Lasse Jepsen, Line Østerbye, Nanna H. Friis Nørtoft
MSc4-ID16 • May 2017

PROJECT TITLE	**BEER ACADEMY**
THEME	**BEER BREWING AT HOME**
PERIOD	**01.02.17 - 18.05.17**
STUDY PROGRAM	**MASTER'S THESIS**
TEAM	**MSC04-ID16**
MAIN SUPERVISOR	**NIS OVESEN**
TECHNICAL SUPERVISOR	**JØRGEN KEPLER**
ISSUES	**7**
NUMBER OF PAGES	**32**

This report, that describes the Beer Academy, is developed by Humlebierne as part of their master thesis in Industrial Design, Aalborg University. Current trends and competitors have been analyzed to find an underpenetrated marked to develop for, resulting in new home brewing equipment aiming at the novice beer fans.

HUMLEBIERNE

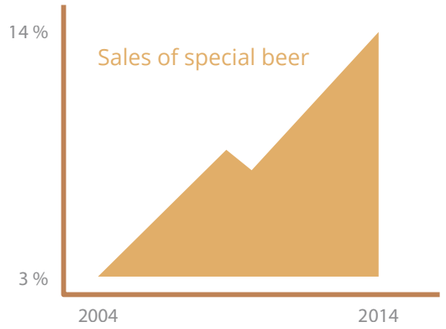
Line Østerbye Nanna H. Friis Nørtoft Lasse Jepsen

CONTENT

POTENTIAL
BEER ACADEMY
USE SCENARIO
MANUFACTURING
BUSINESS
FUTURE DEVELOPMENT

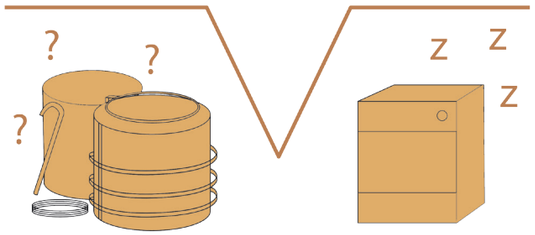
BEER IS BOOMING!

Beer is popular like never before, with microbreweries, beer pubs and beer communities popping up everywhere. It is no longer just beer, but an epicure product with a wide range of flavors, colors and foam.



YOU DON'T HAVE TO BE AN EXPERT TO HAVE FUN WITH BEER BREWING!

At the present time there is a big gap in the market of home brewing. Products are either too comprehensive and complicated or too easy and boring.



TIME FOR A HOME BREW!

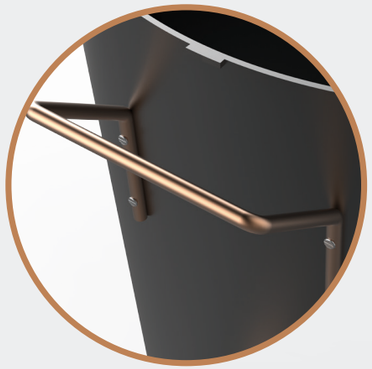
Since the beginning of the millennium home beer brewing has gained currency; Danish home brewers are responsible for 0.2 % of the Danish beer production.
All the while DIY (Do It Yourself) projects are widely shared across all social platforms, making this a perfect time for DIY beer.

EVERYBODY CAN DO IT!

Brewing beer does not have to be difficult, it is a fairly simple process. It is time for a product which lowers the barrier of starting beer brewing and teaches novices, who care about beer and want to broaden their horizon, about the craftsmanship of beer brewing.

With Beer Academy it is easy to start brewing your own beer. Hopsie, your learning companion, will take you through a simplified brewing process of four easy steps, no prior experience is needed. Beer Academy will take care of all the tedious tasks, ensure the precision and minimize the risk of error. The Beer Academy is also fully capable of performing an authentic brewing experience in all its detail, meaning there is plenty of time for you to have fun developing as a brewer. Take an afternoon off for a fun time and receive you reward after a couple of weeks wait; 6 liters of your own special beer! You can brew any beer you like, even develop your own, or you can use any of the 20 basic recipes, which are developed specially for the Beer Academy by Danish Microbreweries. The Beer Academy is fitted to your own kitchen, even pleasing the aesthetic critique of the boss of the house; the wife. The product consists of 7 parts: A tank w. lid, a brew unit, a cleaning tank, a rack, a fermentation lock and ingredients bags.

Straightforward programming



Elegant copper looking details

Protecting your beer in every step

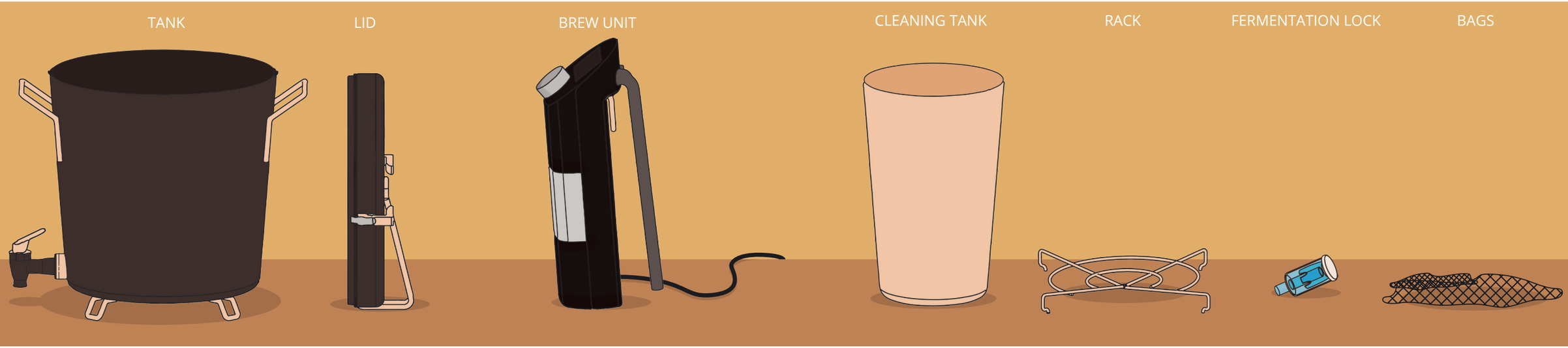
Monitor your beer at all times

Tap for easy filling of bottles

LET’S BREW BEER!

Hi! I am Hopsie and will teach you how to brew beer.

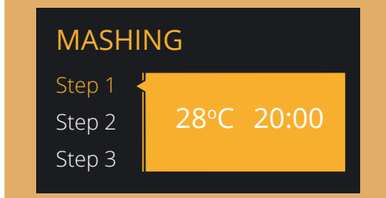
Together with the product, you have the choice to use the appertaining app that informs you about the brewing process and how the ingredients influence your beer.



Beer Academy is fitted to the kitchen. The tank goes in the sink, so the tank can be filled with water easily. The height is also fitted for working under a cooker hood for ventilation during the brew.

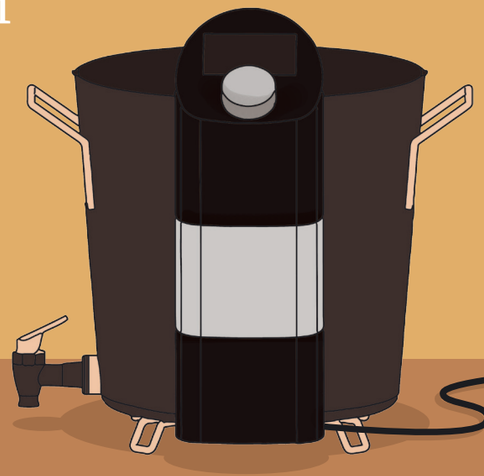
Ingredients needed to brew beer with Beer Academy:

PHASE 1: MASHING

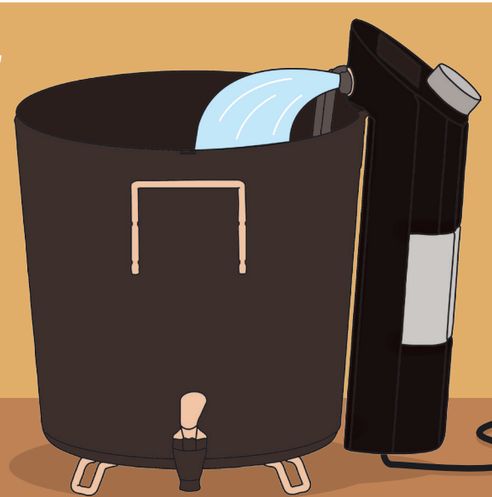


After filling the tank with water, and mounting the brew unit, the mashing can begin. During mashing sugars are extracted from malt, to create flavor and alcohol. For each phase (Mashing & Worting) the program has to be set. Like the professionals Beer Academy can heat the mash by step infusion; you set a temperature and a time for each of the mashing intervals. The times and temperatures can be found in your recipe.

1

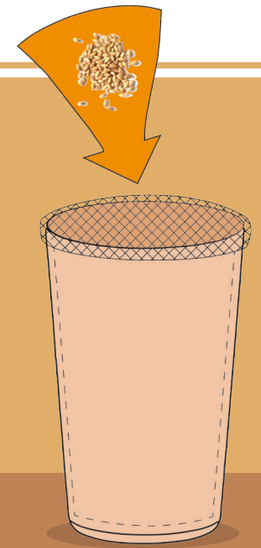


2

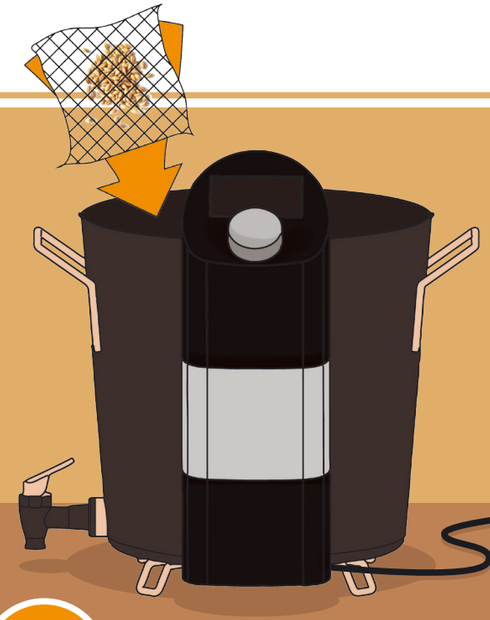


3

The bag for the malt fits perfectly in the cleaning tank and inside the cleaning tank you will find measuring units to make the filling easy.



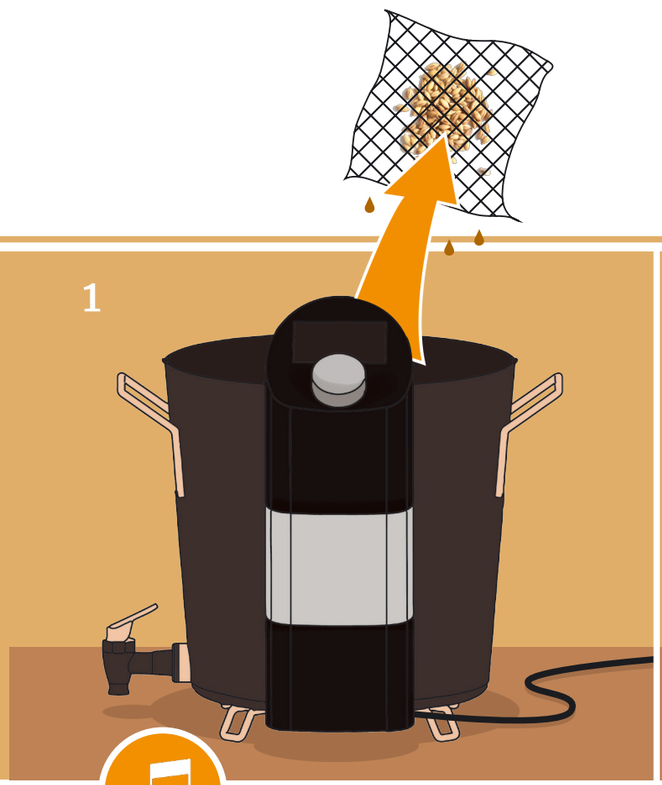
4



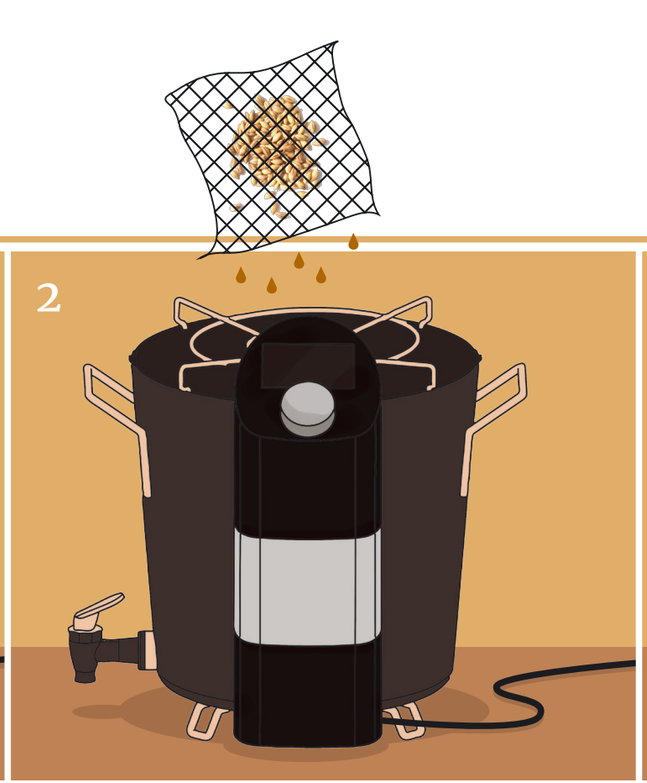
When the program is set and the tank is filled with water, the brew unit will begin heating the water circulate the water from the bottom of the tank, heating it inside the brew unit, and finally distributing it from the top outlet. This method is called RIMS in the brewing world.

An alarm will go off when the water is the right temperature, and it is time to put in the sealed malt bag.

RACK

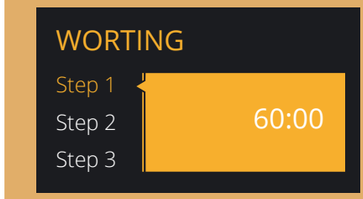


After the set time is up, Beer Academy will remind you to remove the malt.

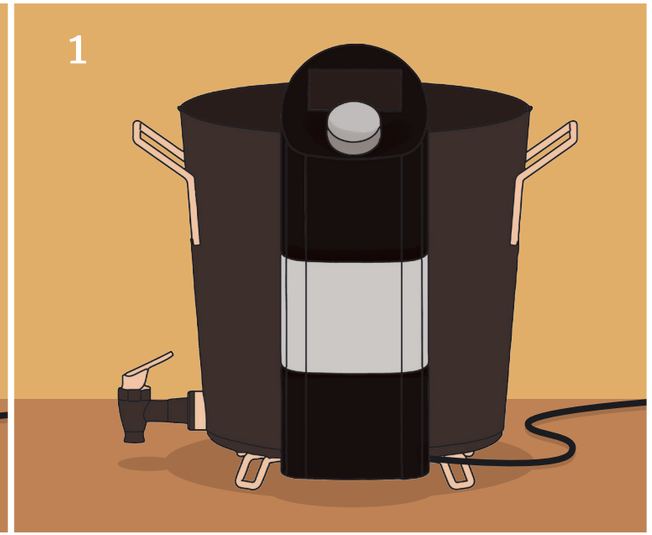


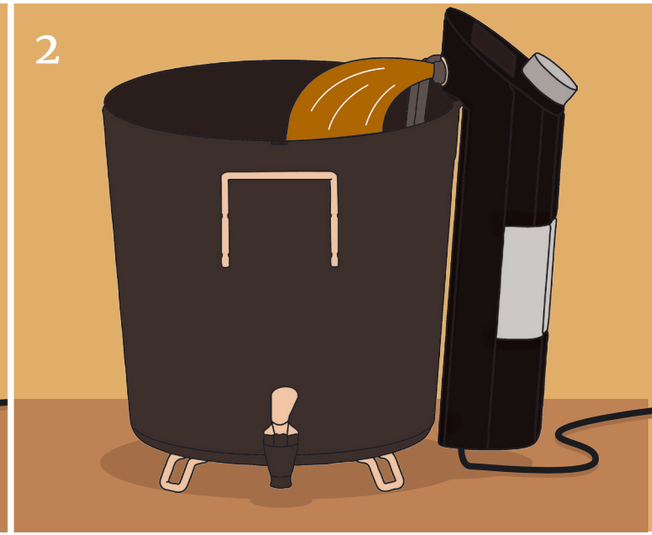
The rack facilitates you to either let the malt bag drain or to sparge the malt. Sparging is a method where you pour 80 degrees hot water out over the drained malt and extract a higher percentage of i.a. flavor, color and sugar. This method is not obligatory, but will influence the efficiency of your malt.

PHASE 2: WORTING



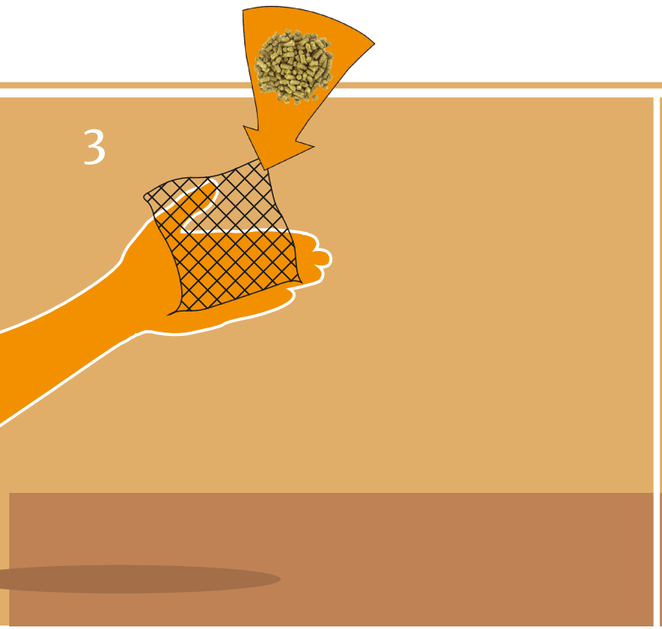
To initiate the worting phase, you begin by programming the steps according to your hops. Again, these settings can be found in your recipe.



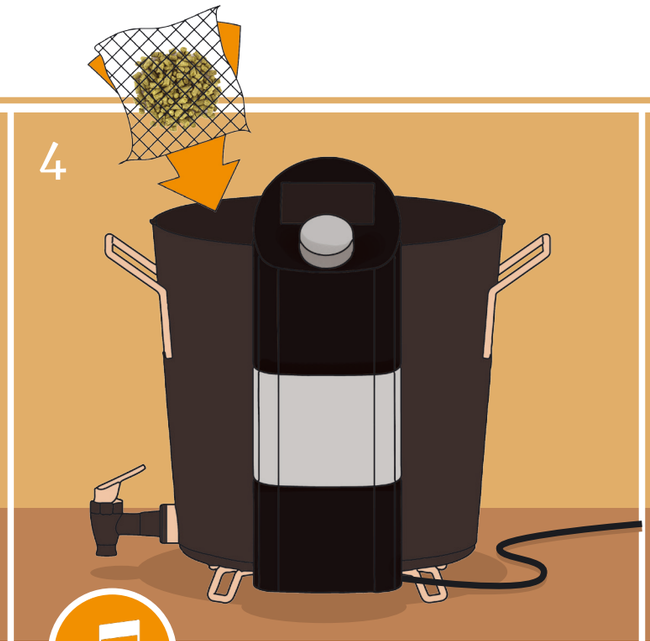


The brew unit will again heat up the water. In the worting phase the brew has to be boiling when the hops is poured in it.

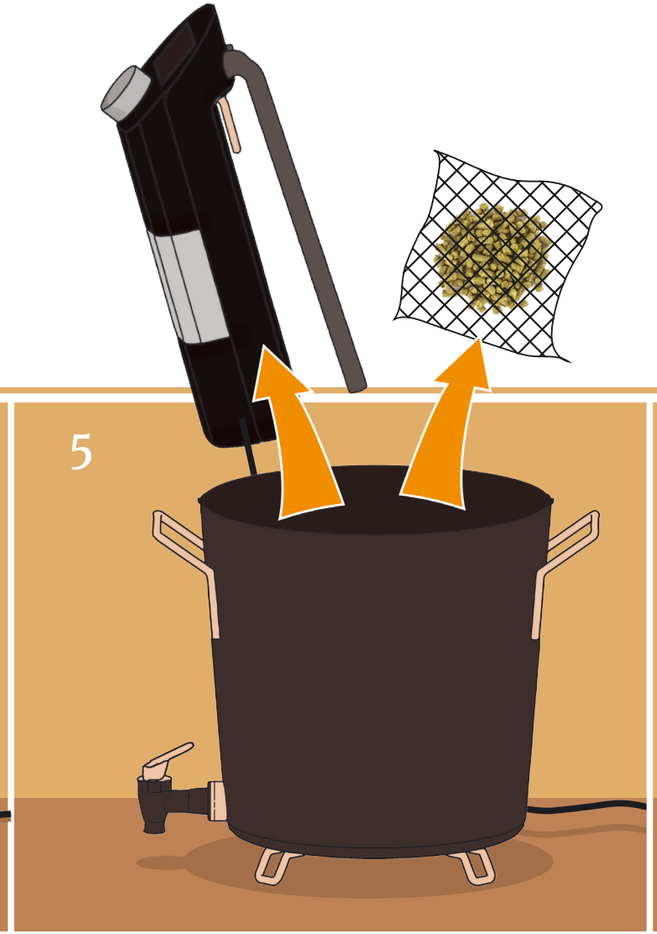
PHASE 2: WORTING



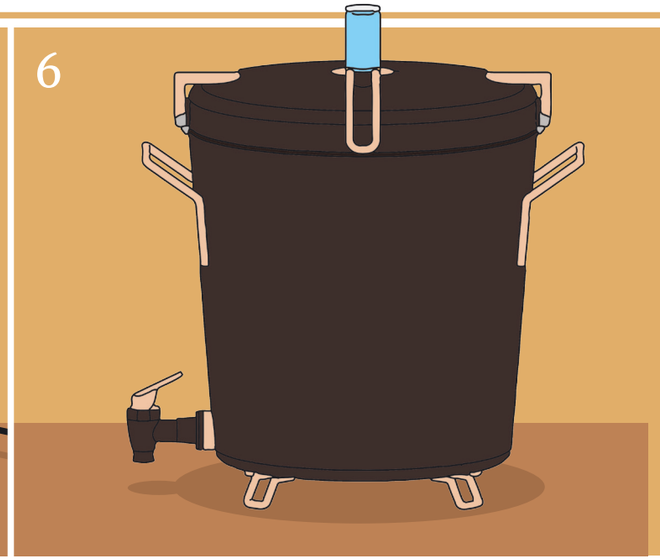
The hops are poured into small, convenient bags and sealed shut. During worting it is also possible to add other flavors besides hops, if wanted.



When the mash is boiling, Beer Academy will remind you to put in the first hops bag. It will remind you again whenever additional hops bag should be put in, and finally when the hops should be removed.



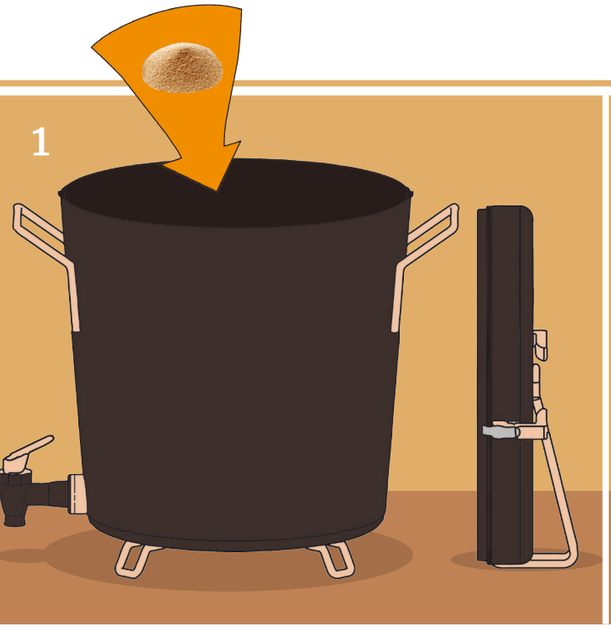
The brew is done when all the hops have been in the tank. When the final bag is removed, the brew unit can also be removed and cleaned.



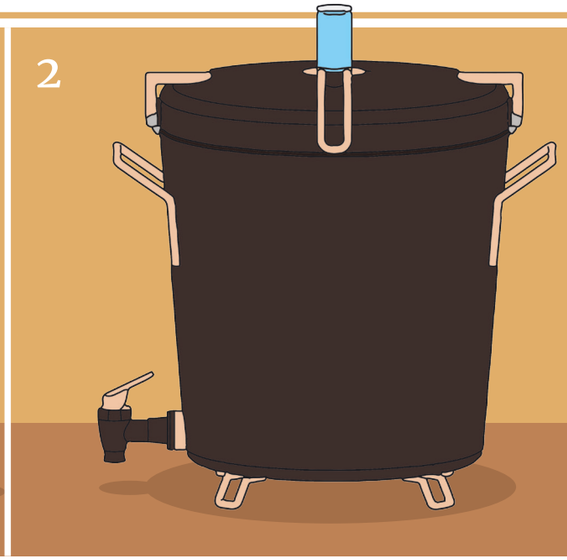
The wort now has to cool over night, and the lid is placed and sealed to ensure that there will be no contermination.

PHASE 3: FERMENTATION

During the fermentation your beer will come to life; you can keep up through the bubbles in the fermentation lock. A thermometer in the lid enables you to check if the beer is at the right temperature.



When the wort is cooled to room temperature, you add the yeast.

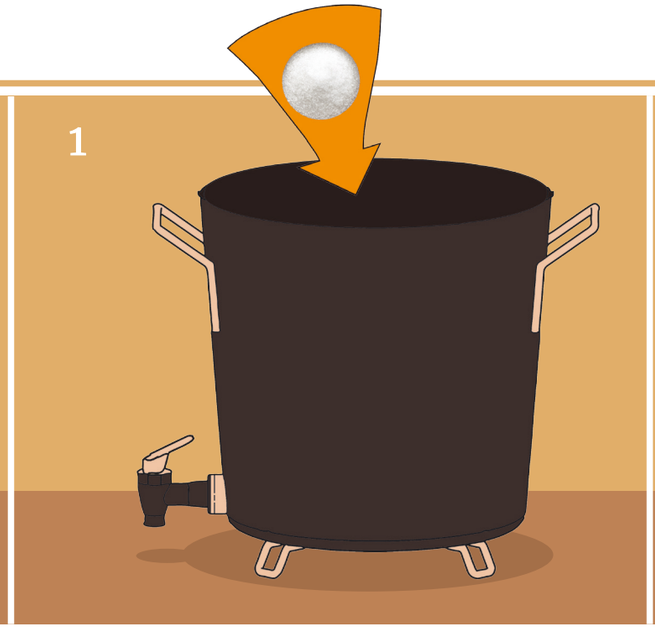


Zzz

The brew now has to ferment for approximately 2 weeks - depending on the recipe. You can move the tank to another context, where the temperature is right. During this time the yeast will transform the sugar in the beer into alcohol and carbon dioxide.

BOTTLING

The tap on the side of the tank is positioned over the dead yeast, so you will not get any yeast in your bottled beer.



When the fermentation is done, the yeast will die and settle in the bottom of the tank. You now add sugar before tapping the beer into bottles.

PHASE 4: SHARING

Enjoy and share your beer with your friends!

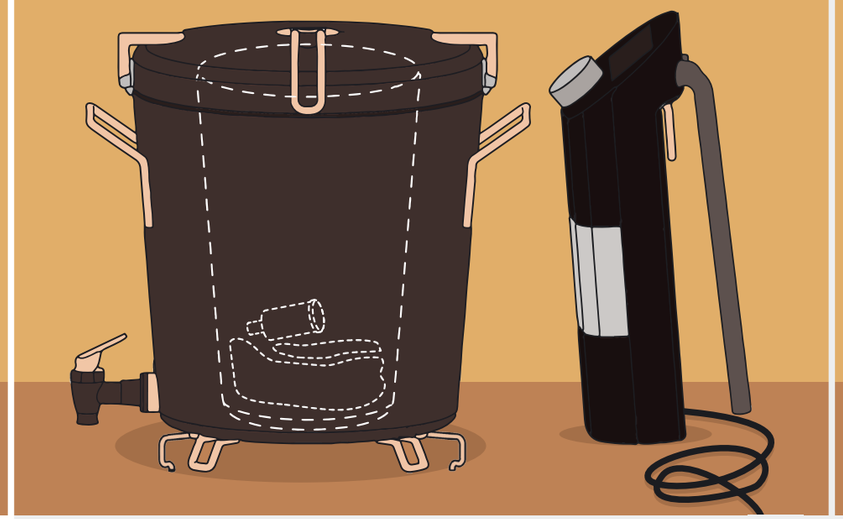
1

2

The sugar will be transformed into additional carbon dioxide by the few remaining living yeast particles. After only two your beer is fizzed and ready to drink.

CLEANING

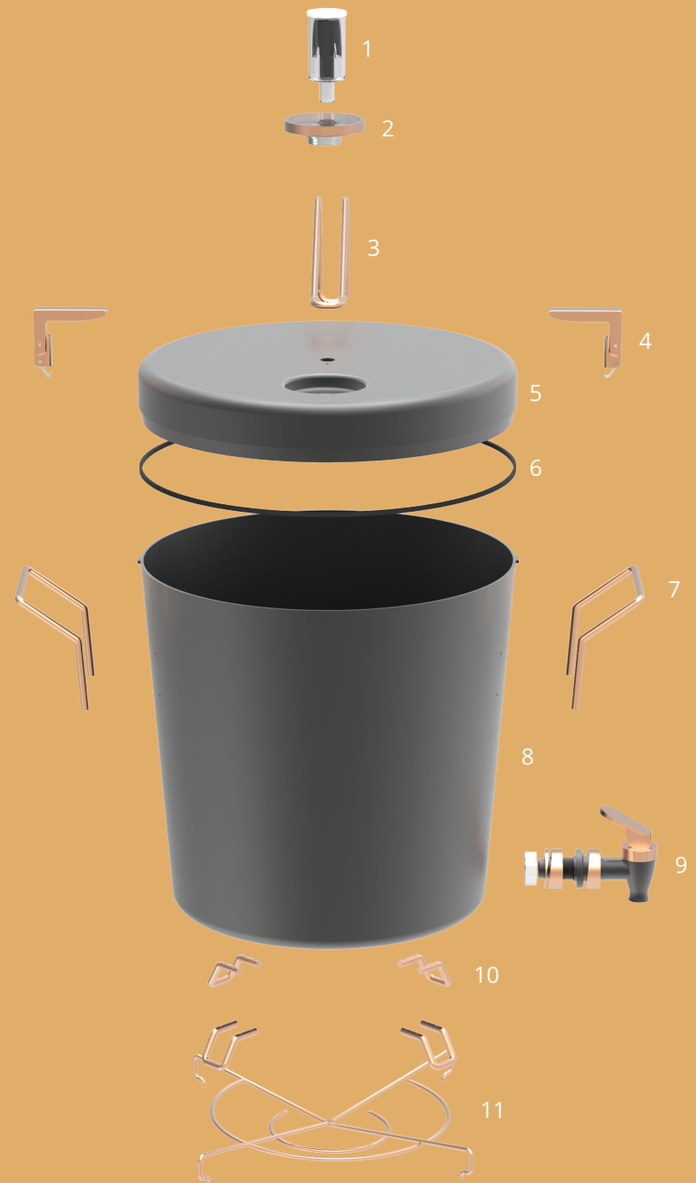
The tank, the lid, and the cleaning tank are dishwasher safe and the bags can go in the washing mashine, making the cleaning process very simple.



Everything except the brew unit can be stacked making the storage of the product convenient and space efficient.

To sterilize the brew unit it is placed in cleaning tank while running the cleaning program. The brew unit will boil the water in the tank, thus sterilizing the inner tubes.

