opening experience because it is so open to begin with.



This concept tries to solve both these issues by making less of a hugging arm and giving it some more height to cover the opening top. While it has some qualities, the concept is discarded as it does not seem rugged and sporty enough, seeming more like a sculpture.

To create more dynamism the "window" is given an angle to match the bike stand. This gives some space to place the second refill option, which is a nice touch.

It is also decided to make a more protected version based on shells and a more symmetrical design. The shells seem rugged and protective while also hiding some of the seam lines between the lid and the box. The bike stand is likewise better integrated in the design due to the way it completed the shape with the shells.

Both of these concepts are 3D modeled and printed to show to users for feedback.

Illu. 3-28, Water tank style sketches

These are the 3D models of the water tank that are shown to users for feedback. For easy reference the concepts are referenced as Across and Turtle

Across

Turtle

Illu. 3-29, Water tank style 3D mockups

Wishes
- Electronic nozzle switch

Feedback

The obvious next step is getting feedback on the styling of the gun and water tank in regards to how well it fits into the context of mountain biking. In doing this an interview with a potential user is conducted. The interview is also questioning the implemented features and the bike stand. This should lead to the final decision regarding features so detailing and placement of components can be finalized. The questions used in the interview can be seen in appendix 12.

Initially the interviewee prefers the more dynamic design of Across as it appears 'active' and 'capable' whereas Turtle looks like a backpack or something to roll a hose around. This however changes when the renderings with context are shown. Here the Turtle seems to fit better into the context by being more rugged and sturdy. This is because of the symmetrical design and the lines aligning better, which also makes it look bigger than it is. Working with symmetrical design is to be investigated further in the next sketching round.

For the gun design there seems to be more of an interest in the simpler design of 'basic' than the dramatic lines of 'DMG'. "It appears too much like a gun and it is too futuristic - the other one fits the water tank much better" - Jens [Worksheet 45]

There is also an interest in knowing how the solution would be stored in the car. Here the interviewee says that having a lashing point would allow for storing it safely in the back of the car while driving. Alternatively it can be laid on its back as long as it lays flat and can have the handle towards the tailgate.

As it was previously made a wish to incorporate an electronic nozzle switch, it is asked whether this feature is a necessity or a gimmick. He states that it could be very cool to have and he would use it much more often than a manual solution, which he may not even use. He might press the button once in a while, just because it is a nice experience to have. He thinks that it is a nice feature that fits a product like this well.

In regards to the bike stand, it was decided in the bike stand research that it was preferable to use a bike stand that goes around the wheel. The interviewee has experience with these types of bike stands and encourages to find another solution or be absolutely sure the stability is ok. This leads to a test that should conclude this which is essential to do before developing further on the styling.

3.14 TESTING THE BIKE STAND

First test

After the interview it has become apparent that there might be severe issues with the current solution for the bike stand and its flexibility and stability or lack thereof. To test this a mock up is made of wood and tested on two bikes, a slim tire (XC-style comparable) and a regular mountain bike tire.
The bike is supposed to be rolled easily into the tire slot. The model shows that even with the narrow tire it is not as easy as expected. It is difficult to align correctly and the stand is too small. The bike can be held up by the bike stand as long as the spokes hit the bike stand. However, if the spokes do not have contact with the bike stand, the bicycle is going to fall while creating a twisting force for the tires as seen on illu 3-30.

Illu. 3-30, First bike stand test

The bike stand was also tested on a normal mountain bike, since the wide tyres might improve the friction between the bike and the stand and therefore the stability. Here the same problem was observed. If the spokes don't touch the stand, it will simply fall over. Here it is even more difficult to align the tyre and hit the bike stand correctly without moving the stand.

For this bike stand to work a beam between the two sides should be created which could stabilize the bike by touching the spokes. However if we were to avoid leaning on the spokes, which some of our users would require, this solution would not work.

Illu. 3-31, First bike stand test

3.15 RETHINKING THE BIKE STAND

As it is clearly evidenced by the test, another solution is needed. This could be some of the solutions evaluated in the bike stand section in 3.8 that does not use the spokes for creating stability.
Two possible solutions are found. One lifts the wheel axle and the other lifts on the frame. First the frame lifting is tested with a new model.

Illu. 3-32, Alternative bike stands

Second test

#1

The first test is just a rod going through between the spokes and supporting the frame of the bike. The bike is sliding off and it is believed that adding grip to the rods is not enough to give a good, solid experience. Furthermore the experience of getting the rod between the spokes is not nice enough for a product like this.

Illu. 3-33, Second bike stand test

#2

To give a more secure experience a couple of blocks are added to avoid transverse movement. This gives a better feeling of control as the bike is put in place even without the grippy surface.
There is a potential to do it with both one rod going all the way through supporting both sides or two shorter rods supporting the frame on only one side. Ideally it is easier to have one side only as it will fit more bikes and there is no chance of hitting the spokes like with a lock.
The bike stands secure and is quite easy to mount and the principles are taken to a new design.

Illu. 3-34, Second bike stand test

Mockup and test version 3

Illu. 3-35, Mockup and bike stand

With a new working principle for the bike stand the next step is to try to integrate it into the design of the water tank - whether it is internally or externally.
Even though these could support the bike perfectly fine, some issues arise when the solution is evaluated up against the water tank design. First is in the case of the rods going through and supporting the bike on both sides, it has to be rather long rods, which will clash with the placement of the gun and spool inside the box. In the other case, with two support points on the same side with the blocks, as this has to reach the seat stay in addition to the chainstay, it will become too tall to fit into the box design. Extending the box further in height will impact the carrying negatively along with the water tanks stability and as such is not a possibility.

The fork

Therefore the other possible solution from the bike stand research is mocked up and tested. This time having a fork-like sheet grabbing onto the wheel hub to support the bike while it stands. For space saving reasons there won't be room for a large angle inwards as the original stand has. To work around this it is necessary to see how stable the bike is, if the bike stands totally upright and if it is angled slightly.

First is putting the bike upright like with the normal bike stands of this type. This was very stable in one direction due to the long "foot", however it was a little risky when the bike got a push towards the support, as it didn't take too much force to tip it over.

Illu. 3-36, Third bike stand

As a result, it was likewise tested with the bike angled, to see if this would work. And this was a vast improvement, as it was no longer as easy to topple over.The drawback is that this could make the bike slightly harder to clean properly on the other side, but it is the compromise to go with for now, in an effort to implement the bike stand as seamlessly as possible into the box.

Illu. 3-37, Third bike stand test

In summary the first test shows that the intended bike stand does not function properly resulting in a return back into the design process of the bike stand. It became important to develop a new direction for the bike stand while simultaneously working with the aesthetics of the water tank to keep them aligned.

To do so, tests were made to determine a viable working principle for the new bike stand. The new bike stand principle is decided on being the easiest bike stand to use for the user and the easiest to incorporate into the overall design. The next step is to once again incorporate this new bike stand into the design of the water tank and match the appearance.

Demands

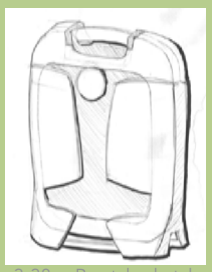
- Wheel hub supporting bike stand
- ~~Around wheel stand~~

3.16 RE-STYLING

Based on the feedback from interviews regarding the overall style and the necessary changes to the bike stand a new sketch round is initiated. The goal is to create a new design that accommodates the new bike stand that is placed underneath and on one side rather than a bike stand that goes underneath and on two sides. Based on previous information a symmetrical design is desired. The new designs will try to challenge this insight since the new bike stand is not double symmetrical and will therefore be more difficult to implement in a symmetrical design than the last one. This round is split into two, where one focuses on developing new styles with Across as the initiating style. The other part takes inspiration from the Turtle design. The styles are evaluated internally.

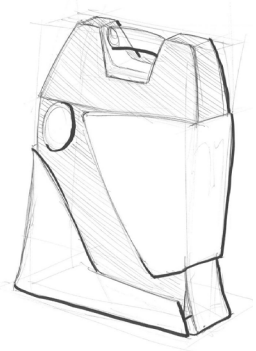
The water tank

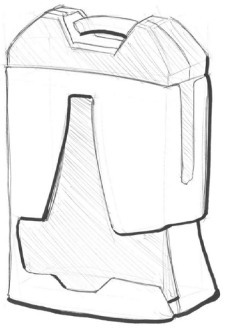
This design was the first initial replacement for the old design; it reuses some of the same lines for the shell construction and the tank itself. Its slim look poses a problem in implementing a bike stand in the proper size though. The light (floating) appearance of the feet also falls short when the bike stand is placed in the construction. The "seamless" implementation of the bike stand is however something that is usable for other designs. Additionally, there is no clear handle at the bottom of the construction for when the tank is to be held with both hands.



Illu. 3-38, Re-style sketch

The following designs are variants of this concept in an asymmetrical variation.





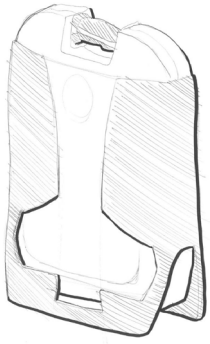
Illu. 3-39, Asymmetrical sketches

The asymmetrical lines don't work that well. The top looks too tall and narrow and the bottom looks wide and heavy. It does not project liftability.

The lines of the shell make it look very top heavy. It tries to be symmetrical in its centered lines and the correspondence between them, but is then asymmetrical on one side which makes it look wrong.The flat line against the lid makes a too clear distinction between the top and bottom to make it look like the parts fit together.

Here the asymmetrical cut makes it heavier to one side. This makes it appear inharmonious. Compared to a bike, where the visual center of gravity is (likely) somewhat in the middle both horizontally and vertically. Additionally the wide bottom makes it look bottom-heavy and not very liftable.

Seeing as the asymmetrical design does not work well with the 'turtle' design language, it is decided to try making a symmetrical design.



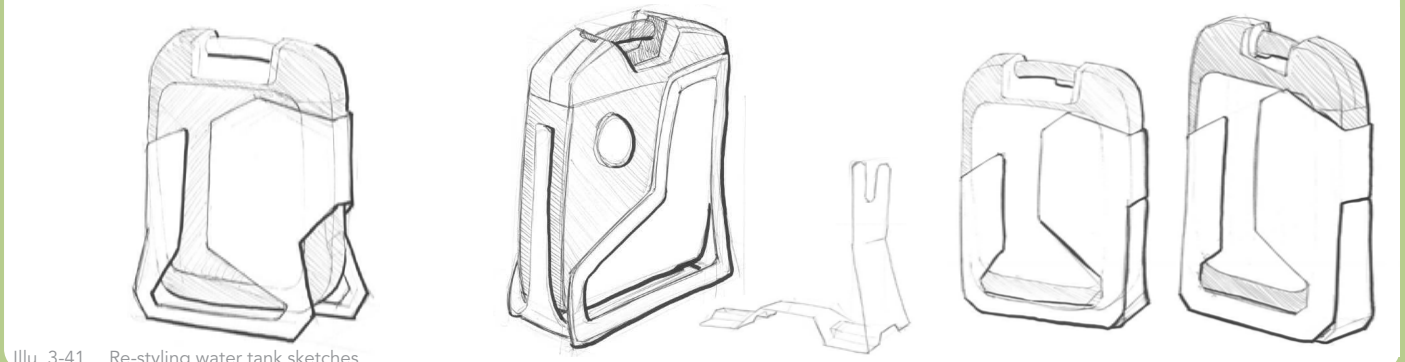
Illu. 3-40, Symmetrical sketches

The first variant misses the light look and ends up with a unharmonic stand to shell connection.

Resembles a water bottle holder on a mountain bike and looks nice, but it is not rugged enough and may work better as a design for a road bike. The symmetrical design makes it look bigger than it is.

The shells are quite heavy but also have a nice cohesion in the lines both horizontally and vertically. The centered refill lid works well and is 'in focus'.

It is also tried to work on the 'Across' design language with the implementation of the new bike stand.



Illu. 3-41, Re-styling water tank sketches

The first idea works with the floatiness of earlier concepts and a more angular design. Despite the asymmetrical design, the concept appears to be in weight balance horizontally and have a low center of gravity visually. It looks sturdy while still being liftable. This is to be worked upon as the specific concept does not incorporate the bike stand at this point.

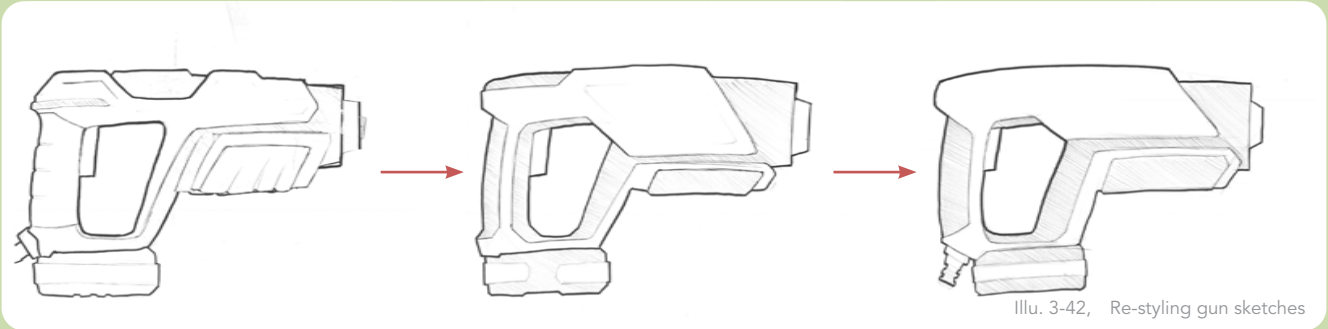
The last one presents a distinct bike stand on the side of the water tank. The angled 'frame' of the stand is inspired by a bike frame and goes across the front and creates a dedicated space for the refill lid. This concept is liked quite much, but it does not fit the context well, as it is not rugged enough.

The next two are trying to integrate the bike stand on the side by making it 'close' the shape. The right one has some longer and more relaxed lines, but it makes it look way taller, slimmer and more prone to tipping over. The life one with the shorter lines and more angles is liked. It is a mix between the 'turtle' shells and 'Across' and inspiration from bike frames. Sadly the concept is not ready for the milestone but from feedback, the design is working ok, but it is not clear why this fits the context any better than previous designs.

This leads to the next big step, which is to get a better understanding of what the mountain bike look should be. To do this two designs will be made based on new styleboards representing each direction. This is to be made in the next phase after the milestone.

The gun

The objective with this activity is to choose a variant of the gun concept. To do this three variants of the gun with different amounts of distinct details are made and discussed with three different users. Their feedback should provide an indication of how "clean" the design should be and can lead to a decision upon the design



Illu. 3-42, Re-styling gun sketches

This is the most complex gun in the right dimensions according to the weight distribution test.

Feedback
- "A lot of things are happening"
- "Doesn't really match the tank"
- The inlet for the water would not fit.
- The grip looks soft

Trying to simplify the lines a bit. The grip is simplified as well.

Feedback
- "Much more harmonious"
- There is no inlet for the water
- The user seems to like this the best, at least when it's on its own.
- They like the slight curvature of the top

And simplified further to see where it gets too boring/clean.

Feedback
- "It matches the tank the best"
- "Its maybe a bit too plain"
- "I like this grip the most"

Because the differences between the middle one and the most simple one are very slight, and as the users like aspects of both, a mixture of these is to be made in 3D for a better visual understanding. It is also used to compare the gun design to the 3D model of the 'turtle' design language.

According to internal beliefs, this design matches the water tank quite well. However, some problematic areas occur with this design.

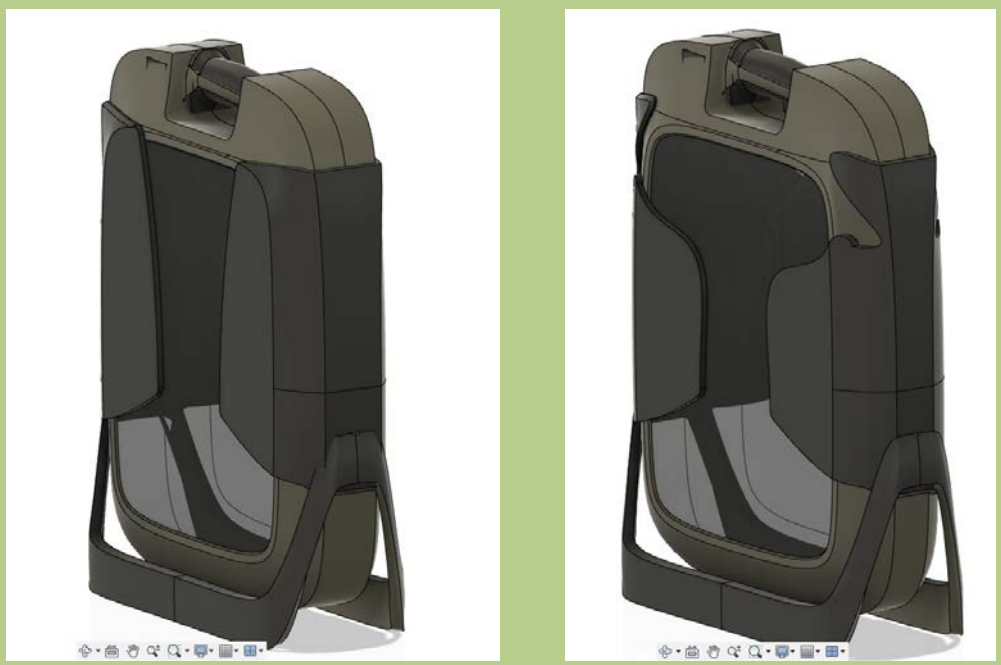
- The hole for the grip seems very large and there is not enough space for the hand when the lid is to open.
- There is still no inlet for the water anywhere on the gun.
- The lid needs to be taller for the handle to be useful
- The battery doesn't fit inside the lid.

Illu. 3-43, Battery issue

Illu. 3-44, Concept 3D mockup

To try fitting the gun within the lid, the 3D model is adjusted. Even when widening the edge to create more space, the battery is too wide to fit. Either an adjustment to the tank, battery or the gun is needed. It may be more achievable to accommodate for this by changing the water tank design, which most likely has to be adjusted anyways in order to fit the mountain bike style better.

Before creating a new design of the water tank, the next step is to decide upon the dimensions of the water tank. This decision should create design boundaries that can help in the future design of the new water tank.



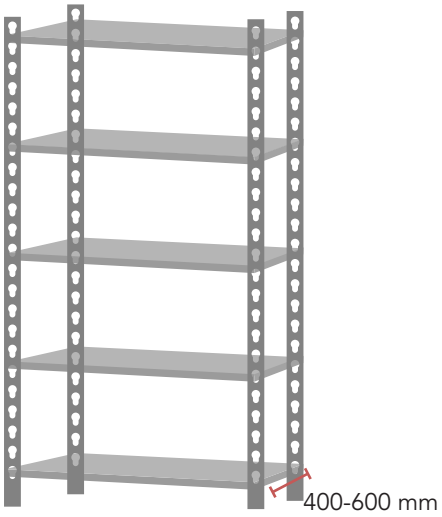
Illu. 3-45, Battery issue solution attempts

3.17 DIMENSIONING

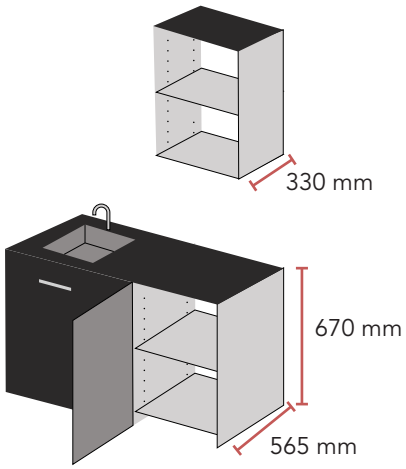
By having the insight of the importance of the "wife approval", it is investigated how big of a cleaning solution it can be to easily be stored. This would provide some overall limitations of the dimensioning of the product. The task involves looking at places to store and the size requirements that will follow this. Different places are chosen to have opportunities for users to store the product. The full sheet can be seen in appendix 13.

The most common storage spaces would be
- Under the kitchen sink
- In a cupboard in the kitchen or scullery
- On steel racks in the garage or workshop
- Or under the bed

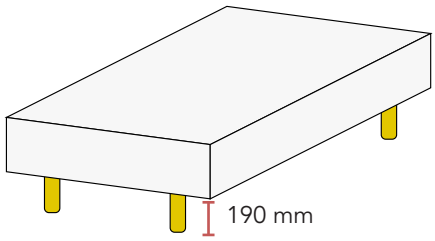
Steel racks



Cupboards



Under the bed



Illu. 3-46, Storage dimensions

If placed in other cabinets, the depth is generally around 33 cm, with some down to 26 cm.
Wardrobe cabinets are generally 56 cm in depth
Steel racks, as you would typically have in a garage or workshop, mostly have a depth of 40-60 cm.
If you wanted to store it under the bed, it would have to be a maximum of 19 cm in thickness, this is the height of IKEAs bedrollers.

Knowing the potential overall dimensions of the product it is possible to determine some of the product's parameters including the carrying height and amount of water. This is the next step in the process, before the design can be finalised inside and outside. Having these dimensions allows for the storage and transport of the product in the car.

Demands
- Storage in cupboard, under sink or under bed
  - Max allowable dimensions: 565, 670, 190 mm (w,h,d)

Wishes
- ~~Easy to store~~

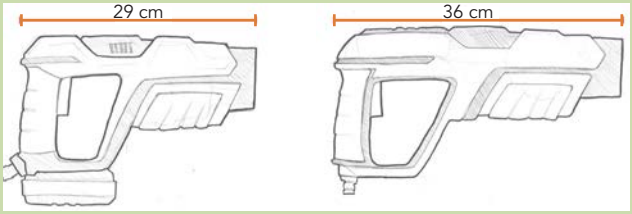
3.18 PARAMETERS

This section is supposed to show all parameters for this product so far. Some parameters are decided earlier, whereas parameters not decided at this point are to be decided.

- Weight / Amount of water
- Water pressure (bar)
- Lance length
- Carrying height
- Center of mass with and without water
- Spray angle
- Battery life time (for charging)
- Hose length

Lance length

The lance length has been narrowed down to a short range of 290-360 mm in total length of the gun. The length is partly dictated by the placement of the inner components, and the weight balance if this has been tested in the section 'weight balance test' in phase 3. However, the final decision is dependent on feedback from users who, when trying to hold the gun, preferred to be able to hold the gun with a single hand in order to get into the nooks and crannies, while holding it with two hands was preferred when roughly spraying the soap off.



Illu. 3-47, Lance length

Water pressure (bar)

It was decided in the section 'testing pressure washers' in phase 2, that the pressure of 20-30 bar they deliver is enough to do the job, and this is the range that is targeted. This has the added benefit that the same components can be used to potentially save cost. The hardness of the spray is regulated with the different nozzles rather than modifying the pressure.

Battery life time (charging)

From testing of the existing pressure washers it was found that 15 minutes of spraying time is enough to clean at least 3 mountain bikes. A similar battery life is chosen, to find a sweet spot between the size and weight of the battery and how often the user has to charge it.

Illu. 3-48, Battery

Spray angle

The spray angle should be 15 and 25 degrees, as this is what the tests and user feedback indicated to be the preferred for bike cleaning in the 'pressure washer testing' section.
An upwards spraying nozzle is added for the cleaning of chain, cassette, crankset and underside of frame.

Illu. 3-49, 6-in-1 nozzle

Carrying height

The test is performed to understand which height would be the ideal for the handle for lifting the heavy water tank. It's performed with a rough build to hold weight, with adjustable handle height in 50 mm intervals.
People of different heights are to pick it up from the ground, to gain feedback on what is the most optimal height for the handle. The test setup uses a rough model that can fit paper stacks as the weight to achieve the max allowable weight of 15 kg. The ends are extended with holes in 50 mm intervals for the handle to be screwed into.
With the handle at a height of ≈670 mm, it was possible to lift it from the ground. But depending on the height of the person lifting it, it will be so close to the ground that you want to lift it up further. This results in a lot of stress in the arm and shoulder, making it uncomfortable to lift.
On the positive side, the height was good for picking it up, as bending it kept to a minimum.

Thus it was concluded that 670 mm is definitely too high for the handle, but it also must not be too low, to avoid bending.

Illu. 3-50, Handle height test

The handle was lowered 100 mm, to ≈570 mm.
This saw a vast improvement in the feeling of lifting it. The ground clearance is way better, making everyone able to hold it with the arm straight down the side, without pulling up on it.

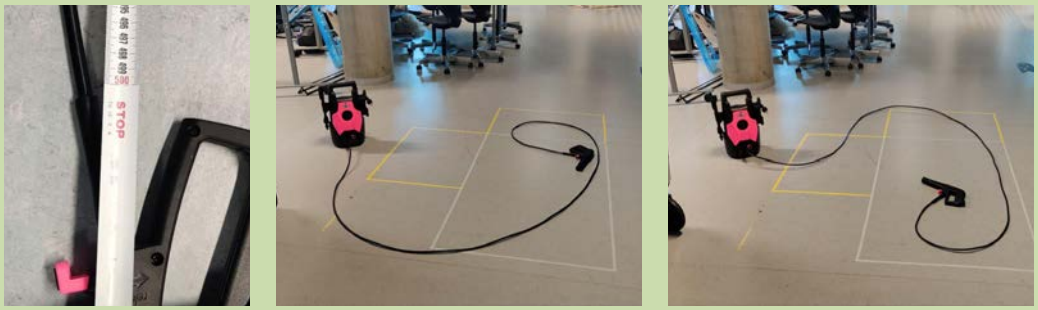
The pick-up height is still fine, it can be picked up without much bending and discomfort. With this result a new handle height has been decided upon.To have a range to work within, the Muc-Off is used as guidance. The Muc-Off handle is placed in 460 mm height, which is slightly too low, which leads to a minimum carrying height of 500 mm.

Illu. 3-51, Handle height test

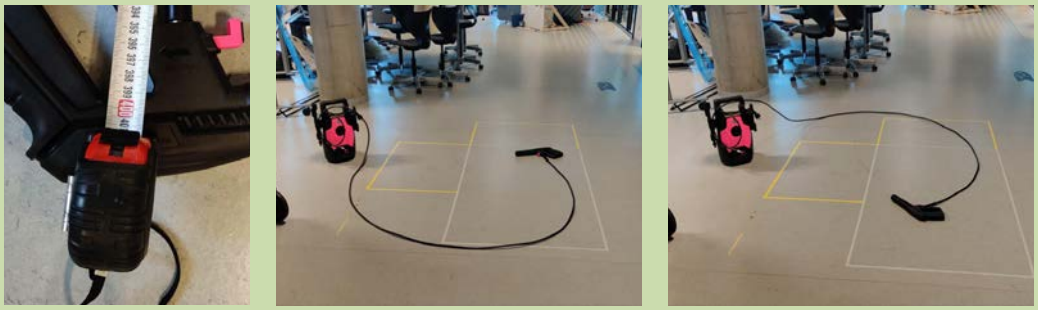
Hose length

Modern mountain bikes can be upwards of 1220+ mm in wheelbase, and with 29" wheels, this can bring the total length up to nearly 2000 mm. (Corfield, 2017)
The hose length is tested in a simple test setup, with a 2 m indication on the floor, and the hose from the Muc-off washer. The Muc-Off is placed on one side of the "bike" and the hose is dragged to the other side as a simulation, to see how far it can reach.

First test is with a 5 m hose. And here it can reach well around the 2 m bike, so a shorter hose is tested.



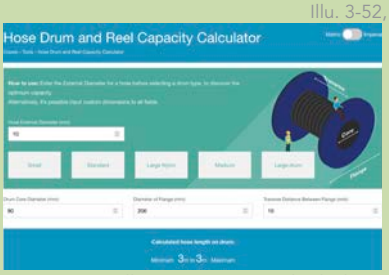
The second test is with a 4 m hose. And while it can reach somewhat, it is slightly too short to reach comfortably and not having to fight the hose and bike.



Illu. 3-52, Hose length study

The length, based on this, should be 5 meters, as this allows the user to easily reach most of the way around, without quarreling with the bike. But during the test the use of the product is discussed. Here it becomes clear that it is wrong to have the water tank placed on the other side of the bike and spray towards the water tank, meaning that it makes more sense to move the water tank when cleaning the other side of the bike. This reduces the necessary length of the hose to 3 meters.

The sizing of the hose reel is calculated with a calculator in Copely's website. (Copely, n.d.)



Illu. 3-53, Hose reel calculator

This section has had the focus of showing some essential parameters that have been decided earlier and some which are decided in the section itself. The parameters are necessary for the detailing phase to place components, interaction points and find sourced components when necessary/ possible.

Demands
- 290-360 mm lance length
- Carrying height: 500-580 mm
- 15 & 25 degree nozzle angle and upwards
- Battery life 15 minutes
- 3 metre hose

Wishes
- ~~Appropriate lance length*~~
- ~~Appropriate hose length*~~
- ~~Appropriate lifting height*~~

3.19 DESIGN BRIEF

PROBLEM STATEMENT

To create a new industrial design product which aids the cleaning process of mountain bikes and speaking to the emotions of the user

VALUE MISSION

Making mountain bike cleaning a desirable experience

VISION

An experience for both user and surroundings
A dedicated mountain bike tool

GENERAL REQUIREMENTS

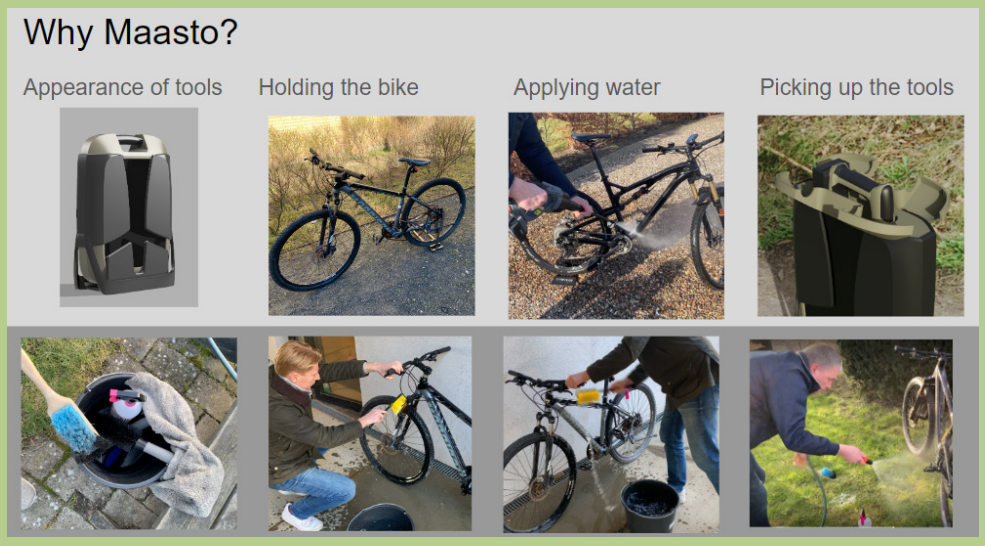
		Section
01	Must be safe to use on a mountain bike	1.4
02	Battery and water included	1.4
03	Transportable in car	1.4
04	Can be used with existing cleaning products	1.4
05	<15 minutes cleaning	1.4
06	The product should be able to be placed away from the bike when cleaning	2.1
07	20-30 bar water pressure	2.5
08	No louder than existing solutions*	2.5
09	No interaction under 300 mm	2.5
10	Removable battery	2.7
11	Efficiency of cleaning must be equal to or better than current solutions	2.7
12	Bike stand	2.9
13	Out of car use	2.10
14	Battery and pump in handle	2.10
15	Must work with garden hose	2.10
16	Foam dispenser included	2.10
17	Must contain the essentials for cleaning *Detergent, Brush, Water, Cloth*	2.10
18	Nozzle switch	2.13
19	Remaining water indication	2.13
20	6-7 liters of water	3.2
21	Max 15 kg	3.2
22	Upright or laid placement possibilities in car	3.5
23	Automatic hose reel	3.10
24	Two hand gun	3.11
25	Wheel hub supporting bike stand	3.15
26	Storage in cupboard, under sink or under bed *Max: 565, 670, 190 mm (w,h,d)*	3.17
27	290-360 mm lance length	3.18
28	Carrying height 500-580 mm	3.18
29	15 & 25 degree nozzle angle and upwards	3.18
30	Battery life 15 min	3.18
31	3 metre hose	3.18

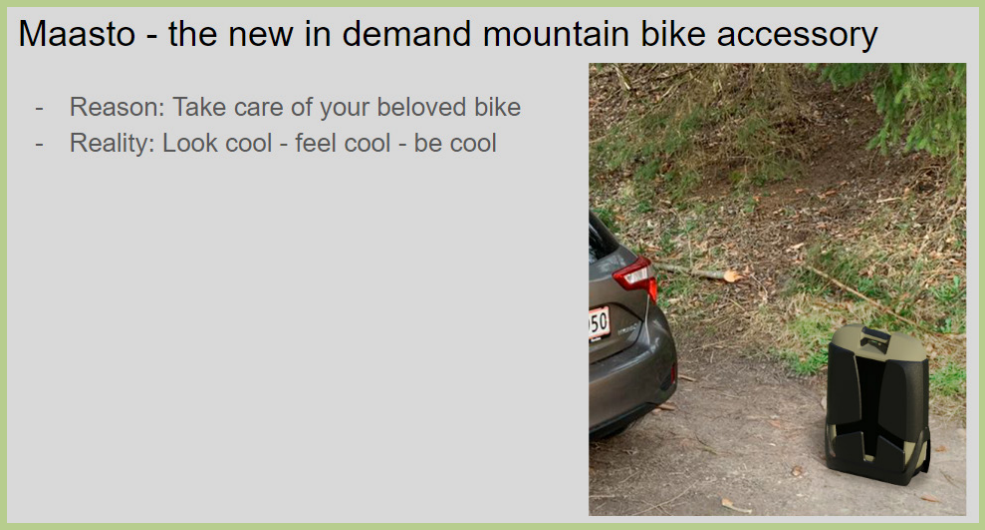
WISHES

		Section
01	Tap refill	1.2
02	Wife approvable	1.2
03	Space optimised features	1.2
04	Transportable / mobile	1.4
05	Easy to use	1.4
06	Easy / fast to prepare	1.4
07	Minimise body strain	1.4
08		
09	A user experience relating to the mtb lifestyle	2.2
10	Give a feeling of performance increase and professionalism	2.2
11	Rollable hose	2.5
12	Visually relating to a mountain bike context	2.7
13	Wow effect to user and surroundings	2.10
14	Remove damaging dirt and grime from frame and mechanical parts	3.1
15	Weight close to the body when lifting	3.2
16	Target 12 kg	3.2
17	Steady On different terrains	3.6
18	Avoid becoming excessively dirty	3.6
19	Presenting the gun and tools	3.7
20	Weight of the gun close to hand	3.11
21	Electronic nozzle switch	3.13

Presented at milestone

For this milestone it was decided to do something different and try more of a sales pitch than before. The illustrations shown here are from the presentation and was supplemented by a video of the opening experience.





The presentation also included how the product was intended to develop at this point, because the project had run into issues shortly before the milestone.

Illu. 3-54, Milestone 4 concept

04DETAILING

The third phase has a lot of development time spent in the experience of the product. This is both the opening experience, as well as going through a user scenario and zooming on each interaction and identifying how the specific interaction should look, feel and sound. Furthermore the phase has had focus on the styling and detailing of the most essential features of the product. From the milestone it is clear that the presented concepts are still not sharp on why they fit mountain bikes specifically from a design perspective. As stated earlier, there is a big wish for them to feel like professionals and it should be clear why these user values are integrated in the product and how it differentiates from a cleaning solution for road bikes. There is also feedback upon the opening and how it may collect dirt over time. This could potentially harm the longevity of the product which is not ideal. This leads to a new demand. The first step is to look into professional bike cleaning and thereafter create a new style that has a better fit to mountain biking before technical- and business aspects can be looked into.

Demands

- Should be cleanable inside and out with its own spray

4.1 PROFESSIONAL BIKE CLEANING

Based on feedback from the milestone it is not clear what 'professional feeling' is in the mountain biking world. For this reason it is looked into what professional mountain bike teams do, when they clean their bikes.

A lot of the mountain bike cleaning in professional scenarios happens with high pressure jets and bike stands that lift the bike like in illu 4-1. The lifting is mainly because the bike is maintained in the same sequence as the cleaning - after each race. This maintenance includes greasing or changing worn parts on a regular basis. Furthermore the cleaning is often done by a mechanic and not the mountain biker after each run. Because parts are changed so regularly compared to hobbyist mountain biking, any damage from high pressure washing is less likely to show. As this process is time consuming and regular, it makes sense to take the time and mount the bike up in the air in a very expensive stand, but for hobbyists who have 15 minutes, it makes no sense to do. The cost in time is not worth it compared to the benefit in feeling professional. The professionalism in this product lies in doing the same cleaning of the bike as the pros and like the pros doing it right after a run. For many hobbyists the cleaning process is a hassle to quickly get over, whereas maintaining is part of the biking experience and 'bonding' with the bike.

Illu. 4-1, Professional bike cleaning

So to sum up it is not optimal to copy the professionals' cleaning scenario 1:1 to make the hobbyists feel professional. The professionalism lies in cleaning right after riding the bike with the proper tools at hand for the process like the pros.

4.2 ROAD BIKE VS MOUNTAIN BIKE

Illu. 4-2, Road bike

Illu. 4-3, Mountain bike

From the milestone feedback it was mentioned that the design did not have a clear identity as to why it fits a mountain bike rather than e.g. a road bike. As these images illustrate, there are clear differences in what defines performance in the different ends of the bike world. On the one hand, road biking is all about going in a mostly straight line on a paved road as fast as possible. This is evident in both the bike, the gear and the rider. The bike is built to limit the aerodynamic drag, and as such will have a slender frame with a narrow handle and narrow wheels that can efficiently transfer the force from the pedals to the road. The frame is also very stiff with no suspension to maximise the efficiency of the power output going to the road. Likewise, the clothing is tight and the helmet is minimal and aerodynamic. And lastly the rider's position on the bike is trying to be as small and aerodynamic as possible, so he leans forward on the handle and has a very narrow grip.

On the other hand mountain biking is more about traversing challenging environments or tracks on uneven surfaces. While there is a speed aspect, it is more about the technical skill and ability, and through that complete the track faster. For that reason the mountain bike doesn't need to be aerodynamic, but instead it has suspensions to help dampen the uneven surfaces and jumps, and large wide wheels that can get a good grip in the underground. Like road bikes, the individual parts of the mountain bike also benefit from being stiff, however in this case it is to make the steering more precise to the input. The steering is also why the handle is so wide, as the wide stance makes the steering input easier and more precise, and also helps with the balance. The rider will move more around on the mountain bike and stand or sit, forward or backward, depending on the situation which is part of the skill involved. Because of this the clothing is also more practical than it is aerodynamic.

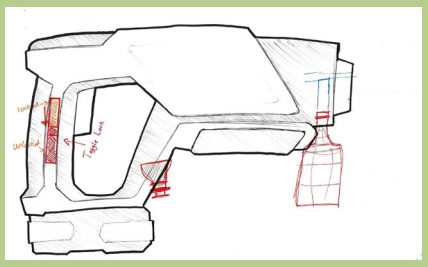
A product designed for road biking is going to focus on looking aerodynamic and light whereas a mountain biking sketching focuses on being balanced when standing, looking durable and having excess muscle to defeat any challenge.

When comparing this knowledge to the presented concept from the last presentation, it can be seen why there is confusion as to why it fits a mountain biking context. The large unbroken surfaces of the shells are giving it an aerodynamic look more so that it is durable and muscular as intended. With this in mind a new styleboard is to be made that defines the new style which should be more clearly designed for mountain biking purposes.

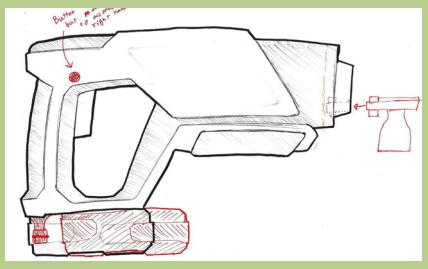
Illu. 4-4, Previous sketch

4.3 GUN DETAILING

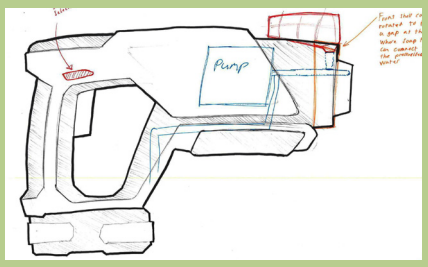
After gaining knowledge about the last of 'the unknowns' from milestone feedback in defining how the professional aspect is given to the user by this product and how the solution differs from e.g. a solution for road bikes, the next step before finalizing the style is to determine the placement of components and features in the gun. The features in contention are the water connection, locking of the trigger for lifting and the connection of the foam sprayer.
As it has previously been decided that the water connection should use a standard hose connection, it is only the placement of this that is up for question. This is drawn on top of a sketch of the gun, keeping the overall dimensions the same.



