ma4-ID3, Camilla Vigsø & Mette S. S. Christensen, May, 2012

TITLE SHEET

Title
Ghost

Project group
Msc4-ID
Department of Architecture, Design & Media Technology
Aalborg University

Collaborator
Martin Professional A/S

Period
1st of February 2012 – 23rd of May 2012

Supervisor
Finn Schou
Studieadjunkt, Department of Architecture, Design and Media Technology
Aalborg University

Camilla Vigsø

Mette Struwe Skytte Christensen

INTRODUCTION

This process report is conducted on 4 MSc-ID, Industrial Design and Planning at Aalborg University, in connection with the master thesis.
The project is completed in cooperation with Martin Professional A/S in the period from the 1st of February 2012 to the 23rd of May 2012.

The project has resulted in two reports; a process report, communicating the process from introduction to final product proposal, and a product report, which presents the final solution and function as a promotional literature.
The reports can be read in order, starting with process report and then the product report, or the product report can be read separately.

For this report there is used Harvard references, where books are stated[author, year of publication], and web addresses [Web xx], which are found in the back of the individual report.

In the back of the process report you can find the enclosed CD, that contains digital versions of the reports, technical drawings and an extended appendix.

The group would like to use this opportunity to thank Henrik Sørensen, and the people at Jem factory in UK. Henrik has been our contact person at Martin Professional A/S, and has helped the group throughout the project.
Furthermore the group would like to express a thanks, to the people who have helped us to understand the environment in the music business, and the handling of the equipment.
René Petersen, owner of 3style
Søren Christiansen, owner of SoundSpec
Hans Jørn Foght Hansen from Aalborg Kongres og Kultur Center
Finn Boysen, owner of Fi-Pa Sound, and Nick Baade Pedersen, his light technician.

Fig. 2: Happy factory,
Frederikshavn, DK

INDEX

SUMMERY

Dette projekt er lavet i samarbejde med Martin Professional, hvor der er udviklet på en ny haze maskine. En haze maskine er i familie med røgmaskinen, men i stedet for den tykke røg, hvor røgen er effekten, består hazen af små vandpartikler, der først ses når det rammes af en lysstråle. Dette gør, at hazen ikke er en effekt i sig selv, men fremhæver lyseffekterne. Maskinen bliver en af de dyreste på markedet, hvilket stiller krav til blandt andet designet og brugervenligheden, og ikke mindst at opretholde den forventede kvalitet der er ved Martin produkter.

Denne rapport fortæller om processen fra første møde til detaljering på produkt forslaget.
Martin er i dag verdensførende inden for intelligent lys, og sidder på 25% af verdens røg og haze marked. Deres ønske er at blive verdensførende på røg- og haze markedet. Dette har de et godt udgangspunkt for, med det image der er opbygget på baggrund af deres lys. Martin lys omtales som: Stabile, robuste, tilregnelige og med en god service garanti.
Som udgangspunkt for projektet laves der en fase oversigt, hvor de forskellige faser inddeles og indsættes i en kalender, for at sikre at gruppen når gennem det hele inden for den afsatte tid.

Research

Grundlæggende for alle produkter er forståelsen af brugeren. Gruppen besøger og interviewer derfor tre forskellige brugergrupper: Den private mobil DJ, SoundSpec Aps, et medium størrelse udlejningsfirma, Fi-Pa Sound og Aalborg Kultur og Kongres Center. Ud fra interviewene opstilles brugernes krav og ønsker til en røgmaskine, hvilke bliver brugt som designparametre og detaljerings krav.
Efter brugerundersøgelserne tog gruppen på besøg på Jem Factory i Louth, UK, hvor Martins røgafdeling hører til. Her får gruppen al den baggrundsviden der kræves for sådan et projekt. Udover fabrikken besøger gruppen også Jem's underleverandør, Bullet, som laver størstedelen af Martins røgmaskiner.

Ud fra besøget i Louth vides det, at maskinen består af flere komponenter, der skal sættes sammen på en hensigtsmæssig måde, så div. krav kan opfyldes. Maskinen består af fire tanke: En hoved tank, hvor hazen bliver produceret; en sump tank, hvor væsken bliver opsamlet, når maskinen lukkes ned; en koncentrat tank, og en vand tank. Foruden de forskellige tanke er der generelt elektronik, som skal få maskinen til at virke, der er en luftkanal, som skal separere partiklerne i den haze der bliver produceret, så det kun er de små partikler der kommer ud, for at skabe en mere ensartet og bedre haze.

Koncept udvikling

I udviklingen af produktet er der set på det overordnede design og de indvendige komponenter. Maskinen bygger på en ældre version, som firmaet lancerede i 1995, men som aldrig slog rigtig igennem. Teknologien i den nye hazer er den samme, men alle komponenterne laves på ny. Koncept udviklingen kigger hovedsagelig på det overordnede design i produktet, hvor der er fundet inspiration i eksisterende produkter, både inden for området så vel som møbler, biler, højtaler mm. Under skitseringen af designet er gruppen langt omkring i formsproget, fra den helt organiske form til den meget geometriske form. Det endelige koncept er en sammensmeltning af de to formsprog, hvor produktet er opbygget over geometriske og stringente linjer, hvilke er opblødt af lidt blødere og organiske linjer.
Foruden det overordnede design er der set på koncentratbeholderen. Der er fra Martins side et ønske om, at der bliver set på, hvordan man kan forhindre kunderne i at snyde med koncentrat væsken til maskinen, da det er et problem, at nogle kunder genopfylder koncentrat beholdere med deres egen hjemmelavede væske. Hertil er der undersøgt forskellige metoder og områder, hvor der findes produkter med samme funktion; skal være nem at tømme, men svær at genopfylde. Der er blandt andet set på konceptet bag en fugepistol, en ventil og en medicin flaske. Foruden dette er der set på et elektronisk om-

råde med fx .RFID-tags og NFC-tags, som er små chips, der ved hjælp af radiobølger kan modtage og sende information mellem den selv og en modtager/læser. Ud fra undersøgelsen er det valgt at bruge en NFC-tag. Denne bliver placeret på koncentratbeholderen, med en tilhørende læser i maskinen. Læseren får informationer fra haze maskinen, om hvor meget væske der bliver brugt, hvilket den fortæller videre til NFC-tagen på flasken. På denne måde ved NFC'en altid, hvor meget væske der er i beholderen. Hvis dataene pludselig ikke stemmer overens, fejlmelder maskinen.

Detaljering

Med det overordne design på plads bliver der i detaljeringen set på de indre komponenter i maskinen, og hvordan disse skal designes. Det er et ønske at gøre maskinen modulær, så delene kan genbruges, hvis der skal laves en anden størrelse. Der bliver gået i dybden med nogle af komponenterne i maskinen, mens andre kun bliver diskuteret.

Der er lagt meget vægt på hoved tanken, hvilken er gjort klar til produktion. Der er set på udformningen, i forhold til de krav der er til denne hazer, samt produktionsmetoder. Koncentrat tanken er ligeledes gennemarbejdet ned til produktionsmetode. Til denne er det valgt at bruge en NFC-tag, hvilken kan sættes på alle beholdere. For at give produktet mere karakter er der designet en koncentrat beholder, tilpasset denne maskine, hvorpå NFC'en placeres.

Luftkanalen er designet på et overordnet plan, hvorpå der er lavet simulering af partiklernes forløb, da det er et ønske at frembringe turbulens for at separere partiklerne. For at videreudvikle på luftkanalen er det nødvendigt at lave fysiske forsøg på en prototype, hvor outputtet kan måles. Til denne maskine skal der bruges store mængder af vand, hvilket man derfor fylder op på selve pladsen. Det er derfor valgt at bruge standard komponenter, der kan foldes sammen og pakkes ind i maskinen, når de ikke er i brug. Dette er for at spare plads og gøre det nemmere for brugeren at holde styr på alle delene.

Som en del af detaljeringen er der set på, hvordan de forskellige komponenter fastgøres i maskinen, og hvordan det, i forbindelse med service, er nemmest at komme til de enkelte dele.

Evaluering

Som afslutning er der lavet en evaluering af produktet, for at se om den lever op til de krav og ønsker, der er opstillet i research fasen. Dette danner udgangspunkt for konklusionen og refleksionen, hvor forskellige aspekter i processen bliver diskuteret.

Fig. 3: Final product

FRAME WORK

In this chapter an understanding and overview of the project and guidelines will be given. This includes learning goals form the University and own learning goals, and a time line of the project.

DESIGN BRIEF

Company profile

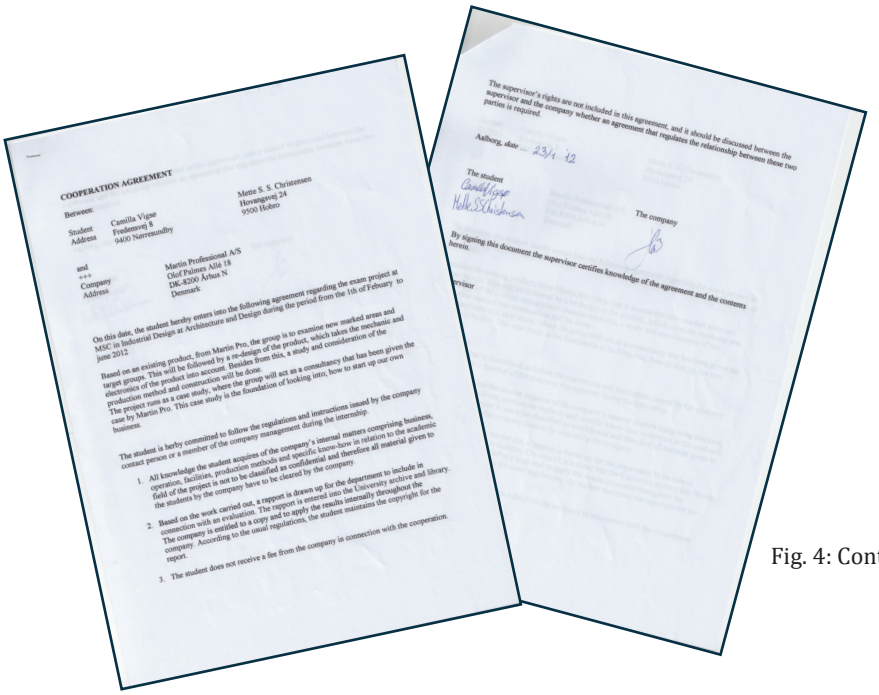
Martin Professional A/S (Martin) was founded in 1987 by Peter Johansen, an entrepreneur from Aarhus. Today Martin is world leading in the creation of intelligent light solutions (computer controlled light) for entertainment, architectural, and commercial sectors, and have 20-25% of the world market within fog machines.
Since the foundation the company has been expanded, and in 1994 their turnover passed 100 million DKK, and in 1995 they were noted on the Copenhagen stock exchange.
Martin Professional is placed in four different countries; the headquarter is placed in Aarhus, Denmark, two factories in Frederikshavn, Denmark, that makes the light, one factory in Louth, United Kingdom, this factory produces the smoke machines, and one factory in China. The production at the factory in China, will, during 2012, be moved to Frederikshavn and Louth, as a part of a new business structure and strategy. [Web 1]

Assignment

Based on a old haze-machine, from Martin, the project-group is to examine the user, design the exterior look, and look into some of the interior components. The mechanic and electronics of the product, must be taken into account. Besides from this, a study and consideration of the production method and construction will be done.

Business & Strategy

The reason for the cooperation between Martin and the project group is, to get new eyes on a product and to develop new ideas. The product must live up to the usability, use of the product, and the high quality, that characterise Martins products. The haze machine is to be the best on the marked, and among the most expensive, which has to show in the aesthetics in the product.
To make sure that there will not be any complication in the corporation now or later, a contract is made and signed by the group and Henrik Sørensen


COOPERATION AGREEMENT

Between:
Student: Camilla Vigne, Frederevej 8, 9400 Nørresundby
Address: Mette S. S. Christensen, Hovagervej 24, 9500 Hobro

and
Company: Martin Professional A/S
Address: Olof Palmes Allé 18, DK-8200 Arhus N, Denmark

On this date, the student hereby enters into the following agreement regarding the exam project at MSC in Industrial Design at Architecture and Design during the period from the 1th of Febuary to June 2012.

Based on an existing product, from Martin Pro, the group is to examine new marked areas and target groups. This will be followed by a re-design of the product, which takes the mechanic and electronics of the product into account. Besides from this, a study and consideration of the production method and construction will be done.
The project runs as a case study, where the group will act as a consultancy that has been given the case by Martin Pro. This case study is the foundation of looking into; how to start up our own business.

The student is herby commited to follow the regulations and instructions issued by the company contact person or a member of the company management during the internship.

1. All knowledge the student acquires of the company's internal matters comprising business, operation, facilities, production methods and specific know-how in relation to the academic field of the project is not to be classified as confidential and therefore all material given to the students by the company have to be cleared by the company.
2. Based on the work carried out, a rapport is drawn up for the department to include in connection with an evaluation. The rapport is entered into the University archive and library. The company is entitled to a copy and to apply the results internally throughout the company. According to the usual regulations, the student maintains the copyright for the report.
3. The student does not receive a fee from the company in connection with the cooperation.

The supervisor's rights are not included in this agreement, and it should be discussed between the supervisor and the company whether an agreement that regulates the relationship between these two parties is required.

Aalborg, date ... 23/1 -12

The student

The company

By signing this document the supervisor certifies knowledge of the agreement and the contents herein.

Fig. 4: Contract, Appendix A

Time and budget

The estimated time for the project is the 1st of February to the 23rd of May, during which a process report (describing the reflections and work) and a product report (describing the product) is to be made.
During the project, travel-expenses to the factory in Louth, UK, are covered by Martin Professional A/S.

Intended market

The haze machine is to increase Martin's marked share within fog machines. The goal is to become one of the leading companies, as they are in intelligent lighting solutions. The product is intended for larger concert places.
The product is to be sold on the marked with a price range from £3000 to £4000, with the expectation to sell 10 a month.

Production facilities available

Martin has factories in China, UK and Denmark. The factory in Louth, UK will be the collaborator in the development of the haze machine.

Date of market introduction

Year 2013

Product life

Based on the old version, the product will run in 12-15 years, if handled as instructed.

Contact person

Henrik Sørnsen
Vice President – Smoke
Henrik.soerensen@martin.dk
25 35 57 25

Important dates

1st meeting with Henrik Sørensen 23.01.2012
Trip to England 20.02.2012 to 02.03.2012
2nd meeting with Henrik Sørensen 09.03.2012
Midterm seminar 13.04.2012
3rd meeting with Henrik Sørensen 19.04.2012
4th meeting with Henrik Sørensen 27.04.2012
Hand in 23.05.2012

Fig. 5: Jem Factory, Louth, UK

OBJECTIVES

For this project the team must full fill the learning goals, listed in the study guide. Furthermore the team will aim for some personal goals.

From study guide

“ **Knowledge**

- ... account for the relevant design related knowledge and identify design relevant problems...
- ... account for the appropriate research-based knowledge ...
- ... demonstrate a high degree of awareness regarding the main experiments, tests, proposals and evaluations affecting the decision-making...
- ... demonstrate a high degree of awareness regarding the main critical issues in the design proposal and the appropriate course of action to amend these
- ... thoroughly account for the scientific validity of test, investigations and other type of data used..

Skills

- ...demonstrate the ability to independently create design proposals of a high standard, integrating selective aspects
- ...demonstrate the ability to frame the design assignment using professional tools and methods
- ...demonstrate the ability to generate a design proposal based on clearly defined values, user needs and/or business plan
- ...demonstrate the ability to select and use the appropriate method, techniques and tools for analysing problems, users, technologies, constructions, competitors, markets, products, strategies, companies and own design proposals
- ...demonstrate the ability to select and use the appropriate method, technique and tools for carrying out experiments and synthesising design proposals, including physical form, 2 and 3 dimensional documentation in both analogue and digital form.

[web 2]

”

Personal

- Gain knowledge about smoke and haze machines
- Get an insight in the marked of haze machines
- Improve skills within designing for a company
- Extend knowledge within production methods
  - Plastic moulding
  - Sheet metal
- Improve skills within project management
- Improve technically English, written and spoken
- Improve skills within meetings on a professional plan
- Gain knowledge about a production company

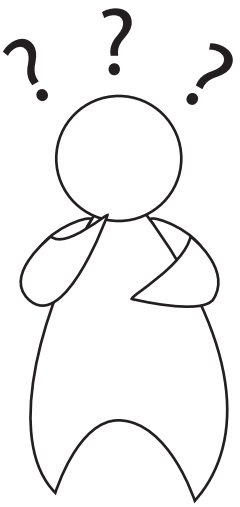
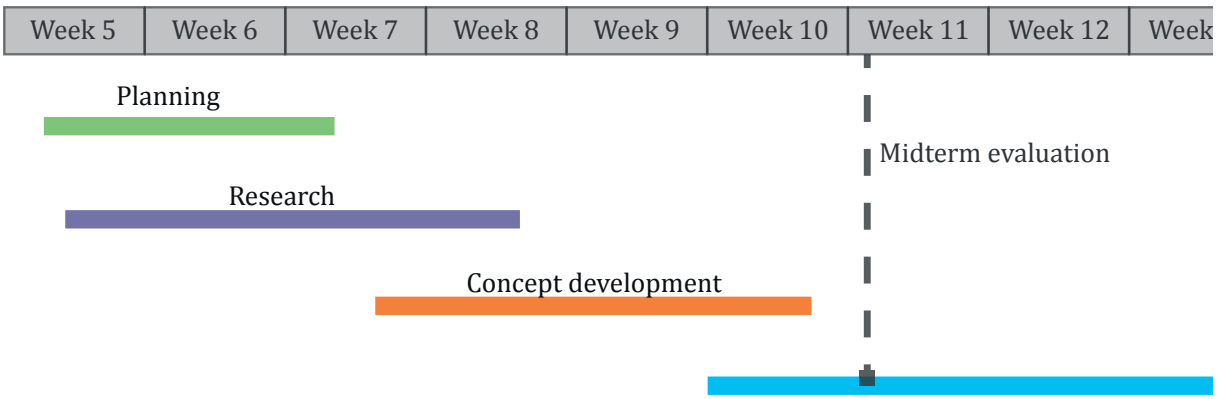


Fig. 6: Learning goal

PROJECT MANAGEMENT

Project management is important in all projects, to make sure the project is finished in due time. To structure the time, and to get an overview of the project, a phase calender is made.

Phase calender



FRAMEWORK

Tools
Time schedule
Design brief
Learning goals
Initiating demands

Outcome
A structured work-process
Project description

RESEARCH

Tools
SWOT analysis
Porters five
Product analysis
Marked analysis
Actors map
Interview
Observation
General knowledge
Technical investigation
Storyboard

Outcome
Understanding of the company
Product and marked understanding
User involvement
Design criteria

CONCEPT DEVELOPMENT

Tools
Brainstorm
Sketching
Technical investigation
Mock - up

Outcome
Hand sketches
Models
A concept

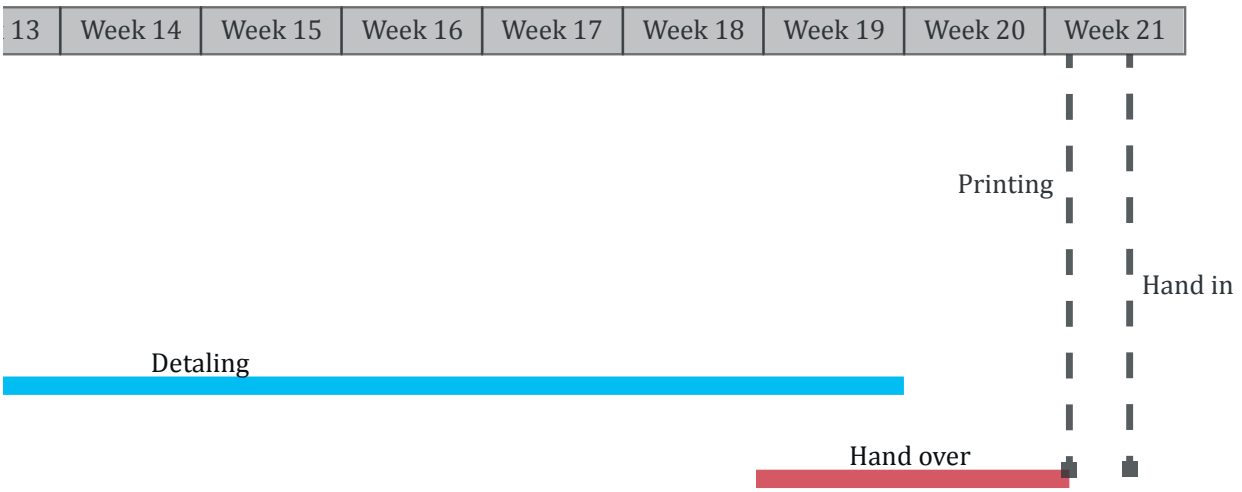


Fig. 7: Time schedule

DETAILING

Tools
Sketching
Mock – up
3D modelling
Finite element
Flow calculation
Mock – up

Outcome
Final design
3D visualisation
Presentation model

HAND OVER

Tools
3D model
Models

Outcome
Technical drawings
Bill of material
Functional model

RESEARCH

This chapter is for research of relevant information, which is used later in the project. There is looked into the mechanics for the haze machine, the users, and the company Martin Professional A/S.

PROBLEM CLARIFICATION

The assignment

The project group is to design a haze machine developed by Martin. The design must take into consideration the mechanics and electronics of the machine, as well as the demands and wishes from the users. There must be looked into material and production methods within the limit of a cost price of £800. The design must furthermore reflect a sales price of £3000 to £4000, which makes the machine among the most expensive on the marked.

Delimitations and weighting

Because of the limited time for the project, there is made delimitations and priorities in the subjects.
Based on information gathered at the factory in UK and from Henrik Sørnsen, different subjects are chosen. These are given a score from one to three, to create a common starting point for the concept generation.

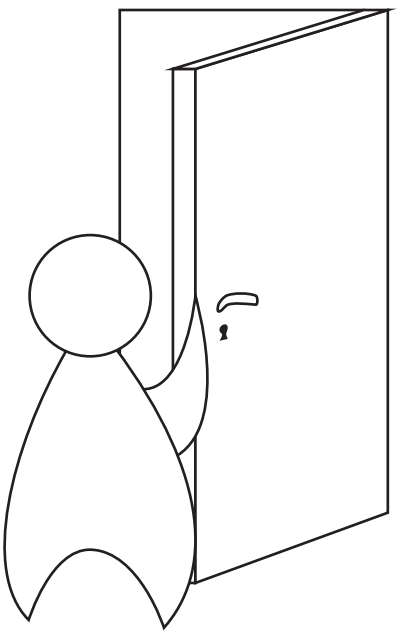


Fig. 8: delimitation

Delimitations

Because of the limited time, it is chosen to make a few delimitations:

- Electronics
- Flight case
- Packaging

Weighting

To get an overview of the elements and their importance, a diagram is made. The elements are based on information from Martin and user research. It is found that there are two target groups in this project: the buyer and the end user. It is therefor decided to divide the elements into the two groups, to see for whom the elements has an influence. The elements are divided into 3 levels, where 3 is the lowest and the one with least influence.

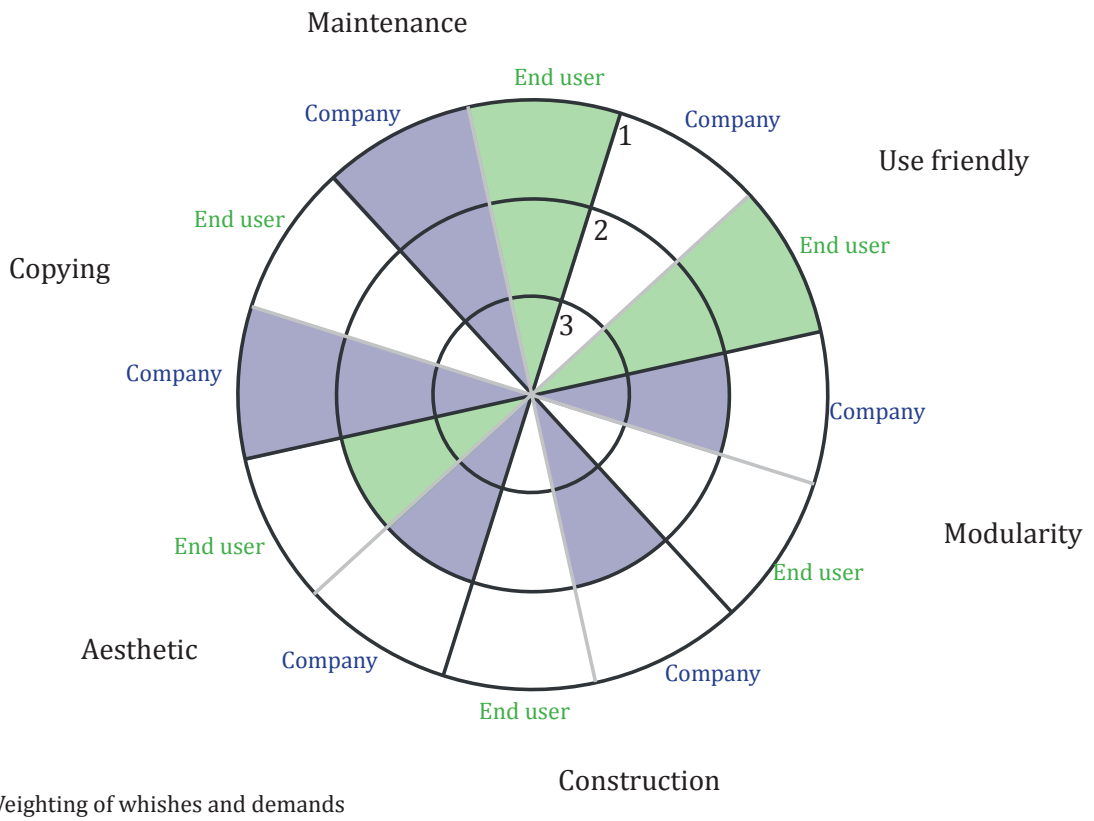


Fig. 9: Weighting of whishes and demands

User friendly: The product must be easy to use, and understandable for the majority.
Maintenance: Easy access to the parts which needs maintenance and replacement.
Copying: Making sure that the concentrate container cannot be copied or refilled by the users.
Modularity: Ability to make different sizes of the tank and the whole construction.
Construction: Flow calculations and production methods.
Aesthetic: The outer look of the product.

BACKGROUND

Three types of smoke machines

A fog machine is common nowadays, and is often used to provide special effects for concerts and TV shows.
There are three types of fog machines

Fog: Normal fog is the most common, and known from e.g. concerts and night club, and appears like a thick smoke. The fog is made by a special fluid which vaporise when being pumped into a heater. This creates a dense fog.

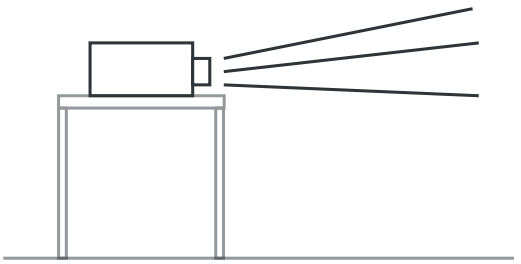


Fig. 10: Fog machine

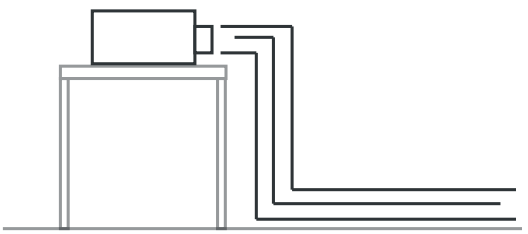


Fig. 11: Low fog machine

Low fog: Low fog is often used at concerts and night clubs, and is an effect in itself. As the name imply low fog moves along the floor, looking like a cloud, and disappears as it floats upward. The effect is created by cooling down the fog, and the most common is to use CO2 or dry ice, to this.

Haze: This type of effect is different. It is an invisible mist, that is used to enhance the effect of the light. The haze consist of small particles which light up when hit by a light beam. This make it possible to see the light beam.
The most common way to create the haze is to use a heater, as in a fog machine or to use a compressor to vaporise the fluid

[Web 3] & [Web 4]

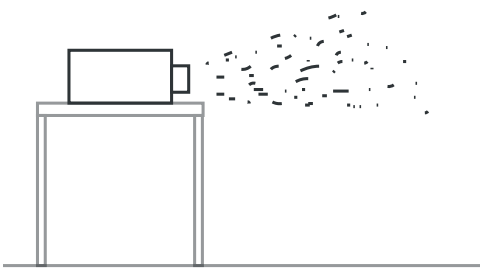


Fig. 12: Haze machine

Haze

Within haze there are three different types of machines: a machine using a compressor, one using a heat exchanger, and one with transducers. The most common machine is the one using a heater.

Fig. 13: Compressor

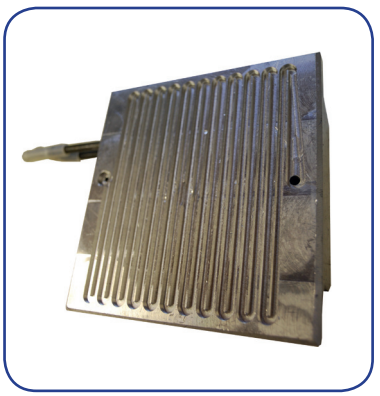


Fig. 14: Heat exchanger

Fig. 15: Transducer

The machine for this project is built on an ultrasonic hazer machine, which uses transducers. The transducers must be covered with hazer fluid to create the misty effect. The ultrasonic hazer is known for a better haze because of the small particles which gives a uniform haze.

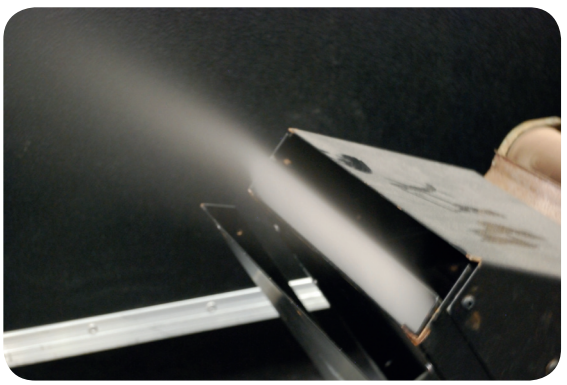


Fig. 16: Haze, HOT 2000

Fig. 17: Light effect in haze

COMPANY ANALYSIS

Martin Professional

When Martin Professional A/S was founded in 1987, they were primarily producing disco lights and fog machines, with the first experiments made in a basement with a coffee machine. Today Martin offers a complete entertainment package with their intelligent light, Mach speaker system and Jem smoke machines.

Martin has a wide range of customers, from the local DJ, to theatre, and big concerts halls, and distributors and local partners in nearly 100 countries worldwide.