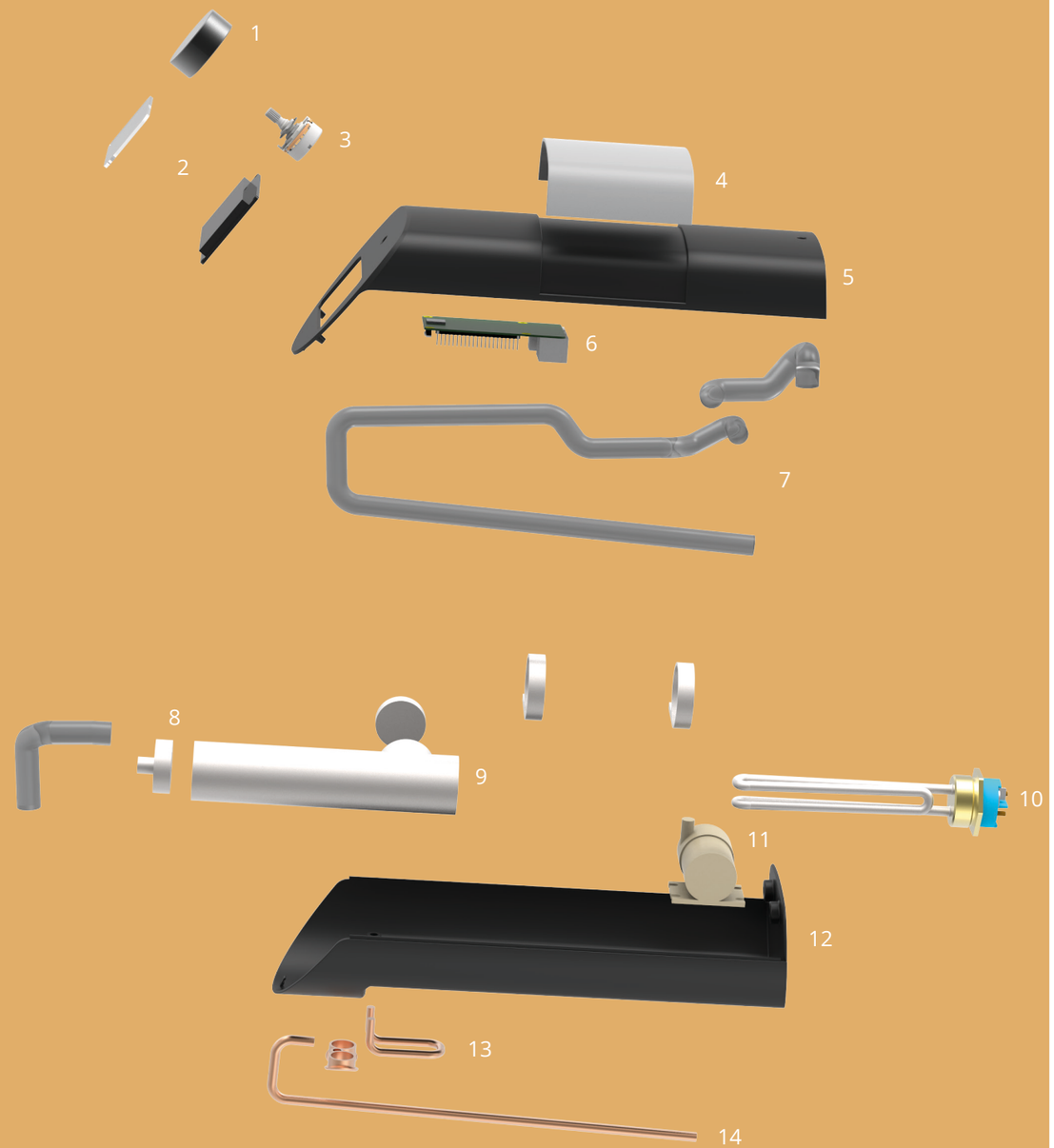
THE TANK



The brew unit consists of many standardized parts widely available making the product cheaper to produce and easier to service.

1	Fermentation lock	20 DKK
2	Thermometer	57 DKK
3	Lid handle	6 DKK
4	Closing mechanism	7 DKK
5	Lid	200 DKK
6	Rubber band	23 DKK
7	Handle	73.5 DKK
8	Tank	349 DKK
9	Tap	12 DKK
10	Foot	2 DKK
11	Rack	14 DKK
	Total (incl. tooling and assembly)	974 DKK

THE BREW UNIT



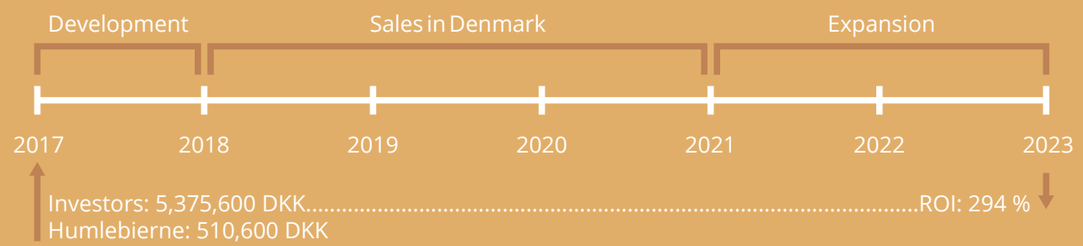
The metal parts are made using simple manufacturing processes, meaning the customer will get cheap high quality parts. The simple geometry makes tooling cost low, but also makes cleaning easy.

1	Knob	15 DKK
2	Screen	200 DKK
3	Potentometer	7 DKK
4	Handle	56 DKK
5	Outer shell	54 DKK
6	Raspberry pi	280 DKK
7	Internal tube	11 DKK
8	Fittings	3 DKK
9	Heat tube	25 DKK
10	Heating element	28 DKK
11	Pump	128 DKK
12	Inner shell	56 DKK
13	Hook	3 DKK
14	Temperature sensor	4 DKK
15	Wiring	20 DKK
	Total (incl. tooling and assembly)	968 DKK

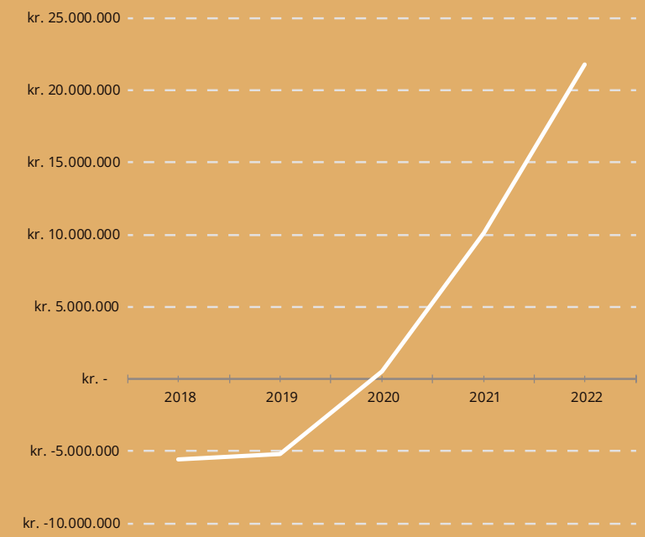
LET'S GET DOWN TO BUSINESS!

Beer Academy is to be sold through a web shop, and awareness will be created through channels hitting the fans were they are: Beer festivals, blogs and breweries. Beer Academy comes with 15 basic recipes developed by microbreweries from across Denmark. The breweries take care of the ingredients and provide an additional marketing channel, while Beer Academy offers a branding opportunity for the breweries.

Humlebierne will take care of the rest of the product development during 2017, making the product ready to launch in 2018. Investors and funds are covering all the development cost, while Humlebierne covers their own salary. Until 2021 focus is on sales in Denmark. In 2021 the company will expand their market to the Nordic countries, England and Holland. Furthermore, a higher focus will be on service development. These investments will be covered by the company's cash position.



BREAKEVEN



Beer Academy

12,000 Brew Academys sold in three years
Sales price: 3,999 DKK
40 % Contribution Margin

Ingredients

36,000 ingredients packs sold in three years
Sales price: 279 DKK
20 % Contribution Margin

FUTURE DEVELOPMENT

Before launch in 2018 the following aspects needs to be developed:

The service surrounding Beer Academy must be developed. The idea is to create an entire community around the product that connects the users and creates the social universe they normally associate with beer. Hopsie is the front figure; his mission is to introduce everybody to the world of beer enthusiasm and create awareness of the simplicity and fun of beer brewing. As part of the service, partnerships have to be set up with Danish microbreweries to develop recipes specific for the Beer Academy.

User interface has to be detailed and tested. This includes an app, which goes with the product. It is through the app the user learns additional facts about the aspects of the beer, while the Beer Academy brewer focuses only on brewing. The app and the user interface on the product should have a coherent style.

Detailed styling improving the WAF (Wife Approval Factor), such as handles and line work in the plastic shell to attain a more distinctive shape, has to be done.

Technical details as the distributing of the mash and wort at the top of the brew unit without evaporation needs to be assessed tested and further detailed, preferably by specialist. This also includes optimization of the component architecture and dimensioning of the material thickness in order to save cost.

Lasse Jepsen ◈ Line Østerbye ◈ Nanna H. Friis Nørtoft

HUMLEBIERNE PRESENTS: *BEER ACADEMY*

Process Report

Master Thesis
May 2017

MSC04-16 INDUSTRIAL DESIGN AAU

HUMLEBIERNE

#3.1 Humlebierne:
Line Madsen-Østerbye, Nanna Harboe Friis Nørtoft, Lasse Wolkers Jepsen.

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NUMBER OF PAGES	**104**
APPENDICES	**13**

SUMMARY

This following report documents the development of the product Beer Academy, which is home brewing equipment for the novice. The project set out to seek for an underpenetrated market, which, through trend mappings, is found in home beer brewing. A competitor analysis maps the market and uncovers a potential in brewing equipment for the fan, who has never brewed before, which lowers the barrier for getting starting, while allowing the user to learn and improve with the product. The project is continuously influenced by six user representatives from the target group and experts from Søgaard Brewery. The product proposal is developed through an iterative integrated process; the result can be seen in the adjacent product report.

READING GUIDE

This master thesis hand in is divided into two reports: A process report and a product report with enclosed technical drawings. The reports can also be found on attached USB along with appendices. This process report documents, evaluates and reflects upon the development process of the project. The report is chronologically ordered except the brewing chapter, and specification chapter, which are described aspect by aspect.

This report is divided into seven chapters: Intro, Framing, Beer Brewing, Concept Development, Detailing, Specification, and Epilogue.

Illustrations are named by their page number: e.g. #52.3 would be the third illustration on page 52. Throughout the report Harvard reference method is used.

Requirement

Throughout the text, product requirements are highlighted using this arrow.

Nice to have

And the nice to have's with this arrow.

Finally, each section is summed up in this grey box.

ACKNOWLEDGEMENTS

Humlebierne would like to thank:

SØGAARDS BRYGHUS AND TOM
for sharing their insights on beer brewing and sharing their craft and ideas through continuous visits.

KEN THØGERSEN, HJEMMEBRYGGEREN.DK
for giving hands-on experience with brewing and his product and providing knowledge and equipment throughout the project.

MADS KIRKEGAARD THOMSEN, SØREN JENSEN, SØREN LORENTZEN, SØREN POLL, BJARNE JEPSEN AND MORTEN JEPSEN
as user representatives for support and contributing with their time, their thoughts and valuable feedback.

LEARNING OBJECTIVES

From the beginning it was a wish for the entire team that the project has a entrepreneurial approach, with focus on every step of the life-cycle - including packaging, the business model & the branding of the product. The project scope focus on product development, thus delimiting service aspects.

Lasse's personal objectives are:
- Work with the supply chain in detail
- Work with the life-cycle of the product and portfolio management
- Be stronger in the business and strategy of a product
- Be better at documenting during experiments and tests
- Be better at pitching

Line's personal objectives are:
- Visualizing the ideation/conceptualization better
- Be able to sketch on a professional level
- Use sketching as a development method
- Work with validation
- Be able to communicate a strong branding strategy

Nanna's personal objectives are:
- Be better at managing
- Be stronger in the business
- Use design as a strategy
- Work with testing and validation at a high level
- Be better at time management
- Become a better pitcher

TABLE OF CONTENTS

INTRO

6 TABLE OF CONTENTS
8 PROCESS TIMELINE
9 GLOSSARY

FRAMING

11 THEME
12 TRENDMAPPING
16 MARKET
18 USER GROUPS
19 INITIAL IDEATION
25 CHOICE OF DIRECTION
26 SYNTHESIS:
26 PROJECT DIRECTION

BEER BREWING

29 BREWING PROCESS
32 SØGAARDS BREWERY
33 HJEMMEBRYGGEREN.DK
34 THE MASHING PROCESS
36 SYNTHESIS:
KEY INSIGHTS

CONCEPT DEVELOPMENT

39 TARGET GROUP: FANS
42 KEY ACTIVITIES
44 INITIAL VALUE MISSION
46 PRODUCT IDENTITY
48 SKETCHING WITH SCALES
52 EVALUATION WITH USERS
56 SYNTHESIS:
CONCEPT DIRECTION

DETAILING

61 CAPACITY
62 YEAST HANDLING I
64 TO SPARGE OR NOT
65 ELEMENT OF HISTORY
66 FORM DIRECTION
68 INTERACTION MAP
70 INTERACTION VISIONS
72 DIMENSIONS
73 UPDATED STYLE BOARD
75 IN SITU SKETCHING
76 SYNTHESIS:
CONCEPT DIRECTION

SPECIFICATIONS

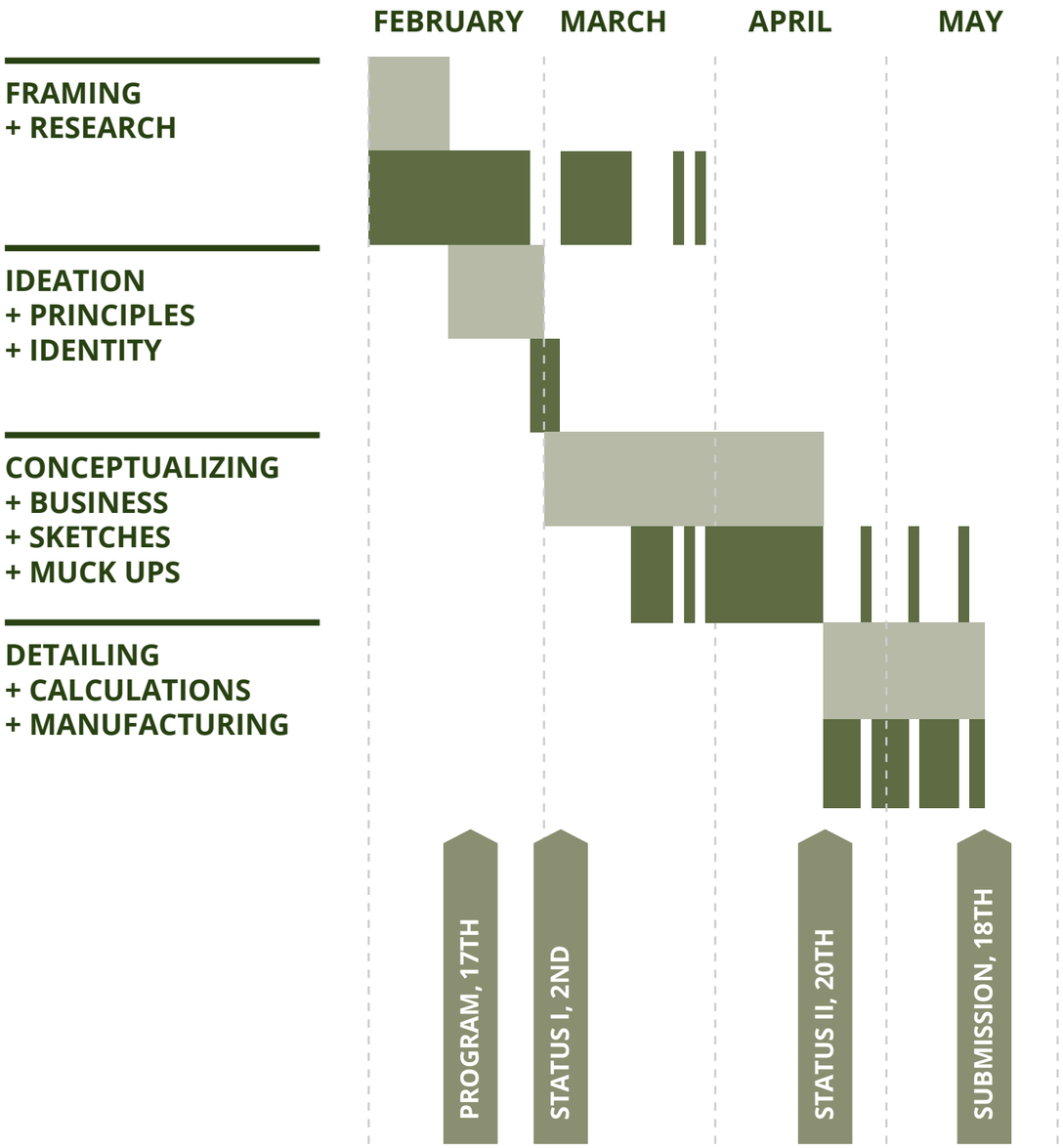
79 KEY COMPONENTS
80 ARCHITECTURE
81 SPECIFICATION
82 ACCESSORIES
83 YEAST HANDLING II
84 FORM DETAILS
86 BUSINESS APPROACH
88 BUSINESS CASE
90 MANUFACTURING & MATERIALS
92 SYNTHESIS:
PRODUCT PROPOSAL

EPILOGUE

95 CONCLUSION
96 PRODUCT REFLECTION
97 PROCESS REFLECTION
99 REFERENCES
101 ILLUSTRATIONS

PROCESS TIMELINE

The process is divided into 4 phases; Framing, Ideation, Conceptualizing, and Detailing, and runs over four months. Four milestones are showed in the bottom of the page; program, status I & II, and submission. The lighter color shows the estimated time, and the darker color showed the actual time spend in the project. The time spend was tracked using a tool called Toggl.



#10.1 Process overview.

GLOSSARY

MALT
Base ingredient in beer.

HOPS
Taste ingredient in beer.

MASHING
A process in beer brewing where malt and water is heated to extract sugars, starch and enzymes.

MASH
Malt soaked in heated water.

WORT
Filtered mash: Water with sugar, starch and enzymes.

LAUTERING
Filtering the wort from the mash and the process of sparging.

SPARGING
To run water through filtered malt to increase efficiency.

FERMENTATION
The first fermentation where yeast reproduces and converts sugars to alcohol, carbon dioxide and a variety of flavors.

SECOND FERMENTATION
The fermentation after the beer has been bottled or kegged, where added sugar carbonize the beer.

FERMENTATION LOCK
Air lock that ensures carbon from the fermentation can escape while preventing contamination.

RACKING
Fermented beer is poured into another fermentation container for the yeast to get new oxygen and the yeast can further develop.

FRAMING

PRESENTING THE UNDERLYING WORK BEHIND THE DESIGN BRIEF LEADING TO A PROJECT DIRECTION

THEME

INTRODUCTION

On an autumn Tuesday morning three design students set out to choose a master thesis theme. Naturally, the theme should contain a business potential and facilitate every team members learning objective. Essentially, the theme must interest all team members while simultaneously hit an equal knowledge level, the first challenge of many. And so, like all good stories, it begins...

Has an element of tradition

Beer is the oldest human produced drink in the world, dating back to at least the ancient Egyptians. It's the most widely consumed alcoholic drink, and third most popular drink overall, after water and tea, in the world. (Wikipedia.org - Beer) Beer has gone from being necessary to drink during the Middle Ages, because of contaminated water, to being the stimulant it is today (Nielsen 2004).

The last 20 years the interest in beer has been rising and becoming more common; consumers have more focus on the different aspects of the taste of beer. (DR.dk – Danskerne vil have ekslusive øl) Likewise, the hobby of home beer brewing has grown in popularity (Haandbryg.dk), also worldwide where american home brewers are responsible for 1 % of the total U.S. beer production (HomeBrewerAssociation.org – Homebrewing Stats). In Denmark homebrewers are responsible for 0.2 % of the Danish beer (Ken Thøgersen 2017). How could home brewing and the love of beer gain currency in Denmark? What if brewing ones own beer wasn't more difficult than making your own bread? Could the barrier for getting starting with beer brewing be lowered, so more people could have the opportunity to learn the craft of beer brewing?

This project focuses on exploiting the potential of the rise in beer interest, finding a gap in the market of home beer brewing and helping broaden the knowledge behind beer.

TRENDMAPPING

Since the foundation of this project is the growing interest in beer and home beer brewing, a deeper understanding of the underlying trends is needed. This will indicate which values to exploit and thus where the market potential is, leading to a direction to go for. Trends are registered empirically and analysed in terms of driven factors and history in order to estimate where it can go.

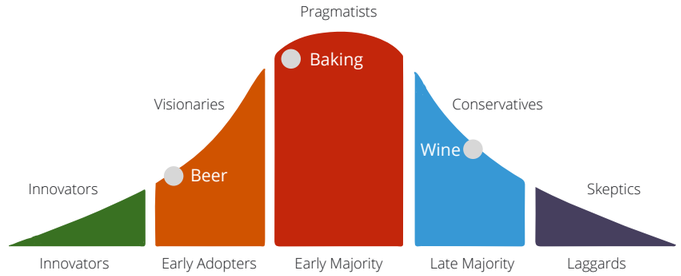
BEER ENTHUSIASM

For a long time beer was drunk because of necessity, later as a stimulant, however it suffered of low status because of wine; Even the romans considered beer barbaric (Nielsen 2004). When traveling south became popular in Denmark, wine was brought home, and beer was the cheap working class drink with beer being served at Danish workplaces (Frich et al 2014) (Øhrstrøm 2014). Thanks to "De danske ølentusiaster" beer import was made possible in Denmark in 2002 and demand, and hereby interest, for beer has been growing ever since. Still the Danish consumption of beer is declining; 10 % between 1998 and 2004, among others because of no-alcohol politics around Danish workplaces, but the variety of beer is growing; a rise of 300-400% between 1998-2004 (DR.dk – Danskerne vil have ekslusive øl), see illustration #12.1, indicating that the Danes care more about the actual beer. Beer was heavily industrialized in 1980, which resulted in a lot of microbreweries being bought and closed down, today referred to as the brewing death. In the beginning of the millennium a second rise of microbrewery started in Denmark. Today Denmark has 120 microbreweries (breweries brewing less than 500,000 liter beer yearly), world record for breweries per citizen, and the surrounding countries are starting to follow suit.

#12.1 Beer popularity: A) The beer selection in Salling Aalborg. B) Information regarding colour and bitterness as part of the new label design on Royal Classic.

HOME BREWING

Historically beer has been following baking. They are related because they are both made of crops, water and yeast. Historically they were produced at home until the industrialization and mass production took over. Producing your own baking goods has been rising for the last 30 years, and beer is slowly following suit (Realfoods.co.uk – The rise and fall of British baking). It is a trend that is trickling up.
During the 70'ies making your own beer with beer-making-kits was popular, but beer brewing started its popularity at the start of the millennium (Haandbryg.dk). Ever since, it has only been rising; 165 participants in Danish championship in home beer brewing in 2004 (Preisler 2004), and a 13% increased revenue for hjemmebryggeren.dk in 2016 (Ken Thøgersen 2017).



#13.1 Technology adoption life-cycle of the trend of beer, baking, and wine enthusiasm

Beer is slowly following in the footsteps of wine in terms of interest and enthusiasm and the world of beer is growing and expanding. It is still far behind, but none the less more reason to believe in a future growth. These times, beer enthusiasm is about to become a real big thing. Despite a decline in total sale of beer there has only been a rise in beer varieties the last ten years. The same goes for sale of home brew equipment. Even at low conjectures there was a rise, indicating that the rise is stable (Ken Thøgersen 2017).

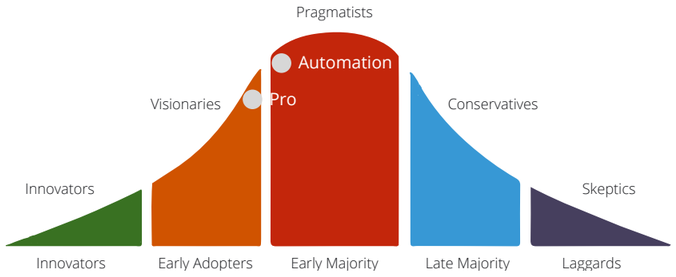
KITCHEN TRENDS: PROFESSIONALISM & AUTOMATION

In order for it all to fit together it is also important to gain insights on trends within the context of the product, which is the kitchen. The trend analysis of kitchens is mostly based on field trips to Multiform Aalborg. They do luxury kitchens and are therefore on the cutting edge of new kitchen trends before the rest of the consumer market follows.

The standard of the kitchen is rising. People aspire to be professionals at home and products like the sous-vide, steam ovens and espresso machine enables you to raise the bar on your food creations. According to Multiform, Aalborg, the amount of professional equipment and machines in the kitchen is rising and becoming more of a norm. This leads to the other kitchen trend: Automation. In general technology is becoming a bigger part of our lives and homes, including our kitchens, where it is integrated more and more. Everything is made smarter, more functional, and easier.

#15.1 Products from Multiform: A) Espresso machine making you a professional barista B) Sensor activated faucet, easy and clean.

Has a professional feel
(Look and interaction)



#14.1 Technology adoption life-cycle of the trend of beer, baking, and wine enthusiasm

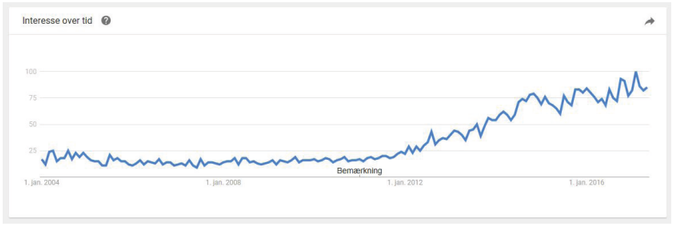
According to Multiform going professional in your kitchen has just started going mainstream. Products like sous vide are slowly trickling down to normal appliance stores. An example of a product that has already gone mainstream and stayed there is espresso machines. At this moment there are 130 different espresso machines for sale at Elgiganten.dk (Elgiganten.dk – Espressomaskiner). This is indicates that professional products can find a place in the common kitchen. Meanwhile there is no doubt that automation has found a place in the kitchen and is only going to do so more and more. In general there seem to be no limit on where automation can go.

MEGA TREND: LESS, BUT UNIQUE

Has a feeling of accomplishment (DIY)

Shares your experience (Not necessary knowledge)

Home brewing, professionalism and automation all relate to an overall mega-trend: Less, but unique, where time and uniqueness are the new value. The mega trend involves the trends of DIY (Do it youself) and minimalism; both a respond to the overconsumption of mass produced goods, environmentally and economically, and the lack of time everybody feels. Minimalism results in a movement back to basic: Simplicity and honesty is important. Experts believe the trend is here to stay. (Millennialmarketing.com – Millennials becoming minimalists) Meanwhile doing things yourself is also becoming increasingly popular, see illustration #14.2, and has yet to peak. One popular aspect of DIY is sharing the experience with the rest of the world. DIY projects give bragging right, showing that you are unique and also that you have sur plus in time and energy to do things yourself. (Fromm 2013)



#14.2 Screenshot from Google Trend: The rise in search for DIY in Denmark.

INTERCONNECTIONS

Home brewing perfectly fits the wave of DIY; it is an opportunity to create your own unique beer and showing sur plus of time and energy. A big part of beer is the social aspect, leaving plenty of opportunity to share your beer brewing experience. Going professional in your kitchen is also interconnected with doing things yourself. Professional equipment allows you to raise the bar on your own creations. The same goes for automation, which in addition can give you the extra time, we all want, by taking care of tedious tasks. Automation also gives opportunity to customize your experiences and making it unique. However there is a potential conflict between the professionalism, automation and DIY. Where goes the line between becoming too professional, with too much equipment, and actually doing something yourself? Do you create unique DIY projects, if you make them perfect? How professional and DIY are you, if there is too much automation? Can you be minimalistic and go back to basic, while being professional and/or using automation? Clearly home beer brewing fits the trend of DIY and beer enthusiasm nicely, indication that there is an interest and a market. The trends of professionalism and automation in the kitchen must be considered though; otherwise the product will not fit the context. The challenge will be to find the level of professionalism and automation, where it is not overdone and still goes together with the values of DIY and beer brewing.

Trends within beer enthusiasm and DIY indicate there is a market for home beer brewing products. The likelihood of this being new to everyone is small, so a competitor analysis will be conducted next to see who else found the market. It is important that the product gives the feeling of doing something yourself, meanwhile fitting the trends of the context; professionalism and automation. The potential conflict between the two, needs to be investigated and the balance between them need to be played with and pushed, to find the middle course.

MARKET

The market is analyzed in terms of competitors to see what is already available on the market, is there a gap and if so; where. This should also help in the selection of direction by evaluating which user needs are covered by the market. The analysis is inspired by the Strategy canvas (W. Chan 2005). The competitors are compared on parameters set by the team based on initial competitor research. See appendix A for full competitor matrix.

MARKET CLUSTERS

AUTOMATIC
The market is split in three fragments. In one end are the full automated brewing machines. They take care of everything, you just have to pick a beer, put in ingredients and press go. The ingredients are bought in packs fitted to the machine, which gives a limitation to the variation of beers available. (Picobrew.com) (Brewie.org)

TRADITIONAL MANUAL
In the other end are the traditional brewing equipment; basically a fermentation set, where you use your own pots and pans for the brewing process. This equipment is normally bought in pieces so the user can build the exact set they want. (Wikihow.com – Brew your own beer)

SEMI-AUTOMATED
Around the middle are semi-automated solutions. While traditional equipment is basically a fermentation set, these products are a brewing set. The two are therefore often used together. The semi-automated solutions are principally combining a pot with a control unit that takes care of the temperature and time control. They are highly industrial and fairly complicated to use. (Speidels-Braumeister.de) (Brewolution.com – Brewster)

KITS
As a joker one can buy beer making kits, where you just add hot water to the extract and wait, while it ferments. (Brewdemon.com)

Except from traditional set and Brew Demon, all of the competitors need extra equipment to ferment the beer. See example below, #16.1.

#16.1 Pico Brew with all equipment

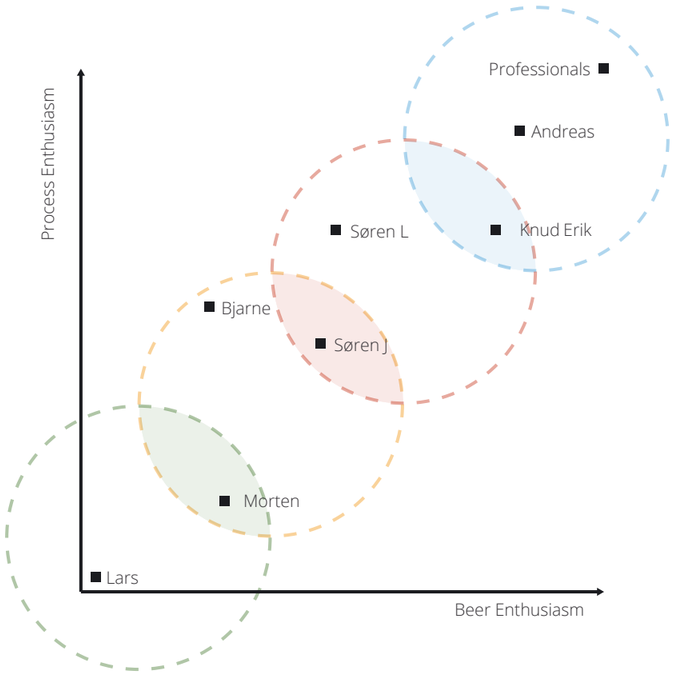
#17.1 Competitor matrix: A) Brewie B) Brew Demon C) Pico Brew D) Braumeister E) Brewster F) Fermentation set

In the home brewing market there are already some competitors; they scatter across the market, with some being highly automated and kitchen-like and others being close to manual and industrial like. In the middle of the market a few semi-automated solutions exist. However the team believes there is room for a semi-automated solution, which is less complicated and easier to use. The question of how semi-automated and how simple the product should be remains to be answered; first step is to start an ideation.

USER GROUPS

To broaden out the project before the initial ideation insights related to beer, kitchen and DIY are gathered on potential users through structured interviews. The users are defined and later grouped by their specific beer interest and their general process enthusiasm. The insights should help spark the ideation and create a foundation for a later target group.

USER GROUP SCALE



#18.1 User group scale showing the four user groups.

FOUR GROUPS

Based on the answers the users can be divided into four main user groups. The lines between the different user groups are blurry, whereupon the groups are overlapping.

The first group is the Show-Offs. The people in this group does not care much about the flavor of the beer or the process of making them. They want the luxury of having a product to brag about.

The second group is the Fans. They want to know more about the brewing process, but has not yet tried it themselves because of various worries like price, knowledge and space.

Works with a least some real ingredients

The third group is Mad Scientists. They are fascinated by the process, and wants to experiment in terms of time, ingredients, and temperature to get different results. They want control.

The fourth and final group is the Nerds. These are the ones using a traditional brewing set, expecting a proficient and efficient process and personal quality beer.

INITIAL IDEATION

To generate initial concept ideas ideation is started based on the four user groups. The ideation is split into several aspects; interaction, functions and style, which is combined in sketches on principle level. These can be grouped into initial concepts, which can then be evaluated according to market potential.

The plan for the ideation is stated below and the results are showed on the following pages.

INTERACTION
1. Create one common timeline of the brewing process for all user groups.
2. Look at each user group one at the time - where do they want to integrate, and to what extend.

This indicates which steps should be manual and which should be automated.

FUNCTIONS
3. Find out which components that have to be in the product for each user group.

STYLING
4. Create a styleboard for each user group - using pinterest.com.

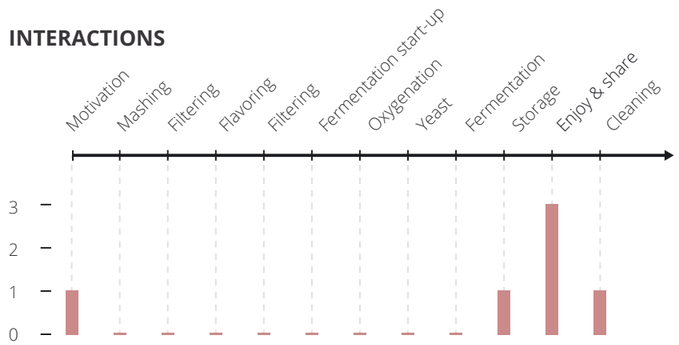
SKETCHES
7. Combine components, interaction and style, to ideate in principle sketches.
8. Cluster the ideas.