Water:
The first water connection is placed in the sloped part in front of the trigger and the battery. This makes it stick less out, and it can make the hose fit better in the water tank.
Trigger lock:
The first trigger lock is a sliding lock on the handle that functions like a toggle. The idea of it is to visually reassure the user that the trigger is locked safely and the lock supports the trigger so it is not susceptible to breaking.
Soap:
The soap here is a bottle like the current solutions that can be connected from the bottom near the nozzle. It draws on the pressurized water like the current solutions, but requires no nozzle extension.



Water:
The second water connection option is having the connection behind the battery in extension of the handle. This requires the battery to be moved forward slightly, and extend beyond the structure.
Trigger lock:
This second trigger lock is similar to the current solutions, with a push button that resets itself when the trigger is released. It is however changed to work for both right and left handed people by extending through and being able to be pushed from both sides.
Soap:
This soap attachment is like the current solutions with a nozzle extension that is put in and rotated to fasten. This is simple as it is done already with the current solutions, however it will require the nozzle switch part to be deep enough to accommodate the insertion.

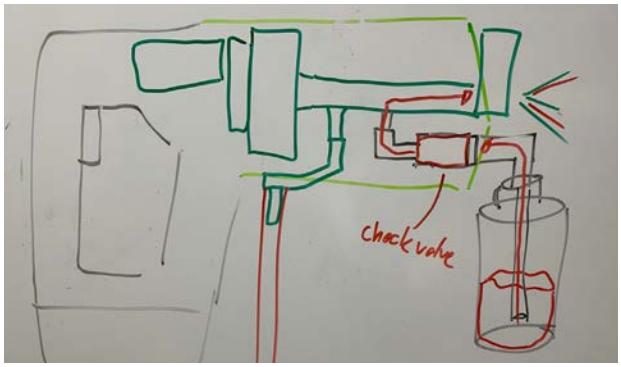


Trigger lock:
The third trigger lock option takes inspiration from the forward and reverse selection on drills. It has toggle positions, between locked and unlocked.
Soap:
The third soap option is a small attachment to the top of the gun near the nozzle. This attaches with a check valve and the soap can drip slowly into the water jet before exit.

Illu. 4-5, Gun detailing sketches

Using a check valve for the soap input would allow use of the same principle as an existing soap cannon. Here the water flows out the nozzle creating a suction in the T-piece, sucking up the soap. If a check valve is added no air would be sucked up and only when a soap bottle is attached it would be able to suck.

The chosen solutions are the water inlet placement from the first suggestion, as it fits the best into the water tank. The soap dispenser from the second suggestion as it is the closest to the feeling of loading a magazine, that is decided upon in section 3.5 and the trigger lock from the third suggestion as it can be operated by both right and left handed users. With these decisions it is possible to place the components within the gun and find working principles for the soap dispenser, as it has been shown in illu 4-6. The next step is making the new style board, which should lead to a new and more mountain bike related design.



Illu. 4-6, Soap nozzle sketch

4.4 MOUNTAIN BIKE STYLING

As stated the objective is to find a style that resembles the mountain bike world more than the previous concepts. This will be done by creating a style board for both the tank and the gun with designs that roughly have the same shapes. The focus of the design is to look into the values that differentiated mountain biking from road biking and use these parameters to design. This new style should work towards being more durable and more 'in balance' on the terrain. Afterwards, a design will be made based on these styles.

With the creation of the new and more sporty rugged style boards, it is possible to find inspiration and create a new style for the product. The new style intends to be the finalised style and should target being more fitting into the context of mountain biking than previous concepts.

MTB Universe Water Tank

MTB Universe Gun

Illu. 4-7, Re-design style boards

Water tank redesign

With inspiration from the styleboard these initial sketches are made. They focus on having a transparent core, well protected by the outer frame. The lid is larger and looks less fragile. Generally the box looks more like it contains something important and powerful than previously.

The concept works with large surfaces being protective, having outer assembly points and ridges to show its strength. On top is an aluminium inlay to express more strength and high-end feeling towards the user. The concept seems more fitting into the context and has opportunities to show off components to the surroundings to complement the opening experience in presenting the gun. The next step is to make a quick 3D model and get feedback upon it.

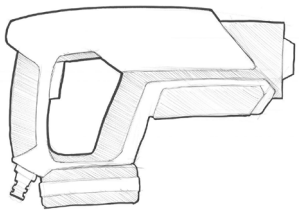
Illu. 4-8, Re-design sketches

The 3D model is shown to 3 potential users and gets feedback stating that it looks more rugged and seems to fit better into the context. Furthermore it looks cool and different to any other cleaning solution they have ever seen. It seems much more durable and steady in its appearance. With this concept approved by potential users, it is necessary to design a new gun which fits to this water tank.

Illu. 4-9, Re-design 3D mockup

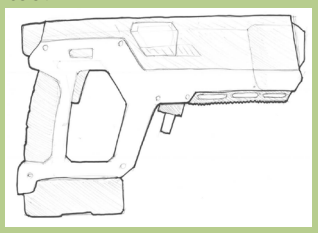
Gun redesign

The old gun is based on reusing the principles of having outer shells like the old water tank style. This is not usable for the new water tank, which leads to a new design. Many different iterations are made before the final design is reached.

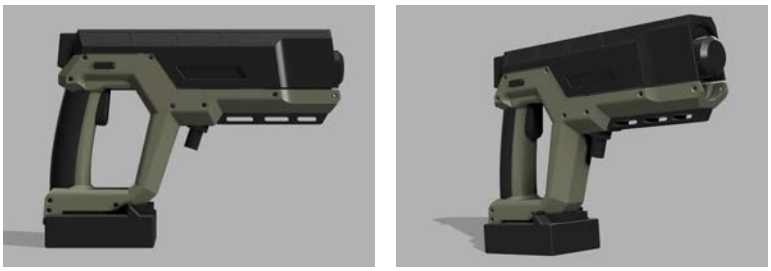


Illu. 4-10, Previous sketch of gun

The new gun takes inspiration from the more straight lines of the water tank and using a larger outer surface. The gun is split in parts, where the lower one has outer assembly points and reuses the half-hexagonal shape of the water tank. On top is an aluminium surface like on the water tank with a similar pattern. The concept is 3D modelled, see illu 4-12, to get a feeling of the three-dimensional expression and 3D printed.



Illu. 4-11, New sketch of gun



Illu. 4-12, Gun 3D mockup

The 3D print shows that some minor changes have to be made for usability. The trigger lock must be moved for easier access and the gun has to be scaled down slightly, as it is a bit too large. It also shows that a new pattern on top is needed, as it does not quite fit. The handle is a bit too thick for a nice grip but the second hand support is really nice. It is also a bit nose heavy, so if possible the pump should be moved back a bit. Additionally it is noted that the gun should be slightly smaller and that the front is a bit flat surfaced which takes away some of the direction in the design.

Illu. 4-13, 3D print of new gun concept

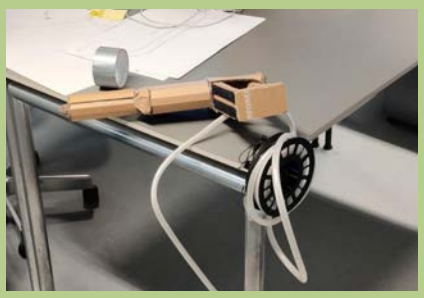
The flat surface of the gun is mocked as different versions in CAD, where some iterations can be seen here. The second iteration is the chosen direction, which leads towards the final gun design seen in illu 4-14.

Illu. 4-14, Front end re-design

4.5 TECHNICAL CONSIDERATIONS

With the style in place, the next step is to test and/or determine the features and mechanical parts in this product. The first is a test to see whether an automatic hose reel will work. The test is done by taking a cord reel from a vacuum cleaner and outfitting it with the hose instead. The reel is fastened, and the hose is pulled and retracted.
The desired result is to see whether it works, or if something needs changing.

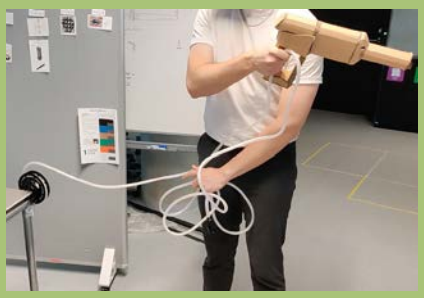
The test setup with the reel fastened to a table and the hose rolled on the reel.



The hose is pulled out rather smoothly.

The gun can be used easily when the hose is pulled out.

The retraction of the hose functions somewhat. However it seems that the spring coil is not strong enough to pull it properly.



Additionally, it is clear that the hose has to be guided properly into the reel, as to not spill over the flanges.

This test with another cord reel, shows that the hose is not good at laying multiple rows, and will stack on itself until it blocks the reel.

Illu. 4-15, Hose reel test

In short, the test indicates that a hose reel is possible, however some issues are to be resolved. First off, the retraction spring has to be stronger to pull the hose properly. While the spring in the last cord reel showed better results by retracting much smoother, it is not enough. This should be achieved by widening the spring coil. Secondly, it is evident that the hose has to be directed all the way to the reel, which can be obtained in the design. This test is made at a late stage and looking retrospectively, it could have been ideal to make it a lot earlier.

The next step is to find appropriate hinges for the opening. These should be as small as possible, while holding the necessary forces when lifting the product in the handle, supporting on the lids. Based on the worst case scenario, where the water tank weighs 15 kg, and a safety factor of at least 2, the hinges should be able to withstand 30 kg in total. This can be configured with each lid being supported by 1, 2 or 3 hinges. However 2 has the advantage of providing more stability than 1, and taking up less space than 3. The hinges are glued on both the water tank and lid as it allows for an 'invisible' mounting solution rather than having visible screws or a moulded-in hinge.

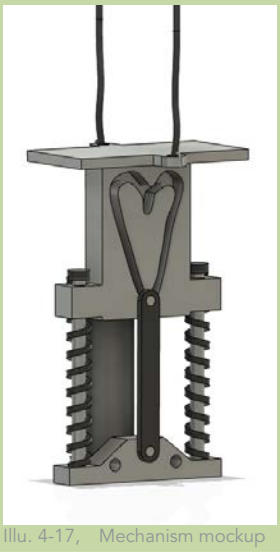
Regular hinges can be made from either metal alloy or plastic. While metal offers the benefit of more strength in a smaller size, the plastic hinges will have the benefit that they will be nearly silent, with no risk of creaking like the metal hinges. This will naturally also be applicable for the integrated hinge. (Monroe, 2022)

The initial component search revolved around regular known hinges, like the butt hinges, cup hinge and concealed hinge. The evaluation was that the curved butt hinge or the concealed hinge were the best options as they can allow the lid to open outward, while being placed on the inside, while also having great strength.
However, when making the 3D model it is found difficult to place logically considering the production of the plastic components and it does not seem transparent enough in its movement and durable enough. For this reason, a new hinge is chosen that seems more appropriate in its movement and is easier to fit while also having the added benefit of clear visual strength. (Fruugo, n.d.)

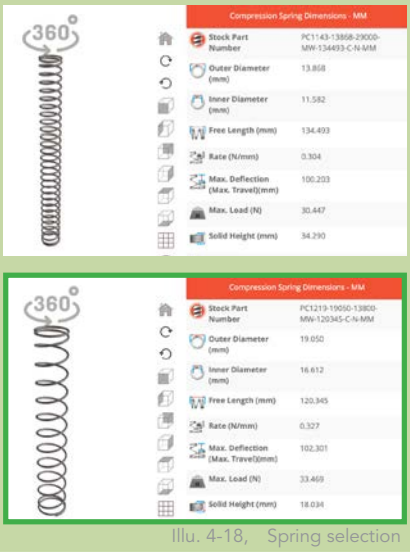
Illu. 4-16, Hinge selection

With the opening decided both in terms of mechanism and hinge, the next step is to determine the size of the spring needed to actuate the upwards movement of the gun when opening the water tank.

A suitable spring for the opening mechanism is found by searching a retailer with the demands for the spring, being able to push the roughly 1300-1400 gram, that the gun will weigh, up while also being small enough to fit nicely in the water tank. (Compression Spring, n.d.) It is decided to use two springs, as that will provide a better stability in the mechanism than just one, which halves the weight requirement for each spring. Several options are explored, but the choice falls on the marked spring on illu 4-18, because it offers a great compromise between the diameter and the solid height.



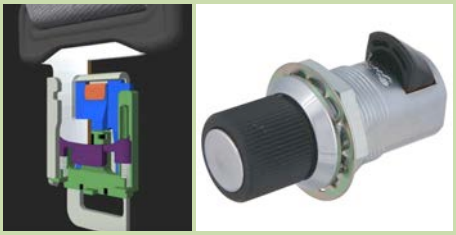
Illu. 4-17, Mechanism mockup



Illu. 4-18, Spring selection

Having prepared the opening mechanism, the next step is to determine the mechanism for the bike stand. In section 3.7 Opening Experience, the principle of a rotary latch, actuated with a lever connected to a cable, similarly to a car hood, was found. This can be used for this product to release the bike stand. Before making a final decision, it is necessary to look into if there are better solutions for releasing the bike stand.

In terms of being both secure and easy to use, the slide latch, slam and push latch or seat belt latch are the most optimal.
The slide latch has the benefit of being very simple and functions in a plane that is easy to work with.
The seatbelt is super easy to use, but it has a higher complexity.
The slam and push latch being similar to slide latch, can be better potentially if the cam can be rotated to fit the direction of entry of the bike stand.
In the end the rotary latch with a brake wire actuation is chosen because it allows the actuation to be placed in an appropriate place, while maintaining simplicity in the mechanism. This component would also be able to be pre fabricated.



Illu. 4-19, Release mechanism selection

4.6 PRODUCTION

The objective of this section is to gather knowledge about the number of mountain bikers in Europe and America. This information should be used to estimate the number of potential users of the product and thereby decide the production methods and materials. It has been looked into during the process to check if custom parts and production are viable for a product like this.

According to the international mountain bike association of canada, there are approximately 40.000.000 mountain bikers annually in north america. (IMBA Canada, 2018) The estimated numbers for Europe are similar, despite no statistics being readily available. This estimation gives a total number of 80.000.000 mountain bikers.
With so many mountain bikers worldwide possibilities for different and more expensive production methods arise. With a different user group it may have been viable to start off with a cheap production method to test the market, but the user group values professional and durable products, for which reason it is decided to do injection molding from day one, despite high initial investment cost.

The main material for this product is chosen to be PP (polypropylene) in a competition between PP, PC and HD-PE. PP is chosen because of its price, transparency, strength and molding properties compared to the others. It is necessary to add stabilizers to give it properties to withstand UV radiation and water. (Ashby and Johnson, 2014)

The load bearing lids in the top should be reinforced either in design or material properties to withstand.

The gun is also of PP and should likewise be reinforced to withstand the load when lifting. The gun two-shot injection molded with TPE as the second material for the handle to give it a softer surface, thereby improving the user's experience.

Aluminum pieces are added as details. These parts are press cut and anodized to maintain its surface appearance in the product's lifetime. As an additional bonus the anodizing makes it possible to make the aluminum parts in different colors depending on preferences.

The bike stand is made of steel - press cut and galvanized. This is a cheap and simple way of making the parts for the bike stand, but does require a lot of assembly afterwards.

With the final material choices made it is possible to calculate the total cost per unit, which is essential for the NPV in a later section. The total cost per unit can be seen in illu 4-20 and the full calculations can be found in appendix 14.

In order to calculate the cost of production for this product, a number of calculations and estimations have been made.

Firstly each custom component's weight has been extracted from the CAD software, a waste percentage is added and the price for the materials is calculated.

Injection moulding

	Quantity			Weight in grams	Waste		Total weight of plastic m
Transparent part water tank	1	PP	injection	950	5	%	997.5 g
Lid for water tank	1	PP	injection	120	5	%	126 g
Right lid	1	PP	injection	140	5	%	147 g
Left lid	1	PP	injection	140	5	%	147 g
Window end (case)	1	PP	injection	105	5	%	110.25 g
Stand end (case)	1	PP	injection	111	5	%	116.55 g
Spool side (case)	1	PP	injection	207	5	%	217.35 g
Front side (case)	1	PP	injection	180	5	%	189 g
Inner part stand (case)	1	PP	injection	95	5	%	99.75 g
Foot bottom	1	PP	injection	189	5	%	198.45 g
Foot top	1	PP	injection	144	5	%	151.2 g
Bike stand plastic part	1	PP	injection	105	5	%	110.25 g
Cap for tank	1	PP	injection	10	5	%	10.5 g
Gun bottom side right	1	PP	injection	60	5	%	63 g
Gun bottom side left	1	PP	injection	60	5	%	63 g
Gun top side right	1	PP	injection	40	5	%	42 g
Gun top side left	1	PP	injection	40	5	%	42 g
Trigger	1	PP	injection	5	5	%	5.25 g
Soap bottle	1	PP	injection	35	5	%	36.75 g
Soap bottle cap	1	PP	injection	20	5	%	21 g
Cap for tank	1	TPE	injection	5	5	%	5.25 g
Gun bottom side right	1	TPE	injection	10	5	%	10.5 g
Gun bottom side left	1	TPE	injection	10	5	%	10.5 g
			Sum of product	2781	Sum =		2920.05 g

Material cost per kg	1	€/kg	PP
Material cost per kg	1	€/kg	TPE
Material cost PP	2,894	€	Material cost per kg [€/kg] * (Weigt per part [g] / 1000) =
Material cost TPE	0,026	€	Material cost per kg [€/kg] * (Weigt per part [g] / 1000) =
Material cost per unit	**2,92**	€	Material cost upper part [€]+ Material cost lower part [€] =

Press cutting

Gun part			Parts produced per	Total weight of parts per unit:
Weight per part	62	grams		
Waste per part	30	%		
Mateial weight per part	80,6	grams	2	161,2 grams
Tank part				
Weight per part	118	grams		
Waste per part	30	%		
Mateial weight per part	153,4	grams	2	306,8 grams
			Sum alu:	**468 grams**
Bike stand				
Weight per part	1300	grams		
Waste per part	30	%		
Mateial weight per part	1690	grams	1	1690 grams
			Sum steel:	**1690 grams**

Material cost per kg	1,2	€/kg	Steel
Material cost per kg	2,4	€/kg	Alu
Material cost Gun part	0,39	€	Material cost per kg [€/kg] * (Weigt per part [g] / 1000) =
Material cost Tank part	0,74	€	Material cost per kg [€/kg] * (Weigt per part [g] / 1000) =
Material cost Bike stand	2,03	€	Material cost upper part [€]+ Material cost lower part [€] =
Material cost per unit	**3,15**	€	Material cost upper part [€]+ Material cost lower part [€] =

The chosen amount of units produced over a certain time period is defined. Here it is estimated that around 80.000 units will be produced in one year:

Units produced (1 tank + 1 gun +	80000	parts
Delivery time	1	year

Illu. 4-20, Production calculations

The chosen mean of production is defined and calculated upon. In this case injection moulding for the plastic parts and press cutting for the metal parts are chosen. The cycle time, cavities per mould, mould cost, mould cycles and machine cost is defined in order to get a mould cost per part and operating cost per part. An overhead cost per part is also added, which is estimated to be 25% of the operating cost. The mould cost is estimated using this CustomPartNet (CustomPartNet, n.d.)

Injection moulding (small parts)			
cycle time	13	Sec.	
Cycle time in hours per piece	0,0036	Hours	Cycle time [s] / 3600 =
Cycle time in all	288,8889	Hours	Cycle time in hours per piece * Parts produced =
Cavities per mould	1	cavities	
Hours worked per year	1500	Hours	200 work days * 7,5 hours =
Hours worked (hours needed)	288,89	Hours	Cycle time in all [h] / Cavities per mould =
Hours per machine in all	288,8889	Hours	
Machines and moulds needed	1,00	machines	Hours per machine in all / hours worked per year =
Machines and moulds needed	1	machines	Machines and moulds needed. Rounded up =
Mould cost	40000	€	https://www.custompartnet.com/estimate/injection-molding/
Mould cycles	200000	cycles	
Mould cost per part	**0,5**	**€**	Mould cost [€] * Machines and moulds needed / Parts produced =
Mould cost per part (life time)	0,2	€	Mould cost [€] * Machines and moulds needed / (Mould cycles * Cavities per
Machine cost	80000	€	Arburg Allrounder [SIZE UNKNOWN]
Machine and wage cost per hour	26,14	€	Hourly cost calculations
operation cost per hour	26,14	€	Machine and wage cost per hour * Machines and moulds needed =
operation cost per part	**0,094**	**€**	Hours worked per year * operation cost per hour / Parts produced =
overhead cost per part	**0,024**	**€**	operation cost per part * 0,25 =

Press cut (Gun part)			
cycle time	5	Sec.	
Cycle time in hours per piece	0,0014	Hours	Cycle time [s] / 3600 =
Cycle time in all	111,1111	Hours	Cycle time in hours per piece * Parts produced =
Cavities per mould	1	cavities	
Hours worked per year	1500	Hours	200 work days * 7,5 hours =
Hours worked (hours needed)	111,11	Hours	Cycle time in all [h] / Cavities per mould =
Hours per machine in all	111,1111	Hours	
Machines and moulds needed	1,0	machines	Hours per machine in all / hours worked per year =
Machines and moulds needed	1	machines	Machines and moulds needed. Rounded up =
Mould cost	2000	€	http://www.andeastamping.com/metalstamping
Mould cycles	500000	cycles	
Mould cost per part	**0,025**	**€**	Mould cost [€] * Machines and moulds needed / Parts produced =
Mould cost per part	0,004	€	Mould cost [€] * Machines and moulds needed / (Mould cycles *
Machine cost	30000	€	https://china-hydraulicpress.en.made-in-china.com/product/XNM
Machine and wage cost per hour	19,80	€	Hourly cost calculations
operation cost per hour	19,80	€	Machine and wage cost per hour * Machines and moulds needed
operation cost per part	**0,027**	**€**	Hours worked per year * operation cost per hour / Parts produced
overhead cost per part	**0,007**	**€**	operation cost per part * 0,25 =

In order to figure out what machine and wage cost is for each production process, an hourly cost is calculated and estimated, taking into account the main costs of running an industrial production machine. Here it is estimated that one operator will be able to run multiple machines.

Manufacturer (if revevant):	Arburg Allrounder	**Type (if relevant):**		
Space requirements m² :	28	**Power consumption :**	17	kWh
		Initial cost:	80000	€
		Depreciation period:	8	Years
Operator demand:	0,33	**Hourly wage:**	24	€
Additional equipment				
Number	**Type**	**Initial Cost €**		
1	Heat exchanger	13200	13.200,00	€
1	Granulator	17200	17.200,00	€
1	Dehydrator	4000	4.000,00	€
Total initial cost of additional equipment			**34.400,00**	€
Salvage value				
Machinery	10%		8.000,00	€
Equipment	10%		3.440,00	€
Depriciation per year			12.870,00	€
Internal interest rate	10,00%	**Internal rate of return**	6.935,50	€
Sundries				
Insurance	0,25%		86,00	€
Maintenance	5%		1.720,00	€
Oil ect.	75	€	75,00	€
Power	0,3	€ per kWh	3.825,00	€
Rent	55	€ per m²	1.540,00	€
Heating	10	€ per m²	280,00	€
Total expenditure per year			**27.331,50**	€
Utilized capacity hours	1500	**Available capacity hours**	1.500,00	Hours
Average utilization ratio per machine			100,00	%
Machine cost per hour			18,22	€
Machine cost per hour, wage included			**26,14**	€

Manufacturer (if revevant):		**Type (if relevant):**		
Space requirements m² :	40	**Power consumption :**	17	kWh
		Initial cost:	30000	€
		Depreciation period:	8	Years
Operator demand:	0,5	**Hourly wage:**	24	€
Additional equipment				
Number	**Type**	**Initial Cost €**		
			0,00	€
			0,00	€
			0,00	€
Total initial cost of additional equipment			**0,00**	€
Salvage value				
Machinery	10%		3.000,00	€
Equipment	10%		0,00	€
Depriciation per year			3.375,00	€
Internal interest rate	10,00%	**Internal rate of return**	1.818,75	€
Sundries				
Insurance	0,25%		0,00	€
Maintenance	5%		0,00	€
Oil ect.	75	€	75,00	€
Power	0,3	€ per kWh	3.825,00	€
Rent	55	€ per m²	2.200,00	€
Heating	10	€ per m²	400,00	€
Total expenditure per year			**11.693,75**	€
Utilized capacity hours	1500	**Available capacity hours**	1.500,00	Hours
Average utilization ratio per machine			100,00	%
Machine cost per hour			7,80	€
Machine cost per hour, wage included			**19,80**	€

Because there is significantly different parts that should be injection moulded, two different price points for moulds are considered to be used, with one costing 50.000 and the other 40.000 €.

Ammount of different small parts (>5g):	13	different molds needed	
Cost of a mold for small part with 4 caveties:	40000	€	
Cost for all small moulds:	520000	€	different moulds needed * cost of mould =
Ammount of different big parts (>5g):	7	different molds needed	
Cost of a mold for small part with 2 caveties:	50000	€	
Cost for all big moulds:	350000	€	different moulds needed * cost of mould =

Afterwards the amount of machines needed is calculated based on the time it requires to produce the components within the chosen time period. From this the overall machine cost is calculated.

Machines needed:			
Hours worked per small mould	288,89	hours	
hours worked for all small moulds:	3755,555556	hours	hours worked per mould * different moulds needed =
Hours worked per big mould	800,00	hours	
hours worked for all big moulds:	5600	hours	hours worked per mould * different moulds needed =
Hours worked per machine per year	1500	Hours	200 work days * 7,5 hours =
Machines needed per year:	6,237037037	machines	hours worked for all moulds /hours worked per year =
Machines needed per year:	7	machines	Machines needed. Rounded up =
Machine cost:	80000	€	Source
Total cost of machines:	**560000**	€	Machines needed * machine cost =

Ammount of press cut machines needed:			
hours worked per gun part - mould:	111,11	hours	
hours worked per tank part - mould:	200,00	hours	
hours worked per bike stand- mould:	444,44	hours	
Hours worked per machine per year	1500	Hours	200 work days * 7,5 hours =
Machines needed per year:	0,50	machin	hours worked for all moulds /hours worked per year =
Machines needed per year:	1	machin	Machines needed. Rounded up =
Machine cost:	30000	€	https://china-hydraulicpress.en.made-in-china.com/pro
Total cost of machines:	**30000**	€	Machines needed * machine cost =

Illu. 4-21, Production calculations

All the outsourced components prices are estimated/found and added to find the total cost of outsourced components per unit:

	Outsourced components:	Cost:	Link:
Gun			
	Battery	6 €	
	Pump	4 €	
	Motor	4 €	
Tank			
	Brush	0,5 €	https://www.alibaba.com/product-s
	Hose lead	0,5 €	
	Hose	0,3 €	
	Hose reel	3 €	https://www.alibaba.com/product-s
Mechanism			
	CNC milled 'heart'	1,5 €	
	Brake line	0,5 €	https://www.alibaba.com/product-s
	Springs (*2)	0,5 €	
	Rods	0,04 €	https://www.alibaba.com/product-s
	Hinge (*2)	0,4 €	https://www.aliexpress.com/item/4
	Latch	1 €	https://www.alibaba.com/product-s
	Total cost of outsourced components per unit:	**16,24 €**	**sum of all outsourced materials=**

A galvanization cost is added for the metal parts per unit:

Post processing (galvanisering osv)	2 €	

QUANTITY	LEAD TIME	ANODISING COST (PER ITEM)
1-off	6-7 Business Days	£126 + VAT
2-off	6-7 Business Days	£60 + VAT
5-off	6-7 Business Days	£24 + VAT
10-off	6-7 Business Days	£12 + VAT

The unit requires some assembly time. it is estimated that at 80.000 units/year it would take 1 hour to completely assemble one unit. This does include all the welding:

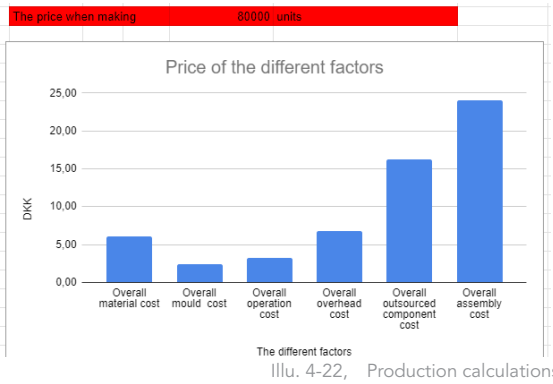
Assembly			
assemblying time per unit	3600	sec	
assemblying time per unit	1,0000	hours	
avarage wage	24	€/hours	
Assembly cost	**24,000**	€	(assemblying time per unit* parts produced)/average wage
overhead cost per unit	**6,000**	€	operation cost per part * 0,25 =

50-off	6-7 Business Days	£4 + VAT
100-off	6-7 Business Days	£2.80 + VAT
200-off	6-7 Business Days	£2.50 + VAT
500-off	7-10 Business Days	£2.20 + VAT
1,000-off	7-10 Business Days	£1.95 + VAT

All the costs can then be summed to get the final cost estimate per part:

Summed up costs	
Material cost per unit	**6,07 €**
Mould cost per unit (press cut)	**0,15 €**
Mould cost per unit (injection m	**1,13 €**
Mould cost per unit (injection m	**1,09 €**
Operation cost per unit (steel pa	**0,19 €**
Operation cost per unit (injectio	**3,06 €**
Overhead cost (steel parts)	**0,03 €**
Overhead cost (Injection mould	**0,76 €**
Overhead cost (assembly)	**6,00 €**
Outsourced component cost pe	**16,24 €**
Assembly cost per unit	**24,00 €**
Total cost per unit	**60,72 €**
	451,76 dkk

A schematic of the distribution of cost for the product is made:



Illu. 4-22, Production calculations

As it can be seen in the diagram, the assembly time is the biggest cost. This could be reduced by simplifying the welding needed or making the assembly automatic, especially at this volume of production. When producing 80.000 units a year the mould cost per unit is quite low. This would however be very different if the units produced were reduced to 20.000 where it most likely would be the biggest cost. The potential of reducing the number of outsourced components should be investigated if the production gets to the point of 80.000 units/year.

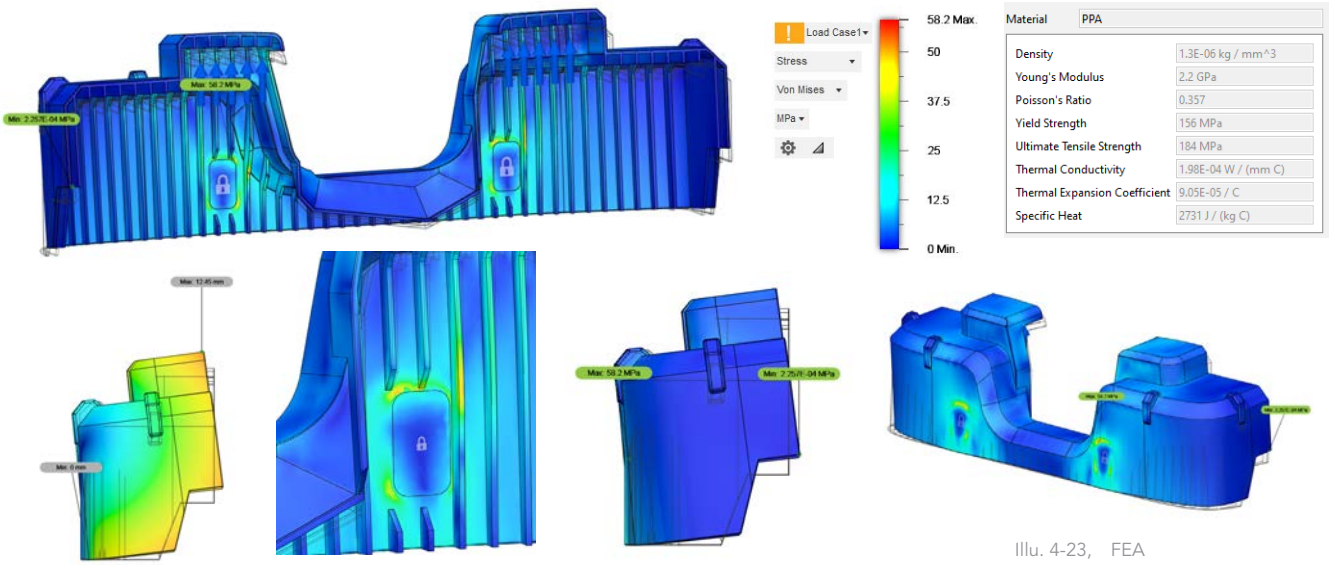
The validity of these calculations are very uncertain. Material cost and outsourced components cost are relatively certain, but the other costs are based on rough estimates. The amount of produced units is of course also very uncertain which in turn affects the whole price calculation. The next step is using FEA to check if the construction can withstand the loads of lifting the water tank fully loaded.

4.7 FEA

To figure out if the lid is able to withstand the necessary weight of the tank. The lid is chosen, since it is believed to be the critical point in the construction, since all the weight should be led through the hinges. The other parts of the construction could quite easily get additional points for assembly.

For all these FEA's it is assumed that the hinges are glued to the lid and function as fixed points. The load is set to 150 N, which is more than the tank is gonna make when completely full. Here it is worth noting that the weight of the gun does not impact the weight handled by the lid, as it is held by the hand of the user. The actual deformation of the parts are displayed, not exaggerations.

For the first lid simple non-strategically placed ribs are placed on the inside for extra strength. The material of the lid is PP which has a yield strength of 31-35 MPa. The stress concentrations in the lid approaches 60 MPa. Which would lead to a plastic deformation of the lid.

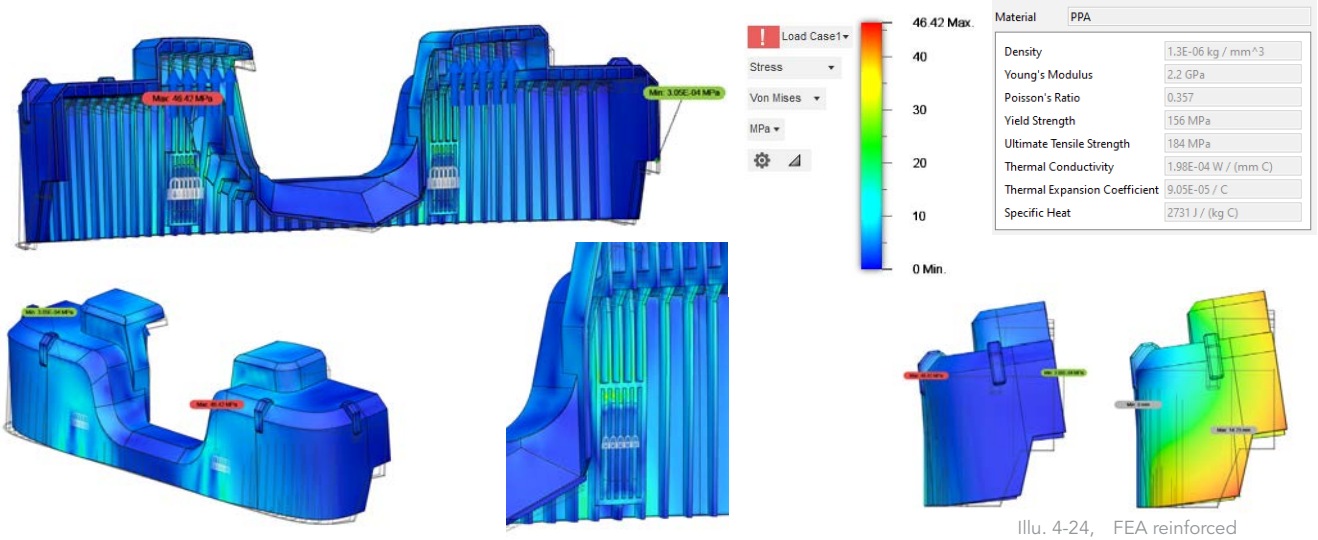


Illu. 4-23, FEA

With this model there is two main problems:

- The yield strength of the material and the deformation. A stronger material can replace the PP. With a yield strength of up to 156 MPa, PPA is chosen as the new material. Furthermore, adding more ribs could provide more reinforcement which could reduce stress concentrations.
- Deformation problem. The lid deforms more than 12mm at the worst point, which definitely is too much. Adding more ribs could reinforce this and lower the deformation.

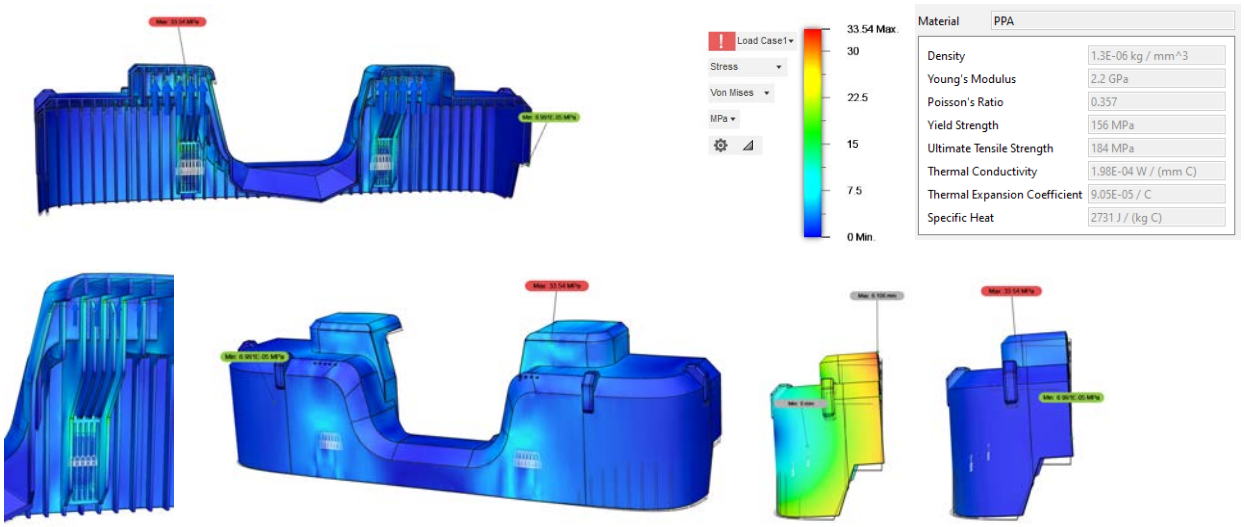
Ekstra reinforcement and hinges placement:
To see how the ribs affect the deformation and stress concentration, ribs are added to the model and recalculated.



Illu. 4-24, FEA reinforced

The addition of ribs reduced the stress concentrations considerably, but did not affect the deformation as intended. It is believed that longer ribs are necessary for improving this.

Longer and higher ribs:
To test this the ribs are prolonged and the FEA is recalculated again.



Illu. 4-25, FEA extra reinforcement

The longer ribs reduced the deformation by half to 6 mm which is a drastic improvement compared to how little material was added. It is estimated that additional ribs would reduce the deformation even more along with the metal part put on top.

Additionally the stresses were also reduced significantly down to 33.5 mPa from 46 mPa.

It is estimated that a few additional strategically placed ribs would stiffen the construction even more, so the deformation would be unnoticeable. However, for now the change in material and the added ribs prove that it is possible to use the lids as the primary weight bearing component.

Knowing that the critical points of the construction can withstand the load, the next step before calculating NPV is the business model.

4.8 BUSINESS

The next step is to look into the business aspect of the project. For a company like this to function, it is necessary to have a plan of connecting with customers and finding both partners and investors. For a product like this it is important to define the business model, as the initial investment is quite large. The model is made to get an overview of the different material and non-material assets of the company and how these can be utilised.

Key Partners

- Retailers
- Suppliers
  - Production
  - Materials
- Partners help produce and deliver high quality products and allow for the company to put its focus on creating and maintaining the user experience throughout the product from retailer to user cleaning.
- Bike brands, biking teams and sports-branding companies like Red Bull. For investment, knowledge or marketing collaborations. Opportunity to create special editions of the product.

Key Activities

- Experience design
- Networking
- Relations
- Quality control

Key Resources

- Knowledge of the biking world
- Assembly
- Partners
- Dedication to (mountain) biking compared to competition

Value Propositions

- We not only offer a product, but an experience throughout the user's interaction with the product. From dedicated designed stands in stores, a well thought of online experience and a fitting opening to have a professional feeling throughout. The main experience is being projected by the product itself when cleaning by giving off the emotions of being effortless, fast, elegant and professional. These are feelings projected by the product to the user and the surroundings allowing for the user to 'show off'.