The company's headquarter is placed in Aarhus, and consist of Martin Entertainment and Martin Architectural, and manufacturing in Frederikshavn, Denmark, and in Louth, UK. [Web 5]

FACTS

1987: Founded by Peter Johansen
1998: Kristian Kolding takes over as CEO,
and Martin Group A/S enters the exterior architectural lighting market.
2000: The Danish private company Schouw & Co. buys the company.
2001: World leading producer of intelligent light
2005: New CEO Christian Engsted
2006. Moves into LED lighting
2009: Online eShop for business
[Web 6]

MISSION

"...to understand, inspire, and enable customers to develop attractive environments and create excitement through the use of dynamic light and visual effects" [Web 7]

VISION

" ...strive to be the obvious choice for the globale professional lighting market. We add value through superior quality, industry-leading competences, full accountability and die-hard dedication to our customers." [Web 7]

To understand Martin, and the background for a new design, there is looked at different elements that affect the company and their products, along with competitive products.
The results are shown in two diagrams; SWOT and Porter's Five Forces.

SWOT

The SWOT-analysis gives an overview of the company's internal strengths, weaknesses, external opportunities, and threats. This analysis can help to find a company's competitive position and strategic options.

The aim is to take advantage of the strengths and minimise the weaknesses by making them into opportunities. [Web 8]

Strength

- Good reputation/brand and loyal customers
- High quality
- 24 hours support
- Long experience with smoke
- Efficient fluid plant
- Recognizable design

Weaknesses

- High price-tag
- Organisation is split
- Never made it on the haze- and smoke market
- Older styling

Opportunities

- New marked areas
- Larger market share
- New technology/products
- Safety minded customers (less chemicals)
- New design
- Restructuring providing a better company structure

Threats

- General opinion against smoke and haze
- Competitors overtake market share
- Economic instability
- Copy cats

Fig. 18: SWOT analysis

Porters Five

Porter's Five Forces is a framework, which can help a company outline their competitive situation and profitability.
There are looked at five elements, which influence the balance of power in the market, and helps to point out where the company has power or weakness.
The model is used to get an understanding of Martin's current situation on the market and see which strategy to use, when developing a new product. [Web 9] &[Web 10]

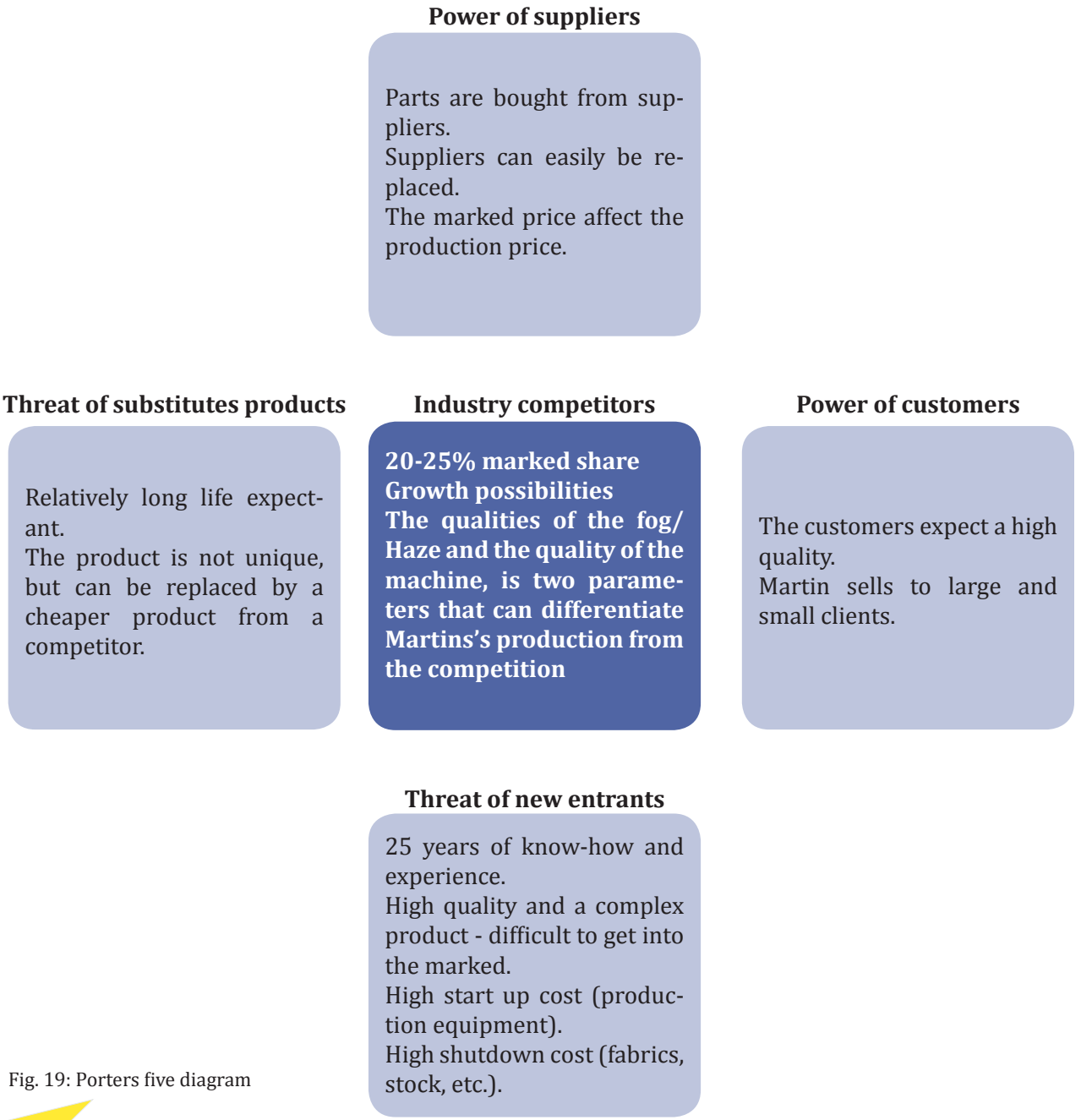


Fig. 19: Porters five diagram

Marked analyses

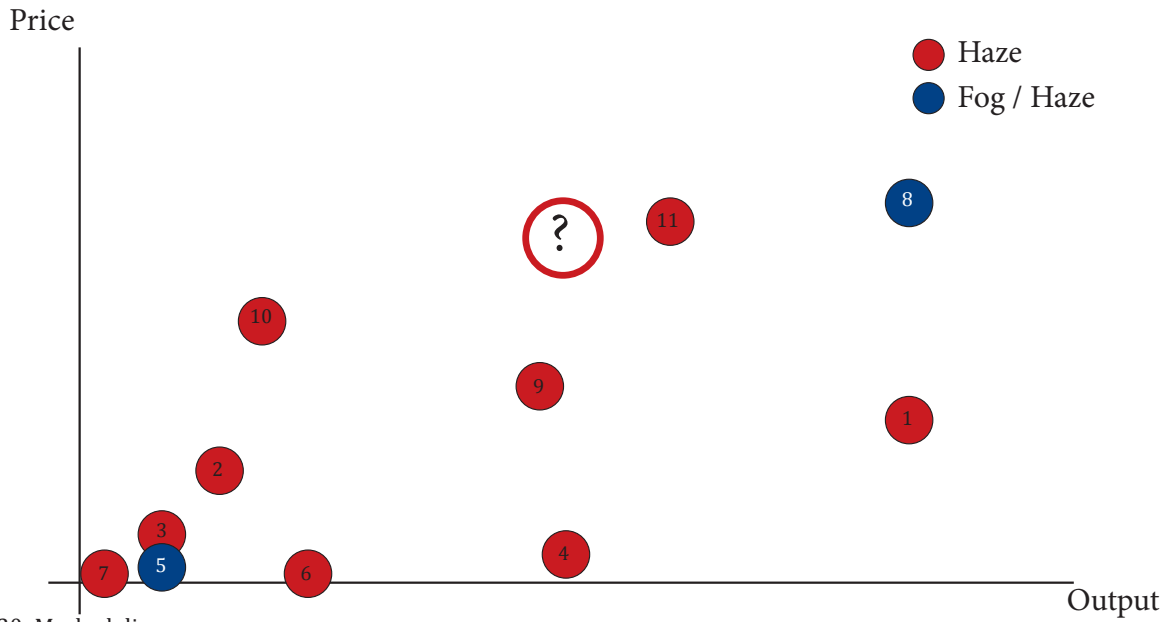


Fig. 20: Marked diagram

To get a better understanding of the marked and the competition, a marked analysis is made. The diagram shows where the new hazer is to be placed on the marked, marked by a question mark. The output for the hazer is unknown, from where the question mark.
The diagram shows that the hazer will be among the more expensive hazers on the marked, and with the wish of having the highest output. Being at the top of the price scale sets demands for the product, to make sure it lives up the price and more importantly the users expectations. The number refer to the images below. At each image some general information about the different machines is written for comparison.

1:
Martin Professional JEM-K1, 115V Hazer
Price: £1198.08, output: 5000 m3/min, weight: 21,5 kg,
Size: 544x459x344 mm, Warm-up time (approx.): 5 minutes
Fluid capacity: 2,5 litre, Fluid consumption at peak output: 140 ml per hour
[Web 11]

2:
Antari Lighting & Effects HZ-500, Haze Machine, Touring Class
Price: £1132.88, Output: 79.3 m3/min., weight: 31.5 kg,
Size: 510 x 375 x 350 mm, Noise: below 70dB at 10cm distance,
Air Pressure: 30 psi, no heat up time, Fluid Tank Capacity: 2.5L,
Fluid Consumption Rate: +20 hours/per liter
[Web 12]

Fig. 21: Competitors

3:
Antari Lighting & Effects HZ-300, Haze Machine, DMX
Price: £443.02, Output: 56.6 m3/min, Weight: 14kg, Size: 502x299x235mm,
Tank Capacity: 2.5 liters, Fluid Consumption Rate: 21 hr/liter,
Air Pressure: 30 Psi, no heat up time
[Web 13]

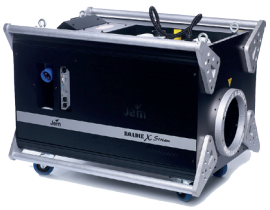
4:
Martin Professional MAGNUM-2500, Haze Machine
Price: £342.34, Output: 2500 m^3/min, Fluid capacity: 3.8 liter,
Fluid consumption at peak output: 10.5 ml/min, Warm-up time: 6 - 8 min
[Web 14]& [Web 15]

5:
Antari Lighting & Effects Z-300II, 700W Fogger/Hazer Combo
Price: £246.79, Output: 56.6 m3/min.
Warm-up Time: 4 minutes, Tank Capacity: 1.3 liters
[Web 16]

6:
Omnisistem Hazer 900 Plus - DMX Haze Machine
Price: £195.5, Output: 339.8 m3/Min, Weight: 7.3kg,
Size: 470x235x 229mm, Warm-up time: 2-3min, Tank capacity: 1.2 l
[Web 17]

7:
Chauvet Hurricane Haze 2D
Price: £189.8, Output: 34 m3/min, weight: 8.5 kg,
Size: 285 x 267 x 350 mm, Heat-up time: 5 min, Tank Capacity: 2.5 L,
Fluid consumption: 8.2 ml/min
[Web 18]

Fig. 21: Competitors



8:
Martin Jem Roadie X-Stream, Fog/Haze
Price: £5622.55, Output: 5000 m^3/min Size: 1140x645x655mm
Weight: 167kg, Heat-up time: 18 min, Fluid capacity: 2 x 9.5 liter,
Fluid consumption at peak output: 500 ml per minute
[Web 19]& [Web 20]

9:
Swefog, XEON II intellahazer, haze machine
Price: £1,500.48, Output: 2,500 m3 / minute, Size: 650 x 203 x 430 mm,
Weight: 21.2 kg, Heat-up time: 7 minutes, Fluid capacity: 5L,
Fluid consumption: 0 - 17.5ml / min (1,050 ml/h max)
[Web 21]& [Web 22]

10:
Robe, HAZE 500 FT PRO™
price: £1710.63, Output: 85 m3/min, Size:490x351x338mm, Weight: 31.5 kg
Air Pressure: 30 Psi, no heat up time, Fluid Tank Capacity: 2.5 liters
Fluid Consumption Rate: +20 hours continuous work/per liter
[Web 23]& [Web 24]

11:
MDG Atmosphere Haze Generator High Output
Price: £5,048.00, Tank capacity: 6.5l, Blowing agent: CO^2-gas
Size: 280x320x740 mm, Weight: 31 kg without fluid, Output: ?
[Web 25]& [Web 26]

Fig. 21: Competitors

Subject conclusion

Martin is world leading in light solutions, but has not been able to become generally accepted on the smoke- and haze marked yet. For a company as big as Martin it is important to listen to their customers and their comments and wishes, and follow the trends of the time.
Martin is at the moment going through a re-organization within strategy and production, where they are closing the factory in China, and moving the work to Denmark and UK.
The new Hazer, Ghost, is an opportunity for Martin to take over the smoke- and hazer marked.

VISIT IN UK

Jem Factory

To get a better understanding of the product and the company, a trip to the factory in Louth, UK, is arranged. 12 days in Louth gave an insight of the manufacturing at the factory, the difference between the hydrosonic and a traditional hazer, and an idea of what to take into consideration for the design.

The first day at the factory involved a tour around the factory. During the tour at the factory it became clear, that all most everything is done by hand; the heater for the smoke machines is moulded by hand, the dressing of the heater, the wires, and the machines are assembled by hand. Furthermore all machines are tested before leaving the factory, to insure the Martin quality. This results in a factory covered in smoke every thursday.

During the stay the group was introduced to Nick Scully, Head of research and Development department and the one behind the hydrosonic, and Michael Dixon, from the Research and Development department, who stands for construction and the 3D modelling of the machines. During the stay, Nick gave an explanation of the hydrosonic and the difference between a traditional hazer and the "new" hydresonic machine. He explained the problems with the old machine, and discussed the possibilities for the machine, with the group.

At the factory different hazer's and smoke machines were shown, to illustrate the difference in the output and effect, and to explain how the machines works.

Fig. 22: Tour at Jem Factory

Fig. 23: Test at Jem Factory

Fig. 24: Introduction at Jem Factory

Bullet

During the stay, the group visits Bullet, the main sup supplier for the factory in Louth. Bullet is a small local, family owned business, who makes the casing for the different smoke machines.
At Bullet they do all most anything in sheet metal; bending, cutting, and welding. They can make square and round objects, but round objects are made by hand, whereas the bending is made by a machine.
When the sheet metal arrives at Bullet, it is cut by a machine, using a punching stamp to cut though the metal. Afterwards the metal is bend, and screws and bolts are fastened on the piece, if this is needed. The parts are welded together, and if the piece is to be painted, it is send to the painter, before going to Martin.

Fig. 25: Tour at Bullet

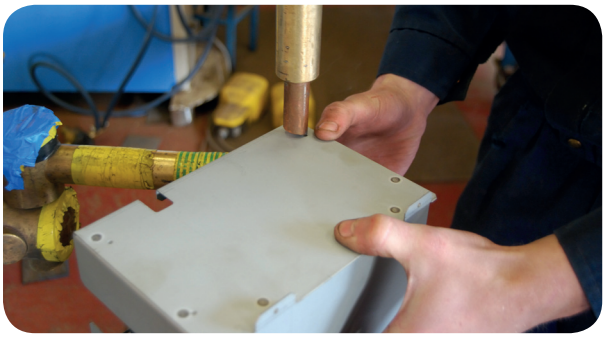


Fig. 26: Tour at Bullet

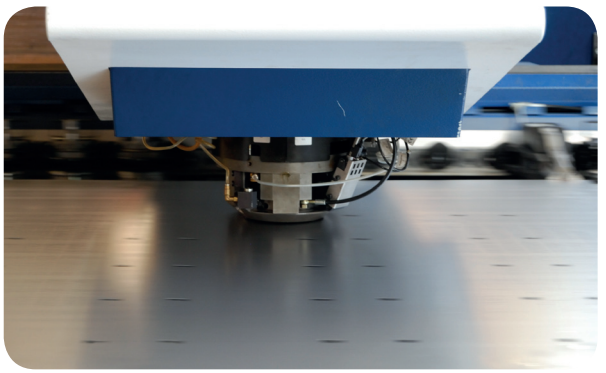


Fig. 27: Tour at Bullet

Subject conclusion

The tour to the Jem factory and Bullet in UK, has given the group an understanding of smoke machines in general. This information will be used in the design process.

MY LIFE AS A SMOKE MACHINE

To illustrate the workflow at Martin Manufactory UK (MMUK), a general description of how a fog/haze machine is assembled, in form of a short cartoon, is made. Some parts are made by sup-suppliers and some at the factory. An overview of the factory shows, the different work areas are marked by numbers.

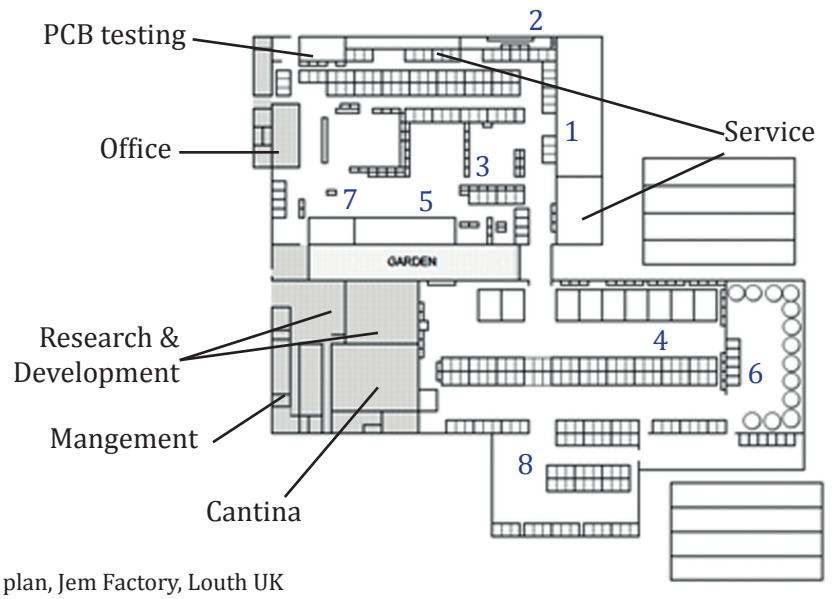


Fig. 28: Ground plan, Jem Factory, Louth UK

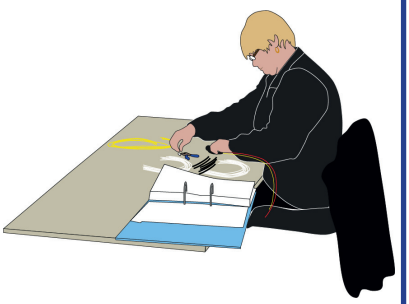
1

Aluminium is cast around a coil made out of copper or steel. There is drilled into the block to attache a thermal couple, which is used to measures the temperature of the block.

2

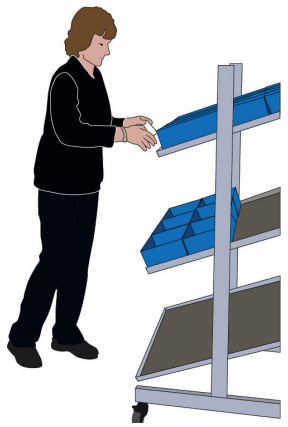
The block is now dressed in isolation, and becomes a heat exchanger. Most heat exchangers consist of an outer frame made of metal, insulation and the aluminium block.

3



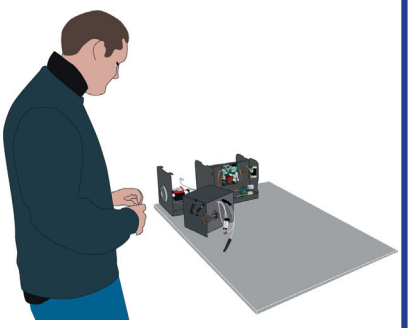
At the same time, wires are produced. MMUK produces its own wires. The wires are mostly made by order.

4



All parts for a certain machine are gathered in a kit. These kits are prepared in the kitting department, where they are stored and picked, according to the production plan.

5

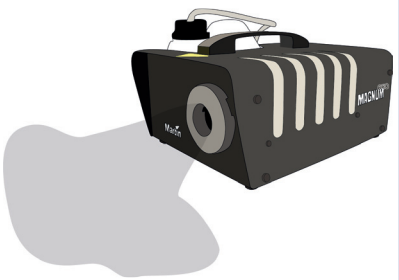


The kit is sendt to main assembly, where the builders manually put the machines together. They only need to stock their bench up with screws, taptites, cables ties etc., all remaining parts will arrive in boxes from the kitting department.

6

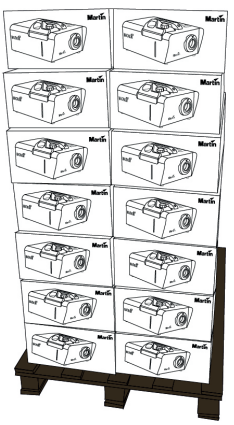
At the fluid department, the bottles are labelled and filled with fluid. The screw lid is tightened and the bottles are packed in boxes for shipping.

7



Before any fog machine dispatches from MMUK, it has to undergo several tests to ensure that the product carries the required standard.

8



The machines are packed and stacked on pallets. If a dealer or Martin subsidiary orders an entire container, the shipment is made directly from MMUK.

9

The machine ends at the end-user, and is ready for use.

Fig. 29: My life as a smoke machine

PRODUCT ANALYSIS

Three Martin products

To get a better understanding of the Martin products, and in order to find out what is needed on a haze machine, three machines are analysed.

Magnum 2500 Hz

Fig. 30: Magnum 2500

W455mm x D285mm x H280mm

- Plug-and-play
- Optional DMX
- 900W heat exchanger
- Integrated fan
- Continuos output
- Output and density level control
- Fluid-out sensing
- Timer and output level remote control
- Orientation: floor

Jem K1 Hazer

Fig. 31: Jem K1 Hazer

W544mm x D459mm x H344mm

- Service ease
- DMX; 3 and 5 pins
- Low fluid consumption and long hang-time
- 600W heat exchanger
- Integrated fan
- Continuos output
- Output and density level control
- Automated shut-down
- Timer and output level remote control
- Orientation: floor or flying kit

Roadie Compact

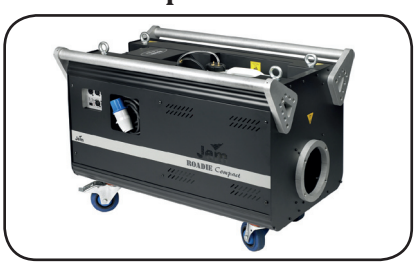


Fig. 32:Rodie Compact

W800mm x D500mm x H600mm

- DMX; 3 and 5 pins
- Preprogram stand-alone
- 2 x 1500W heat exchanger
- Integrated fan
- Continuos output
- Output and density level control
- Low fluid sensing
- Different fluid option for different applications
- Orientation: floor (horizontal or vertical)or flying kit

[Product guide, vol. 10]

General specifications

Machine	Weight kg	Output m^3/min	Fluid con. - peak output ml/min	Operation time, full output min.	Warm-up time min.	Fluid capacity l.
Magnum 2500 Hz	11,9	2500	10,5	?	7	3,8
Jem K1 Hazer	21,5	5000	2,33	17	5	2,5
Rodie Com-pact	80	2500	220	90	9	9,5

DNA of Martin smoke and haze machines

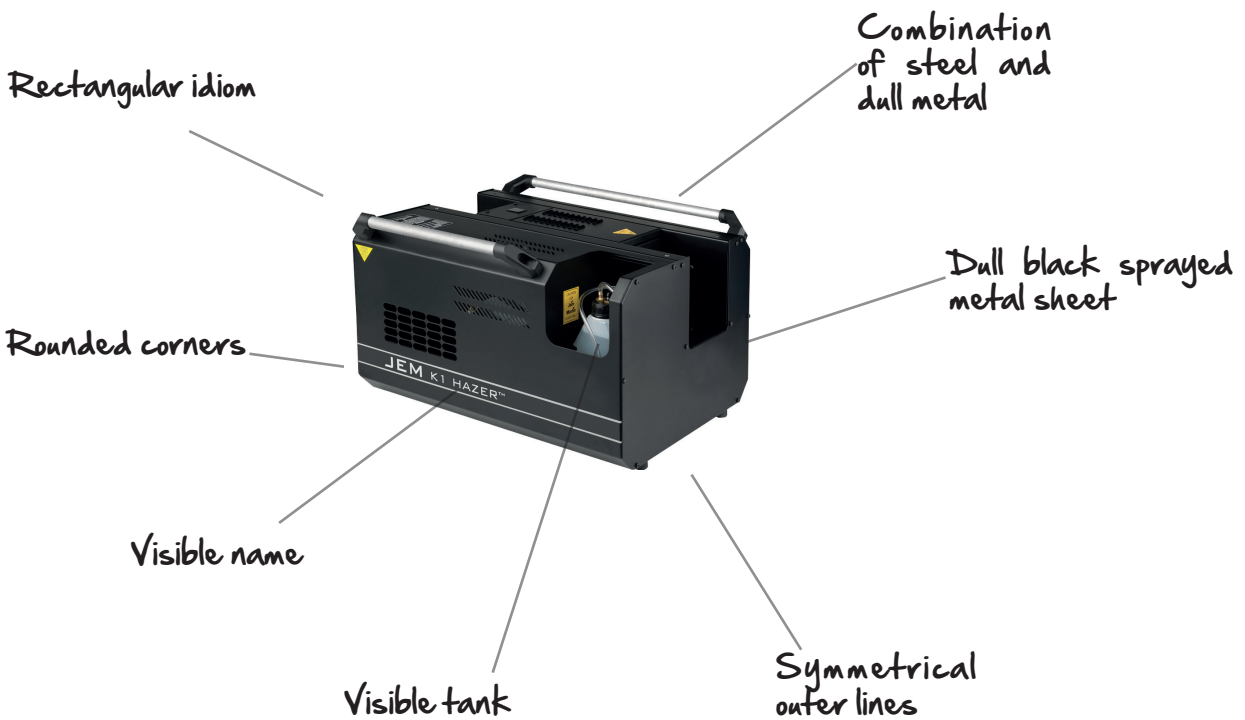


Fig. 33: Jem K1 Hazer

Hydrosonic

The project is based on an older version of the hydrosonic Hot 2000, which was made in 1995, but never became generally accepted. The Hot 2000 was the reason why Martin bought the Jem factory, but based on different elements, the Hot 2000 it did not come out as planned.

The Hot 2000 is still to be found today, at universities where they are used for wind tunnels. There are a few problems with the Hot 2000 such as a complicated user menu and problems with emptying out the fluid when turned off.

Fig. 34: Hot 2000, old hazer

Overview of the Hot 2000

Tank: with transducers (that create the haze) and fluid
Fan: a fan for dividing the haze in the room.
Fluid tank: a water based fluid that is pumped into the tank.
General electronics.

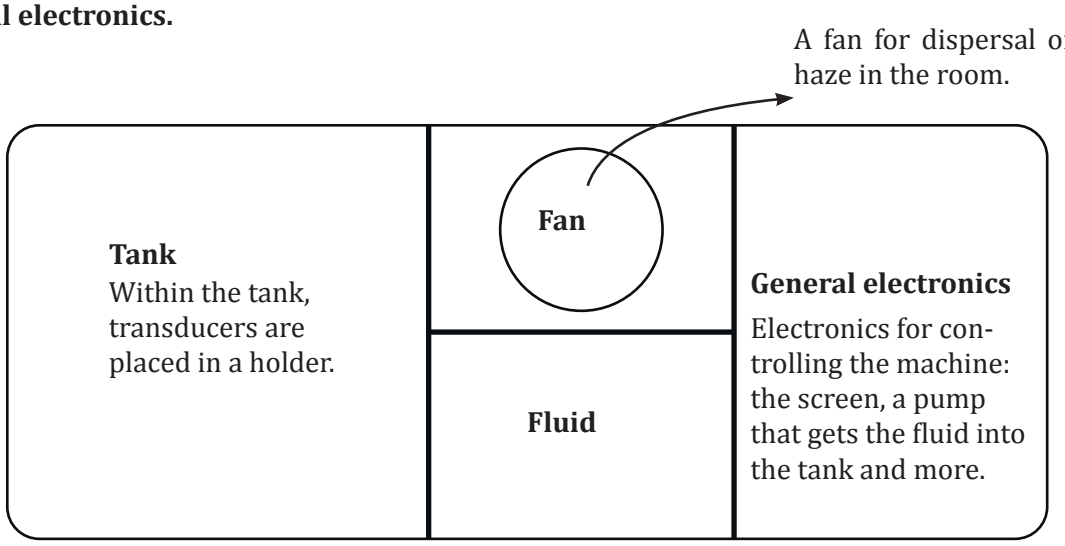


Fig. 35: Overview of Hot 2000, old hazer

Overview of Ghost

The new hazer is build on top of the old machines principles. But there are some differences. In the old machine there was only used one fluid tank, since most of the fluid was water. This meant that a lot of water was transported around. In the new machine there is only a concentrate tank, and water is added at the place. Because of this there is needed a tank for concentration, a water tank, a tank with transducers, and a sump tank to empty out the fluid in, when the machine is turned off.

The old machine had one tank with 24 transducers, which meant, that if a smaller or bigger machine was needed, a new tank and PCB should be produced. This is to be changed in the new hazer, the machine is build on a modular system, where more tanks can be added or removed, depending on the size of machine that is wanted. Also the PCB for the transducers is to be placed on the tank with the transducers.