From the clusters combined ideas for each user group can be created.

SHOW OFFS

Entertains during long waits (feedback, experience, etc.)

INTERACTIONS



#20.1 Interesting interaction points for show offs.

FUNCTIONS

- Ingredients kit (Malt extract & Hops flavor)
- Control Unit
- Pumps
- Water inlet & outlet
- Tap (keg)
- Container x4 (Soap, Yeast, Beer and Ingredients)
- Heating & Cooling element
- Sensors; Temperature, sugar, time, and pressure
- Stirring device
- Valve

STYLING

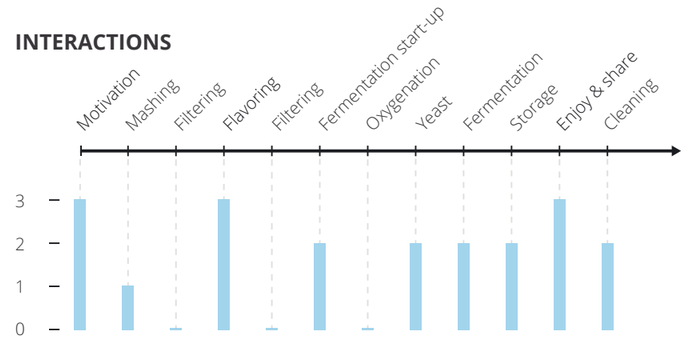
#20.2 Show offs' style references: A) Build-in B) Futuristic C) Lines D) Displayed

SKETCHES

#20.3 Sketches of ideas for show offs: A) Beer dispenser B) Add-on to sous vide C) Black box

FANS

INTERACTIONS



#21.1 Interesting interaction points for fans.

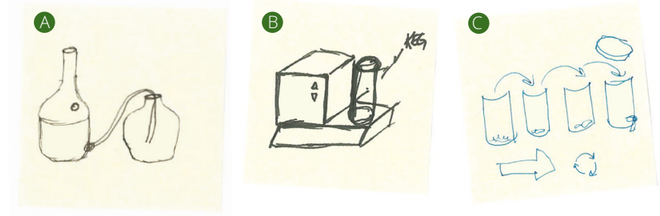
FUNCTIONS

- Recipes & programs = CPU
- Recipe package
- (Movable) Container for beer/water
- Heating & cooling element
- Sensors; temperature, sugar, time and pressure
- Container (ingredients)
- Actuator & filter
- Pumps & tubes
- Valves
- Feedback from fermentation
- Separate Keg
- Software monitoring
- Stirring device
- Bottle equipment

STYLING

#21.2 Fans' style references: A) Honest B) Romantic C) Familiar D) Hidden

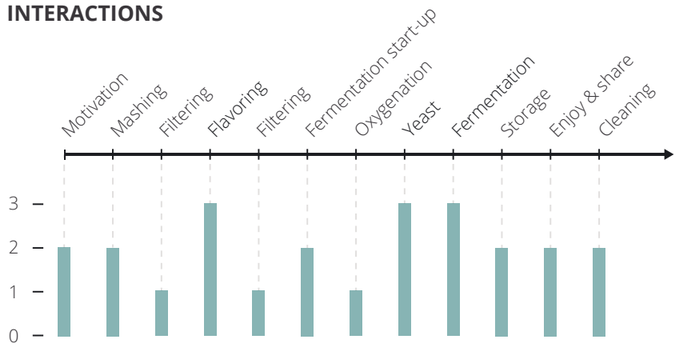
SKETCHES



#21.3 Sketches of ideas for fans: A) Glass and wine-like B) Coffee-machine-like C) One-time Use

MAD SCIENTISTS

INTERACTIONS



#22.1 Interesting interaction points for mad scientists.

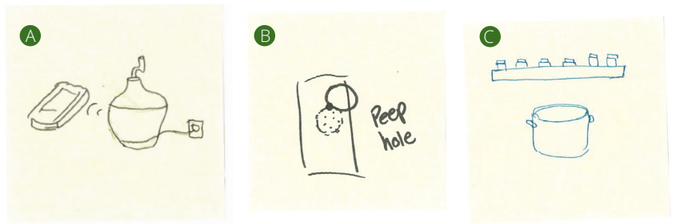
FUNCTIONS

- Container x 2
- Heating & cooling element
- Sensors; temperature, sugar, time and pressure
- Filter
- Pumps & tubes
- Valve
- Fermentation lock
- Separate keg
- Bottle equipment

STYLING

#22.2 Mad scientists' style references: A) Structural B) Recognizable C) Chemical D) Many parts

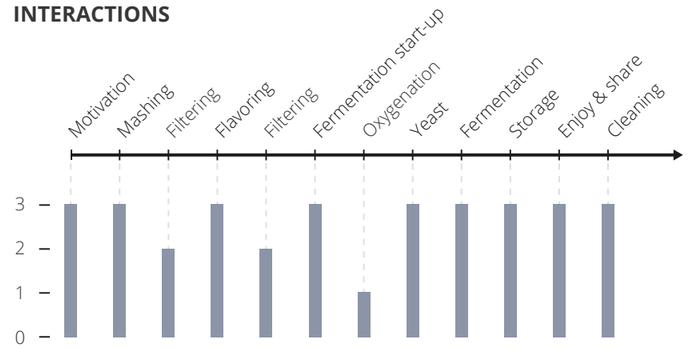
SKETCHES



#22.3 Sketches of ideas for mad scientists: A) App controlled B) Peep hole C) Ingredients display

NERDS

INTERACTIONS



#23.1 Interesting interaction points for nerds.

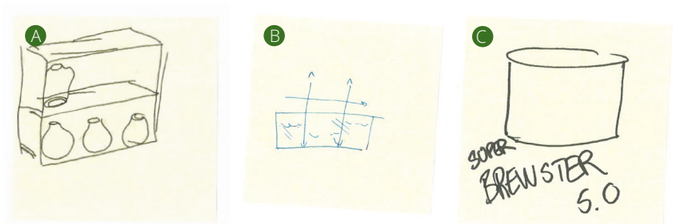
FUNCTIONS

- Container x2
- Sensors; temperature, sugar, pressure, time, and pH
- Seperate filter
- Heating & cooling element
- Fermentation container
- Fermentation lock
- Valve
- Bottle/can equipment

STYLING

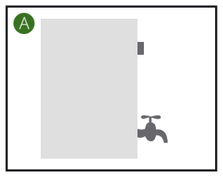
#23.2 Nerds' style references: A) Copper. B) Old fashioned C) Detailed D) Visual

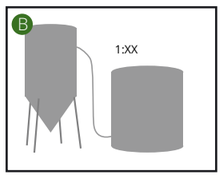
SKETCHES

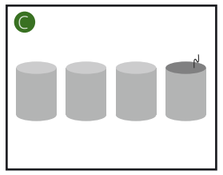


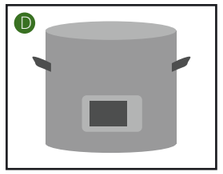
#23.3 Sketches of ideas for nerds: A) Build-in closet B) Glass tank C) Next Generation

COMBINING SKETCHES









#24.1 Initial concepts: A) Black box B) Scale Down C) One time use D) Next gen

For each user group the sketches are clustered, evaluated and combined to create new ideas simply based on sense making. This ended in four concepts; one for each user type.

BLACK BOX
It is the team's assumption that the show-offs only find Enjoy & Share truly entertaining on the interaction timeline, and most of the functions will be done automatically. The style is very futuristic and is characterized as minimalistic and could even be built into the kitchen. The ideas drawn from these factors is combined into a "Black Box" that is fully automatic.

SCALE DOWN
The Mad Scientists are the experimenters and this type would find it entertaining to try out the more complex steps of the brewing process, but still interact with most of the steps. More functions would be manual, and the style becomes chemist-like. The collective idea from this is a scaled down version of professional industrial brewing equipment focusing on experimentation instead of efficiency.

ONE-TIME USE
The fans are more interested in the steps of the brewing process, which highly influence the end result, such as the Motivation and Flavoring, but still also Enjoy & Share. This means that the tedious functions are automated, while the rest is manually. The style is romantic and honest. The collective idea from this is also a scaled down version of the traditional, industrial way of brewing, however focusing on fun learning, instead of experimentation or efficiency. Another idea for the fans is the idea of making a One-time usable brewing, which highly simplifies the brewing process.

NEXT GEN
Looking at the interaction-line for the nerds, most of the steps are entertaining and they want to interact with every step. All the functions are manual and the style becomes very detailed and romantic. The idea surfacing by this is new ways of designing the traditional home-made brewing set or the idea of making a new improved version of the Brewster (competitor, see page 17).

Splitting the ideation in four makes it more comprehensible and results in four different concepts; one for each user group. However the concept "Scale down" can be modified to fit either the fans or the mad scientists. One of the groups has to be picked as a direction, before the team can deep dive into ideation and conceptualization.

CHOICE OF DIRECTION

In order to go for one direction the initial concepts are evaluated in terms of market potential. The team sees equal potential in terms of interest and learning objectives, meaning market will be the only basis of decision. The market potential is estimated by comparing the ideas to the existing products, see Appendix B for full matrix.

BLACK BOX
The Black Box concept is almost solely covered by the PicoBrew and Brewie. There is a possibility in working with build-in fermentation, since it hasn't been covered by any existing solutions, however it still seems as a too small improvement.

SCALE DOWN
The Scale Down concept has many interesting aspects that are not yet covered by one product only. Brewie, PicoBrew and Brewster all cover different aspects; however it is possible to design a combination that none of the competitors cover by themselves.

ONE TIME USE
The One Time Use is covered by several products - such as the Brew Demon. It could be possible to change some aspects, like selling it in normal grocery stores (e.g. Føtex), but the market would still be fairly covered and the solution space seems fairly limited.

NEXT GEN
The Next Gen concept is basically covered, however mostly by the Brewster. A new generation of Brewster would take over the market and eliminate the competition. This would also create the possibility to work with the user experience of the existing Brewster, as well as the styling and branding, since these are the currently weak aspects.

The Black Box and One Time use is deselected, since the existing solutions on the market fulfill their purpose, leaving the Scale Down and Next Gen as opportunities. The team sees a potential in combining the two and work on Scale Down as a Next Gen. This also enables the Next Gen to reach new users; the fans. However focus will foremost be on the Scale Down concept, where the Next Gen will be added later in the process in relation to details, specification and business.

Comparing the initial concepts with the existing market leads to the direction from now on: Scaling down the traditional industrial brewing process. The concept is developed for the fans, and next step is to define the target group before opening up the project once again through conceptualization.

SYNTHESIS: PROJECT DIRECTION

While trendmapping and competitor analysis confirm there is a market for a home brewing product, a comparison of initial ideation and the competitive landscape leads to a direction for the project: A product, which scales down the brewing process and aims at the target group “Fans”.

VISION

The direction is transformed into a vision to serve as a guiding star for the project:

THE VISION IS TO CREATE A PRODUCT THAT LOWERS THE BARRIER FOR STARTING YOUR OWN HOME BREWING, SO EVERYONE CAN MAKE THEIR OWN BEER IN THEIR KITCHEN.

REQUIREMENTS

Has an element of tradition

Has a feeling of accomplishment (DIY)

Has a professional feel (Look and interaction)

Entertains during long waits (feedback, experience, etc.)

Shares your experience (Not necessary knowledge)

Works with at least some real ingredients

Is semi-automated

BEER BREWING

A DETAILED WALK-THROUGH OF THE PROCESS OF BREWING BEER WITH DEEP DIVES INTO IMPORTANT ASPECTS

BREWING PROCESS

In order to work with home brewing one has to understand the process of beer brewing. Furthermore, a basic understanding of the process enables more rewarding interviews with users and experts. Simple desktop research is used to investigate the different stages of the process.

INGREDIENTS

Beer consists of four basic ingredients; water, malt, hops and yeast, which decide the taste and color of the beer. Other spices can be added like cinnamon or anise for extra flavor and twist to the beer.

MALT
The selection of malt has great effect on the taste, color and foam of the beer. Malt is made from various types of grains, such as barley and wheat, which are soaked in water and placed in a room with 100% air humidity to germinate; the cell structure start to breakdown and starch, which becomes malt sugar during the mesh, uncovers. Meanwhile the grains start sprouting, but they are stop when kilning begins; the grains are dried. This determines the color and starch contribution of the malt. High temperature creates dark malt, which gives a dark beer. At lower temperature the malt is lighter and it contains sugars that are easier to convert to alcohol. The combination of malt is the foundation for the beer; often light malt is used as base malt (70 %) and then other types are added to spice the beer, e.g. create coffee or chocolate flavor.

HOPS
Hops add bitterness and aroma to beer, in the old times it served as preservative. There are many different sorts depending on geography and growth conditions. Hops are categorized as bitter hops and aroma hops, which dictates when they should be added in the brewing process.

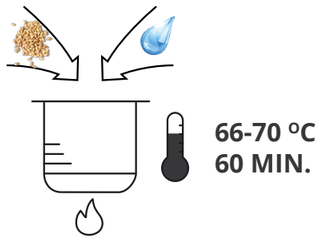
YEAST
Yeast is what makes the beer come alive, it being a living organism. In general there are two main types of yeast used in beer. Ale yeast also known as top-fermenting and lager yeast also known as bottom-fermenting, 90 % of beer in the world is buttom-fermentated beer. (Erenson, P. 2014). These can be broken down into hundreds of different strains of yeast, which offers a variety to the finished beer. Some brewers also work with wild yeast.

#29.1 Beer ingredients

All these ingredients allow for a huge variety of beer, but the ingredients must be chosen with great care to achieve a specific taste. But the ingredients are not enough. The process must also be controlled with great care to achieve a great result. (C. Papazian 2003) (S. Wrisberg 2006)

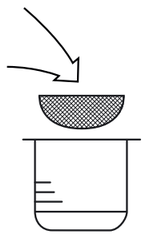
THE BREWING PROCESS

MASHING



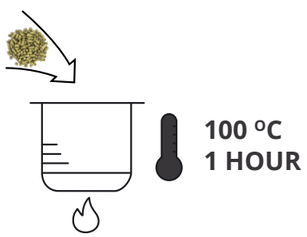
1 Water is heated and malt is poured in, this is called the mesh. The hot water extracts sugars from the malt. Mashing can be done as one step (“One step”) or as a series of steps (“Step - infusion”).

LAUTERING

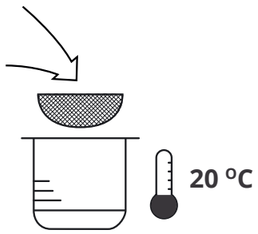


2 The malt is filtered from the mesh, which is poured into another container. The result of the process is the wort.

WORTING



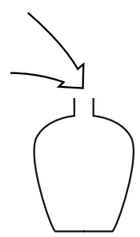
3 The wort is boiled and the hops are added in stages. In the beginning hops are added for bitterness, and during the last 10 minutes additional hops are added for aroma.



4 The hops are removed by filter and the wort is cooled down to room temperature.

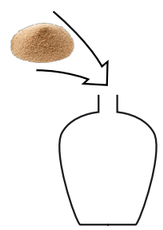
#30.1 The brewing process

FERMENTATION

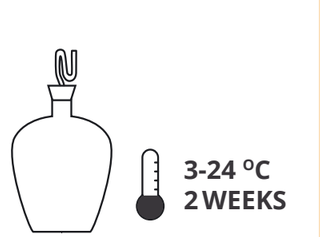


5 The wort is poured into a fermentation bottle.

6 The wort is oxygenated.

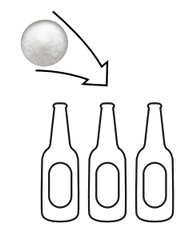


7 The yeast is poured into the wort.

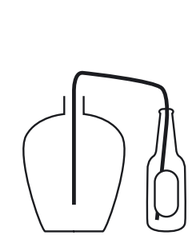


8 A fermentation lock is sealing the bottle and the beer has to ferment. The temperature depends on the yeast, and the time depends on the beer type.

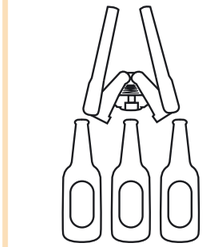
STORAGE (BOTTLING)



9 Sugar is poured into the bottles.



10 The fermented beer is transfered to the bottles.



11 A capper puts caps on the bottles.

12 The beer carbonize in the bottle, also called after-fermentation. After a while the beer is ready to drink.

Making a drinkable beer isn’t hard; the process can be quite simple. However making a great beer is very hard, and demands a high attention to detail, such as temperature, cleaning and ingredients. Desktop research offers an insight to beer brewing, but to understand which details are important, tolerances, and the consequences of scaling down the process expert advice is needed.

SØGAARDS BREWERY

Søgaard Bryghus (brewery) is visited to get a physical look at the process and obtain knowledge related to the precision of beer brewing, which is important when moving to the small scale of home brewing. Furthermore, the visit can evaluate the possibility of Søgaard being a knowledge and/or business partner.

FIELD TRIP

Has temperature control during mashing +- 1°C

Has temperature control during fermentation +- 1°C

UV protects stored beer

The field trip consist of a tour of the brewery with master brewer Tom and a concurrent semi-structured interview. Their plant is very industrial and most components are made of stainless steel, except from the parts visible for the public, which are covered in cobber because that is what the customers expect, according to Tom.

The desktop research is presented in order to validate the insights. Different points in the processes is added, refined and explained, which give the team a better understanding of the process. The key points are described underneath; all the points can be seen in Appendix C.

The tank where the mashing and worting happen is temperature controlled within one degree Celsius of accuracy, which is essential to ensure the desired taste from the malt.

To secure an even distribution of sugar before bottling, the brewers suggest mixing sugar with water and add it to the beer before bottling. The fermentation temperature is important to keep steady to get consistent quality and the best growth conditions. This can be a challenge when dealing with small quantities, which are more sensitive to environmental changes. From the fermentation starts and henceforth, the beer should be protected from UV.

When presented with the opportunity to broaden their business to home brewing, the brewers immediately admit that it would be fun and interesting to tune and simplify their own top selling beers to recipes, which could be sold to home brewers.

#32.1 Presentation of malt types

#32.2 Søgaard's brewing tank

#32.3 Feedback session

Tour of brewery, semi-structured interview and walk-through of the desktop research provides the team with a better understanding of the beer brewing world, which can be used during the development. Specific points even lead to requirements for the product.

HJEMMEBRYGGEREN.DK

To understand the home brewing process fully and get key insights, a hands-on experience is arranged at Hjemmebryggeren.dk (the seller of Brewster). It is also a possibility to gain key numbers about the home beer brewing business.

FIELD TRIP

Filters (Trub/Malt and Hops)

Lauters by filter
Minimizes oxygination during lautering

Makes samples at different stages

Makes it possible to sterilize things that touch cold wort
Makes it possible to remove residue on all components

Minimizes smell and vapor while brewing

Minimizes the smell during fermentation

Brews at least 4 liters of beer

The field trip centers around the brewing of beer, where the team is involved in beer brewing while concurrently doing a semi-structured interview with Ken Thøgersen, the owner of Hjemmebryggeren.dk. Key insight are listed below, all insights can be seen in Appendix C.

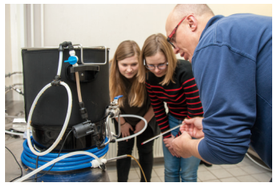
Mashing is a very important step of beer brewing and highly inflicts the flavour. It is fairly easy to follow a recipe, but the amount of underlying reasons behind the mashing is incomprehensible and very chemically. E.g. the mash should be heated up to 77 celsious degrees at the end to close the enzymes.
During lautering there is a process called sparging, where hot water is poured over the filtered malt to increase efficiency. It is also important to minimize the oxygenation during the lautering process.

According to Ken an important factor in understanding the brewing process is to have ongoing samples, so you understand the journey of the beer and the changes each step makes.

Cleaning is a big part of brewing beer; all components must be cleaned properly, but it is especially vital when the wort is cooled. Everything that touches cool wort must be sterilized. After the brewing the whole room was hosed down, and in general the experience is quite messy, damp and smelly.

Buyers of the Brewster are 95% men, mostly in the late 20's and early 30's up to 40's. They are the enthusiasts, who experiment a lot and care about brewing the beer. A secondary group is men in their 40s and older, who are more casual users that don't test as much and mainly uses all grain kits from the website. Their focus is usually on the amounts of beer rather than the differentiation. In general it is Ken's experience that when you go through the five hours of beer brewing, which can be a hassle, you do not want less than four liters of beer for it to be worth it. Ken sells 1,000 Brewster a year, and last year his company had a growth of 12-14 % (he mainly sells ingredients).

#33.1 Cleaning



#33.2 Checking temperature

#33.3 Lautering

The visit provides a shared experience of the brewing process for the team. It gives some insights into the challenges the home brewer faces, and some requirements for the product as a direct results. Most insights are quite simple and easy to understand, but the mashing step shows itself to be very complex and is therefore investigated further.

THE MASHING PROCESS

The mashing process is seen as a great potential for the users to experiment with; it's a process that demands precision, patience, and skill. Since it's where the foundation of the beer is built, it makes sense to understand the world of mashing in detail and learning the different techniques and approaches within home brewing.

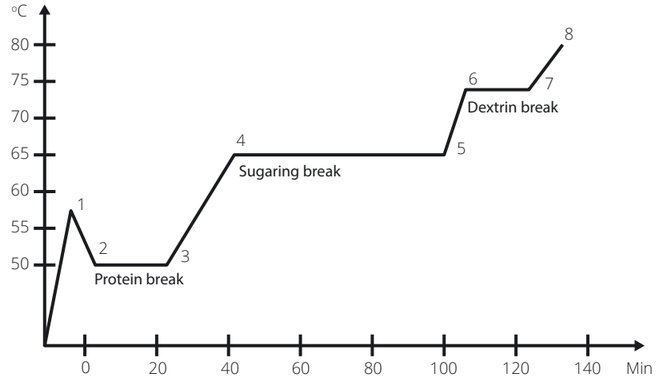
MASHING METHODS

ONE STEP INFUSION

One step infusion is the most basic way of controlling the temperature and is also the most used method for beginners. It's a process where the temperature 62-68°C is kept consistent throughout the mashing, and at the end, the temperature is brought up to nearly 80°C for a couple of minutes to stop the enzyme process. (S. Wrisberg 2006)

STEP INFUSION

In step infusion the temperature changes during different time intervals, see illustration #34.1, to get the best out of the malt. It is gaining popularity because it's easy to automate and gives the possibility of controlling the sugar composition and protein content of the wort. (S. Wrisberg 2006)



#34.1 Step infusion

DEKOKTION

Dekotion is the most traditional brewing method derived from Germany; it's mostly used in bottom fermenting beer types and German Weis beer. The dekotion method was developed in a time where the mashing was done in wooden vessels and the temperature was hard to control and heat. A dekoktion is taken from the mash and brought to a boil before added to the mash again, this is repeated multiple times. (S. Wrisberg 2006)

HEATING AND CIRCULATION

There are different ways to circulate and heat the mash; it is important to stir the pot to avoid the mash caramelizing at the bottom during heating. Some methods are easier but have lower efficiency, and others are more comprehensive and give a clearer beer with higher efficiency. The different methods are suitable for specific purposes for different types of brewers.

BIAB

BIAB (Brew In A Bag) is a method which contains the malt during mashing and makes it easier to lauter. The method is like making tea, the malt is stored in a bag where water can go through. The bag also makes it easy to dispose the malt after use.

STANDARD

Standard (traditional) is the method that is used by many homebrew beginners. A pot of water is heated and the temperature is regulated manually by the brewer. The malt is poured in and manually stirred with a spoon, like soup. The method requires much attention by the brewer, and there is a high risk of making mistakes, due to the manual control and inaccuracy of the stove. (Papazian, C. 1991)

RIMS

RIMS (Recirculating Infusion Mash System) is a method where the mash is circulated using a pump, and heat is applied at the same time. RIMS have different definitions, but the common for all is that the mash is circulated, by taking the mash outside of the pot and recirculate it, while heat is applied. Heat can either be applied by a heating element at the bottom of the container or inside the tube that transports the mash. The method enables precise temperature control, often done with electronic equipment which can be programmed for a particular recipe, a clearer wort and more consistent, reliable batches. Scalding of the mash can happen if the heating element and pump are not calibrated to each other (Beersmith.com 2011).

HERMS

HERMS (Heat Exchanger Recirculating Mash System) is a method like the RIMS method where the mash is circulated by a pump outside of the mashing container. The mash is pumped outside the container and through a heating coil in hot water, which apply the heat, and back into the container. The key advantage of the method is that the possibility of scalding the mash is eliminated by using water as the heat source. The temperature is controlled by raising the coil in and out of the hot liquid tank and thereby having a high degree of control. The solution is very simple however not an elegant solution, and it takes up a lot of space (Byo.com 2004).

The mashing process includes many sub processes, which can be done in different ways. Each method has its advantages and disadvantages. The process is crucial for the beer, thus making it exciting, but it is also very complex, which propose a future challenge in helping the user understand the brewing process. These insights will serve as foundation for future decision related to brew functions in the product.

SYNTHESIS: KEY INSIGHTS

SCOPE

Desktop research shows that beer brewing is overall a fairly simple process, but difficult to manage. Going into details, however, it can be very complicated. Meanwhile field trips give hands-on experience of the brewing process, which will be valuable later in the project.
The product has to work with the brewing process from mashing to drinking and the cleaning and storing part. The solution should allow the user to have a systematic approach to the brewing process and make the process understandable for the user.

REQUIREMENTS

Has temperature control Mashing $^{+}_{-}$ 1°C

Has temperature control Fermentation $^{+}_{-}$ 1°C

UV protects stored beer

Lauters by filter

Minimizes oxygination during lautering

Makes it possible to sterilize things that touch cold wort

Makes samples at different stages

Minimizes smell and vaper while brewing

Minimizes the smell under fermentation

Makes it possible to remove residue on all components

Filters (Trub/Malt and Hops)

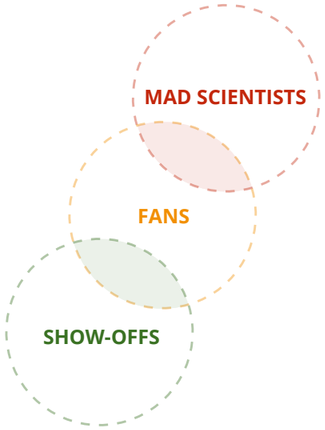
CONCEPT DEVELOPMENT

DISPLAYING THE JOURNEY FROM DIRECTION TO INITIAL IDEAS TO A CONCEPT WITH DEFINED FUNCTIONS: BREWTOOL

TARGET GROUP: FANS

A definition of the fans as the main target group will aid in the development of the concept, but to be sure to hit all the fans, two extremes within the target group is defined (see illustration 39.1). When the product hits all three definitions, it is the perception that it will hit the entire target group. The definitions are based on qualitative empirical data: Interviews with representatives from the user group.

FANS



#39.1 Fans and their extremes

The fans want to know more about the brewing process, but have not yet tried it themselves. However, they have a great interest in beers and special beer, and will occasionally go to a pub or microbrewery to get a unique experience.

They are adult men living independently and they have a steady paycheck. The fans have a curious mind and they are willing to try new things, that they can work with, learn and develop themselves with. They are controlled by their head and thoughts, not their heart, and they weigh the value of a product in terms of money. This also means that the process of making a beer is more important than the quality of the beer, but that said, the beer should still be drinkable for them to use the product again. In case of error, it should be for them to trace back to where it went wrong.

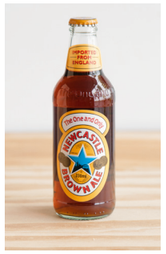
The fans are people that would want to share their experience with others, and therefor the product should work as conversation-starter. Also, the fans would not adjust their life around their hobby, but rather make their hobby fit to their way of living.

MADS KIRKEGAARD

#39.2 Mads' favourite beer

INFO	26 years, Sous Chef in Rema 1000, Single, 2-bedroom apartment
BEER ENTHUSIASM	Chairman of a beer club for 10 years. His apartment is decorated with beer signs.
DIY & BEER BREWING	He builds his own furnitures and likes to use his hands. He knows the process, but thinks it is too complicated.
KEY INSIGHT	He would like to evolve with the product

BJARNE JEPSEN



#39.3 Bjarne's favourite beer

INFO	51 years, Constructor of tools, Grandparent, 134 m^2 house.
BEER ENTHUSIASM	He likes a beer occasionally at lunch and social events
DIY & BEER BREWING	No experience with brewing, but likes to use his hands to fix things.
KEY INSIGHT	Rather do without than poor quality product

EXTREME USER: SHOW-OFF FAN

An extreme version of the fan is the show-off fan. This person values the opinion of others and has the need to share inside informations about the experience, which makes him feel special. The show-off fan needs entertainment in the use of the product, for him to stay focused and remain interested. This also means that he needs to see results fast and constantly, and for the show-off fan, if one step goes wrong, the entire experience will be ruined.

The product's aesthetics are valued high, as well as the level of convenience. He weighs the value of the product in terms of time; the time spend on tedious tasks will affect the perception of the value of the product.

SØREN POLL

#40.1 Søren Poll's favourite beer

INFO	24 years, Student in Robotics - 4th semester, Single, shared 79 m^2 apartment
BEER ENTHUSIASM	Enjoys beer on various social occasions
DIY & BEER BREWING	He has only little knowledge about the brewing process, but enjoys making food from scratch.
KEY INSIGHT	He buys products, that he can brag about

MORTEN JEPSEN

#40.2 Morten's favourite beer

INFO	27 years, Refridgeration Engineer, Single, 70 m^2 apartment
BEER ENTHUSIASM	Drinks beer in his everyday life
DIY & BEER BREWING	He does DIY, when it is economicly necessary. He has friends that brew beer, but has not tried it himself.
KEY INSIGHT	He does not want to use time on e.g. cleaning, so everything should be dishwasher safe.

EXTREME USER: MAD FAN

In the other end of the fans, you will find the other extreme user; the mad fan. He likes to experiment on his own and creates his own entertainment by being detail-oriented and micro-manage each step of the process in a scientific way. This will make him feel like an expert, a pro brewer, which is a feeling he aspires to get. The history and craftsmanship are important to him. Mad fans will immerse themselves into the process in steps, which they will broaden out as they go e.g. mashing. According to Ken, Hjemmebryggeren.dk, the mad fan is around 30-40 years of age.

SØREN LORENTZEN

#41.1 Søren Lorentzen's favourite beer

INFO	25 years, Engineer; Electrical Energy Technology, Married and dad, 70 m^2 apartment
BEER ENTHUSIASM	He has been member of Mads' beer club for 10 years. He occasionally has a kegerator for parties.
DIY & BEER BREWING	He finds value in DIY: Entertainment and customization.
KEY INSIGHT	He would like to create his own recipe

SØREN JENSEN

#41.2 Søren Jensen's favourite beer

INFO	54 years, Educated Photo Journalist - Works as unskilled specialist at a wooden door fabric, Married, 150 m^2 house
BEER ENTHUSIASM	He prefers special beers
DIY & BEER BREWING	Does not DIY much, since he tends to go too much into detail to be able to do it. He tried brewing once at a course with his previous beer club
KEY INSIGHT	Always functions before looks

The target group and extreme users will enable the team to put themselves in the users' place when concept developing. The target group proposes some dilemmas, which need to be tackled in the development: How to entertain the show off fan and leave room for exploring for the mad fan, how to make the product work holistically (show off fan) while still enabling the user (mad fan) to go into detail, and lastly functions (mad fan) and aesthetics (show off fan) need to interact.