Customer Relationships

- Communicating to their emotions
- Offering a fair warranty of mechanical parts
- Online guides to cleaning

Channels

- Social media
- Exhibitions / shows
- Commercial relationships
  - Bike brand, major biking teams, general sports sponsoring
- Retailers

Customer Segments

- 25-60
- Above average income
- Expensive bikes and equipment
- 80% men
- Generally more men in mountain biking and they spend more
- Professionals

Cost Structure

- Main expenses are initial production, assembly and materials
- Product development and maintaining high quality experience throughout
- Marketing and sponsoring

Revenue Streams

- To cost approx 3700 ,- DKK. Main source of revenue
- Brand collaborations potential revenue
- Possible expansion to other markets

Initial financing

For a hobbyist product like this, it is essential to hit the market with the right product from the start. For this reason a production method like injection moulding is chosen. But getting a handful of moulds is an expensive move for a new business and therefore some initial investment is necessary. There are different opportunities to gather an initial investment but for a hobbyist product that speaks to an upper class segment it could be a possibility to raise capital on a reward based crowdfunding platform like Kickstarter or equity crowdfunding. Otherwise outside investment into the company will be a necessity to get the production rolling - this could potentially be brands investing in the company as stated in the Canvas. For an investment like this size and for a product like this, loans and grants seem an unlikely option. (BDC, n.d., a)

Market entrance and marketing

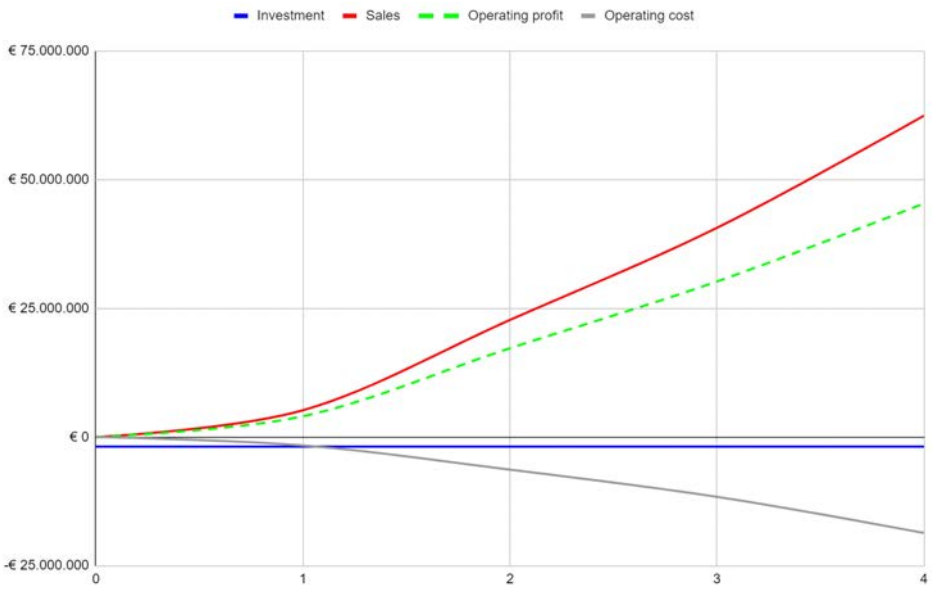
With a user group like this, it is important to market the product. Ideally the market entrance could happen in a collaboration with a major company within the mountain biking world, such as Specialized, Cannondale or Trek, that can help attract attention to the product as well as 'professionalise' the product to the customers. The initial marketing could happen with a stand in an exhibition. Additionally the user group likes to buy equipment online, so having a well designed and easy to use website is an essential part.

Selling

The product is to be sold online at the company's own webshop or at retailers with a product catalogue of high-end mountain bikes and accessories. With inspiration from Muc-Off stands in stores, the product is to have a dedicated and experience-designed stand. After the feedback from Rold Skov cykler, it may be a viable solution to give retailers some directions to the stand and let them design it themselves to correspond with the goals of the company while also fitting into the store's decor. This way more high-end stores are likely to carry this product.
Having a business plan with estimated sales of 1% market share, this leads to sales of 800.000, which will be spread out over a 5 year period. This seems very optimistic, so it is scaled to 0.5% meaning 400.000 units over 5 years.
Now having defined both production methods and expenses, together with how investment and customer relations are to be handled, the next step lies in exploring the finances of the company. This is done by using the manufacturing, assembly and sourcing outflow together with potential sales as the inflow to calculate NPV .

4.9 NPV & CASH FLOW

With the initial investment into moulds known and the operating costs in sourcing materials and parts for the product described, it is possible to calculate the economic situation for the company and optimise the sales price. To know the break-even time it is necessary to know the sales price, as this affects the operating profit by deciding the revenue. A price range of 3-5000 DKK is known from users to be realistic. It is important to hit the sweet spot of not being too expensive to acquire and not being so cheap it offends the rich by being 'discount'. At the same time it is necessary to have a sales price so high, that the company has a reasonable break-even time.



Illu. 4-26, FEA reinforced

NPV - Good scenario

					Investment				Salaries	monthly	yearly	
		EUR-DKK conversion rate	7,45		initial		€1.472.000,00		Marketing	€ 40.000	€ 480.000	
		Discount Rate:	10%									
			Production info									
		Production cost per unit	€4,04									
		Material cost per unit	€6,07									
		Assembly cost per unit	€30,00									
		Outsourced part cost per unit	€16,24									
		Total cost per unit	€60,72									
		% of units sold online	30%									
		% of store profit	50%									
		Sales price per unit EUR	€500,00									
		Sales price per unit DKK	kr 3.724,22									
		Money from sale after VAT	€400,00									
		Money from sale after store profit	€260,00									
		Time (years)	**Units sold**	**Development**	**Investment**	**Marketing**	**Production cost**	**Sales**	**Yearly profit/loss**	**Balance in bank**		
Year		0	0	-€ 400.000	-€ 1.472.000	€ 0	€ 0	€ 0	-€ 1.872.000	-€ 1.872.000		
Year		1	20000	€ 0	€ 0	-€ 480.000	-€ 1.214.398	€ 5.200.000	€ 3.505.602	€ 1.633.602		
Year		2	75000	€ 0	€ 0	-€ 360.000	-€ 4.553.991	€ 17.550.000	€ 12.636.009	€ 14.269.611		
Year		3	85000	€ 0	€ 0	-€ 360.000	-€ 5.161.190	€ 17.901.000	€ 12.379.810	€ 26.649.421		
Year		4	115000	€ 0	€ 0	-€ 360.000	-€ 6.982.787	€ 21.797.100	€ 14.454.313	€ 41.103.734		
Year		5	115000	€ 0	€ 0	-€ 240.000	-€ 6.982.787	€ 19.617.390	€ 12.394.603	€ 53.498.337		
Year		6	90000	€ 0	€ 0	-€ 240.000	-€ 5.464.790	€ 13.817.466	€ 8.112.676	€ 61.611.014		
Year		7	80000	€ 0	€ 0	-€ 240.000	-€ 4.857.591	€ 11.053.973	€ 5.956.382	€ 67.567.396		
Year		8	50000	€ 0	€ 0	-€ 240.000	-€ 3.035.994	€ 6.217.860	€ 2.941.865	€ 70.509.261		
		Total units sold:	630.000									
NPV=		**€70.509.261,02**		**-€400.000**	**-€1.472.000**	**-€2.520.000**	**-€ 38.253.527**	**€113.154.789**				

NPV - Bad scenario

					Investment				Salaries	monthly	yearly	
		EUR-DKK conversion rate	7,45		initial		€1.472.000,00		Marketing	€ 40.000	€ 480.000	
		Discount Rate:	10%									
			Production info									
		Production cost per unit	€4,04									
		Material cost per unit	€6,07									
		Assembly cost per unit	€30,00									
		Outsourced part cost per unit	€16,24									
		Total cost per unit	€60,72									
		% of units sold online	30%									
		% of store profit	50%									
		Sales price per unit EUR	€500,00									
		Sales price per unit DKK	kr 3.724,16									
		Money from sale after VAT	€400,00									
		Money from sale after store profit	€260,00									
		Time (years)	**Units sold**	**Development**	**Investment**	**Marketing**	**Production cost**	**Sales**	**Yearly profit/loss**	**Balance in bank**		
Year		0	0	-€ 400.000	-€ 1.460.000	€ 0	€ 0	€ 0	-€ 1.860.000	-€ 1.860.000		
Year		1	1500	€ 0	€ 0	-€ 240.000	-€ 91.080	€ 390.000	€ 58.920	-€ 1.801.080		
Year		2	3500	€ 0	€ 0	-€ 40.950	-€ 212.520	€ 819.000	€ 565.530	-€ 1.235.549		
Year		3	4500	€ 0	€ 0	-€ 47.385	-€ 273.239	€ 947.700	€ 627.076	-€ 608.474		
Year		4	6000	€ 0	€ 0	-€ 56.862	-€ 364.319	€ 1.137.240	€ 716.059	€ 107.585		
Year		5	4500	€ 0	€ 0	-€ 38.382	-€ 273.239	€ 767.637	€ 456.016	€ 563.600		
Year		6	3500	€ 0	€ 0	-€ 26.867	-€ 212.520	€ 537.346	€ 297.959	€ 861.559		
Year		7	1000	€ 0	€ 0	-€ 6.909	-€ 60.720	€ 138.175	€ 70.546	€ 932.106		
Year		8	500	€ 0	€ 0	-€ 3.109	-€ 30.360	€ 62.179	€ 28.710	€ 960.815		
		Total units sold:	**25.000**									
NPV=		**€960.815,23**		**-€400.000**	**-€1.460.000**	**-€460.464**	**-€ 1.517.997**	**€4.799.276**				

Illu. 4-27, NPV's

In appendix 14 the NPV can be seen and it shows that the break-even lies after about 12000 sales for the good NPV and 14600 with the bad NPV. The sales price is decided to be 500€, which is roughly 3700 DKK. Two NPVs are made with different factors. The 'good' one estimates high sales, whereas the 'bad' one has way lower sales affecting the break-even time considerably as it can be seen. The good NPV breaks even after about half a year, whereas the bad NPV uses four years. The Bad NPV works with a lower marketing budget than the good NPV, which makes the break-even unit count closer than otherwise expected. To do the NPVs some factors were to be decided. This was factors like marketing budget, discount rate and the split of revenue with retailers.

To calculate the company's finances it is necessary to know the cost of marketing. Business Development Bank of Canada states that it is normal to spend 5-10% of the revenue on marketing. (BDC, n.d., b)
This is added to the NPV as an outflow. Furthermore the main spend of marketing is placed in the first couple of years, when the product needs to attract attention. As it is stated in section 4.8, it is intended to be sold in high-end bike stores as well. These stores will need 40-60% of the revenue of sales according to Entrepreneur. (Sugars, 2011)
The calculations are based on a 50/50 split between retailer and company. It is also estimated in the calculations, that 70% of the sales are in stores and 30% are online or in exhibitions.

The calculations also use a discount rate to know the value of the futures income in present value. (Hayes, 2021)

The calculations are based on selling the product in both Europe and America, which allows for such high sales and revenue. The calculations are also based on an optimistic sales ramp-up of only 1 year, before sales rise quickly. To counter these optimistic assumptions the 'bad' NPV is also made as a worst case scenario.

4.10 SPECIFICATIONS

PRODUCT SPECIFICATION	MIN	MAX	TARGET	UNIT
Overall product				
Can be used with existing cleaning products	-	-	Yes	Binary
Cleaning time	10	20	15	Min
Includes brush, water, cloth and detergent	-	-	Yes	Binary
Works with garden hose	-	-	Yes	Binary
Weight	12	15	12	Kilograms
Dimensions, > 565, 670, 190 mm (w,h,d)	-	-	Yes	Binary
Carrying height	500	580	560	mm
Pressure washable	-	-	Yes	Binary
Two filling options	-	-	Yes	Binary
Close to body when carrying	-	-	Yes	Binary
Interaction points over 300 mm	-	-	Yes	Binary
Water tank				
Capacity	6	10	7	Litres
Material, PP	-	-	Yes	Binary
Transparent sides	-	-	Yes	Binary
Steady in terrain	-	-	Yes	Binary
Gun				
Weight	1	1,5	1,2	Kilograms
Dimensions = 325, 216, 56 mm (w,h,d)	-	-	Yes	Binary
Nozzle switch, manual	-	-	Yes	Binary
15 & 25 degree nozzles + upwards	-	-	Yes	Binary

PRODUCT SPECIFICATION	MIN	MAX	TARGET	UNIT
lockable trigger	-	-	Yes	Binary
support for two hand use	-	-	Yes	Binary
Lance length, 290-360 mm	-	-	Yes	Binary
weight of gun close to hand	-	-	Yes	Binary
Material, PP+TPE	-	-	Yes	Binary
Motor				
Voltage	12	20	20	V
Pump				
Noise	78	90	78	dB
Water pressure	20	30	25	Bar
Bike stand				
Weight	1	1,5	1,2	Kilograms
Dimensions = 377, 400, 140 mm (w,h,d)	-	-	Yes	Binary
Engagement point, wheel hub	-	-	Yes	Binary
Material, steel	-	-	Yes	Binary
Battery				Li-ion
Capacity	1,5	2,5	2	Ah
Voltage	12	20	20	V
Removable	-	-	Yes	Binary
Hose				
Length	2000	5000	3000	mm
Retractable, automatic	-	-	Yes	Binary

05EPILOGUE

The project will be concluded on and reflected upon. The reflection will focus on process and product individually.

CONCLUSION

Initial research, interviews and later testing led to knowledge about the cleaning process of mountain bikes and the 'world of mountain biking'. From an earlier project it was known that there would be an interest in a product which would allow for the cleaning process to be handled by the trail. This together with knowledge of the mountain bikers, their reasoning and their product choices has made it possible to design a new cleaning solution, that should make it a more desirable part of the mountain biking experience. This change should come in the improvement of the cleaning experience from being a necessary hassle of a job to being quick and easy. This is achievable with a product that shows off its qualities as a tool by presenting the gun to the user and thereby inviting the user to start, while also making an unexpected movement that should draw jealous looks from other mountain bikers nearby cleaning the traditional way.

With 40.000.000 mountain bikers in the US alone, the market for a product like this has great potential. This potential has the added benefit of allowing for more advanced and expensive production methods that are mostly available for high volume products. This however also leads to high initial investment into the tooling, which prolongs the break-even time. In other instances a product like this could be made with cheaper production methods initially and scale up production later, but with the complex construction of the product and possibilities for better materials and more precise manufacturing and assembly, the proper production methods are to be initiated from day one.

With Exhume the mountain bikers can clean their bike by the trail in an effortless way and showing off their gear - even when cleaning. The solution is easily transportable, powerful enough to clean efficiently without harming the bike and has proper sizing to be stored both in car and in cupboards when not in use, meaning the wife could approve of it.

With so many technical aspects, features and a wide user group it has been necessary to focus on some parts of the product more than others, which is something to reflect upon in the following section.

REFLECTION / PROCESS

Project start
In the initial stages of the project, the scoping was a lot different. The early scope was in creating a new electric long-distance bike, but it was found to be an unnecessary product when talking to users. After this a lot of time was spent identifying a new project scope, and the group was very picky and therefore slow to identify the right scope. After three weeks of uncertainty the group settled on the project at hand, but the time spent being uncertain and unsettled in the project, has also been time that could have been spent improving the product and getting early user feedback. Instead the project was initially in a state of catch-up to the lost time.

Milestone use
The lost time in the early process also had the consequence of affecting the quality of the milestones. The presentations in the milestones were not always as sharp as hoped, which affected the feedback gotten. Especially in the early milestones it became clear, the basis of the users and their interests were unclear. There is never any doubt that the market exists, but the interests, selling points and how the product fits the users and context is not communicated properly leading the feedback being not as expected and hoped.

The user group - and inclusion
The user group of this product being very hobby based it is clear that there is a market for a new product if it is framed correctly. To do this framing it has been important to get in touch with the user group. In the early stages it was especially important to identify the user needs and while it was easy to get contact with the user, it was often not possible to see them clean a truly dirty bike in the right context, as the project start was off-season for mountain biking. Instead the cleaning process has been acted out using an old mountain bike that has been covered in dirt rather than picking it up from the trail, which may have affected the end results.

Modelling
When interviewing the user group in the early stages a mock up model of the initial concept was used to show the dimensioning and features. This model has been extremely important during this project. Not only in the interviews early on, but also when quick and dirty tests were needed during the later stages of the project and it could be used to e.g. test a specific interaction or user scenario. The mock up has also been essential in deciding dimensioning in collaboration with research and 3D modeling. In the later stages of the process 3D modeling and 3D printing became an important part in the design process. Especially when detailing the gun, it was an important step to 3D print it, as it showed that it was too large overall and the handle was not comfortable to hold. The revised model is not printed due to time-constraints, but it could have been valuable to do another feedback loop upon it.

Sketching
During the project there have been countless sketching rounds. Especially in the beginning, they could be without proper focus points, making it difficult to come up with good or innovative ideas. When this issue was identified, the following sketching rounds were split into 'concepts' with focus points for each. This improved the overall quality and speed of the sketching rounds drastically, but it is also noted that to do this, it is necessary to have adequate knowledge of the solution space, which is often not attained in the early stages of a project.

REFLECTION / PRODUCT

Context fit and user fit
During the project it has been difficult to communicate what is 'cool' from a user perspective. It has also been difficult to define how this fits the specific context both visually and in features. The features for cleaning are not different from that of cleaning any other bike other than the need of a brush is bigger than e.g. a road bike, meaning that what defines it as a product for mountain bikes should lay in non-cleaning features and the visual expression. With such a wide mountain biking market it may have been easier to create different expressions for the different types of mountain bikes with the same feature set instead of trying to make a 'one-size fits all solution'. Defining cool and creating the right experience and visual appearance is something that has been very time-consuming which has led to the lowered priority of other aspects like the design of the bike stand, which would be worked upon if more time was given.

Customization
During the project it was discussed if the product should be customizable for the user, this meaning that different features could be chosen depending on the specific users needs. This was disregarded as the identified feature-set could be seen as more or less equal for all potential customers. It was also decided that making a 'base' version and a 'pro' would lessen the prestige of owning the product overall, and as branding is something important to these customers the verdict is that it would not make sense to do. It could still be possible to create different variants of 'pro' models with different bike stands, nozzles and sizes, but this is regarded as further work.

Visual balance
Already from the very first mock up it became clear just how important the visual balance of the product is. This poses a dilemma since it is important not to look too heavy in the bottom, which would make it uninviting to be lifted, but at the same time, it is also important for it to look steady when standing on the ground. It is something that has been fought throughout the development process and in the end it is regarded as solved okay, but it could still be improved. To do this improvement though, the next step would be to make a 1:1 model with the design and weight and move it into the proper context, because as with the 1:1 model of the gun, it may be perceived when it is made in the real world and tested.

Technical complexity
With the chosen opening experience and the placement of the battery deciding that the opening should be purely mechanical, there have been a lot of work finding mechanisms that could make this opening work and fit into the scenario of use. Speaking to users it was clear that for this to be a desirable product it would be essential to get this opening looking, feeling and sounding right. If this could not be attained, it would not be a good product and the opening may not affect the use of the product negatively as 'cool gear is only cool if the basic user needs are met'. At this point it is unclear exactly how the mechanism will feel and sound. The target experience is defined in section 3.7, but how this is attained is also regarded as further work at this point. If the desired feel is not obtainable, it would probably be better to save the added weight and space, that the mechanism requires, in order to make the cleaning tool smaller and lighter.

Production
When 3D modeling it also became apparent that almost no two parts are the same, which has the effect of a larger amount of molds than necessary. These molds are expensive and they are necessary to obtain from day one, meaning the initial investment is massive. As some parts are almost identical, the design could be altered to have identical parts that could share molds. Doing this it might be possible to reduce the drawbacks to the design and thereby decreasing the initial investment, which would make the start-up of the business much more viable. Doing this design change would be further work into if the time schedule allowed for it.

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LIST OF ILLUSTRATIONS

All illustrations not named in this list is created by the project group.

LIST OF ILLUSTRATIONS

AALBORG
UNIVERSITY

June 23

Appendix
for Exhume

Master Thesis : MA4-ID6

Jacob Kjær Gertsen
Kasper Birkeskov Drejer Axelsen
Nicholas Alexander Mäkelä Green

Appendix 1

Activity: Assembling previous knowledge gathered

Worksheet no.: 2	**Date:** 21/2	**Deadline:** 22/2	**Responsible: KAX**

Objective: *Here you briefly state the intention, plan, method, and desired result for the activity*

The objective with this activity is to assemble all the previous knowledge gathered in a previous mini-project. This includes interviews with mountain bikers living in apartments in the city with limited possibilities for cleaning their bike. The mini-project concerned itself with people who didn't have a water supply for cleaning their bike outdoors or would prefer to clean their bike before attaching it to their car.

Experiment/data: *Here you put in a sketch, storyboard, diagrams, photo of mock-up or experiment, rendering of 3D model, interview, etc, including own explanatory comments, analysis and perhaps evaluation*

Questions for the mountain bike users:

- Where do you live?
    - Apartment or house?
    - Is there facilities for cleaning your bike there?
    - Do you utilise them?
        - why, why not?

Where do you store your bike?

How often do you ride your bike?

- How often do you clean it? (deep clean and surface clean)
- Would you rather wash it on site or at home? (mountain bikers) (if they use cars for transportation.
- How often would you like to clean it?
    - Why do you not clean it as often as you would like?

How do you clean it?

- Steamer, brush, pressure washer?
- What would make the cleaning experience better?
- What is the worst part about cleaning your bike?
- Is it physically straining to clean your bike? What would improve it?

What routines do you have, when you go for a ride?

- Preparation (e.g. checking things, pumping tyres, etc.)
- Afterwards (e.g. cleaning)

Anything to add?

Can we contact you again?

Jens (Jacobs dad):

Lives in an apartment in the city. He goes mountain biking by transporting his mountain bike in his car. He has a space at his apartment where he could clean the bike, but would definitely prefer to clean the bike on-site, because of his need to transport the bike in his car. However, most mountain bike tracks are not equipped with cleaning facilities. Sometimes he brings a cloth and a bottle of water to take off the excess mud.

He stores his bike in the parking garage underneath his apartment complex. This is behind a locked fence.

He rides his bike mostly in the summer, where he can average a couple of times per month. He cleans his bike after every trip so it is ready for the next trip. These are often not complete cleanings but mostly to remove all the dirt and grime. He cleans his bike as much as he would like to have it cleaned.

How does he clean it?:
He uses a bucket of water, some cleaning detergent in a spray bottle and two kinds of brushes, one with the hairs all going in one direction and another in every direction, for the narrow spots on the bike. He would like a pressure washing solution where he wouldn't have to scrub all the way around the bike in order to clean it. The worst thing about cleaning it is that he can't do it on-site. Physically he would like not to bend over in order to clean it. He would also prefer to have everything in a single package, so he would only have to bring one bag for everything with him.

For every trip, he brings water, tyre patches, a pump and maybe food. This he packs in the car beforehand. This "bag" would be preferred to be stored in his standard cupboard. This is also something that the wife would appreciate.

Kasper (arch):
Lives in an apartment in the city and goes mountain biking by mainly biking out from his home. He doesn't have any available facilities for cleaning his bike where he lives. Therefore on his way home after a trip he stops at a petrol station so he can clean his bike.

He stores his bike inside his apartment since he doesn't want to place it outside. This is because he would not like to have it stolen and by doing this he can avoid putting on a bike lock on his mountain bike.

Unless it is winter he likes to ride it several times a month. He cleans it every time it has been made dirty. So if he only rode it on asphalt he might not clean it afterwards. He would like to have it cleaned every time he takes it inside his home, but if it is not too dirty and he plans on going for a ride again soon, he can't be bothered.

At the station, he pours a bucket of soapy water (he can't choose not to have it soapy). Then he takes the available brush and dips it in the bucket and then starts scrubbing. After he has scrubbed the entire bike, using 2-3 buckets in order not to just spread the dirt around, he takes a fourth bucket and pours it over the bike to get the foam off. He can then proceed to ride home on a very wet bike. The brush he uses does have some difficulties since it is not able to get into the most narrow spaces on the bike to clean it. This either leaves dirt on the bike or creates a struggle for him to get it off.
He would like not to have to scrub the entire bike. And would definitely prefer to do it at home, so he has his own brush and can wash off the soap with non-soapy water.

Mountainbiker boys:
Four boys (18-25) were interviewed at a mountain bike track. Two of them were still living at home with their parents in a house. These two boys were not really concerned about cleaning their bike. They had an attachment for the car to hold the bikes, which meant that it didn't really matter if they were very dirty. When they got home they would take the garden hose and remove the worst dirt and grime from the bikes, so the mud wouldn't become too hard to get off later.

The two other boys lived in apartments in the city and were most often picked up from their homes by their friends when going mountain biking. They sometimes just wiped it down with a cloth to get the worst off, or would go to the petrol station to clean them.

They tried cleaning their bikes on the spot with a low-pressure washer (a pressure washer that ran on a battery). They like the ease of not scrubbing the bike but just pointing and shooting. This also allowed them to easily get into the narrow parts of the bike. If they could bring along a package to clean their bikes like this, they would.

Evaluate

Summarise and evaluation. Did the activity meet the objectives and to what extent? How did you evaluate? Did you use external feedback, calculations, estimations, etc.? And what is the validity of the result?

These interviews were done a year and a half ago, in a project that focussed on specifically making a pressure washer to clean a bike. The first two interviews can definitely be used for research for this project, however, the last one was definitely affected by the interviewer having a working model tested on them, which might not correspond with the aims of this research.

Reflection

What did you learn? Do you need to change method, mode, approach or revise the objectives, specification or criteria? What is the next move?

We learned some of the user behaviour and possibilities for improvements. Concepts for solving some of these improvements would definitely be possible based on these interviews. Further research could be beneficial, especially for motorcycle users.

Important notes/observations: *Here you can write the important points and the new/updated requirements/demands and wishes, and how they were found*

Appendix 2

Activity:Concept mock- up test

Worksheet no.: 19	**Date:** 16/3	**Deadline:** 16/3	**Responsible: KAX**

Objective: *Here you briefly state the intention, plan, method, and desired result for the activity*

In order to finally decide what features the solution should have, a test with the remaining undecided features is made. This is done by creating two mock-ups that have some differences to determine what the user likes the best. The features that are wished to be decided are:

- Bicycle holder or not
- Nozzle switch or not
- Water tank placed in the car or taken out.
- Battery and pump placement
- Held with one or two hands
- Where to place the gun when not using it

Additionally where and how to store the product should be considered and investigated.

To get the best test the scenario should be played out by the user and be situated in a similar environment to which they would use normally.

Experiment/data: *Here you put in a sketch, storyboard, diagrams, photo of mock-up or experiment, rendering of 3D model, interview, etc, including own explanatory comments, analysis and perhaps evaluation*

The two concepts differences:

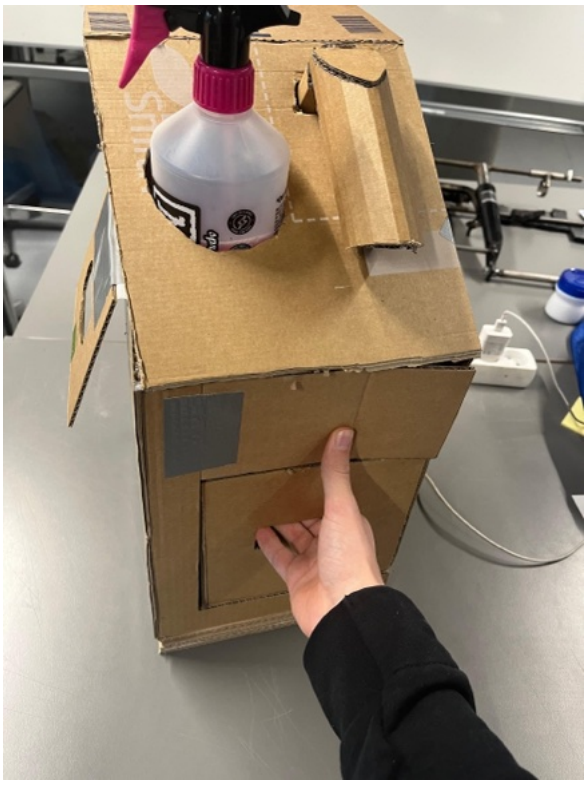
Concept #1	**Concept #2**
Placed in the car when cleaning	Taken out of the car when cleaning
With a bike stand	Without a bike stand
Pistol (short gun- one hand)	Rifle (longer gun - two hands)
Battery and pump in the box	Battery and pump in the gun
Larger storage room	Carries only the essential equipment
Muc-off spray	Soap dispenser
Brush on the gun (or no brush)	Brush in the box.

For creating the two concepts in cardboard a sketching round was completed. This sketching round is described in worksheet 19.

Description of the two muck-ups:

Mock-up #1:

The idea of this mock-up is to have it placed in the trunk of the car at all times. From here the water tank can be taken out and refilled by itself. The battery can be taken out as well. The gun is a small one-hand-held one. This is possible by having the battery and the water in the stationary box in the car. This concept has a separate soap sprayer with it, that can be held in the other hand. A bike stand is attached to it and can be taken out to hold the bike.



Mock-up #2:

The second mock-up is a more portable one. With a large two-hand-held gun with an integrated battery, motor and pump. The gun's handle acts as a handle for the whole thing. The soap can be applied by attaching the dispenser to the gun. A long-shafted brush is also available on the side of the box. The box is meant to be taken out of the car each time the bike is to be cleaned. The gun can also be attached to a normal garden hose for an unlimited water supply. Both models have around 10L of water.


Questions for the user:

Placement:

- Would you prefer to have the box placed in the car while cleaning or not?
- Can you identify any problems with having it trunk of the car when cleaning?
    - Would you always have this solution in the back of the car or would you take it out sometimes?
- Can you identify any problems with taking out the box when cleaning?
    - How is the portable one for carrying?
    - How is the separate water tank to carry?

Gun:

- Would you prefer to control the gun with one or two hands?

Bike stand:

- Would you use this bike stand?
    - What would make you use it?
- Would you use it if it was on the other solution?
- How would you like to hold the bike?

Battery and Water tank:

- Would you prefer to have everything in one box or a separate water tank?
- Do you care about the feature of connecting the gun directly to a garden hose?

Storage:

- Would you prefer to have the brush or not?
- Would you like to have anything else with you for cleaning?
- Do you prefer to apply soap with the spray bottle or foam attachment?
- Which of the models storage solutions do you prefer?
    - Do you prefer to take everything out with you or have it in the car?

Questions for the user: Finn

Placement:

- **Would you prefer to have the box placed in the car while cleaning or not?**

Initially very favoured towards the mobile one to take out of the car, partly because he sees it usable for mountain bikers living in apartments.

Later changes a little, saying it might be very smart with the one stationary in the boot of the car, however he thinks it is a little too large if a bike has to go in there as well.

- **Can you identify any problems with having it in the boot of the car when cleaning?**

Not a lot *when* cleaning, but it can be an issue if it doesn't get smaller, when the bike has to go in the boot as well.

- **Would you always have this solution in the back of the car or would you take it out sometimes?**

He would take it out every time after use, partly because he will need the space for other things, e.g. when he works as a salesman.

- **Can you identify any problems with taking out the box when cleaning?**

Not in particular

- **How is the portable one for carrying?**
- **How is the separate water tank to carry?**

Gun:

- **Would you prefer to control the gun with one or two hands?**

One hand. He holds the bike with the other hand while cleaning it.

The size of the gun is not a big concern, as long as it can be used with one hand

Bike stand:

- **Would you use this bike stand?**

He says he doesn't see a need for the bike holder to necessarily be a part of it.

He just holds the bike when washing, and lays it on the ground opposite the cassette.

- **What would make you use it?**
- **Would you use it if it was on the other solution?**
- **How would you like to hold the bike?**

He holds the bike with with the hand

Battery and Water tank:

- Would you prefer to have everything in one box or a separate water tank?
- **Do you care about the feature of connecting the gun directly to a garden hose?**

It would be a very good idea to be able to connect it to the garden hose, because then it can be used for the detailed cleaning at home easily as well.

Storage:

- **Would you prefer to have the brush or not?**

Always uses a brush. He uses a dish washing brush for the cassette and an auto brush for the rest.

- **Would you like to have anything else with you for cleaning?**

A cloth is a must-have

- **Do you prefer to apply soap with the spray bottle or foam attachment?**

He doesn’t use soap. He only uses a water based detergent for the cassette, which he applies with a spray bottle. For everything else he only uses warm water.

- **Which of the model storage solutions do you prefer?**

He can see a great value in the extra storage for maintenance for extra tubes (if riding with tubed wheels), plugs, chain links etc.

- **Do you prefer to take everything out with you or have it in the car?**

Doesn’t bring a lot on the ride, but has the essentials in the car.

Other notes:

Very careful about his bike. If the roads have been salted, the bike goes in the boot.
SUV Size car, can easily imagine being able to have something like this
He currently uses one hour total on cleaning, and then the bike will also be clean and dry. He says it doesn’t take a long time to bring out the cleaning equipment.
He will dry the fork, front and rear suspension after every ride.
He will typically use approximately 3 hours when riding.
He will not cheap out when buying things for the bike. It’s not always the case of course, but his experience is that quality often follows price, so it’s a good indicator. One time, some years ago, he bought a gold cassette and chains, not because they were better, but he bought it because it looked cool. So there is definitely some element of wanting the bike to look cool. Now he just goes black, because it is cheaper.
Doesn’t care where other people buy their bikes and what they cost, but it has to be well kept and ride nicely, so as to not drag down the other riders.
There is a nice feeling in saddling up on a nice clean bike.

Questions for the user: Nicolas

Placement:

- **Would you prefer to have the box placed in the car while cleaning or not?**

Prefer the solution that you can take out, but don't see a problem with having it in the car if you have the space. A positive about the mobile solution is being able to go away from the car, in the event that the parking lot is crammed. But he would exchange the foam lance for a spray bottle.

- **Can you identify any problems with having it in the boot of the car when cleaning?**

Maybe if you have a bike rack that can’t angle or something. But he can open his boot with the bike rack still on as long as the bikes are not on. But he doesn’t see a large issue with the hose clashing with the rack. Maybe it’s annoying if the hose is short and you have to stand very close to the car.

- **Would you always have this solution in the back of the car or would you take it out sometimes?**

Would probably take it out, to use the space for other things.

- **Can you identify any problems with taking out the box when cleaning?**

- How is the portable one for carrying?
- How is the separate water tank to carry?

Gun:

- **Would you prefer to control the gun with one or two hands?**

One hand would be fine, but with the pressure he would want the handle to have some mass to it, in order to

Bike stand:

- **Would you use this bike stand?**

Yes, he would prefer that, because it seems practical.

- **What would make you use it?**
- **Would you use it if it was on the other solution?**

Yes

- **How would you like to hold the bike?**

The bike stand would be nice, otherwise lean it on something, like a tree or wall.

Battery and Water tank:

Could see a point in being able to connect the stationary solution to the car's 12V outlet.

- **Would you prefer to have everything in one box or a separate water tank?**
- **Do you care about the feature of connecting the gun directly to a garden hose?**

Storage:

- **Would you prefer to have the brush or not?**

Yes

- **Would you like to have anything else with you for cleaning?**

Maybe a cloth

- **Do you prefer to apply soap with the spray bottle or foam attachment?**

Doesn't really use soap at the track, will almost always give the proper washing at home.
But he would prefer the spray bottle. It also preserves water to spray manually, considering the limited amount of water that can be brought.

- **Which of the models storage solutions do you prefer?**

Mostly want storage for cleaning equipment or maintenance stuff.

- Do you prefer to take everything out with you or have it in the car?

Ekstra notes

He has and uses a bike rack, and rides solo most of the time.
He doesn't clean the bike after every use, depending on the weather. If it's dry and only get dusty, he will not clean it every time.
Optimally he would clean it every time, but it comes down to him being lazy, especially when he gets home, and on the drive home he will get tired and not want to do it. If possible he will clean it on-site, e.g. by rold skov and skørping.
He cleans it in the driveway with a garden hose and a bucket of water with auto shampoo and a brush (auto brush). If it really needs it, he will also use a cloth to get in the tight spaces. He often blows the worst water off of the delicate places.
He estimates he uses a maximum of 12 minutes for the thorough cleaning, but often just 5 for the quick clean.
The most annoying part is where the brush can't or is tough to get in, under the shields, under the seat and between the frame and tire.

He sees a value in being able to have it with you in the car and clean the bike before you go home, because you get tired and lazy while driving home.

He has a 15 minute drive to Rold skov, 30 min to storvorde and aalborg and an hour to urhøj.
On a 0-10 scale of pragmatic to stylish, he will place himself as 7 towards pragmatic and 3 towards style. He does not care too much about style, will prefer simple colours and not too much fuzz.
He likes his things having multiple uses
Must work with garden hose as well

Concept #1	**Concept #2**
Placed in the car when cleaning	Taken out of the car when cleaning
With a bike stand	Without a bike stand
Pistol (short gun- one hand)	Rifle (longer gun - two hands)
Battery and pump in the box	Battery and pump in the gun
Larger storage room	Carries only the essential equipment
Muc-off spray	Soap dispenser
Brush on the gun (or no brush)	Brush in the box.

Evaluate

Summarise and evaluation. Did the activity meet the objectives and to what extent? How did you evaluate? Did you use external feedback, calculations, estimations, etc.? And what is the validity of the result?

The objective has been partly met, as three features were clearly decided on. The ability to take it out of the car to clean the bike was the most liked of the concepts. The battery and pump should be in the handle, because the handle should have some mass to handle the pressure spray. And the brush should be a part of it, but having it by the box is best.
The remaining features are not clear-cut in what is the best. The bike stand was split in that one user thinks it's a good thing, and the other thinks he might as well just hold the bike himself if he can use the washer one handed.
They both like that the small gun is compact, but issues might arise when spraying pressurised water, if there is no weight behind it. It might become hard to control.
The storage room is up to debate as the needs are very different, with one having his equipment in a fanny pack which he brings on the ride anyway. While the other thinks it will be nice with storage for extra equipment like tube, plugs and chain links, as he brings this along in a box currently. However he will also bring along his shoes and helmet in said box.
Lastly the foam lance or spray bottle, this depends slightly on how a proper foam lance work, because if it can use minimal water and be precise it could still be a good feature, as the demands for fitting spray bottles and the like can differ a lot from bottle to bottle in diameter and size.

Reflection

What did you learn? Do you need to change method, mode, approach or revise the objectives, specification or criteria? What is the next move?

The next step is to finally decide upon the feature-set. When this is done, it is necessary to decide the gun-form and size.

From supervision; how to clean the product / keep the car clean? Origami/space landing. Make it fucking awesome! Wow-effect
Cleaning should be as good as the existing solutions but should win on the experience.
Create different specs in the same box
Test price and style with set features.
Smart, cheap, simple - ID thinking but not make the product so cheap that it scares the high end buyer.

Selling point - self reasoning and reasoning to others (wife, friends and so)
Professionalise the aesthetics

- Which aesthetics do they hook upon

Qualitative testing on extremes and dial down from there.

Important notes/observations: *Here you can write the important points and the new/updated requirements/demands and wishes, and how they were found*

Appendix 3

Activity:

Worksheet no.: 23	**Date:** 24/3	**Deadline:** 24/3	**Responsible: All**

Objective: *Here you briefly state the intention, plan, method, and desired result for the activity*

During concept development it was discussed whether the anti dirt stand was really necessary. For this reason the group designs a simple test that is easily achieved. Testing this issue should give indication into whether it should be conceptualised further - maybe to be drawn back in later.

Experiment/data: *Here you put in a sketch, storyboard, diagrams, photo of mock-up or experiment, rendering of 3D model, interview, etc, including own explanatory comments, analysis and perhaps evaluation*

The test is designed so that the muc-off is placed in different amounts of dirt. The different scenarios is the following;

- Wet tarmac
- Moist dirt
- Wet dirt
- Mud

In the muddy environment the muc-off sprayer is placed, pressed and twisted to do an extreme scenario.

WET TARMAC

Small rocks on the bottom but otherwise no differences

MOIST DIRT

Slightly more dirt than the wet tarmac but overall no noticeable difference

WET DIRT

Again slightly more but nothing to note

MUD

01)  02) 

Just standing it is by no means an excessive amount of dirt and it is valued to be no issue. Afterwards it is placed, pressed and twisted to do an extreme scenario. In this case it becomes very muddy but it is easily removed with a cloth. In this extreme scenario the track would also be so muddy that most hobby bikers would consider staying home.

Evaluate

Summarise and evaluation. Did the activity meet the objectives and to what extent? How did you evaluate? Did you use external feedback, calculations, estimations, etc.? And what is the validity of the result?

Due to the results of the test it is decided to postpone the use of a anti dirt stand solution. So far it shows that there is no need, but it may need further research further on in the project and in collaboration with the users. There is also the question of “is it cool to have a slightly dirty cleaning solution”

Reflection

What did you learn? Do you need to change method, mode, approach or revise the objectives, specification or criteria? What is the next move?

The next step is to follow up on the feature worksheet and define the working principles and create concepts from this.