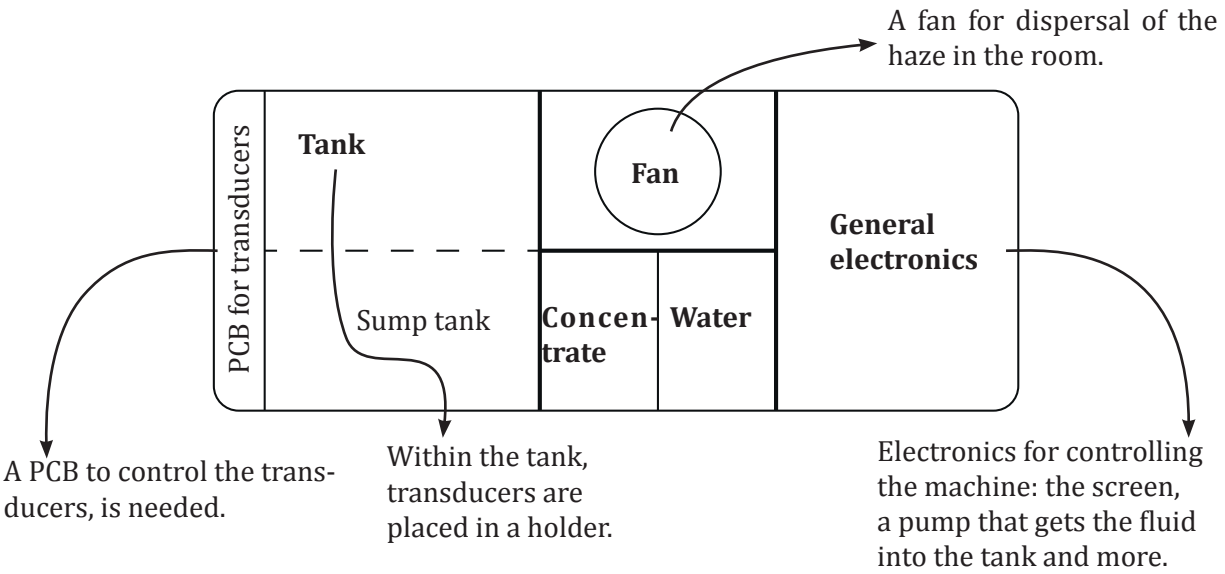
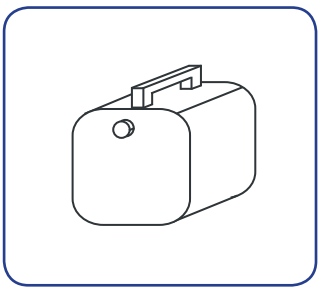


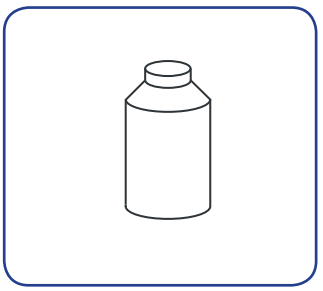
Fig. 36: Overview of new Hydrosonic

Components in Ghost

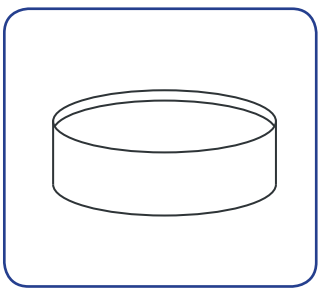
The Ghost has 8 general components which must be arranged in connection with each other and full fill the demands there might be for the individual component



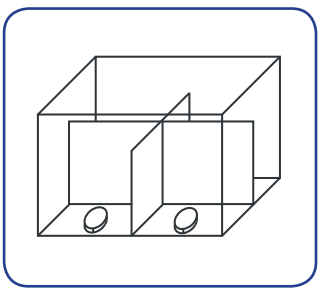
Water tank



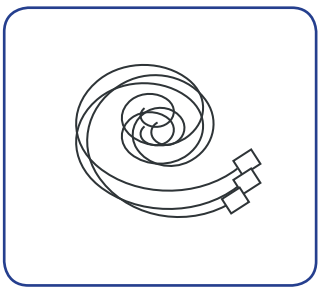
Concentrate container



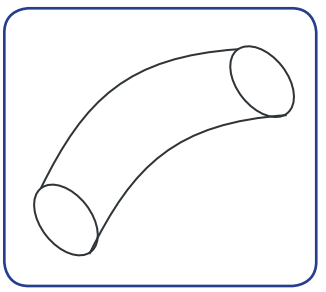
Sump tank



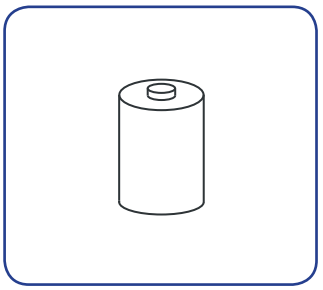
Main tank



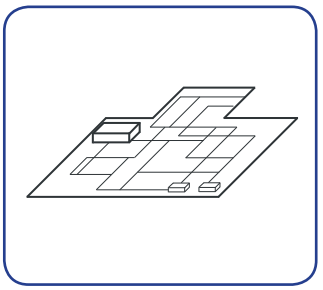
Wire



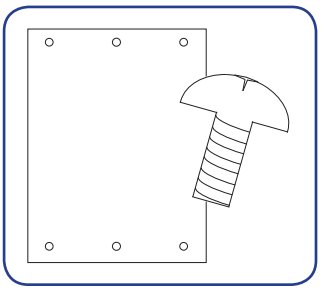
Tubes



Battery



PCB



Screws and plates

Fig. 37: Components of the Ghost

At the visit in Louth, it was explained how the new hazer functions.

Compared to a traditional hazer, which heat up the fluid, like a smoke machine, the Hydrosonic has a transducer (a small metal plate), which moves up and down, and hereby generates small waves in the fluid. One large wave is generated, with small uniformed waves at the neck. The haze emerge when the top of the waves breaks off, similar to what happens in the sea, when waves breaks off and scum appear

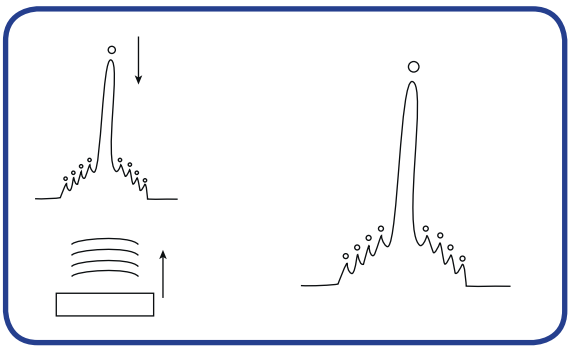


Fig. 38: Waves generated by transducer

The haze consist of small and large particles, which has to be separated. To separate these, the haze goes through an air tunnel which is shaped in a way, so the large particles will drop down a shaft, where the small particles will drift with the air flow and continue up and out of the machine.
The large particles will fall back into the tank with fluid.
A fan is needed to divide the haze in the room, so the haze will not just drift around the machine.

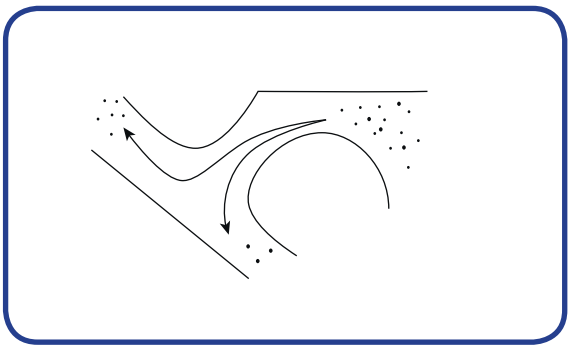


Fig. 39: Sorting water particles

Each transducer has to be controlled individually, because they run on slightly different frequency, which makes it ideal for a modular system. One tank contains a number of transducers, and one PCB for control. If a bigger machine is needed, more tanks are added. This is more efficient than making a new PCB and tank, if you want a larger or smaller machine.

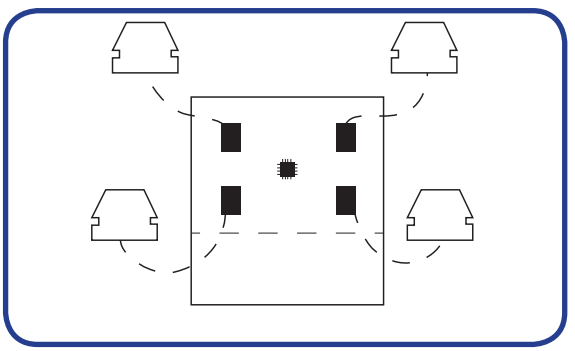


Fig. 40: Contact between transducers and PCB

For the machine to work properly, the transducers has to be covered by 25mm fluid. This can be achieved in different ways, but based on discussion with Nick Sculler, from Jem factory in Louth, it is chosen to make a tank where fluid is constantly poured into, so it creates an overflow. The overflow goes into a sump tank, and is pumped back into the tank. As the fluid is pumped back into the tank the concentration level is measured, and more water or concentrate is added.

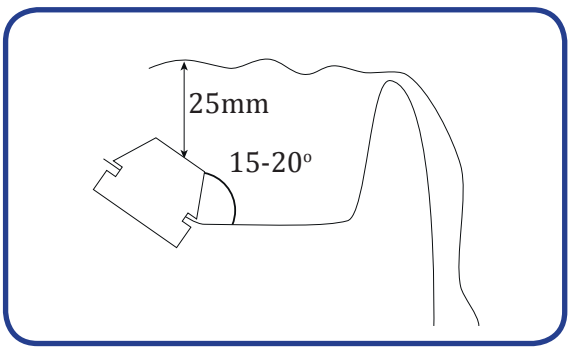


Fig. 41: Placement of transducers

The fluid that goes into the machine consist of water and a concentrate. Therefor two containers are needed; a water tank, and a container for concentrate. When the machine is turned off, all fluid must be emptied out, to prevent possible leak into the electronics, when the machine is moved around. A sump tank is therefore needed to contain the fluid.
With the fluid in the sump tank between use, bacteria growth may be a problem. To handle this, a HINS – light could be a solution. HINS – light have a wave length on 405nm and this starts a chemical process in the bacteria thereby cursing it to self-destruct. Exposure to HINS light reduces the bacteria level 56-86 % depending on the length of exposure. This type of light is harmless for humans. (Appendix B) [Web 27]

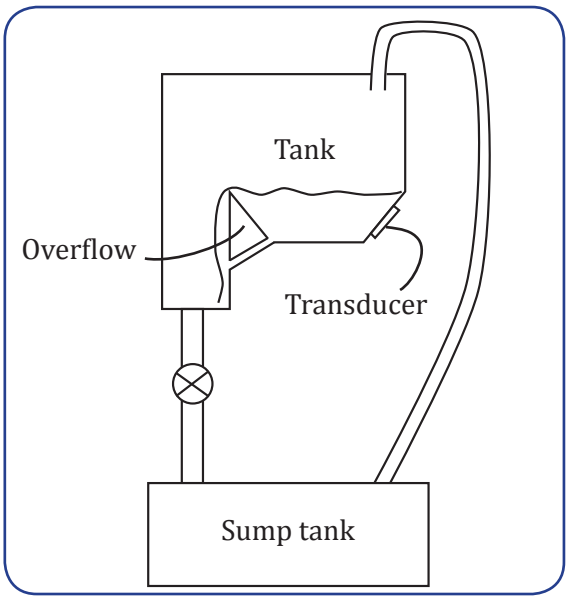


Fig. 42: Water- and concentrate tank

To insure that the machine works properly, a battery is needed, to allow the machine to shutdown properly. This allows the machine to empty the tank, even though the power is cutoff, thereby extending the lifetime of the machine.

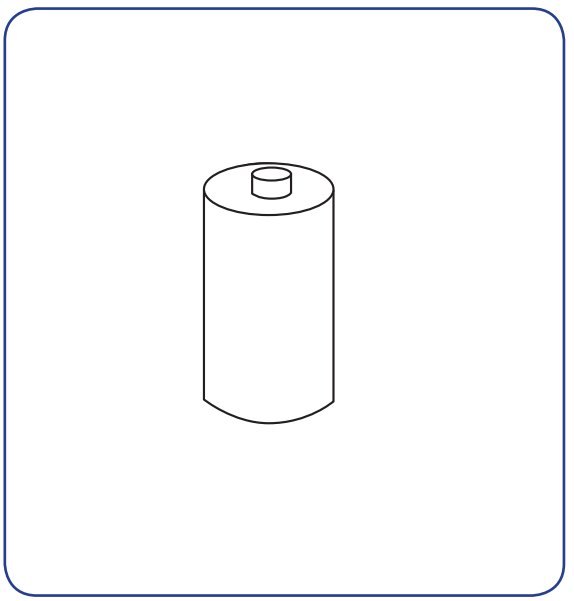


Fig. 43: Battery

Subject conclusion

The trip to the Jem factory, UK, has given the group information and knowledge about the technology behind the hazer. This knowledge will be used in the design of the new hazer. Furthermore the trip gave the group the opportunity to discuss the first ideas with Nick Scully.

Todays issues

There are looked at Martins exciting products and the issues there might be with some of them. There are not many problems with Martin products, because they solve the problems as they show. There are found issues from the everyday use and problems discovered in connection with a service.

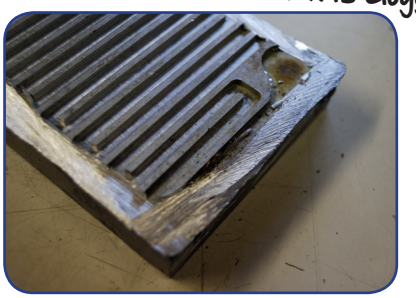
Complicated user menu

When moving the hazer, the tube will get in the way.

Must be lifted manually to get all the fluid out of the tank

Scratches on a Glaciator

A heating element which is clogged up



Collecting dust

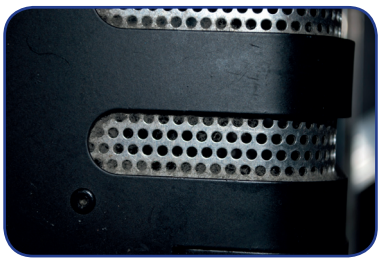


Fig. 44: Issues of today

Classic characteristic

To get as close as possible to a timeless design, there are looked at known classics characteristic.

Few colours

Simple design

Geometrical element

Fig. 45: Classic furniture

Subject conclusion

Based on the product analysis there are found some general design elements and characteristics about Martin products. These will be used in the concept development for the new Hydrosonic.

To understand the product and the needs, it is important to understand the environment that it is used in.

Target group

When an artist and his crew are planning a tour, they contact a company, e.g. Live Nation, who is going to handle the different concerts in e.g. Denmark. The light- and sound crew has very specific demands and wishes for a concert, which they pass on to Live Nation. Live Nation makes a competitive bidding, allowing different companies to make an offer on the different jobs at the concert, such as; setting up the scene, taking down the scene, setting up the light and so on. A company like Nordic makes an offer on rent and installation of light and smoke machines. If they get the job, they will lend the equipment to Live Nation for the tour, and install the light and smoke machines.
The equipment gets transported to the different concert places in a truck, tightly packed. When the truck arrives at the concert place the equipment is unloaded and put up by "hands", guided by the technicians. The "hands" are people hired for that specific job, and they are often without experiences, and sometime even without interest in the job. When the scene and light is put up, the artist and his crew take over and control the light and smoke machines, during the concert. When the concert is over, everything is taken down again, by the "hands".

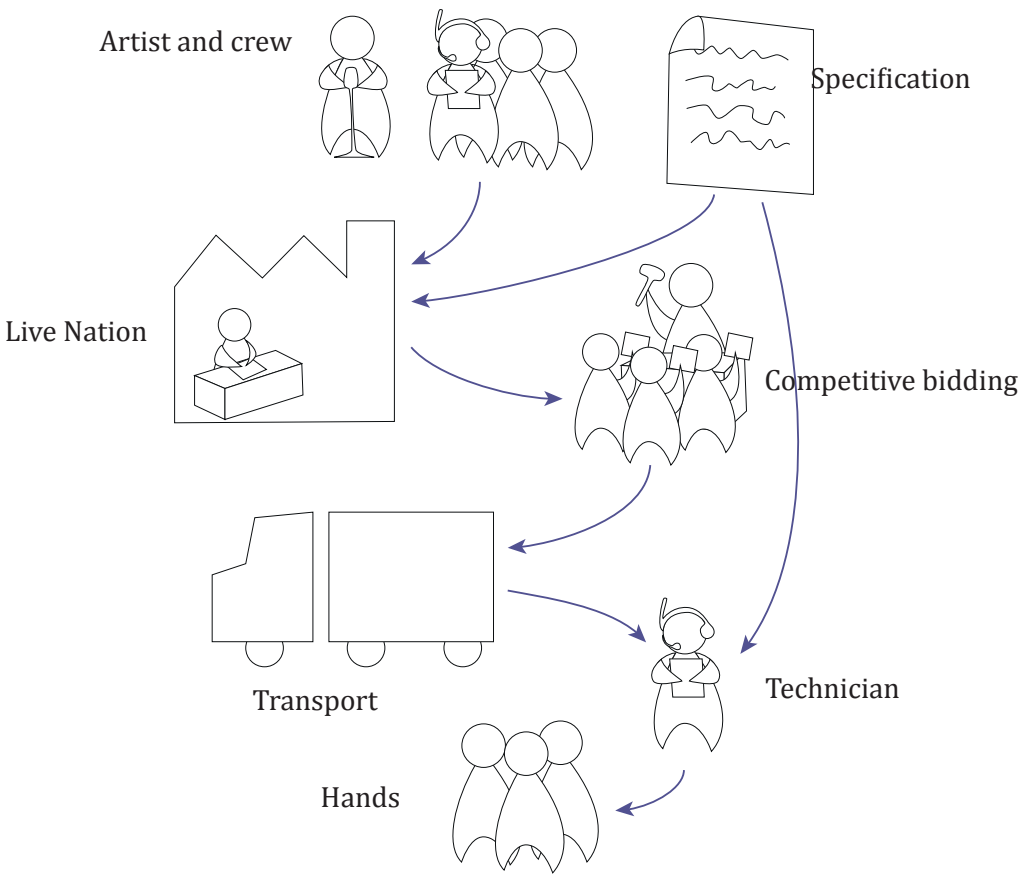


Fig. 46: Planning of a tour

During the concert the smoke machines are controlled by the light-man, who is placed in the back of the concert place. If the smoke machines need refilling during the show, the light man will by radio contact the man on 'damper guard', so he can change the liquid in the smoke machines.
All in all the equipment is handled by a lot of different people, and rarely the same people twice.

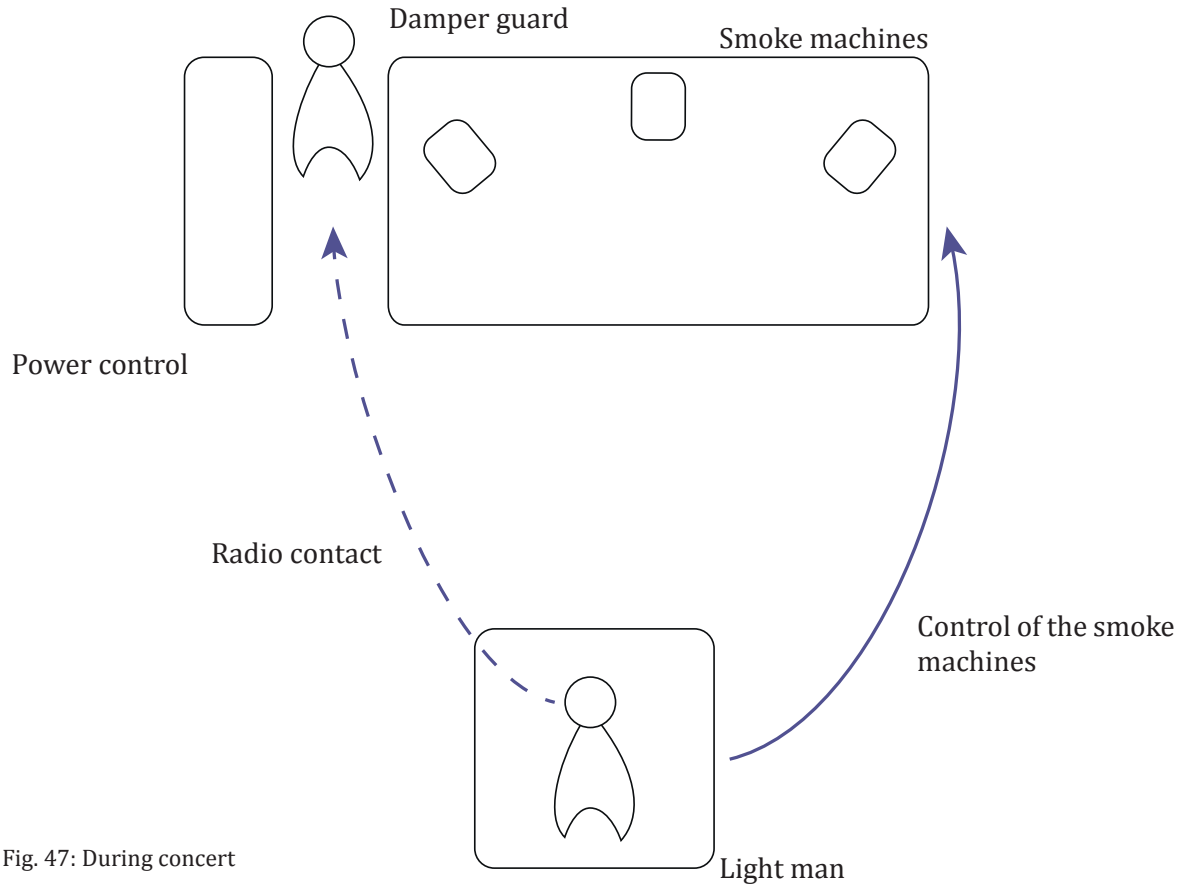


Fig. 47: During concert

The people handling the equipment are in most cases not the owner. This means, that the people handling and sometime using the equipment, may not have the interest of care, as if it was their own. Therefore the machines must be able to withstand bumps, drops and misuse.
From this it is found, that the buyer and the end-user are two different groups of people.

The buyer
A company arranging concerts. In this scenario the target group is Nordic, they own the equipment and rent to concerts and shows.

The end-users
The people installing the equipment, the light-man, that control the machine and the man on 'damper guard', that changes the liquid in the machines and make sure that they work during a show/concert.

Actors map

To get a overview of how many different people there are in contact with the Hydrosonic, an actors map is made, where all the involved people are shown.

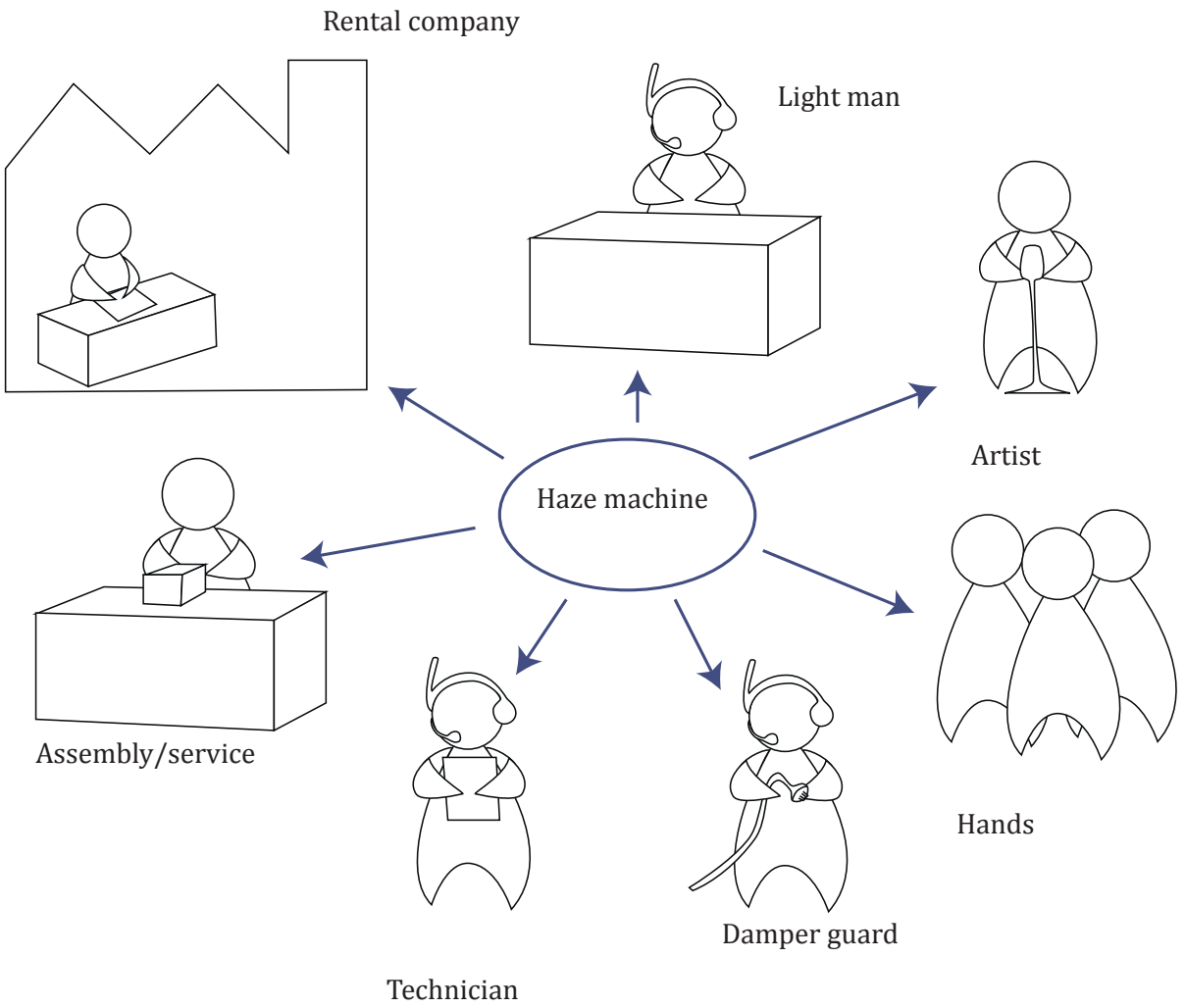


Fig. 48: Actors map

To get an idea and understanding of the handling with smoke machines, user research is made. Nordic is contacted to find out their demands for a product. They tell, that they buy the products that their customers wants, and therefore the user-research is with focus on the end-user.
Interviews is made with three different users; a private DJ, sound-and light technician and a medium size rental company, which help set up the equipment. All users are asked what they like and dislike, with the machines they use today, and what they feel they are missing, to make their job

SoundSpec Aps, private DJ

easier.
Søren Christiansen, owner of SoundSpec Aps, has been a DJ and had his mobile discotheque for three years. He started out with help from his father, who still takes part in some jobs. In 2011 he turned his company into an Aps. company.
Beside his part-time job as DJ, Søren is half way through his education as event technician (Light - technician), at EUC Nord, Frederikshavn.
The group visits Søren on a Friday evening at Frederikshavn Gymnasium, where he is playing at their school dance. He, and two helpers, uses three hours to put up the light, sound, and smoke machines for the party. He gives an introduction to his two smoke machines; a fog machine and a hazer, and tells what he see as pros and cons with the two machines.
The group investigates the hazer; gets a closer look at the elements, tries to move it around, start it, and watch it in action.
During Sørens internship he has been to larger concerts, theatre and TV-shows to help setting up the equipment, including smoke machines.
Hereby he has a qualified opinion on smoke machine, from two sides; the private user, with hands on, and the technician, who delegate the job.
He has some very interesting thoughts about, what he thinks is a must on a smoke machine, the handling, design and much more.


Fig. 49: Interview with Søren Christense

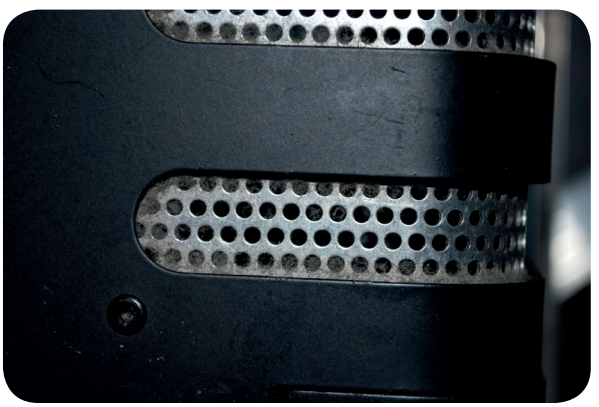


Fig. 50: Dust stored up at the air pocket

Wishes and advice

- The fan and output must be controllable as a minimum.
- An easy clean product - The hazer consist of an open circuit, whereby dust settle on the components.
- An idea to use a powercon plug, but not a must.
- For a permanent installation the design is important.

Aalborg Kongres og Kultur Center- Sound and light technician

Aalborg Kongres og Kultur Center is one of the biggest conference- and culture centre in Scandinavia. On a yearly basic the centre has more than half a million guests, for Music and theatre, mass, exhibitions, meetings, and conferences. They have more than 100 big theatre- and music arrangement a year. [Web 28]

For the big concerts, the artist often brings their own equipment, but for theatres it is the centre who is in charge of light and smoke. One of the people in charge is light technician, Hans Jørn Foght Hansen, who gives a tour around the storage room of Aalborg Kongres og Kultur Center talked the group through a normal procedure, of setting up equipment, including smoke machines, for a concert.

The centre has four hazer machines from Le Maitre. Before a show they place two hazers on the scene, one in each side, which is started two hours before a show, to make sure the room is filled with haze. During the show they start the machines every once in a while, to re-fill the room, and to ensure the optimal effect of lightning.

The hazer, at Aalborg Kongres og Kultur Center, is stored on shelves, without any kind of protection. In busy periods the machines can be placed on the floor for a while, so they do not have to lift them up on a shelve.

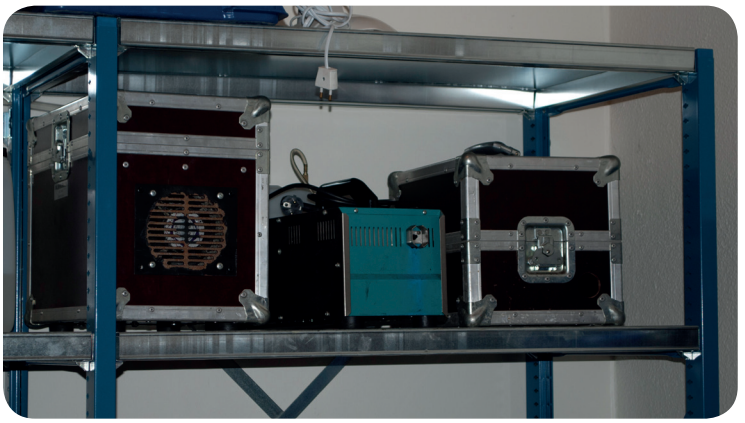


Fig. 51: Storage of old smoke machines

The Le Maitre, the haze machines the centre has today, is randomly chosen. They do not have any specifications to look for, when they buy a hazer, they mainly look at the price.

Fig. 52: Le Maitre Neutron XS

Whishes and advice

- Light weight
- Plug and play
- Easy to move around

Fi-Pa Sound, rental company

Fi-Pa Sound is a medium size company which rent out and set up equipment for concerts and festivals.
The company was established in 2002, by Finn Boysen and partner. In 2005 they started working with Nick Baade Pedersen who is a light designer, and take care of the light shows. The company only uses Martin light heads, because these are the most stabile lights on the marked.
Fi-Pa Sound has both smoke machines and hazers. They use smoke machines for the small concerts and hazers for the bigger concerts. When they arrive at a job they normally start up the smoke machines and hazer 2 – 3 hours before the show. But this is only to use the smoke/haze for testing the lights. If it is only to fill the room, it is not necessary with the smoke/hazer on for more than ½ an hour.


Fig. 53: Light effect at a concert

At an average show the machines are on for 8-10 hours, but are only used with effect/haze for 3-4 hours, the rest of the time they are on standby. When Fi-Pa Sound is on a festival, the equipment can be on for four days in a row. This is to avoid any moisture in the equipment.

Fig. 54: Light effect at a concert

Whishes and advice

- Control the fan - control of flow and possible noise
- Control of Output - concentration
- Prefer a double DMX - control flow and concentration
- Self-cleaning after use, and possible to empty out water
- Prefer the haze is send straight out, the possibility to change direction
- Prefer the display to be operated from the top, and turn off when not used
- Operational by everyone
- Show numbers of hours left on the transducers
- Able to turn in all directions when transported

Subject conclusion

There is looked at the people involved in a show/concert, before and during, and how the equipment is handled. This has led to some demands and whishes that can be used in the design process.