KEY ACTIVITIES

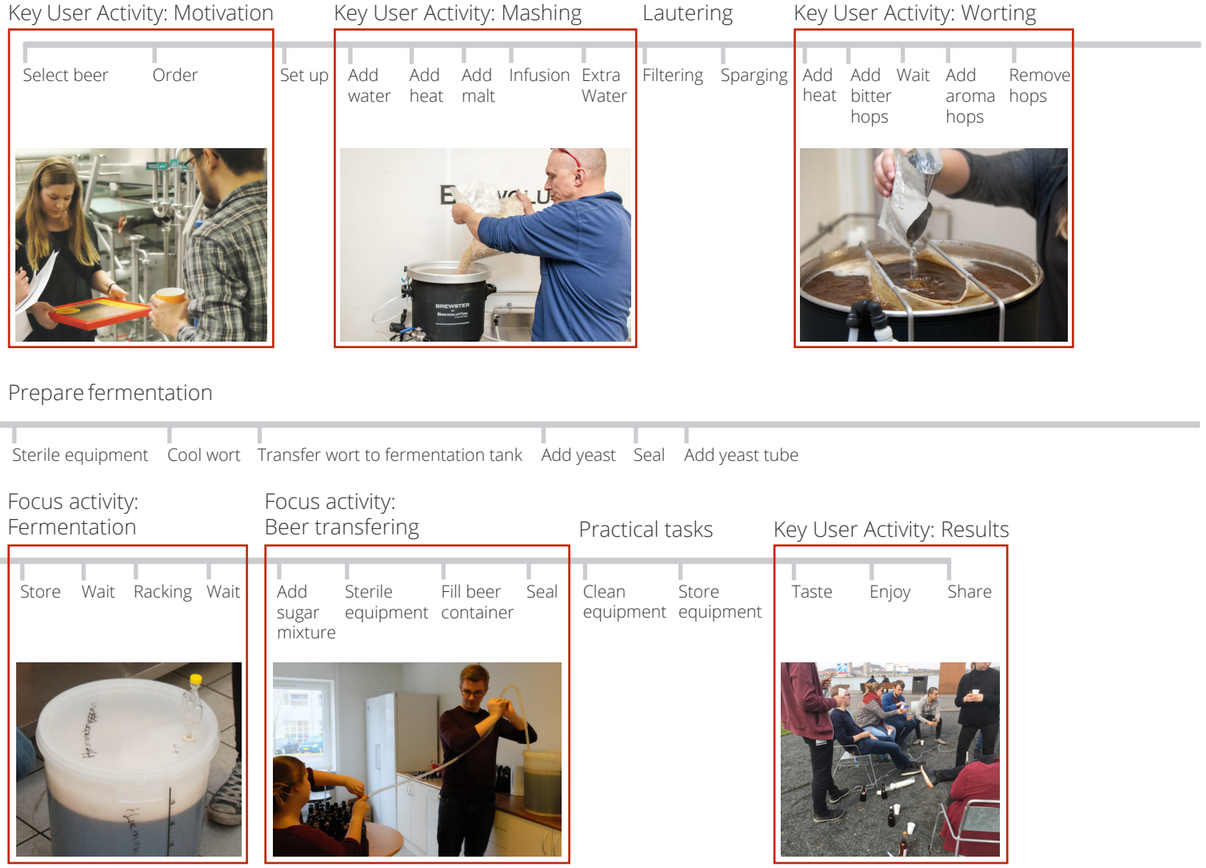
To get an overview of the entire timeline of the product the user experience of brewing beer is mapped. This makes it possible to split the process into steps and define the key activities, which gives value to the user, in order to split and prioritize future work.

USER KEY ACTIVITIES

The focus of the fans is on the actual process of beer brewing rather than details in the beer. Of course still assuming the beer is drinkable. When you are new to beer brewing, you want to put most work where you have the biggest impact on the results, which is in the flavouring. Therefore the key activities from the users perspective is the “Motivation”, which include picking ingredients, “Mashing” and “Worting.” Furthermore it is important for the fans to be able to share their experience, and therefore the “Result” is also a key activity.

BUMBLEBEE KEY ACTIVITIES

Project wise there are additional key activities to be considered. Firstly the show off fans get easily bored if nothing is happening making the minimum two week “Fermentation” a challenge. Second, based on the team’s experience, the current method used for tapping beer on bottle is challenging and tedious, leading the group to think there must be room for improvement.

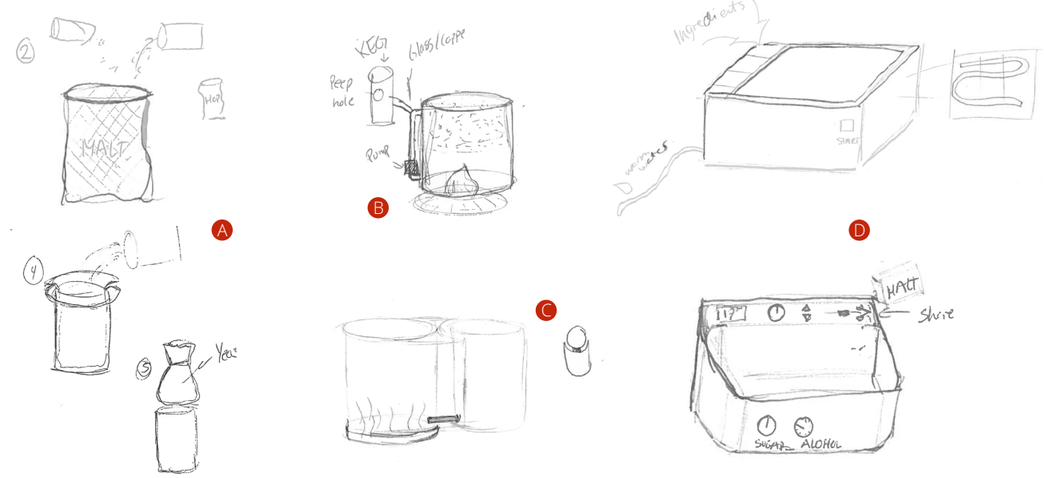


#42.1 Key activities

With the activities of beer brewing in order it is possible to look into the means for every activity through a function mean tree. This gives an opening to the solution space and the option of systematically exploring one activity at a time.

FUNCTION MEAN TREE AND FORCED RELATION SKETCHES

The means are based on previous research and the entire function mean tree can be seen in appendix D. To force solution space expansion sketches are made based on the function mean tree (E. Tjalve 1989). A mean from every function is picked randomly, and together they form an idea, which has to be sketched during a short time. The idea is to generate a high amount of variating sketches to spark the ideation. The ideas can then be evaluated and the potentials can be combined into new ideas, which can be fine-tuned according to user wishes etc.. However during evaluation of initial sketches the method proves it self to be too difficult and demotivating. The beer brewing process is too big and there are too many variables leading to a lack of actual handles for the sketching process. The potentials of the sketches are to diminishing. See illustration #43.1.
To create handles for the ideation process, the ideation will instead be based on an identity, a value mission and scales of interaction, of course with inspiration from the function mean tree and initial sketches.



#43.1 Sketches based on forced relations: A) Ingredients in bags offer a easy cleaning options B) Using the pump for multiple purposes C) Visual connection between parts D) Interesting with a different shape than round; better usage of table space

Splitting the beer brewing process into activities leads to key activities to focus on, both in terms of the product and in terms of the project work, and to the development of a Function Mean Tree. This however was too difficult to ideate on.
Next step is to determine handles to work with during ideation, to be able to work parametric and through that be able to comprehend the entire product and keep taking a step forward.

INITIAL VALUE MISSION

Previous sketching proved that the ideation phase needs better handles. To gain this a better input is needed: A stronger definition of the overall direction and alignment of the team. Working with a potential and not a problem means that the solution needs to be measured against the value it should create. Erik Lerdahl's vision based model is used to create common reference points (Lerdahl 2001).

ERIK LERDAHL'S VISION-BASED MODEL

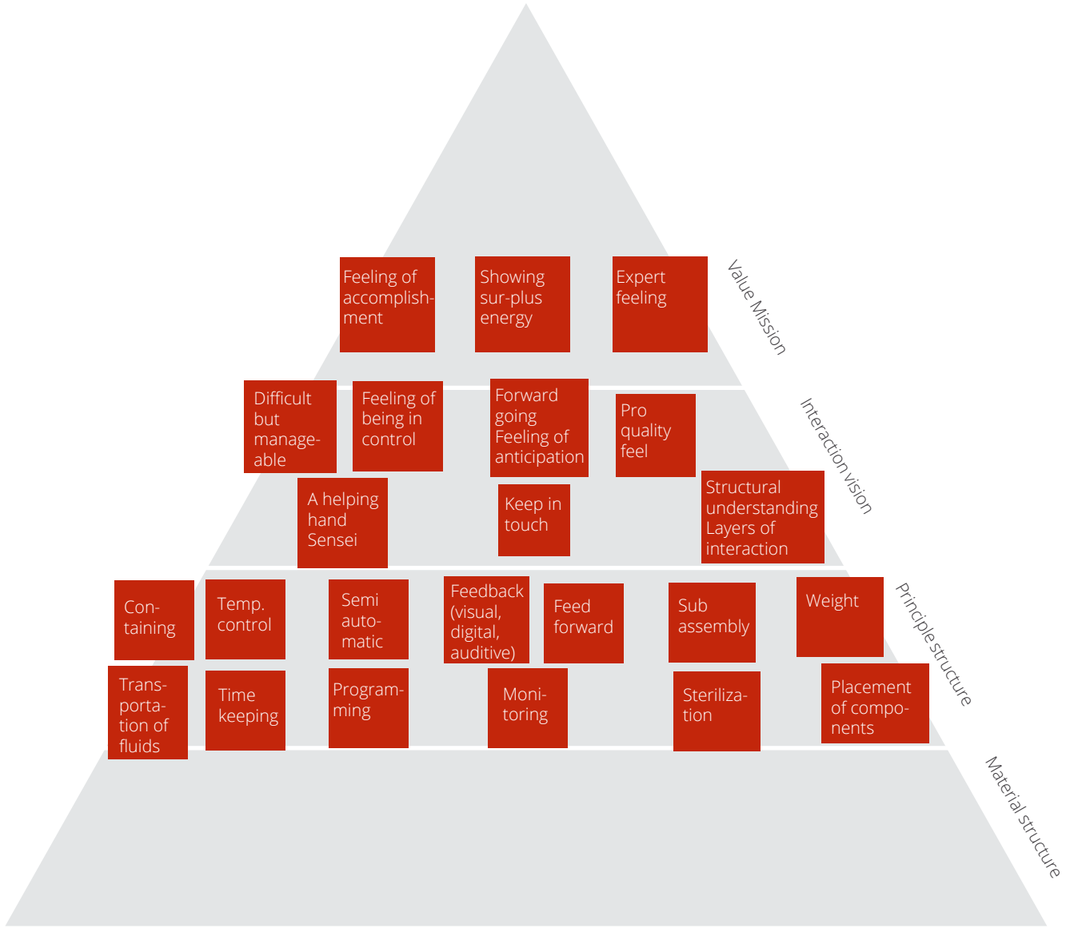
Erik Lerdahl's vision-based methodology divides the products aspect into four abstraction levels, which are all interconnected. Through a design process the focus shifts between the four levels, with a higher focus at the top early in the project, and at the bottom late in the project. (Lerdahl 2001) The model is included because of its starting point in desired values as oppose to a problem statement, which gives a framework for working with the fluffiness of values. In this project the model is especially used internally to create common ground in the beginning.

VALUE MISSION

With the potential of the current trends in mind the first value the product needs to give is "Showing sur-plus of energy" both internally to the user and to the user's surroundings. Thus referring to the DIY and craft trends, which are based on time and energy being the new currency and status symbol, while lack of time is the root to a lot of despair. Trends also lead to the second value of "Expert feeling". Like time, knowledge is also a status symbol, and being nerdy in your craft is the new black. "Expert feeling" is relative; the users are not experts, but they feel treated as one, and relatively to their friends, they know something the others don't. Working with fans the last value of "Feeling of accomplishment" is important. Talking with nerds in the brewing world, they are used to failure and learn from them. Meanwhile fans are worried that they can't brew beer and that they will do something wrong and ruin it; one of the main reasons for not starting beer brewing is: "I think it is too difficult for me". The "Feeling of accomplishment" is therefore essential to get the fans to start and keep brewing.

INTERACTION VISION

Next means to achieve the desired value mission are defined through an interaction vision, which sets the direction for the product development. To achieve "showing sur plus of energy" the product must have a certain level of difficulty indicating that you achieved something. This will also give the "feeling of accomplishment", however it must be "difficult but manageable" to ensure a successful experience. To "Feel accomplish" it is important that the user feels he controls the product rather than the other way around, making him feel that he matters and makes a difference. The product should work as "a helping hand". "Expert feeling" is not only achieved by a "pro and quality feel" in the interaction points, but also through a "forward going process and a feeling of anticipation" ensuring momentum in the experience. An experience "to keep in touch with", the user know what is going on. However this should be done through structural layers of information, so the user can keep up knowledge wise.
The interaction vision sparked a simultaneously brainstorm of principle structure, which was noted as a reminder for future development.



#45.1 Vision-based model

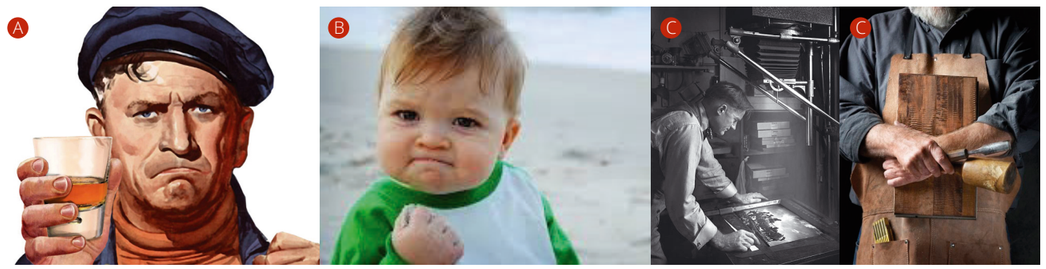
The vision based methodology helps the team to verbalize the desired value of the product and thereby define its initial core. Working with the vision based model is an iterative process and the value mission will be refined later. The interaction vision transitions to the definition of the initial product identity, where the team will work with how to achieve the desired value and interactions.

PRODUCT IDENTITY

A product identity is created as a visual direction to spark the ideation, and to help the team to create a coherent product. The board is split into different groups; mood board, style board and interactions, together creating the product identity. The content is based on the initial value mission, talks with potential users in the target group, trend analysis' and the history of beer making (introduction).

MOOD

The mood part of the board is based on the initial value mission; the product shall give the user a feeling of accomplishment and both extrovert and introvert confidence. Beer brewing is a historical craft so craftsmanship has to shine through the product.



#46.1 Visual mood board: A) Confidence B) Feeling of accomplishment C) Craftsmanship

STYLE

The style of the product is simple, refined and honest with a few colours. It is sturdy and could be of materials like steel, copper, glass.

#46.2 Visual styleboard: A) Honest B) Simple C) Details D) Form follows function

INTERACTION

The complexity of the interaction should be similar to making tea or using a mixer to bake bread: Newbies can use the same equipment and interaction points as proficient users. The feedback of the product needs to be clear and transparent i.e. bubbles during boiling and fermentation. It is cold and scientific and mostly visual and minimal auditory. Physical interaction points should have affordance, so the user instinctively knows what to do. Lastly there should be an indication of progress in the process.

#47.1: Visual interaction board. A) Newbie/proficient tools. B) Affordance; round knobs indicating turn. C) Visual communication of progress. D) Visual and clear feedback.

BREWTOOL

Through the progress of defining the sub-boards an identity forms. The product should function as a motivator for the user; a temptation to get started. It is a mean to a goal. It is a tool, in the same sense that a mixer is a tool for a baker. It is not a helper or an assistant, but a clever tool that makes the progress easier, like various power tools. The work with identity sums up nicely in a initial product name: BrewTool.

The identity of the product is a tool; BrewTool.
The identity has been created using various sub-boards, which can be developed in the future, when detailing the associated aspect of the product. Together with the value mission the identity serves as a direction for the ideation. With the input for ideation in order, the team can look into handles of the ideation through scales.

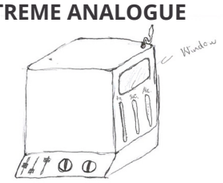
SKETCHING WITH SCALES

With the input in order for the ideation it is time to look at handles to tune. Based on current insights scales of product parameters are set up. The parameters are elements, which are a known part, but not defined, of the product. The team can then play with the extremes in both ends of the scales. The results will be shown to users to get an indication of where on the scales the product should be placed.

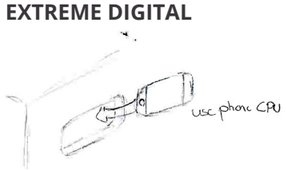
EXTREME SKETCHES

To explore the extremes of the scales quick sketching rounds are conducted, two for each scale. Afterwards the sketches are grouped and general comments on each group are noted along with specific interesting detail in single sketches. The styling scales were done as style boards. A selection of sketches can be seen in illustration #48.1, while the entire selection can be seen in appendix E.

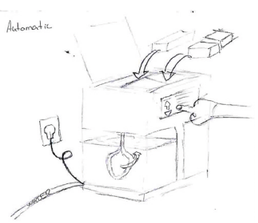
EXTREME ANALOGUE



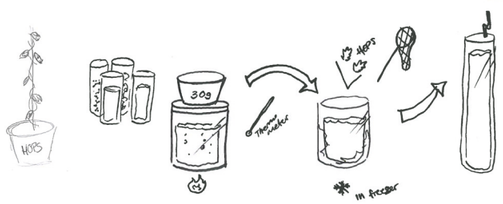
EXTREME DIGITAL



EXTREME AUTOMATED



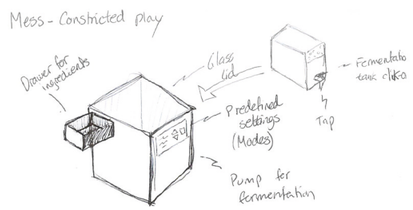
EXTREME PROCESS-ORIENTED



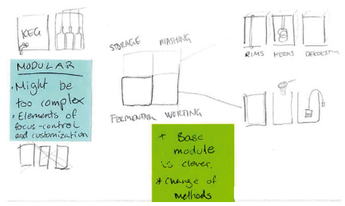
EXTREME OPEN

EXTREME FUTURISTIC

EXTREME CLOSED PLAY



EXTREME MODULAR

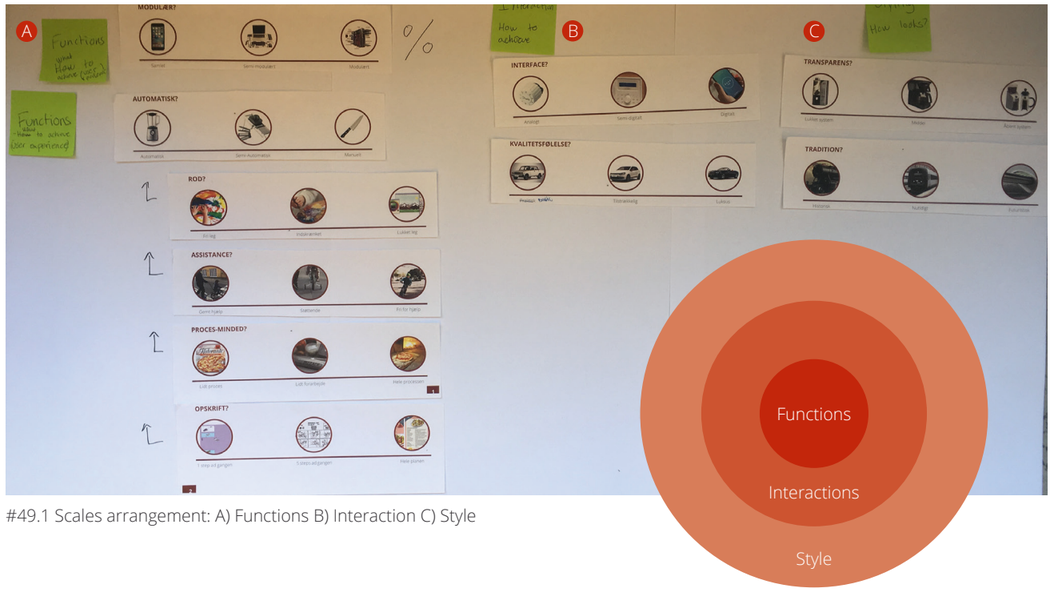


#48.1 Extreme sketches

ARRANGING SCALES

When attempting to combine the various scale sketches into holistic concept ideas, the task proves itself too difficult. The amount of scales is too overwhelming and there are too many combinations to comprehend. During the discussion the problem appears to be a lack of priority and grouping in the scales. The scales are rearranged to give a starting point for the combination of sketches: 1st Priority is the functions; the user experience to achieve, 2nd priority is the interactions; how to achieve the user experience and 3rd priority is styling; how does it look. See illustration #49.1. It is important to point out function and interactions are equal prioritised in terms of the product. This priority is in terms of the process, and where it should take its starting point. The modularity scale would be part of the functions, but for now it is left out, since it could be highly affected by the business model, furthermore, it relates more to the process of cleaning and storing. It is therefore left out, in order to focus on the basic of beer brewing.

Before combining the ideas, represents from the user group are asked to mark their wishes for the product on the scales. It shows few tendencies in the user group, but mostly it is quite scattered. The team set their own expectations for the product beforehand, which approximate the median of the users, see appendix F. This concludes that the users are not significantly better qualified to define their wishes than the team, which in the future can save some time and resources in terms of evaluation concepts on behalf of the users.

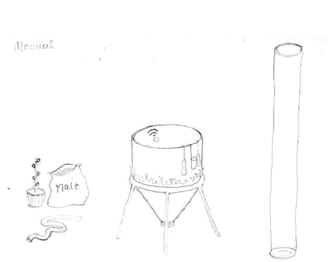


#49.1 Scales arrangement: A) Functions B) Interaction C) Style

COMBINING SKETCHES

Among the function scales the main function is considered to be automation or manual. During the combination of sketches the reminder of the scales related to functions are considered sub scales. By combining all the function scales three concepts are created; manual, semi-automated and automated, see illustration #50.1, 51.1, 50.3. The manual and automated will be used to test the boundaries of the users, to figure out if the product should be leaning towards a manual or automated solution. During the evaluation the layers of interactions and styling will be added through modular models, making the evaluation a co-creative evaluation, where the product will be shaped in cooperation with the users.

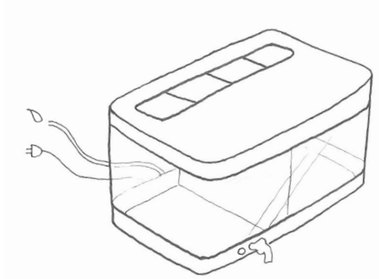
MANUAL



#50.1 Mock up of manual concept.

You start by filling one of the tanks with water and place it on the rack, where you heat it by gas. The temperature is checked with a thermometer, and when the temperature is right, malt is added and a timer is set. When it goes off the mash is filtered by placing the other tank between the brewing tank and the rack. Then you open a plug in the bottom of the brewing tank, and the mash will slowly go into the other tank while the malt acts like a filter. Afterwards the malt can be thrown away and the wort can be heated up. At boiling point the hops is added and a timer is set. When it goes off, the hops are removed with a small fishing net. The wort is cooled by placing the tank on top of the tall fermentation tank and let the wort run through the bottom-plug again. When it is done, the temperature is checked to be at the right degree, yeast is added and the lid is sealed. After a few weeks, the beer should be bottled, and this is done by adding sugar, and pouring the beer through a funnel into about 30-40 bottles. After an additionally few weeks the bottled beer is ready to drink.

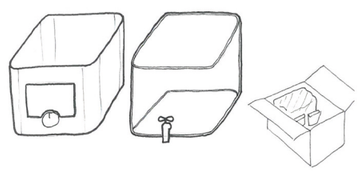
AUTOMATIC



#50.1 Mock up of automatic concept.

The automatic version brews solely on its own. You only insert the ingredients in a tray, and turn the machine on. The machine will automatically control the heat/cool and the adding of ingredients at the right time. It will then tell you about the process, that it is going through, on an app. When it is done brewing, and your beer is ready to drink, you can tap your cold beer directly from it and into a glass. The user does not interact with the machine while it is brewing - only before and after.

SEMI-AUTOMATIC



#50.2 Mock up of semi-automatic concept.

The semi-automatic option does the tedious tasks on its own, but the more entertaining steps are executed by the user. You will learn the important steps of the process, and how they shape your beer.

The ingredients come in bags that also function as filters. First the brewing tank is removed, filled with water, and re-attach to the system. The first phase of the brewing process is programmed on the interface. When the water is heated to the right temperature, you will hear a ‘beeb’ indicating that you should put the malt in. Likewise “beeibing” will indicate, when you should remove the malt, when you should put in the hops, and remove the hops again. When this is done you in-code the next phase into the interface. The wort is cooled while transferred into the fermentation tank, and a “beep” will indicate when to add yeast and the lid. You can now detach the fermentation tank and place it somewhere else while you wait a few weeks. If you buy more fermentation tanks, you can even start a new brew while you wait. You will get reminded when you should add sugar. After an addiotionally few weeks, your beer will be done and the fermentation tank can now be used as a keg.

Working with scales leads to three concepts based on main function; manual, semi-automated and automatic. The concepts will be tested with users through a modular co-creation session, where layers of interaction and styling will be added. For future situations where time and resources are limited, initial user evaluations of scales has taught the team to trust their instinct about user needs and wishes.

EVALUATION WITH USERS

The three concepts are evaluated with user representatives from each extreme to give a better insight in what vision the users have for the future product. The concepts are made extreme to push the users to set a limit for their wishes. Based on the users attitude towards the different concepts it will be possible to form a clear direction for the concepts in terms of function, identity and style.

APPROACH

#52.1 Evaluation with Søren J

Testing two extremes and a middle-way will help in choosing a direction, and find out which functions are valued and which are obsolete. By pushing the user to make up their mind about the manual and automated concepts, the team expects to get a better idea of how to define the semi-automated concept, which is the potential the project is aiming at. Being a combination of the two, the semi-automated will benefit from knowing the users likes and dislikes in the manual and automated concepts. During these evaluations, focus will also be on which aspects make the users feel ownership in the brewing process.

The three concepts, p. 50-51, are built in cardboard models to make it possible for the users to interact with the concept, making the evaluation tangible. The base models represent the function level, see p. 51, while attachable parts represent the interaction level. An example of this is the interface; both a screen and a knob are made to specify, if the interface should be analogue, digital, or a combination. Lastly the style level is presented through the extreme style boards (Appendix E) and attachable models, e.g. pipes for a transparent style and printed out materials.

Three users (Mads the fan, Søren J the mad fan, and Søren P the show off fan) are walked through the brewing process of each concept one at the time (See illustration #52.1). The user is allowed to comment and ask questions whenever he likes.
When the walk through of the concept is done, the user will be shown the four style boards and function-options, and lastly be asked about materials.

Cleans automatically
Has a maximum depth of 60 cm
Has all interaction at max 140 cm in height

All parts are dishwasher safe materials

Additionally to this evaluation the users are asked to fill out a feature matrix before seeing the concepts. They are asked to fill this out with the idea of their ideal product in mind. This filled out matrix can be found in appendix G. From that matrix it is clear that cleaning should either be automatic or by dishwasher. It is also important for the users that the product fits on a kitchen table.

During the evaluation many different aspects were discussed. For each concept the main take aways and a complete requirement list can be seen on the following pages.

AUTOMATIC

COMMON ATTITUDE

CHEERS

- Clear indication of where things go
- Control from app
- Cold served beer

WORRIES

- Not possible to change or make your own recipe
- Not movable during fermentation
- No analogue feedback on machine

#53.1 Automatic concept

COMMENTS

CHEERS

- Can brew from work (Mads)
- Build in keg (Mads & Søren J)

WORRIES

- No historical element (Søren P & Søren J)
- It is too easy (Søren P)
- Too closed - needs glass or tubes (Søren P)
- Kegarator would do most of this (Søren J)

Has clear indication on where the ingredients go
Has clear indication of amounts (fx water)
Communicates through app
Allows the user to make his own recipe, which means he can adjust the settings.
Measures manually ingredients
Has manual setting of temperature and time
Has build-in fermentation, but the tank is movable
Has airtight storage of beer
Has a fermentation tank that also functions as a keg

SEMI-AUTOMATIC

COMMON ATTITUDE

CHEERS

- With an extra tank you can brew a new batch while it is fermenting
- Reminders and advise during brew
- Possibility to tap to bottles
- Dishwasher safe
- Posibility to have multiple tanks in different sizes

WORRIES

- 15 liters capacity is too big

#54.1 Semi-automatic concept

COMMENTS

CHEERS

- Learning by using the product (Mads)
- Screen and knob as interface (Søren P)

WORRIES

- Wants to look inside to see the functions (Søren P)
- Too big for the fridge so needs build in cooling (Mads)

Has the possibility to tap the beer into bottles
Monitors the beer
Has movable tanks that can differ in size

MANUAL

COMMON ATTITUDE

CHEERS

- The ornamental fermentation tank works as a conversation starter
- You get all the needed equipment in one package

WORRIES

- Too comprehensive and messy
- Too many containers
- Too much time spend on idle tasks

#55.1 Manual concept

COMMENTS

CHEERS

- The most fun concept. Can this be made into the semi-automated? (Søren P)
- It is more about the good story than the beer (Søren P)
- You get an urge to start brewing (Søren J)
- Posibility to brew other beverages than beer (e.g. cider) (Mads & Søren P)

WORRIES

- More than one person job (Søren P)

Has an ornamental fermentation tank (show-off)
Filters by having ingredients in bags
Has automatic temperature control
Is operable by one person
Has tanks that are able to be stacked

The evaluation of the three concepts gives numerous insights. In general the semi-automated concept is best received, but a number of aspects from the other concepts are also praised, especially from the manual. Through the evaluation several requirements are formulated, which will guide the detailing phase. The future concept should place itself between the semi-automated and manual concept; the team will continue detailing with a starting point in the semi-automated concept.

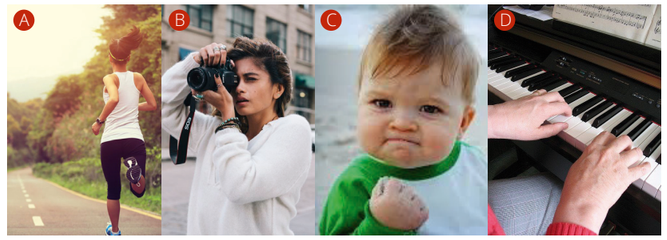
SYNTHESIS:
CONCEPT DIRECTION

VALUE MISSION

After evaluating with the users all insights are synthesized into a concept; an updated value mission, the product identity and a mission enables a selection of means for key activities, altogether defining the concept.

During the evaluation of concepts most of the users focus is on the learning experience of the product. They want to gain knowledge about beer and beer brewing, while using the product. Meanwhile, they are also concerned about the degree of difficulty and making mistakes, and even worse; making mistakes and not knowing it. The observation leads to adding the value of learning to the value mission. The team defines learning as "To understand and be able to use your knowledge in praxis". Superficial research indicates that to learn, you must understand the connection between action and reaction. An insight that will be considered when detailing the product (Generalpsychology. weebly.com - How do we learn).

Furthermore, pictures are also added to ensure a better alignment of the team. See illustration #56.1. Also, the users incline to the manual solution cemented the identity of the product being a tool.



#56.1 Value vision A) Sur-plus time B) Expert feeling C) Feeling of accomplishment D) Feeling a development of practical skills and understanding

UPDATED VISION

THE VISION IS TO CREATE A PRODUCT THAT LOWERS THE BARRIER FOR STARTING YOUR OWN HOME BREWING, SO EVERYONE CAN MAKE THEIR OWN BEER IN THEIR KITCHEN. WHILE IN TIME, RAISING THE USER INTERFERENCE AT THEIR WILL.

MISSION

With a value mission, interaction vision and identity it is clear what the product should achieve. However the team seeks to align on what the product is and what it should do. In order to do so a mission is phrased:

THE MISSION IS TO CREATE A KITCHEN TOOL, FOR THE NEWBIE THAT LOVES BEER, WHICH IS ACCEPTED IN THE HOUSEHOLD (ALSO BY THE WIFE). YOU BREW BEER ONCE A MONTH ON A MACHINE THAT MAKES THE PROCESS TANGIBLE BY TAKING CARE OF THE TEDIOUS TASKS FOR YOU, WHILE YOU FOCUS ON LEARNING THE PROCESS AND HOW EACH STEP SHAPES YOUR OWN BEER. DURING THE BREWING YOU WILL HAVE A FEELING OF ACCOMPLISHMENT AND AS YOUR KNOWLEDGE GROWS, SO DOES THE LEVEL OF INFORMATION GIVEN BY THE PRODUCT. FURTHERMORE, YOU FEEL LIKE YOU ARE A PART OF THE BREWING COMMUNITY, WHERE YOU CAN SHARE YOUR EXPERIENCE.

KEY FUNCTIONS

The specific functions needed to fulfill the mission are decided through a return to the function mean tree, Appendix D. Means, which do not fulfill criteria, are deselected, and in other cases means are evaluated against the value mission. The current functions of the product can be seen in illustration #57.1.

MASHING	WORTING
Step infusion RIMS Malt in a bag (BIAB)	Hops in a bag

#57.1 Determined key functions

ASPECTS FOR FUTURE DEVELOPMENT

The definition of the concept, including an overall list of functions, enables the rest of the product to be broken down into different aspects, which can be investigated in detail. Some aspect can be investigated in parallel, while others are depended.

CAPACITY
Definition of the amount of beer, the product should produce. It relates to the handling, storage and volume of the product.

YEAST
Define the method for separating yeast and beer.

INTERACTIONS
Placement and design of physical interaction points.

INTERFACE
Amount of feedback and channels. This relates to the interactions; however they do not dictate one another.

ELEMENT OF HISTORY
During evaluation the element of history was frequently broad up, leading to the conclusion that there should be an element of history, though it is not clear whether this should be through function, form or materials.

IDENTITY & MATERIALS
Materials have a huge impact on the identity, which still needs to be clearly specified. However this depends on the element of history, which is a requirement and therefore a higher priority.

STORAGE OF FINISHED BEER
The different possibilities of storing finished beer have different pro's and con's, which have to be explored to design a solution, but only after the capacity has been decided.

REQUIREMENTS

Has a maximum depth of 60 cm

Has all interaction at max 140 cm in height

Has all parts is dishwasher safe materials

Cleans automatically

Has build-in fermentation, but the tank is movable

Monitors the beer

Allows the user to make his own recipe, which means he can adjust the settings.