Important notes/observations: *Here you can write the important points and the new/updated requirements/demands and wishes, and how they were found*

Appendix 4

Activity: Bike retailer interview

Worksheet no.: 12	**Date:** 06/03	**Deadline:** 06/03	**Responsible: Kax NG**

Objective: *Here you briefly state the intention, plan, method, and desired result for the activity*

In order to get an insight into what is “nice to have” as a biker, an interview with a salesman from a premium bike store should be made. This could provide information regarding what trends that currently occupy the market and what features the user is willing to pay extra for. (and why)

Experiment/data: *Here you put in a sketch, storyboard, diagrams, photo of mock-up or experiment, rendering of 3D model, interview, etc, including own explanatory comments, analysis and perhaps evaluation*

Rold skov cykel shop in Skørping https://www.roldskovcykelshop.dk/
Fri bike shop in Aalborg by the bridge or by the hospital or in city syd or in Nørresundby
https://www.fribikeshop.dk/
Smartcykler i Støvring https://www.smartcykler.dk/
Design Cykler in city syd https://www.designcykler.dk/shop/frontpage.html
Perform Sport on Hobrovej by Sofiendal https://performsport.dk/

Questions:

- Hvad er noget som køberne bruger unødigt mange penge på, i forhold til hvad de får ud af det?
    - Hvad er det der gør at de vælger at købe det?
- Hvad er den fedeste:
    - Cykelhjelm
    - Cykeltøj
    - Cykelcomputer
    - Tasker
    - Cykelholder
    - Cykelsko
    - Drikkedunke
    - Flaskeholder
    - Er der andet “grej”/tilbehør?
- Er der nogle nye tendenser angående mountain bikes?
    - Nye former for udstyr, stil features?
    - Materialer?
    - Hvorfor ?
- Hvad er noget af det mest populære cykeludstyr?
    - Type
    - Brands
- Kommer kunder tit igen for at opgradere udstyret efter de har købt ny cykel?
    - Hvad er det de opgraderer

Rold Skov cykler

People are spending money on Muc-Off - a company that makes a lot of maintenance products.
Mange der bruger mange penge på muc off, der har virkelig mange niche vedligeholdelse produkter

Kächer OC3 kan be powered in the auxiliary power outlet in the car
Kärcher der kan køre på cigarettænder

A part of the game to maintain the bike. For some it is equal to the actual biking
En del af gamet at vedligeholde, nogle dyrker det på næsten lige fod med selve cyklingen

Money is spent on equipment, swag, helmets, fashion styles.

- Butter series, unpractical for the environment , almost a rude fashion statement
- Freeride segment is almost met
- It does not need to be practical, but it has to look awesome
- When the competitiveness disappears, the user starts to take an interest into looking cool and having nice bikes that they can take care of
- Turning heads is a bonus; powerful colours and designs

Ellers mange penge på grej, swag, tøj, hjelme nye styles, der går på mode
*Butter serie , upraktisk farve, men næsten lidt **flabet mode statement***
Snuser til freeride segmentering
Det behøver ikke være praktisk, det skal bare se fedt ud
Kompetitiviteten der forsvinder, så man interesserer sig for at se fed ud og have fede cykler de pussenusser om
Det må gerne vende hoveder når de kører forbi, skæve farver osv.

The bottle holder is a special thing. The ones that often look the coolest are also the lightest - so it speaks to both the segment of being competitive and cool looking
Flaskeholder er sjov fordi de ting der ser fede ud ofte også er de letteste, så den lette drikkeholder tiltaler begge sider

The bike industry in general is a sport of measuring dicks
Cykelindustri er helt klart en kæmpe pikmåler sport
Den her sportsgren er rigtig meget orienteret mod grejet

Difficult to point out why they pay for extra equipment and cool stuff. It is often connected to the bike they buy/have
Svær at sætte fingeren på hvad de betaler ekstra for af grej og lir. Det hænger emget sammen med den cykel de køber.

When buying a bike for 75k you do not use a plastic bottle holder. You do not put winter tires on a Lambo
Når du har en cykel til 75k sætter du ikke en plastisk flaskeholder på. Du sætter heller ikke vinterdæk på en Lamborghini

Muc off branding is special. The pink colour is powerful. They are good at creating eye catching displays and products in the shops. They are put in the proper order of use.
Mucoffs branding er det specielle. Igen det lyserøde. De har været gode til at lave iøjenfaldende displays i butikker, og sat i rækkefølge af hvordan du bruger.

Tire pumps with wild colours - easy to find in the workshop or garage.

Pumper med vilde farver. Nem at finde, forsvinder ikke bare i værkstedet eller garagen.

Materials are mostly carbon fibre, but also aluminium.
Materialer, primært carbon, men også alu.

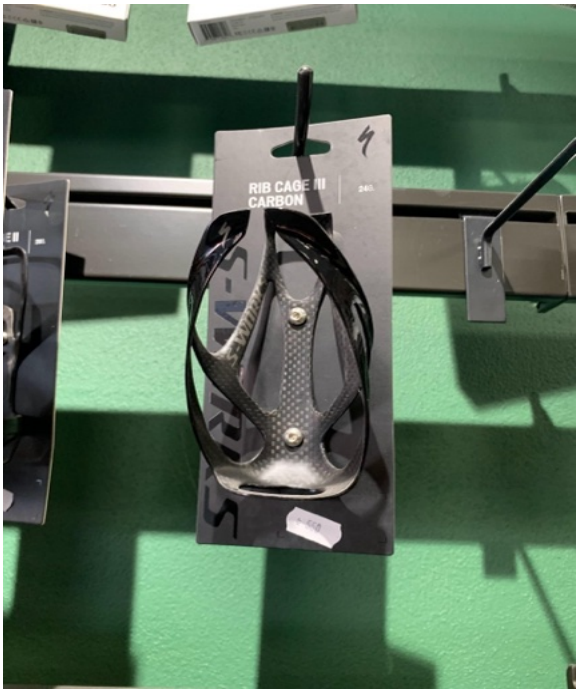
The bike stem is sometimes made from aluminium with a thin layer of carbon fibre on top. This has a higher weight than one of only aluminium due to more material, but it looks cool, light and strong.
Der findes frempinden lavet i alu med tynd kulfiber over fordi kulfiber sælger. Selvom den er tungere end ren alu.

Kashima coating. More oil on the surface due to micropores. Regular users won't know the difference, but it can be seen visually.
Kashima coating, der kan ligge mere olie pga microporer. Almindelige mennesker kan ikke rigtig mærke forskel

Bike development and efficiency. The newest equipment is the coolest because it is the most well developed.
Cykel udvikling, cykel effektivitet, det der er nyeste er fedest fordi det er mest udviklet

<table>
<tr>
<td> 

This is a cheaper plastic bottle holder (159 kr.)

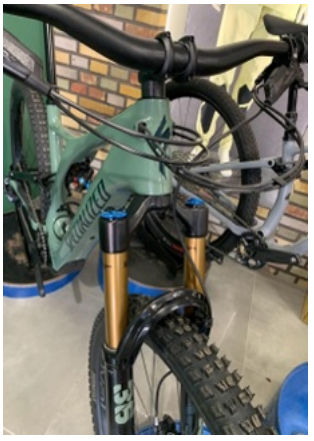
It weighs 33 g</td>
<td> 

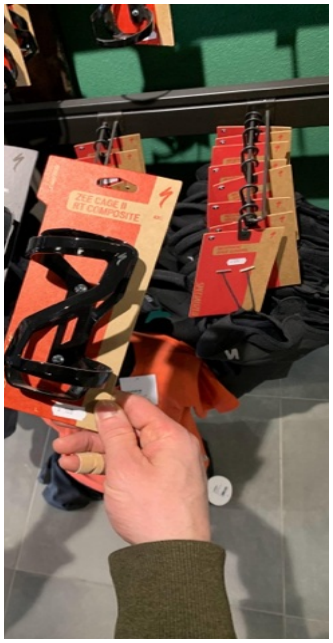
This is a more expensive carbon fibre holder (550 kr.)

It weighs 24g

Performance wise, by saving 9 grams it will cost you 391 kr.

So the weight decreases 27,2%
And the price increases 245,9%
(the cheaper ones price is decreased by</td>
</tr>
</table>

	The salesman mentioned that the carbon look is definitely also something that sells.
 Handlebar aluminium for 500 kr. It weighs 270 grams.	  Handlebar carbon fibre for 1399 kr. It weighs 167 grams. The difference of 103 grams will cost you 899 kr. So the weight decreases 38,2% And the price increases 179,8% Another performance feature of the carbon fibre is that it does not remove the heat from the hands in the same manner as metals. However, this is most often avoided with grips anyway.
 A new type of nano texture, that can hold more oil is an attractive addition, since it makes the suspension smoother.	 Some of these are painted gold, others are black. The salesman claimed that it is definitely a selling point in itself, but by having them being gold there is definitely another aspect of “show off” that is attractive to some.

<table>
<tr>
<td> 

Another example of carbon fibre bottle holders. This is a cheaper plastic bottle holder (160 kr.)

It weighs 43 g</td>
<td> 

This is a more expensive carbon fibre holder (550 kr.)

It weighs 28g

So the weight decreases 34,9%
And the price increases 243,8 %

Performance wise, by saving 15 grams it will cost you 390 kr.</td>
</tr>
<tr>
<td> 
Another aspect for users choosing to buy much more expensive products is if it contains a new type of feature.</td>
<td> 
This is a new type of suspension for gravel bikes that comes with a premium price. The suspension according to the salesman is not that drastically improved to defend the price.</td>
</tr>
</table>

Smartcykler

Mostly the equipment on the bikes that people pay for

Typisk grejet på cykel der betales mest for

Upgrading of the wearing parts comes first for the most part

Opgradering af sliddelene er først typisk

Electronic gear is a popular choice

Elektronisk gear

For helmets it is the weight and aero that is paid for

Cykelhjelme er det vægt og aero du betaler for.

Quality makes people pay

- Example, clothes - some pay a lot for having laser cut sleeves on their clothes

Det er kvaliteten der får folk til at give lidt ekstra

Tøj, nogle giver mange penge for laserskåret ærmer

Selling most XC bikes

De sælger mest XC

Both function and showing that you've got the best of the best

Både funktion og det at vise at man har det bedste af det bedste

Many people buy neutrally - 80-90% wants to be neutral

- Mostly dark bikes is sold

Mange der køber neutralt

80-90% vil nok gerne være lidt neutral

Klar flest mørke cykler der bliver solgt. Også en del cykler med farve men ikke lige så mange

A tendency for increasing suspension travel is seen. Controlled by the industry

Tendens i vandringen på affjedring

Muc off is environmentally friendly that smells nicely

- Some of the products are functionally good but not any better than the competition.
- Sponsoring large biking teams like INEOS

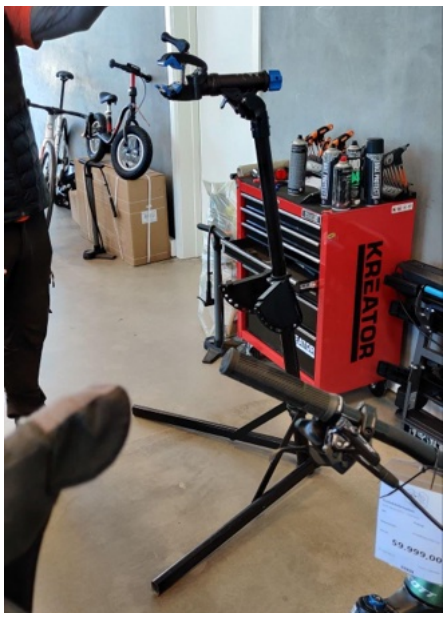
Mucoff slår sig på at være miljøvenlig, dufter dejligt

Nogle funktiknsting hvor de ikke nødvendigvis er bedre end andre

Sponsorerer store hold, som INEOS i landevejscykling

Loads of people have bike stands for the home and use them for washing

Masser der køber bike standere til når man vasker derhjemme



Some has bike stands for just the wheel og for mounting the pedal on the wall

Nogle har også standere til bare hjulet eller hænge i pedalen på væggen

Everybody wants carbon fibre

- Some believe it is the weight but mostly it is the stiffness of the material

Alle skal bare have carbon, det er det der rykker sig.

Nogle tror på vægten og det er det også..men det vigtigste er stivheden i det

If you pay 100k+ for a bike, you are wrong mounting a plastic bottle holder

- Its about taste and value. Some save the money and buy a plastic one despite buying a massively expensive bike

Hvis du betaler 100+ for en cykel er du en skarn hvis du sætter en plastik på

Men det er smagssag, der er også en del der bare sætter plastisk på dyre cykler

Generally the price is not an indication as to whether people maintain their bike.

Prisen er ikke nødvendigvis en indikator om folk passer på cyklen, det er meget personspecifikt

The first store did not have a dedicated muc-off stand like the one pictured above from the second store. This was because the salesman thought that many of their products were unnecessary, and they had to buy a pre made stand (like the one in the stand), so they would rather just have a few of their products in the store. The second and third store had these dedicated stands. According to the salesmen of these stores they did not believe that muc-off were necessarily an especially strong

brand just by their product, but rather in their marketing. They work closely with some of the biggest distributors of bike accessories. Their products are according to the salesmen also easier to sell by not being harming to the environment, smelling nice and more appealing to women (robably because of the colour choice).

Perform

It's about emotion.

- Regular users may not get a lot of performance, but you sell a feeling or dream of performance
- A feeling that it is cool to have the best

Det er følelser

Man skal jo sælge på noget. Almindelige motionister får måske ikke så meget performance for det. Men det er følelsen af at det er fedt når man har det gode

Muc off are good at making products that seem exciting

- Bio degradable
- Is sensible to the fragile bike paint

Mucoff gode til at lave noget der syner spændende

Bionedbrydeligt

Lakering på cykel, ikke så kraftig så det passer på

Maybe talk to some commercial people

Snak med reklame/markedsføring folk måske

Persuade people to believe that they get a bike that rides better or live longer

Not necessarily the ones with the most expensive bikes that buy the most (or most expensive) maintenance equipment

Overbevis om at det her får cykel til at lære bedre eller leve længere

Ikke nødvendigvis den med dyrest cykel der køber dyrest plejeprodukter

Upgrading wearing parts, that are changed once in a while

- Electronic gearing is very popular
- If you try it and notice the difference, you will be willing to pay extra

Opgradering til mountainbike er det pt sliddele man skifter en gang i mellem

Lige nu er det elektroniske skiftere

Hvis man prøver og mærker forskellen er man villig til at give den ekstra pris

It should be noticeably different than what they have to make them happy

Det skal være anderledes end det de havde før hvis de skal være glade

Wheels are an effective upgrade that can be felt.

Hjul har også en effektiv opgraderings forskel, så det er også noget der er meget i at opgradere

Saying the same about the bottle holders as the other retailers

Cheap ones hold the bottle equally as well

Samme omkring flaskeholder som de andre

De billige holder flasken lige godt

You want something that others don't have - whether it has a cool function or not
Man vil nogle gange gerne have noget de andre har eller ikke har, om det så har en fed funktion eller ej.

An argument for buying the bike if you can feel that it drives well
Argument for at købe cyklen, hvis man kan mærke den kører godt

Upgrades because of performance and because it is cool
Opgraderinger er både baseret på performance og fordi det er fedt

Often the buyers does the marketing. “The neighbour has / is very happy with xx, I want this as well”
Kunderne sælger nærmest for dem. "Naboen har/naboen er mega glad for"

It is more expensive to maintain an expensive bike because the wearing parts are more expensive - but it can also last longer if maintained correctly
Rigtig dyr cykel er lidt som dyr bil, kører godt, men er dyrere at vedligeholde fordi sliddelene er dyrere.

Muc off has a nice price point and a lot of products and good suppliers.
Mange har også muc off fordi det er fornuftigt price point med bredt sortiment OG der er nogen store leverandører der også leverer andre ting så der kan det fås nemt til en god pris, sammen med andre leveringer.

Carbon is the most sought off, aluminium is the cheap alternative and titanium is the exotic and expensive choice.
Carbon er dyrest at producere og lettest vægt
Titanium er et mere eksotisk materiale
Ellers er det aluminium

Evaluate

Summarise and evaluation. Did the activity meet the objectives and to what extent? How did you evaluate? Did you use external feedback, calculations, estimations, etc.? And what is the validity of the result?

In short, it is almost always feelings that sell, as it is such a hobby segment people are willing to spend the money if they feel it is an improvement. This is apparent in different ways in the two distinct areas of mountain biking.
They are performance-oriented. Everything should be light, stiff and efficient. If they feel they get extra performance from saving 10 grams on the bottle holder they will buy it.
They are appearance-oriented. It doesn’t have to give performance, it just has to look cool. Much more fashion oriented, and almost making fashion statements by wearing impractical colours of clothing. These are the ones who have cool bikes that they will nurse around a lot making sure it always looks perfect. They want to have the coolest gear.

There is in general a large amount of dick-measuring in the biking community. It’s about having the newest and best equipment.
Right now the newest thing, that is the most common upgrade people spend on, is electronic gear shifters.

In terms of performance value for money, wheels might be the best thing to upgrade in the beginning. More stiff wheels, fitting of the rider weight will make the control more instant and precise.

The materials are in large part carbon fibre due to the light weight and great stiffness, Other than that it is mostly aluminium. There are examples however of aluminium frames with thin carbon fibre coating to make it look cool, even though it is heavier than just aluminium.

There is a soft correlation between the bike of choice and the equipment that people buy. If you spend a lot of money on a bike, the gear is likely to be more expensive as well in order to match. E.g. not putting a plastic bottle holder on a new 75k bike, but spending the extra to get the carbon fibre.

You can't really make a general assumption about who washes and cares more for their bike. There are plenty of people with expensive bikes that don't care too much for their bikes. Either because they don't know how, don't care or their hands are screwed on backwards.

Muc off have been great at branding themselves. The products work, they have a decent price point, the products themselves are eye-catching with the black and pink colour and they are great at making product displays in the stores. The displays are made with lighting and products are placed in the order of use. Muc-off's popularity is also in a big part caused by their marketing strategy and their close relationship with some of the biggest bike accessories distributors.
Additionally they sponsor large teams in cycling, such as INEOS in road cycling.

One salesman said that the customers almost do their job for them in selling the gear, because their neighbour says something is cool or good, then they also want it.

Reflection

What did you learn? Do you need to change method, mode, approach or revise the objectives, specification or criteria? What is the next move?

The knowledge gained is about the general trends in the biking industry and what people might be spending money on. Especially the Rold retailer was great at giving valuable knowledge to focus on the more fashion and gadget experience that is trending. The next task is to do concept work on gadgets and fashion in this scenario. It is also necessary to define the specific experience that is important for the user and thereafter necessary features that are needed for the user.

Important notes/observations: *Here you can write the important points and the new/updated requirements/demands and wishes, and how they were found*

Appendix 5

Activity:

Worksheet no.: 33	**Date:** 3/4	**Deadline:** 3/4	**Responsible: ng, kax**

Objective: *Here you briefly state the intention, plan, method, and desired result for the activity*

The intent of this activity is to walk through the to-be scenario of cleaning the bike, in order to identify and zoom in on all the small micro interactions that occur.

These interactions can be used for determining factors in the storytelling of the product, by indicating where the interactions are to determine how they should feel and look.

The scenario is carried out with the current mock-up model, and is filmed to look back at the interactions and take photos of.

Experiment/data: *Here you put in a sketch, storyboard, diagrams, photo of mock-up or experiment, rendering of 3D model, interview, etc, including own explanatory comments, analysis and perhaps evaluation*

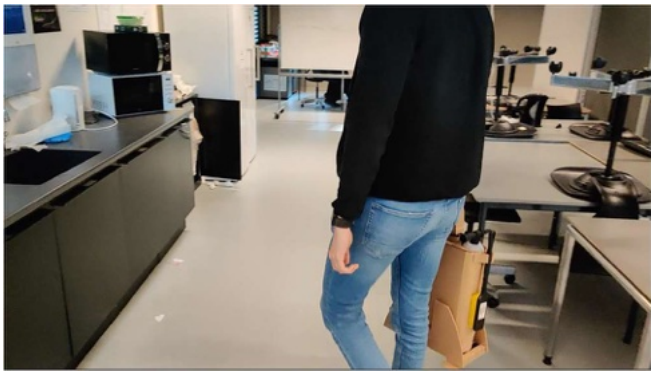
Scenario at home (before ride)

1:

Picks up the product from where it's stored

2:

Bringing the product to the sink



3:

Placing the product in front of the sink

4:

Releasing the gun from the tank

5:

Lifting the gun out of the tank

6:

Disconnecting the hose from the gun

7:

Extending the hose to reach the tap.

8:

Connecting the hose to the tap

9:

Turning on the tap

10:

Leaving it be while it fills up

11:

Turning off the tap again

12:

Disconnecting the hose from the tap

13:

Reeling back the hose

14:

Connecting the hose to the gun again

15:

Placing the gun back in the tank

16:

Picking up the product

17:

Walking to the car with the product.

18:

Placing the product in the boot

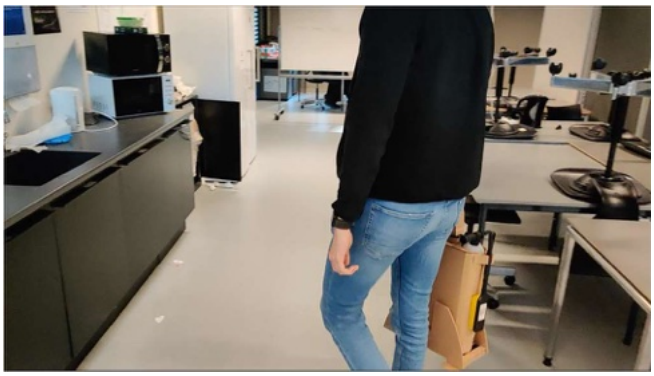
Scenario at home ALTERNATIVE (before ride)

1:

Picks up the product from where it’s stored

2:

Bringing the product to the sink



3:

Using both hands to pick it up

Feeling of control as to not bang the product into the counter

4:

Lifting it under the tap

5:

Unscrewing the lid to the tank

6:

Putting the lid aside

7:

Moving it to fit the opening under the tap

You must feel sure about the water going into the tank and not splashing all over the counter.

8:

Turning on the tap

9:

Waiting for the tank to fill

Know when it is about to be full, as to not spill water all over the place.

10:

Turning off the tap again

11:

Pulling it away from the tap

12:

Picking up the lid

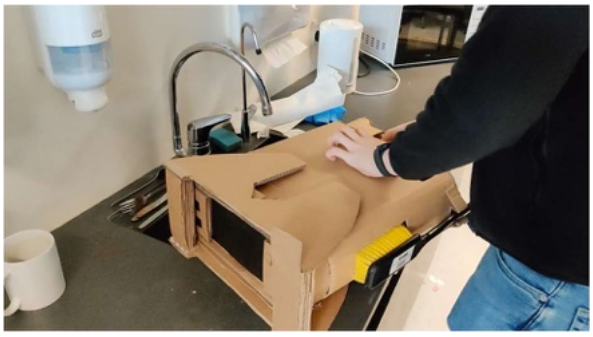
13:

Screwing the lid on

14:

Tightening the lid properly at the end

You should feel confident that it is closed correctly and there will be no leakage,

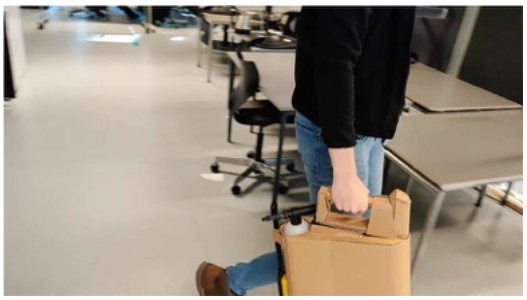


15:

Using both hands to pick it up

16:

Walking to the car with the product.



17:

Placing the product in the boot

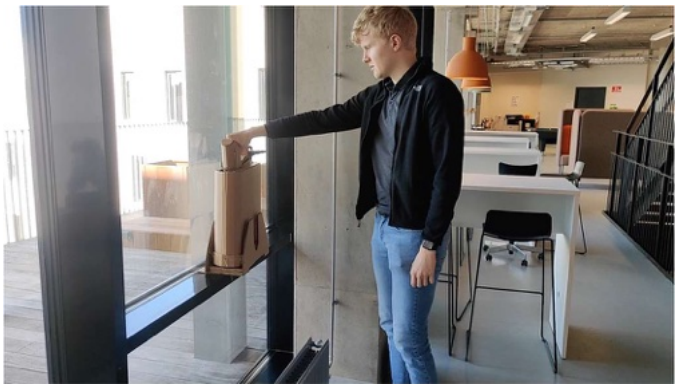
Scenario On site (after ride)

1:

Car boot is opened

2:

Grabs the handle



The product here is stood up right, but might be more stable if it was wider at the bottom or were laid on its side instead.

3:

Lift it up and out of the boot. With two hands for support (lot of weight possibly). Maybe consider if an additional handle or support point should be incorporated. The product might be tilted and dragged along the bottom of the car, to get it out.

4:

Second grip released.

Pic where the user walks with it.

5:

The user walks with the product towards the bike. Here the feeling of approaching the dragon with the sword should be. The product should not limit the users ability to walk/move over to the bike. So the product should not hit the leg or be too uncomfortable for the user to hold.

6:

Bending to put it down on the ground. Here a higher product would result in less bending of the back.

Note that the bike stand is the wrong way around.

7:

The foot can be placed on the bike stand to release it.

8:

The water tank is then pulled up to free the stand. Again lifting the water tank in an uncomfortable position.

9:

When the tank is pulled up, a strain between the bike stand and the tank might occur, caused by the foot only holding down one side of the stand. This might result in more power needed for lifting and potential damage on the product. The feeling of setting up camp and occupying the space for cleaning the bike. The user should feel like he has everything that he needs ready to assist him, just like if he was in his workshop.

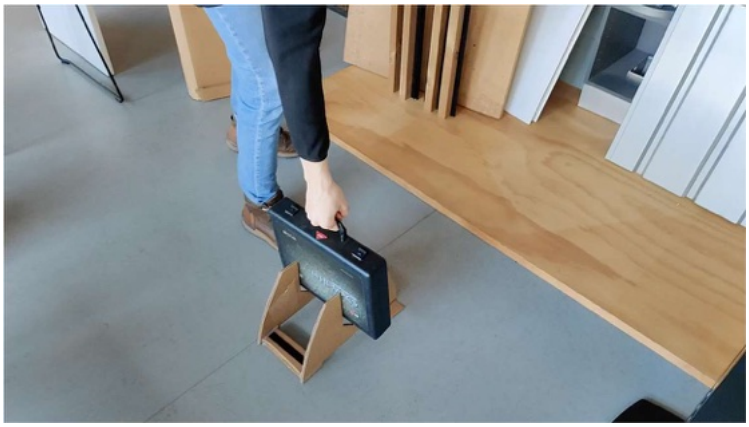
The feeling of placing the bike stand on the ground should be like the pro cup stackers , who holds a stack of cups and places them precisely and fast on top of each other.

10:

When removing the tank the user is most likely to move backwards to place the tank behind.

11:
The tank is placed on the ground again.

12:
The bike is afterwards placed on the bike stand. Here it would be easier to just roll it into place, rather than lifting it up and placing it in.

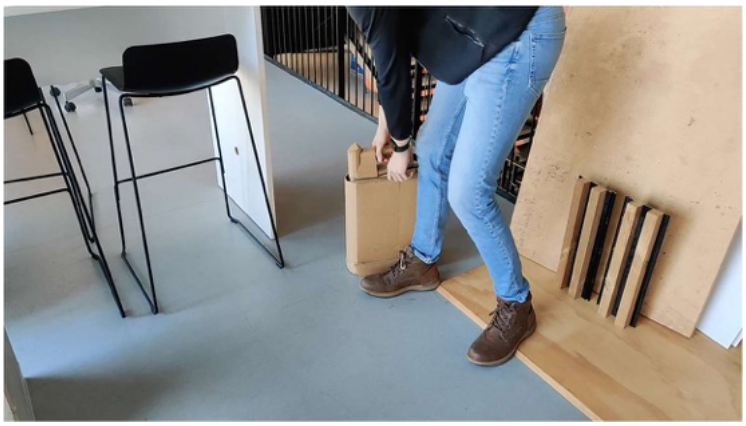


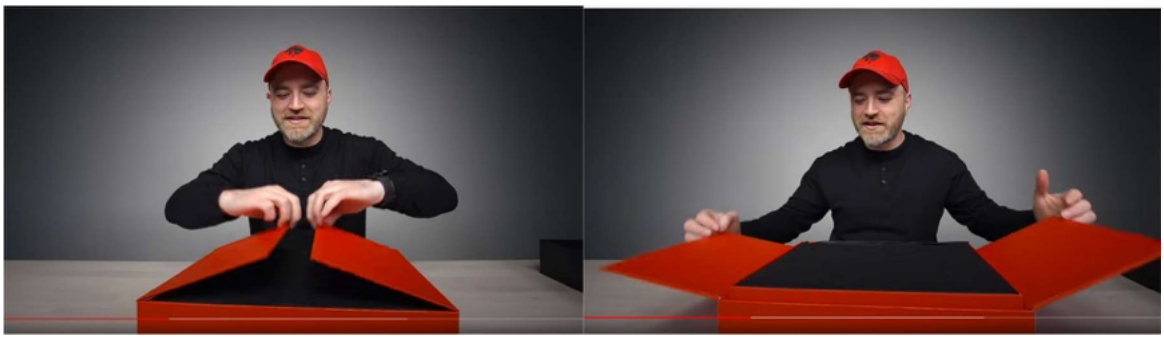
13:
The water sprayer is then retrieved from the water tank. Here a mechanism to easily release the gun should be. The feeling of:

- Releasing

- Taking out

- Gripping





Here an unboxing of a laptop that raises itself up (presents itself) when the doors are opened is shown. This gives the impression of a more expensive and exclusive product.

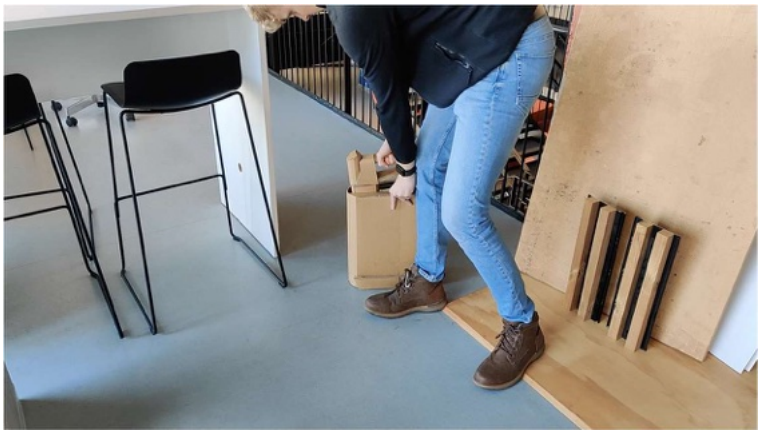



The product should present itself somewhat like the tool box in toy story 2. Here the tool box transforms itself into a small saloon for the toys. The toy refurbisher seems to have everything at hand always, when he has this box with him. Here the feeling of preparedness for any obstacle is cool. In addison the unfolding of the box is satisfying. The small box undfolds many times over and over and ends up covering a big area. A video of this scene is seen 14 million times on youtube.

14: The gun slides out

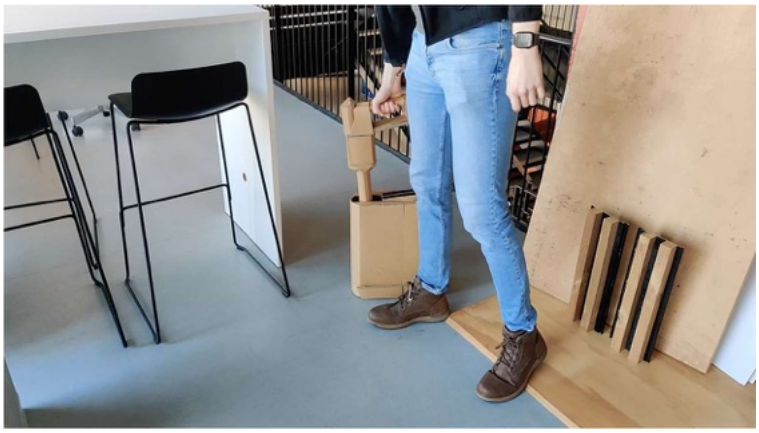
The same feeling of sliding your gun out should be like a gun holster on the belt.





15:

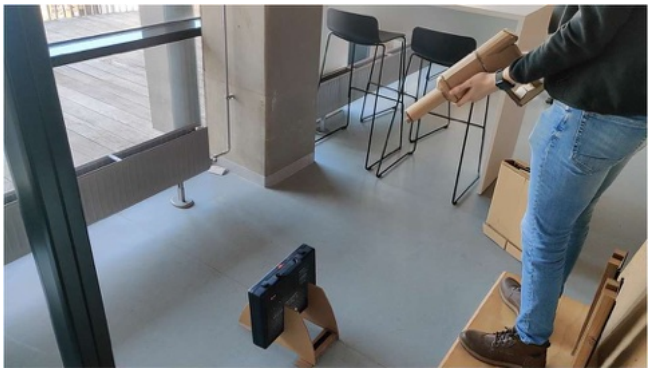
The gun is lifted out from the tank, revealing the nozzle



16:

The gun is used for spraying and wetting the bike

The feeling of placing the gun firmly in the hands and begin shooting should be something like swinging a heavy gun up to the other hand and start shooting like rambo. - you feel strong enough that you can hold it with one hand/arm and still control it.



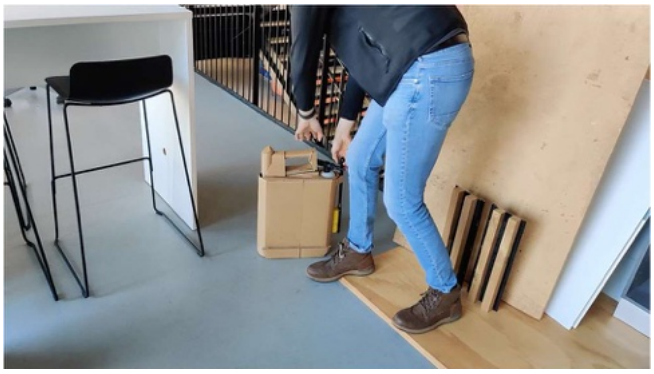
17:

The gun is placed in the tank again

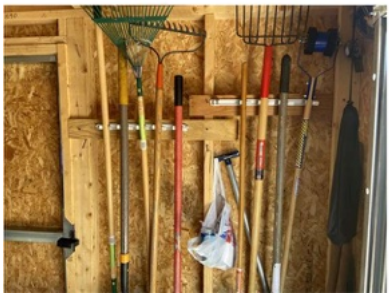
The feeling of placing the gun in the “holster” again should resemble the feeling of placing an air pod on its holster. It has a magnet and sides that guide it into place and gives a satisfying snap, when it is into place.

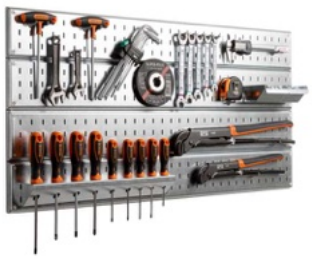
18:

The brush is gripped and removed/detached from the tank. One hand on the brush and one hand holding the tank.



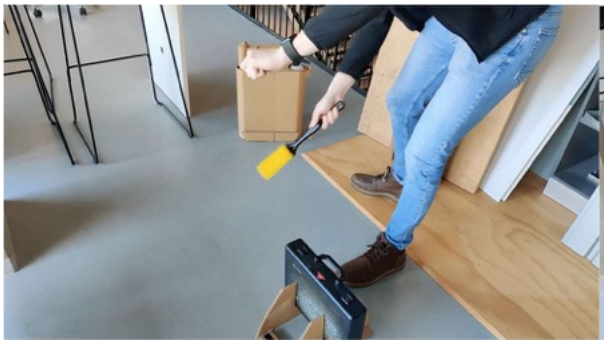
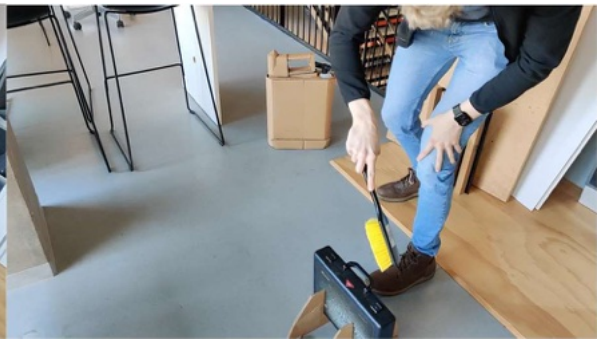
The feeling of taking off the brush should be the same as taking off a tool of a tool board or rack. It has it dedicated place, where it fits exactly and can be taken of with a single hand. When putting it back it should also have the feeling of locking into place.





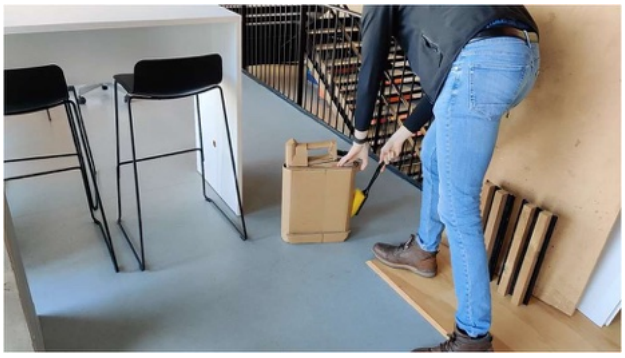
19:

Brushing the bike, and supporting the bike with the other hand.

20:

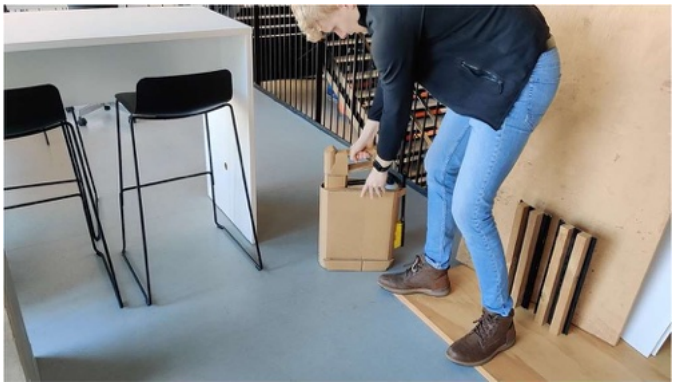
The brush is placed back in the tank, once again just using the other hand as a support.



The feeling of putting the brush back should also resemble the feeling of putting a tool back on the tool wall. It should be done with one hand with a firm grip around the handle, while the hand is not hitting anything. This means that it should not be like the Muc-off holder, since you would need to adjust the grip to press it in.

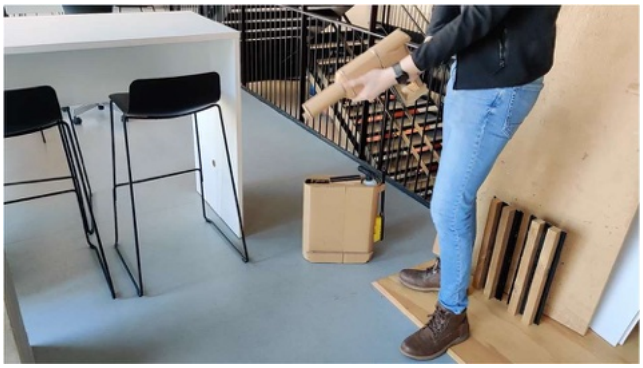
21:

The gun is picked up again.



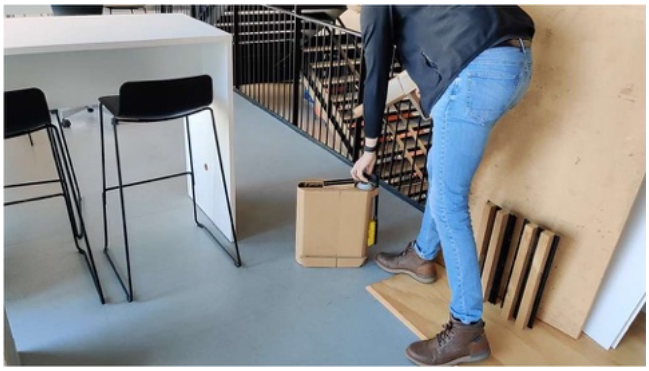
22:

The bike gets a quick spraydown again.



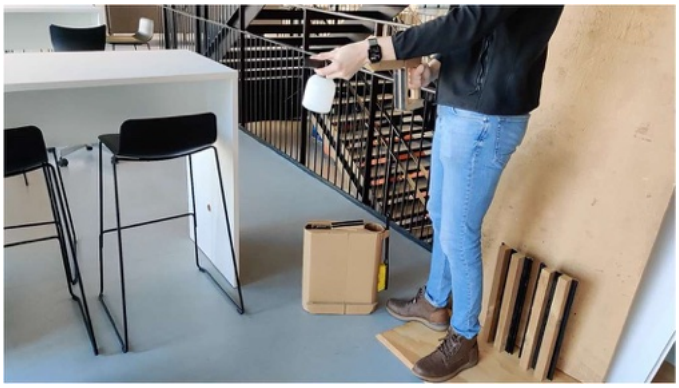
23:

The soap container is picked up

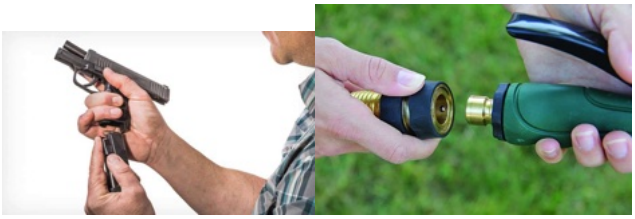


24:

The soap dispenser it put on the end of the gun.