CONCLUSION

The research phase gives the group the needed information to start the design development.
There is made an analysis of Martins existing hazers; the issues there are today, and the design, which gave some criteria to follow. Through the research phase there is looked at the organization behind a concert, and the handling of the products in connection with a concert. Here it is found that the products is in the hands of many different people, and rarely the same person twice. This demand a durable product that can withstand misuse.

To get the full understanding of the hazer the group visits the JEM factory in UK. From the visit in Louth, general information is gathered, which is organised and illustrated in this phase. This will later be useful when designing and detailing the product.

Fig. 55: Jem factory Louth, UK

In connection with the handling of the products, there are made user research on different users: the small mobile DJ, SoundSpec Aps, the medium size rental company, Fi-Pa Sound, and Aalborg Kongres og Kultur Center. From the different users there are found elements which they would like to have, or change, compared with the existing hazer's on the marked. Furthermore there are talked about the design, and how the machine is placed on the scene, regarding the aesthetic aspect.

Based on the different interviews a list of parameters is made. These must be considered when designing the product.
The parameters are divided into demands and whishes. The demands are tangible, and have to be met by the product, the whishes are requests that would be nice to have, but do not need to be fulfilled.

MARTIN GROUP

Demands

- **Modular system**
- **The PCB for the transducers has to be placed on the tank.**
- **Transducers has to be placed at an angle (15-20 degrees)**
- **Plug & Play.**
- **Easy replacement of transducers**
- **A system to control and measure concentrate**
- **Sump tank for fluid storage**
- **2-3 line LCD, for diagnostic**
- **Visible logo**
- **A battery to allow the machine to shutdown properly**

Wishes

- **As small as possible**

USER

Demands

- **Must withstand bumps**
- **Easy change of fluid (a couple of minutes)**
- **DMX as standard equipment**
- **Control of output and fan**
- **Use without instructions**
- **As small as possible for easy transportation**

Wishes

- **Can tip over without breaking and spilling fluid**
- **As little handling as possible**
- **Use of power con jack**
- **As light at possible**
- **A pre-program for testing light**

CONCEPT DEVELOP-MENT

This chapter shows the design process and thoughts behind different ideas, which will end up with a final concept. The concept is detailed in the next chapter. There will be looked into the aesthetic design of the hazer, and the different components within the hazer.

OVERALL CONCEPTS

Before visiting the factory in UK three overall concepts was made, based on the interviews with the users.

The design should be incorporated into a flight case. Incorporating the machine in a flight case reduces the handling for the user.

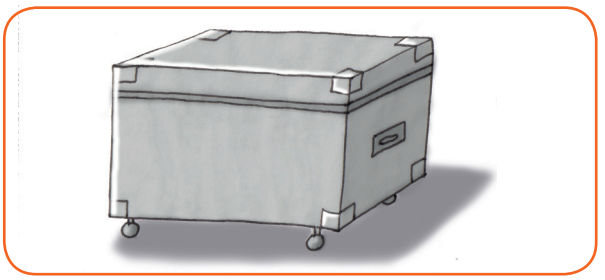


Fig. 56: Flight case

A design that can be used both outside and inside a flight case, making it up to the user if they want to take it out of the case.

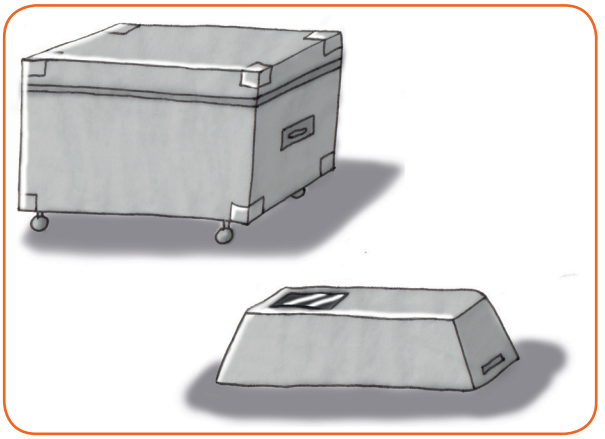


Fig. 57: Flight case and hazer

To focus only on the design of the machine, as it is done today.

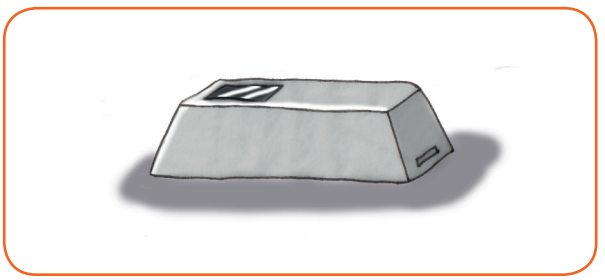


Fig. 58: Hazer

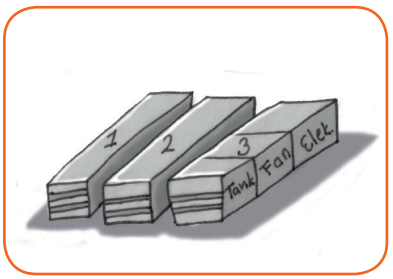
During the visit at Jem factory in Louth, UK, it became clear that Martin was looking for a completely new design. The new design is both the outer aesthetic and the placement of new components inside the machine.
It is chosen to look at the design of the machine, and not how it can be combined with a flight case.

To get started on the design some inspiration pictures is found. Some of the key words are luxury, and high class. Furthermore there is looked at the analyse of Martins own product and the classic's characteristic of furniture from the research phase.

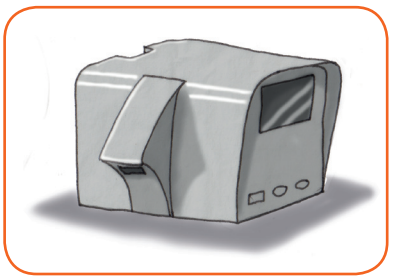
Fig. 59: Inspiration board

BRAINSTORM

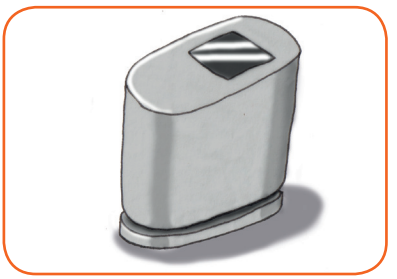
Based on the inspiration pictures and the research, a brainstorm on different ideas and shapes are made. This results in a lot of different ideas within function as well as expression on the haze machine. These are discussed and evaluated, and leads to a new sketching round.

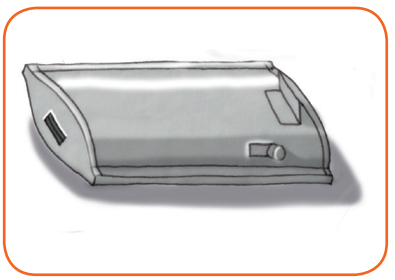


Modular system

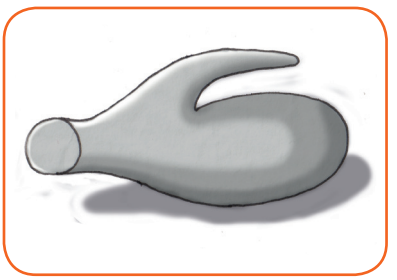


Use the tank to create an organic shape.

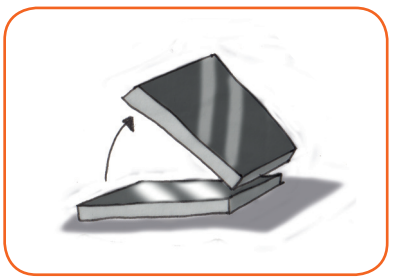




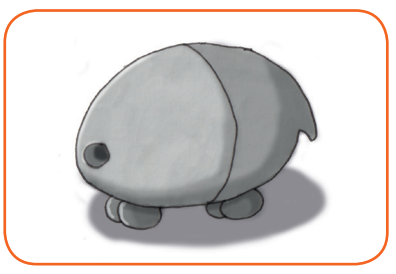
Concentrate is applied in capsules as in a coffee machine.



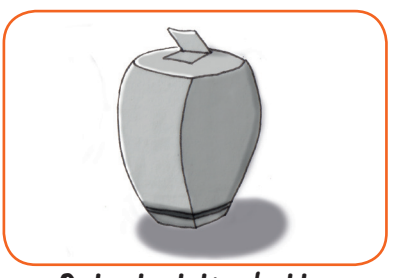
Organic shape, the handle is a part of the shape.



Display can be tilted for user-friendly use.



Wheels making it easy to move the machine.



Output at the bottom of the machine.

Fig. 60: Brainstorm

After discussing the ideas from the first sketches, new sketches are made. To get a better understanding of the different shapes, the group starts working with modelling clay. This leads to the selection of three concepts, which is presented for Henrik at Martins headquarters in Aarhus, the 9th of Marts.

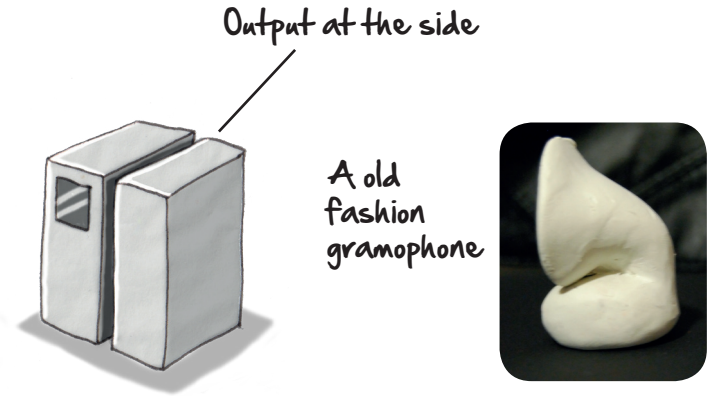


Fig. 61: Idea generation

IDEATION 2

The three chosen concepts

The speaker

The organic shape

The rectangular with haze at the bottom

Fig. 62: The selected concepts

It was decided to continue the work on the organic form to get a clearer concept. This sketching process lead to two concepts.

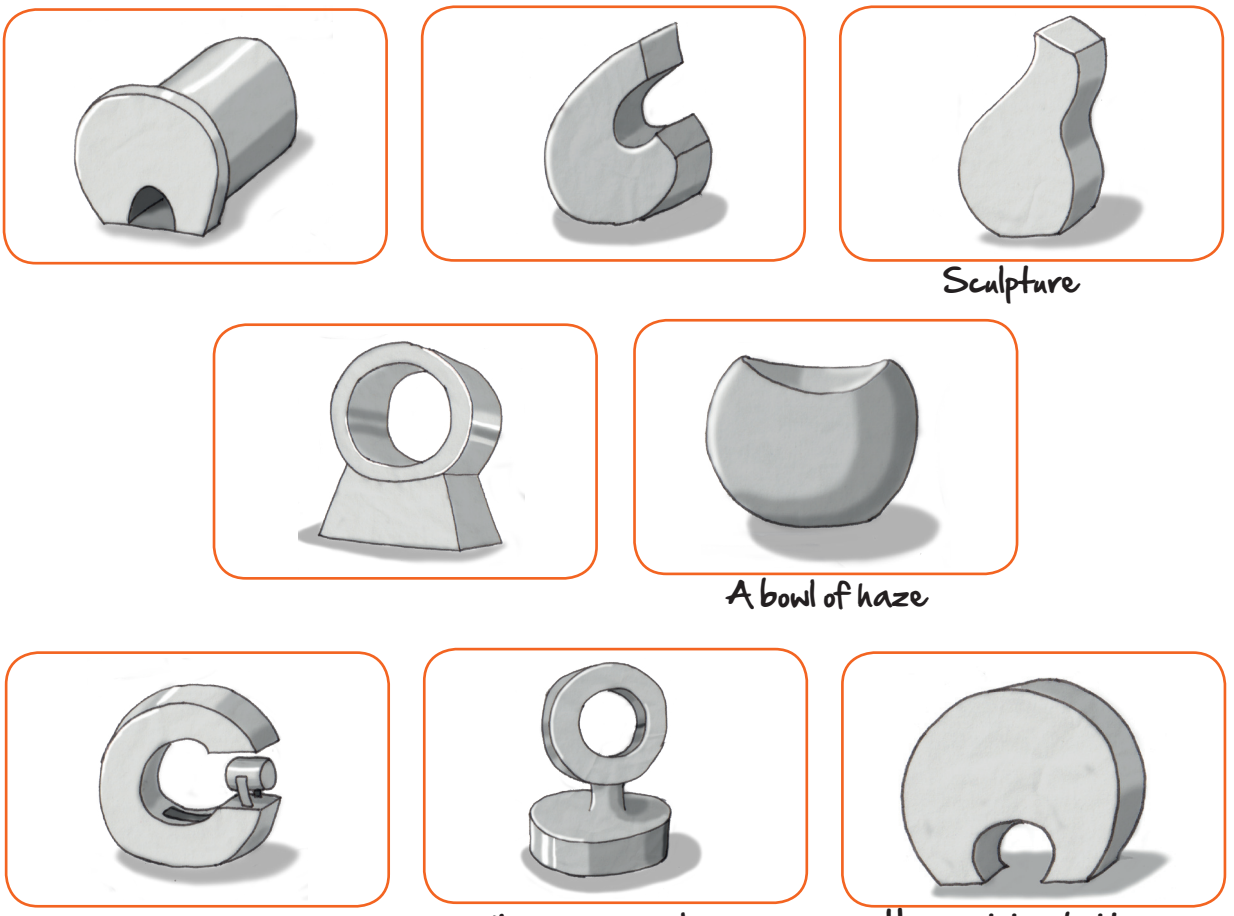


Fig. 63: Idea generation on organic shapes

The two organic concepts

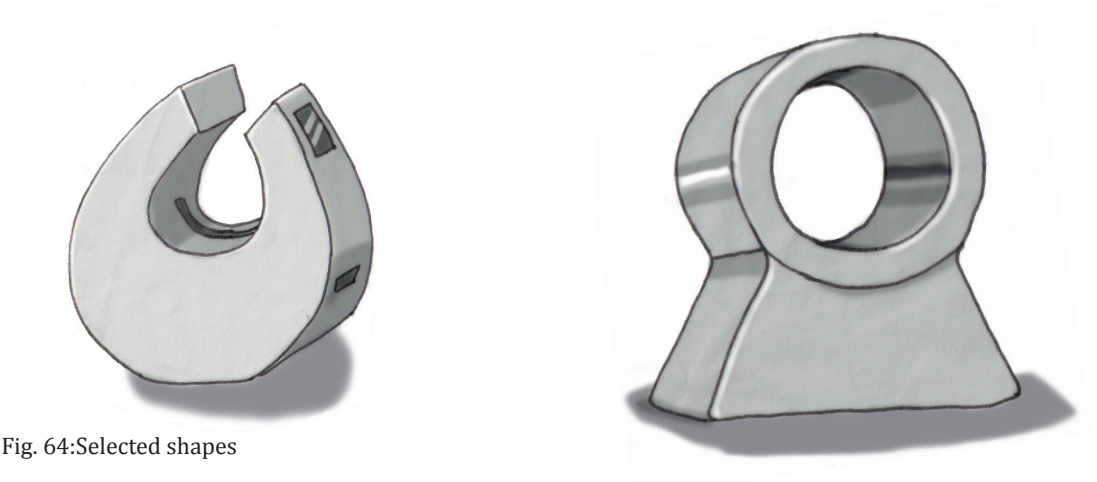


Fig. 64:Selected shapes

The two concepts both have curved shape that set them apart from the traditional Martin design. The group now has 4 concepts. These are shown to people from the Jem factory and Henrik Sørensen from Martin. Based on their comments and the analysis made on a Martin product and classic characteristic, it is chosen to come up with a new design, which will fit the Martin profile and the classic trait better.

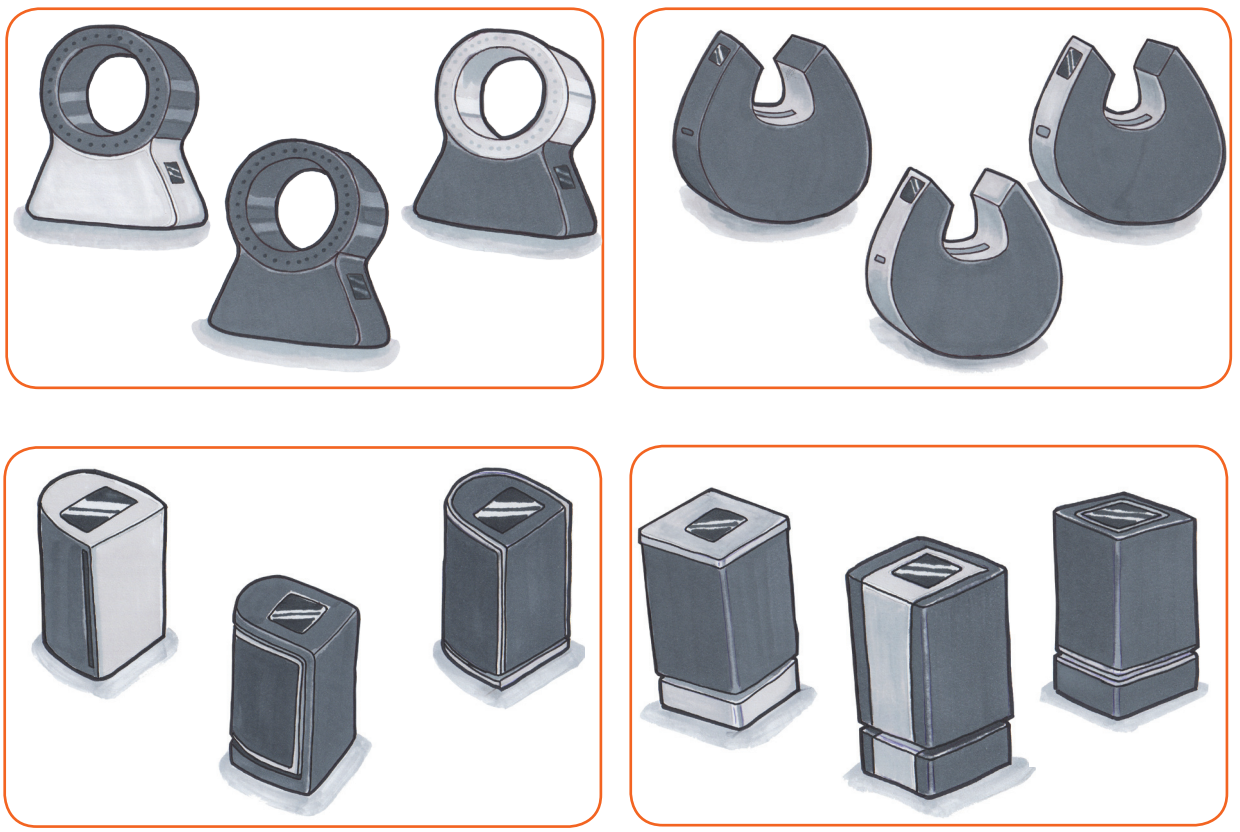


Fig. 65: The four concepts

IDEATION 3

A new sketching round gave some new and different concepts from where it is chosen to work with to parts being put together

Fig. 66: Ideation 3

Based on the analysis of Martins product and classic characteristic, it is decided to work with the square idiom, with the idea of dividing the electronics from the other components, by placing it in a separate box

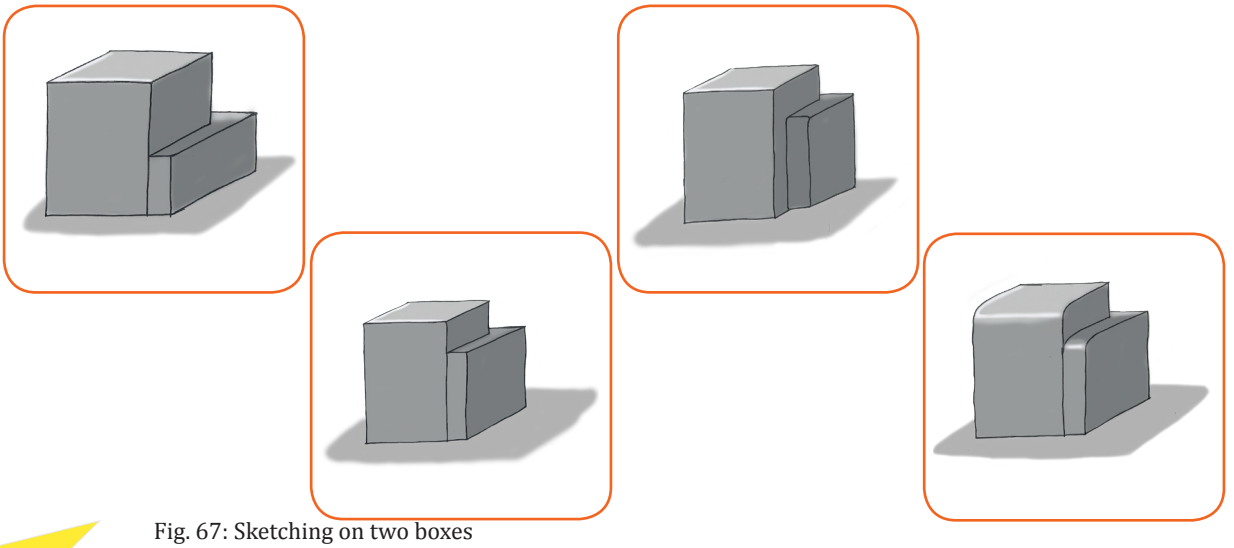


Fig. 67: Sketching on two boxes

Looking at the initiating concept, the group does not feel like the design is there yet.
There is therefor looked at how to ad some curves, to soften up the outer lines.

It is a wish to keep as much electronic as possible separated from the rest of the components, to keep it away from potential water.

Based on another sketching round it is decided to keep the separation within the outer lines, to give the expression of a more uniform shape.
This product is influenced by 'form follows function', which mean that the exterior design is affected by the shape of the interior components. Therefore the final design cannot be finished before the components are designed with size and shape.

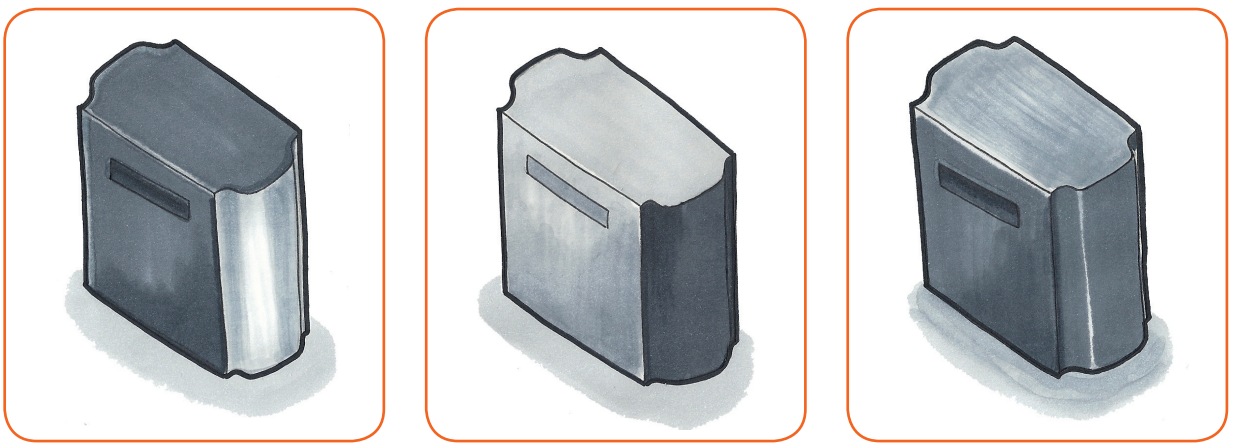


Fig. 68: Final concept

Placement of components

To get an indication of the shaping of the components, different arrangements of the components are lined up.
It is chosen to use the first arrangement, because it takes least tubes and pumps to carry the fluid around.

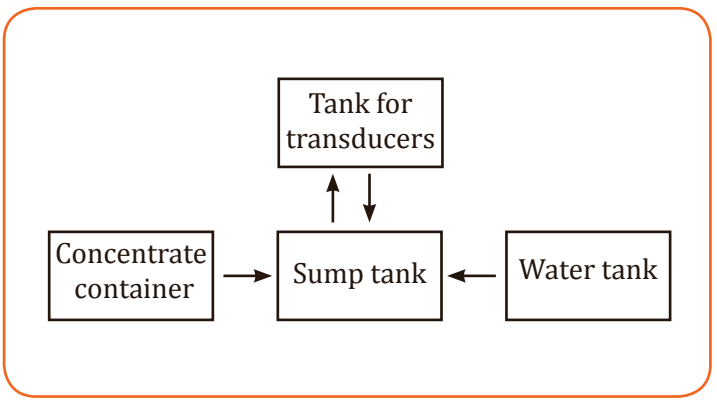


Fig. 69: Line up 1

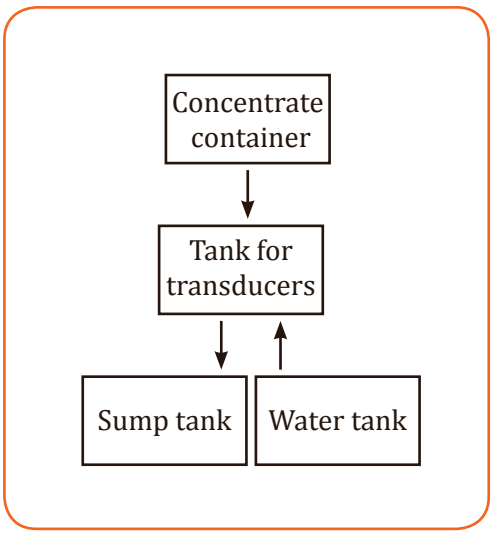


Fig. 70: Line up 2

CONCENTRATE CONTAINER

The concentrate container is an important element of the hazer. The group has been asked to look into how Martin can prevent the users from refilling a container, with their own concentrate. It has specifically been requested, to look into RFID-tags, which is thoroughly investigated, where other concepts are roughly investigated.

Criteria

From the visit to the Jem factory in UK and interviews with users, different criteria has been discovered for a concentrate container.

- None refill container
- Must only use Martins own concentrate
- Must be able to take out and put in a half used container
- Must not leak
- Easy transportation
- Quick and easy replacement

Brainstorm

Based on the criteria a brainstorm is made, on elements where it is easy to get the elements one way but difficult the other way. e.g it is easy to put an expansion screw in a wall, but difficult to get it back out, and it is easy to get toothpaste out of a tube, but difficult to get it back in.
The subjects from the brainstorm are divided into five groups: Vales, Electronic, Brake, Difficult, and Barbs

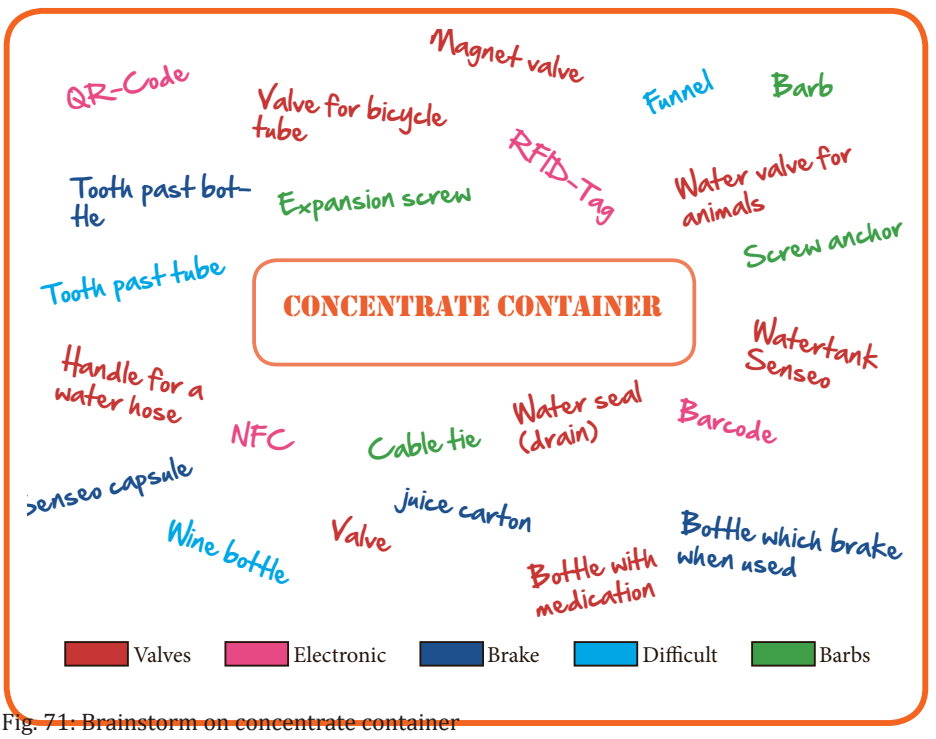


Fig. 71: Brainstorm on concentrate container

Electronic

Based on the request from Martin, the electronic field is thoroughly investigated and compared in a matrix. A subject within the electronic field is chosen and compared with the other subjects. (Appendix C)

RFID

Radio Frequency IDentification is used in a variety of different products, from passports to groceries. In short terms the RFID is a small chip with an antenna, which transmits data when it is hit by a radio wave from a RFID reader. These radio waves generate an electromagnetic field, that gives the chip enough power to send back a signal containing information.
There are three different types of RFID-tag, and three different ways of storing information. For this project a passive read – write RFID-tag could be used. This type of tag can be read at a distant of six meters, and is read by a RFID reader. [Web 29]
The price for a RFID-tag is 8 Cent, and the reader is £431. [Michael Jensen, 2012]
With this technology there is a few problems. The Institutes of Technology, Denmark, informs that the reliability of a RFID-tag, depends on the environment that the tag is placed in, and especially fluid can disturb the signal, by up to 40%, depending on the fluid. [Web 29]

Fig. 72: RFID-tag

NFC

Near Field Communication works much like a RFID, but unlike the RFID the NFC cannot be read at a distant, it only works within a couple of cm. Like the RFID it is possible to write information on the NFC-tag. Today NFC is becoming more and more common, and is used in mobile payment and in posters.
Because the distant between the reader and the tag is much shorter than in the RFID, it could be assumed that the NFC will not have the same problems with fluid. [Web 30] & [Web 31] The price for a NFC-tag is £1, and the reader from £37. [Web 32]& [Web 33]


Fig. 73: NFC

Barcode

A barcode is a small lined image, which can be seen on products that you buy in the store. The black and white lines represent numbers or symbols. The barcode is read by a scanner, that measure the light reflected by the code, and interprets it into a code. [Web 34] A barcode is easy to make, and can be printed straight on the bottle. With a barcode there can be some problems: easy to copy and fake, inconsistent bars, and not reflecting enough light. [Web 35]

Fig. 74: Barcode

QR Code or Quick Response Code

A QR code can be seen in magazines and on groceries.
The QR can be used to store a lot of different information; it could be a web address or contact information. The code is scanned by the camera on e.g. a phone, the code then gives instructions to the phone, telling it to browse a web page or save a phone number.
The QR code consist of black and white boxes, which define the pattern, and the data is repeated more than once which means, that if a part of the code is damaged, it might still be possible to read it.
The problem with the QR code is, that similar to the barcode, it can easy be copied, and it would be easy for people to cheat with the concentrate bottle, if they want to. [Web 36] & [Web 37]


Fig. 75: QR Code

Selection

The electronic field is thoroughly investigated and discussed. The QR Code and the barcode are quickly excluded, because it is easy to copy the code, and hereby reuse a concentrate container. The RFID and NFC, have basically the same qualities. But based on the issue with possible interference between two or more RFID- tags and readers, and the price, it is decided to go along with the NFC-tag.