Has the possibility to tap the beer into bottles

Has movable tanks that can differ in size

Has an ornamental fermentation tank (show-off)

Communicates through digital feedback

Has a fermentation tank that also functions as a keg

Measures manually ingredients

Filters by having ingredients in bags

Has automatic temperature control

Has manual setting of temperature and time

Has clear indication on where the ingredients go

Has clear indication of amounts (fx water)

Has airtight storage of beer

Has tanks that are able to be stacked

Is operable by one person

DETAILING

THE SHAPING OF CONCEPT INTO AN INITIAL PRODUCT PROPOSAL BY THE ADDING OF DETAILS

CAPACITY

The capacity of the product obviously dictates the volume of the product, which highly inflicts the form, but also how the product should be handled and stored. The capacity is mainly specified by wishes from the users.

From field trip to Hjemmebryggeren.dk the minimum capacity is four liters of drinkable beer. The feature matrix, Appendix G, of the user wishes indicates an average wish for 8 (equals a 24 pack) liters drinkable beer. This is determined by the want to share the beer at a small event, where there is a beer for everyone. Calculating the volume of the tank, where waste has to be included, gives a volume of 12.8 liter, which becomes an issue to fit under the tap into a sink, when filling with water. From user interviews the team experienced that the valuation of quantity can be challenging, and most users overestimate to be on the safe side.

Taking into account how long time, it takes to make a beer, the team estimates that the user will brew once a month. An average Dane drinks 6.3 liters of beer a month, including all restaurant visits etc. (Bryggeriforeningen.dk – Salg af alcohol pr. indbygger fordelt på øl, vin og spiritus). 6 liter of drinkable beer needs a tank of 9.6 liters to take waste and room for malt into account. This is possible to fit into the sink. It also fits the market potential where most of the competitors that are not automated, make about 25 liters of beer, which is quite a lot for a fan, where the focus is on the process and the experience rather than the quantity of beer.

6 liters brewed beer =
10 liters tank

#61.1 Testing capacity weight

As a final aspect the team wants to ensure that lifting the product and 6 liters of water from the sink to the kitchen top isn't too hard and uncomfortable. Different weights between 4 and 10 kg were tested in a kitchen with an average sized man, who deemed them all bearable.

Based on user wishes, statistics and test the capacity of the product is set at 6 (18-pack) liters of drinkable beer, which leads to a tank volume of 10 liters.

YEAST HANDLING I

After the beer has fermented the yeast will die and go to bottom of the tank. At some point the product has to separate the yeast and the beer, before the beer can be drunk. To choose how the BrewTool should do this the different options are investigated and the choice is based on pros and cons.

REMOVE YEAST

#62.1 Industrial brewing tank

TEABAG/FILTER

To remove the yeast by teabag or filter, the filter has to be so compact that yeast can't go through it. Yeast used in beer has the size of 5-10 micrometers (Wikipedia.org – Saccharomyces Cerevisiae), which means that the filter would be so compact that it would remove flavor along with the yeast (Tom, Søgaard).

PUMP

Removing the yeast with a pump would create a hassle and add to the product price, since a pump can be expensive.

CONE-SHAPED BOTTOM

A third way to remove the yeast is the cone shape used in industrial breweries, which was registered at field trips to Søgaards Brewery and Aarhus Brewery. The yeast is tapped from the bottom of the tank, which is cone-shaped to ensure the yeast will slide out (Søgaard 2017). All the yeast is gone once clear beer starts coming out, and the tap is simply closed. This solution would create an interesting shape and a professional feeling to the process and also allows the user to save the yeast for another brew like sourdough.

REMOVE BEER

TRADITIONAL POUR OVER, ALSO CALLED RACKING

Pouring the beer over to another tank and leaving the yeast behind would require a shape that makes the process easier. However, this option would be a hassle that would be greater than the value the process gives the user. The task would become a tedious time consuming task (Ken Thøgersen 2017).

TAPPING WHILE AVOIDING THE YEAST

If the beer is tapped above the yeast through a tap, facilitating gravity, the tap is going to be placed according to an average measurement. Different beers requires different yeast types, which would mean that the tap would be placed too high for some yeast types, while too low for others. You would either not be able to get all of the beer out or there would be yeast in the first drafted beer. It is not unhealthy but not delicious either. If you don't remove the beer, and keep the yeast in the tank, you will not be able to move the tank alot, since this would make the beer hazy when the yeast would start moving around in the beer (Janux 2014). The expiration of the beer would be shorter; however it should easily be good for a month (Søgaard 2017).

#63.1 Pumping beer into bottles, keeping the inlet above the yeast

Yeast removal in bottom

One tank for brewing, fermentation, and keg

PUMPING SOMEWHERE ELSE

Competitors with a capacity lower than 10 L leaves the yeast in the tank and pump the beer out above the yeast, either directly when it is served or it go to another tank first. The pump is not a simple task, see illustration #63.1 and you might also need another tank to pump the beer into.

With the low capacity it is wishful to waste as little beer as possible. Yeast is a leftover product, for which reason a yeast removing solution as the cone-shaped bottom seems to be the better option. The value vs. the time spent is also a factor that influences the choice, and even though the yeast, which is gross to some, will be visual to the user, the beer will be clear, you only need one tank, and it has a nice industrial and professional reference.

Investigation of different separation methods and pros and cons lead to the solution of a cone-shaped bottom of the tank, which makes it possible to do with only one tank. How to make the interaction work will, however, be a challenge.

TO SPARGE OR NOT

Sparging is a way to exploit the malt by pouring 78 degrees warm water over the malt after mashing to get all the flavor out of the malt. You can brew beer both with and without this step, but it is part of a lot of recipes. To decide whether BrewTool should do this or not, pros and cons are weighted.

INTEGRATED; BREWTOOL DOES IT

- Low risk of failing, since it is automatic
- No need to change recipes
- When sparging you get a higher exploiration of the malt
- No mess outside the machine

- More components = more expensive
- Space consuming, since you need two tanks; brewing and water-heating

FACILITATED

- All recipes can be used, both with sparging and without
- Freedom of choice
- Fewer components = cheaper
- When sparging you get a higher exploiration of the malt
- You will not need two tanks in product, water-heating can be done by the users own kettle

- Requires extra equipment: Thermometer, kettle, bowl, drain
- Risk of error - lack of temperature control
- Higher risk of making a mess in the kitchen

NO SPARGING

- Low risk of error
- No components = cheaper
- No mess
- No components = takes up less space on the counter

- No sparging means you get a low exploiration of the malt
- May have risk of error if user sparges anyway
- Lack of recipes made for no sparging

A facilitated solution is picked, since no sparging and a depriviation of the option will create problems for the user, if he finds a recipe where sparging is a step and an integrated solution is too automatic to add value for the user. An initial idea of a rack where the malt can lie and drip, when mashing is done, can also be used for sparging. The user can simply choose to warm water himself and pour it over the bag.

Pros and cons of the different sparging options lead to the decision giving the user the option of sparging by designing a rack for the product, which facilitates sparging.

ELEMENT OF HISTORY

As part of the exploration of form, the element of history needs to be defined. Looking at an example, where a new product uses some features that links back to an historical product, gives an indication of what historical aspects to bring into the new product.

ANALYSIS

A new but retro Olympus camera is analyzed in comparison with a new modern camera and one of the first Olympus camera ever made. This analysis was made of what is taken from the new camera and what is related to the old camera to give an idea on how to make a new functional product a romantic historical touch.
Hereafter, pictures of traditional breweries are found and the aspects/ features found in the historical cameras are also found in the brewing equipment. These can later be tranfered to the final product.

Recognizable aspects

Materials

Shapes/Lines

#65.1 History of element analysis: A) Features from new Olympus B) New Olympus with historical features C) Features from old Olympus D) Historical features from breweries

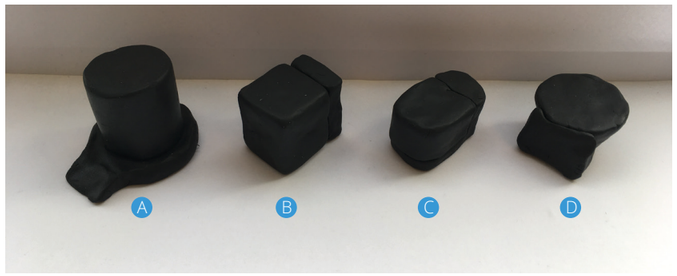
By analyzing other products with elements of history four possible ways to bring the historical value into the products is found:
Analogue interfaces, Copper, Knobs and tubes, and Circles and s-shapes.

FORM DIRECTION

Based on capacity, functions from yeast handling, and the knowledge of potential element of history the form of the concept is explored through various sketching rounds in different medias.

CLAY MODELS

A large range of clay models is evaluated and the best expressions is selected and turned into four suggestions A, B, C, D:



#66.1 Form models in clay

At this point it is the wish that the tank can stand alone without the base unit, but also that the base unit can stand alone when the tank is away. Therefor form A and C is deselected because the base unit is too reliant on the tank.

#66.2 Form B & D in principle sketches

FORM B

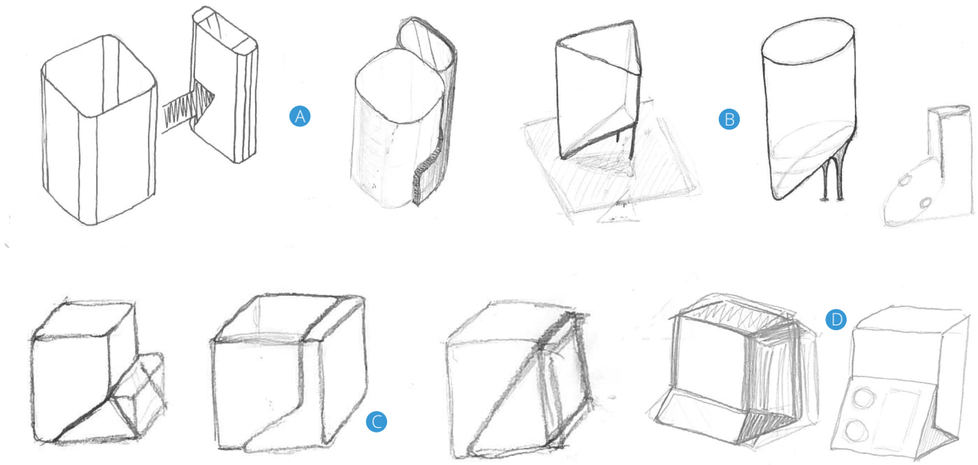
Both the tank and the base unit can stand alone, and the base unit does not take up much space on the counter. However, the shape comes off too heavy and massive, so working with rounded corners and trying to lift the shape is needed. Doing this might also make the shape more intriguing.

FORM D

The shape of form D is more interesting to look at, however the base unit might need to be more alone-standing, which also could make the expression more calm. The shape has a new interpretation of the historical aspect that is admired, and a shape that is honest in the way that it shows the function of the component.

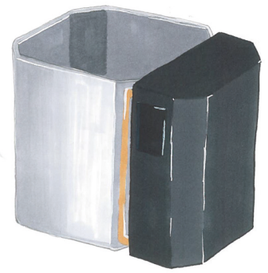
SKETCHING

A sketching round explores the two shapes by trying to merge the admired features from the evaluation. Both round and squared shapes is explored and the yeast handling cone shape is also considered. How the base unit and the tank works together and how the two stand alone. The display or interaction area is also considered.



#67.1 Form sketches: A) The squared shape with rounded corners and the connection between base unit and tank B) Yeast handling cone shape C) Making the cone shape more incorporated D) Turning the interaction to the front of the product

SQUARED EXPRESSION



#67.2 Suggestion for expression.

The sketches are evaluated and a suggestion that seems the most promising is detailed with potential materials. The squared expression has a masculine and confident style to it, and the shape looks honest, but still discrete in a kitchen. The base unit will also be able to stand alone in the kitchen without drawing attention to it. Hereby this shape lives up to the common wanted identity. The history of element is expected to be in the details; recognizable aspects and materials.

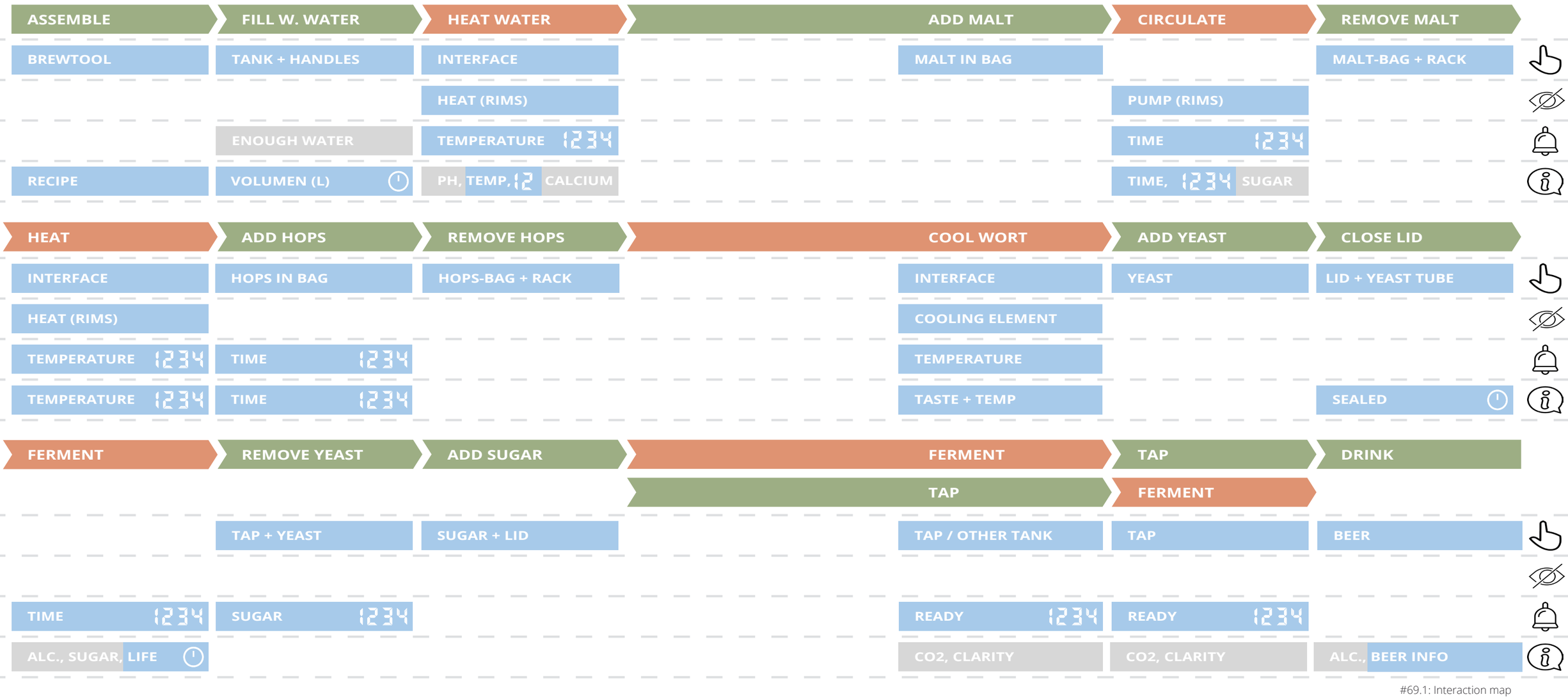
INTERACTION MAP

To understand each step and which physical touch-points the user interacts with, the interaction is mapped throughout the brewing process with the BrewTool. From this it becomes clear what physical and auditive touch-points should be designed and also what information the user will need under each step.

ACTIVE INTERACTION
INACTIVE INTERACTION
DESELECTED FEATURE
SELECTED FEATURE

1234 DIGITAL
ANALOGUE

TOUCHPOINT
HIDDEN
ALARM
INFORMATION



#69.1: Interaction map

The process of brewing with BrewTool is mapped in terms of interactions and all possible information flow, of which some are later deselected to create the best user experience for the fan. Afterwards every information channel is determined either analogue or digital, again to create the best experience.

INTERACTION VISIONS

For each previous determined physical touch point an interaction vision is created through metaphors in order to align the team and help making choices for the physical touch-points in the product development. Key words and images will work as methaphors and guidelines when the details needs to be designed.

TANK HANDLES

- SECURE
- FIT TO HAND (SHAPE)
- SOFT
- SENSE-MAKING IN PLACEMENT

TANK ATTACHMENT TO BASE UNIT

- SECURE, NO LEAKS
- CLICK, FEEDBACK
- A BIT ROUGH, HANDYMAN, LIKE A TOOL
- ONE HAND OPERATIONAL

INTERFACE + PROGRAMMING

- A BIT HARDER THAN
- IPHONE ALARM
- PHILLIPS WAKE UP LIGHT

MALT IN A BAG

- QUICK
- SECURE, PRACTICAL
- LOW TECH
- WASHING BAG

RACK

- NOT PRECISE
- EASY
- LIKE TICKETS IN A RESTAURANT

HOPS IN A BAG

- TEA BAG
- SECURE

LID

- CLEAR HANDLING
- PROTECTION OF BEER
- SECURE, SEALED
- TUPPERWARE-LIKE
- “ONLY ONE RIGHT WAY”-FEEDBACK

YEAST TUBE

- EASY - NO STRENGTH
- INDICATION OF CLOSED - LIKE LOCK
- ONE HAND - ONE MOVEMENT

YEAST HANDLE

- TRUSTWORTHY - CLOSED MEANS CLOSED
- FAST

TAP

- TAP (BIER VOM FASS)

TANK DETACHMENT FROM BASE UNIT

- RELEASE
- CAREFULNESS, SECURE, CALM (PROTECT THE BEER)
- TWO HANDS

#71.1: Interaction visions

DIMENSIONS

The specifications of the form are dictated by the interaction of the product. The height, width and depth will be determined by placing the product in its context and using a man of average height to interact with a model. Acting out the process with the product also indicates the placement of the physical touch-points on the product.

HEIGHT OF INTERACTION

#72.1: Height of interaction testing

Three different heights are tested for the interaction area. One have to be able to comfortably put in ingredients in the top and also interact with a screen. Both test persons agree that the best height for the tank is 25 cm, which is around an average elbow height (Panero & Zelnik 1979). They also agree that the interface should be tilted.

Maximum interaction height of 25 cm above table
Tilted interface

BASE UNIT VS. TANK

#72.2: Relationship between tank and base unit models

Various ratios between widths and depths of the tank are tested. The tank is where you want to focus, since this is the entertaining element for the user, and therefor the tank should be the biggest part.

During the test and act it out the development process seems stuck. It is not intuitive to interact with the square tank, so it is clear that the form needs a revisit.

While working with dimensions the team realizes the form is not working, and it needs more work. Act it out concludes the interface will be tilted and the tank will be the main element of the product.

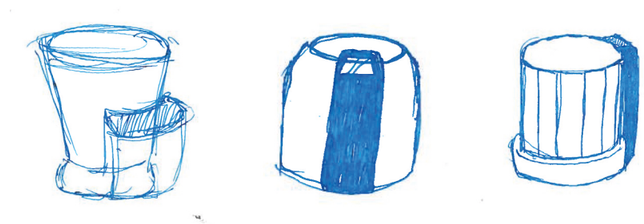
UPDATED STYLE BOARD

To revisit the form of the product new input has to be made. It is discovered that the common alignment of the style of the product is off, and to get clearer on this, a new style board is made. Before, the style was based on being simple and honest, but not what the fans know and love about the beer community. Therefor, a mood board of beers, bars and alike is formed.

BEER

#73.1: Beer/bar style board

Colors from this style board is very clear. Other than that a lot of round shapes are noticed, which indicates that the squared shape that is used for the form at the moment, is wrong. Because of this another sketching round commences:



#73.2: Sketching upon beer/bar style board

The outcome is a cylindric tank, while the base unit is more discrete. The kitchen feel is, however, almost lost. This indicates that the style board is too onesided, and will need another revisit.

To ensure a better connection to the context, the kitchen, another style board is done. It takes it starting point in an analysis of a well-known and successful kitchen appliance that stands out in a kitchen and is very popular. The reason behind the success can the be applied to the BrewTool.

HONESTY

#74.1: KitchenAid baking machine

From looking at kitchenware the style differs alot, but what is very interesting to observe, is the honesty in the products. A product like the KitchenAid baking machine is very popular and stands out in the kitchen, like it is wanted for the BrewTool. To gain insights to KitchenAids popularity an analysis is conducted (Appendix H). It is for one thing, the retro design that leads back to the 1950'ies, but also for the honesty in the product. It is clearly indicated where the mechanicals of the product are placed, and also what the bearing elements are. The interaction touchpoints in the product are also very clear and honest.

These features are desired in the BrewTool, so for inspiration a variety of kitchenware which somehow does the same as the KitchenAid are found and turned into a second styleboard.

KITCHEN

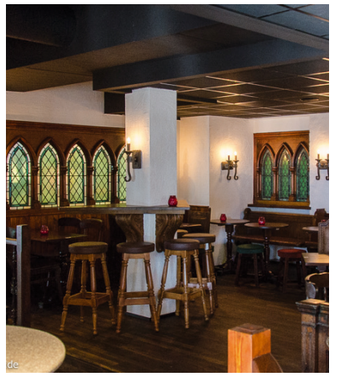
#74.2 Kichen style board

An update of the style board is done to incorporate the fans' beer reference. Furthermore, an analysis of popular kitchen appliance leads to another update ensuring a reference to the context, the kitchen. Features from both have to be passed onto the product in a new sketching round.

IN SITU SKETCHING

To understand close hand what the fans know and love about the beer community, the team takes another trip to the local brewery pub. The inspiration for a new sketching round is found in these surroundings but also in the style boards from the previous pages.

FIELD TRIP



#75.1: The interior of Søgaard Brewery Pub

At Søgaards Brewery Pub the interior is very ornamental. Every stool, table and alike have curved lines, and the historical beauty is in the small details.

After some sketching on the general impression, a decision is made to break the product down into three overall components; the tank, the base unit, and the interface. Each of these three components are then distributed to one of the three team members, so each member sketches on a different subject.

From this sketching round it is decided that the tank will be the ornamental part of the product, since it should be visible for the user for the longest time. The base unit is only used for about four hours per brew and only in the kitchen, while the tank is standing somewhere in the household of the user for up to a month. The visual expression of the base unit will therefor be more kitchenware-like, while the tank is going to be more beer/bar like. Of cause, the tank and base unit should still have a common style, and fit together stylistically when attached to each other.
Since the interface will be placed on the base unit, this will also be kitchenware-like, but honest in the same way as it is on the KitchenAid and the products alike in the kitchen style board.

CLICK ON BASE UNIT

A breakthrough in this sketching round is the click on base unit. Since the base unit is the component that is used the least, it makes sense to make the tank the bearing part of the product. Before, the tank was attached to the base unit, but now it is decided to be the other way around.

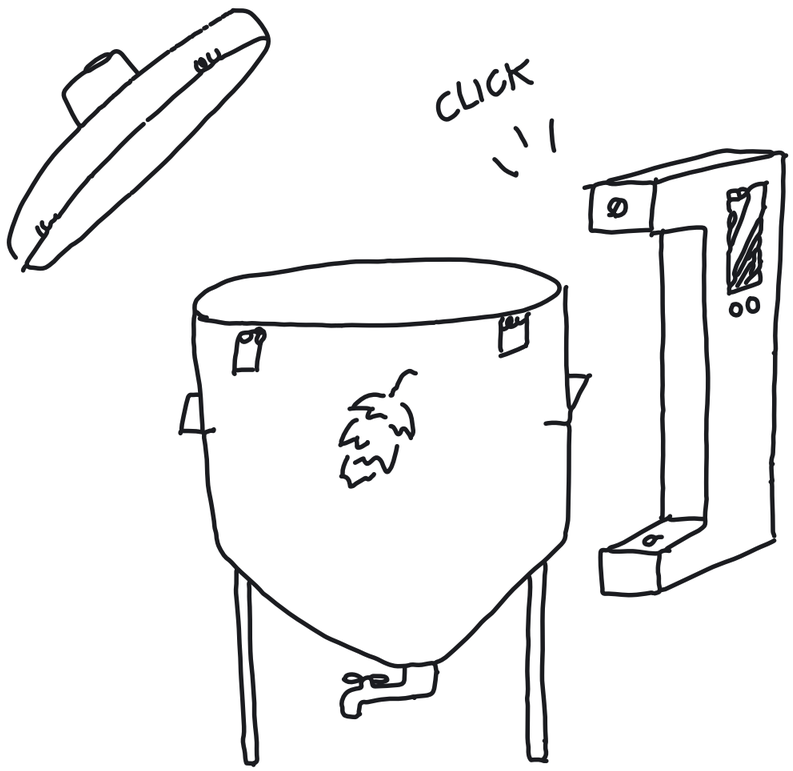
#75.2: A) Click on base unit B) Ornamental tank C) Interactions

In situ skething at Søgaard Brewery pub provides a common inspiration reference among the team, which leads to the conclusion that the tank should be the ornamental part. Working from there an idea about a click on base unit originate.

SYNTHESIS:
FINAL DETAILED CONCEPT

FORM AT THIS POINT

Throughout detailing definition of various aspects changes the concepts back and forth, until it reaches its final form, which is ready for specification. From now on the base unit is named Brew Unit, since the base of the product is now the tank.



REQUIREMENTS

6 liters brewed beer = 10 liters tank

Yeast removal in bottom

One tank for brewing, fermentation, and keg

Physical touch-points:
- Brewing tank
- Tank handles
- Interface
- Malt bag
- Rack
- Hops bag
- Lid
- Yeast tube
- Tap
- (Bottles)

Hidden features:
- RIMS equipment:
  - Heating element
  - Pump
  - Cooling element

Alarms:
- Temperature right
- Time up
- Sugar reminder
- Ready to tap reminder

Info:
- Recipe
- Volume indicator
- Temperature
- Time
- Taste sample
- Sealed lid
- Beer information

Maximum interaction height of 25 cm above the table

Tilted interface

SPECIFICATION

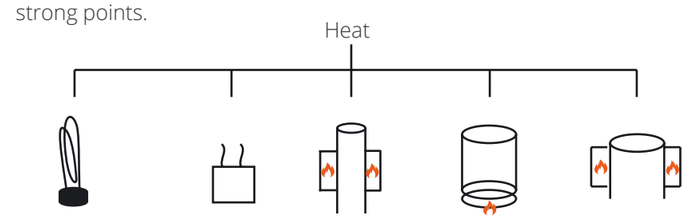
SHOWING THE SPECIFICATION OF IMPORTANT KEY ASPECTS WHILE MAKING IT ALL FIT TOGETHER IN A FINAL PRODUCT PROPOSAL

KEY COMPONENTS

To be able to generate architecture for the brew unit the functions are broken down into key components with inspiration from the component tree by Ulrich and Eppinger, where each function is broken down into means that could fulfill that function (Ulrich & Eppinger 2000). The main deciding factor is the user experience closely followed by price.

HEAT

Several technologies are explored and the selection is based on desktop research on prices of components and technologies weaknesses and strong points.



#79.1 Functions mean tree: Heating

When exploring the heat elements other products are analyzed and the technologies are compared by price, size and efficiency. The data is retrieved from specification documents and forums where people share their experience with the elements. A water heater module is most commonly used in RIMS system and fits with standard components bringing the costs down. Furthermore, the long profile will give a vertical expression to the brew unit.

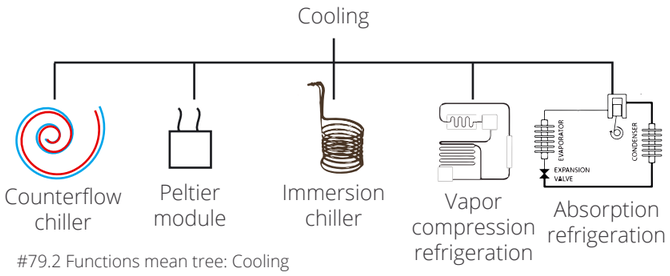
PUMP

Since size and price are a key factors along with food grade approval, there are only two pump options: Peristaltic pump, which is a very precise pump often used in the medical industry. However they are expensive, 1,500 DKK pr. piece (Appendix I) with the capacity necessary to brew. Centrifugal pumps are widely used in brewing equipment and sous vide (Amazon.com, 2017). They are cheaper; around 150kr with capacity needed for the system. Eventhough it is more compact, thus harder to clean, the price and size difference makes the centrifugal pump an obvious choice.

COOLING

Researching cooling solutions similar systems are analyzed. The solutions are either inefficient and expensive (peltier), too big and expensive (Vapor compression, absorption refrigeration) (M, Jepsen, 2017) or too cumbersome and demand external water source (Counterflow chiller, immersion chiller).

It is concluded to use time as cooling by simply leaving the wort to cool overnight. This however introduces a risk of bacteria in the wort, but it can be handled by having a lid.

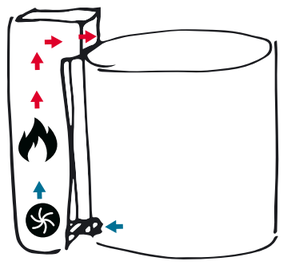


#79.2 Functions mean tree: Cooling

ARCHITECTURE

To gain the vertical look of the brew unit the architecture of the components must be considered. Standard components resembling the size and estimated capacity of the system are found online and through psychical models the architecture is explored.

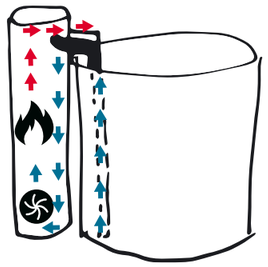
CONCEPT 1



#80.1 Concept 1

The inlet of wort is placed on the side of the tank and then pumped to the top and distributed over the wort. The challenge of this solution is to make the connection on the side between brew unit and tank; there are many risks of spillage, it is cumbersome to use and hard to clean; it would need another tank with the same fitting. The solution also dictates the placement of the brew unit on the tank which could be inconvenient for some users. However, the connection on the side can also be used for placing a tap.

CONCEPT 2



#80.2 Concept 2

A tube going to the bottom of the tank saves a connection. That the tube might cause spillage on the countertop when removed, but the interaction makes more sense, since the brew unit can be moved around the tank and thereby fit the user's preference. Cleaning of this concept would be a bit inconvenient as a cleaning tank would be necessary to clean the system. However, the cleaning tank would be relatively inexpensive as no special features are needed.

CONCEPT 3

#80.3 Concept 3

Radically different from the two others the brew unit is mounted horizontally on the tank. The way it works is by having a heat element hanging from the bar and propeller that circulates the water and thereby avoiding scourging. The systems also allow for easy cleaning. It would give a completely different interaction which would be interesting, but after testing with models it is found too hard to add the ingredients during the process.

SPECIFICATION

In order to specify the final form of the brew unit, actual components, pump and heating element, have to be selected based on capacity. The calculations can be seen in appendix J.

HEAT

The capacity of the heating element dictates the amount of time the user must wait for the water to heat. With a volume of 8 liters of water, going from tap water temperature to mashing temperature, and a target heating time of 20 minutes the heating element should provide 1675 Kj of energy.

PUMP

It is important that the pump is specified to pump at a high enough flowrate, ensuring the wort does not go to slow through the heating element and gets scolded. The enzymes in the malt are killed at 77 degree, which is set as max temperature, which gives a flowrate of 0.064 [M^3/h]. This is however a theoretical example and therefor a safety factor of three is added. Furthermore the pressure loss in the tubes is calculated, based on rough estimations of the dimensions of the tube (standard components), to be 0.95 Bar.

The specific capacity of the components are calculated based on the fragility of the beer and a good user experience. This enables the team to pick the exact components and start modeling the brew unit.

HEATING ELEMENT	PUMP
Energy: 1675 kJ	Flowrate: 0.064 [M^3/h] Pressure loss: 0.95 Bar

ACCESSORIES

For the whole brewing process to work smoothly and as convenient for the user as possible, a few accessories need to be added and designed. They are based on gaps in the user scenario found through acting out and in the interaction map on page 68-69.

CLEANING TANK

Since the brewing tank can go in a dishwasher, the cleaning of that is not an issue. However, the cleaning of the brew unit is somewhat tricky. The hardware inside means that the exterior of the brew unit is going to be cleaned with a wet cloth, but the tubing inside has to be boiled for sterilization and cleaning for which a cleaning tank is designed. The brew unit will be attached to the cleaning tank filled with water, as it is attached to the brewing tank, and the RIMS-method will be used to boil the water running through the tubes, thus sterilizing the inner components.

BAGS

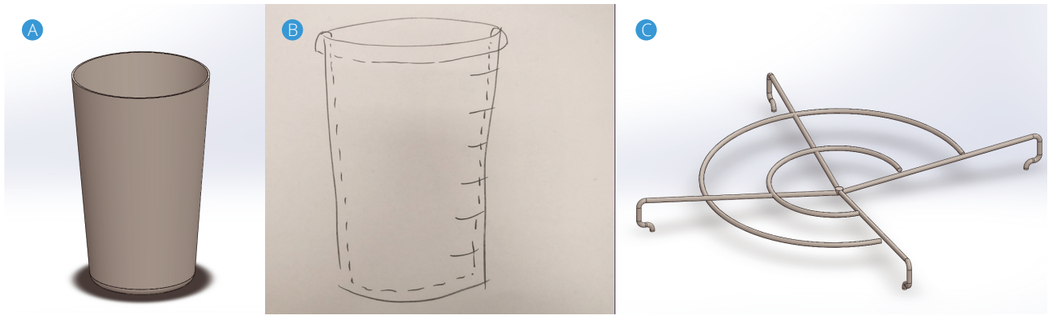
To make the most of the cleaning tank it is also used to measure the amounts of malt. The brewing bag for the malt fits perfectly in the cleaning tank, so when you fill the bag with malt, you can read off the amount on the cleaning tank. When the right amount is in the bag, the bag closes easily in the top with a string. The capacity of the cleaning tank is therefore determined by the malt capacity - which is up to 3 L. The cleaning tank must be the same height as the brew tank to fit with the brew unit, and its form is like the brew tank.