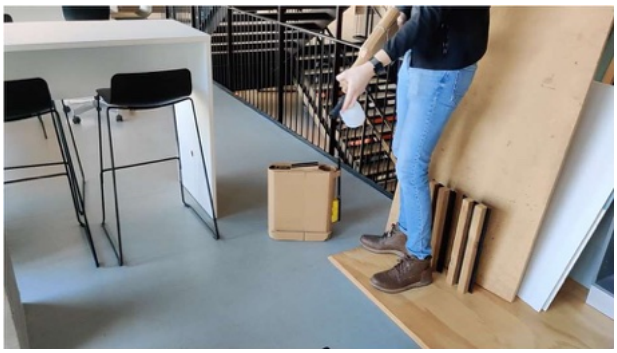


The feeling of attaching the soap dispenser should resemble the feeling of loading a magazine into a pistol. Or connecting a quick release hose. The click sound along with the tactile feedback of it being connected should be replicated.



25:

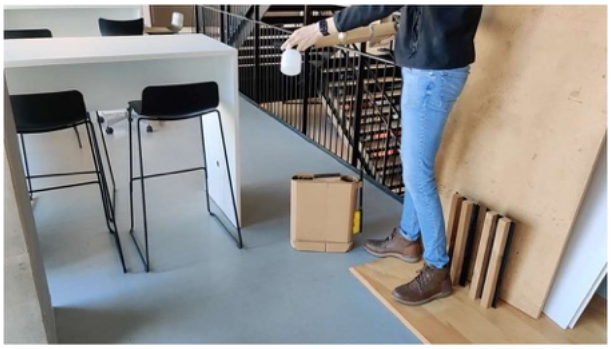
The bike is sprayed with soap foam.



It is definitely not in the interest of the user to “litter” with the soap. Therefore the soap stray should feel very controlled. This means that it should have a sharper angle than the current one, and spray less soap onto the bike. The precision and feeling should resemble the people who spray insulation in homes.

26:

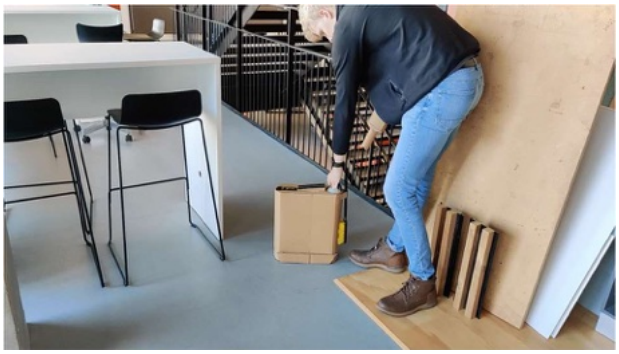
The soap dispenser is removed from the gun



This interaction should be like releasing a magazine from a rifle. The muc-off release trigger for the hose is awkwardly placed for one hand since it would require the point finger to press it down (it is way too hard). The thumb would be a much better choice.

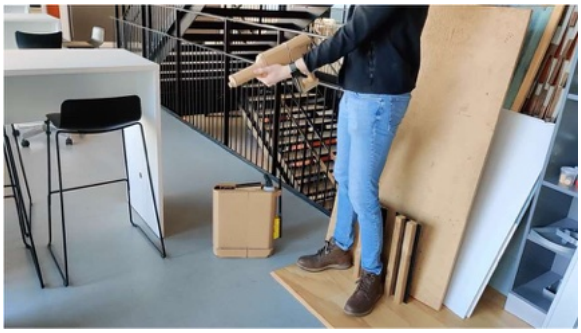
27:

The soap dispenser is placed back in the tank



28:

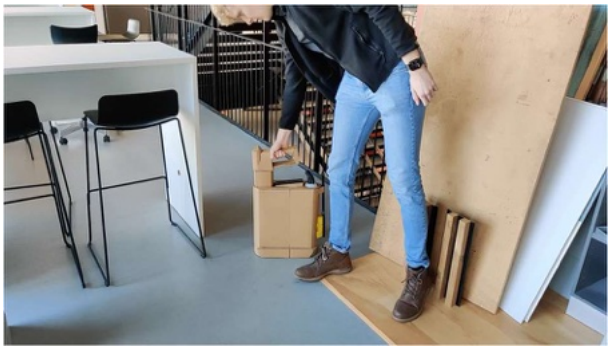
After letting the bike soak in the soapy foam, it is rinsed off with the gun.



The feeling of washing off the soap should be like cleaning a window and scraping the soapy water away.

29:

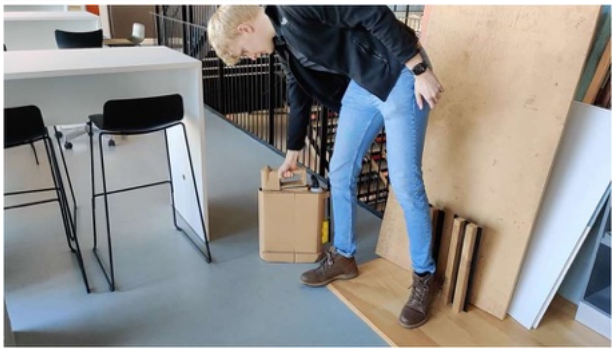
The gun is placed back in the tank



29.5:

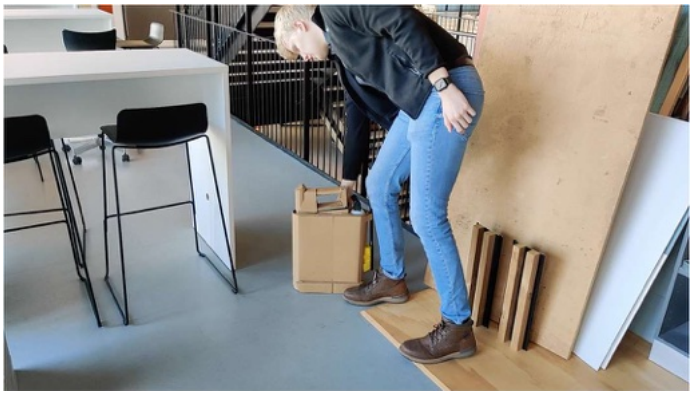
The gun gets a firm push down, as it was the last use.

It should feel secure and a tactile feeling or sound that it is locked in place, like a padlock being closed.



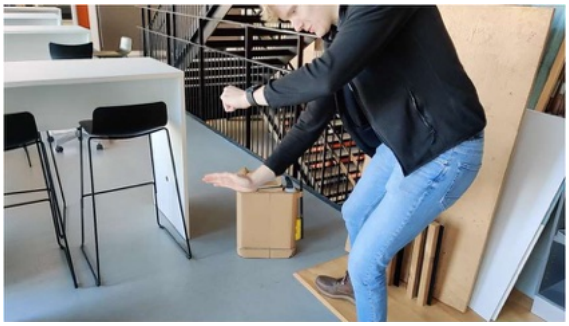
30:

A cloth is taken from the side.



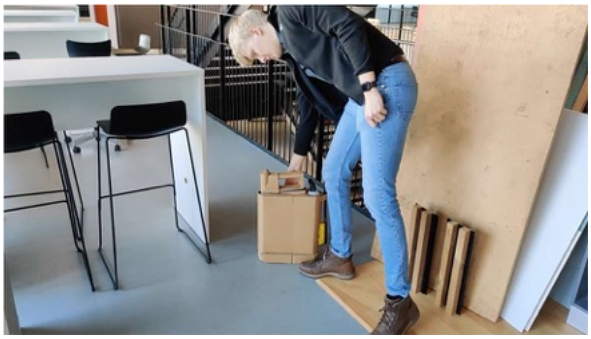
31:

The bike is dried off with the cloth. (Doing sick dance moves) (smack that… all on the floor)



32:

The cloth is put back



33:

The bike is removed from the bike stand.

It should feel smooth and straightforward to remove the bike from the bike stand.

Like a pallet jack?

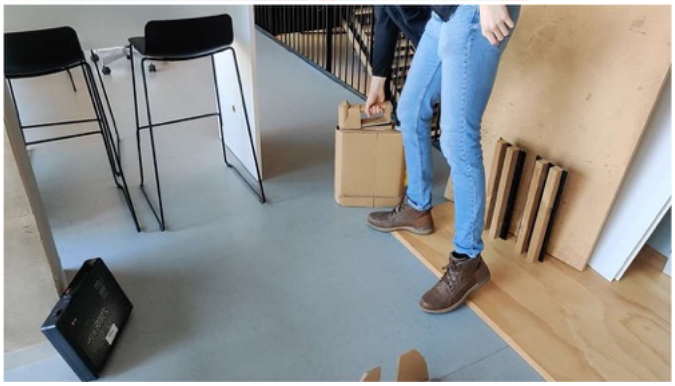
34:

The bike is carefully leaned on something nearby

35:

The tank is picked up.

The feeling should be of stability and the handle is secure, as picking up an important briefcase



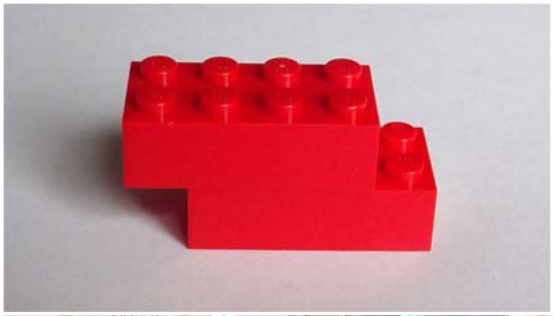
36:

A foot is placed on the bike stand

37:

The tank is slid in on the bike stand.

This should feel easy and you should feel that it fits together, and it should be clear when it is in place and locked, like lego bricks snapped together



38:

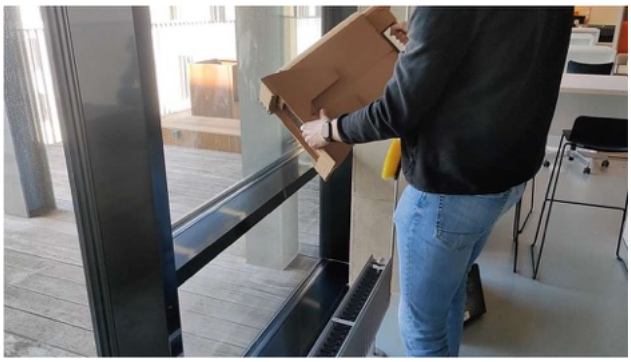
The product is picked up again, ready to be stowed after a successful cleaning job.

Again it's the feeling of stability and that both the handle and bike stand are secure, as picking up an important briefcase.

39:

The product is lifted into the boot.

It is held with both hands, giving a feeling of control and not bashing it into the car.

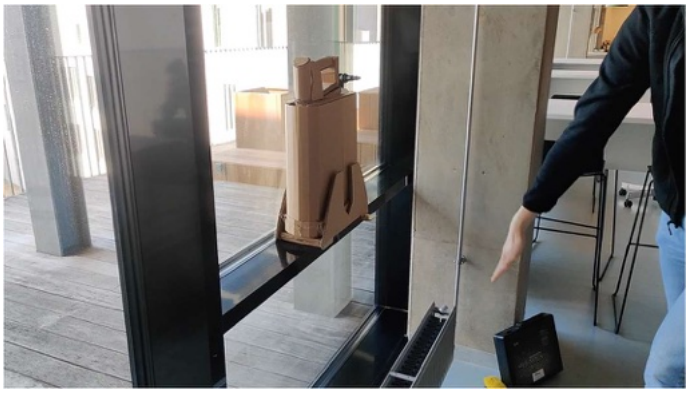


40:

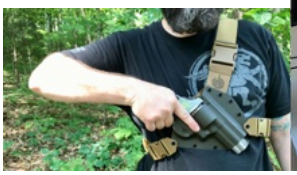
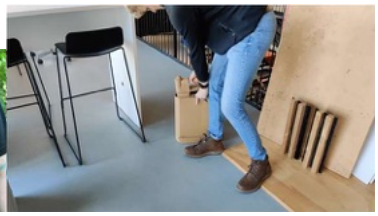
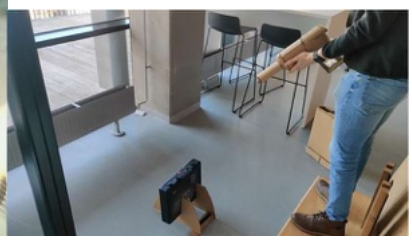
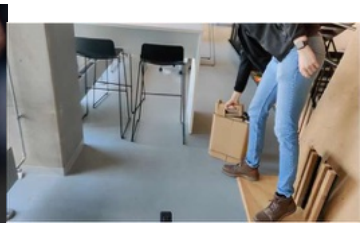
The product is put down, either standing or laying down

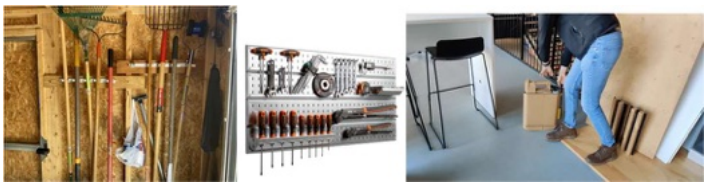
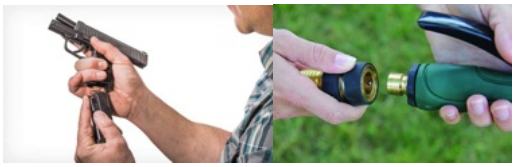
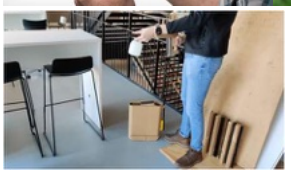
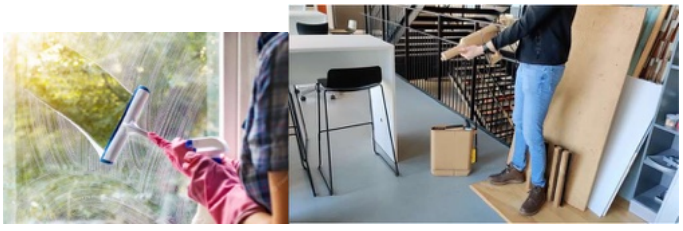
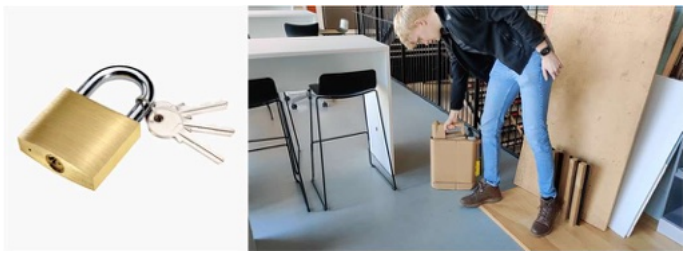
41:

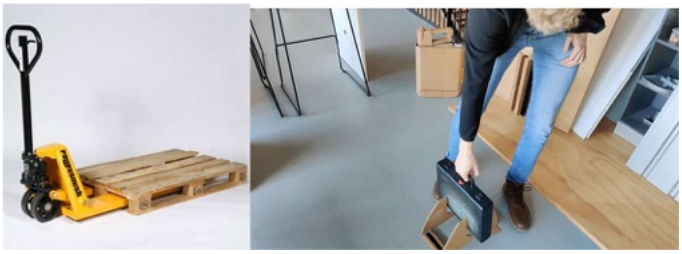
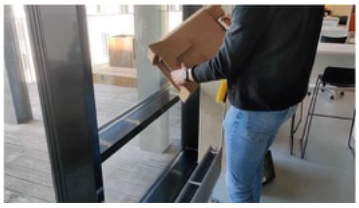
Car boot is closed



Slide	Feeling	description	Score / rank

9	 		6
13	   Taking out, Gripping		8
13	 		10
14	 		9
16	 		8
17	 		8

18			7
24	 	The feeling of attaching the soap dispenser should resemble the feeling of loading a magazine into a pistol. Or connecting a quick release hose. The click sound along with the tactile feedback of it being connected should be replicated.	6
25		It is definitely not in the interest of the user to “litter” with the soap. Therefore the soap stray should feel very controlled. This means that it should have a sharper angle than the current one, and spray less soap onto the bike. The precision and feeling should resemble the people who spray insulation in homes.	5
26		This interaction should be like releasing a magazine from a rifle. The muc-off release trigger for the hose is awkwardly placed for one hand since it would require the point finger to press it down (it is way too hard). The thumb would be a much better choice.	6
28		The feeling of washing off the soap should be like cleaning a window and scraping the soapy water away.	7
29.5		It should feel secure and a tactile feeling or sound that it is locked in place, like a padlock being closed.	9

34		It should feel smooth and straightforward to remove the bike from the bike stand. Like a pallet jack?	2
35		The feeling should be of stability and the handle is secure, as picking up an important briefcase (neuclear codes)	6
37		This should feel easy and you should feel that it fits together, and it should be clear when it is in place and locked, like lego bricks snapped together	7
39		giving a feeling of control and not bashing it into the car.	7

Evaluate

Summarise and evaluation. Did the activity meet the objectives and to what extent? How did you evaluate? Did you use external feedback, calculations, estimations, etc.? And what is the validity of the result?

By having done a to be scenario on the product and describing the feelings of the interaction for the user it enables us to rank the different interactions compared to each other. This ranking can provide information on what interaction/ working principals we should focus on when detailing the product. Some of these interactions / working principals should be tested on the users to figure out if the chosen principals is contributing in making the product cool.

Reflection

What did you learn? Do you need to change method, mode, approach or revise the objectives, specification or criteria? What is the next move?

- We learned what the most important interactions are.
- We need to test the chosen feelings on our user to be sure we do not implement anything that doesn't contribute to the overall feeling of the product.
- The feelings should be kept in mind when making concepts / principles.

Important notes/observations: *Here you can write the important points and the new/updated requirements/demands and wishes, and how they were found*

Appendix 6

Activity:

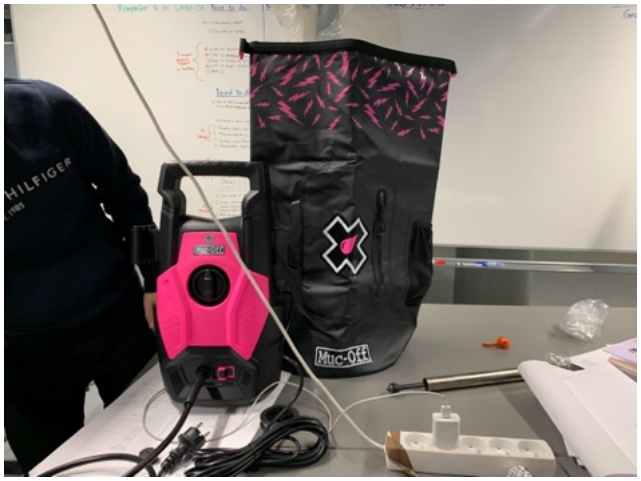
Worksheet no.: 20	**Date:** 22/3	**Deadline:** 22/3	**Responsible: All**

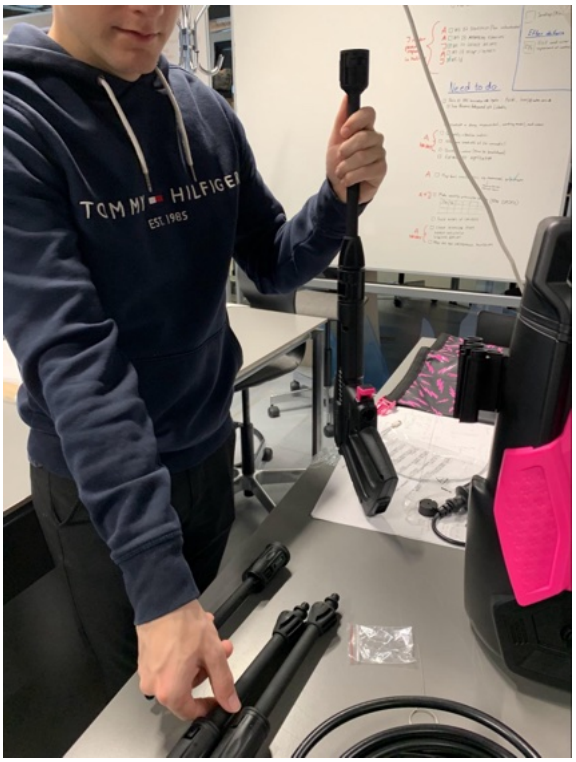
Objective: *Here you briefly state the intention, plan, method, and desired result for the activity*

Testing the Muc-off pressure washer compared to the Grouw. The intention is to see if there are differences in use and where our product can further improve the experiences of the machines. The test is done spraying the bike with either washer and noting any differences - positives and negatives.

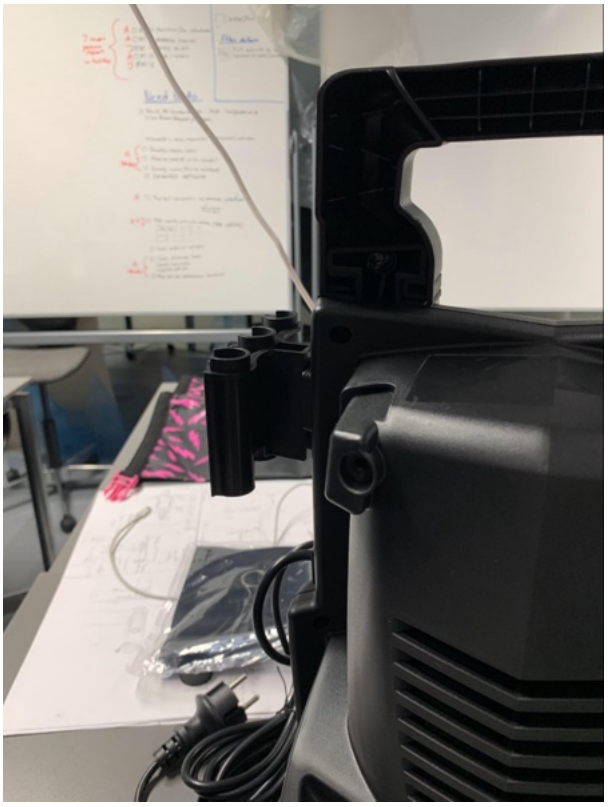
Experiment/data: *Here you put in a sketch, storyboard, diagrams, photo of mock-up or experiment, rendering of 3D model, interview, etc, including own explanatory comments, analysis and perhaps evaluation*

Assembly




TOMMY HILFIGER
EST. 1985


Mac-Off



Notes:

The Muc-off makes a lot more noise (too much)

It is obviously not made for pulling water through a hose
The Grouw spray angle is nicer and seems more powerful and precise
It is cumbersome and time consuming to prepare and pack up
The bag is not nice to carry
The foam sprayer is at all perfect
Storage is okay, but there is not space for all nozzles and extender
The gun cannot be put away when not in use - it must be put on the ground
The hose is too stiff
The interaction points are too low
It is nice that it automatically pulls water thru until ready
The spray lock is very nice
The hose clips are handy

Evaluate

Summarise and evaluation. Did the activity meet the objectives and to what extent? How did you evaluate? Did you use external feedback, calculations, estimations, etc.? And what is the validity of the result?

The Muc-off pressure washer is by no means a perfect product. In relation to its normal price it is actually a bit disappointing. It is loud, cumbersome and often inefficient. It is not a bad product

either. It is mostly well thought of and it looks nice from the front. The bag gives a good experience of the quality but it could also be smarter as it is not good for carrying.

Some nice solutions like the hose clips and spray lock are noted and easily implemented in our solution.

Reflection

What did you learn? Do you need to change method, mode, approach or revise the objectives, specification or criteria? What is the next move?

There is a potential for improving the general cleaning solution by moving it to the track. The Muc-off test gives a look into where we can improve the general experience of cleaning that has nothing to do with the Perception of the product usage itself.

The next step is to define the features in a brief based on speccable (nice to haves) and needs. After this it is possible to make new aesthetic solutions and price points and test on users (hopefully before milestone).

Appendix 7

Activity:

Worksheet no.: 37	**Date: jep**	**Deadline: jep**	**Responsible: Kax**

Objective: *Here you briefly state the intention, plan, method, and desired result for the activity*

Seven different parking lots will be visited in order to gather information about where the scenario is situated. This will also give information regarding the ground the product is to be placed on and the bicycle is to be cleaned on. It's our hope to figure out if muddy ground is a problem. The seven parking lots are all placed on one of the main roads going through Rold Forest.

Experiment/data: *Here you put in a sketch, storyboard, diagrams, photo of mock-up or experiment, rendering of 3D model, interview, etc, including own explanatory comments, analysis and perhaps evaluation*

Pictures of different kinds of parking lots near mountain bikes trails	Description	rank
 	-Mainly grass and gravel. -Slope on the ground - plenty of space - trees for standing up the bike.	6
 	-Forrest ground -mainly dirt and stones -slight slope of the road - moderate space -trees for standing up the bike.	3

 		-Asphalt parking - School parking lot - slight slope - trees for standing up the bike. -moderate space by parking lot, but plenty of space beside parking lot.	10
 		ADDISIOAL INFO: -At the school parking lot a washing station for bikes is placed. This is the station that one of our users currently uses.	
 		-Grass and gravel parking lot - slightly muddy. - no slope (why it is muddy. -trees for stand the bike up - plenty of space	6

		-Hotel parking lot -stone, pavement and grass hybrid. -moderate space. - no slope - trees for stand the bike up right.	10
		-Rebild bakker - gravel parking - grass right by the parking - No trees, but steep hill - slight slope -little space by the car, but plenty of space beside the parking	6
		Forest entrance -Dirt, sand -Slight slope -both trees and steep hill for stand the bike up - plenty of space.	4

Evaluate

Summarise and evaluation. Did the activity meet the objectives and to what extent? How did you evaluate? Did you use external feedback, calculations, estimations, etc.? And what is the validity of the result?

With this activity, we have gathered information about the placement our scenario is in.
We can see that there is:

- a lot of variation in the parking lots

- Different slopes, resulting in muddy areas
- Different terrain, asphalt, grass, gravel, dirt, stone, sand and hybrids.
    - Some of these will end up in dirt getting on the product.
- Mostly trees or other things to place the bike on, but not all the time
- There is not always enough space to clean the bike by the car.
- There is almost always grass somewhere.
- The ground is most often a slope.

Reflection

What did you learn? Do you need to change method, mode, approach or revise the objectives, specification or criteria? What is the next move?

This information confirms the point that always cleaning the bike right by the car is not a good idea. Additionally, our product needs to be quite stable. This information can be used when making the feet for the product along with the bike stand.

Important notes/observations: *Here you can write the important points and the new/updated requirements/demands and wishes, and how they were found*

Appendix 8

Activity: Looking further into opening mechanisms specifically

Worksheet no.: 49	**Date:** 21/4	**Deadline:** 21/4	**Responsible: All**

Objective: *Here you briefly state the intention, plan, method, and desired result for the activity*

Exploring different mechanisms to achieve the opening of the lids with the movement of the gun downwards from its lifting position. The plan is to do this by desktop research and find reasonable solutions that can be developed in co-op with Lars. The desired result is one or two mechanisms that can both secure the gun vertically and allow for the correct vertical movement when necessary. It is made concurrently with WS50 which does the same as this worksheet but for attaining rotational movement to the lids from the vertical gun movement.

Experiment/data: *Here you put in a sketch, storyboard, diagrams, photo of mock-up or experiment, rendering of 3D model, interview, etc, including own explanatory comments, analysis and perhaps evaluation*

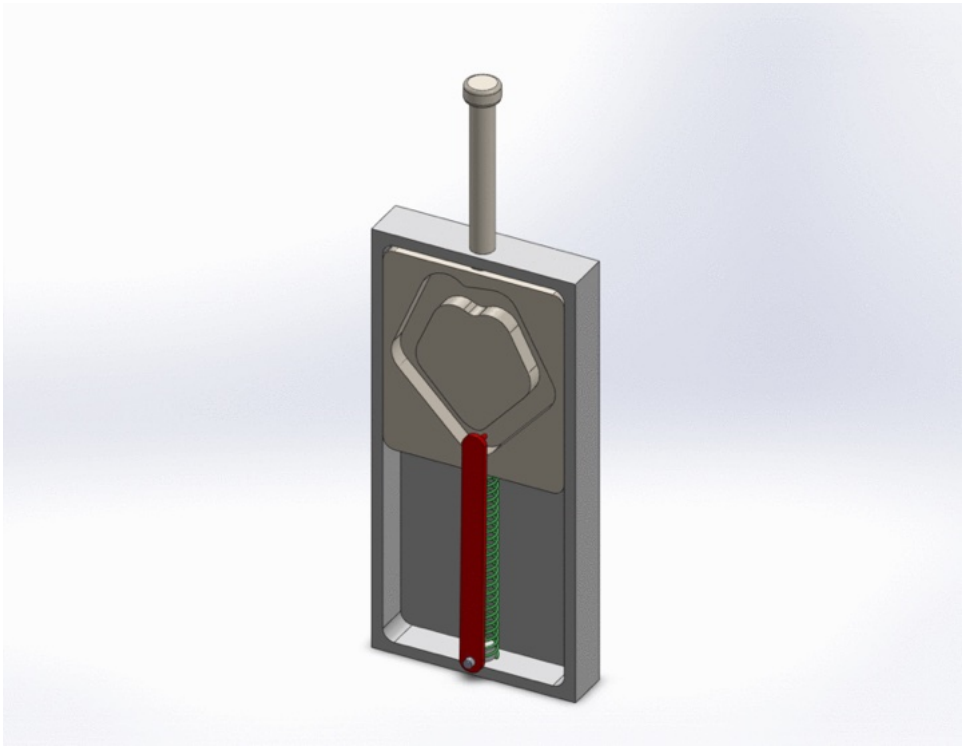
Mechanisms

https://bpb-us-w2.wpmucdn.com/sites.gatech.edu/dist/2/334/files/2017/09/1700-Animated-Linkages.pdf
https://www.youtube.com/watch?v=YSnQ8ZdU2x4&t=113s
https://www.youtube.com/watch?v=stObRUtcdRo
https://www.youtube.com/watch?v=N395Mxotd2M

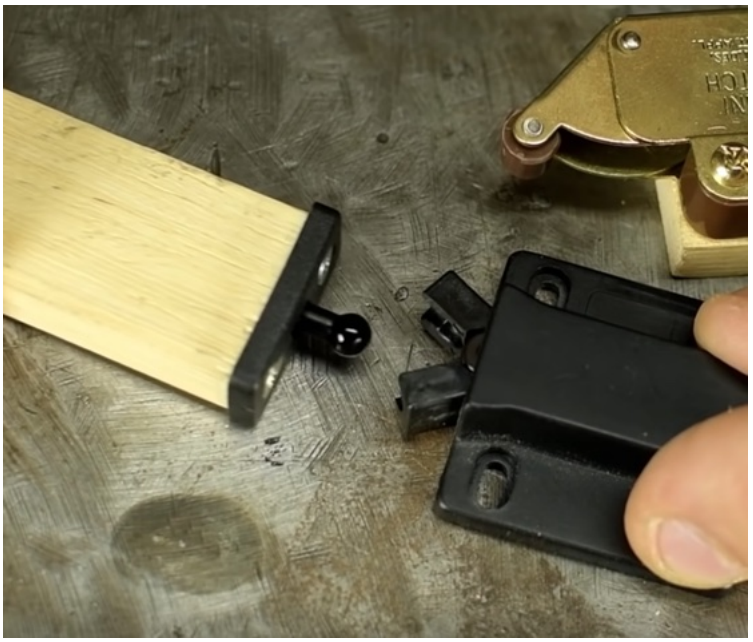
Releasing the opening

- Push to open the latch.

Pushing on it to release the two gripping arms. Likewise pushing on it to lock it in place, with the two gripping arms closing.



https://grabcad.com/library/push-push-button-mechanism-1
https://www.youtube.com/watch?v=VA7UGVCpcFk



https://youtu.be/3_wPH904a_8?t=311
https://www.youtube.com/watch?v=tTKHTnD20CI

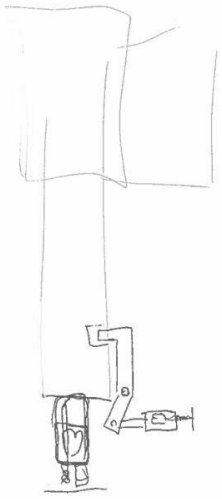
- Rotary latch

Similar to opening the hood of a car.
Using a lever, that the user interacts with, a cable to transfer the action, and the rotary latch itself.

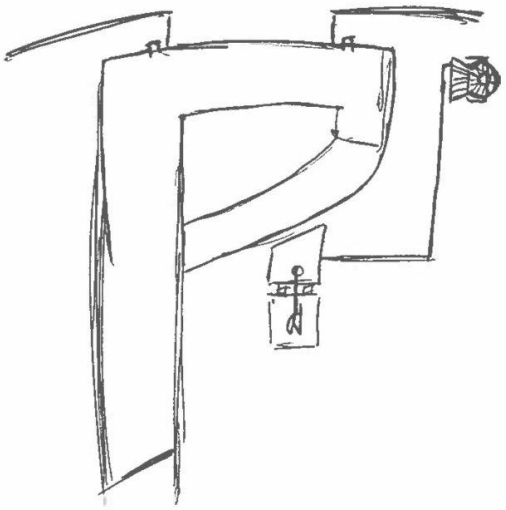
https://www.machinedesign.com/automation-iiot/cables-connectors-enclosures/article/21832079/how-to-get-the-best-rotary-latches

https://www.camlock.com/video-how-it-works-series-100-rotary-latch
https://www.youtube.com/watch?v=FZ1owuollXU

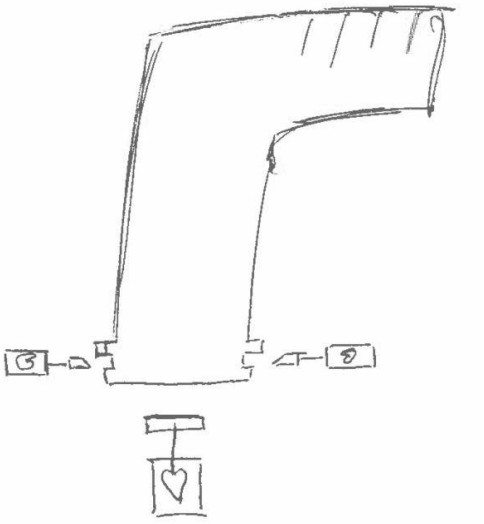
Initial concepts using push - push



The push - push mechanism is used in two places. To lock vertically and achieve rotation in the lid. Both mechanisms are actuated pushing the gun downwards - hence why it is called push - push.

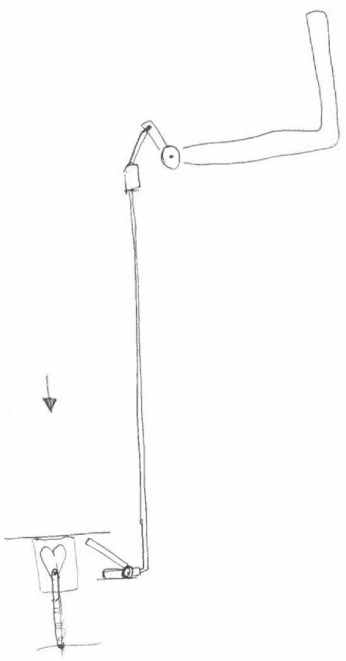


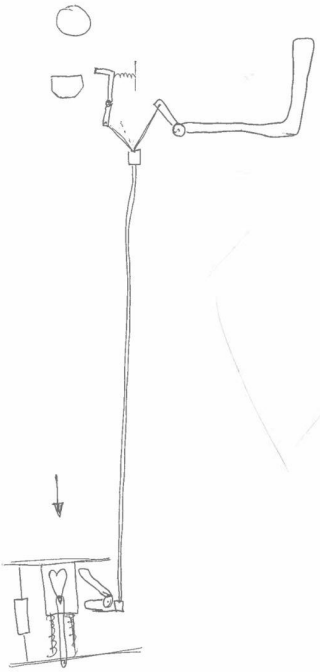
The gun is locked vertically by the shells in the top and secured horizontally by the bumps on the gun that are fitting to the moulded indents in the shells. The vertical movement in the push - push mechanism is converted to a rotational movement which is again angled and geared up using bevel gears - more on this in WS50.



Here the push - push mechanism is used in three different places. It is used to close the lid with the lower push - push mechanism, whereas the two mechanisms on the side are locking the gun from moving vertically. These mechanisms have angled end points to allow for some movement in one direction when it is pushed down to make them pull back and unlock the gun.

Initial concepts using rotary latch principle (or brake line principle)

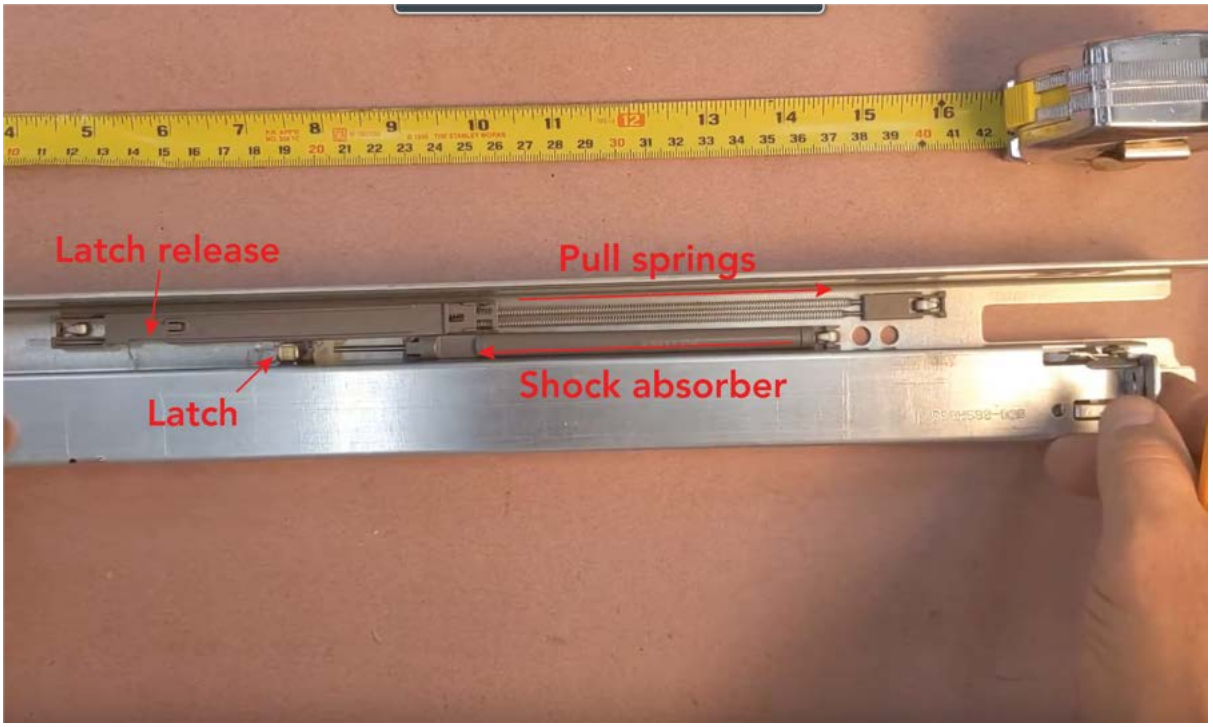




- The side panels collide with themselves when opening the box
- The speed of the opening is not controlled

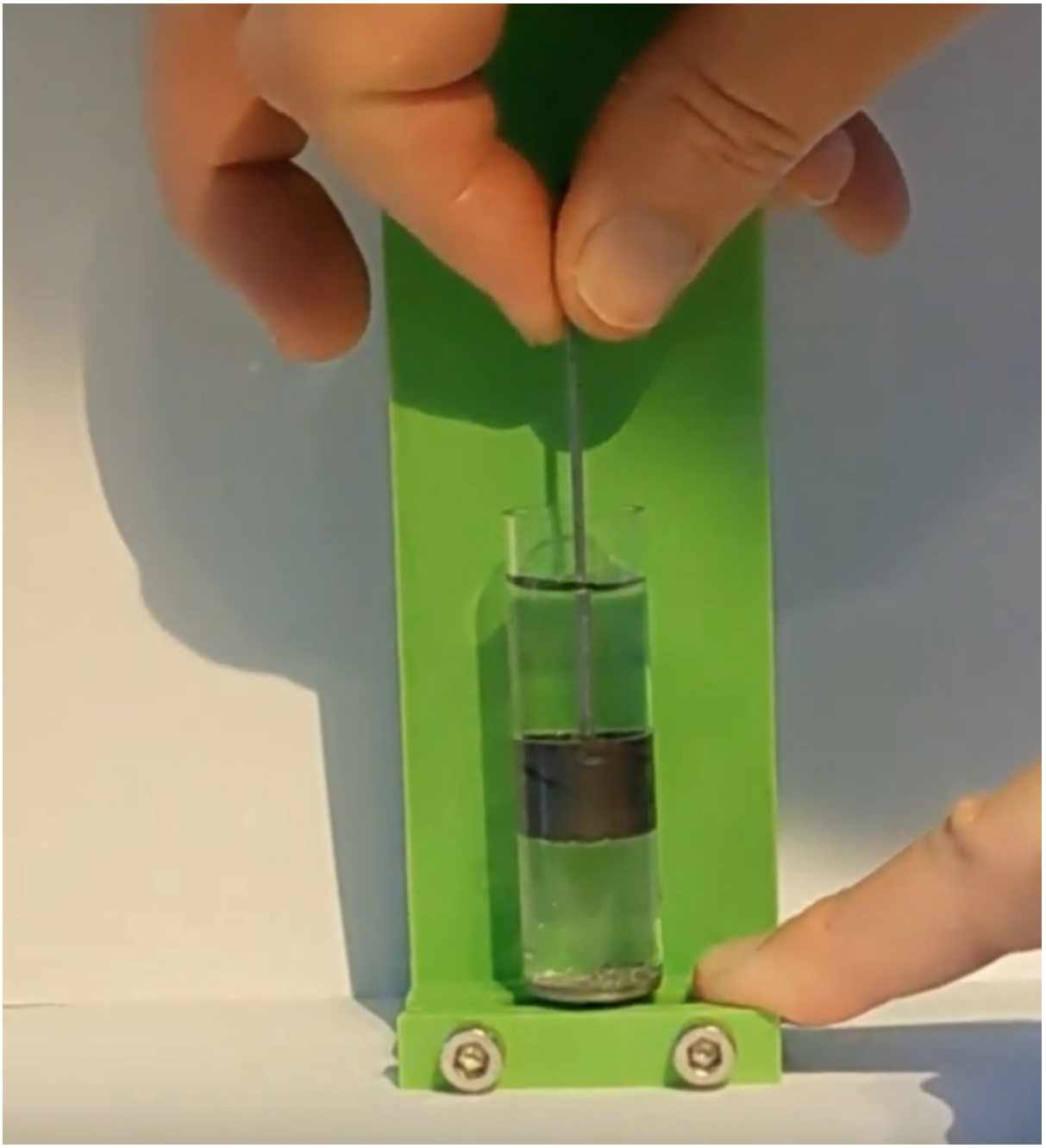
This solution is a mix between push-push and brake line principles.
The push-push limits the gun to its vertical positions and allows for the actuation of the brake line which then actuates the movement of the lid and the mechanism that locks the gun vertically for lifting purpose. This is a very simple solution and is intended to develop further in co-op with Lars after MS4.