Valves

A valve is often used to control the fluid flow, and can for instance be seen in; drinking valves for animals, lighters, and coffee machines. This type of valve has a bar, which is kept in place by a spring, when the spring is pushed back the valve opens, and the fluid can run through.
It could be a possibility to use a valve on the concentration container, this would make it difficult for the user to refill the container. The container could be filled as a regular bottle on the fluid plant, and instead of a regular lid the valve could be used.
Another option could be to have a permanent container in the machine, which is refilled using the valve system. That would how ever make it impossible to remove the fluid from the machine during storage.

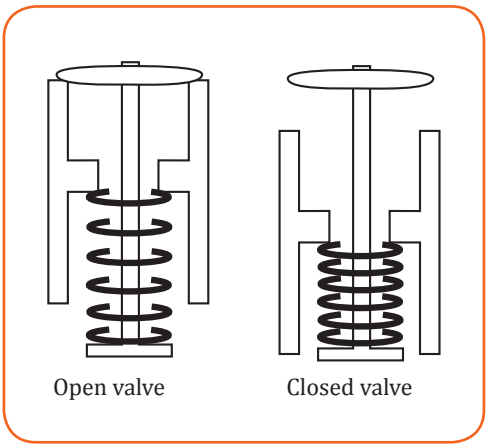


Fig. 76: Valve

Braking the container

In some coffee machines you use a small capsule, instead of using powder coffee, the coffee machine break the capsule when making the coffee making it impossible to reuse the capsule (Fig. 77).
The same principle could be used for the concentration container, but the problem with this type of construction is that the user has to use all the fluid in a capsule, before removing it from the machine.
Another possibility is to look at a caulking gun (Fig 78) the bottom is slowly screwed up into the container by a threaded bar, and the grout is pressed out of the container. This principle could be used in the concentrate container, where the bottom is slowly pushed up in the container, pushing the fluid out. This method would make it difficult to reuse the container, because you would have to get the bottom back down before refilling it. The problem with this method is that it is space consuming. You need threaded bar, the same length as the container in continuation, and this take up a lot of space.

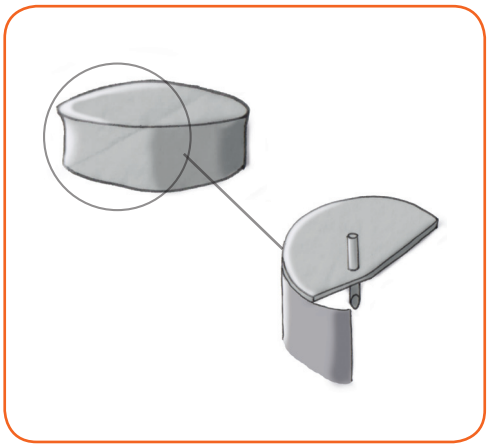


Fig. 77: Capsule


Fig. 78: Caulking gun

Barbs

This concept could be added to the previous concept with the caulking gun, by adding barbs to the bottom of the grout container, and applying a rubber coating on the inside of the container, the container would become more tight, and the barb would prevent the user from pushing the bottom back down.

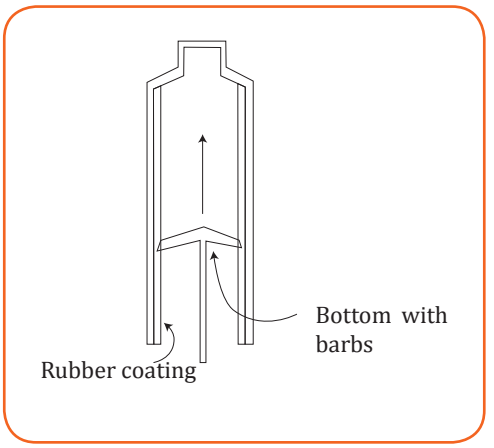


Fig. 79: Adding barbs to the caulking gun

Troublesome

This concept is about making it as difficult for the user as possible, to re-use the bottle, thereby making it more attractive to buy a new container. In this concept the inspiration comes from a medicine bottle, and a funnel, where it is easy to pour from one side but not the other.
Especially the medicine bottle could be used in this case; with a rubber fitting held in place by a metal lid. The rubber allow for a needle to penetrate and drain the bottle for fluid, and the metal capsule makes it impossible to take off the lid of the bottle without breaking it. This means that if the user wants to refill the bottle they have to inject the fluid through the lid. This would make it time consuming, but not impossible to refill the container.

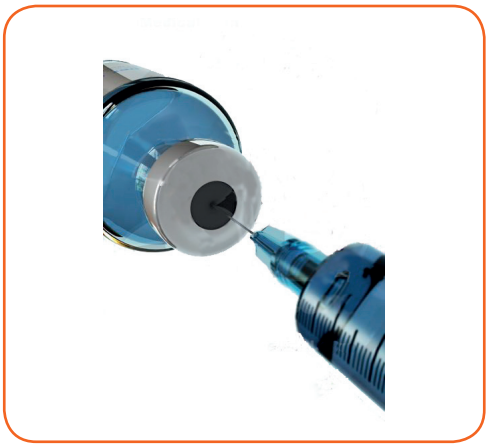


Fig. 80: Medicine bottle

Comparison

Criteria / Concept	Difficult refill/copy	Change at fluid plant	Quick & easy change	Transportation	Weight	Price
Valves	+	0	+	+	+	-
Braking the container	+	0	+	-	+	+
Barbs	+	0	0	0	+	+
Troublesome	0	0	+	+	+	+
NFC	+	+	+	0	0	+

Good + Neutral 0 Bad -

Fig. 81: Evaluation

Subject conclusion

The concept and the ideas are discussed with Henrik Sørensen, where all possible ways of cheating
The system are talked trough. Based on the discussion, and with a cost price in mind, it is decided to work with the NFC-tag. The troublesome concept is not secure enough, and will take up too much space.
There will be designed a concentrate bottle for the NFC-tag.

Conclusion

To get started on the concept development, a moodborad is made to get inspiration from existing products. Based on this, there is sketched on concepts.
The first concepts are organic shapes, but it is found that the machine will need a certain size to hold the needed components, and there will be a lot of unused space. Next concept is more geometric, where the shape is divided in to two separate boxes to keep the electronics from the rest. The thought is, that if a machine needs service the user only has to send in the electronic part. But it is found that this would never be the case. The whole machine will at all- time be sent in for service, so every component can be tested. It is therefore decided to look at the design again.
The final concept is sketched, where all components are gathered within the same shell, but the electronic is still separated from the rest, in a separate room. The shape is a mix of straight and organic lines.
Beside the shape, there is looked into the concentration container, where different areas are investigated. Martin has specifically asked the group to look into how to make a concentrate container which cannot be re-filled by the user, to make sure the only fluid used, is Martin fluid. Furthermore it is requested to look into RFID-tags. It is therefore decided to go into details with the electronic area, to investigate the RFID-tag, and get an idea of which other products there can fulfill the request, where other areas are only scratched.
Based on the investigation it is decided to use a NFC-tag. The NFC-tag has the same qualities as the RFID-tag. The biggest different is the reading distance, which, in this case, might be an advantage, so the risk of readers interference is eliminated. Furthermore the NFC-tag has a considerably lower cost price.

DETAILING

This chapter is looking into the details on the aesthetic side, as well as the elements inside the hazer. The Concept development looked from the outside and in, where the Detailing will look inside and out. There is looked at the components where the production methods and materials are found, and ending with the exterior design.

MAIN TANK

Initiating sketches

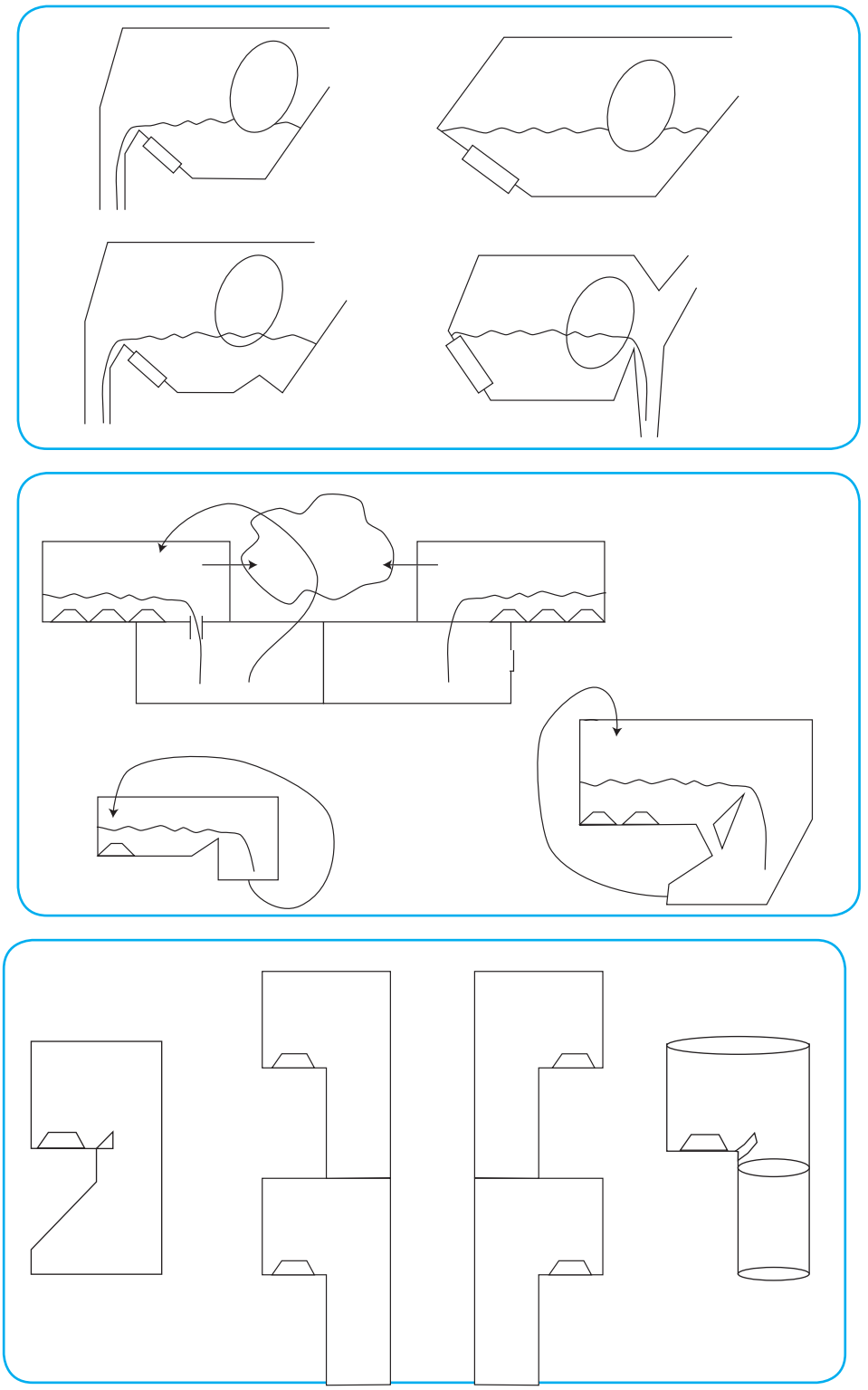


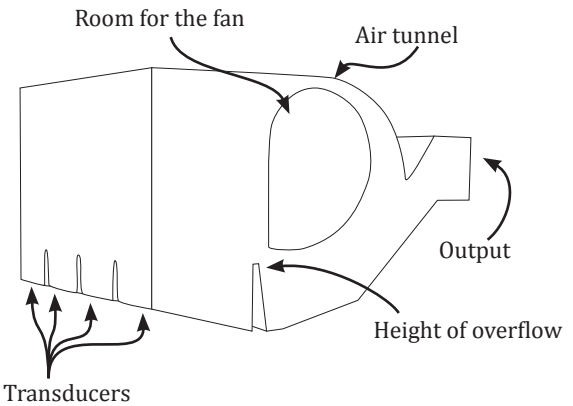
Fig. 82: Skeetching on tank

Selection

The main tank contains the transducers, whereby specifications learned in the research phase must be fulfilled.

- An air tunnel for separation of particles
- A PCB placed on the tank
- The transducer should be placed at an angle of 15-20 degrees
- There must be 25mm fluid above the transducer.
- There must be a constant overflow of fluid, to insure the correct fluid level is maintained.

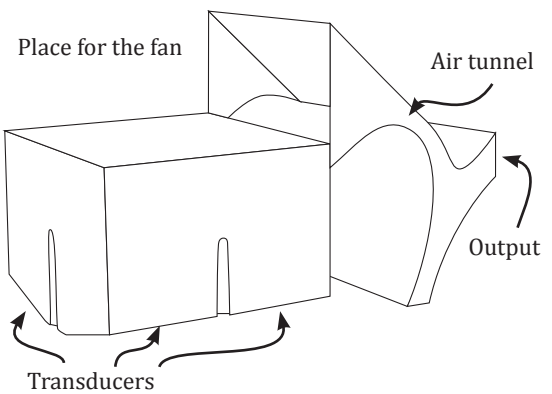
The first tank that is made have a build-in air tunnel, and room for four transducers, in a row.
To make sure that the transducers do not interfere with each other, they need their own compartment.
The fan is placed in the middle of the tank, which put some restrictions on the size of the machine.



W: 241mm, D: 308mm, H: 193mm

Fig. 83: First suggestion of tank

With the second tank the four transducers are placed in a square to save space. Furthermore the air tunnel is separated from the tank, to make it more space efficient. The transducers are still placed in their own compartment, but the fan is placed on top of the tank.
This tank has an issue regarding changing the transducers, which are difficult because of their placement in two rows, pointing away from each other.



W: 120mm, D: 222mm, H: 147mm

Fig. 84: Second suggestion of tank

In reflection of the two designs it is decided to make some experiments to get a better idea of the needed size (Appendix D). The wave a transducer produce is measured, to make sure that the tank do not interfere with the wave. This experiment shows that the tank must be at least 130mm high.

The third tank is a mixture of the first and the second tank. The air tunnel is separated from the tank, and the transducers have their own compartments, to prevent interference between the transducers.
The tank has two rows of four transducers, giving a total of eight transducers, which makes it the most space-saving of the three tanks. The transducers are placed in a way that makes it possible to reach all the transducers from the same side.

All this taking into consideration, it is chosen to use tank three in the machine.

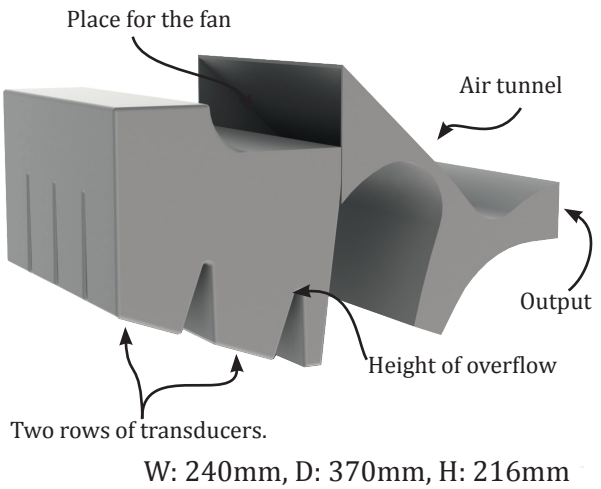


Fig. 85: Third suggestion of tank

The main tank is looked at in two pieces; the tank with the transducers and the air tunnel.

Tank for transducers

Production

After a discussion about the form, it is found that the tank for the transducers cannot be moulded, as it is. There is looked at different ways to shape the tank so it will be more suitable for moulding. When the production method is found, the tank must be adjusted for the specific moulding method.

One suggestion is to make the tank in a way, so there are no outer notches. Instead there will be placed a tube inside the tank, for each transducer. The tube will be put in together with the bung for the transducer.
This concept has some issues in proportion to the demands for the transducer. There will be a problem with the overflow between the compartments with transducer as well as the supply of fluid, which will need several more tubes than needed at the moment.

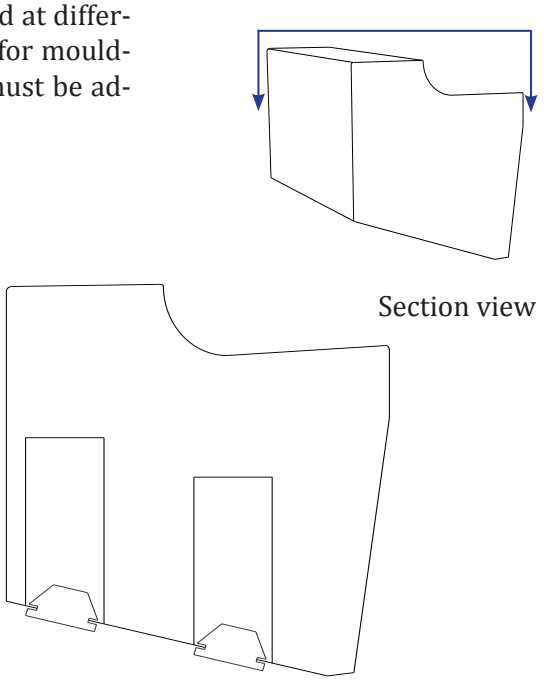


Fig. 86: Adjustment suggestion for production

The second suggestion is more or less like the original tank. The notches at the front piece are made lower and wider.
This should make it possible to use blow moulding as production method. It is therefor decided to work on this shape,.

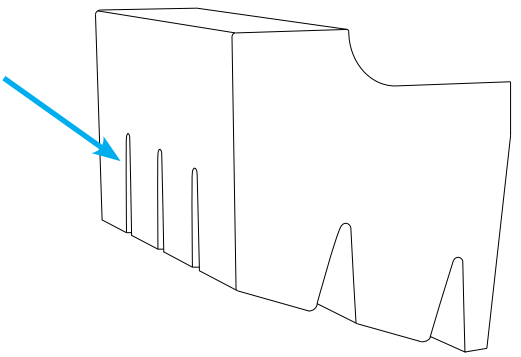


Fig. 87: Selected adjustment for production

Blow moulding

For production of the tank, there is looked at three different methods: vacuum forming (Appendix E), rotation moulding (Appendix F) and blow moulding. (Appendix G)
It is chosen to use blow moulding because it is the best suited. With blow moulding it is possible to make the notches and still have a closed item.

The basic principal behind blow moulding is, that a soft plastic tube is placed inside the moulding form, the tube is in one end flattened by the mold, and the other is kept open. A blow drift is inserted in the tube which inject air into the tube. The tube is blown up like a balloon, hereby getting the shape of the moulding form. [Bjarne Jensen, 2005]

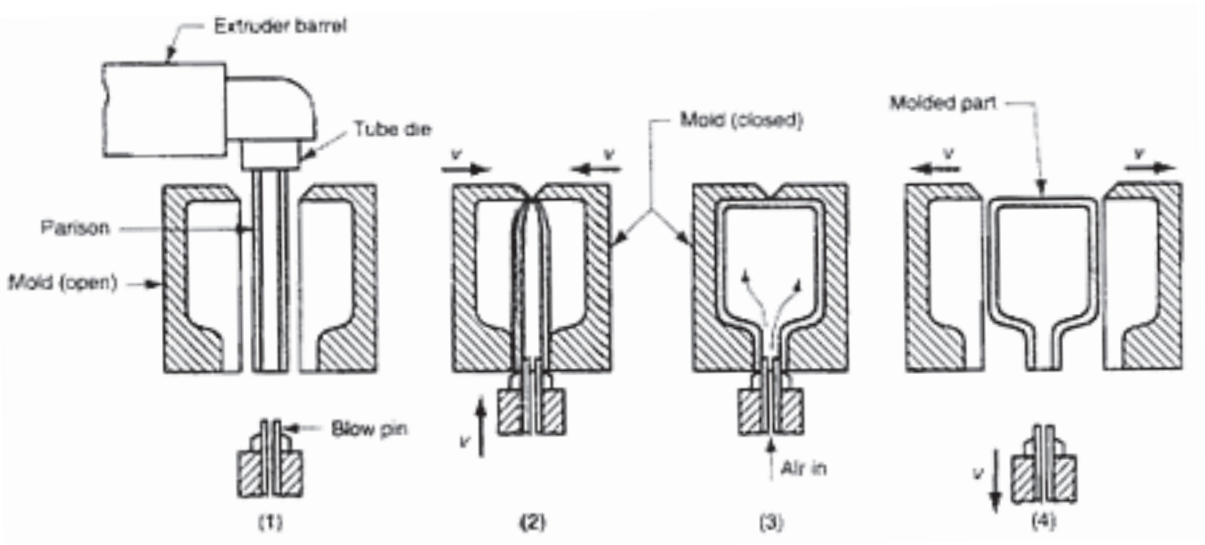


Fig 88:The principal of blow moulding

When designing for blow moulding there are some basic principal to follow:

- All angles and shape edges has to be rounded to minimize difference in wall thickness
- Radii should be two times the material thickness.
- Parts should be as symmetrical as possible to avoid uneven wall thickness
- Large flat surfaces, are prone to warpage, because the plastic is cooled by one side only, it is recommended to make corrugated designs on these surfaces.
- Draft angel should be 1-2 degrees, where 2 is recommended. [Web 38]

The pros and cons of blow moulding:

Pros

- *"Tooling cost is typically less than injection molding.*
- *Piece price is typically less than rotational molding.*
- *One piece construction (no welding or gluing part halves together.)*
- *No cores allow for irregular shapes.*
- *Seamless construction is ideal for liquid filled or airtight containers.*
- *Excellent ESCR (Environmental Stress Crack Resistance.)*
- *Quick product revisions allow for increased flexibility (wall change is process change, not a tooling change. Tools made from aluminum are less costly to revise.)" [Web 39]*

Cons

- Difficulties with unsymmetrical parts
- Uneven wall thickness
- Only good for hollow parts

Adjustments for production

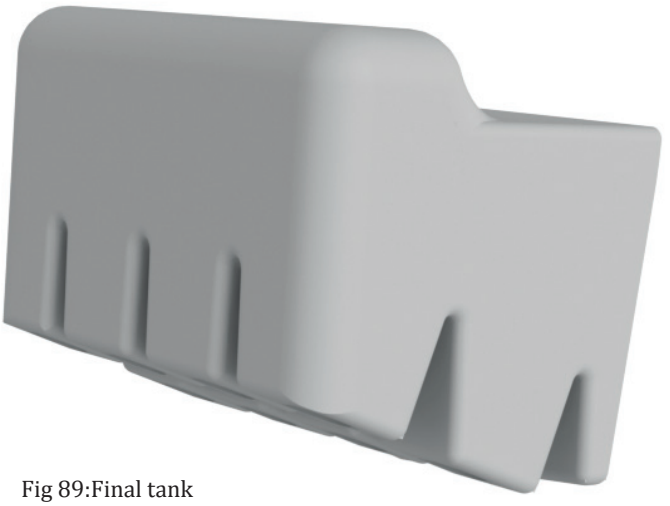


Fig 89:Final tank

Based on the information about blow moulding, the shape of the main tank is adjusted, so it is ready for production. There are made draft angles at 2°, and all corners and notches are rounded.
It is decided to use HDPE for the tank, after talking to ScanVakuum a company that specialises in both blow moulding and vacuum moulding. HDPE is good for chemical resistance, and do not absorb water well. [Web 40]

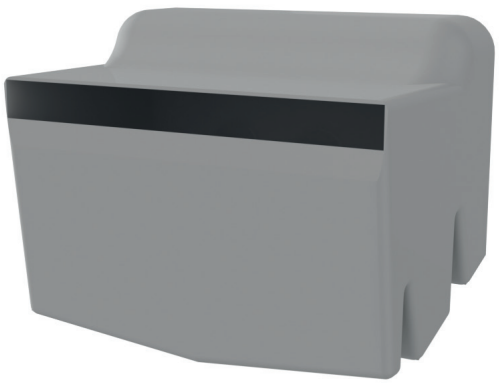


Fig 90:Final tank, front

From the front, where the haze comes out.

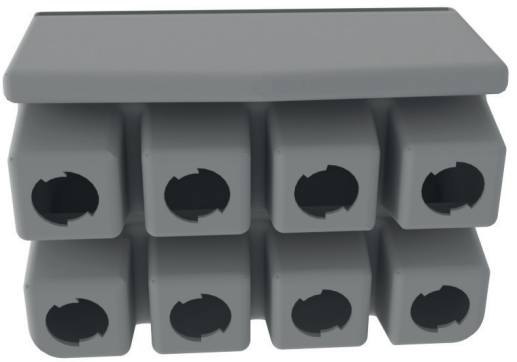


Fig 91:Final tank, bottom

Seen from the bottom, where the transducers are placed by snapfit.

Air tunnel

The air tunnel cannot be finished for production, because it is necessary to make various prototypes and tests, to find the optimal shape.

To make sure the air tunnel functions as intended, and to reach the most optimal shape for prototyping, a flow simulation is made. The goal is to create some turbulence at the middle, to separate the large particles and hereby only using the small particles for the actual haze.

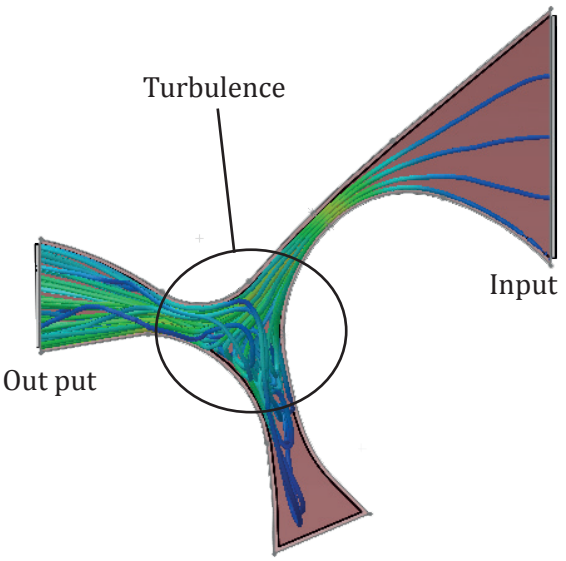


Fig 92: Turbulence

Sketches and selection

Four different shapes are tested, to get an idea of, how to create the air tunnel in a way, so turbulences are created.

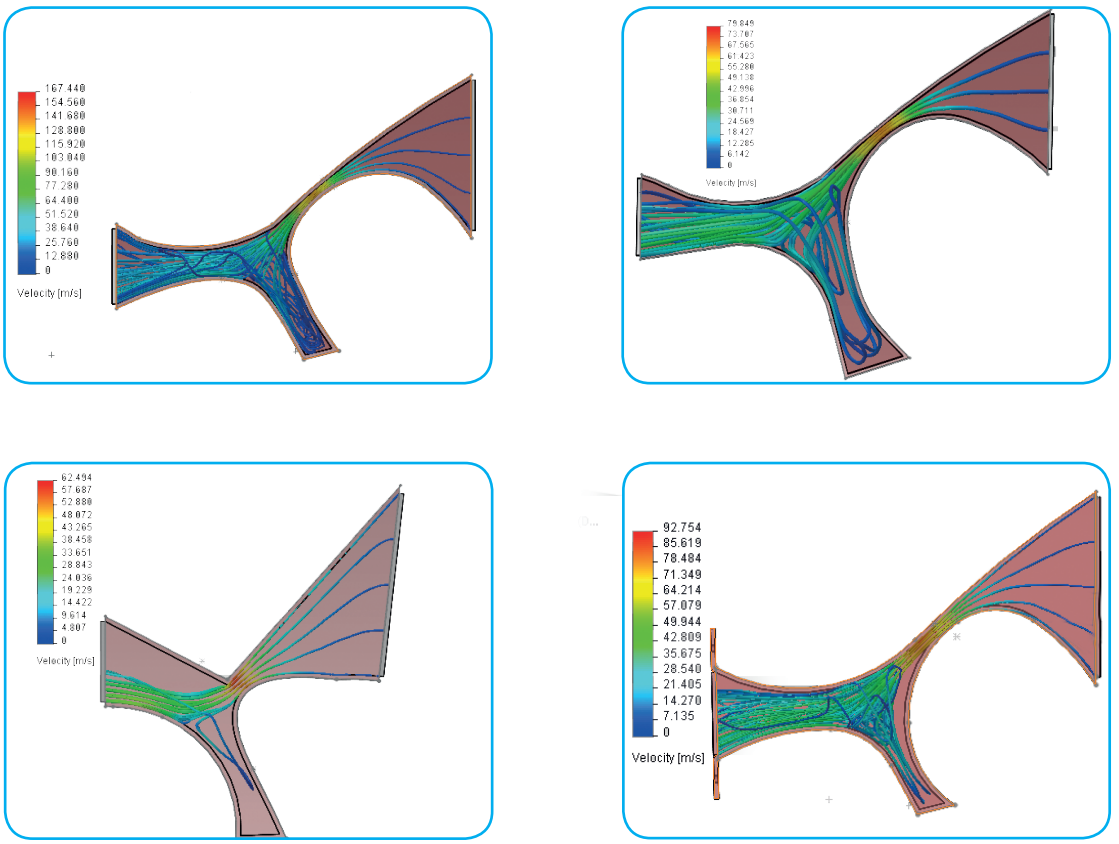


Fig 93: Flow simulations

It is decided to work with the last air tunnel, based on the created turbulence, and because it is 40mm shorter than the others.