The bag for the hops is much smaller and the principle of it is a reusable tea bag that closes in the same manner as the malt bag.

RACK

During brewing the filled bags have to be removed from the brewing tank after use. Since it is a requirement that sparging is facilitated, a rack is needed that the bags can be placed on over the brewing tank. If sparging is not a part of the specific brew, the rack can still be used as a draining rack, where the bags can be placed until it stops dripping. The rack has to be able to place easily on top of the brewing tank while the brew unit is still attached to the tank. It also has to be dishwasher safe for easy cleaning, and fit under the feet of the tank for easy storage when product is not in use.

The designs of the three accessories can be seen here below.

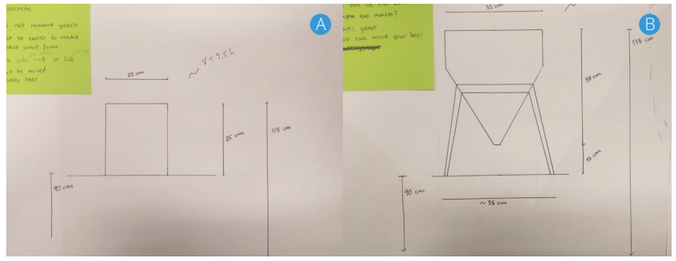


#82.1 Accessorie designs: A) Cleaning tank B) Bags C) Rack

YEAST HANDLING II

Before detailing the form and styling of the product rough dimensions are defined. However, the way of separating yeast from the beer, p. 62-63, requires a very high tank due to the angle of the cone has to be 60 degrees (Søgaard 2017), meaning the project has to return back and rethink the yeast handling.

To achieve an angle of 60 degrees in the bottom of the tank, it would be too high to interact with comfortably, see illustration #83.1. The second best suggesting of dealing with yeast is a flat-bottomed solution, where beer is tapped just above the yeast line. The concern about beer waste due to variating yeast growth is dismissed after talking to an experienced home brewer, (Appendix M). The amount of dead yeast does not variate a lot, when dealing which a capacity of 6 liter. The maximum amount of yeast which would collect at the bottom of the tank would be around 2.5 deciliter of dead yeast, meaning the beer waste is limited. The tap should be placed roughly 2cm above the bottom of the tank to avoid getting the dead yeast out when tapped. When yeast is contained in the storage solution problems arise regarding using the same tank for brewing, fermentation and serving keg. The tank can't be moved within a half hour of serving because it would stir up the yeast, making the beer hazy (Søgaard 2017). This arised disadvantage together with another arised problem of keeping the beer carbonated is making the serving keg a less desirable solution. Alternatively all the beer could be tapped onto bottles for carbonation. The fans want the ability to tap onto bottles for transportation and romantic reasons, but finds the keg option could be lovely. Even though it creates a task of cleaning and sterilizing bottles, and the product is not a completely all in one solution, storing the beer in bottles is considered the best option, and the product is still deemed to be an all in one solution.



#83.1 Tap yeast or not A) No removal of yeast B) Cone-shaped bottom for removal of yeast

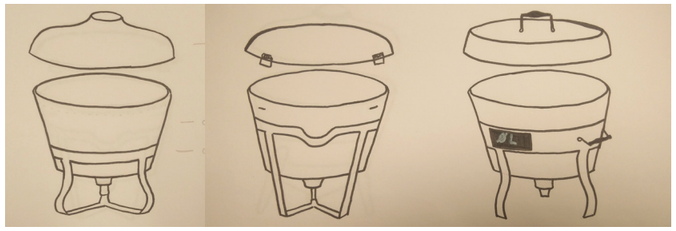
FORM DETAILS

To get to the end result; the final design proposal, the final specifications of the form needs to be determined. The gaps are established, and the tank and brew unit gets ready for 3D modeling. The final styling of the product will be determined through the 3D modelling, but the overall shape is decided in this section.

TANK

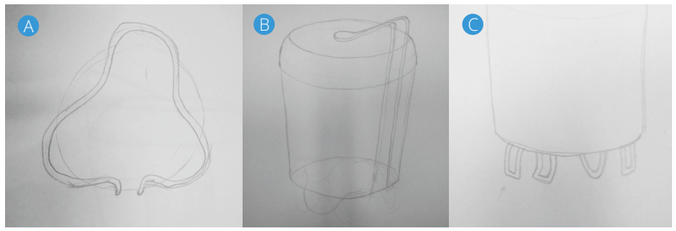
At the moment the tank is a cylindrical shape with the volume of about 10 liters. To complete the aesthetics of it, there are a few criteria to live up to: The tank has to have feet, so the user will not have to place the hot tank directly on the table. It also has to have handles to make the lifting of the tank easier. And thirdly the lid has to close in a manner that is airtight.

The process of the feet is based on a wish to make the tank ornamental, and many different options are tried out. To get a better understanding of the overall shape and detailing of the product, it is sketched upon what the shape would look like in the fermentation stage, where the lid is also on. This is also the state it would stay in the longest time.



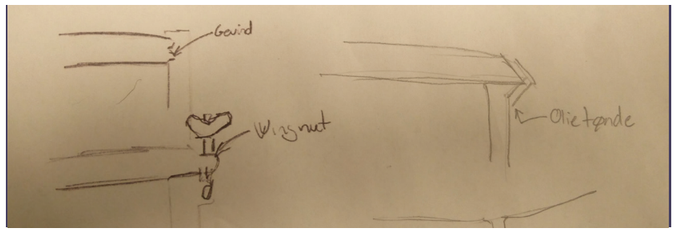
#84.1 Sketching upon an ornamental tank with feet, handles, and lid.

Later, when the final shape of the feet is decided, an idea about tubes comes to the table. It is tried out to use one long tube for all 4 feet, but the manufacturing becomes an issue in that case.



#84.2 A) One tube B) Tubes up the side C) 4 individual feet

The lid has to be sealed closed, and a variety of options for this are also explored. It both has to be convenient and quick but also visually explicit for the user that the lid is sealed.

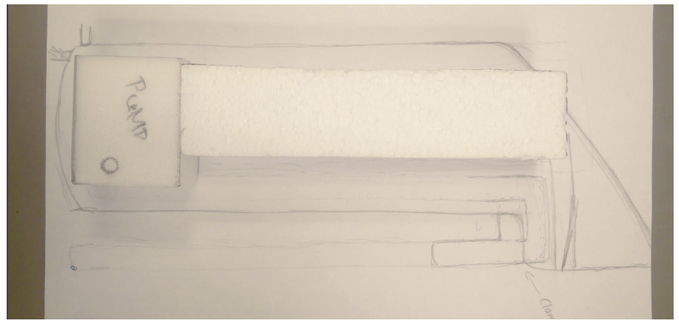


#84.3 Lid, closing mechanisms

BASE UNIT

Until now the brew unit has not had a form. The components inside are defined and the interface at the top of the brew unit will be tilted.

With this knowledge, a shell around the components is designed by using foam models in the right size and sketching.



#85.1: Foam models in 1:1 on paper sketches.

The angle of the tilted interface is determined by the human looking at it. A human being has a natural comfortable tilting of the head and neck (Panero & Zelnik 1979), and the angle is strived at being as close to this as possible, while maintaining a nice look.

During the following 3D modelling, details in cobber are added to the form giving it an element of tradition, that the users want. The specifications of the interface also gets finalized with details. The tank gets handles later on as well, and the sealing solution is finisihed.

BUSINESS APPROACH

The business is continuously developed through the process, and especially during framing, detailing and specification. The focus is especially on how to ensure revenue streams and how different partners affect the business model. Overview is gained through business model canvas (Osterwalder & Pigneur 2010).

BUSINESS PARTNERS

The business approach is continuously developed through the business model canvas, which functions as a brainstorm platform. In the beginning various partners are considered, along with what value the product creates for them and the team and which channel would fit to the respective business model. E.g. A partner as Thisted Brewery would provide a smaller, but nerdy platform to sell through; in return they will get extra revenue through the product and the possibility of selling their recipes and ingredients. Whereas a partner as Carlsberg wouldn't gain any noticeable revenue, but rather have an opportunity to brand themselves through the product, while the team would get a large selling platform. Non-beer associated partners as Miele are also shortly considered, but when targeting fans, beer association is desirable.

During the ideation a next gen concept is considered, which would require a partnership with Hjemmebryggeren.dk. Hjemmebryggeren.dk can provide a selling platform, knowledge and ingredients in return for a new product to gain revenue. When target group is defined as fans, the next gen is abolished because it would require a redesign of Hjemmebryggeren's platform, which is fitted to nerds, and then a startup might as well be done.

BUSINESS MODEL

During detailing the value proposition canvas (Osterwalder et al 2014) transitions the implied vision based values of the product into explicit values for the user. The value proposition is: An all in one solution, a playful learning experience, reducing the risk of failure. These serve as input for the final business model.

With a value proposition and a startup plan the rest of the business model canvas is filled out, see appendix K. Even though the channels are cut from wholesalers to web sales, it quickly becomes evident that the business is not feasible if it relies only on revenues from sales of Beer Academy. During detailing of the product the team has realized that while the product can brew any way you want it, the best solution is the option of a couple of basic recipes adapted to the machine. Since Søgaard already showed interest in this possibility it seems obvious to partner up with them and similar microbreweries. Meaning there is an added revenue stream in form of ingredients sales.

Cutting wholesaler from channels, awareness needs to be created otherwise. The goal is to hit the fans where they already are by utilizing secondary channels like beer blogs, newsletters, fairs etc. The team even considers doing a competition "The great brew off" inspired by the classic "The great bake off" or renting out the equipment for bachelor parties. The ideation on channels lead to the conclusion that Beer Academy should in time serve as an universe, teaching the common man about beer and beer brewing in a fun and easy way. This however requires quite a service setup, which is not part of the scope for now.

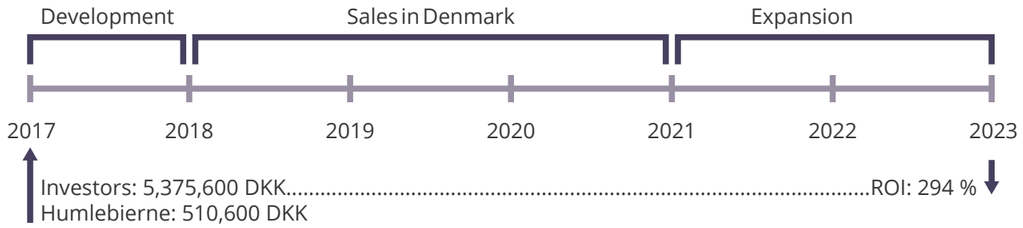
Different business models have been considered during the project. In the final proposal Beer Academy is sold through web sales and awareness is gained through secondary channels which are already hitting the fans. Working with business cements that Beer Academy should aspire to become an entire universe with the mission to teach beer brewing to the people.

BUSINESS CASE

With the overall business approach defined and a detailed product a business plan can be developed and a specific business potential can be calculated. This is done through an investment plan and a break even analysis. The entire business case can be seen in appendix H.

PLAN OF INVESTMENT

Investments are needed in order to acquire expertise help during development, start up production and marketing. Especially the marketing part is an expensive post. To prove the investors that the team is committed they will provide an investment in form of free work during the development. Furthermore a small investment from innovation funds will provide start money, which can help attract investors.
The first three years focus is on sales in Denmark. After three years the company should be so established that a big marketing roll out, a cementation of the universe and expansion to other countries, similar to Denmark, should be possible. The vision for the universe is that Brew Academy is for men, what Kitchen Aid is for women, however specified at fans.



#88.1 Roll out plan for Beer Academy

PRODUCTION, SALES AND BREAKEVEN

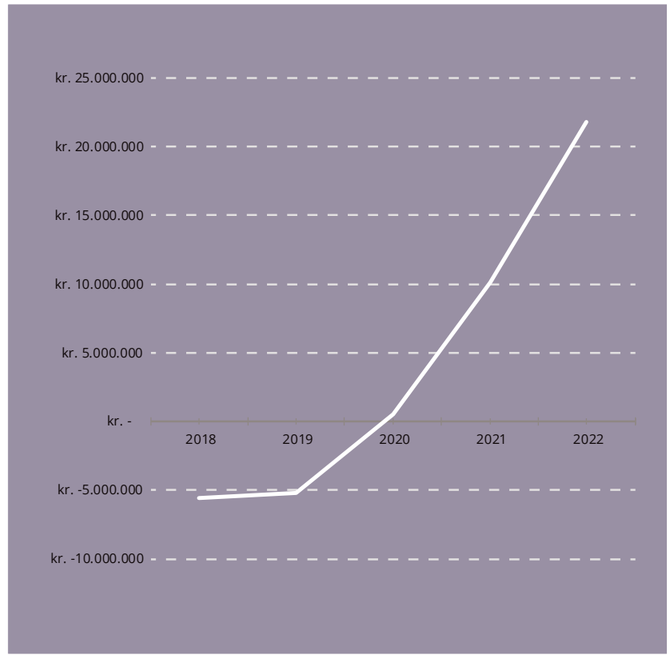
Based on the user's feature matrix, appendix G, the target price is 3,500 DKK, max 5,000 DKK. The sales price is highly depending on the components, resulting in a high focus on constructing the product to minimize cost. This means simplifying in order to ease production and picking standard components. Since the product is sold directly from web shop, the only contribution margin is Humlebierne's.

The prices of ingredient for basic recipes are calculated based on Hjemmebryggeren.dk's prices. This is worst case scenario, since the brewery, which will be responsible for this, will have better supply deals. Likewise, the production costs for Brew Academy are estimated conservatively, given a sales price of 3,999 DKK, a bit above the target price, however still acceptable.

The market potential is based on statistics; 13 % of total beer sales are special beer (Bryggeriforening.dk – Danske og udenlandske øl), which is directly interpreted as 13 % of men being fans, of which the team estimates to hit 5 %. This give sales number of 12,000 products, which is divided across three years since this is the max break even period.

The business case is quite optimistic, which is partly caused by the optimistic sales numbers. Alternative sales numbers could have been set to rise 25 % each year. Instead the high sales numbers are mitigated estimating high marketing costs; based on the fact that if you want to ensure high sales numbers, you have to invest highly in marketing. In this business case marketing is the biggest expense. However the team has no knowledge on marketing, and in general lack of knowledge about the initial investments, which at current point are rough estimates and plain guesses. The uncertain investment estimation therefore suspected to be the main caused behind the optimistic business cause alongside optimistic sales numbers. Furthermore, the expenses of the planned service are not taken into account, since the scope delimits from service. Service is, along with marketing, one of the forces behind the high sales number, contributing to the skewed business cases.
The investment is reliant on investors investing in the company. Currently all the investors, including Humlebierne, are payed back after 5 years. More realistically Humlebierne should be paid back earlier, while investors providing venture capital most likely would require yearly paybacks of 20 %, but for simplicity sake the current business case is estimated with the presumption that an investor, willing to invest and wait five years for payback, can be found.

BREAKEVEN



#89.1 Breakeven graph for Beer Academy

The target price, derived from the feature matrix, is almost hit. One Brew Academy costs 3,999 DKK, and a pack of ingredients costs 279 DKK. With estimated sales of 12,000 products sold in three years, breakeven point is reached within three years. The business case seems to be too optimistic, mainly because of high sales number and knowledge lack in marketing.

MANUFACTURING & MATERIALS

To be able to estimate a production cost, an overview of production methods and material is needed. This is also factors that are considered during the construction of parts within CAD.

BREW UNIT

The brew unit shell will be produced using injection moulding, a process where plastic granulates are heated and injected into a mould under high pressure. The part is then cooled and ejected from the mould. The method allows for various polymers to be used. (Thompson R., 2007) Injection moulding allows for various shapes and the limitation of what can be done is usually economics. (Thompson R., 2007) The process has been chosen because of the relative high production number, and the complexity of the shell form makes injection molding a suitable choice.

For the shell, Polypropylene(PP) has been chosen as material, because it is used for other kitchen appliances such as kettles. PP is a widely-used material for food handling and is known to have good heat resistance and high impact strength. The material offers good blend with colors and can be processed in various ways such as thermoforming and injection molding also it is cheap roughly 17DKK/kg (Chris L., 2014) However as polymers are a deep and complex area, where additives can be added to get the desired result, an expert within polymers will have to consulted to make sure to get right composition of material. ABS was also considered as it has similar properties and is widely used within kitchen appliances, but due to the higher material price of 21DKK/kg (Chris L., 2014) it is excluded as the extra features of ABS is unnecessary for the application, such as resistance to cold.

TANK & LID

The tank will be produced using deep drawing technique where a sheet of metal is placed and a form then presses down and draws the material into the desired shape. Depending on the shape of the tank one or more draws are needed to achieve the desired shape. Tooling cost is relatively high (Thompson R., 2007) and the price pr. tank will be, according estimates from an expert, around 100kr + material. The production of the lid, is the same technique as the tank, however, there will be two press tools; one for the rough press and one for more detailed press. The price will be like the tank as it has similar process. After the tank and lid have been pressed, then they will be laser cut for the holes. Alternatively spinning could have been chosen for the tank, but the process is long and costly and wouldn't be as efficient (Thompson R., 2007).

The tank and lid must be able to be dishwashed and the deep drawing process requires a material that has good ductility. AISI 316 is considered an appropriate material as it is a high quality stainless steel already used for food grade applications such as sinks which is a hard environment. The material has good ductility and is suitable for deep drawing components. (matweb.com) The material price is depending on the amounts roughly 23DKK/Kg (Appendix M).

HANDLES AND FEET

The feet and handles will be produced by bending rods using a mandrel bending process where the rods are forced over a rotating die and thereby shaped to the desired radius. The method has a very low tooling cost and unit price is also going to be relatively low (Thompson R., 2007).
For handles and feet AISI 316 is considered an appropriate material as it is a high quality stainless steel already used for food grade applications meaning it can be dishwashed. The material has good ductility and is suitable for deep drawing components. (matweb.com) The material price is depending on the amounts roughly 23DKK/Kg (Appendix M)

BREW UNIT HANDLE

For the handle on the brew unit shell TPE is considered as material that fulfills the requirement of a grapy handle which feels nice. TPE is however quite expensive at roughly 140DKK/kg (Chris L., 2014) This is however considered to be acceptable as it is a small part. Alternatively the handle could have been made in PP and small ridges could have given a grippy feel as well. However, it was considered to not fulfill the interaction vision for the product.

COLORING

The metal parts will get a color treatment because the natural color steel and the shape of the product gives an aesthetic expression close a cooking pot. The tank will be treated to get a dark grey color and the other parts will get a cobber color. The metal parts are all going to be Physical Vapour Deposition (PVD) treated. It's a process where a thin film is disposed on to a surface under vacuum and the desired color can be applied. The process is used widely both for technical demanding tasks such as drill bits and milling tools, where the added hardness and lower fiction is a very useful asset. However, it is also used in consumer products. One of the main advantages is that the process keeps the texture of the material it is applied to, resulting in components that still have steal tactility and feel. One of the disadvantages of PVD is that after application the component can't be welded as it would change the color of the coat. The process also gives a surface that can be dishwashed (Kosmac 2011) the alternatives such as galvanising, to achieve the cobber finish, would give a surface that can't be dishwashed (Samvirke.dk, 2017).

SYNTHESIS:
PRODUCT PROPOSAL

Through the definition of the last details the product reaches its final specified form, which is fully presented in the adjacent product report.

#92.1 Final product proposal: Beer Academy

EPILOGUE

RECAPITULATION OF THE PROJECT, WHICH INCLUDES A CONCLUSION OF THE PROJECT AND A REFLECTIONS UPON THE RESULTING PRODUCT AND THE PROJECT PERIOD

CONCLUSION

Trend mapping has showed a rise in beer interest and DIY, which mixed together makes home brewing of beer; A business potential confirmed by a competitor analysis. Existing products are either too easy or too difficult and complicated; consequently this project has worked on making brewing easy to get started with as well as a learning experience for the users. The users are defined as fans; they are fan of beer, but have never tried brewing, because they think it is too difficult. Through a process focusing on values and interactions brewing equipment called Beer Academy has been developed. Beer Academy is semi-automated, helping you and taking care of the tedious tasks for you, but with room for growth and more and more user control. The product is to be surrounded by an entire universe with a complimenting service, thus making the marketing post rather big, meaning focus has been on lowering production costs.

PRODUCT REFLECTION

SCALABILITY

The product is easy scalable, one basically only need a bigger tank. However at some point the brew unit and its components will need to be dimensioned different. This also pose the risk of users not buying extra tanks but instead using their own equipment. A risk which has been considered; however, anyone could build their own simple brewing equipment from very simple and cheap components, which many home brewers do. Since the product is aiming at fans, the team does not value the risk to be partically high.

COMPROMISING

Late in the process the team had to delimit themselves from providing a solution, which takes care of the entire process, including storage of beer. Originally the product should take of everything, however, there are many challenges related to making the fermentation tank work as a keg; among others yeast handling and pressure. It can be done, but the team deems the proposed principle too complicated and a bad experience for the users. In the end more is lost by making the keg work, than by delimit and make a solution, which easily can transfer beer to bottles, which are the user's favorite storage solution. It cannot finally be concluded that it cannot be solved with a good and elegant user experience; however it would demand for more expert knowledge.

WIFE APPROVAL FACTOR (WAF)

An important factor of the product is the wife approval. If difficulty is number one reason for not brewing beer, wife acceptance is a close second. The team has aimed at making the product aesthetically fit the kitchen in hope to please the wives, alongside with the element of romantic beer history. The success cannot be verified before the product has been evaluated by the wives, and it might lead to minor tweaks; the team is especially worried about the look not being minimalistic enough for the women.

BREW ACADEMY UNIVERSE

A big part of the product is the entire universe around it, which has not been designed; due to a scope delimiting the project from service design. Unfortunately, a big part of the product identity lies in the service. The service and universe are mostly derived from working with the business, which has not been through enough iteration, especially given this project deals with a potential. Earlier focus on the business, would have led to a better and earlier definition of the universe, even without a specified design due to scope, thus also making it possible to incorporate more of the universe in the product itself.

DETAILS

The team believes that the key to many issues, as wife approval factor and good interactions, which are the competitive aspects of the product, lie in the details. Unfortunately, it is hard to design details without a base, and this is especially where the product lacks work. The product would benefit from more play with materials and colors, which might inflict the WAF. Details like tap, rack, and bags have not been prioritized, and lastly the components of the brew unit need to be designed more efficiently in terms of space and function; e.g. the heat element run at a different voltage than the other parts.

PROCESS REFLECTION

ALIGNMENT

The project work has been characterized by a high amount of misalignment, which naturally comes with frustration and time waste. The team is composed of very different mindsets with completely different work flows and understanding of terms; e.g. what characterize a round or a square shape. Different mitigation techniques have been applied with various results. Switching between workflows never hit the right frequency and attempts to make them fit together failed. More parallel and individual work could have been preferred to accommodate for this. However, a lot of work has been done in plenum to minimize the risk of misunderstandings. A big time consumption has been redoing work due to misalignment, but equally working in plenum. Misunderstandings have thus been the crux of much adversity. During the work with value mission and interaction vision the team worked with pictures, as Lerdahl (Lerdahl 2001) suggest, which proved itself to be of use. A higher focus on actually solving the misalignment issues and using pictures as communication tool would have been desirable.

TARGET GROUP

Likewise has the work with target group been characterized by misalignment. The lack of clear target group can be seen in the product, where there is a general concern that the product has become too nerdy and close to the competitors Brewster and Braumeister, where there is a lack of interaction design. The extreme users have not been used properly, since there has been a disagreement on where the limit of the target group is; a focus on who the product is NOT for could have provided a stronger target group definition.

WORKING WITH A POTENTIAL

The team has found it interesting to work with a potential instead of a problem. One of the objectives for this thesis is to gain experience within this field, which has not been explored before. Looking back the challenge was bigger than expected and the severity of the challenge has not been taking seriously or handled properly. The team wishes for a higher focus on the business potential and strategy, and could with great advantage have dived into blue ocean inspired strategies and methods.
Working with fluffiness of values and interactions, and evaluating ideas against them, has also been a challenge in working with potential. The team should have had a higher focus and putted more work into these values, identity and interactions, instead of diving too deep into the brewing process. The brewing process has been a tangible challenge and a safe spot for the team, allowing them to escape from the fluffiness. The vision based methodology (Lerdahl 2001) was a step in the right direction, however there was too much talk and too little doing, once again relating to the misalignment. When done rapid prototyping, higher level sketches and models proved valuable, and "suggesting you way out" of problems has been a great lesson.

SUPERFICIALITY VS. DEEP DIVES

The safe space of brewing research is a prime example of the difficulty in specifying ones level of focus. Some aspect should have been more superficial, while others should have been researched deeper, however this is always an easy reflection. The issues have been when deep dives have led to time delays, which lead to a fast pace forward / stress, which causes delay in the long run. Too many good intensions and agreements have been dropped on the floor as a direct consequence. E.g. research on professional yeast handling, where the task of determining the angle and calculate it into the product has been postponed to a point where a lot of work had to be redone. In the end it has caused a big deselecting in the scope at last minute; accessories, styling, interface and business all lack work. Deselecting is necessary, however preferably done deliberately.

WORKING WITH BEER BREWING

No doubt beer brewing is a fun and interesting subject. The team has been overwhelmed with the openness, willingness and help they have received from the brewing world. Likewise the help from the outside world; what you can achieve with beer is astonishing. It has been a nice motivator and made research an easy pleasure. The beer brewing process is a long potential complicated process, which can demand a high level of detail; a fun challenge, which might have gotten too much focus. Meanwhile the opportunity to get hands on experience and great insights from the breweries have paced the project enormously.

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B) http://atmedia.imgix.net/3790c8a3d4f381e82360ffad87a0d-f5a8402128f?auto=compress&w=540.0&h=245.0&fit=max (Accessed 15.05.17)
C) https://www.dpreview.com/files/p/articles/2576234880/SemiOlympusII.jpeg (Accessed 15.05.17)
D1) http://pop.h-cdn.co/assets/cm/15/06/54cfcf4b33dc7_-_beerequipment1-855-xl.jpg (Accessed 15.05.17)
D2) http://seelaendisch-flandern.de/wp-content/uploads/2015/03/Brewery-Westmalle_Antwerpen_cwww.milo-profi.be_VisitFlandern.jpg (Accessed 15.05.17)
D3) http://www.tov.be/sites/default/files/from-editors/TOV/plan_bier/Roman_0.jpg (Accessed 15.05.17)
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9) https://images-na.ssl-images-amazon.com/images/I/614EvNRFlML._SY355_.jpg (Accessed 15.05.17)
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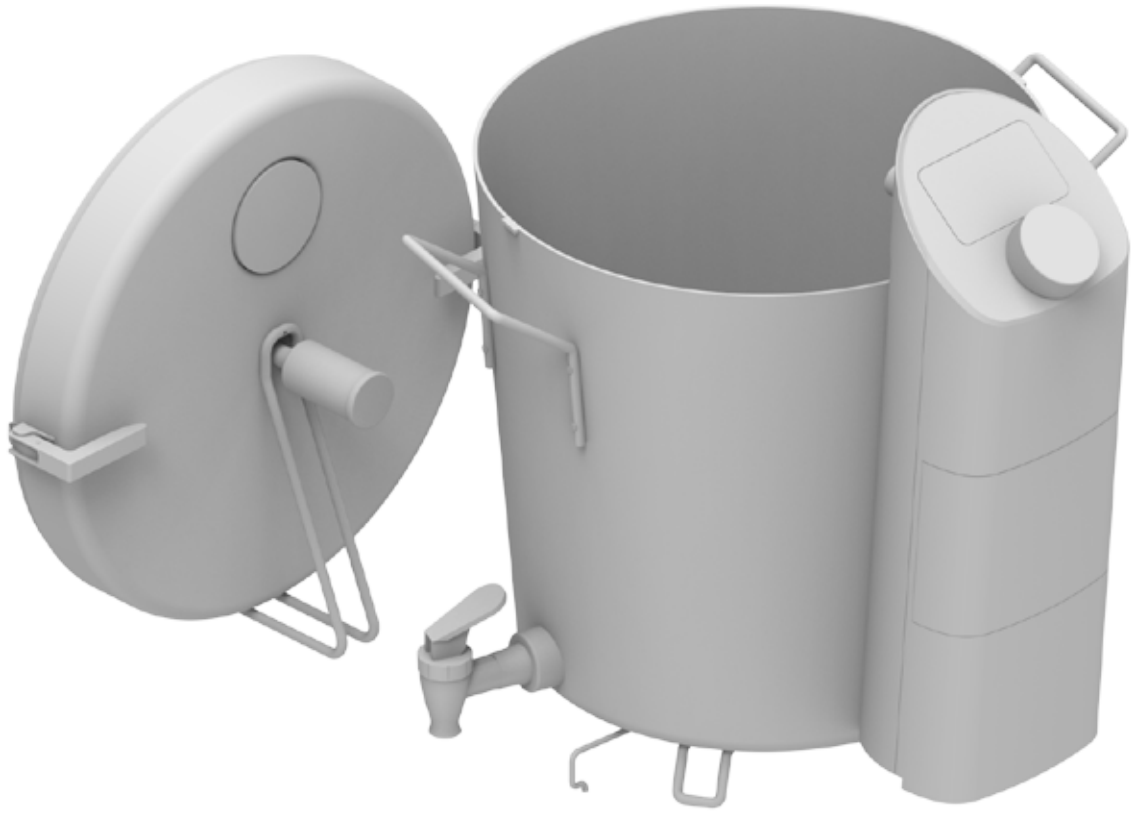
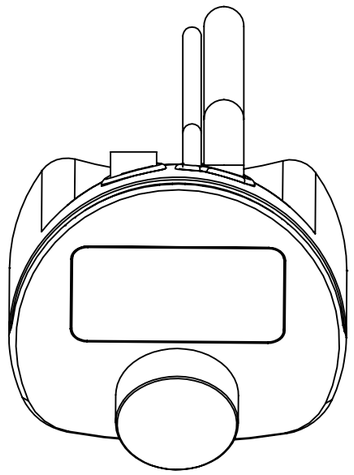
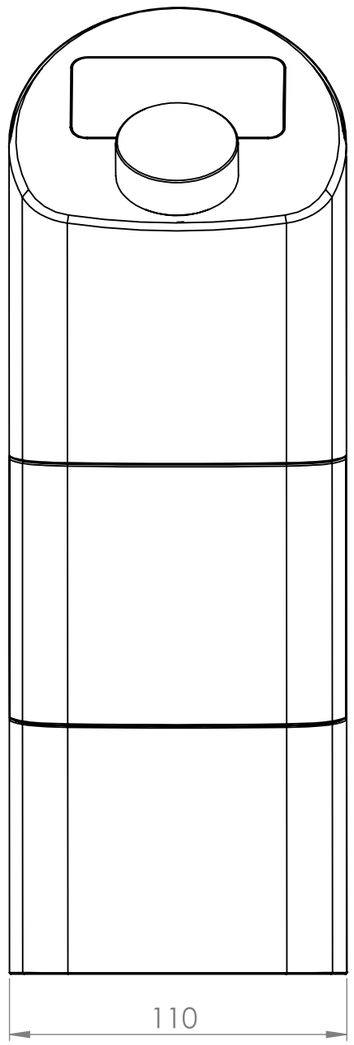
The rest of the illustrations are the teams own creating.