Soft close dampening



The pull springs pull the drawer close, when the latch is engaged. When the drawer is past the latch release it moves freely. The shock absorber works against the pull springs, to dampen the pulling effect. It consists of a rod being pushed by a spring inside. The inside is lathered with silicone fluid.
https://youtu.be/3HXxgUfc_-w

The first type pulls a drawer controlled in place. This type however, will only dampen the motion in the one direction (the pull spring is not included). This also means it will be held in place in the closed position only by the force or weight of the door being too heavy for it to push open.



Fluid dashpot damping is where a viscous fluid (water here, could also be air depending on the loads) has to travel through (a) small hole(s) or grooves in the piston, and as such is limited, damping the pressure and movement.
Limitations are the buckling of the rod in compression damping, and cavitation of the tube in extension damping.

https://www.youtube.com/watch?v=nW4q8X0RbnI
Pull damping as explained here, using air, works great if the load to be damped is not too great, and the piston is reset to the end position before each damping. Otherwise the air column will be longer and the airspring will make the movement jump a couple times.

Evaluate

Summarise and evaluation. Did the activity meet the objectives and to what extent? How did you evaluate? Did you use external feedback, calculations, estimations, etc.? And what is the validity of the result?

This task has shown different possibilities for achieving the needed movement mechanically. That is in regards to both the releasing of the bike stand and the presenting of the gun and opening of the lids.

Reflection

What did you learn? Do you need to change method, mode, approach or revise the objectives, specification or criteria? What is the next move?

With the knowledge from this task, the next step is to determine the style of the water tank and start to dimension the mechanism so the components can be placed.

Important notes/observations: *Here you can write the important points and the new/updated requirements/demands and wishes, and how they were found*

Appendix 9

Activity: Bike Stands

Worksheet no.: 30	**Date:** 3/4	**Deadline:** 3/4	**Responsible: KAX**

Objective: *Here you briefly state the intention, plan, method, and desired result for the activity*

The objective of this worksheet is to figure out what kind of bike stand is the best suitable one for our product. In order to simplify our solution and not focus solely on the bike stand, it is wished to incorporate an already existing bike stand design if possible. This will be done by collecting all the available bike stands which are in a compact size. it will also just include 2-1 bike rack and floor standing. This is done by desktop research, searching google images.

Experiment/data: *Here you put in a sketch, storyboard, diagrams, photo of mock-up or experiment, rendering of 3D model, interview, etc, including own explanatory comments, analysis and perhaps evaluation*

This type of stand was seen at Finn's place during the interview. While it does look really professional in its use, Finn also stated that it is not optimal to use in conditions less than perfect. A slope and a slight breeze they fall over. Furthermore they are a hassle to set up even in ideal conditions. For these reasons, this type of bike stand is disregarded early on.

https://www.walmart.com/ip/Vokewalm-Bike-Rack-Garage-Bike-Stands-For-Indoor-Storage-Wooden-Bike-Stand-Floor-Single-Suitable-For-Small-Light-And-Durable-Bicycles-amicable/1175948569

https://www.core77.com/posts/36227/Small-Space-Challenge-Storing-Bicycles-Indoors

https://www.amazon.com/dp/B012HFJGMI/ref=asc_df_B012HFJGMI4289549/?tag=INSERT_TAG_HERE&creative=394997&creativeASIN=B012HFJGMI&linkCode=df0

https://www.amazon.com/2006-RAD-Cycle-Bicycle-Instant/dp/B003RX3G08/ref=sr_1_2?c=ts&keywords=Bike+Racks+%26+Stands&qid=1680505606&s=hi&sr=1-2&ts_id=165113011

https://www.amazon.com/Bike-Bicycle-Floor-Stand-Storage-Rack/dp/B017EEUMF2/ref=sr_1_10?c=ts&keywords=Bike+Racks+%26+Stands&qid=1680505606&s=hi&sr=1-10&ts_id=165113011

https://www.amazon.in/WALMANN-Parking-Garage-Storage-Outdoor/dp/B08YNV5XX5?th=1

https://www.instructables.com/Wood-Bike-Rack/

https://www.pinterest.dk/pin/67976275627736433/

https://www.pinterest.dk/pin/693976623856747237/

https://www.pinterest.dk/pin/654499758340160855/

https://www.pinterest.dk/pin/359162139036176028/

https://www.pinterest.dk/pin/544794886182798935/

https://www.pinterest.dk/pin/441141725995766123/

https://www.pinterest.dk/pin/65794844539289540/

https://www.pinterest.dk/pin/306385580902101418/

https://www.google.com/search?q=small%20bike%20stand&tbm=isch&tbs=rimg:CXpYO_rNG1YnYUYQXxiauyJysgIOCgIIABAAKAE6BAgBEAHAAgA&hl=en&sa=X&ved=0CB8QuIIBahcKEwjwqq_zjI3-AhUAAAAAAHQAAAAAQJA&biw=1903&bih=937#imgrc=zaVmmXCJGNvCbM

https://www.pinterest.dk/pin/583568064207926387/

https://www.topeak.com/global/en/product/1137-TUNE-UP-STAND-X

https://www.topeak.com/global/en/product/315-FLASHSTAND-FAT

Concepts	Size (6)	Weight (9)	Setup (7)	Cleanability Stand (6)	Cleanability Bike (5)	Cool (visual) (3)	Stability (7)	Total score:
	7	8	8	5	6	3	6	28,1

	6	7	6	4	5	3	7	24,8
	8	6	6	7	9	8	5	29
	9	2	8	7	7	7	4	25,4
	4	7	2	8	10	8	6	26,5
	7	8	8	5	6	3	6	28,1
	10	10	3	6	10	5	2	28,6

Evaluate

Summarise and evaluation. Did the activity meet the objectives and to what extent? How did you evaluate? Did you use external feedback, calculations, estimations, etc.? And what is the validity of the result?



These three concepts were the main concepts that could be used for the bike stand. The first one which is attached to the pedal arm, is not considered a viable option, because of its low stability and problematic setup. This might indicate that we need a demand for how stable it should be or how easy it should be to set up.

The second and third concepts seem to be good solid options. These should be tried to be implemented into the overall concepts to see which one fits the best.

Reflection

What did you learn? Do you need to change method, mode, approach or revise the objectives, specification or criteria? What is the next move?

We narrowed the concepts for the bike stand down to two principles of holding the bike. To figure out which solution should be implemented in the final product further testing of implementation is needed. This could provide information about space optimization and workflow in the setup and cleaning process.

Testing out the bike stands is not something that we want to do yet, since we believe that both are viable options and we believe that not limiting the tank because of the bike stand might be beneficial when implementing some of the other features.

Important notes/observations: *Here you can write the important points and the new/updated requirements/demands and wishes, and how they were found*

Appendix 10

Activity:

Worksheet no.: 36	**Date:** 11/4	**Deadline:** 11/4	**Responsible:**

Objective: *Here you briefly state the intention, plan, method, and desired result for the activity*

The worksheet is aimed at doing styleboards for two different style directions, the modern sleek style and the more rugged outdoorsy style. The goal is to have style boards that can help gather information about what direction to go, by showing to users and getting feedback.

Experiment/data: *Here you put in a sketch, storyboard, diagrams, photo of mock-up or experiment, rendering of 3D model, interview, etc, including own explanatory comments, analysis and perhaps evaluation*

Modern sleek

Modern sleek look











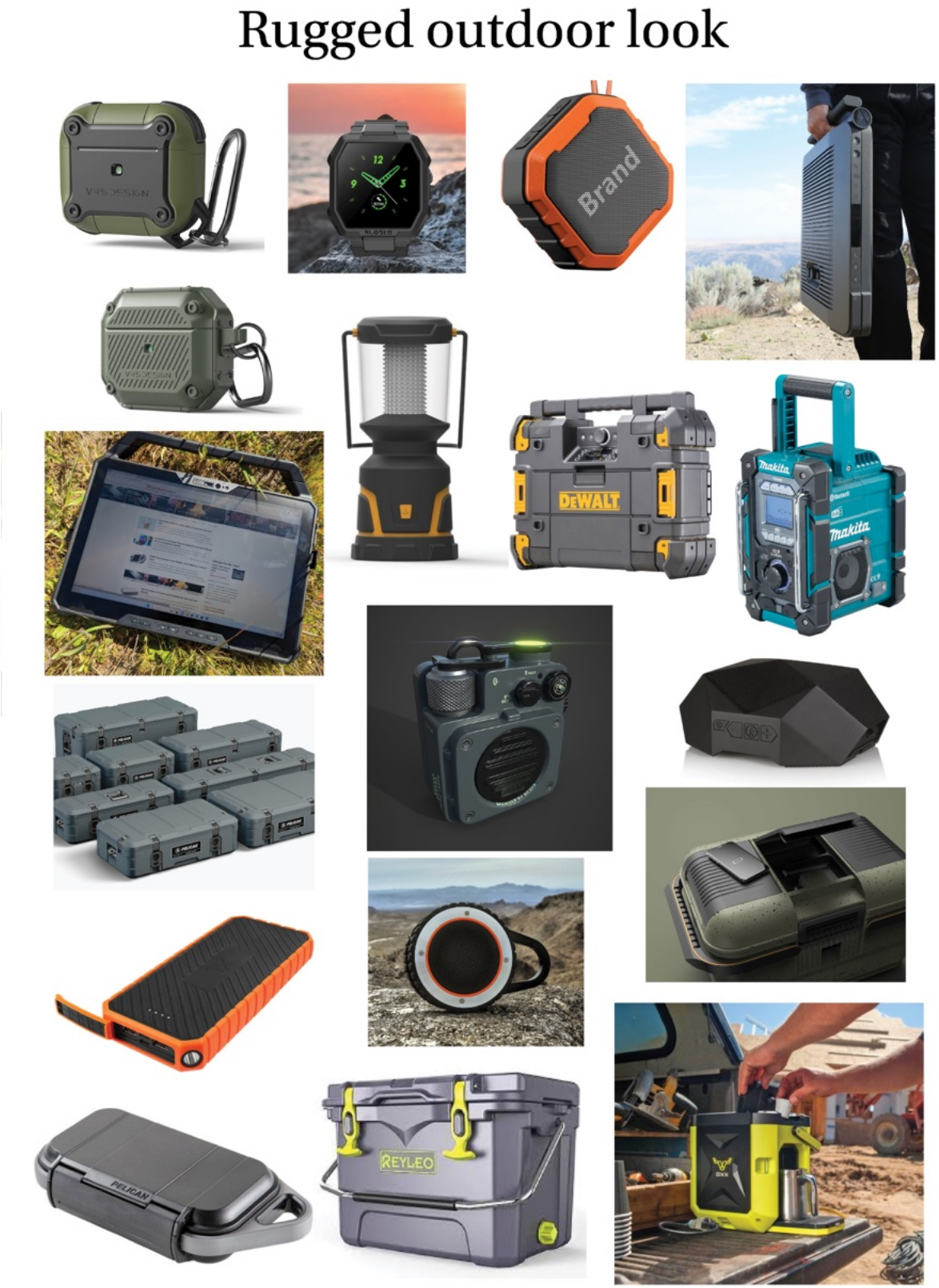








Outdoorsy rugged



Sporty outdoor

Sporty outdoor look




























Evaluate

Summarise and evaluation. Did the activity meet the objectives and to what extent? How did you evaluate? Did you use external feedback, calculations, estimations, etc.? And what is the validity of the result?

This worksheet presents the full style boards that have been used in the development of style in phase 3. Though the intention was to create two style boards it eventually ended up with three which is just a bonus at this point.

Reflection

What did you learn? Do you need to change method, mode, approach or revise the objectives, specification or criteria? What is the next move?

The next step is to use the style boards as inspiration for the design.

Important notes/observations: *Here you can write the important points and the new/updated requirements/demands and wishes, and how they were found*

Appendix 11

Activity: Weight balance testing the gun

Worksheet no.: 40	**Date:** 14/4	**Deadline:** 14/4	**Responsible: NG**

Objective: *Here you briefly state the intention, plan, method, and desired result for the activity*

The objective of this activity is to determine how the placement of the pump, motor and battery impacts the weight balance of the gun, and in turn how this impacts the feeling when holding the gun.

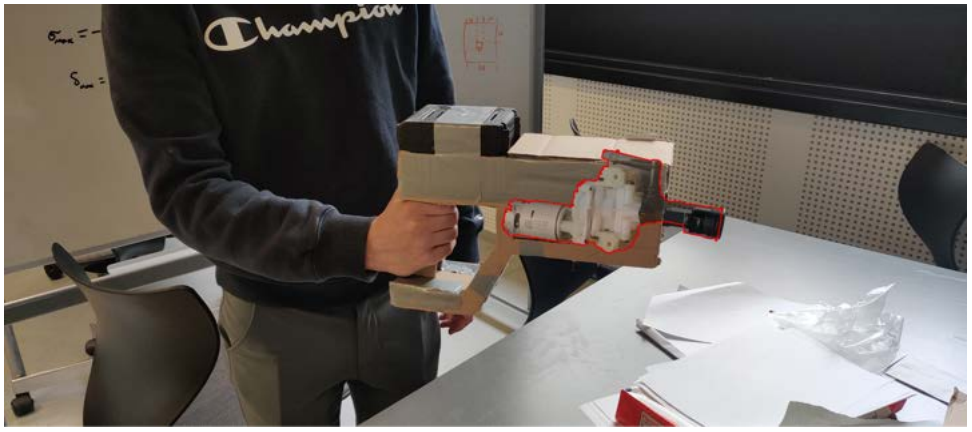
The aim is to determine how the components should be placed in the gun.

The theory is that placing the motor and pump close to the hand above and the battery below the hand is the best for weight balance. However for design purposes it should be tested whether placing the battery above the hand as well is doable while maintaining a decent weight balance.

This will be tested with mock-ups, where the components can be placed in different placements.

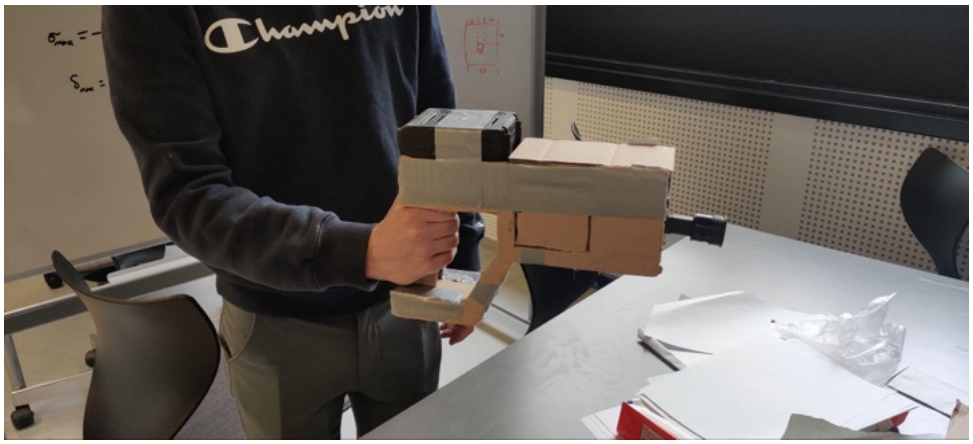
Experiment/data: *Here you put in a sketch, storyboard, diagrams, photo of mock-up or experiment, rendering of 3D model, interview, etc, including own explanatory comments, analysis and perhaps evaluation*

First off, a mock-up is built with cardboard. The mock-up allows for two configurations of the components. Placement of motor and pump can be seen in the images below.

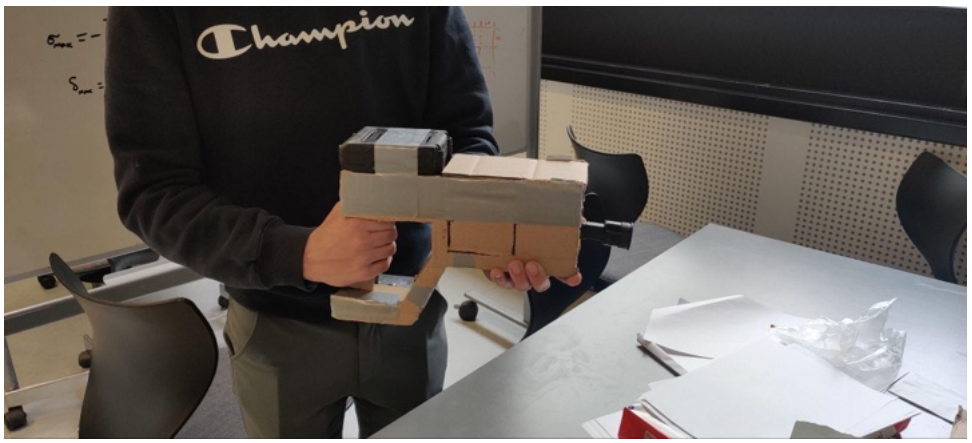


The mock-up gun is configured with the close design first, and tested by team members holding it and simulating spraying a bike.
The remark about this is, that the weight balance feels good, when it is close to the hand like that.

Afterwards, the long design is configured, and tested. Instantly it was noticeable that the balance was way worse, as expected. It is noted that it makes the gun feel a lot heavier to hold and use.



It is further noted for both, that getting close and tilting the gun sideways feels heavy and straining, and as a result you might want to use both hands in this case.
Therefore, two hand grips were attempted on both the configurations, as seen below. Here it is noted that the bottom part that would be gripped should be slightly further forward on the gun, in the scale of 2-3 cm, as this will accommodate better where you naturally would grip it.



Lastly it is noted that, mock-up looks a little too massive in the front, as the narrowing is not represented. This simply supports the notion that the nozzle end should narrow down, to give a sense of direction, and lighten the look and feeling of the front end.

Evaluate

Summarise and evaluation. Did the activity meet the objectives and to what extent? How did you evaluate? Did you use external feedback, calculations, estimations, etc.? And what is the validity of the result?

In summary, the close design feels a lot better to hold and operate, and should thus be the aim to use when designing the gun.
The secondary grip surface should be extended 3 cm forward to better accommodate the natural grip.
And lastly it's understated that the nozzle end should be narrowing, like drawn on the sketches, to avoid a too bulky gun.

Reflection

What did you learn? Do you need to change method, mode, approach or revise the objectives, specification or criteria? What is the next move?

The activity has given the wanted information, and the design direction is helped in moving forward. Going forward the gun design is to get another go, incorporating the new knowledge, and also make it fit with the box design.

Important notes/observations: *Here you can write the important points and the new/updated requirements/demands and wishes, and how they were found*

Appendix 12

Activity:

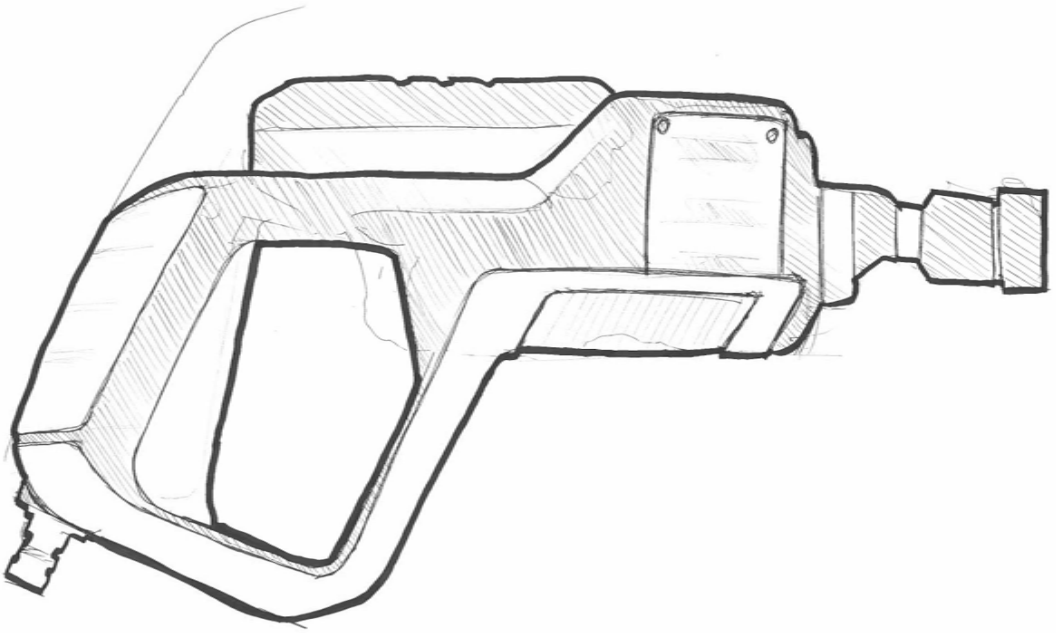
Worksheet no.: 41	**Date:** 12/4	**Deadline:** 17/4	**Responsible: J+Kax**

Objective: *Here you briefly state the intention, plan, method, and desired result for the activity*

Trying different styles for the gun and water tank in relation to the defined style boards that can be seen in WS36. This round is based on feedback from worksheet 39 and should lead to an aesthetic concept that can be 3d modelled and shown to potential users for further work. The gun sketches are based on the placement of the pump and motor taken from a Worx Hydroshot and the battery from a Grouw low pressure washer.

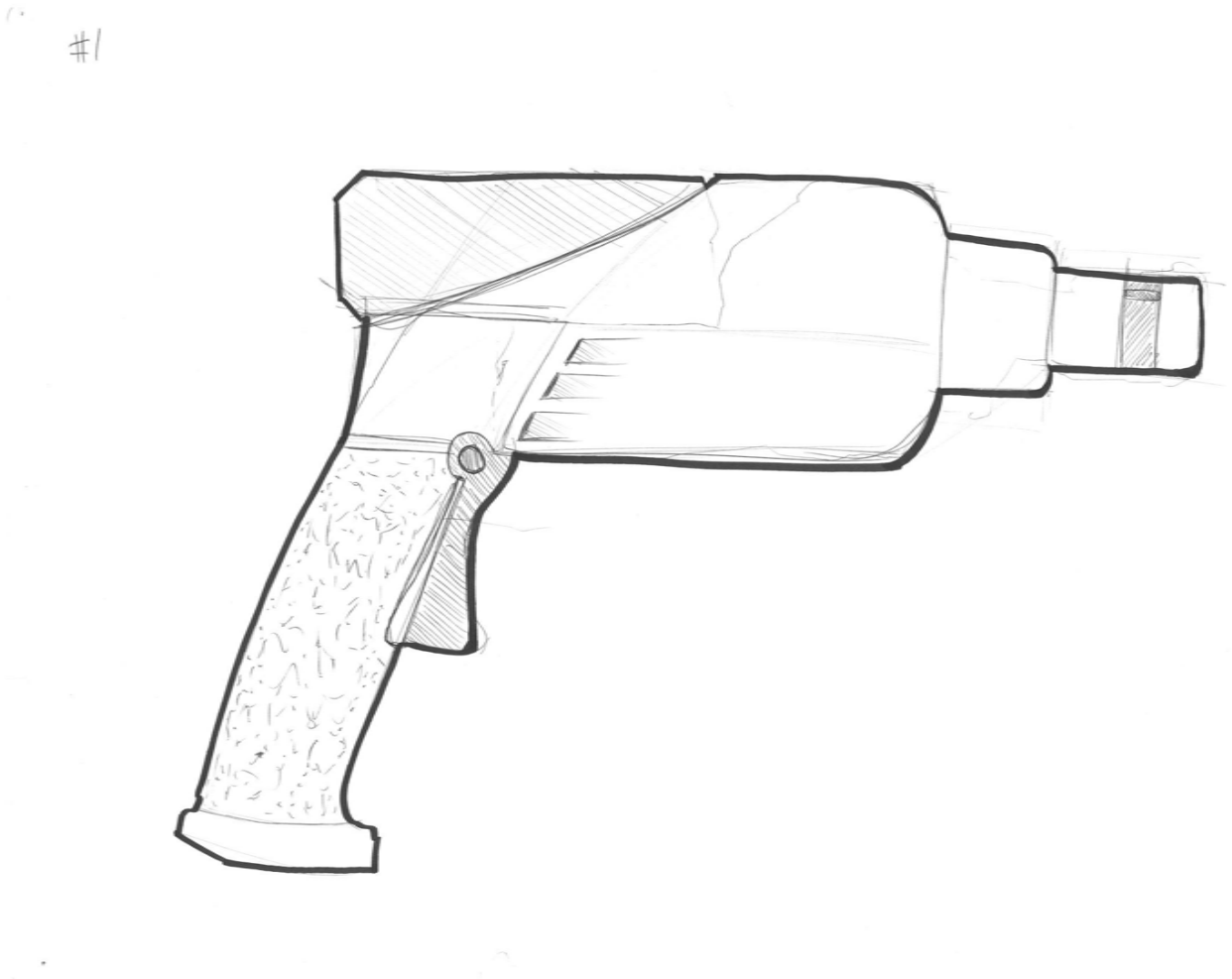
Experiment/data: *Here you put in a sketch, storyboard, diagrams, photo of mock-up or experiment, rendering of 3D model, interview, etc, including own explanatory comments, analysis and perhaps evaluation*

GUN

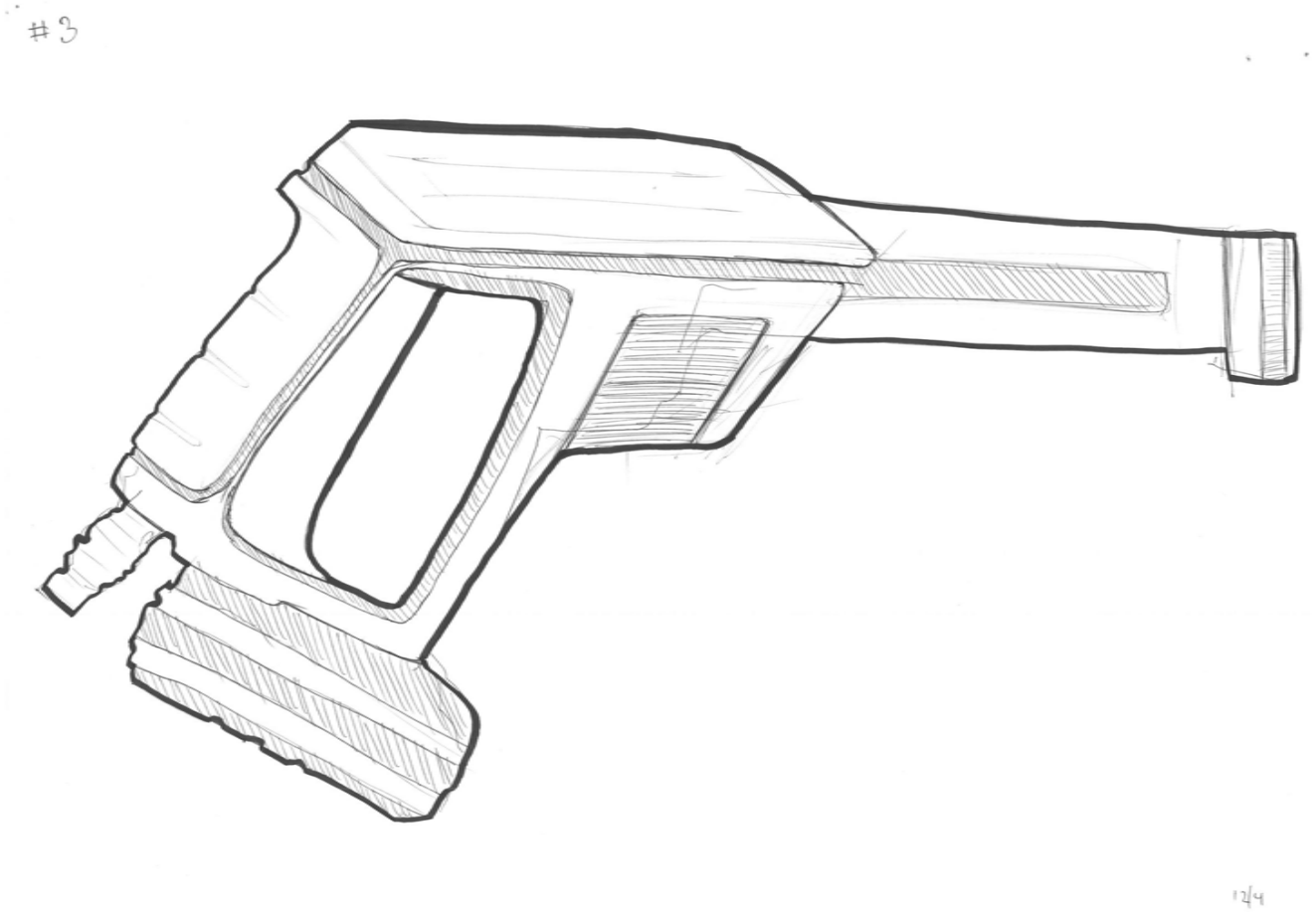


13/4

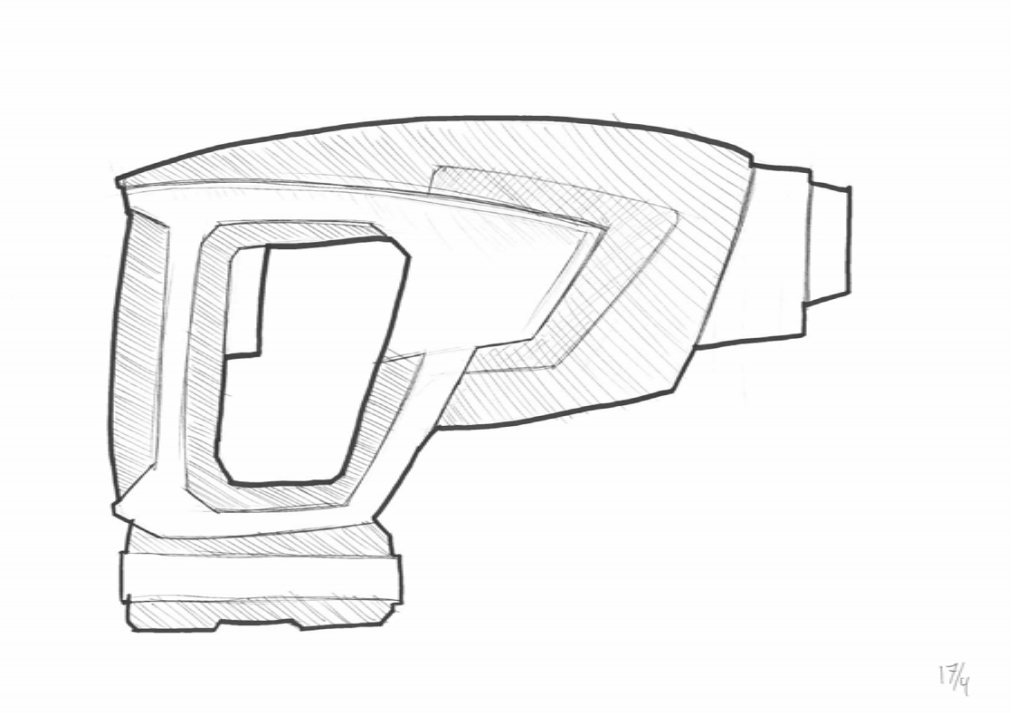
This gun initiates the sketching round. The pump and motor is placed at the front with the battery on the top. The appearance is valued to be too soft and a bit weird looking.



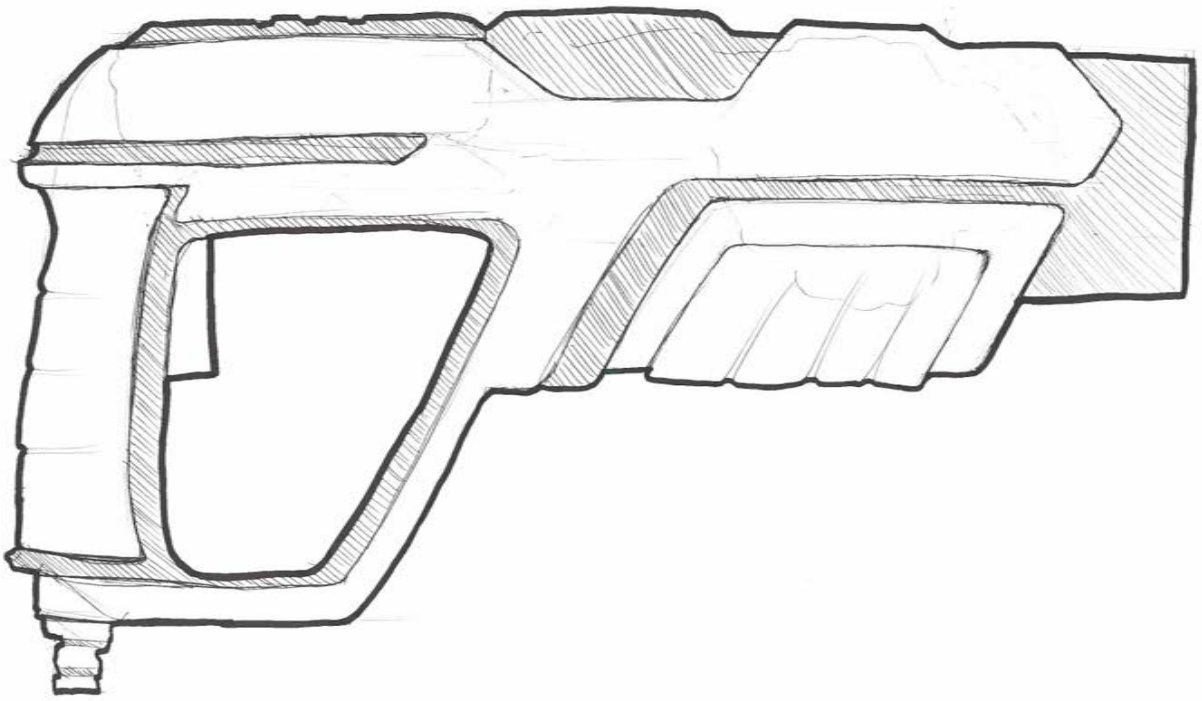
This one looks like a tool, but the “speed stripes” are not fitting and the trigger is really not cool looking.



This one is too long and while looking sporty there are difficulties having this sloped handle when in its lifting position.



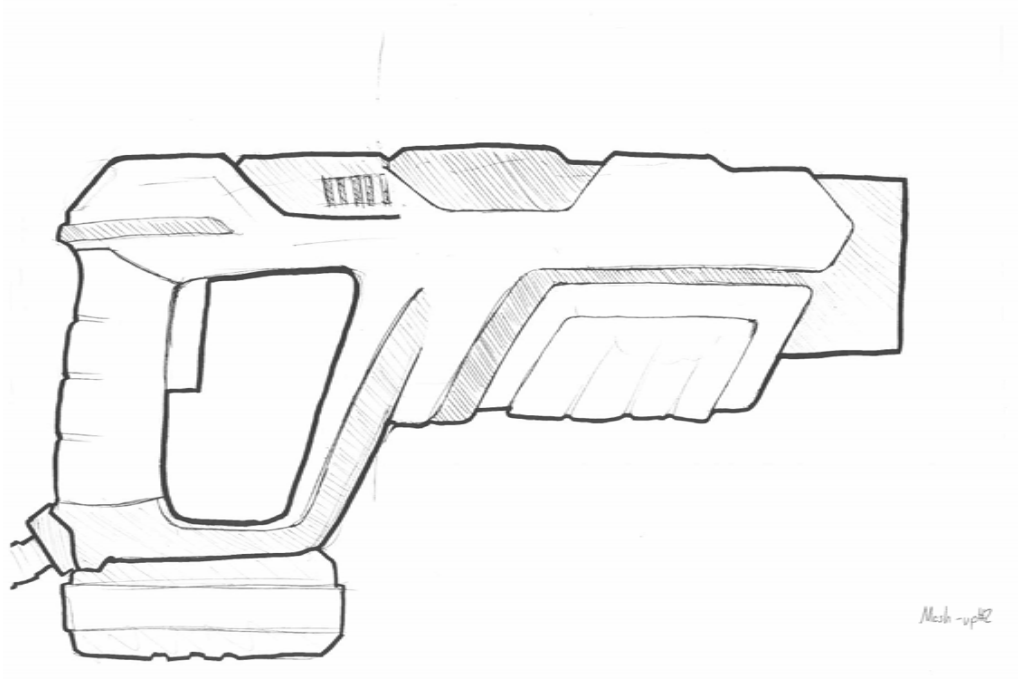
This one is tested but is quickly regarded as being too ‘space-blaster’ or ‘water gun-toy’ inspired and would not fit the very serious mountain biking target group.



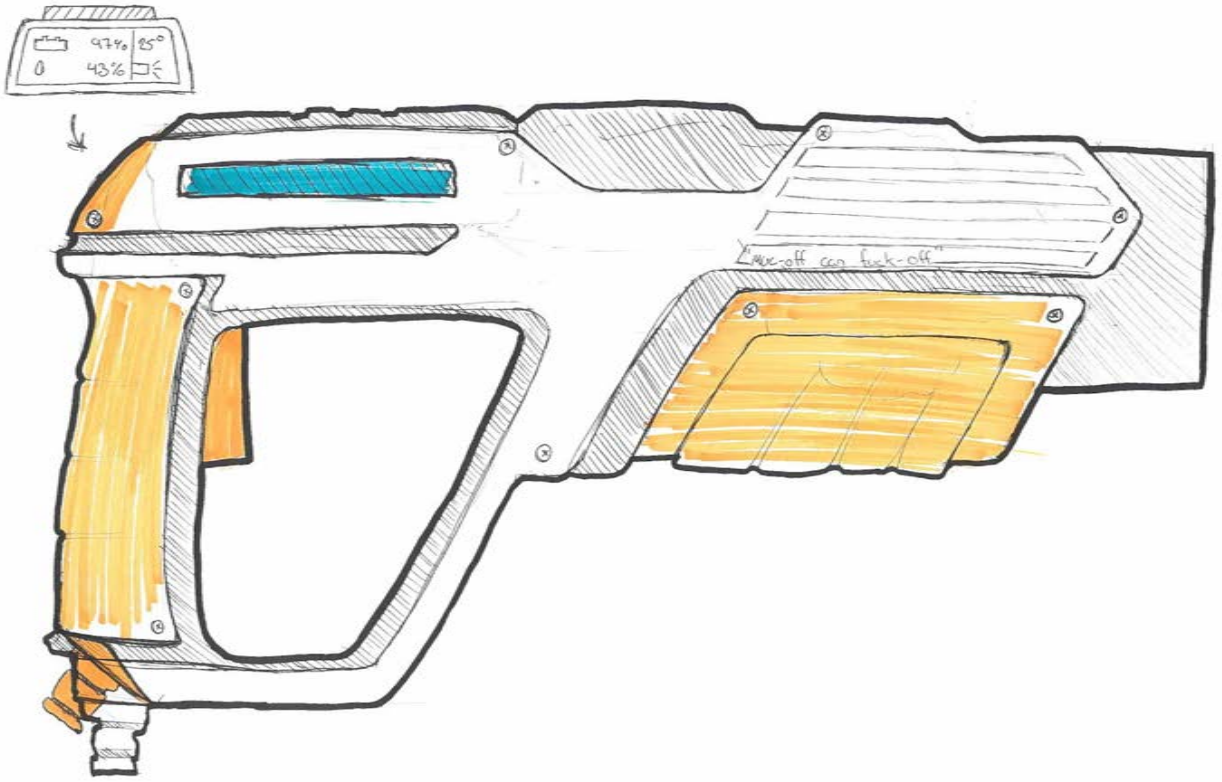
13/4

This gun is designed to be much more sporty in its appearance. It is based on a concept presented in worksheet 39 that got some nice feedback in that interview. The handle is straightened and some more defining lines are added in comparison to the first edition. The battery is still placed on top. The clear indication of interaction points is something that is really appreciated in this concept and should be carried on for future concepts.