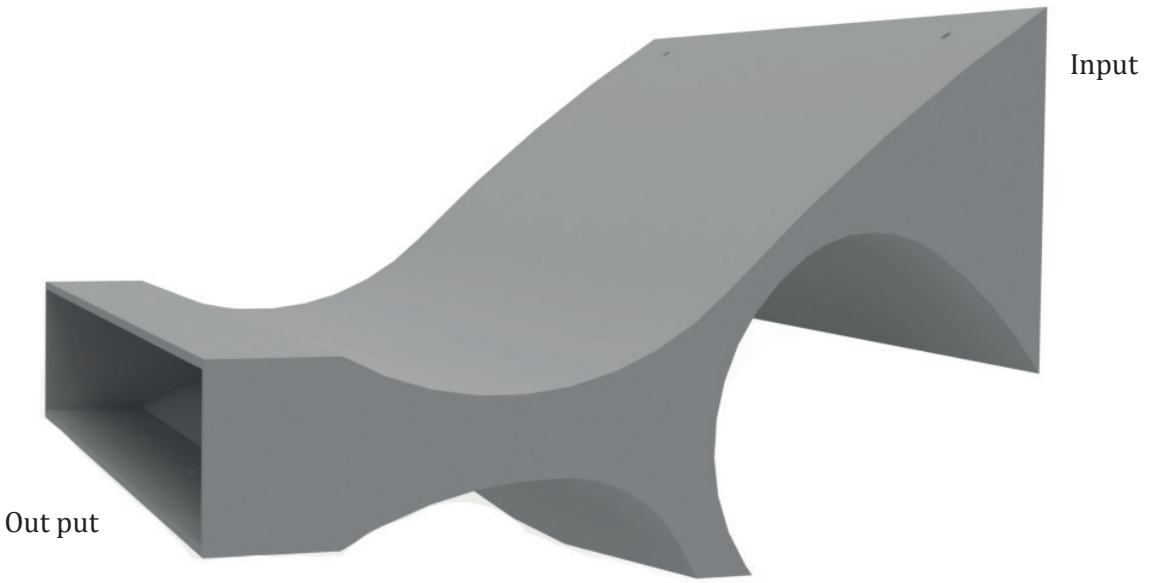


Fig 94: Final air tunnel

With the overall shape in place, there can now be made test on prototypes. When the best prototype is found, the air tunnel can be produced. Based on the shape and the low production number, it could be an idea to use 3D printing as a production method.

TRANSDUCERS

The transducers in the main tank has a life time of 5000 hours, which means that they have to be replaced every once in a while. This sets a requirement for the design of the transducers; they have to be placed on the tank, in such a manner that the users easy can replace them without any tools. Some of the first ideas are shown in the sketch below.

For a transducer there is needed a holder and electronics.

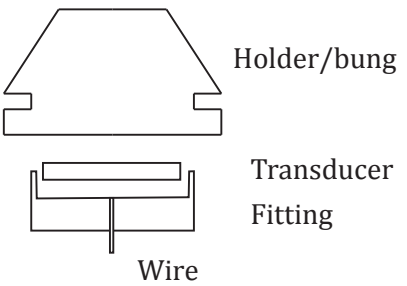


Fig 95: The construction of the transducer fitting

Sketches and selection

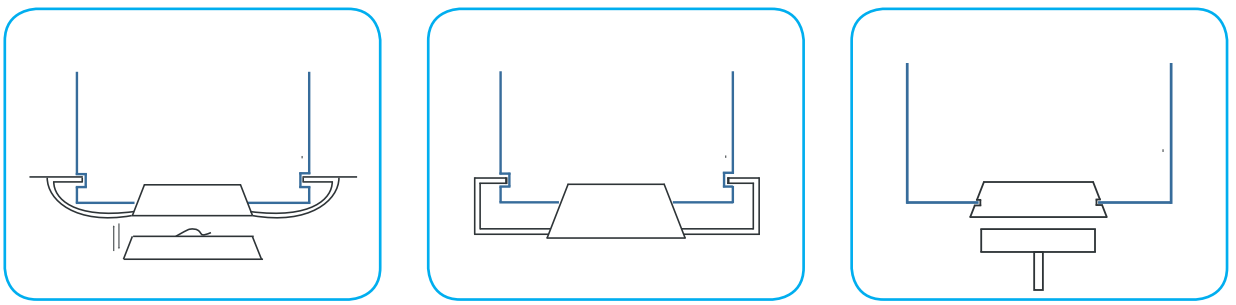


Fig 96: Sketching on fastening mechanisms

Going through the ideas an issue is discovered. There is not enough space between the compartments to use this concept.
A new concept is brought up, and chosen. The concept consist of a bung, which is placed in the tank, and a fitting, containing the transducer and the wire. The fitting container is inserted into the bung.
A drawing is send to Vink, a plastic company, to get some inputs on what material to use, and how to make it tight to avoid leaking.
Jette Ø. Jeppesen form Vink suggested three different materials for the holder. For bung she suggested PUR and PE, and for the fitting POM C. Furthermore she suggested a few changes in the parts, so the bung works as a snap fit.

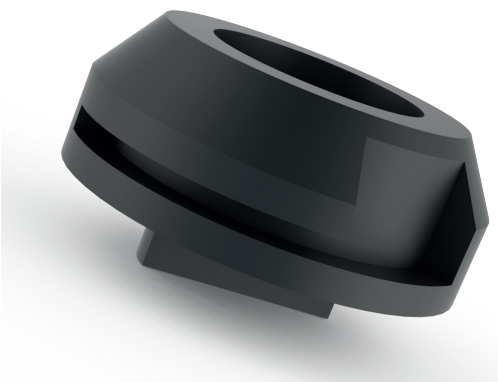


Fig 97: Final solution

Production

Material / Characteristic	PUR	POM	PE
Regular use	The chemical industry and the machine industry	Production subjects with a good surface finish	Used within most industries
Good qualities	• Flexible • Durability • High tensile strength	• Stiff, hard and resilient • High strength and elasticity • Easy clean	• Relative soft and flexible • Resilience • Chemical constancy • Vibration deaden
Employment temperature	-40° C → 70° C Few hours: 100° C	- 50° C → 115° C Few hours: 140° C Melt temp.: 165° C	-200° C → 90° C Few hours: 120° C Melt temp.: 135° C
Be aware of	• Contact with hot water and steam	• UV-light • Contact with hot water and steam	• UV-light • Shrink resistance • Stability of dimensions

Fig 98: Material selection

It is chosen to use PUR for the bung and POM C for the fitting. PUR is chosen because it has a high tensile strength, durability and is flexible. The bung has to withstand the wear that comes each time the transducer has to be replaced. [Web 41]
POM C has a god dimension stability which is necessary if the holder is to be waterproof, also it has high strength which is needed because it has to withstand the being pulled out of the bung. [Web 42]

How to change transducers

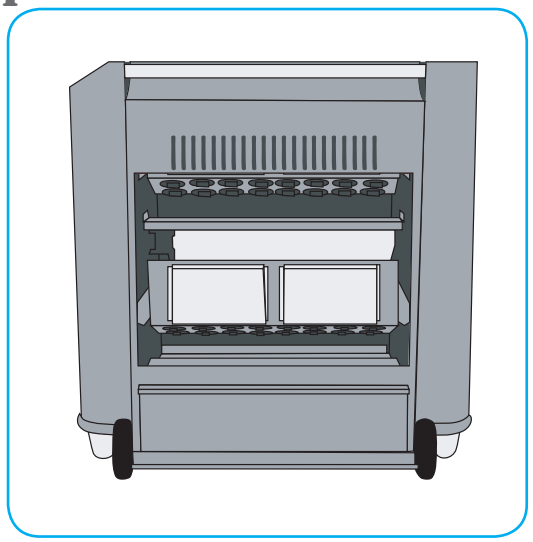
The holder for the transducers consists of two parts:

Part one: The bung, which is made from PUR, a rubber like material, and placed in the main tank by a snap lock.

Part two: The fitting container, which is made by POM C, a hard plastic material.

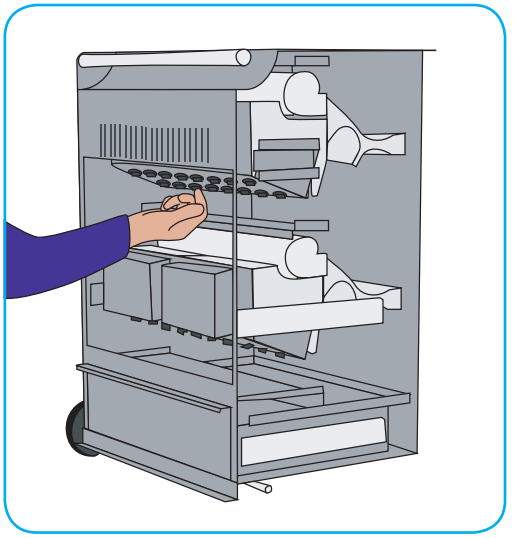
When replacing a transducer, the door is opened to gain access. The holder for the transducer is twisted, and it can be removed from the tank. The fitting is pulled out of the bung, and the transducer, a metal plate, can be changed. The fitting is put back into the bung, which is pushed up into the tank and turned, fastening it to the main tank.

1



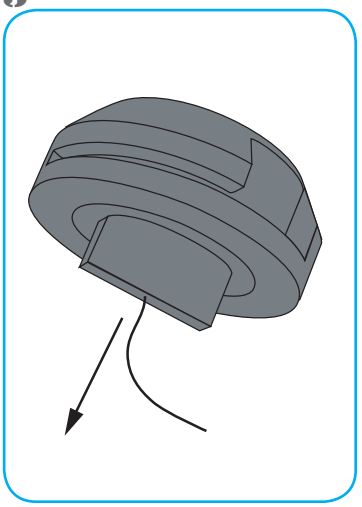
Open the door at the back of the machine

2



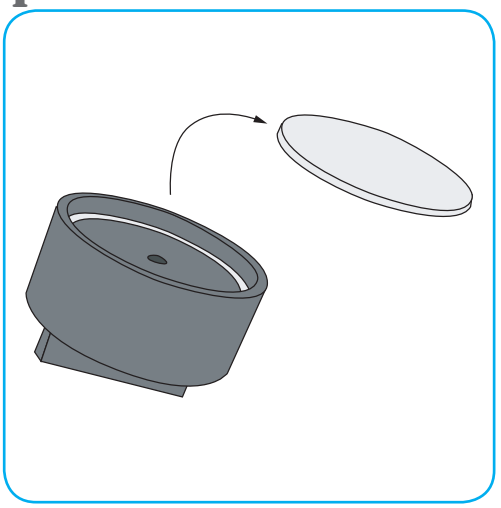
Take hold of the transducers underneath the tank, and twist it around to pull it out.

3



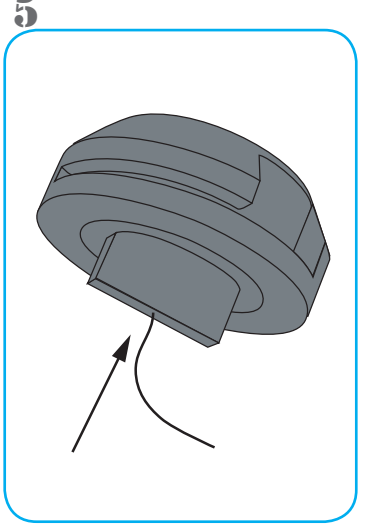
Pull the parts apart

4



Change the metal plate

5



Push the parts back together and put it back in place

Fig 99 How to change the transducers

Sketches and selection

In the Concept development it is decided to use NFC-tag to prevent the users from refilling the concentrate container. It is decided to make a new container, which fit into the new hazer, and gives the customer a feeling of quality.
There are made design suggestions, from where the final concentrate container is shaped.

To make the right size of the container, calculations are made (Appendix H), where it is found, that a container must hold 7.3 l, which is enough fluid for 15 hours show in full output.

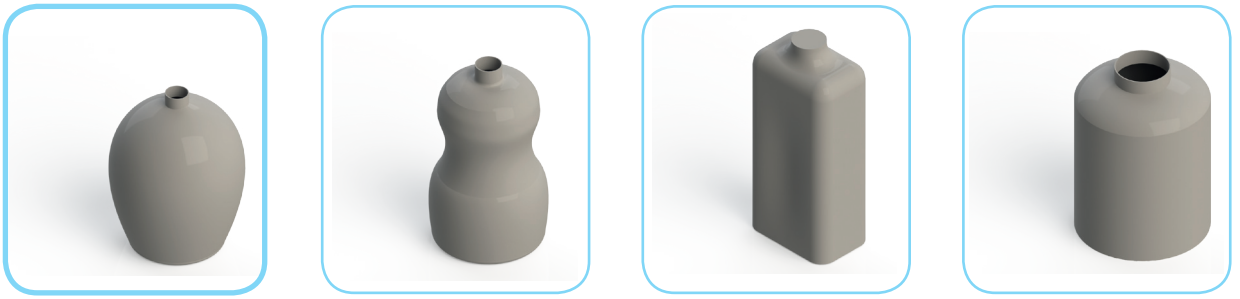


Fig 100: Concepts for the concentration tank

Fig 101: Design ideas for the concentration tank

Production

The container is blow moulded, which sets specifications for the shape (Appendix G). There are made round corners, so there are no perpendicular corners. It is decided to use HDPE for the concentration container, because it need some of the same qualities as the main tank.

Material, colour and surfaces

Fig 102: The final concentration tank

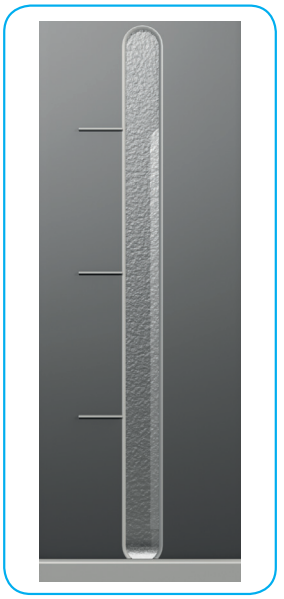
Details

The container is made with different features, to make it as user-friendly as possible, and give it 'Martin look'.

Place for the NFC-tag

Visible logo at the container

Handle which do not take up space



Fluid indicator divided in fourth

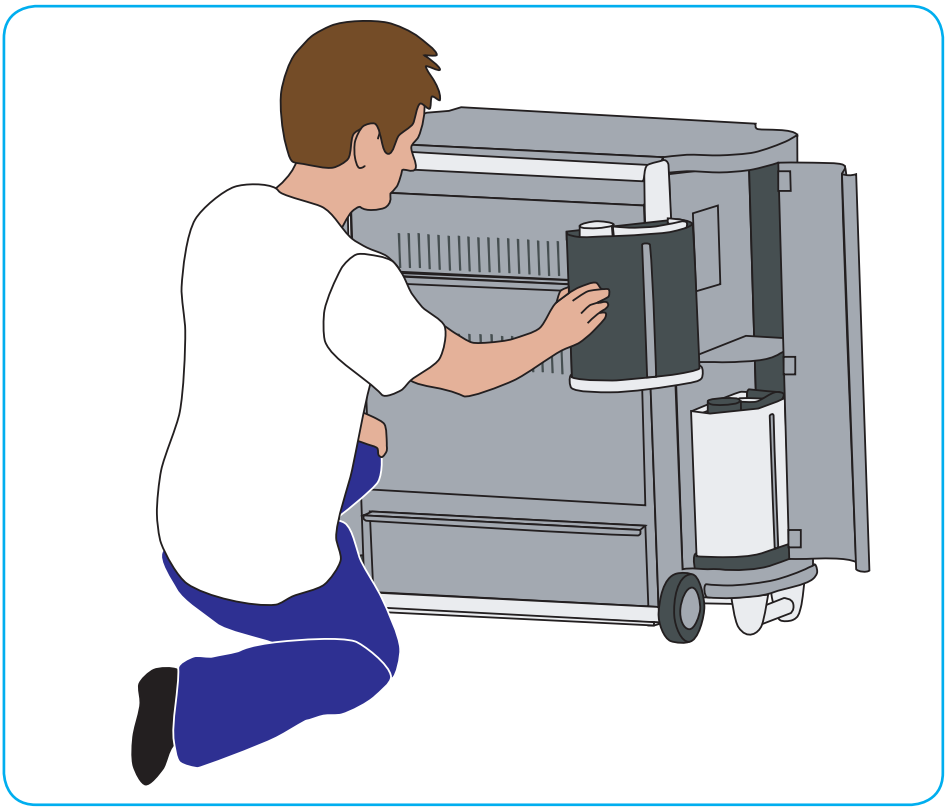
Fig 103: Details

How to change Concentrate container

Changing the concentrate container is a simple three step action. First the empty container is removed, the lid with tubes are moved from the empty container to the new container, which is placed at the shelf for the concentrate.

1

The concentration is found through the side door, on the top shelf.



2

The tube has to go all the way to the bottom of the container.

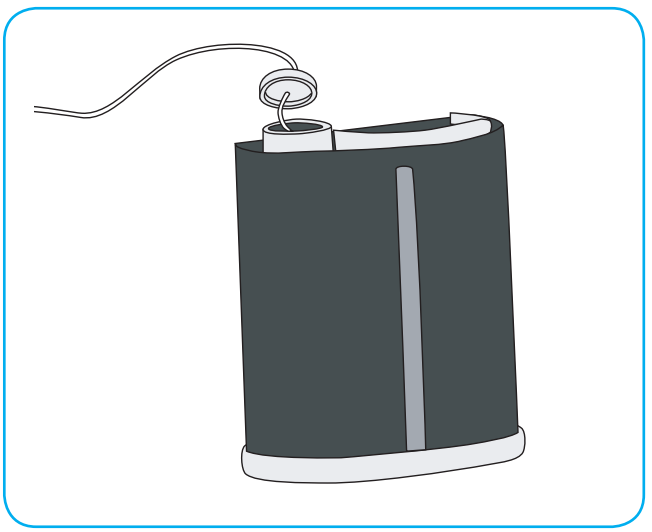


Fig 104: How to change the concentration

Initiation sketches

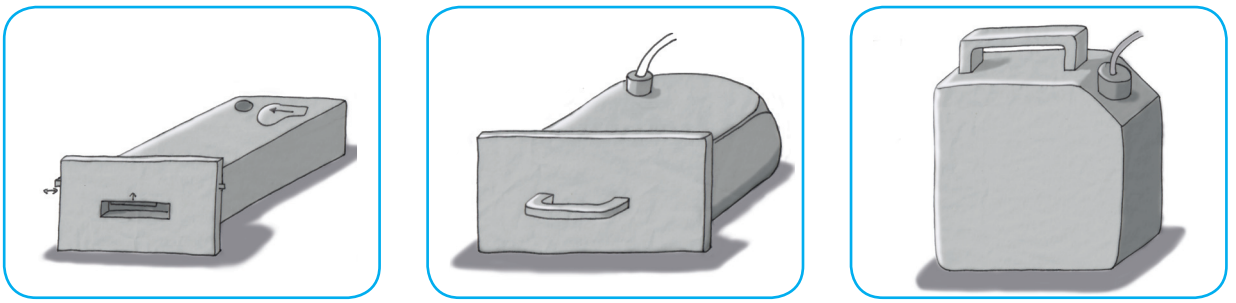


Fig 105: Preliminary sketching on the sump tank

Selection

It is decided to use the same container for sump tank as used for concentrate container. This gives two containers, which are specifically made for this hazer, and cannot be used for another machine. Based on calculations (Appendix H) it is found that the sump tank must be able to hold at least 6.84 l of fluid.
To be able to tell the difference between the two containers, they are in different colours.
To make sure there is no bacteria in the fluid, there will be placed a HINS-light (Appendix B) underneath the container. Therefor the bottom must be transparent, to allow the light waves penetrate the bottom.

Fig 106: The final sump tank

Fig 107: Placement of the HINS light

Fig 108: Transparent bottom

WATER TANK

For a show of six hours it is calculated that there are needed 30 l. of water, for full output. The water there is needed is pure tap water, which is not necessary to move around. It is therefor decided to look at water tanks which are filled at the place.
The rental company, which moves the equipment around, have a lot of equipment to keep track of. It is therefor decided to look into a water tank which can be placed in the machine, when it is not in use.
For this there is looked at foldable water containers, used for e.g camping.

Fig 109: Collapsible water tank

The water tanks are placed in the drawer when not used. Above the tanks there is a shelf, where the tubes and lids are placed. This makes it possible for the user to quickly pack or unpack the machine

When the water tanks are filled, they are replaced in the drawer, and the lids with tubes are screwed on.

Fig 110: Placement of water tanks, empty

Fig 111: Placement of water tanks, full

Overview

Now all the inner components are in place, there can be looked at the shell. It is predeterminded to produce the shell in sheet metal. Martin uses sheet metal for all their products today, and it is a whish to keep their own suppliers and preserve the look of a Martin product.

Fig 112: The new hazer; Ghost

Fig 113: Front

Fig 114: Back

Fig 115: Right side

Fig 116: Left side

Production

Sheet metal

It is decided to use the same subcontractor (Bullet) that is used in the production of the other haze and smoke machines. This means that the machine primary will be made out of sheet metal.

At Bullet they are able to work on sheet metal from 0.9mm to 4.0mm.
For this product there are used 1.5mm sheet metal, and 2.0 for the buttom plate. This is based on the existing machines.

The metal sheet is cut by a punching machine, and afterwards it is bend, this is done by a pressbrake.
The pressbrake consist of an upper part know as the punch, and a lower part known as the die.

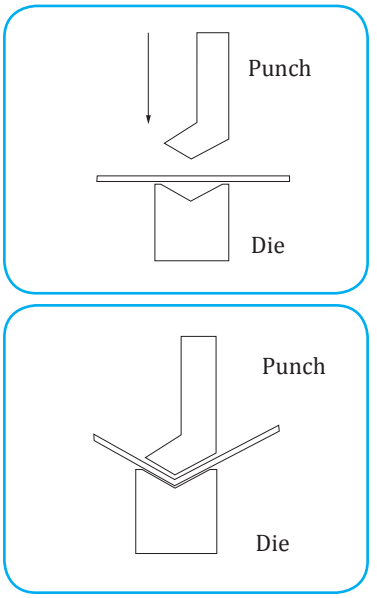


Fig 117: Bending principle

When the punch is pressed into the die it forces the sheet metal to bend, and the angle is determined by how far the punch is pressed into the die. [Web 43]
When you are working with sheet metal, there are a few things that has to be taking into consideration:

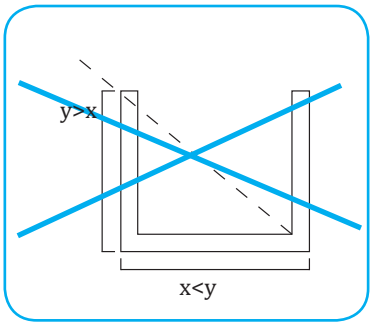


Fig 118: Wrong dimensioning of the bend

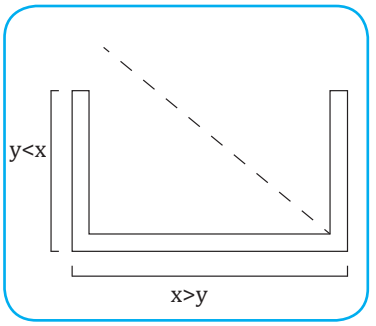


Fig 119: Right dimensioning of the bend

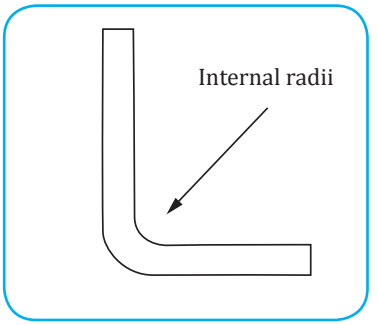


Fig 120: Dimensioning of the radii

The base of the part has to be longer than the flange, for the punch to be able to make the bend.

The internal bend radii is smaller than the external bend radii, when dimensioning the part it is the internal radii that will be used.

Way of bending

Knowing how the bending works, there are different possibilities regarding the assembly of the chosen design.

One possibility is to make the joint in the side of the front and back plate. This means two sides and a front and a back plate.
The second possibility is to make a joint at the front and the back of the machine. This way only two parts are needed, but the parts have to be pressed into shape, instead of bending the part. Which can not be done at Bullet.
The third possibility is to make the joint at the side. This means two parts, that can be bend, but it will give some conspicuous assembly lines.

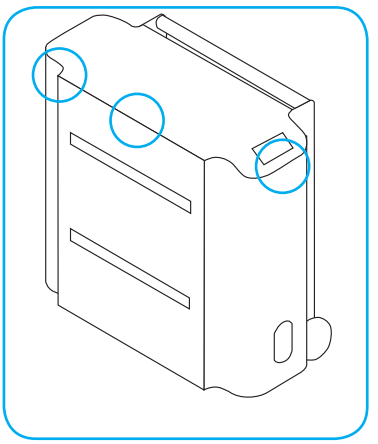


Fig 121: Placement of the joint

It is chosen to make the assembly at the corners. The design already have an edged between the front and the sides, and it is chosen to use this for the assembly, to make it look more natural.
The exact joint can be done in different ways. It is chosen to use the joint shown in Fig 123. This joint is chosen because it will give a smooth corner and make the assembly less visible.

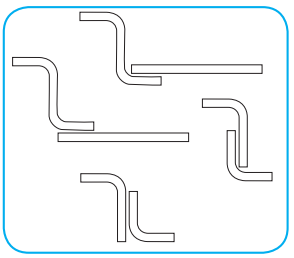


Fig. 122: Different solutions in joint

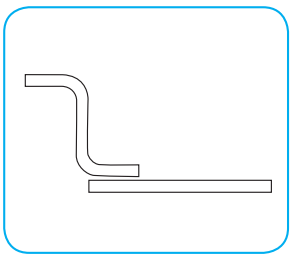


Fig. 123: The chosen joint

FEM analysis

To make sure the 1.5mm sheet plate is enough, a FEM analysis is made on the bottom.
The first analysis shows, that there is no support at the ends. Therefor feeds are added.
On the second analysis a deflection of 5mm is shown. It is therefore decided to make the bottom plate of a 2.0mm sheet plate.

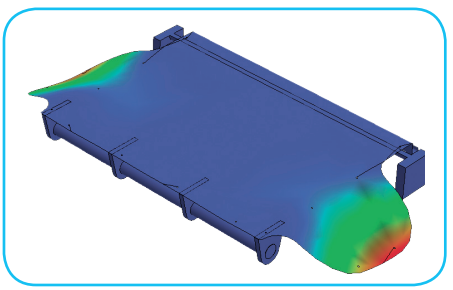


Fig. 124: FEM without feed

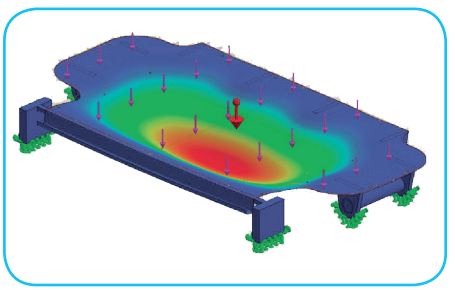
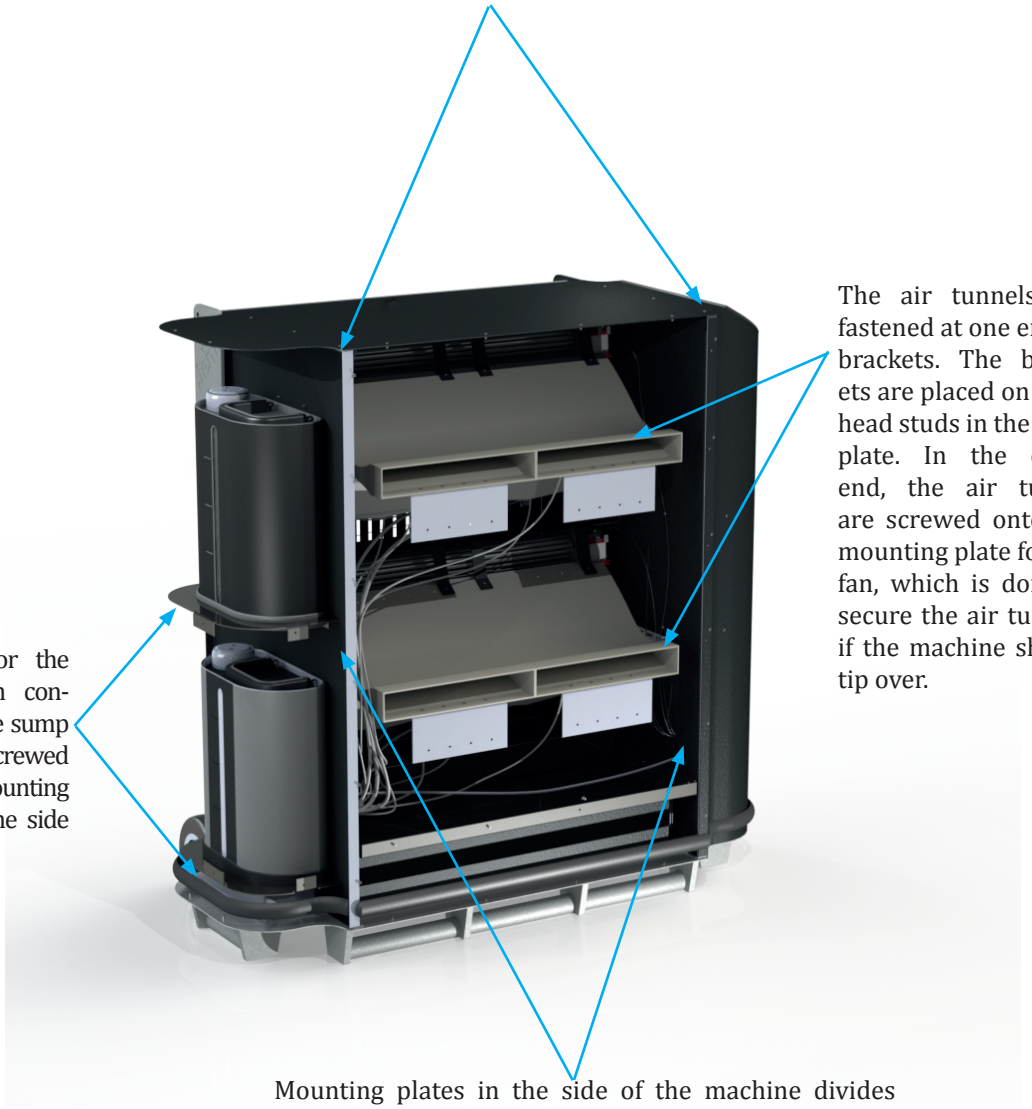


Fig. 125: FEm analysis with feed

MOUNTING OF INNER COMPONENTS

The different elements has to be mounted in the machine, this is done by various mounting plates. An overview is made on how the different elements is mounted in the machine:

Between the mounting plates and the front plate a weather-strip is placed, to stop fluid from one compartment to another, if leaking should occur. Also the weather-stripe prevent any haze that may have been spilled out into the machine, from slipping into the electronics.



The air tunnels are fastened at one end by brackets. The brackets are placed on flush head studs in the front plate. In the other end, the air tunnel are screwed onto the mounting plate for the fan, which is done to secure the air tunnels if the machine should tip over.

The shelf for the concentration container and the sump tank, are screwed into the mounting plates and the side plate.

Mounting plates in the side of the machine divides the compartments in the machine, and are used to fasten the different elements. Another benefit from the mounting plates are that they help to stabilise the structure of the machine.

Fig 126: Mounting of inner components front

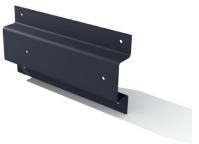
Surface finish, black parts:
Epoxy-polyester Powder
Ral No.9005
"Traffic light black"
AKA Vedoc™ F1 Black
Fine texture

Surface finish, grey parts:
Rumble finished, no paint

The handle is placed on the machine by bolts, which goes through the handle bracket and the side plate, into the handle.
The Jem logo is embedded into the handle bracket.

The display panel is fastened by press fit on to the top plate.

The top layer of the tanks are hold in place by two distance pieces.



The PCB's are placed on shelf's.

The fan is hold in place by a mounting part that allow air to the fan.