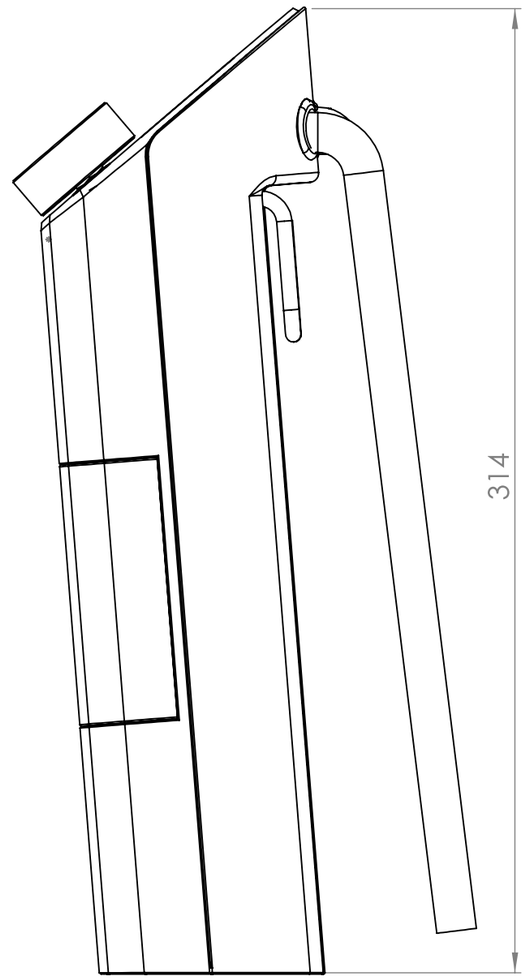


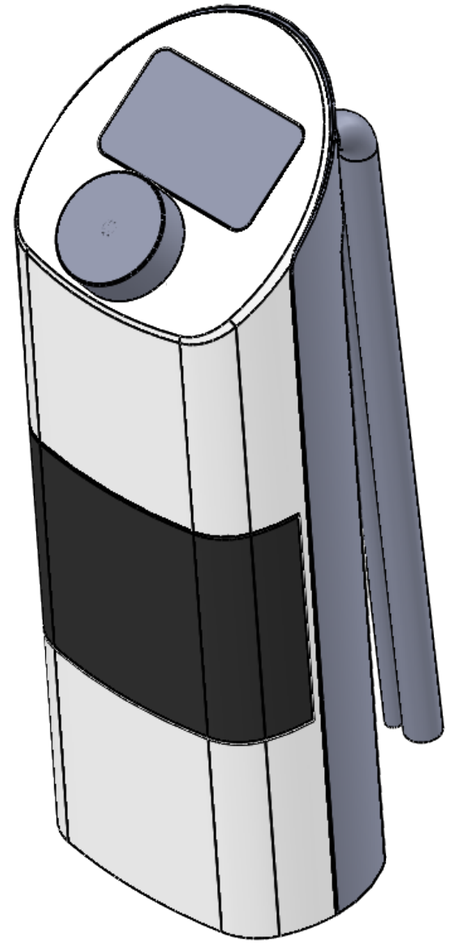
BEER ACADEMY TECHNICAL DRAWINGS

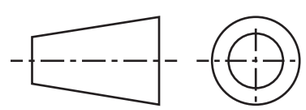
B1.0: Brew Unit - Main Drawing
B2.0: Brew Unit Exploded
B2.5: Inner Shell
B2.8: Hook
B2.9: Fitting Outlet
B2.10: Fitting Inlet
B2.16: Outer Shell
B2.19: Grib Handle
C.1.0: Cleaning Tank
R1.0: Rack
T1.0: Tank - Main Drawing
T2.0: Tank Exploded
T2.1: Tank
T2.2: Handle
T2.3: Foot
T2.8: Lid Handle
T2.9: Lid



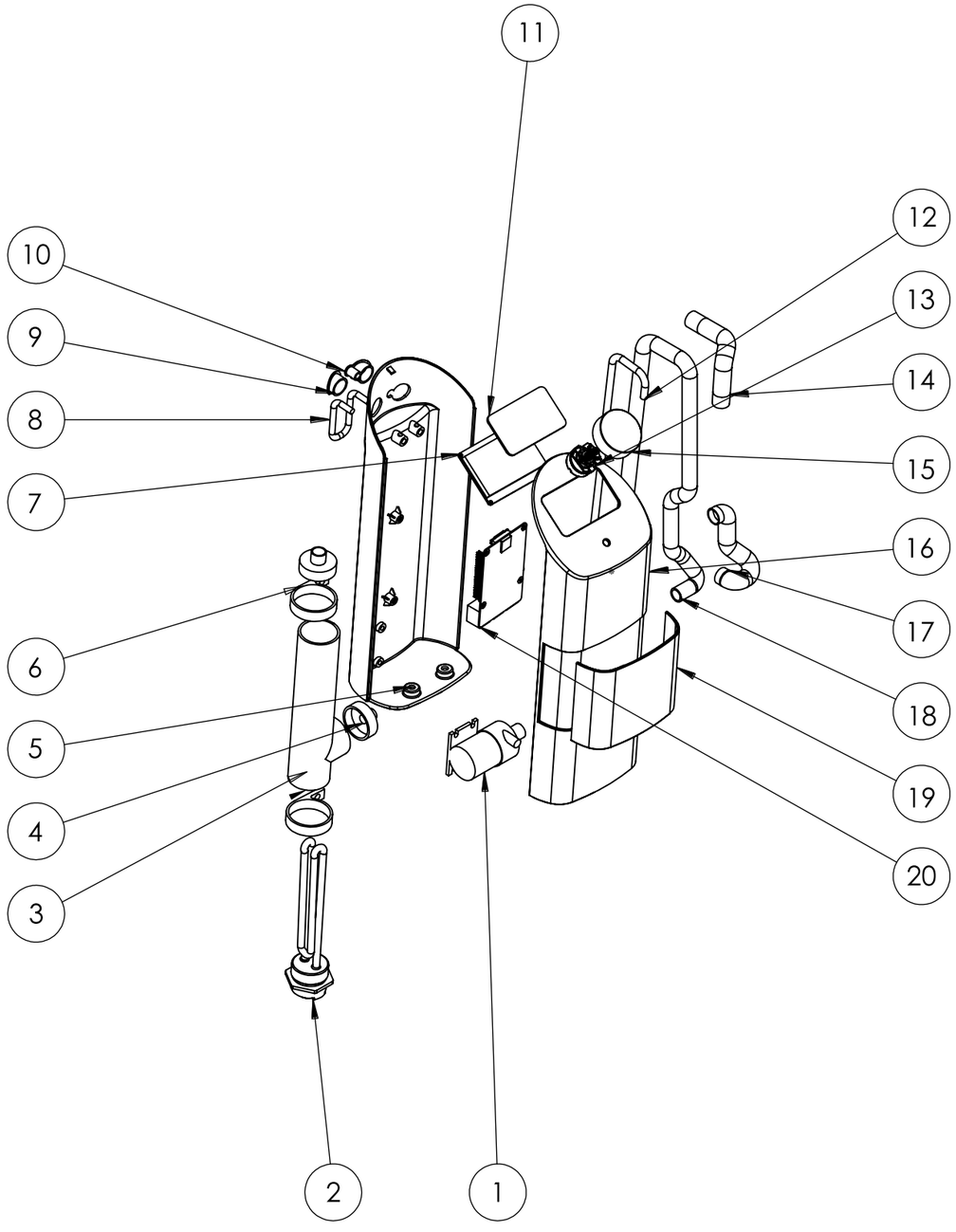






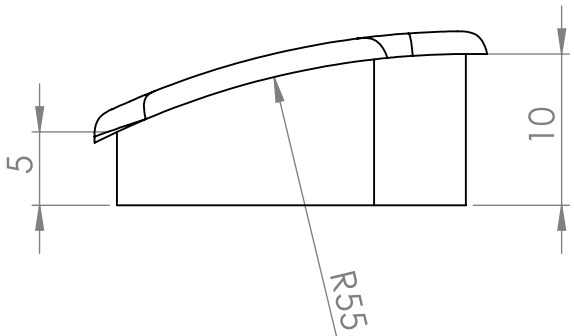


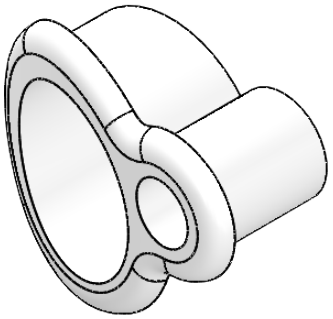
Tolerance	**Created by** NN	**Approved by** LJ
Material	**Type of document** Main Drawing	**Scale** 1:2
		Drawing nr. B1.0
Owner MSc04-ID16	**Title** Brew Unit - Main Drawing	**Date** 17-05-2017

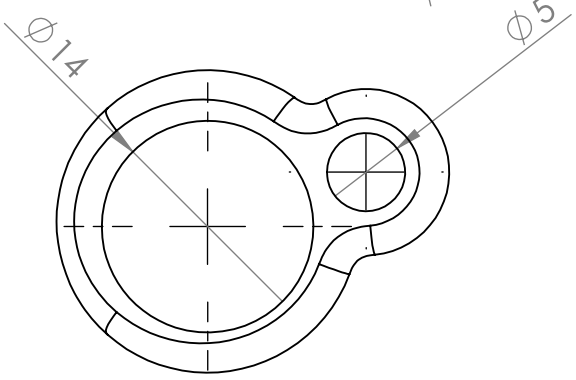


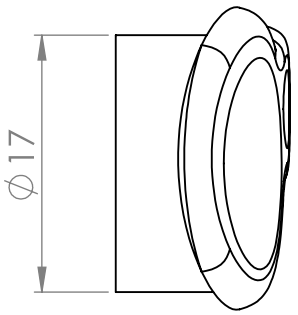
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Pump		1
2	Heating Element		1
3	Heating Element Tube		1
4	Fitting		2
5	Inner Shell		1
6	Mounting Ring		2
7	Screen		1
8	Hook		1
9	Fitting Outlet		1
10	Fitting Inlet		1
11	Screen Protector		1
12	Temperature Probe		1
13	Potentiometer		1
14	Tube Outlet		1
15	Knob		1
16	Outer Shell		1
17	Tube Inner		1
18	Tube Inlet		1
19	Grib Handle		2
20	Rasberry Pi		1

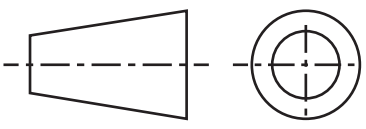
Tolerance	**Created by** LJ	**Approved by** NN
Material & finish	**Type of document** Exploded view	**Scale** 1:5
		Drawing nr. B2.0
Owner MSc04-ID16	**Title** Brew Unit Exploded	**Date** 17-05-2017



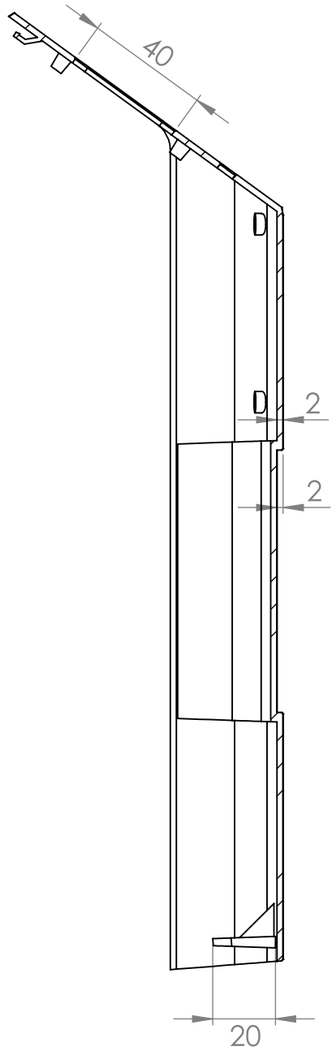




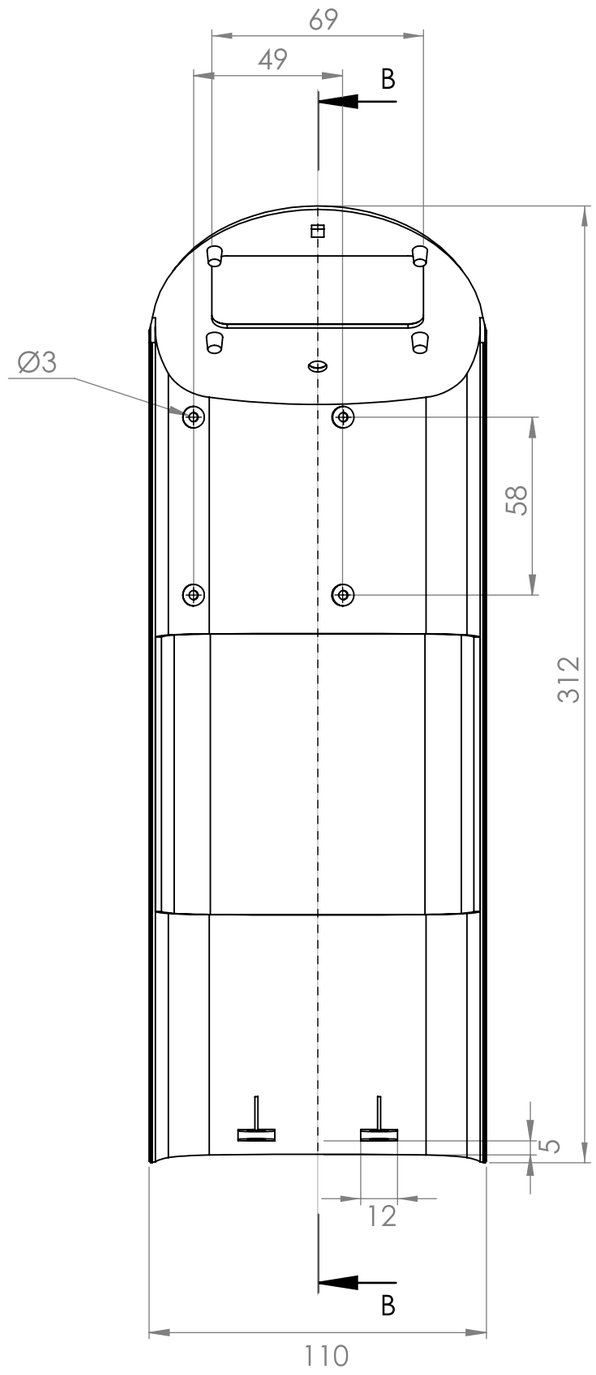


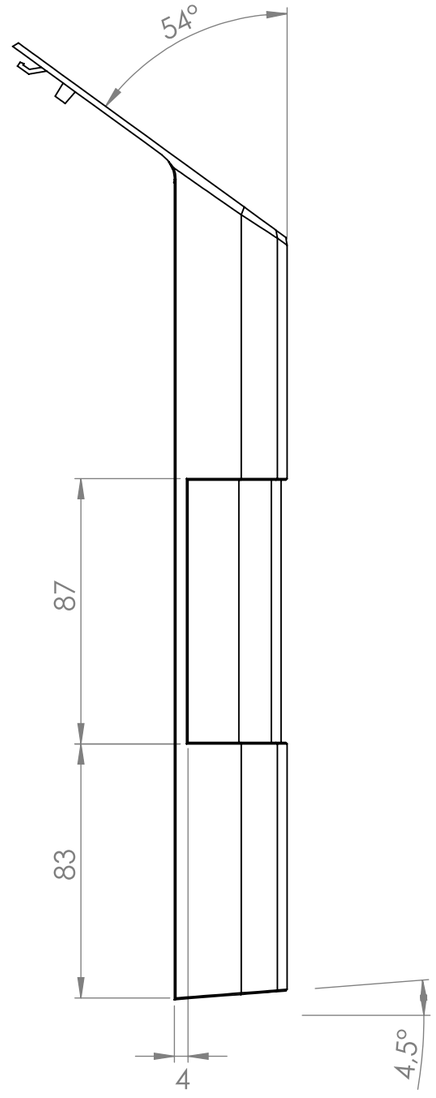


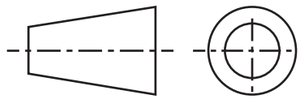
Tolerance 2768M if not other specified	**Created by** NN	**Approved by** LJ
Material & finish PP & PM-T2	**Type of document** Construction	**Scale** 2:1
Owner MSc04-ID16	**Title** Fitting Inlet	**Drawing nr.** B2.10
		Date 17-05-2017



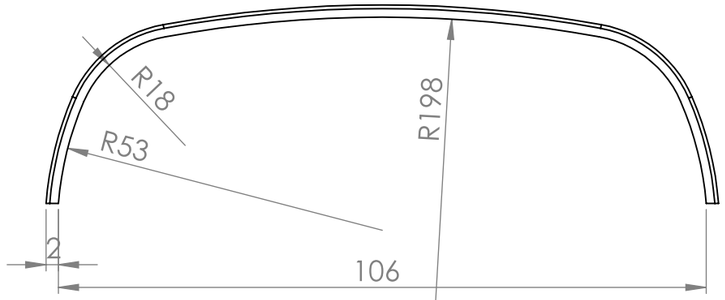
SECTION B-B
SCALE 1 : 2

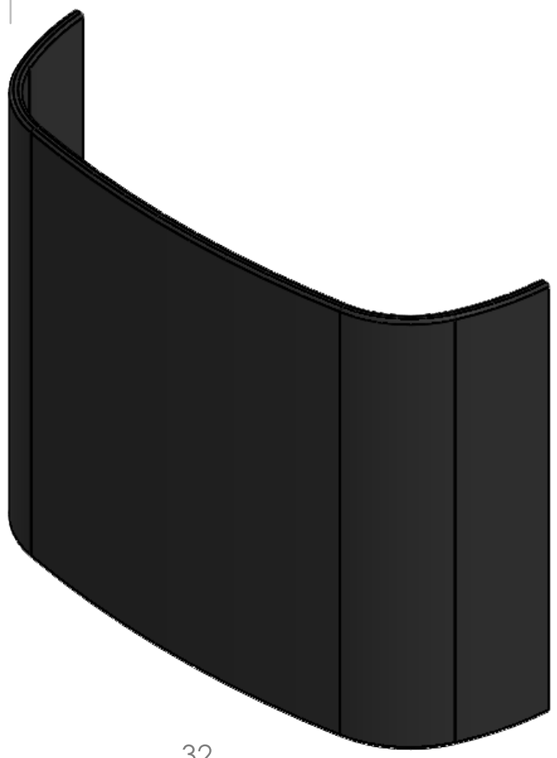


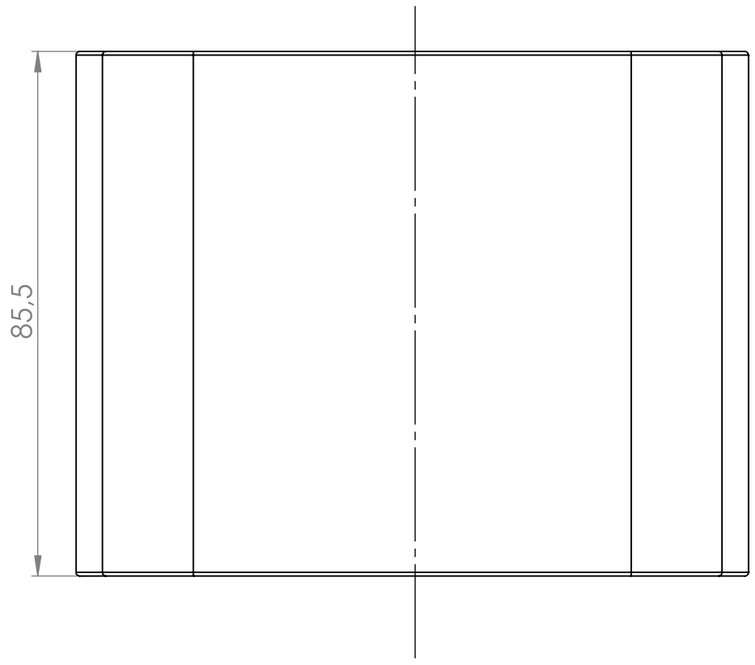


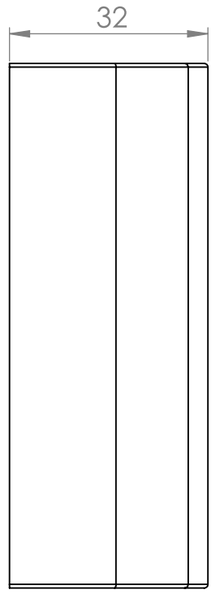


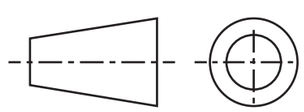
Tolerance 2768M if not other specified	**Created by** NN	**Approved by** LØ
Material & finish PP & PM-T2	**Type of document** Construction	**Scale** 1:2
Owner MSc04-ID16	**Title** Outer Shell	**Drawing nr.** B2.16
		Date 17-05-2017



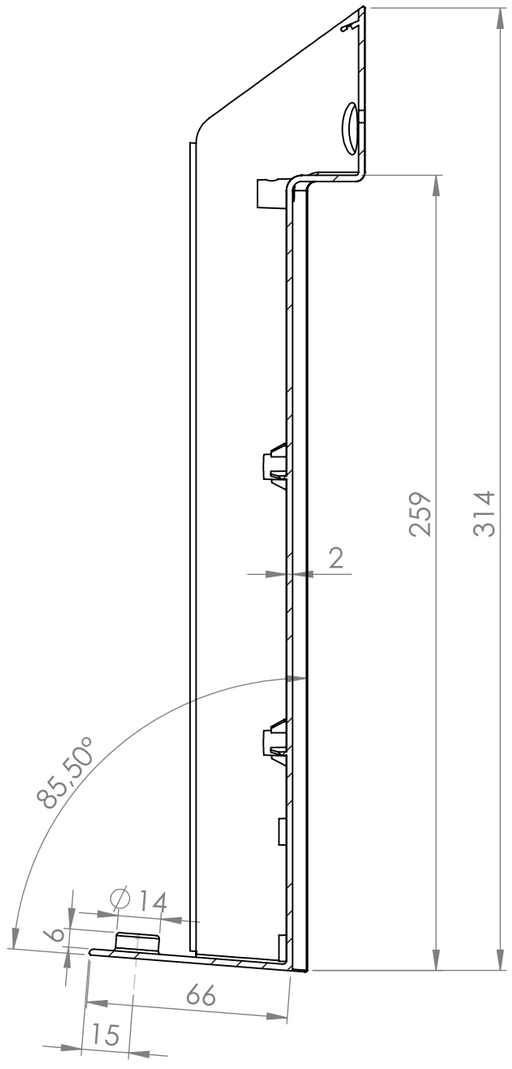




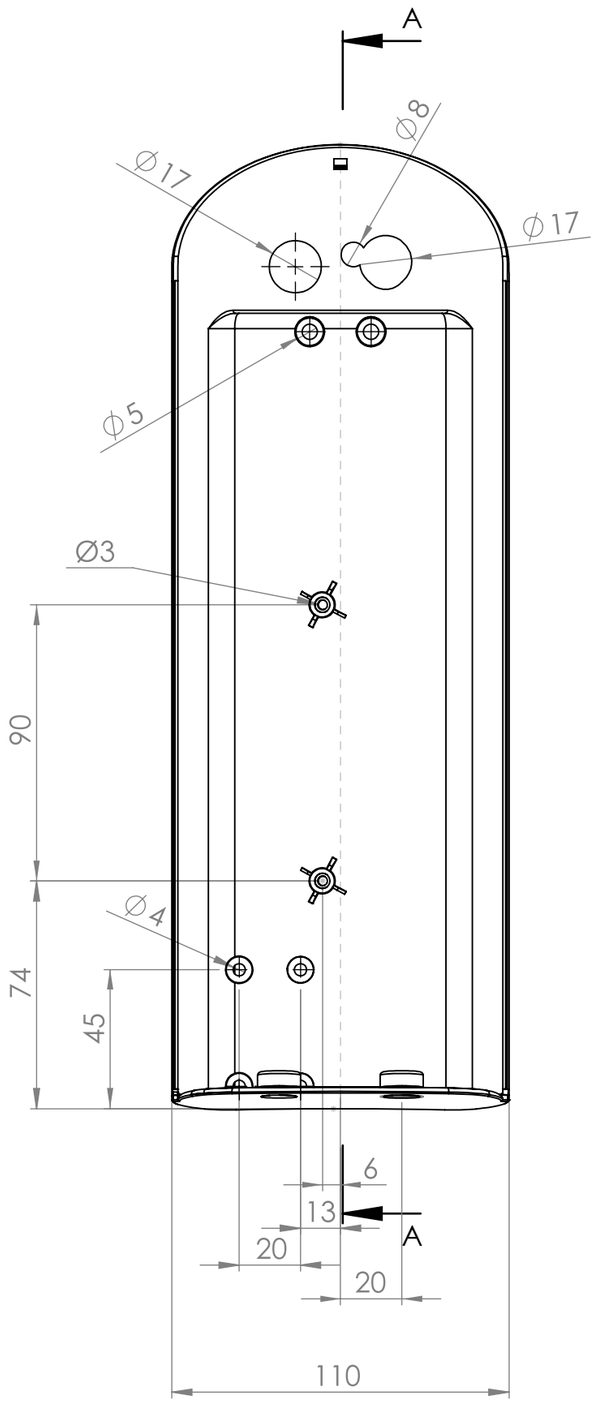


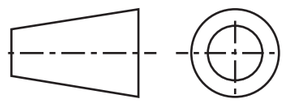


Tolerance 2768M if not other specified	**Created by** LJ	**Approved by** NN
Material & finish TPE	**Type of document** Construction	**Scale** 1:2
Owner MSc04-ID16	**Title** Grib Handle	**Drawing nr.** B2.19
		Date 17-05-2017

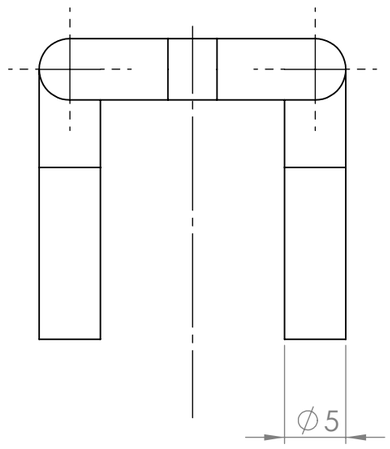


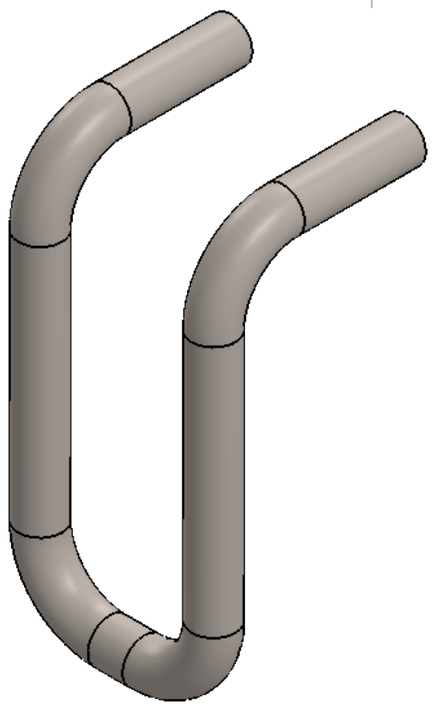
SECTION A-A
SCALE 1 : 2

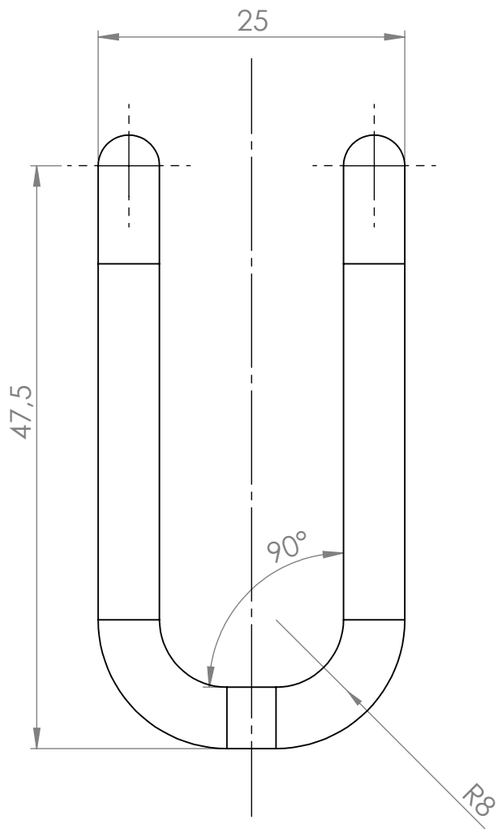


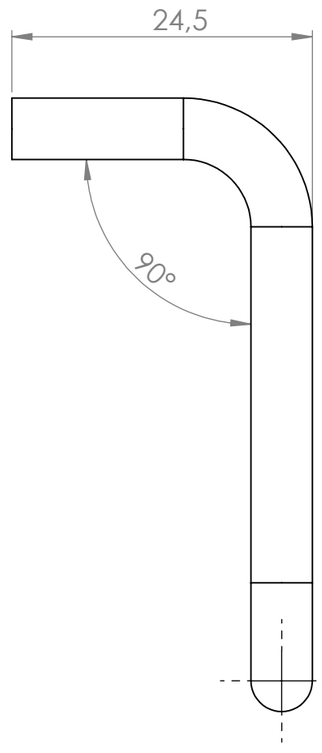


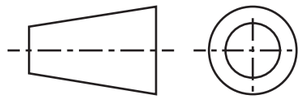
Tolerance 2768M if not other specified	**Created by** NN	**Approved by** LØ
Material & finish PP & PM-T2	**Type of document** Construction	**Scale** 1:2
Owner MSc04-ID16	**Title** Inner Shell	**Drawing nr.** B2.5
		Date 17-05-2017



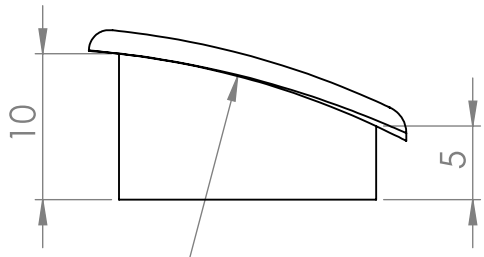


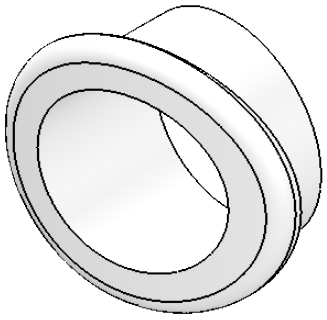


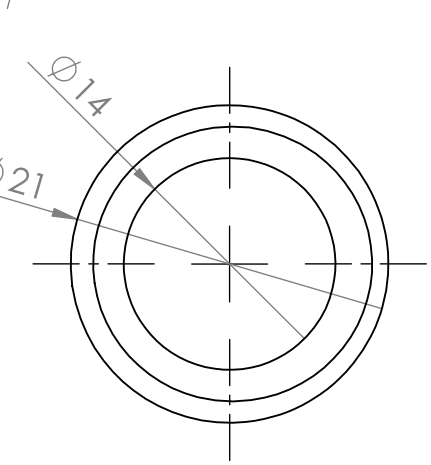


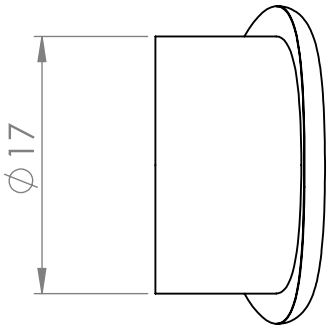


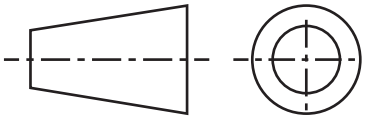
Tolerance 2768M if not other specified	**Created by** LJ	**Approved by** LØ
Material & finish AISI 316 & PVD	**Type of document** Construction	**Scale** 1:2
Owner MSc04-ID16	**Title** Hook	**Drawing nr.** B2.8
		Date 17-05-2017



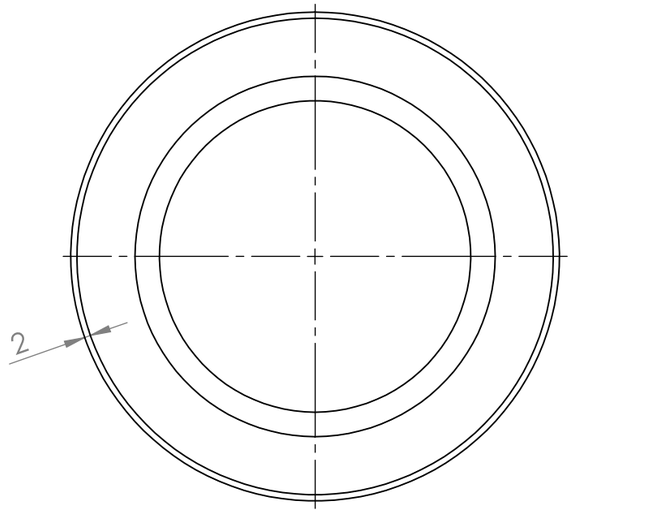


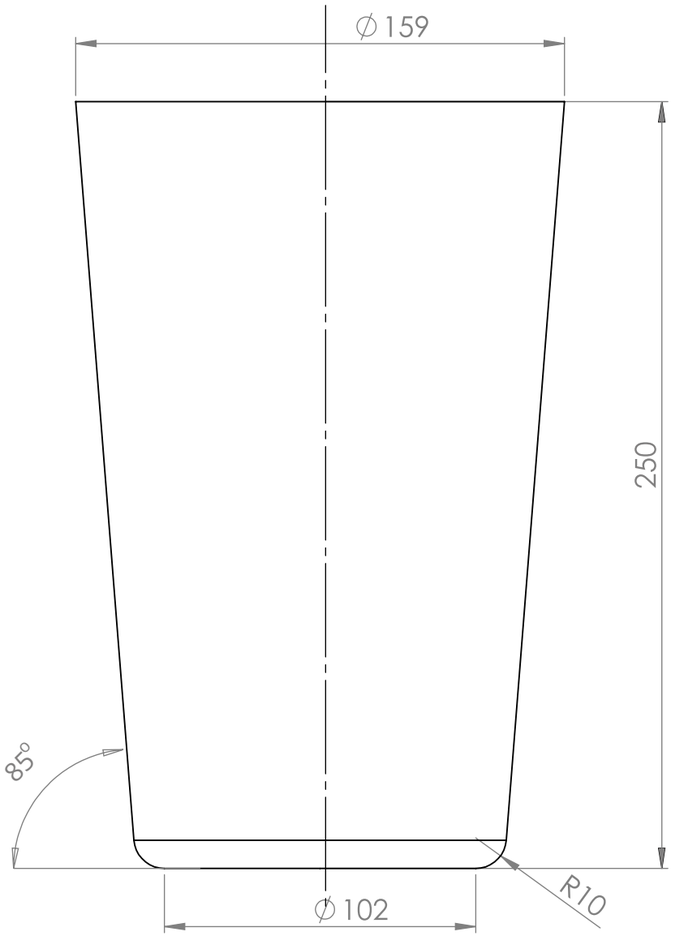


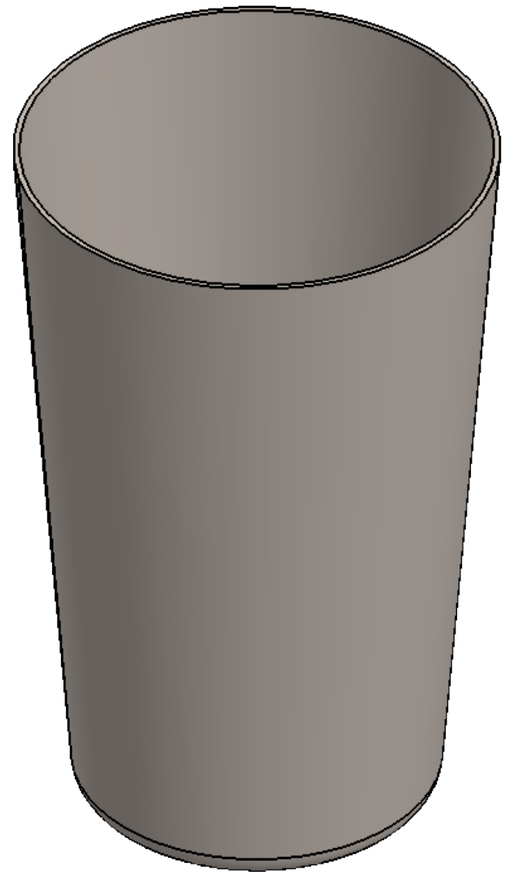


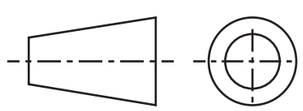


Tolerance 2768M if not other specified	**Created by** NN	**Approved by** LØ
Material & finish PP & PM-T2	**Type of document** Construction	**Scale** 2:1
Owner MSc04-ID16	**Title** Fitting Outlet	**Drawing nr.** B2.9
		Date 17-05-2017