Here it is tried to move the battery to the bottom and shorten the “barrel”. The decision here is that it is too short and becomes almost quadratic in its looks with the two changes. Testing done simultaneously (WS40) shows it is preferred to have the battery in the bottom and the battery and pump close to the hand to achieve a nice centre of gravity and avoid strain in the hand.

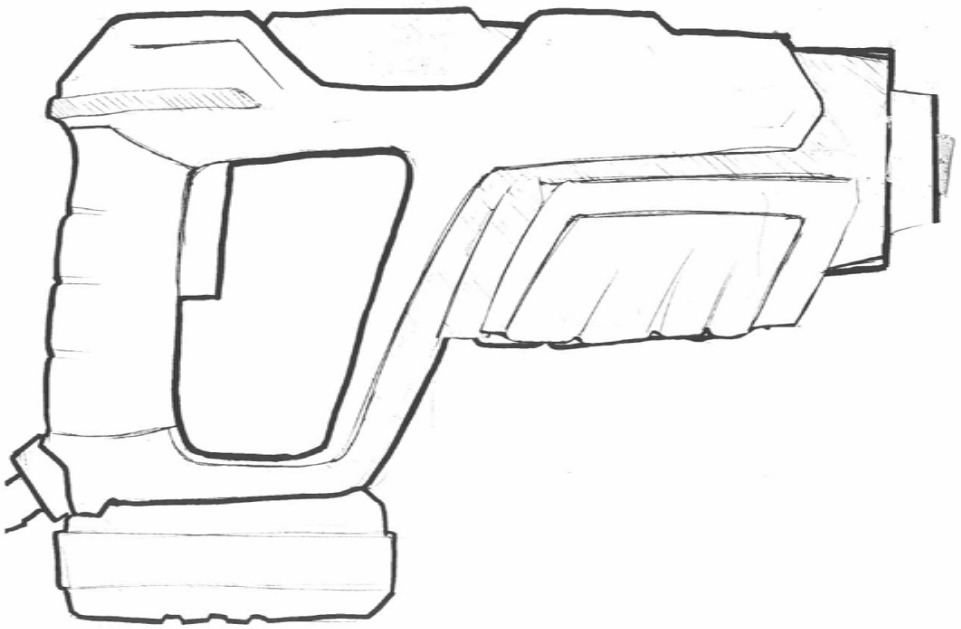


The next step is to take the same concept and make it longer again to achieve a more coherent aesthetic. Generally this is appreciated, but maybe somewhere in between.



13/4

This tries to add a bit more ruggedness on the surfaces and interaction colours. The four “adidas lines” in the top right are nice, but while the visible assembly points can give some value it may not be a nice look for this user group. **This must be tested.**



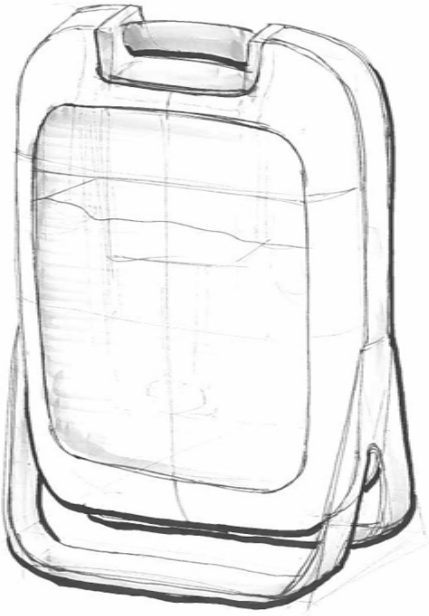
This concept tries with a narrower end of the barrel to give a feeling of more control in the spraying action. The supporting handle is moved slightly forward to give a different grip and it is tried to remove some of the “unnecessary lines” for a more balanced look in relation to the works being made to the water tank.

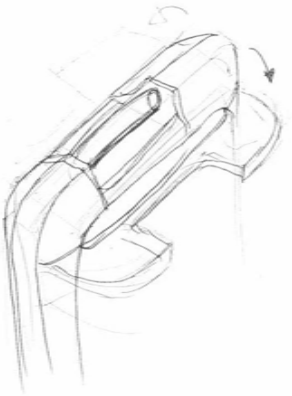
Seeing as this drawing is two dimensional, it is decided to 3d model it when the water tank has been finished. This 3d model should give a better feeling of the overall appearance to decide if it is too futuristic in its looks and should be toned down or it is alright in relation to the water tank.

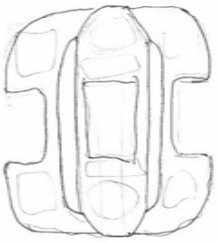
Water tank

This was initiated on the basis of the VW wall box charger from the modern sleek style board. It led to different concepts (the jerry can presented in interview ws39 as an example). The overall shape is still nice and got some fine feedback. This is the basis for some of the concepts presented from now.

#1

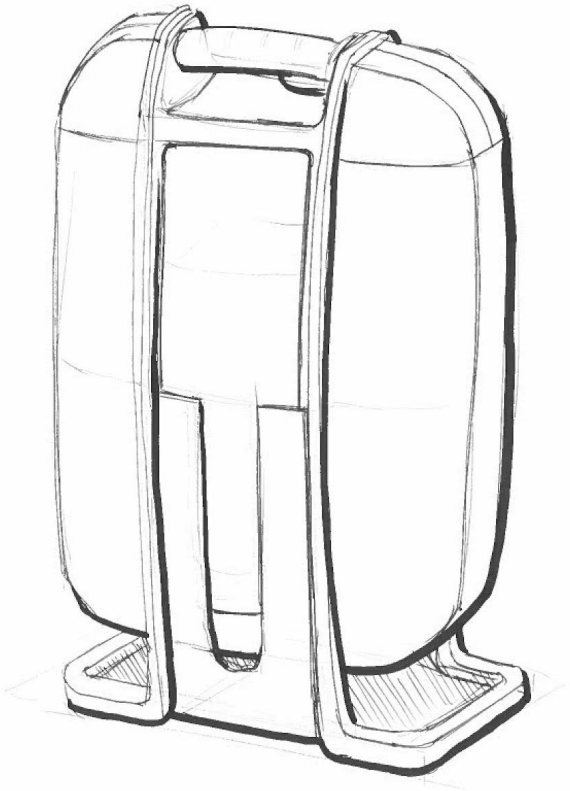






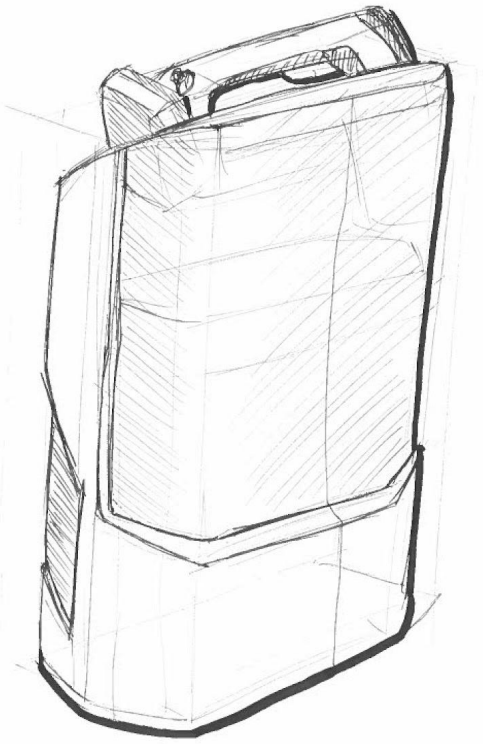
11/4

In WS39 it was presented as this concept. The “floatiness” of the concept was liked and it seemed in balance with a solid base.



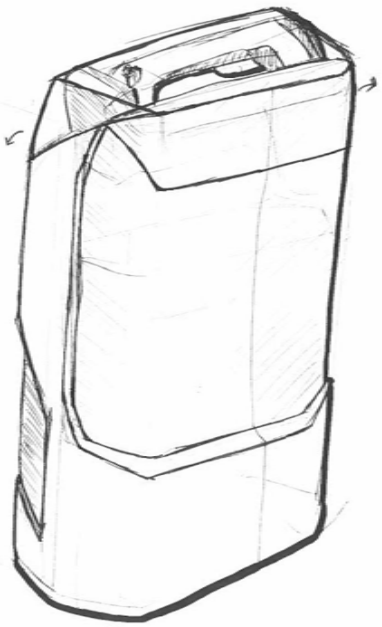
This led to new versions of that concept. The first was this rail which would include a bike stand and work as a solid base while creating the floating/hanging experience. More on this later.

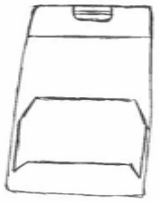
#3

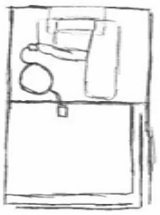


Another direction is this more angular shape with indentations in the surface to create a visual dynamism. On this first concept it works well but there are issues with the opening experience not being possible. This leads to new and realistic versions.

#3



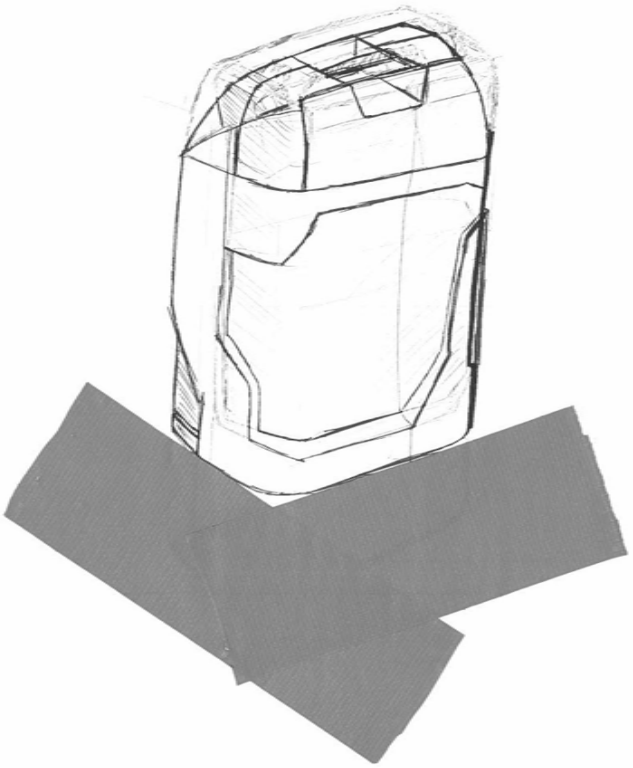




12/4

The second version has a two part folding top, but it quickly becomes apparent that the lack of the angled top makes it seem much larger and way less dynamic. Also the two part folding is way too complex for the value gained.

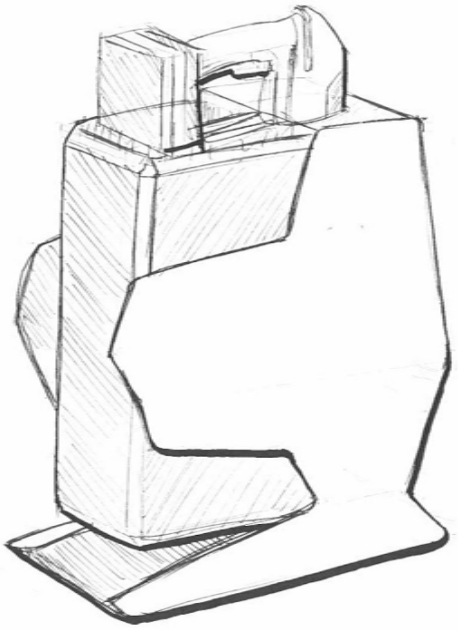
#3

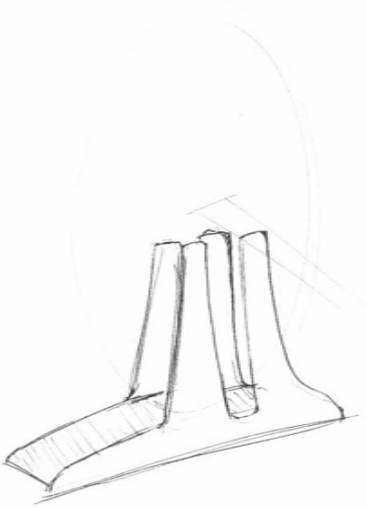


12/4

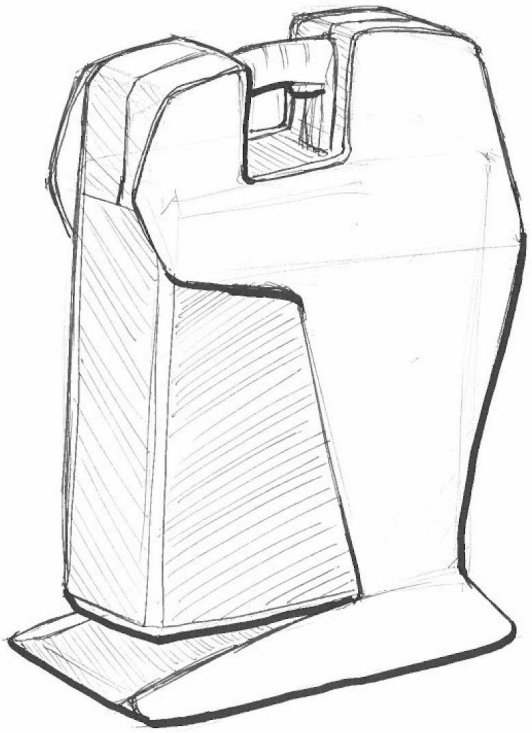
The third version includes a slimmer top and a simpler two part opening. This is more viable, but the concept becomes out of balance so the indentations are changed. It loses a lot of dynamism and becomes very tall in its looks.

#3

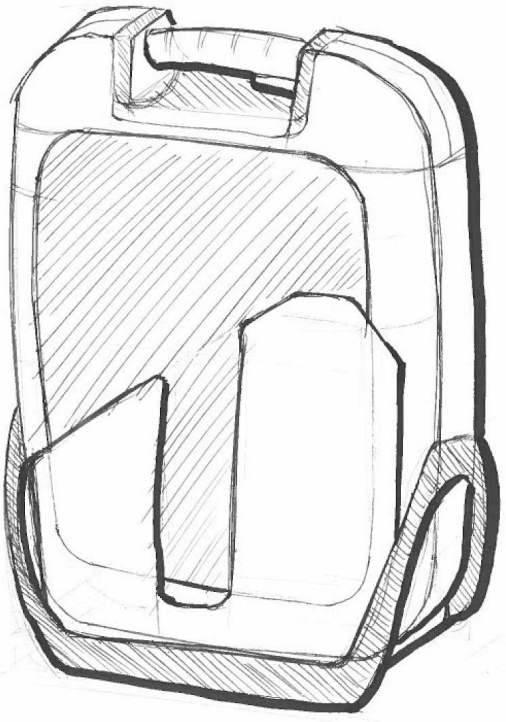




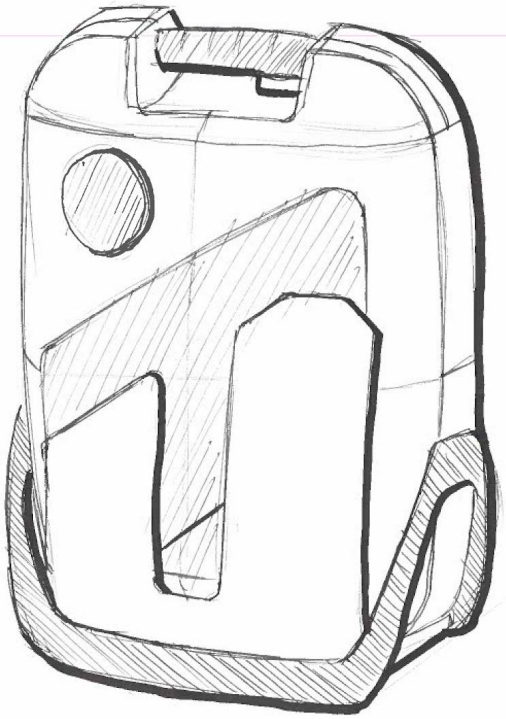
The third is based on another floating concept from the modern sleek / sporty outdoor style board. It is deemed as quite nice, but it seems a bit too much like a bear hugging something. Also the top is open which is not coherent with the opening / presentation experience. Leading to a new concept which should solve this.



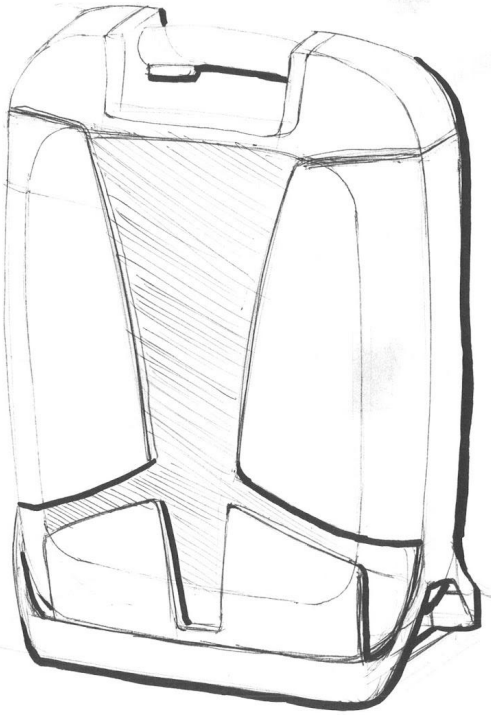
This concept tries to solve this by making less of a hugging arm and giving it some more height to cover the opening top. While it may have some competencies, the concept is discarded as it does not seem rugged and sporty enough. It is more like a sculpture - but the floatiness from it is taken to merge with other concepts.



This concept works with a large transparent side slightly showing the internals and water level. The bike stand is on the outside and a part of the visual appearance. The flowing foot creates the floating look and other than the handle the gun is covered by the opening mechanism which makes it more appealing to use the gun handle to lift everything.



To create more dynamism the “window” is given an angle to match the bike stand. This gives some space to place the second refill option, which is a nice touch. The specific drawing has a smaller top than the previous drawing. It should be as on the first drawing as it becomes a tad too small for the overall model. This one is 3D modelled and printed to show to users.



This one is also valued highly. The shells seem rugged and supportive and tried to hide some of the seam lines between the lid and the box. The bike stand seems more integrated in the design due to the meeting lines and the water tank foot is also well integrated.
This concept is also 3d modelled and printed.

Evaluate

Summarise and evaluation. Did the activity meet the objectives and to what extent? How did you evaluate? Did you use external feedback, calculations, estimations, etc.? And what is the validity of the result?

This work has driven the project towards having a specific style. Different styles have been tried out and some visual features like floatiness and dynamism have been deemed valuable.
The two tested design directions both seem nice enough to show to users and get feedback.

Reflection

What did you learn? Do you need to change method, mode, approach or revise the objectives, specification or criteria?

What is the next move?

The next step is to create a 3d model and do small corrections in that to make the concept somewhat viable. This model is to be 3d printed, rendered and shown to potential users in interviews. What do they hook on and why? Also looking into the functional principles behind the features and overall experience and whether it is actually possible to create.

Important notes/observations: *Here you can write the important points and the new/updated requirements/demands and wishes, and how they were found*

Appendix 13

Activity:

Worksheet no.: 38	**Date:** 12/04	**Deadline:** 12/04	**Responsible: NG**

Objective: *Here you briefly state the intention, plan, method, and desired result for the activity*

The activity seeks to research and investigate where the product could be stored in the homes. This involves looking at places to store and the size requirements that will follow this. It is furthermore relevant to look at how it should be stored in the car with the same dimensions.
Desktop research and physical research will be done.

Experiment/data: *Here you put in a sketch, storyboard, diagrams, photo of mock-up or experiment, rendering of 3D model, interview, etc, including own explanatory comments, analysis and perhaps evaluation*

Where could you store the product?

- Under a kitchen sink
- In a cupboard
- In the garage
    - Steel racks
- Under the bed

Kitchen cabinets:

HTH:

Counter cabinets
56.5cm deep (minus backplate)
67-70 cm in height total. Will be divided by shelves that are movable.

Tall cabinets
56.5cm deep (minus backplate)
124/195/211 cm in height. With shelves dividing

Top cabinet
33 cm in depth (minus backplate?)
86/70/57 cm in height. With shelves dividing

IKEA:

Counter cabinets
58/35 cm in inner depth
78 cm in height

Wall cabinets
35 cm in inner depth
56/76/96 cm in height

Tall cabinets
35/58 cm in inner depth
136/196/216 cm in height

Top cabinets
58 cm in inner depth
36/56 m in height

If placed in other cabinets, the depth is generally around 30 cm, with some down to 26 cm.

Wardrobe cabinets are generally 50-55 cm in depth

Steel racks, as you would typically have in a garage or workshop, mostly have a depth of 40-60 cm.

If you wanted to store it under the bed, it would have to be a maximum of 19 cm in thickness, this is the height of IKEAs bedrollers.

Orientation
When stored in the home, it will generally be empty, and as such the orientation does not matter much, as long as the design allows for the orientation.
When placed in the car on the other hand, it will typically be filled with water, which can influence the way users would want to store it. It has been mentioned previously that when it is full of water, it seems unintuitive to lay it down, as it creates a concerned feeling whether or not it will leak. Furthermore, if the aim is to create a wow-feeling, then it will be beneficial if it was standing up as intended, when the boot is opened, though this requires a lot more stability, which might make it infeasible.

Evaluate

Summarise and evaluation. Did the activity meet the objectives and to what extent? How did you evaluate? Did you use external feedback, calculations, estimations, etc.? And what is the validity of the result?

So to summarise, to be able to store the product in the home, it should at the least be able to fit in cabinets or shelves of 40 cm in depth, optimally it can fit in 30 cm, but this should not be necessary. Storing it in the garage or workshop is likely the most common, and these shelves and cabinets are generally at minimum 40 cm in depth.
The height requirements should not be relevant, as the shelves are always adjustable in the height if necessary.

Reflection

What did you learn? Do you need to change method, mode, approach or revise the objectives, specification or criteria? What is the next move?

We now know an estimated size requirement for easy storage in the home. Furthermore that the desired way to place it in the car boot would be upright, but as it might require more stability than feasible, this has to be evaluated further.
These findings will be taken into account when detailing and designing the size of the product.

Important notes/observations: *Here you can write the important points and the new/updated requirements/demands and wishes, and how they were found*

Appendix 14

Units produced (1 tank + 1 gun +	80000	parts	
Delivery time	1	year	
Material cost per kg.	1,2	€/kg	Steel
Material cost per kg.	2,4	€/kg	Alu

Material cost Gun part	0,39	€	Material cost per kg [€/kg] * (Weigt per part [g] / 1000) =
Material cost Tank part	0,74	€	Material cost per kg [€/kg] * (Weigt per part [g] / 1000) =
Material cost Bike stand	2,03	€	Material cost upper part [€]+ Material cost lower part [€] =
Material cost per unit	**3,15**	**€**	Material cost upper part [€]+ Material cost lower part [€] =

Material cost per kg.	1	€/kg	PP
Material cost per kg.	1	€/kg	TPE

Material cost PP	2,894	€	Material cost per kg [€/kg] * (Weigt per part [g] / 1000) =
Material cost TPE	0,026	€	Material cost per kg [€/kg] * (Weigt per part [g] / 1000) =
Material cost per unit	**2,92**	**€**	Material cost upper part [€]+ Material cost lower part [€] =

Press cutting

Gun part			Parts produced per	Total weight of parts per unit:	
Weight per part	62	grams			
Waste per part	30	%			
Mateial weight per part	80,6	grams	2	161,2	grams
Tank part					
Weight per part	118	grams			
Waste per part	30	%			
Mateial weight per part	153,4	grams	2	306,8	grams
			Sum alu:	**468**	**grams**
Bike stand					
Weight per part	1300	grams			
Waste per part	30	%			
Mateial weight per part	1690	grams	1	1690	grams
			Sum steel:	**1690**	**grams**

	Quantity			Weight in grams	Waste:		Total weight of plastic needed for each		
Transparent part water tank	1	PP	Injection	950	5	%	997,5	g	weight+(weight*
Lid for water tank	1	PP	Injection	120	5	%	126	g	
Right lid	1	PP	Injection	140	5	%	147	g	
Left lid	1	PP	Injection	140	5	%	147	g	
Window end (case)	1	PP	Injection	105	5	%	110,25	g	
Stand end (case)	1	PP	Injection	111	5	%	116,55	g	
Spool side (case)	1	PP	Injection	207	5	%	217,35	g	
Front side (case)	1	PP	Injection	180	5	%	189	g	
Inner part stand (case)	1	PP	Injection	95	5	%	99,75	g	
Foot bottom	1	PP	Injection	189	5	%	198,45	g	
Foot top	1	PP	Injection	144	5	%	151,2	g	
Bike stand plastic part	1	PP	Injection	105	5	%	110,25	g	
Cap for tank	1	PP	Injection	10	5	%	10,5	g	
Gun bottom side right	1	PP	Injection	60	5	%	63	g	
Gun bottom side left	1	PP	Injection	60	5	%	63	g	
Gun top side right	1	PP	Injection	40	5	%	42	g	
Gun top side left	1	PP	Injection	40	5	%	42	g	
Trigger	1	PP	Injection	5	5	%	5,25	g	
Soap botlle	1	PP	Injection	35	5	%	36,75	g	
Soap bottle cap	1	PP	Injection	20	5	%	21	g	
Cap for tank	1	TPE	Injection	5	5	%	5,25	g	
Gun bottom side right	1	TPE	Injection	10	5	%	10,5	g	
Gun bottom side left	1	TPE	Injection	10	5	%	10,5	g	
			Sum of product	**2781**	**Sum =**		**2920,05**	**g**	

Press cut (Gun part)			
cycle time	5	Sec.	
Cycle time in hours per piece	0,0014	Hours	Cycle time [s] / 3600 =
Cycle time in all	111,1111	Hours	Cycle time in hours per piece * Parts produced =
Cavities per mould	1	cavities	
Hours worked per year	1500	Hours	200 work days * 7,5 hours =
Hours worked (hours needed)	111,11	Hours	Cycle time in all [h] / Cavities per mould =
Hours per machine in all	111,1111	Hours	
Machines and moulds needed	1,0	machines	Hours per machine in all / hours worked per year =
Machines and moulds needed	1	machines	Machines and moulds needed, Rounded up =
Mould cost	2000	€	http://www.andeastamping.com/metalstamping
Mould cycles	500000	cycles	
Mould cost per part	**0,025**	**€**	Mould cost [€] * Machines and moulds needed / Parts produced
Mould cost per part	0,004	€	Mould cost [€] * Machines and moulds needed / (Mould cycles *
Machine cost	30000	€	https://china-hydraulicpress.en.made-in-china.com/product/XNM
Machine and wage cost per hour	19,80	€	Hourly cost calculations
operation cost per hour	19,80	€	Machine and wage cost per hour * Machines and moulds neede
operation cost per part	**0,027**	**€**	Hours worked per year * operation cost per hour / Parts produce
overhead cost per part	**0,007**	**€**	operation cost per part * 0,25 =

Injection moulding (small parts)			
cycle time	13	Sec.	
Cycle time in hours per piece	0,0036	Hours	Cycle time [s] / 3600 =
Cycle time in all	288,8889	Hours	Cycle time in hours per piece * Parts produced =
Cavities per mould	1	cavities	
Hours worked per year	1500	Hours	200 work days * 7,5 hours =
Hours worked (hours needed)	288,89	Hours	Cycle time in all [h] / Cavities per mould =
Hours per machine in all	288,8889	Hours	
Machines and moulds needed	1,00	machines	Hours per machine in all / hours worked per year =
Machines and moulds needed	1	machines	Machines and moulds needed, Rounded up =
Mould cost	40000	€	https://www.custompartnet.com/estimate/injection-molding/
Mould cycles	200000	cycles	
Mould cost per part	**0,5**	**€**	Mould cost [€] * Machines and moulds needed / Parts produced =
Mould cost per part (life time)	0,2	€	Mould cost [€] * Machines and moulds needed / (Mould cycles * Cavities per mould) =
Machine cost	80000	€	Arburg Allrounder
Machine and wage cost per hour	26,14	€	Hourly cost calculations
operation cost per hour	26,14	€	Machine and wage cost per hour * Machines and moulds needed =
operation cost per part	**0,094**	**€**	Hours worked per year * operation cost per hour / Parts produced =
overhead cost per part	**0,024**	**€**	operation cost per part * 0,25 =

Press cut (Tank part)			
cycle time	9	Sec.	
Cycle time in hours per piece	0,0025	Hours	Cycle time [s] / 3600 =
Cycle time in all	200,0000	Hours	Cycle time in hours per piece * Parts produced =
Cavities per mould	1	cavities	
Hours worked per year	1500	Hours	200 work days * 7,5 hours =
Hours worked (hours needed)	200,00	Hours	Cycle time in all [h] / Cavities per mould =
Hours per machine in all	200,0000	Hours	Cycle time in all [h] / Cavities per mould =
Machines and moulds needed	1,0	machines	Hours per machine in all / hours worked per year =
Machines and moulds needed	1	machines	Machines and moulds needed, Rounded up =
Mould cost	4000	€	http://www.andeastamping.com/metalstamping
Mould cycles	500000	cycles	
Mould cost per part	**0,05**	**€**	Mould cost [€] * Machines and moulds needed / Parts produced
Mould cost per part	0,008	€	Mould cost [€] * Machines and moulds needed / (Mould cycles *
Machine cost	30000	€	https://china-hydraulicpress.en.made-in-china.com/product/XNM
Machine and wage cost per hour	19,80	€	Hourly cost calculations
operation cost per hour	19,80	€	Machine and wage cost per hour * Machines and moulds needed
operation cost per part	**0,049**	**€**	Hours worked per year * operation cost per hour / Parts produce
overhead cost per part	**0,012**	**€**	operation cost per part * 0,25 =

Injection moulding (big parts)			
cycle time	36	Sec.	
Cycle time in hours per piece	0,0100	Hours	Cycle time [s] / 3600 =
Cycle time in all	800,0000	Hours	Cycle time in hours per piece * Parts produced =
Cavities per mould	1	cavities	
Hours worked per year	1500	Hours	200 work days * 7,5 hours =
Hours worked (hours needed)	800,00	Hours	Cycle time in all [h] / Cavities per mould =
Hours per machine in all	800,0000	Hours	Cycle time in all [h] / Cavities per mould =
Machines and moulds needed	1,00	machines	Hours per machine in all / hours worked per year =
Machines and moulds needed	1	machines	Machines and moulds needed, Rounded up =
Mould cost	50000	€	https://www.custompartnet.com/estimate/injection-molding/
Mould cycles	100000	cycles	
Mould cost per part	**0,625**	**€**	Mould cost [€] * Machines and moulds needed / Parts produced =
Mould cost per part (life time)	0,5	€	Mould cost [€] * Machines and moulds needed / (Mould cycles * Cavities per mould) =
Machine cost	80000	€	Arburg Allrounder [SIZE UNKNOWN]
Machine and wage cost per hour	26,14	€	Hourly cost calculations
operation cost per hour	26,14	€	Machine and wage cost per hour * Machines and moulds needed =
operation cost per part	**0,261**	**€**	Hours worked per year * operation cost per hour / Parts produced =
overhead cost per part	**0,065**	**€**	operation cost per part * 0,25 =

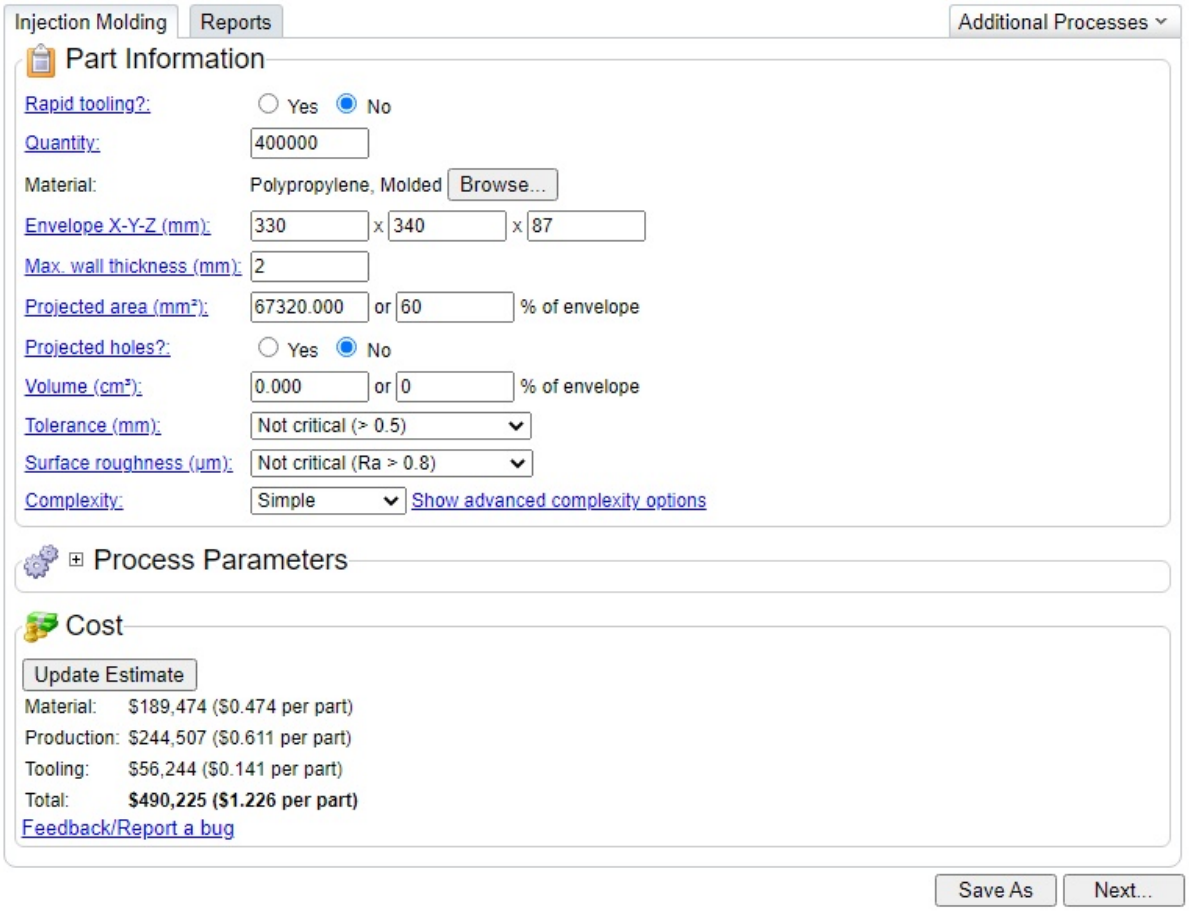
Press cut (Bike Stand)			
cycle time	20	Sec.	
Cycle time in hours per piece	0,0056	Hours	Cycle time [s] / 3600 =
Cycle time in all	444,4444	Hours	Cycle time in hours per piece * Parts produced =
Cavities per mould	1	cavities	
Hours worked per year	1500	Hours	200 work days * 7,5 hours =
Hours worked (hours needed)	444,44	Hours	Cycle time in all [h] / Cavities per mould =
Hours per machine in all	444,4444	Hours	Cycle time in all [h] / Cavities per mould =
Machines and moulds needed	1,0	machines	Hours per machine in all / hours worked per year =
Machines and moulds needed	1	machines	Machines and moulds needed, Rounded up =
Mould cost	6000	€	http://www.andeastamping.com/metalstamping
Mould cycles	500000	cycles	
Mould cost per part	**0,075**	**€**	Mould cost [€] * Machines and moulds needed / Parts produced =
Mould cost per part	0,012	€	Mould cost [€] * Machines and moulds needed / (Mould cycles * Cavities per mould
Machine cost	30000	€	https://china-hydraulicpress.en.made-in-china.com/product/XNMEqoxYAchb/China-
Machine and wage cost per hour	19,80	€	Hourly cost calculations
operation cost per hour	19,80	€	Machine and wage cost per hour * Machines and moulds needed =
operation cost per part	0,110	**€**	Hours worked per year * operation cost per hour / Parts produced =
overhead cost per part	**0,012**	**€**	operation cost per part * 0,25 =

Price of all the machines and moulds:

Ammount of different small parts (>5g):	13	different molds needed	
Cost of a mold for small part with 4 caveties:	40000	€	
Cost for all small moulds:	520000	€	different moulds needed * cost of mould =
Ammount of different big parts (>5g):	7	different molds needed	
Cost of a mold for small part with 2 caveties:	50000	€	
Cost for all big moulds:	350000	€	different moulds needed * cost of mould =
Machines needed:			
Hours worked per small mould	288,89	hours	
hours worked for all small moulds:	3755,555556	hours	hours worked per mould * different moulds needed =
Hours worked per big mould	800,00	hours	
hours worked for all big moulds:	5600	hours	hours worked per mould * different moulds needed =
Hours worked per machine per year	1500	Hours	200 work days * 7,5 hours =
Machines needed per year:	6,237037037	machines	hours worked for all moulds /hours worked per year =
Machines needed per year:	7	machines	Machines needed, Rounded up =
Machine cost:	80000	€	Source
Total cost of machines:	**560000**	**€**	Machines needed * machine cost =

Amount of press cut machines needed:

hours worked per gun part - mould:	111,11	hours	
hours worked per tank part - mould:	200,00	hours	
hours worked per bike stand- mould:	444,44	hours	
Hours worked per machine per year	1500	Hours	200 work days * 7,5 hours =
Machines needed per year:	0,50	machin	hours worked for all moulds /hours worked per year =
Machines needed per year:	1	machin	Machines needed, Rounded up =
Machine cost:	30000	€	https://china-hydraulicpress.en.made-in-china.com/produ
Total cost of machines:	**30000**	**€**	Machines needed * machine cost =



	Outsourced components:		Cost:	
Gun				
	Battery		6	€
	Pump		4	€
	Motor		4	€
Tank				
	Brush		0,5	€
	Hose lead		0,5	€
	Hose		0,3	€
	Hose reel		3	€
Mechanism				
	CNC milled 'heart'		1,5	€
	Brake line		0,5	€
	Springs (*2)		0,5	€
	Rods		0,04	€
	Hinge (*2)		0,4	€
	Latch		1	€
	Total cost of outsourced components per unit:		**16,24**	**€**

Post processing (galvanisering osv)		2	€

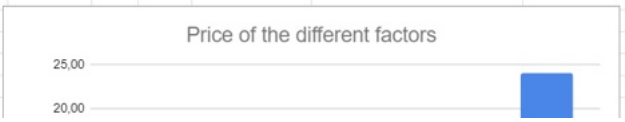
Assembly

assemblying time per unit	3600	sec	
assemblying time per unit	1,0000	hours	
avarage wage	24	€/hours	
Assembly cost	**24,000**	€	(assem
overhead cost per unit	**6,000**	**€**	operatic