The fan is placed directly above the tanks, and blows air into the air tunnel

The bottom layer of tanks are placed on draw fittings, so they can be slighted out of the machine, to give better room when changing the transducers.

The collapsible water tanks are placed in a drawer. The draw fitting is strong enough to take 120 kg, if a person should step on the drawer. Also the idea is to keep the filled water tanks in the drawer during use.

The PCB for the transducers is held in place by small boxes. The boxes acts as a shield against any moist that could be in the machine

On the bottom plate, a foot support is made, to make it easier to tip the machine when moving it around.

Fig 127: Mounting of inner components back

MOUNTING OF EXTERNAL COMPONENTS

Doors

The door is mounted with three butt hinges, and has a magnetic catch, to prevent the door from opening when the hazer is moved around.

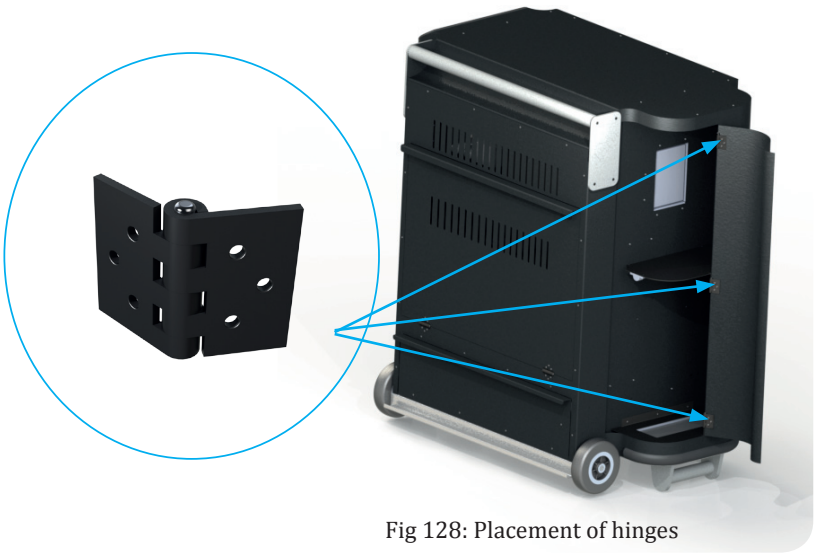


Fig 128: Placement of hinges

Drawer

The drawer is mounted on drawer fittings, which are mounted onto mounting plates at the sides. The draw has a magnetic catch like the door, to prevent it from opening during transportation.
The drawer fitting can withstand a load on 120 kg [Web 44]. This is done to prevent the drawer from breaking, if a person accidently should step on the drawer. It is the idea that the water tank can be placed in the drawer when the machine is in use.

Fig 129: Drawer fitting

Plug

The different plugs are placed 20mm into the machine. This is done to protect the plugs, if a person accidently should step on the cables.

Fig 130: Plug

Display

An important part of the machine is the display. There is looked at two different kinds of display, which are evaluated and compared.

LED

Led stands for ”light emitting diode”. It is a small electronic leader, which convert electronic energy into visible light. The colour, brightness, and sharpness of the light, is decided by the chemical composition. [Web 45]A LED is robust, and can handle vibrations no matter if it is on or off. [Web 46]
To calculate the size of the characters, an equation can be used:
Reading distance in meters x 2 = high of characters in millimetres.

Fig. 131: LED clock

The standard colour of the characters is red, but it is possible to use yellow, green, blue and white.[Web 47]

Scroll display

Within LED light, Martin has a scroll display which they uses for some of their lights. The scroll display has an extended menu, which is operated by a simple control knob and a return button.

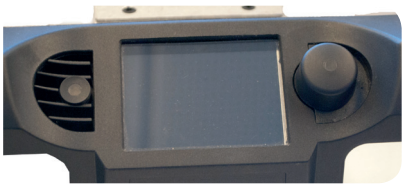


Fig. 132: LED Display

Touch-screen

Touch-screens has become more and more common, and is used almost every where today; on a smart phone, on self-service at the grocer, at the check-in in the airport, and many other places.
The touch-screen has three systems to recognize a touch: Resistive, capacitive, and surface acoustic wave.
The resistive system is not affected by outside elements such as water, but can be damaged by sharp objects. It registers all touch, no matter if it is a finger or a rubber ball. This system transmits about 75% of the light.
The capacitive system is not affected by outside elements. It must have a conductive input, usually your finger, to register a touch. It transmits almost 90% of the light, which gives a clear picture.
The surface acoustic wave system allows touch with almost any objects, except object like a pen. It is the most advanced of the three systems, and can be damaged by outside elements.
Looking at price, the resistive system is the cheapest, where the surface acoustic wave usually is the most expensive. [Web 48] & [Web 49]


Fig. 133: Touch screen

Selection

With simplification and similarity in mind, it is chosen to use the scroll display. This will contribute with something familiar from Martins products. There is looked at the display used on e.g Martins moving head, Mac III, because of a good feedback from the users.

The group investigates the display, from where there is found a few issues, as it is today; there is not much space for the fingers when scrolling the control knob. When navigating the knob from a certain angle, the hand is twisted in an uncomfortable position. The return button is almost invisible for the uncustomed user. The group was not aware of the button, before it was told, that it is a return button.
It is therefor decided to make a few changes for the Ghost.

Fig. 134: Mac III

Fig. 135: Placement of return button

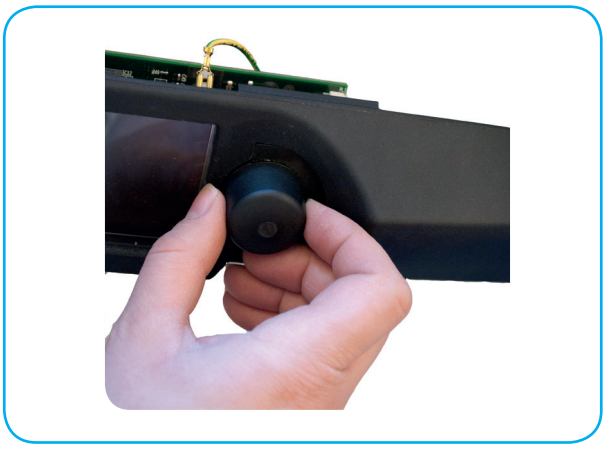


Fig. 136: Space around the scroll button

There is used the same screen, and software, as the display for the Mac III, which links the Mac III and the Ghost. There is made changes on the exterior look, to make the display suitable for the Ghost. The interaction face is levelled out, to fit the straight lines on the machine. Furthermore this makes it easier to access and navigate the control knob, which is level with the frame, with an indication for the finger. The return button is made visible with a simple illustration of a return arrow, know from other electronics.

Fig. 137: New display

Fig. 138: Ghost

EVALUATION

COMPARISON

With the design of the product in place it is time to evaluate to see if it lives up to the expectations This is done by comparing the new hazer with the existing products from Martin and by comparing it to some of the competitors on the marked.

Product analysis - within Martin

Magnum 2500 Hz

W455mm x D285mm x H280mm

Fig. 139 Magnum 2500

Jem K1 Hazer

W544mm x D459mm x H344mm

Fig. 140: Jem K1 Hazer

Roadie Compact

W800mm x D500mm x H600mm

Fig. 141:Rodie Compact

W870mm x D444mm x H870mm

Fig. 142: Ghost

The machine is bigger than what originaly was planed, which can be a problem, based on one of the demands being a machine as small as possible.
The machine has 32 transducers and it may be an idea to cut down on the numbers of transducers. Cutting down on transducers means, that a main tank contains 6 transducers, and therefore the size of the concentration tank, sump tank and water tanks can be minimized. This could help on the size of the machine.
Looking at the machine the group feels that the expression fits in with the Martin products, but still stand apart. The wish has been to create a machine, that have the Martin feeling but still ad some thing new to the design. The group feels this have been achieved.

Product analysis - competitors

With the design of the product in place it is time to evaluate, to see if it full fills the expectations. This is done by comparing the new hazer with the existing products from Martin, and by comparing it to some of the competitors on the marked.

Fig. 143: Swefog

Fig. 144: Jem K1

Fig. 145: MDG atmosphere

Looking at the aesthetics of the product it is found, that it has some qualities that can compete with the other hazers on the marked.
Rounded corners, and the use of aluminium and black, gives a high class expression.
But it still has the disadvantage of being bigger than the rest.

Aesthetics is one thing, but the real competition is the quality and amount of haze that the machine produces. In this, the new hazer has some advantage. The machine produces a fine haze, and has a low power consumption, because it runs on transducers instead of a heater, which uses a lot of power.
But the quality of the haze would have to be tested.

Fig. 146: Ghost

CONCLUSION

During the project different people was interviewed, to get an understanding of what was needed in a new haze machine. The demands and whishes were listed, divided in two groups; Martin and users. The diagram shows if they have been full filled, and the conclusion will be based on this.
The triangles in the diagram show the areas there are within the delimitations, and therefore not worked through.

Demands from Martin

Modularity and PCB on the tank

Martin wanted a product that was future-proof in a way, so it is possible to scale the machine up and down, without changing all the components. To meet this demand it was decided to make the main tank modular. This was done by making a tank containing eight transducers, and by placing the PCB for the transducers by the tank. The system makes it possible to add or remove more tanks if a bigger or smaller machine is wanted, without changing the tank and the PCB, this minimizes the cost for a new hazer.
The PCB is not placed directly on the tank, but on the holder for the tank. The demand is therefore only partly meet, but the group feels, that this is a satisfying solution, because the PCB is still close to the transducers, and by making one PCB for one tank it is still modular.

The angle of the transducers and replacement

For the transducer to give the best output it has to be placed in an angle of 15 to 20 degrees. The design of the tank places the transducers in an angle of 20 degrees so this demand has been meet. The design of the main tank and the placement of the transducers is done in such a way, that the transducers face out toward the user, making it easier to get to the transducers, when they need to be changed.
The shaping of the holder for the transducers, with the bung and the fitting, makes it possible to change the transducer without any tools.

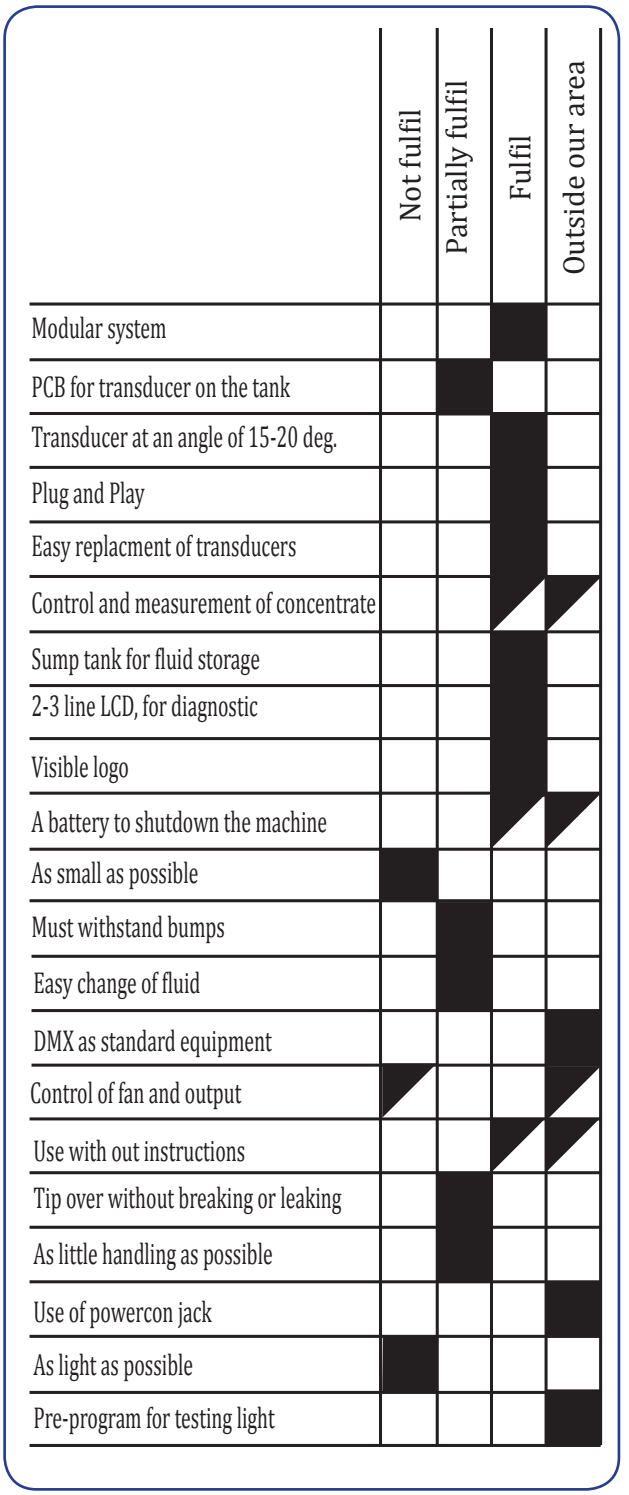


Fig. 147: Compliance of demands and wishes

Control and measurement

Martin wanted to make sure that the users cannot refill the concentration container with their own fluid for the hazer, this was archived by using NFC-tags. This makes it possible for the machine to "tell" the bottle when it is empty, meaning that it cannot be reused and filled with homemade fluid.
To measure the concentration of the fluid, a censor can be used. The system for the censor can tell how much fluid there has been used, and the concentration level in the mixed fluid, in the sump tank. This is within the electronic, which the group has delimited itself from.

LCD screen

It is decided to use the display that Martin uses on their Mac III light. This is done to create coherence between the products by using the same display and layout, and it will make it easier for the user to understand the machine. The panel for the display has been changed to fit the machine, and to make it more user friendly. On the Mac III light there are two buttons, a scroll button and a return button. The scroll button is difficult to use, because of limited space for the fingers, and the return button is too neutral and is almost invisible, this have been changed on the new panel. The return button is made visible by adding an icon, and there is made space for the scroll button, which is made flat to make it less vulnerable against bumps. This type of screen is a LCD

Visible logo

The smoke machines from Martin have two different logos, the Martin logo and Jem logo.
The Jem logo is embedded on the handle brackets and on the display panel.
The Martin logo is painted on the drawer, at the back of the machine. The placement of the logos makes them visible for the users of the machine.

Battery

There is made room for the battery in the electronic side of the machine. The battery is rechargeable and is used to make sure that the machine shutdown properly. When the power is pulled the machine starts a shutdown procedure, which empty out the main tank into the sump tank. This is done to make sure that there is no fluid in the main tank, if the machine should be placed on the side during transportation.
The battery allow the display to be turned on, so it is possible to see if the transducers or the light needs changing, or if there is something wrong with the machine without plugging the machine in. The battery is within the electronic -

Sump tank

The sump tank is placed under the concentration tank. It is decided to use the same type of bottle for the sump tank as for the concentration tank. This is done to save money on the bottle, and to make a more uniformed expression, when opening the door to the concentration and sump tank.

Plug and Play

This was archived by using a battery to automatically shutdown the machine, and by using a HINS-light to clean the fluid for bacteria, instead of having to ad disinfectant. Furthermore water is to be added at the concert place, to avoid unnecessary transportation of kilos. Hereby it is only needed to bring the machine and extra fluid, if it is needed. A concentration tank last for 15 hours.

Demand from both Martin and the users

As small as possible

This goal has not been meet, the machine is W870 x D444 x H870mm big, this is bigger than the group wanted. The reason is that the machine is made module, this takes up more space than if the machine had only had one tank for all the transducers. The machine also has both a concentration tank, a sump tank and water tanks and this also is space consuming. The construction also ad an extra fan instead of using just one, as in the old machine

Demands from the users

Must withstand bumps

It has not been possible to test if the design of the haze machine can withstand bumps, but the bending of the sides adds strength to the construction. The construction with the internal plates; both the mounting plates at the sides, and the plates connecting them vertical, also helps to stabilize the construction and make it stronger. The week points are the front and the back of the machine. To protect the machine, there is placed bumpers on the ends at the top and bottom, which are the most exposed points.

Easy change of fluid

This demand from the user has been partly meet. The user has to open a door, unscrew the lid, take out the bottle, put in the new bottle, and screw the lid back on. A container of fluid last for 15 hours, which means, that it will not be necessary to change during a show.

DMX as standard equipment

This falls under electronic and therefore outside the focus area of the group. Furthermore it is found, that DMX is a standard today on all new machines from Martin

Control of fan and output

The control of the fan is under electronic, and the group has therefore not worked with this. Control of the output has not been archived due to time limitation, but some sketches on the subject are made in the reflection.

Use without instruction

This is partly under the electronic, because of the interaction happens through the display, and from the light men's control board.
The group feels that the general interaction with the machine can be done without instructions; it is clear where to open the machine, by the visible door handles. But it may be difficult to recognize where to change the fluid, which could be a problem. The transportation of the machine is easy to interpreted, by the visible wheels, and the placement of the handle.

Wishes from the users

Tip without breaking or leaking

This wish has been partly meet, the machine empty out the main tank when it shuts down, but if the sump tank is not emptied out, then this could leak if the machine is placed on the side, along with the concentration tank. If the machine s turned over with fluid in, the main tank will give problems. The group has tried to prevent the worst problems, by using water strips between the compartment with the main tanks, and the compartment with electronic, but this may not be enough.

As little handling as possible

This wish has not been meet, due to time issues.

Powercon jack and pre-programing for testing of light

This falls under electronics, and the group has therefore not gone into this.

As light as possible

The machine weighs about 80 kg. (Calculated by solidWorks) which is the same as the Jem Roadie Compact, which is a popular smoke machine. The weight has not been a focus point, and optimizing the machine may bring down the weight.

Aesthetics

It has been a goal from the group that the hazer has a connection with the other smoke and haze machines from Martin. The group feels that this have been archived with the rounded corners, which can be seen on several of Martins smoke machines. Furthermore the same colors have been used, with the black on the machine and the steel colour on the handle brackets and the ventilation plate, and by using other elements, such as the handle brackets with Jem logo. All in all, the group feels that the hazer can fit into the selection of smoke and haze machines that can be found at Martin.

REFLECTION

After every project it is valuable to look back and reflect on the process; what could be done differently and what turned out well.

The project is done in cooperation with Martin Professional and the manufacturing in Louth UK, which has given the group access to a lot of know-how in the business. Furthermore the cooperation has given the group an insight into the company as a whole, and an understanding of the marked for smoke/haze machines.

The process

Before the trip to Louth, UK, the process was slow, but during the trip the assignment became clearer, and a better understanding of the product was achieved.
During the project the group has been in contact with the Jem factory and Henrik Sørensen in Aarhus. The group took it for granted that everyone within the same company knew the same things. This resulted in lack of information and presentation for Henrik, about what was going on, and hereby not taking advantage of Henriks knowledge. It was not until the last part of the project, that the group became aware of the misinterpretation. Based on this, the group has learned a great lesson; do not expect anything, ask instead. If the group had used some time on the first meeting and asked the people involved, how much they knew about the product and which parts of the product they knew something about, there would have been a better discussion from the beginning.
This project differs from the usual projects, done during our time at the university, by being more complex. The functionality of the product comes first and the aesthetics come second, in most projects the aesthetics have played a bigger role. The design of e.g. the main tank and the air tunnel is purely functional, and this has given the group an insight into a more functional design.
In the beginning of the project the group used a Gant chart to keep track of the hours spent on the project. But it quickly became confusing, because of the new way of approach, and the fact that the group had difficulties remembering to put on the hours. After a month the use of the Gant chart was discussed and the group agreed, that the time spent on filling out the chart and making it understandable, was not worth the outcome. The Gant chart can be a useful tool in planning the process, when used correctly, because it tells you where you are in a project, where you should have been and how much time that is spend on the various things. But during the project the group is more comfortable using phase's overview, with milestones and weekly planning, a more simple solution, which has been used in all the projects during our time at the university.

The product

Because of the time frame of the project, there are made some delimitation in the beginning of the project, where it is chosen not to go into details in certain areas. Furthermore there are elements in this product, which the group has no knowledge within or the funds for to investigate.

The air tunnel

The design of the air tunnel is based on facts given by Nick Scully. There are made flow simulations to make sure, that the air tunnel creates turbulence, needed to separate the large particles from the small. But the group does not know how much turbulence is needed to create the desired output, and therefore the simulations only leads to a qualified guess on the design of the air tunnel. The design and size of the air tunnel could be discussed, and it is design purely from a functional point of view, with no regard of the aesthetiec and production. In connection with the design, the influence of the length of the tunnel has not been tested, and it is possible that the same outcome can be reached with a shorter tunnel.

Sump tank

It is chosen to make the sump tank just like the concentration container, so the same mold can be used, and hereby save money. It is chosen to use two different colourings, to help the user to tell the containers apart. But it could be questioned if this is enough. During the research it is found, that it is rarely the same person who handles the equipment twice, and it can be that it is not intuitive enough to tell the containers apart, based on color only. A suggestion for this could be to make two different designs, in a way so the shape gives an indication of where to be placed in the container.

The handle

The handles on the Ghost, are with inspiration from the Rodie. But during a conversation with Henrik Sørensen it is found, that these handles are very expensive, and Martin does not use these handles anymore, because of a cost price of £6 each.
A suggestion could be to use a 4mm plate, with the logo punched through as a hole, and herby having it made at Bullet, Jem's sup supplier. Furthermore there could be made reinforcement on the other side of the side plate, shaped accordingly to the rounding of the top plate. This would lower the price, and make the Jem logo more visible.

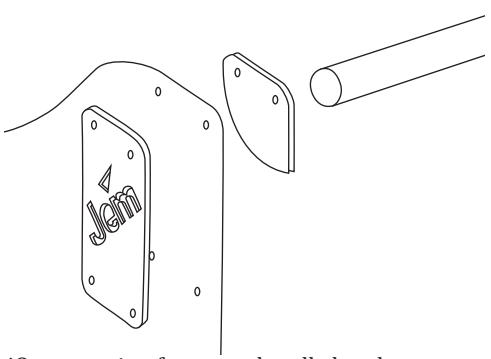


Fig. 148: suggestion for a new handle bracket

Display

Because of the time limit the interaction with the display is not thoroughly worked through. The design is changed to make it easier to use the display and make it more intuitive. The menu, and navigation in the menu, is not specified, but the idea is to base it on the menu used on Martins moving head Mac III, where the original display is from. This is to give the experienced user the feeling of the coherence between Martins products.

Control of the output

It has been a whish from the group to make a devise for controlling the output of the haze, but due to time issues this has not been possible. There has been made a rough research and experiments on the subject, to get an idea of what is needed to achieve the wanted effect. There are various factors to keep in mind when controlling the output. The more features there are added, the less output there will be. The idea is discussed with the company, from where it is decided to keep this as an add-on, and hereby making it optional for the user. It was therefore decided not to go into details with this.
Based on the research with different user segments, it is the opinion of the group, that a control device for the output, could add more value to the product.

Design

It is chosen to make the machine higher to give something new to the design, compared to the traditional machines from Martin. Furthermore this is better for the users, from an ergonomic point of view, because they will not have to bend and lift the product, and bring them self to an inexpedient position. This has an influence on the interior design of the product, where there is installed shelf for mounting of the different components. If the machine had been designed to be low and wide, more components could be mounted on the bottom plate, which may decrease the weight of the product. But by making the machine higher, the transportation of the

product, from the truck to the scene, has become easier. Instead of having to bend down to push the machine or lifting it up, it can be pushed as a sack truck. The idea with the sack truck could give some conflicts because the machine is only 870mm high. For the machine to be transported you would have to push down, bringing the machine to low to be comfortable to move around, an idea could be to put two smaller wheels at the front and underneath the machine, and push it like a trolley, this would be better for the user.
The group has made some experiments during the project to get an understanding of the product and to use in the designing of the main tank.

Experiments

Through the project simple experiments have been made to improve the group's understanding. The experiments where made with a transducer for garden pounds with a ceramic plate. The transducer for the new hazer uses a metal plate, and the group do not now how this difference affect the experiments. Also many experiments was done with tap water and not with the mixture of concentrate and water, which is used in the machine, this could also affect the results. All in all, the reliability of the experiments can therefor be questioned, and further experiments would be recommended.

Future development

The next step would be to make a model of the air-tunnel and test it to see the effect, and see if the chosen design gives the desired output and separation. This would demand a 3D printed model of the air tunnel and preferably some equipment to measure the size of the particles in the output. In this project there was neither the time nor the opportunity to make this type of tests. An alternative could be to make a model of the air tunnel for the experiments, and just watch the effect, which properly would be the way the company would do the test. This gives a rough estimate of the effect from the air tunnel.

The air tunnel also need to be prepared for production. The group has chosen to go more into details with other components in the product and did not have the time to go into the production of the air-tunnel. But had there been more time, this is one of the things that could have been looked into. Based on the small amount of air tunnels there are needed each year, and the complexity of the shape, 3D printing could be the way of production.
As a part of the future development in the design of the air tunnel, there must be found a way to put the main tank and the air tunnel together. The joint must be closed and without any holes, to prevent the haze from getting out. At the same time it has to be possible to separate the two parts, because this will be done at the bottom layer of tanks, each time the transducers have to be changed.

Furthermore there must be made a through analysis of the product, to see if the weight could be minimized. As it is now, the weight is about 80 kg. (The calculation is done in Solidworks) and the group finds this a bit high, and would like to bring it down. This can be done by using different thicknesses in the sheet metal, which, in the design, is 1.5mm, except for the bottom plate where 2mm is used. FEM analysis can show if some of the plates could be changed to 1mm, but also if some of the plates would have to be thicker.

Besides from the weight, the machine is much bigger than expected. The reason is the extra elements that are added in the new machine. Four different tanks, takes a lot of space. One solution could be to cut down on the numbers of transducers, by making a main tank containing six transducers instead of eight, this would give about 120mm extra space. By cutting down on the numbers of transducers, from 32 to 24, would mean that less fluid is needed, and hereby the machine could be made even smaller.
The construction of the machine, makes it necessary with two fans. It could be an idea to look

into the design of the air tunnel to see, if it can be made in a way, so only one fan is needed, this would also make the machine smaller.

It can be discussed if some of the solutions chosen for the product should have been different. The group chose to use collapsible water tanks, to save space, based on one of the main demands from both the user and Martin; to make the machine as small as possible. The question is if this type of water tanks can take the strain of being used for this type of job. The durability of the tanks would have to be tested, because they may be easy to replace. It may cause some inconvenience for the user if the water tanks starts to leak, and in worst case scenario it may destroy the machine.

Electronic

It was decided not to go into the electronics of the product, due to time issues and lack of knowledge. But this would be one of the next steps; to make sure that there is enough space for the different PCB's, cooling and wires in the machine.

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APPENDIX

APPENDIX A

CONTRACT

COOPERATION AGREEMENT

Between:

Student	Camilla Vigsø	Mette S. S. Christensen
Address	Fredensvej 8 9400 Nørresundby	Hovangsvej 24 9500 Hobro

and
+++

Company	Martin Professional A/S
Address	Olof Palmes Allé 18 DK-8200 Århus N Denmark

On this date, the student hereby enters into the following agreement regarding the exam project at MSC in Industrial Design at Architecture and Design during the period from the 1th of Febuary to june 2012

Based on an existing product, from Martin Pro, the group is to examine new marked areas and target groups. This will be followed by a re-design of the product, which takes the mechanic and electronics of the product into account. Besides from this, a study and consideration of the production method and construction will be done.
The project runs as a case study, where the group will act as a consultancy that has been given the case by Martin Pro. This case study is the foundation of looking into; how to start up our own business.

The student is herby committed to follow the regulations and instructions issued by the company contact person or a member of the company management during the internship.

1. All knowledge the student acquires of the company's internal matters comprising business, operation, facilities, production methods and specific know-how in relation to the academic field of the project is not to be classified as confidential and therefore all material given to the students by the company have to be cleared by the company.

2. Based on the work carried out, a rapport is drawn up for the department to include in connection with an evaluation. The rapport is entered into the University archive and library. The company is entitled to a copy and to apply the results internally throughout the company. According to the usual regulations, the student maintains the copyright for the report.

3. The student does not receive a fee from the company in connection with the cooperation.

The supervisor's rights are not included in this agreement, and it should be discussed between the supervisor and the company whether an agreement that regulates the relationship between these two parties is required.

Aalborg, *date* ... 23/1 12

The student

Camilla Vigsø

Mette S Christensen

The company

By signing this document the supervisor certifies knowledge of the agreement and the contents herein.

Supervisor

APPENDIX B

BACTERIAL CONTROL

To control the growth of bacteria in the tank there are different possibilities. One is to use chemical, but this would leave residue in the water, which is unwanted.
Another possibility is to use light as a mean to disinfect the water. There are two different types of light that destroys the bacteria in the fluid.

UV-light

UV – light
UV – light is not visible for the human eye, and is divided into three groups, based on wavelength: UVA (320 to 400 nm), UVB (280 to 320 nm) and UVC (200 to 280 nm).
UVA and UVB is the light that courses a tan on the skin, and UVB also increase the danger of skin cancer.
The UVC is the one used in bacteria control. UVC has mutagenic, carcinogenic and germicidal characteristics and can therefore be harmful to human. When used in bacteria control it is these characteristics that are used, because the light changes the DNA in the bacteria, making it incapable of reproduction.
The DNA absorb the UV-light, which leads to a chemical connection in the DNA, that makes is impossible for the DNA to copy itself, thereby sterilizing the bacteria.

Pros:
No chemicals needed
Quick proses
Easy to use
Minimum maintenance (the lamp should be changed every once in a while)

Cons:
Can be harmful for human

[http://www.eoearth.org/article/Sunlight?topic=49585]
[http://www.waterlogic.dk/viewdoc.asp?co_id=935]

HINS-light

HINS stands for High Intensity, Narrow Spectrum, and compared to UV-Light it is visible for the human eye. The technology was invented to disinfect hospitals, by scientist from the University of Strathclyde in Glasgow. The wave length (405nm) of the light starts a chemical process in the bacteria, hereby cursing it to self-destruct. This type of light is harmless for humans. The scientists have made experiments where it was found, that exposure to HINS light, in a unoccupied room, reduces the bacteria level by approximately 90%, and 56-86% in a room occupied by burns patients infected by MRSA (meticillin-resistant Staphylococcus aureus) depending on the length of exposure.
The HINS light is a relatively new technology, it was still being tested in 2010, and the result is effected by the length of time the bacteria is exposed to the light. There is a risks, that the light may not work on all the bacteria in the fluid, because it works on specific molecules in the bacteria.

Pros:
Harmless to people
Cons:
New technology, it may not be thought tested

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"

Microorganisms Susceptible to 405-nm HINS - light

Gram-Positive Bacteria

- *Staphylococcus aureus (incl. MRSA)*
- *Clostridium perfringens*
- *Clostridium difficile*
- *Enterococcus faecalis*
- *Staphylococcus epidermidis (CONS)*
- *Staphylococcus hyicus (CONS)*
- *Streptococcus pyogenes*
- *Listeria monocytogenes*
- *Bacillus cereus*
- *Mycobacterium terrae*

Gram-Negative Bacteria

- *Acinetobacter baumannii*
- *Pseudomonas aeruginosa*
- *Klebsiella pneumoniae*
- *Proteus vulgaris*
- *Escherichia coli*
- *Salmonella enteritidis*
- *Shigella sonnei*
- *Serratia spp*

Bacterial Endospores

- *Bacillus cereus*
- *Clostridium difficile*

Yeast & Filamentous Fungi

- *Aspergillus niger*
- *Candida albicans*
- *Saccharomyces*

** All organisms tested to date have shown susceptibility to HINS-light*

"

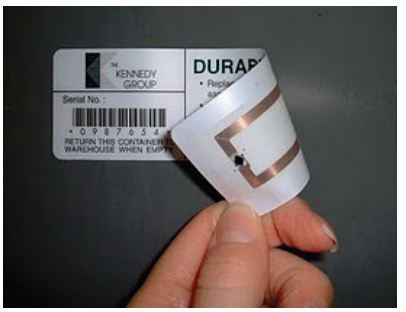
[http://www.fitwise.co.uk/events/snn/documents/13.MichelleMacLean.pdf]

APENDIX C

ELECTRONICS

RFID

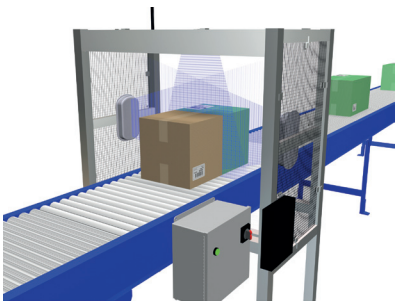
RFID, or Radio Frequency IDentification, is commonly used around the world today, and within different areas such as: key cards, car keys, passports, mobile phones, airports, and air planes.
RFID is a small chip which transmits date. The most common has no power sours, but uses radio waves to transmit data, and therefore cannot transmit on its own. The chip gets power from a nearby transmitter, a RFID reader, by sending a radio wave at the RFID chip an electromagnetic field is created around the tag, power is generated, and the chip sends information back to the transmitter.
[http://electronics.howstuffworks.com/gadgets/high-tech-gadgets/rfid2.htm]
To do this, the chip needs an antenna, by combining the chip with an antenna you get an RFID-tag. [http://rfid.net/basics]



RFID-tag: http://tingenesinternet.dk/?p=379

There are different types of RFID-tags and different types of information stores:

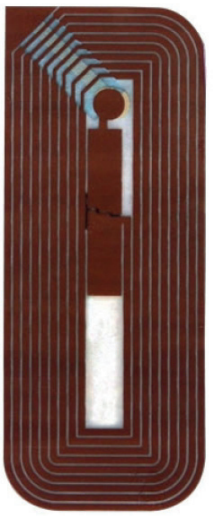
Active RFID: uses a battery to power its circuit, and to broadcast radio waves, and is readable at a distance at 100 m.
Semi active RFID: uses a battery to power its circuit, but uses the power from the reader to broadcast the radio waves, and is readable at a distance at 30.5 m.
Passive RFID: uses only power from the reader, and has no additional power sours, and is readable at a distance at 6 m.


http://www.rfideducationlabs.com/TheBusinessSeries/tabid/57/Default.aspx

In addition to this there are different types of information stores:
Read-write: this type of data makes it possible to ad information and to overwrite the existing information on the RFID.
Read only: as the name imply, it is not possible to ad information, and the tag only contains information from the manufacturing.

WORM: with this tag it is only possible to ad information once, and then it cannot be changed, only read.
[http://electronics.howstuffworks.com/gadgets/high-tech-gadgets/rfid3.htm]

Problems:
Institutes of Technology, Denmark, informs that the reliability of a RFID-tag, depends on the environment that the tag is placed in, and especially fluid can disturb the signal, by up to 40%, depending on the fluid. [www.electronics.com]
NFC is developed on the basic of the RFID-tag, and like RFID it works with radio frequency. NFC is mostly passive, meaning that it does not have a power sours, and is powered by the reader. But unlike the RFID, the NFC only works over a small distance, only a couple of cm.
[http://www.nfcrumors.com/05-30-2011/nfc-tags/]



NFC-tag: http://pocketnow.com/android/nexus-s-nfc-writing-capabilities-included-but-hidden

NFC or Near Field Communication

Today the NFC is used in posters and billboard, from where it could be assumed, that they can endure a certain amount of dirt and water without being damaged.
[http://www.addictivetips.com/hardware/what-is-nfc-how-it-works-what-are-its-practical-applications/]
The NFC-tag is used within many different areas, and often in products where cost is an issue. They are becoming more and more common. The price on a tag is low, and it can be assumed that they will be cheaper.

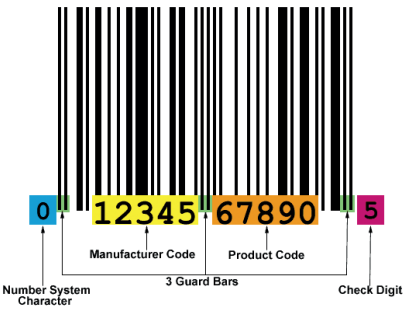
There are four types of NFC-tags:

1: Read and re-write capable, with a memory on 96 bytes, but can be expanded up to 2 kbytes.
2: Read and re-write capable,with a memory of 48 bytes, but can be expanded up to 2 kbytes.
3: Has a 2 kbyte memory, and a faster communication speed: 212 kbit/s and is fit for more complex applications.
4: Is pre-configured at the manufacture and can be either read/re-writable or read only. It has the largest memory up to 32 kbytes and the communication is between 106 kbit/s and 424 kbit/s.

With type 3 and 4 you need a special tag writer to write information on the tag.
[http://www.radio-electronics.com/info/wireless/nfc/nfc-near-field-communications-security.php]

Barcode

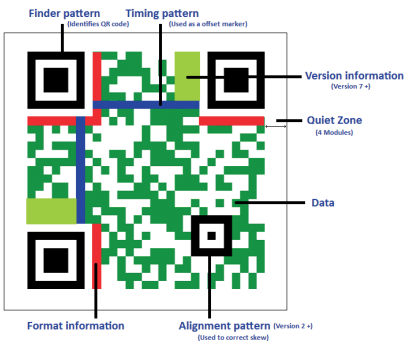
A barcode is a small lined image, which can be seen on products that you buy in a store. The black and white lines represent numbers or symbols. It has a start and a stop code, where the lines in-between is the code. The barcode is read by a scanner, that measure the light reflected by the code, and interprets it into a code.
[http://www.dataid.com/whatisbarcode.htm]
A barcode is easy to make, and can be printed straight on the bottle, which means that it is easy to copy and fake. Beside people copying a barcode, and using their own fluid, there can be problems with the barcode itself, which has to be taken into consideration. If the width of the



Barcode: http://www.av1611.org/666/barcode.html

QR code or Quick Response code

bars in the barcode is inconsistent, is damaged in anyway, or the space is not reflecting enough light, there may be a problem of reading the code.
[http://www.pointil.com/support/solver/barcode.htm]
A QR code is two dimensional, compared to a barcode there is one dimensional. The QR code can store much more information than the barcode, and store information both horizontal and vertical. But a two dimensional code is not just the QR code, they come in many different forms; colour code, Bulls eye, Aztec code and many more. The QR code is just the most common.
The QR can be used to store a lot of different information; it could be a web address or contact information. To read the QR code you have to use camera technology. The code is scanned by the camera on e.g. a phone, the code then gives instructions to the phone, telling it to browse a web page or save a phone number.
Looking at a QR code, it has three large squares in the corners, which define the pattern. It is white all the way around, called the quiet zone, this defines the border of the QR code. The green and white is the data that is stored. The data on a QR code is repeated more than once, which



QR Code: http://www.qrme.co.uk/qr-codes-explained.html

means, that if a part of the code is damaged, it might still be possible to read it.
The problem with the QR code is, that similar to the barcode, it can easy be copied, and it would be easy for people to cheat with the concentrate bottle, if they want to.
[http://www.youthedesigner.com/2011/09/29/what-is-a-qr-code-and-how-does-it-work/]
[http://www.qrme.co.uk/qr-codes-explained.html]

Comparison

Criteria / Concept	Difficult refill/copy	Change at fluid plant	Quick & easy change of fluid	Transpor-tation	Weight	Price
RFID	**+**	**-**	**0**	**0**	**0**	**-**
NFC	**+**	**-**	**0**	**0**	**0**	**-**
Barcode	**-**	+	**0**	**0**	**0**	**+**
QR code	**-**	+	**0**	**0**	**0**	**+**

Good + Neutral 0 Bad -

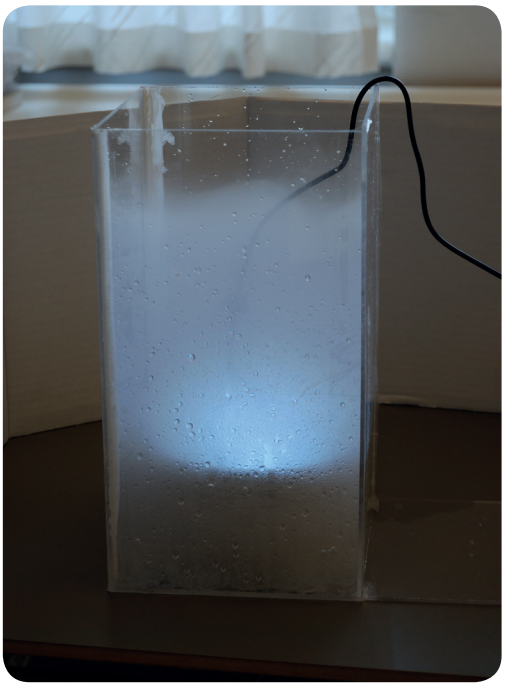
APPENDIX D

EXPERIMENTS

As a part of the research and design development, some experiments have been made, to clarify different issues concerning the product.

Experiments with the tank

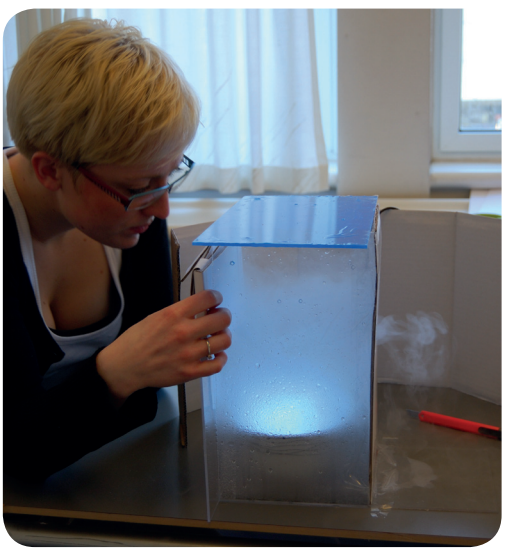
To find out more about how the transducers work, and to get a better idea of how to design the tank, the group bought a transducer for garden pounds. This type of transducer is slightly different from the transducers that will be used in the haze machine, because it have a ceramic plate instead of a metal plate. But it functions more or less the same way, the vibrations is a bit different.
First the group made a box that could function as a tank, to see how the haze react when it is confided but not disturbed. It was found that the haze would lay as a cloud in a height of 150 mm, but it would not go higher then that.



This means, that if the fan do not blow directly into the tank, the output hole can not be placed higher then 150 mm above fluid level.
The experiment is made on water and it may be that the haze fluid acts a bit differently.

Experiments with output of the tank

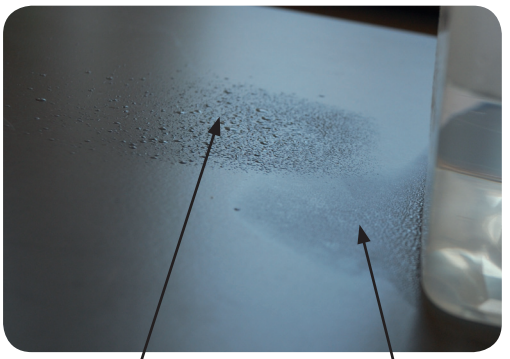
Knowing how high the haze reach inside a closed container leads to the next question: how would the haze react given a output hole. It is found that the haze will pore out of every hole within the 150 mm limit. It is possible to get the haze out of a hole placed above the 150 mm, but it requires a fan, that can blow the haze out of the tank.



Condensation

The group found it important to find out, how prone the haze is to condensate. An experiment with and without a fan is done.

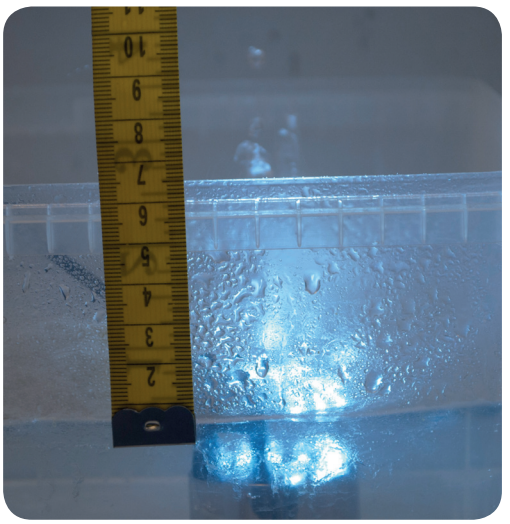
It is found, that without a fan the haze will condensate where it falls in large quantity, as can be seen on the picture. The haze has fallen over the side of the box, and onto the table, creating a area with condensation.
When using a fan the haze still condensate, but only where the wind from the fan do not reach.

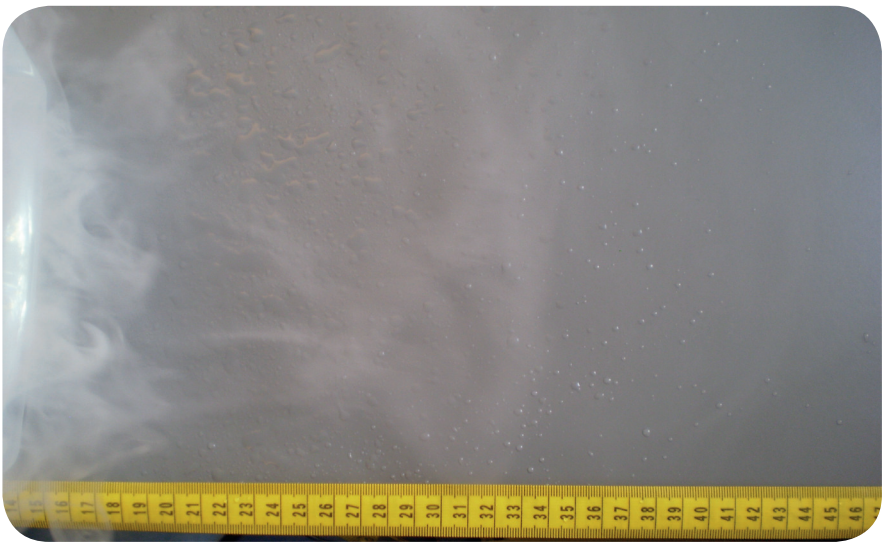


Splash from the transducer

One of the things discovered during the experiments is, that the transducer splash during use. It is decided to measure the splash, as it can have an effect on the design of the tank.

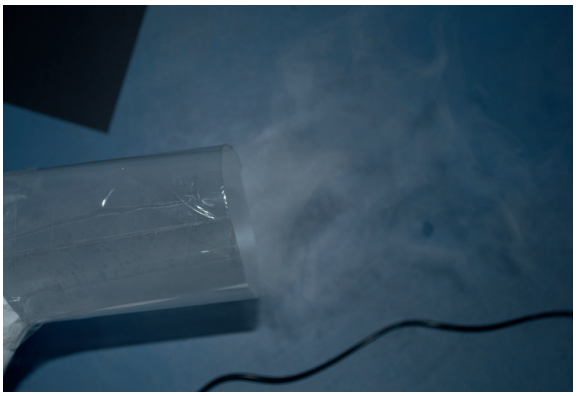
It is found that the wave the transducer produce, is about 100-120 mm high, and that the splash reach about 300 mm from the centre of the transducer.

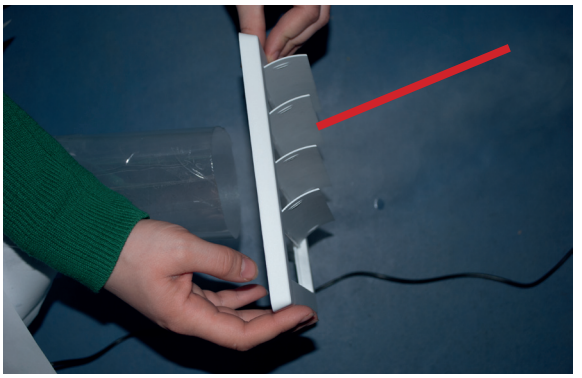


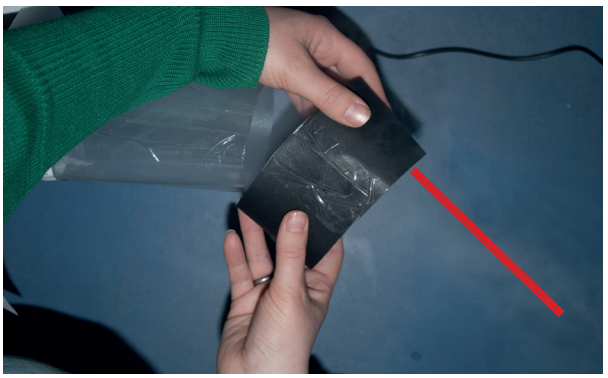


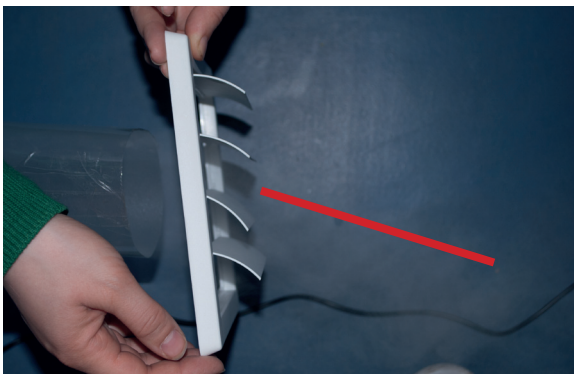
Control of output

It is found, that the haze can easily be directed, but, surprisingly, it is not the number of lamella that are important, but the depth, that influence the direction. As seen on the pictures, the lamella and the larger of the circles gives the same result, therefore it must be concluded that the best would be to use something similar to the large circle, to hinder the haze as little as possible.







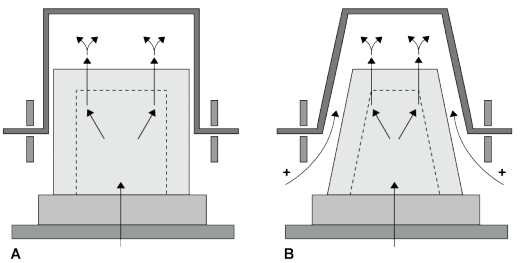


APENDIX E

VACUUM MOULDING

Vacuum moulding is a low cost production method, which is suitable for prototypes, and when a small number of units are needed. A unit is formed by a plastic plate which is heated up, and sucked over a mould by vacuum. To make sure the plate stays in the new shape, the plate is cooled down on the mould, where after it is taken off, and the unit is done.
This method is good when dealing with subjects with large surfaces and a small material thickness.

Within vacuum forming there are two kinds of moulds; a positive- and a negative mould.



The negative mould is good with small draft angles. Everything with a draft angle under 0,5°, is made on a negative mould.
Above an angle of 0,5° is made by a positive mould. The most common is a draft angle between 3-5°.

Pros

- Low cost tooling
- Mould can be made of relatively inexpensive material
- Economical for prototypes
- Low start-up costs
- Suitable for small production lines
- Provides design flexibility
- Time efficient, for small productions

[http://wiki.answers.com/Q/What_are_the_advantages_and_disadvantages_of_vacuum_forming]
[http://www.ehow.com/list_7332827_advantages-vacuum-forming.html]

Cons

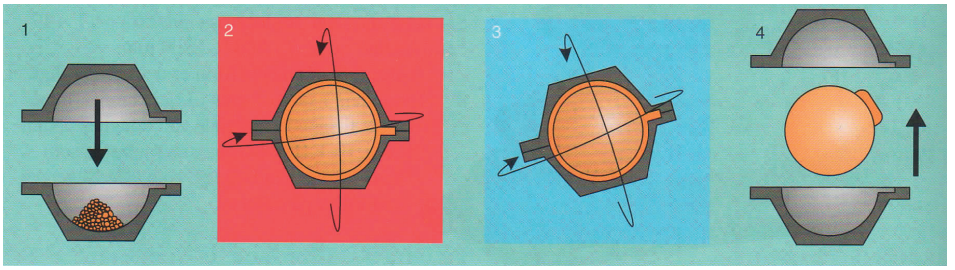
- Only for shallow pieces
- Risk of bubbles - air pockets which get in the material during production
- For Slow production method for loarge productions

[http://www.ehow.com/list_6890658_disadvantages-vacuum-forming.html]

APENDIX F

ROTATIONAL MOULDING

In rotation moulding plastic powder is poured into one half of the moulding form, the form is then closed and placed in an oven. The moulding form is heated up, while the mould is rotated, hens the name. The rotation makes the plastic spread out in an even layer on the inside of the mould, and is continued while the mold cools down. When the mold is cooled down, the part can be taken out of the mold, and the process can start again.
This type of production method is well suited for small and medium sizes productions of a 100 – 10,000 pieces a year. [Plast teknologi, 2. udgave]



The principal of rotational mounding [Plast teknologi, 2. udgave]

When designing for rotation moulding there are a few things that must to be taken into consideration.

- The wall on the outside corners is thicker, because the material will gather here.
- Walls on the inside corners is thinner, because the material will fall away.
- The larger radii the more uniform wall thickness
- The wall thickness will vary, but this can be controlled by different methods, e.g the rotation speed and with heat.
- Dimensional tolerance is 1-2 % (shrinkage)
- Flatness tolerance is 2-5 % (because the element is cooled from the out side only). Avoid large flat areas, by using curved surfaces to conceal the warpage.
- It is possible to mold metal parts into the product.
- Ribs is difficult to make, but the product can be stiffened by corrugating the form, if this is the chosen option, the depth should be four times the material thickness, and the width five times the material thickness.
- The draft angel depend on the mold, because the plastic in some cases will shrink away from the mold, as it cools, but in cases where the shrinking will place the mold more tightly in the mold, a draft angel on 1-20 is sufficient for polypropylene and nylon, but for stiffer material an extra degree is needed.
- Holes has to be made in the part after moulding.

http://file.seekpart.com/keywordpdf/2011/1/12/201111252045548.pdf

The pros and cons for rotational molding:

Pros

- *"A hollow part can be made in one piece with no weld lines or joints*
- *The molded part is essentially stress-free*
- *The molds are relatively inexpensive*
- *The lead time of the manufacture of a mold is relatively short*
- *Wall thickness can be quite uniform (compared with other free surface molding methods such as blow molding)*
- *Wall thickness distribution can be altered without modifying the mold*
- *Short production runs can be economically viable*
- *There is no material waste in the at the full charge of plastic is normally consumed in making the part*
- *It is possible to make multi-layer parts, including foamed parts*
- *Different types of products can be molded together on the one machine*
- *Inserts are relatively easy to mold in*
- *High quality graphics can be molded in."*

http://file.seekpart.com/keywordpdf/2011/1/12/201111252045548.pdf

Cons

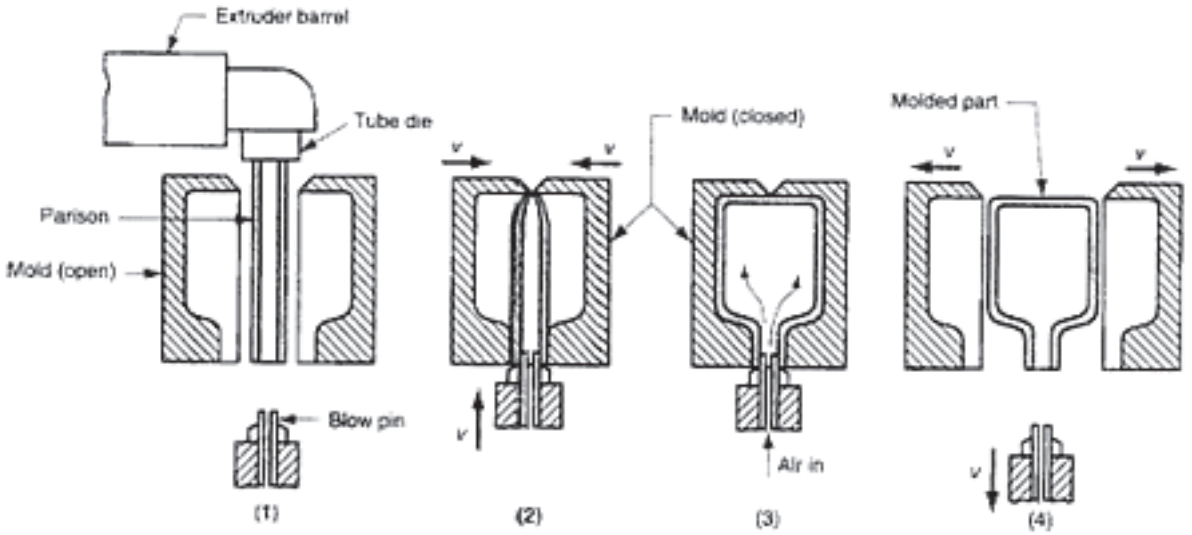
- *"The manufacturing times are long*
- *The choice of molding material is not as great as with other molding methods*
- *The material costs are relatively high due to the need for special addi tive packages and the fact that the material must be ground to a fine powder*
- *Some geometrical features (such as ribs) are difficult to mold"*

http://file.seekpart.com/keywordpdf/2011/1/12/201111252045548.pdf

APPENDIX G

BLOW MOULDING

The basic principal behind blow moulding is, that a soft plastic tube is placed inside the moulding form, the tube is in one end flattened by the mold, and the other is kept open. A blow drift is inserted in the tube, which injects air into the tube. The tube is blown up like a balloon, hereby getting the shape of the moulding form. [Plast teknologi, 2. udgave]



The principal of blow moulding [Plast teknologi, 2. udgave]

When designing for blow moulding there are some basic principals to follow:

- All angles and shape edges has to be rounded to minimize difference in wall thickness
- Radii should be two times the material thickness.
- Parts should be as symmetrical as possible to avoid uneven wall thickness
- Large flat surfaces, is prone to warpage, because the plastic is cooled by one side only, it is recommended to make corrugated designs on these surfaces.
- Draft angel should be 1-2 degrees, where two is recommended.

http://engr.bd.psu.edu/pkoch/plasticdesign/blow_design.htm

The pros and cons of blow moulding:

Pros:

- *"Tooling cost is typically less than injection molding.*
- *Piece price is typically less than rotational molding.*
- *One piece construction (no welding or gluing part halves together.)*
- *No cores allow for irregular shapes.*
- *Seamless construction is ideal for liquid filled or airtight containers.*
- *Excellent ESCR (Environmental Stress Crack Resistance.)*
- *Quick product revisions allow for increased flexibility (wall change is process change, not a tooling change. Tools made from aluminum are less costly to revise.)"*

http://www.paarloplastics.com/public/blowmolding.cfm

Cons:

- Difficulties with unsymmetrical parts
- Uneven wall thickness
- Only good for hollow parts

APPENDIX H

CALCULATION

In order to figure out the size of the different tanks, calculations are made.
Based on user interviews it is found, that one show is approximately 5 hours, but taking unexpected elements into account, there is calculated with 6 hours. When using the Hydrosonic on full effect it uses 116 ml fluid pr. transducer an hour. The fluid is a mix of 90% water and 10% concentrate. The transducers in the tank must at all time be covered with 2,5cm fluid. Based on the existing products from Martin, it is decided that one concentrate container must last for 15 hours.
The machine has 32 transducers

Main tank

The volume of the main tank is found in Solid Works:
One tank for 8 transducers contains 1137901.80mm^3 ≈ 11.4dl
For the hydrosonic to have 32 transducers there is needed 4 tanks:
11.4 dl *4 tanks = 45.6dl = 4,56l

This means, that the tanks must have 4.56 litter of fluid at all time, when in use.

The fluid for the machine consist of 90% water and 10 % concentration
Therefore
Concentrate: 4.56l * 0.1 = 0.46l
Water: 6.7l * 0.9 = 4.10l

This shows that there is needed 0.456l concentrate and 4.56l water.

Sump tank

To be able to place the components and find the size of the hazer, it is necessary to make approximately calculations, to get an idea of the needed fluid. Later, when components and tubes are placed, a final calculation will be made, and the exact amount of fluid is found.
The main tank with the transducers contains 4.56 litres of fluid. To make sure that the sump tank is big enough to hold the fluid from the main tank, the tubes, and the sump tank itself, it is evaluated that the sump tank must contain 1 ½ time more than the main tank.

The size of the sump tank: 4.56l * 1.5 = 6.84l

Sump tank and hoses during use: 6.84l – 4.56l = 2.28l

The 2.28l must be divided in concentrate and water

Concentrate: 2.28l * 0.1 = 0.23l
Water: 2.28l * 0.9 = 2.05l

This means that the sump tank must contain 6.84l, where 2.05l is pure water, and 0.23l is concentrate.

Water tank

One transducer uses 116 ml/ hour, where 90% of this is water.
116ml/hour fluid * 90% => 116 * 0,9 = 104.4ml/hour

With 32 transducers this becomes:
104.4ml/hour * 32 transducers = 3340.8ml/hour

The water tank only needs to contain water for one show, therefore
3340.8ml/hour * 6 hours = 20044.8ml ≈ 20.05l

Besides water for the transducers, it has to be taken into account, that there is needed water for the tubes, the main tank, and the sump tank.

Therefore the total need of water is:
4.1l + 2.05l + 20.05l = 27,5l ≈ 30l

A water tank of 30 litres is needed for one show of 6 hours.

Concentrate container

One transducer uses 116ml fluid an hour. The machine has 32 transducers and consumes therefore:
116 ml/hour * 32 transducers = 3712ml/hour

The fluid consist 10% concentrate, therefore:
3712ml/hour * 0.1 = 371.2ml/hour

The average length of a show is 5 hours, but taken unforeseen elements into account, there is calculated with 6 hours per show.
371.2 ml/hours * 6 hours = 2227.2ml ≈ 2.23l

Besides from what the transducers uses, the fluid in the tubes, the main tank, and the sump tank has to be taken into consideration.
For one show lasting 6 hours the machine needs:
0.46l + 0.23l + 2.23l = 2,92l

Based on the existing hazers from Martin it is chosen, that a concentrate container must last for 15 hours = 2.5 show, at peak output. Therefore:
2,92l * 2.5 = 7.3l

A concentration container of 7.3 litter is needed.

This project is a master thesis made in collaboration with Martin Professional. The task is to develop a new hazer (a smoke machine). The process report is the first of two reports, and describes the process, from user research, that gives an insight into the music business, to finial design proposal and detailing, where production methods and technical solutions will be discussed. Beside the design there is made a thorough investigation on, how to prevent the users from re-filling the concentration container.