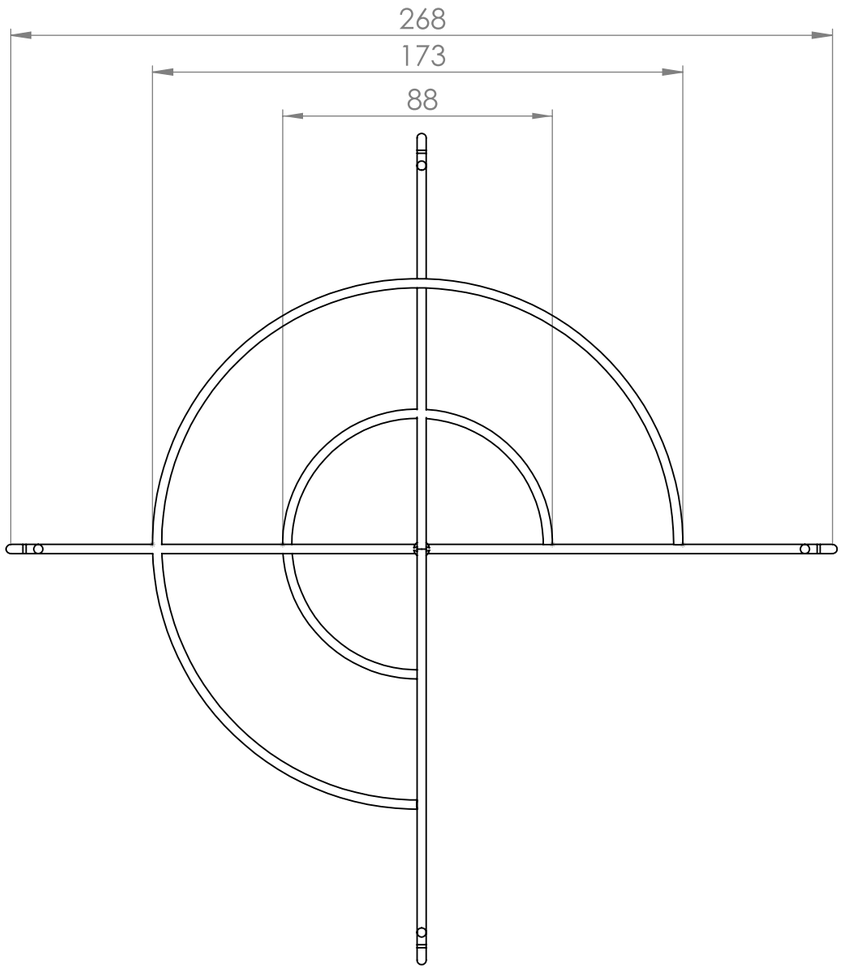


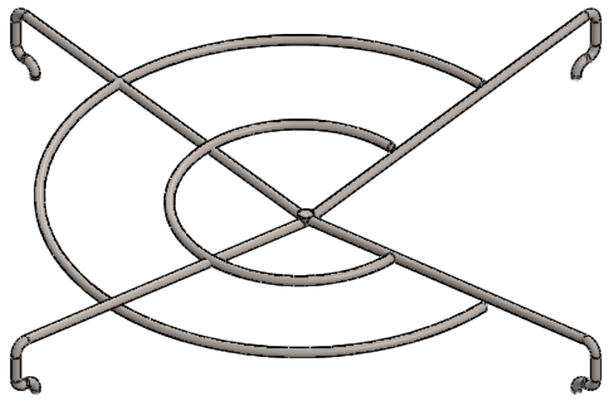


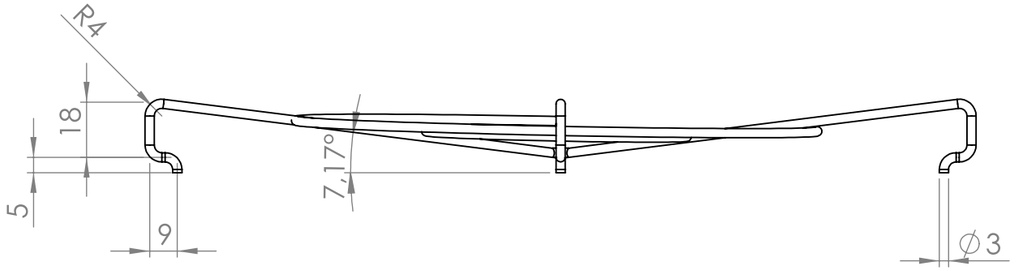


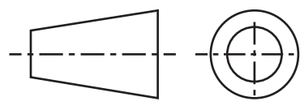


Tolerance 2768M if not other specified	**Created by** NN	**Approved by** LØ
Material & finish AISI 316 & PVD	**Type of document** Construction	**Scale** 1:2
Owner MSc04-ID16	**Title** Cleaning Tank	**Drawing nr.** C1.0
		Date 17-05-2017

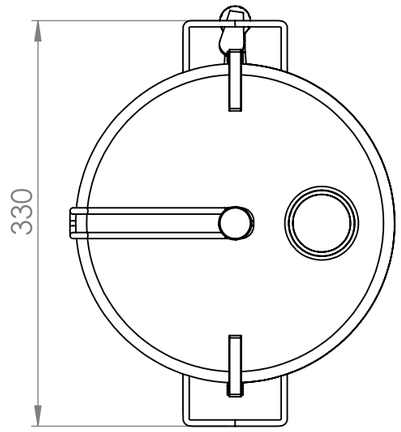


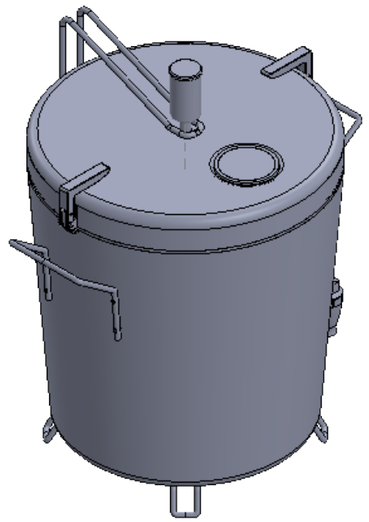


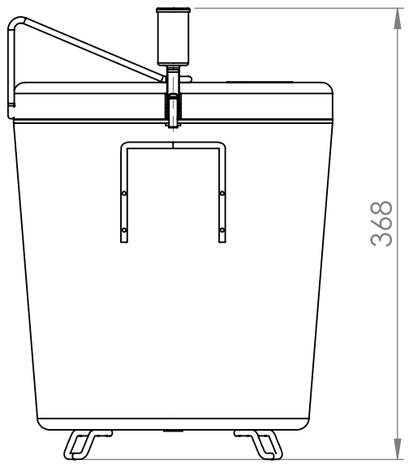


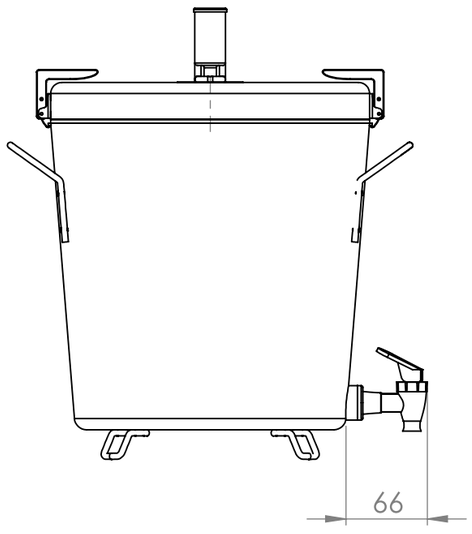


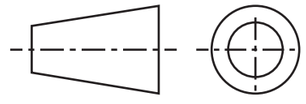
Tolerance 2768M if not other specified	**Created by** NN	**Approved by** LJ
Material & finish AISI 316 & PVD	**Type of document** Construction	**Scale** 1:5
Owner MSc04-ID16	**Title** Rack	**Drawing nr.** R1.0
		Date 17-05-2017





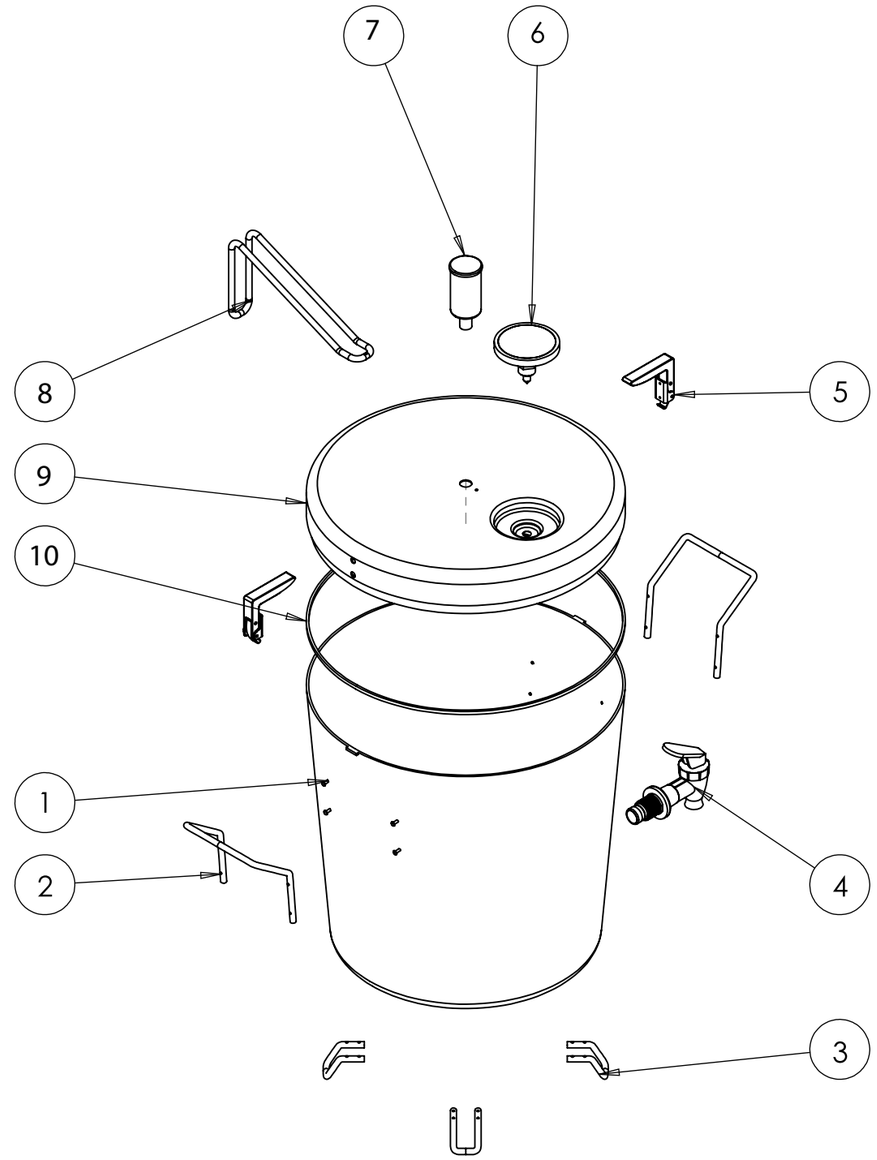


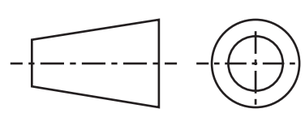




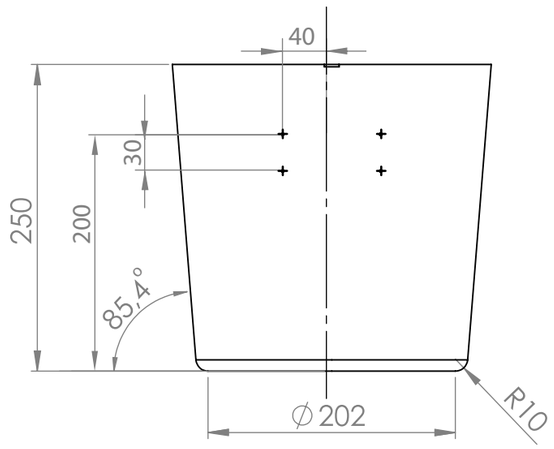
Tolerance	**Created by** NN	**Approved by** LJ
Material & finish	**Type of document** Main Drawing	**Scale** 1:5
		Drawing nr. T1.0
Owner MSc04-ID16	**Title** Tank - Main Drawing	**Date** 17-05-2017

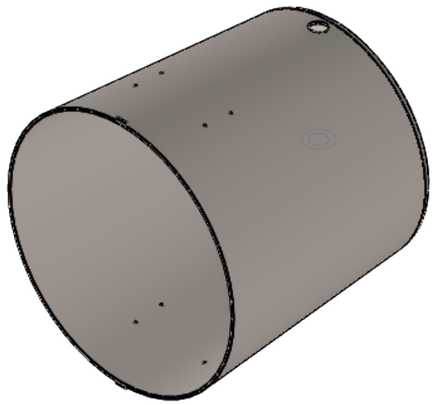
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Tank		1
2	Handle		2
3	Foot		4
4	Tap		1
5	Hasp		2
6	Thermometer		1
7	Fermentation lock		1
8	Handle lid		1
9	Lid		1
10	Rubber seal		1

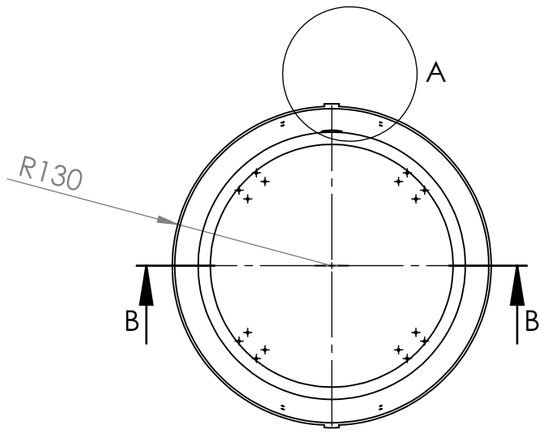


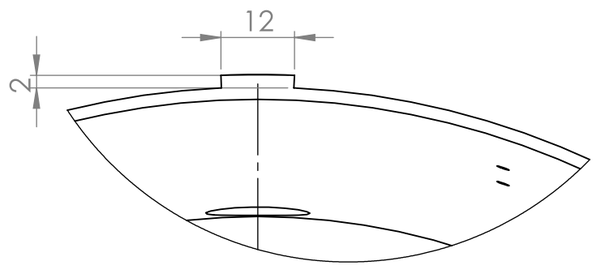


Tolerance	Created by LJ	Approved by NN
Material & finish	Type of document Exploded View	Scale 1:5
		Drawing nr. T2.0
Owner MSc04-ID16	Title Tank Exploded	Date 17-05-2017

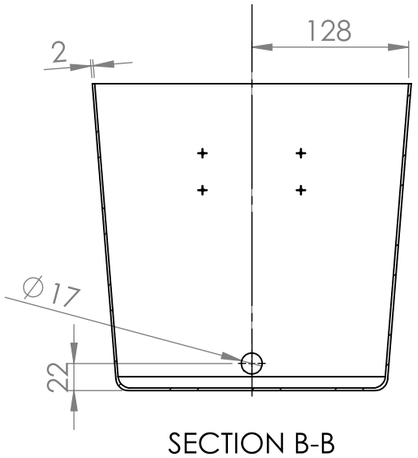




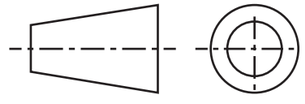




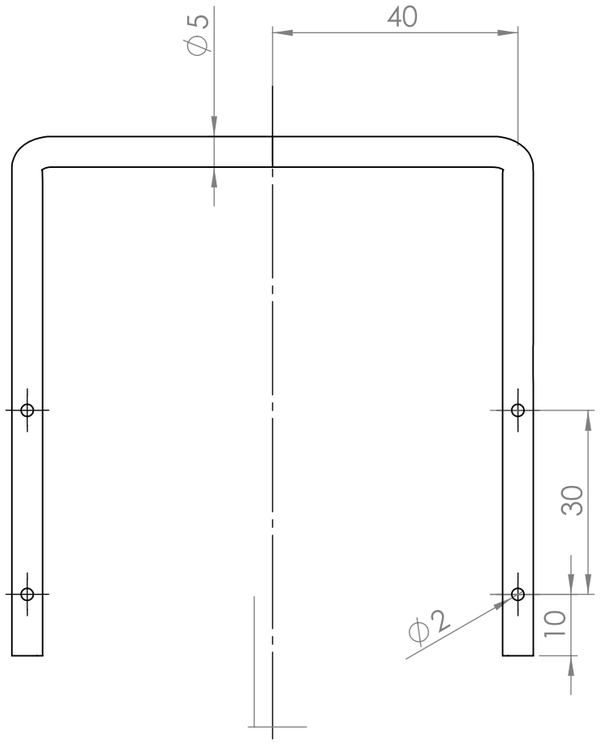
DETAIL A
SCALE 1 : 1

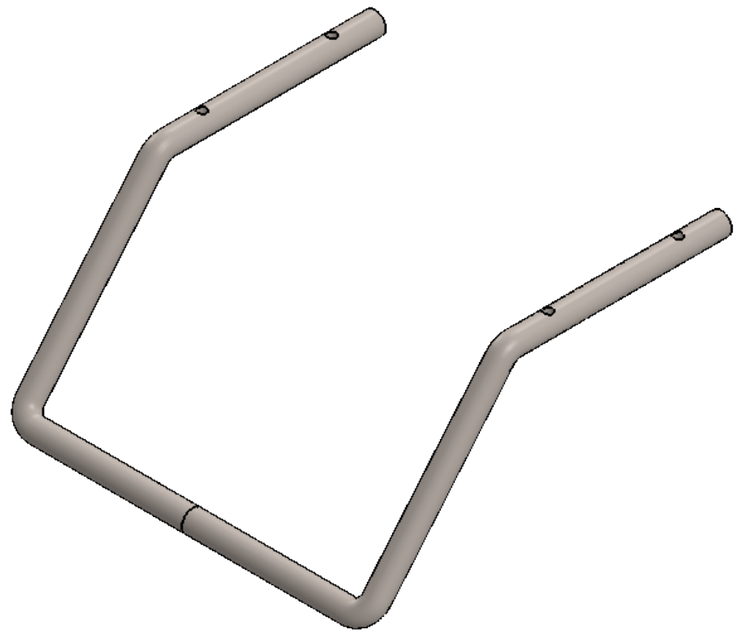


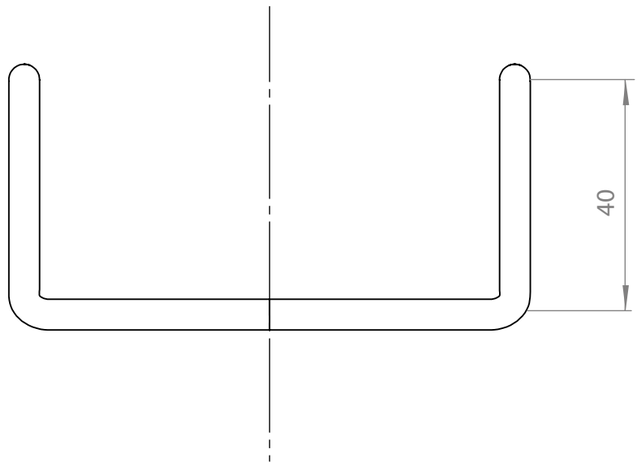
SECTION B-B

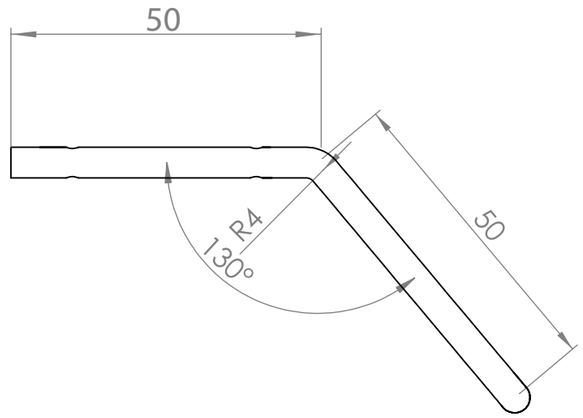


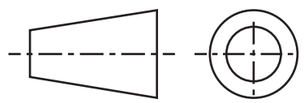
Tolerance 2768M if not other specified	**Created by** NN	**Approved by** LØ
Material & finish AISI 316 & PVD	**Type of document** Construction	**Scale** 1:5
Owner MSc04-ID16	**Title** Tank	**Drawing nr.** T2.1
		Date 17-05-2017



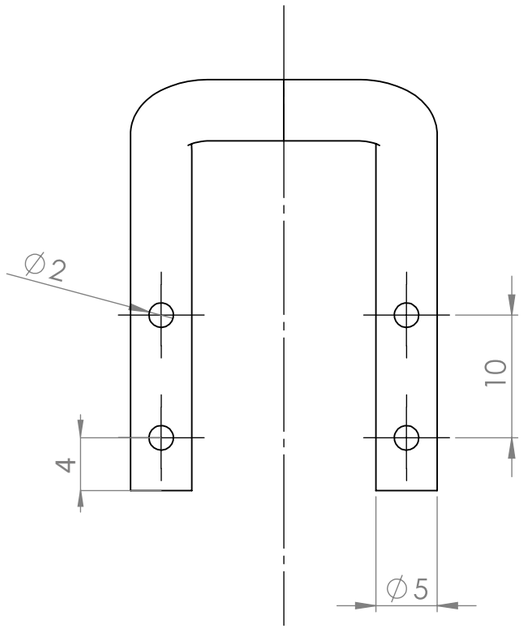


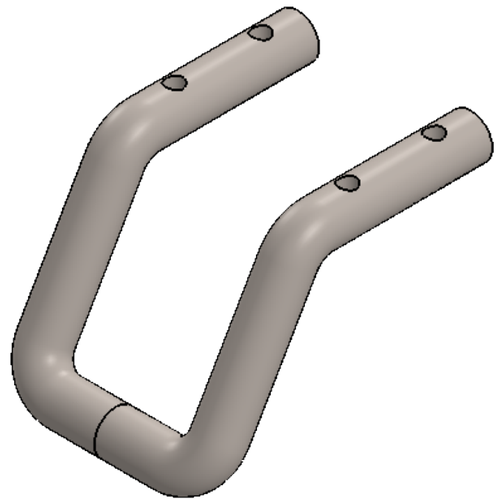


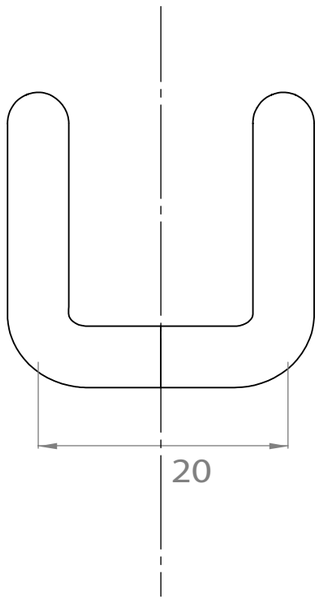


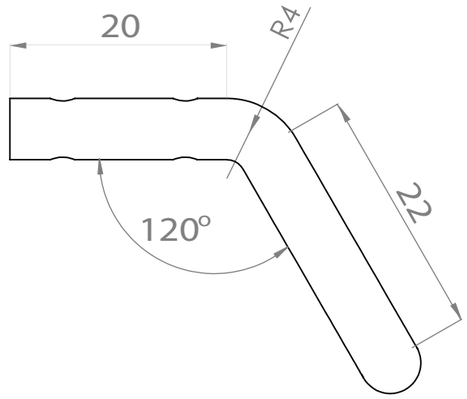


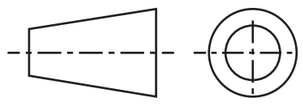
Tolerance 2768M if not other specified	**Created by** NN	**Approved by** LJ
Material & finish AISI 316 & PVD	**Type of document** Construction	**Scale** 1:2
Owner MSc04-ID16	**Title** Handle	**Drawing nr.** T2.2
		Date 17-05-2017



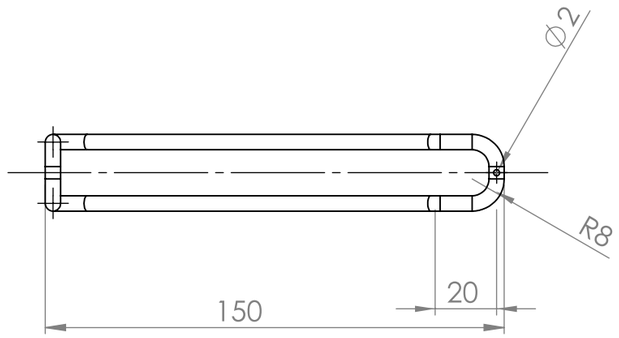


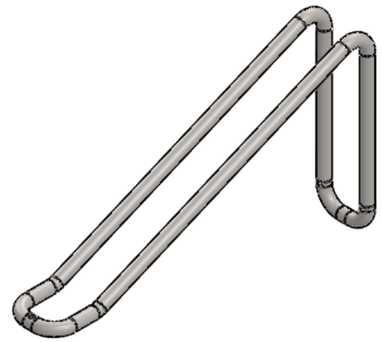


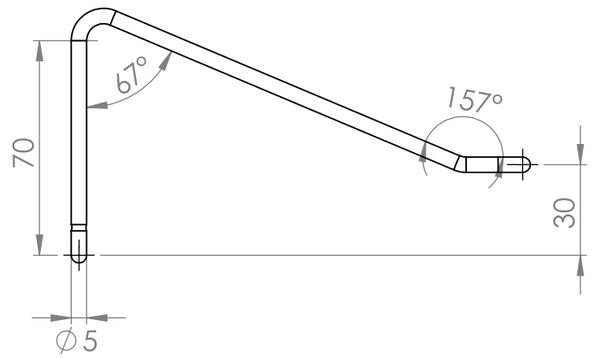


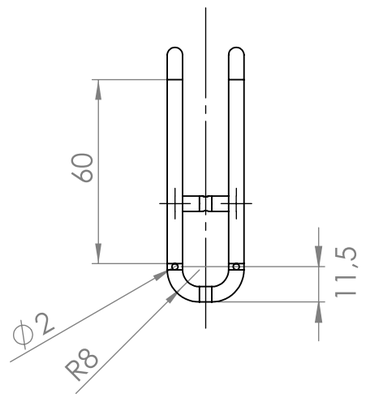


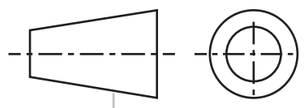
Tolerance 2768M if not other specified	**Created by** NN	**Approved by** LØ
Material & finish AISI 316 & PVD	**Type of document** Construction	**Scale** 2:1
		Drawing nr. T2.3
Owner MSc04-ID16	**Title** Foot	**Date** 17-05-2017



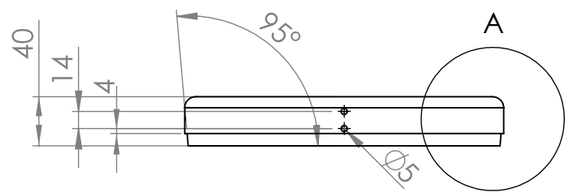


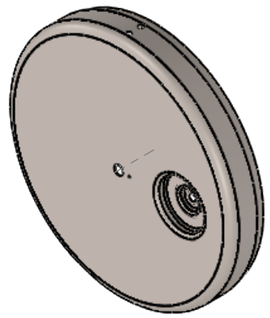


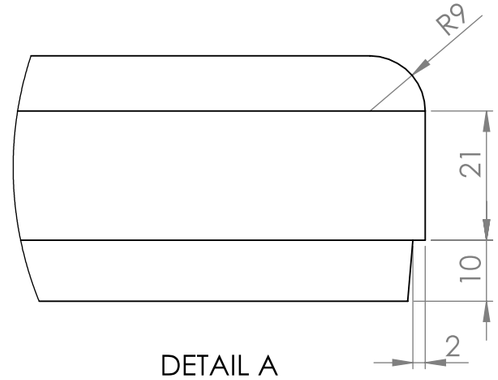




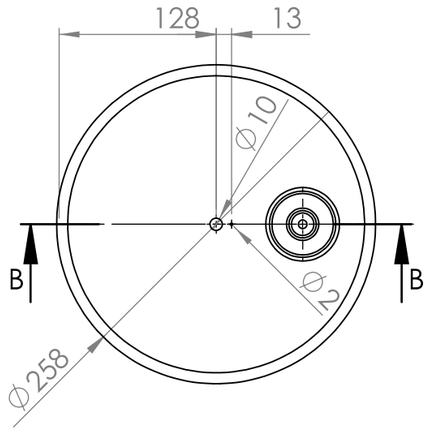
Tolerance 2768M if not other specified	**Created by** NN	**Approved by** LØ
Material & finish AISI 316 & PVD	**Type of document** Construction	**Scale** 1:2
Owner MSc04-ID16	**Title** Lid handle	**Drawing nr.** T2.8
		Date 17-05-2017

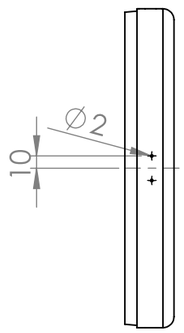


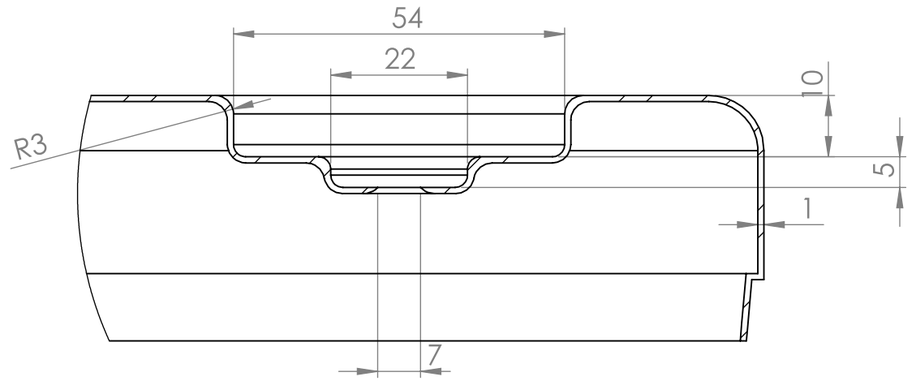




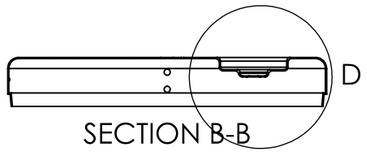
DETAIL A
SCALE 1 : 1



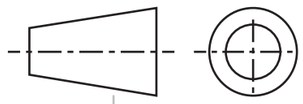




DETAIL D
SCALE 1 : 1



SECTION B-B



Tolerance 2768M if not other specified	**Created by** LJ	**Approved by** NN
Material & finish AISI 316 & PVD	**Type of document** Construction	**Scale** 1:5
Owner MSc04-ID16	**Title** Lid	**Drawing nr.** T2.9
		Date 17-05-2017