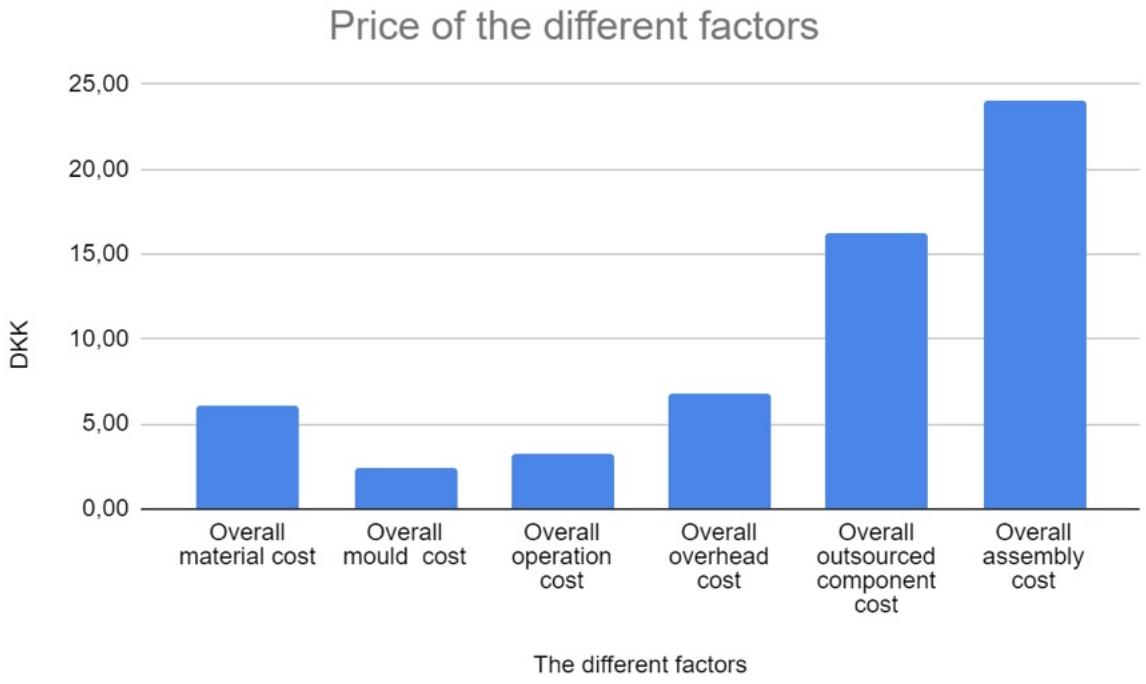
QUANTITY	LEAD TIME	ANODISING COST (PER ITEM)
1-off	6-7 Business Days	£120 + VAT
2-off	6-7 Business Days	£60 + VAT
5-off	6-7 Business Days	£24 + VAT
10-off	6-7 Business Days	£12 + VAT
20-off	6-7 Business Days	£10 + VAT
50-off	6-7 Business Days	£4 + VAT
100-off	6-7 Business Days	£2.80 + VAT
200-off	6-7 Business Days	£2.50 + VAT
500-off	7-10 Business Days	£2.20 + VAT
1,000-off	7-10 Business Days	£1.95 + VAT

Summed up costs

Material cost per unit	**6,07**	**€**	Steel + PP + TPE =
Mould cost per unit (press cut)	**0,15**	**€**	Sum og all press cut moulds =
Mould cost per unit (injection m	**1,13**	**€**	mould cost per part * ammount of small moulds **/ divided by 4 years (lifetime of moulds)** =
Mould cost per unit (injection m	**1,09**	**€**	Mould cost per part * Ammount of big moulds **/ divided by 4 years (lifetime of moulds)** =
Operation cost per unit (steel pa	**0,19**	**€**	Sum of all operation costs for steel parts =
Operation cost per unit (injectio	**3,06**	**€**	(operation cost small mould * ammount of small moulds) + (operation cost big mould * ammount of big moulds) =
Overhead cost (steel parts)	**0,03**	**€**	Sum of all overhead costs for steel parts =
Overhead cost (Injection mould	**0,76**	**€**	(overhead cost small mould * ammount of small parts) + (overhead cost big mould * ammount of big parts) =
Overhead cost (assembly)	**6,00**	**€**	
			The price when making 80000 units
Outsourced component cost pe	**16,24**	**€**	
Assembly cost per unit	**24,00**	**€**	
Total cost per unit	**60,72**	**€**	Sum of all
	451,76	dkk	costs per part =



Cost per unit:				
Overall material cost	6,07	€	45,2	DKK
Overall mould cost	2,37	€	17,6	DKK
Overall operation cost	3,24	€	24,1	DKK
Overall overhead cost	6,80	€	50,6	DKK
Overall outsourced component co	16,24	€	120,8	DKK
Overall assembly cost	24,00	€	178,6	DKK



Initial investment		
overall price of moulds (injection moulding)	**870000**	**€**
overall price of moulds (press cut)	**12000**	**€**
Overall machine price (injection moulding)	**560000**	**€**
Overall machine price (press cut)	**30000**	**€**
Total initial investment	**1.472.000**	**€**
	10.951.68	DKK

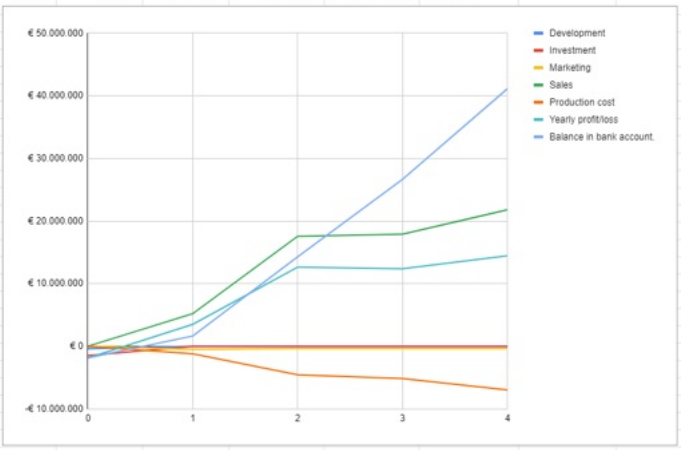
NPV Good

NPV Calculation - good scenario

			Investment			Salaries	monthly	yearly
	EUR-DKK conversion rate	7,45	initial		€1.472.000,00	Marketing	€ 40.000	€ 480.000
	Discount Rate:	10%						
		Production info						
	Production cost per unit	€4,04						
	Material cost per unit	€6,07						
	Assembly cost per unit	€30,00						
	Outsourced part cost per unit	€16,24						
	Total cost per unit	€60,72						
	% of units sold online	30%						
	% of store profit	50%						
	Sales price per unit EUR	€500,00						
	Sales price per unit DKK	kr 3.724,22						
	Money from sale after VAT	€400,00						
	Money from sale after store profit	€260,00						

	Time (years)	Units sold	Development	Investment	Marketing	Production cost	Sales	Yearly profit/loss	Balance in bank
Year	0	0	-€ 400.000	-€ 1.472.000	€ 0	€ 0	€ 0	-€ 1.872.000	-€ 1.872.000
Year	1	20000	€ 0	€ 0	-€ 480.000	-€ 1.214.398	€ 5.200.000	€ 3.505.602	€ 1.633.602
Year	2	75000	€ 0	€ 0	-€ 360.000	-€ 4.553.991	€ 17.550.000	€ 12.636.009	€ 14.269.611
Year	3	85000	€ 0	€ 0	-€ 360.000	-€ 5.161.190	€ 17.901.000	€ 12.379.810	€ 26.649.421
Year	4	115000	€ 0	€ 0	-€ 360.000	-€ 6.982.787	€ 21.797.100	€ 14.454.313	€ 41.103.734
Year	5	115000	€ 0	€ 0	-€ 240.000	-€ 6.982.787	€ 19.617.390	€ 12.394.603	€ 53.498.337
Year	6	90000	€ 0	€ 0	-€ 240.000	-€ 5.464.790	€ 13.817.466	€ 8.112.676	€ 61.611.014
Year	7	80000	€ 0	€ 0	-€ 240.000	-€ 4.857.591	€ 11.053.973	€ 5.956.382	€ 67.567.396
Year	8	50000	€ 0	€ 0	-€ 240.000	-€ 3.035.994	€ 6.217.860	€ 2.941.865	€ 70.509.261
	Total units sold:	630.000							
NPV=	**€70.509.261,02**		**-€400.000**	**-€1.472.000**	**-€2.520.000**	**-€ 38.253.527**	**€113.154.789**		

Development Indicating a high initial investment in development
Investment Number of machines injection molding*machine price + number of big molds*big mold price+number of small molds*small mold price + number of machines metal stamping*machine price
Marketing Indicating a high initial investment in marketing
Production cc Units sold * total cost per unit
Sales Units sold * sales price



Accumilated

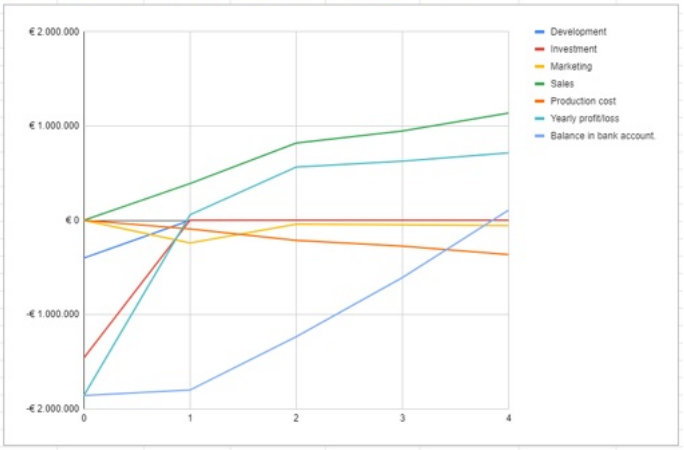
NPV Bad

NPV Calculation - bad scenario

			Investment			Salaries	monthly	yearly
	EUR-DKK conversion rate	7,45	initial		€1.472.000,00	Marketing	€ 40.000	€ 480.000
	Discount Rate:	10%						
		Production info						
	Production cost per unit	€4,04						
	Material cost per unit	€6,07						
	Assembly cost per unit	€30,00						
	Outsourced part cost per unit	€16,24						
	Total cost per unit	€60,72						
	% of units sold online	30%						
	% of store profit	50%						
	Sales price per unit EUR	€500,00						
	Sales price per unit DKK	kr 3.724,16						
	Money from sale after VAT	€400,00						
	Money from sale after store profit	€260,00						

	Time (years)	Units sold	Development	Investment	Marketing	Production cost	Sales	Yearly profit/loss	Balance in bank
Year	0	0	-€ 400.000	-€ 1.460.000	€ 0	€ 0	€ 0	-€ 1.860.000	-€ 1.860.000
Year	1	1500	€ 0	€ 0	-€ 240.000	-€ 91.080	€ 390.000	€ 58.920	-€ 1.801.080
Year	2	3500	€ 0	€ 0	-€ 40.950	-€ 212.520	€ 819.000	€ 565.530	-€ 1.235.549
Year	3	4500	€ 0	€ 0	-€ 47.385	-€ 273.239	€ 947.700	€ 627.076	-€ 608.474
Year	4	6000	€ 0	€ 0	-€ 56.862	-€ 364.319	€ 1.137.240	€ 716.059	€ 107.585
Year	5	4500	€ 0	€ 0	-€ 38.382	-€ 273.239	€ 767.637	€ 456.016	€ 563.600
Year	6	3500	€ 0	€ 0	-€ 26.867	-€ 212.520	€ 537.346	€ 297.959	€ 861.559
Year	7	1000	€ 0	€ 0	-€ 6.909	-€ 60.720	€ 138.175	€ 70.546	€ 932.106
Year	8	500	€ 0	€ 0	-€ 3.109	-€ 30.360	€ 62.179	€ 28.710	€ 960.815
	Total units sold:	25.000							
NPV=	**€960.815,23**		**-€400.000**	**-€1.460.000**	**-€460.464**	**-€ 1.517.997**	**€4.799.276**		

Development	Indicating a high initial investment in development
Investment	Number of machines injection molding*machine price + number of big molds*big mold price+number of small molds*small mold price + number of machines metal stamping*machine price
Marketing	Indicating a high initial investment in marketing
Production co	Units sold * total cost per unit
Sales	Units sold * sales price



Machine cost

Machinery:	Press cut mashine	**Number:**	1	Pcs
Manufacturer (if revevant):		**Type (if relevant):**		
Space requirements m² :	40	**Power consumption :**	17	kWh
		Initial cost:	30000	€
		Depreciation period:	8	Years
Operator demand:	0,5	**Hourly wage:**	24	€
Additional equipment				
Number	**Type**	**Initial Cost €**		
			0,00	€
			0,00	€
			0,00	€
Total initial cost of additional equipment			**0,00**	€
Salvage value				
Machinery	10%		3.000,00	€
Equipment	10%		0,00	€
Depriciation per year			3.375,00	€
Internal interest rate	10,00%	**Internal rate of return**	1.818,75	€
Sundries				
Insurance	0,25%		0,00	€
Maintenance	5%		0,00	€
Oil ect.	75	€	75,00	€
Power	0,3	€ per kWh	3.825,00	€
Rent	55	€ per m²	2.200,00	€
Heating	10	€ per m²	400,00	€
Total expenditure per year			**11.693,75**	€
Utilized capacity hours	1500	**Available capacity hours**	1.500,00	Hours
Average utilization ratio per machine			100,00	%
Machine cost per hour			7,80	€
Machine cost per hour, wage included			**19,80**	€

Machinery:	Injection moulding	**Number:**	1	Pcs
Manufacturer (if revevant):	Arburg Allrounder	**Type (if relevant):**		
Space requirements m² :	28	**Power consumption :**	17	kWh
		Initial cost:	80000	€
		Depreciation period:	8	Years
Operator demand:	0,33	**Hourly wage:**	24	€
Additional equipment				
Number	**Type**	**Initial Cost €**		
1	Heat exchanger	13200	13.200,00	€
1	Granulator	17200	17.200,00	€
1	Dehydrator	4000	4.000,00	€
Total initial cost of additional equipment			**34.400,00**	**€**
Salvage value				
Machinery	10%		8.000,00	€
Equipment	10%		3.440,00	€
Depriciation per year			12.870,00	€
Internal interest rate	10,00%	**Internal rate of return**	6.935,50	€
Sundries				
Insurance	0,25%		86,00	€
Maintenance	5%		1.720,00	€
Oil ect.	75	€	75,00	€
Power	0,3	€ per kWh	3.825,00	€
Rent	55	€ per m²	1.540,00	€
Heating	10	€ per m²	280,00	€
Total expenditure per year			**27.331,50**	**€**
Utilized capacity hours	1500	**Available capacity hours**	1.500,00	Hours
Average utilization ratio per machine			100,00	%
Machine cost per hour			18,22	€
Machine cost per hour, wage included			**26,14**	**€**

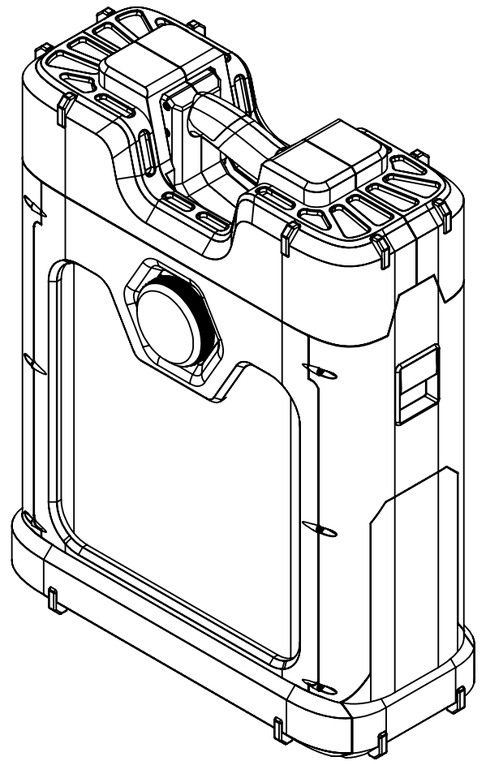
June 23

Technical Drawings

for Exhume

Master Thesis : MA4-ID6

Jacob Kjær Gertsen
Kasper Birkeskov Drejer Axelsen
Nicholas Alexander Mäkelä Green



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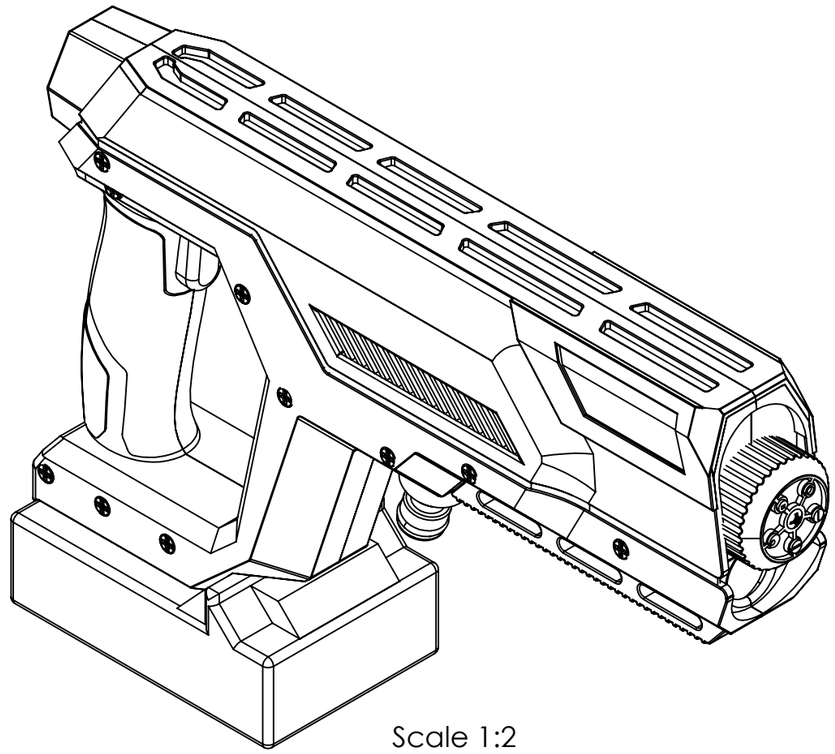

Scale 1:2

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Width: 56 mm
Legth: 325 mm

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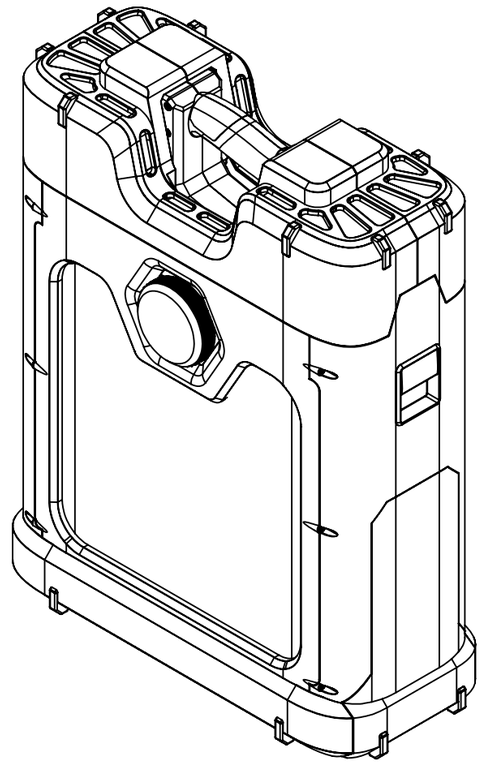
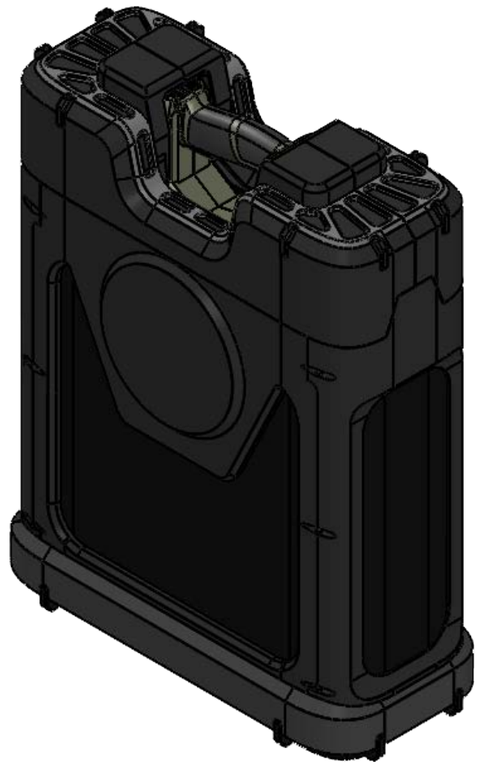
Unless Otherwise Stated: Linear Tol.: , Angular Tol.: Surface Finish: All Dimensions: **mm**		Document Type:	Drawn by: **Group 6** / Drawn Date: **30-05-23**
Drawing Scale: **1:5**			Checked/Approved by: / Checked/Approved Date:
Approx Weight: 6 Kg	Drawing Produced In Accordance With:	Legal Owner: 4 MSc ID group 6 2023	Part Number:
Projection method: ISO	Sheet Size: **A3**		Drawing Number: / Sheet: **1 of 5** / Revision:

Part Number	Group	Part Name	Quantity	Material	Weight in g
1	Water tank	Transparent part water tank	1	Polypropylene (PP)	950
2	Water tank	Lid for water tank	1	Polypropylene (PP)	120
3	Lid	Right lid	1	Polyphthalamide (PPA)	140
4	Lid	Left lid	1	Polyphthalamide (PPA)	140
5	Lid	Metal lid	2	Aluminium	118
6	Case	Window end	1	Polypropylene (PP)	105
7	Case	Stand end	1	Polypropylene (PP)	111
8	Case	Spool side	1	Polypropylene (PP)	207
9	Case	Front side	1	Polypropylene (PP)	180
10	Case	Inner part stand	1	Polypropylene (PP)	95
11	Foot	Foot bottom	1	Polypropylene (PP)	189
12	Foot	Foot top	1	Polypropylene (PP)	144
13	Bike Stand	Bike stand metal	1	Steel	1300
14	Bike Stand	Bike stand plastic	1	Polypropylene (PP)	105
15	Cap	Cap for tank	1	Polypropylene (PP)	10
16	Cap	Cap metal grib	1	Aluminium	10
17	Gun	Gun bottom side right	1	Polypropylene (PP)	60
18	Gun	Gun bottom side left	1	Polypropylene (PP)	60
19	Gun	Gun top side right	1	Polypropylene (PP)	40
20	Gun	Gun top side left	1	Polypropylene (PP)	40
21	Gun	Trigger	1	Polypropylene (PP)	5
22	Gun	Gun metal left	1	Aluminium	62
23	Gun	Gun metal right	1	Aluminium	62
24	Soap botlle	Soap botlle	1	Polypropylene (PP)	35
25	Soap botlle	Soap bottle cap	1	Polypropylene (PP)	20
	Outsourced components:				Cost in €
26	Gun	Battery	1	-	6
27	Gun	Pump	1	-	4
28	Gun	Motor	1	-	4
29	Tank	Brush	1	-	0,5
30	Tank	Hose lead	1	-	0,5
31	Tank	Hose	1	-	0,3
32	Tank	Hose reel	1	-	3
33	Mechanism	CNC milled 'heart'	1	-	1,5
34	Mechanism	Brake line	1	-	0,5
35	Mechanism	Springs	2	-	0,5
36	Mechanism	Rods	1	-	0,04
37	Mechanism	Hlnge	4	-	0,4
38	Mechanism	Latch	1	-	1





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Finish: **30-05-23**

Unless Otherwise Stated:
Linear Tol.: , Angular Tol.:
Surface Finish:
All Dimensions: **mm**

Drawing Scale: **1:5**

Approx Weight: 6 Kg

Drawing Produced In Accordance With:

Projection method: ISO

Sheet Size: **A3**

Document Type:

Legal Owner: 4 MSc ID group 6 2023

Description: **BOM for Exhume**

Drawn by: **Group 6**

Drawn Date: **30-05-23**

Checked/Approved by:

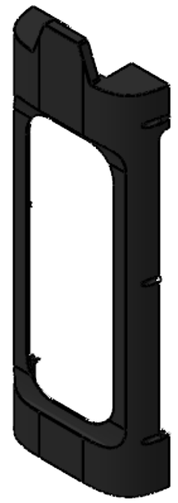
Checked/Approved Date:

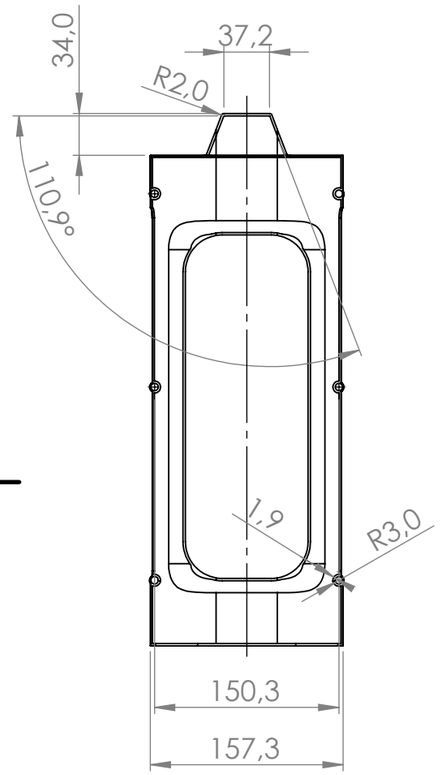
Part Number:

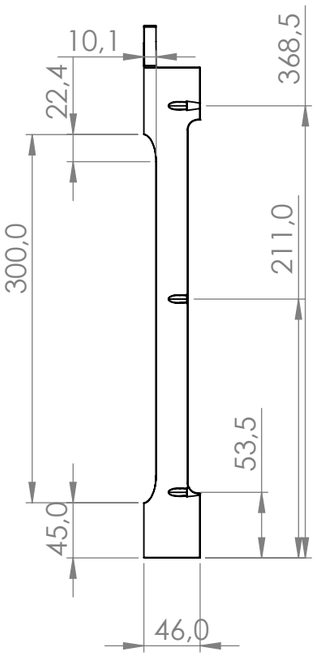
Drawing Number:

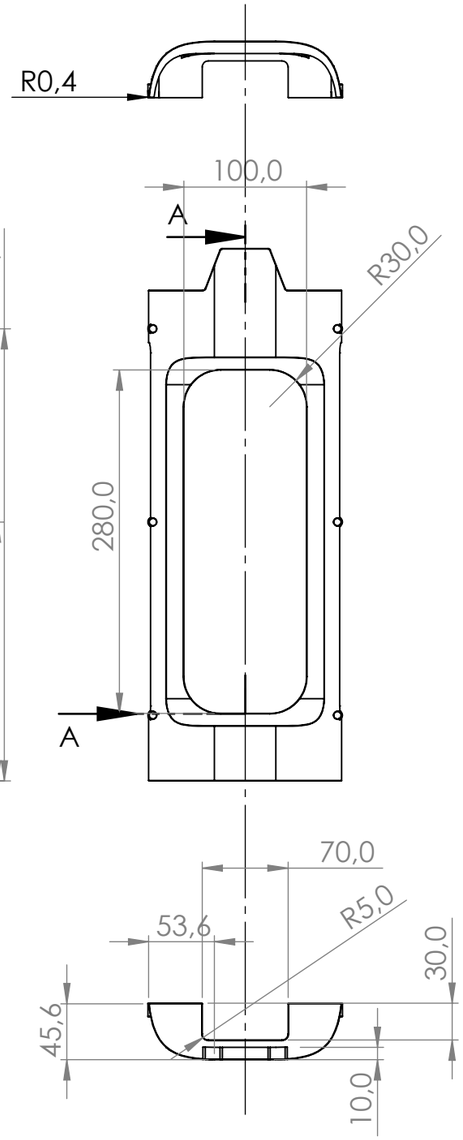
Sheet: **2 of 5**

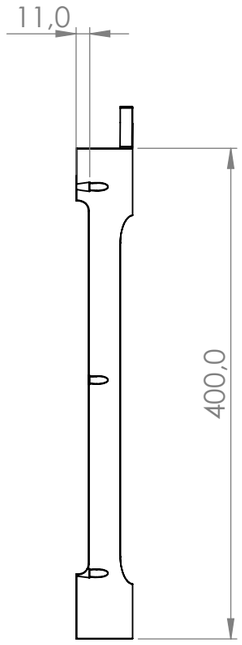
Revision:

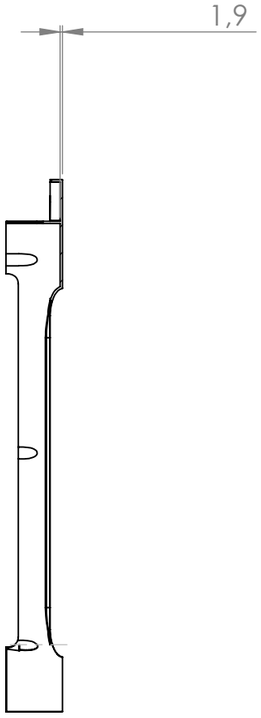






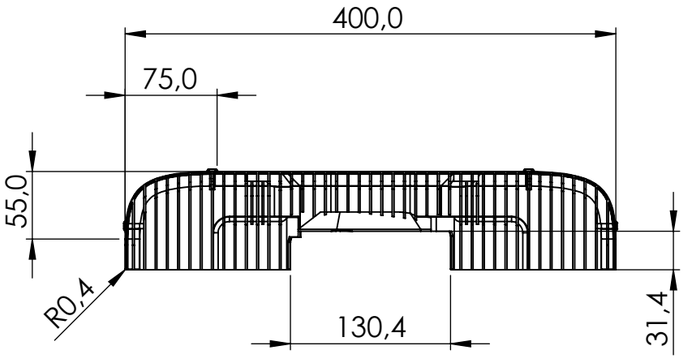


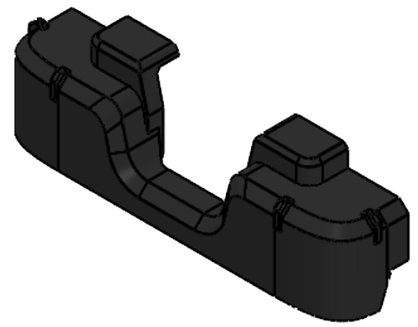


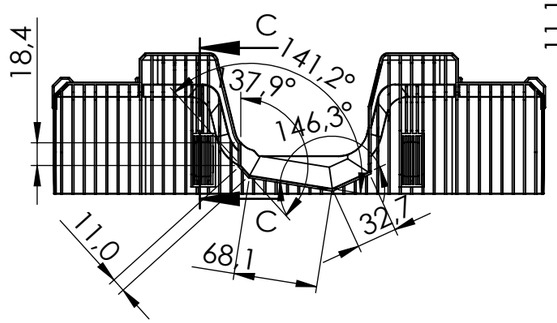


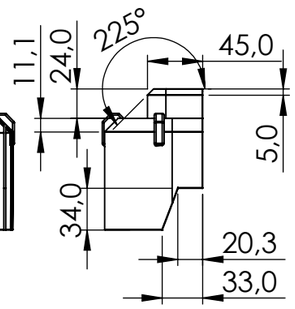
SECTION A-A

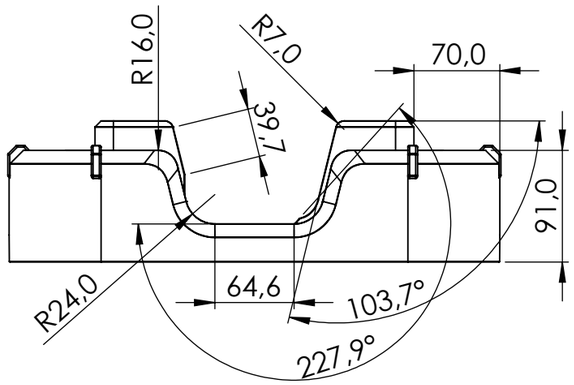
Material: **PP**			Description: **This component is the side shell of the product, which contains a "window".**
Finish: **30-05-23**			
Unless Otherwise Stated: Linear Tol.: , Angular Tol.: Surface Finish: All Dimensions: **mm**		Document Type:	Drawn by: **Group 6** / Drawn Date: **30-05-23**
Drawing Scale: **1:5**			Checked/Approved by: / Checked/Approved Date:
Approx Weight: 0,1 Kg	Drawing Produced In Accordance With:	Legal Owner: 4 MSc ID group 6 2023	Part Number: **6**
Projection method: ISO	Sheet Size: **A3**		Drawing Number: **1** / Sheet: **3 of 5** / Revision:

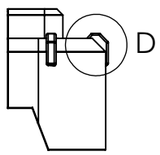


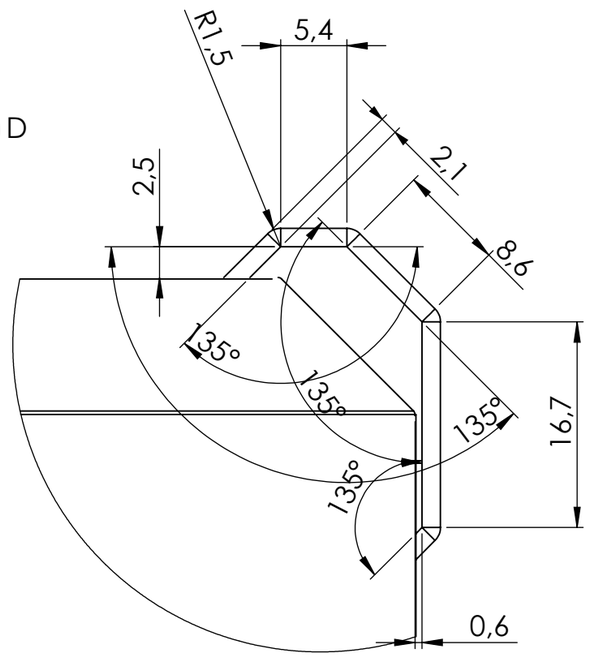




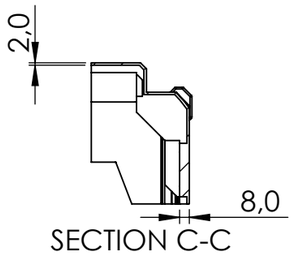




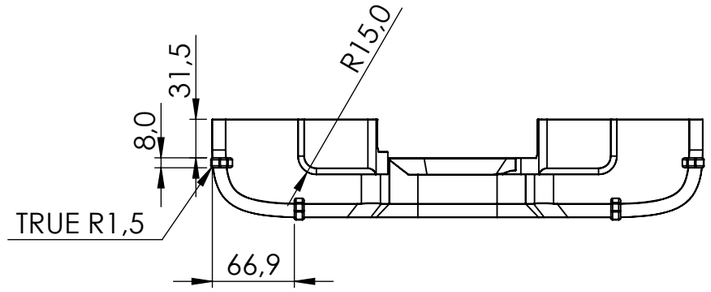




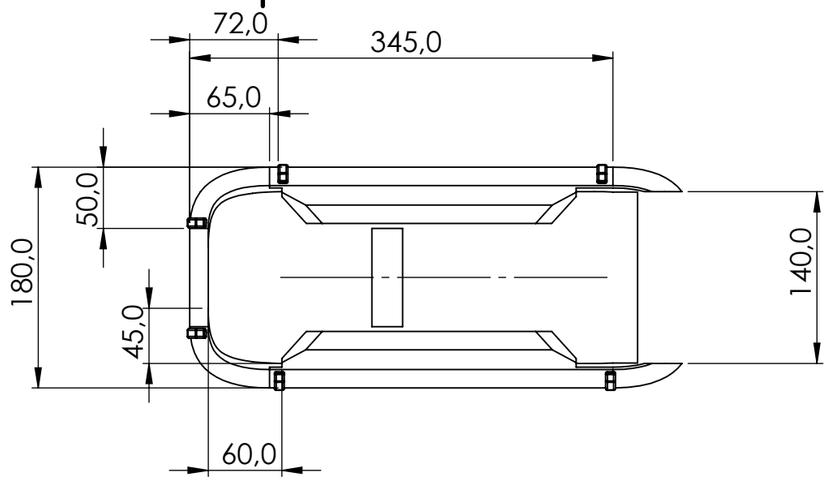
DETAIL D
SCALE 2 : 1

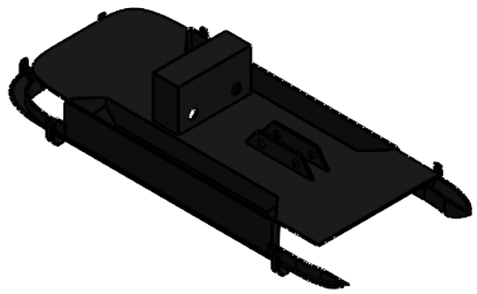


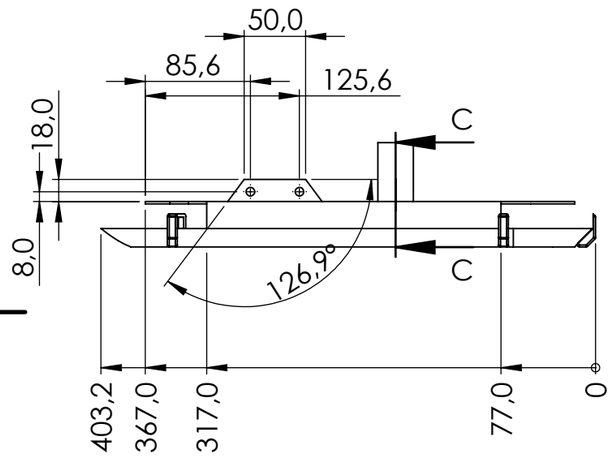
SECTION C-C

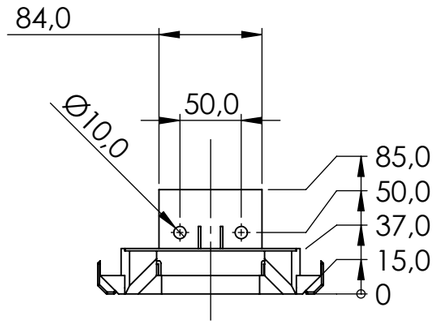


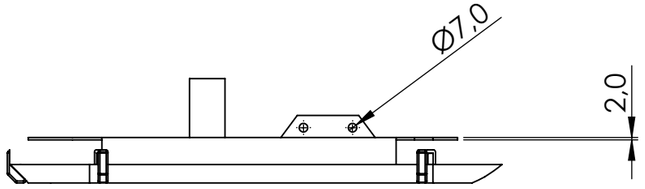
Material: **PPA**			Description: **The lid for the opening mechanism. The ribs included in this drawing is not finalized and therefore not defined.**
Finish: **30-05-23**			
Unless Otherwise Stated: Linear Tol.: , Angular Tol.: Surface Finish: All Dimensions: **mm**		Document Type:	Drawn by: **Group 6** / Drawn Date: **30-05-23**
Drawing Scale: **1:5**			Checked/Approved by: / Checked/Approved Date:
Approx Weight: 0,15 Kg	Drawing Produced In Accordance With:	Legal Owner: 4 MSc ID group 6 2023	Part Number: **4**
Projection method: ISO	Sheet Size: **A3**		Drawing Number: **2** / Sheet: **4 of 5** / Revision:

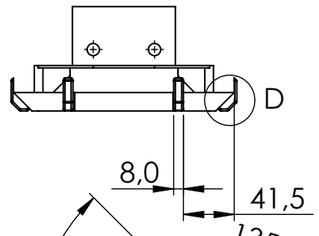


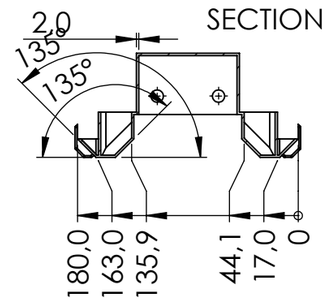


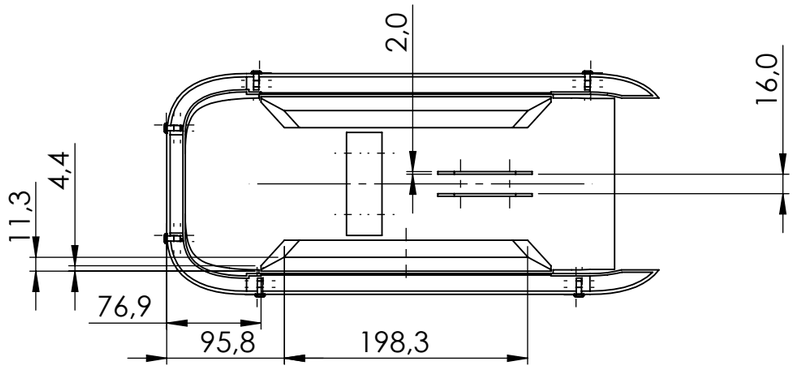


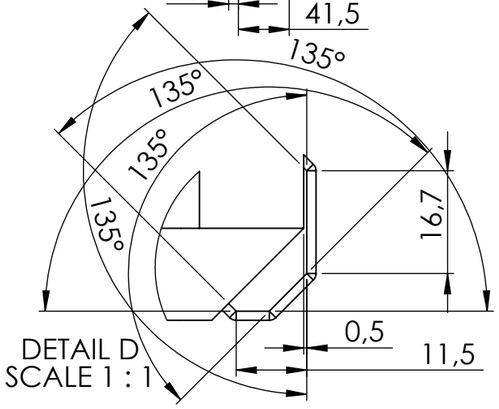












Material: **PP**			Description: **The buttom of the foot.**
Finish: **30-05-23**			
Unless Otherwise Stated: Linear Tol.: , Angular Tol.: Surface Finish: All Dimensions: **mm**		Document Type:	Drawn by: **Group 6** / Drawn Date: **30-05-23**
Drawing Scale: **1:5**			Checked/Approved by: / Checked/Approved Date:
Approx Weight: 0,2 Kg	Drawing Produced In Accordance With:	Legal Owner: 4 MSc ID group 6 2023	Part Number: **11**
Projection method: ISO	Sheet Size: **A3**		Drawing Number: **3** / Sheet: **5 of 5** / Revision: