How to make a cleaning product with a simple and attractive refill system

- Knut Håkon Breivik

A project by Knut Håkon Breivik, department for Product Design at Akershus University College, spring of 2011

simple smart new

Summary

This report shows the process up to and including the result of the Tersus project.

Tersus, meaning clean, is a detergent spray bottle. It has a refillable water chamber and a system using compressed gas and high concentrated cleaning agent capsules to give the user access to which ever type of detergent he or she wants at the time.

A bottle contains 4 different capsules simultaneous. The user can change between these at any time without having to refill the water tank, since the detergent is mixed right before it exits through the bottles nozzle.

The project is based on a an idea of diminishing the required size of a product with a compound liquid content by using high concentrated capsules.

The goal of the project was to make a cleaning product using capsules as a refill solution to make the refill option simpler and more attractive.

This report includes concept development, design drawings, engineering schematics and marketing strategies for making the Tersus -system and -brand a success.

Figure 1.

Sammendrag

Denne rapporten vise utviklingen og resultatet av Tersus prosjektet.

Tersus - betyr ren, er en sprayflaske for vaskemidler. Den har et påfyllbart vannkammer og et system som bruker komprimert gass og kapsler med høykonsentrert vaskemiddel som gir brukeren tilgang på hvilket vaskemiddel han eller hun trenger, når som helst.

En flaske inneholder 4 forskjellige kapsler samtidig. Og siden vaskemiddelet blandes inn i vannstrømmen rett før flaskas dyse, kan brukeren bytte mellom disse når som helst, uten å måtte fylle på vanntanken.

Prosjektet er basert på en idé om å senke størrelseskravet på et produkt som inneholder en blandet væske, ved å bruke høykonsentrerte kapsler.

Målet med prosjektet var å utvikle et rengjøringsproduct som bruke kapsler som refill for å gjøre refill enklere og mer attraktivt for brukeren.

Rapporten inkluderer koseptutvikling, design- og tekniske tegninger og markedsføringsstrategier for å gjøre Tersus -systemet og -merket en suksess.

Preface

This master thesis has been conducted at Akershus University College (HIAK), faculty of Product Design.

The rapport describes a concept based master thesis. The rapport is written to give an insight into the work I've put into the development of Tersus.

The product idea for the project came while working on a project at a professional industrial design company(Eker Design AS). I hope this rapport give you, the reader, a clear and simple insight into parts of my life as an industrial designer.

I want to thank Nenad Pavel at HIAK for supervising and helping me when ever I asked for help throughout the project.

A special thanks out to Victor Rosenvinge at Eker Design for helping me turn the idea into a project and for being my external mentor during the project.

I also want to thank my friends and fellow students for bearing with my never ending questions, and for helping me get through the project how ever glum it might have seemed at times.

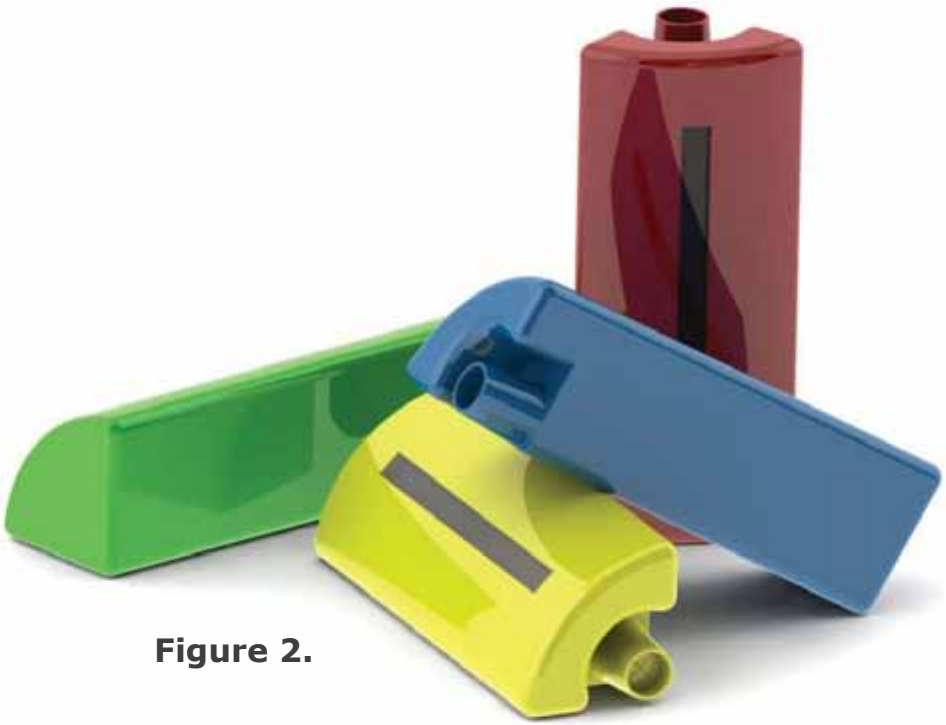


Figure 2.

Kjeller, May 18. 2009

Knut Håkon Breivik

Part I - Introduction

What is Tersus?

Background

The Tersus project idea is based on some of the work I did during my placement period at Eker Design AS.

The background for the idea is that quite a few market segments using compound liquids can gain from having the liquids separated until they are needed. Some gain a longer life span because of chemical reactions that reduce their life span when they get mixed. Other can be made smaller by having the different liquids separated, especially ones using water, as water is easy to come by for refilling.

Eker case

The project I did at Eker Design that triggered the idea, involved a mechanical solution and design of a system using capsules to keep two separate fluids separate until the user wished to mix the content.

During the project I familiarized myself with working with liquids, and also with working in a professional environment. Throughout the project I have looked at the work I did at Eker compared to the work I'm doing academic wise in the thesis.

The biggest difference between the two is the documentation, with an academic work that will be evaluated in the end of the term, by an outside evaluator that has no previous knowledge of the project, every step up to the completion needs to be documented in the rapport. Whilst at Eker I got to have an open dialogue with the client at all times, keeping them updated on the progress and therefor at the completion of the project they only required the finished files for production.

Research question

During the project, the aim of the research narrowed down to look primarily at one market segment, cleaning products. It was then that I understood that the original research question was too wide, and too focused on the mechanical aspect of the concept to fit this education.

I therefore altered it to revolve around user perception- and use of a product, based on the original idea.

Original:
"How to improve a compound products life span by mechanically separating its content during storage?"

New:
"How can a capsule system for cleaning products be developed to make refill solutions simpler and more attractive to the end user?"

Goals for the project

The projects main goal is to develop a cleaning product that uses a capsule containing a liquid, separated from the rest of the product, until the user has need for the liquids to mix.

Problem formulation

How to design a cleaning product for the Norwegian consumer market, based on a capsule solution for mixing fluids.

Result goals

- Develop a concept and design for a refill based cleaning product by implementing a capsule system.
- Construct a digital- and physical 3D model to show the finished design.
- Propose a marketing strategy for the product
- Create a rapport as a basis for documentation of the work put down into the project, and the result of that work.
- Conduct a self-reflection on the project in the rapport.

Effect goals

My goal with the project is to create a cleaning product that can be viable to enter the Norwegian market.

Project management

Time schedule

To uphold a constant flow throughout the time period the project has been set to, it was started up with a project plan containing milestones. This tool has been vital in upholding the flow of the project through thick and thin.

New temporary ones, large and small have been created in between periods. But the main one has still been used as a project guideline.

Guidance - HIAK

During the project there has been three different main supervisors for this project. Two fell out rather soon due to overloaded work schedules, but the last one, Nenad Pavel stuck and have been helping with keeping the project going through tough times.

He has also been a sparring partner in regards to market placement and form development.

Guidance - Eker

Victor Rosenvinge at Eker Design agreed to supervise this master project after I ended my placement period there. He has been helpful in making sure I've stayed true to the concepts qualities and that the projects goals have been maintained.

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**Rapport**	**97 days**	**Tue 04.01.11**	**Wed 18.05.11**	
2		Case study(Eker)	97 days	Tue 04.01.11	Wed 18.05.11	
3		Market research	20 days	Tue 04.01.11	Sun 30.01.11	
4		Rapport composition	6 days	Mon 31.01.11	Sun 06.02.11	
5		Interview	16 days	Mon 31.01.11	Sun 20.02.11	
6		Fieldwork	26 days	Mon 14.02.11	Sun 20.03.11	
7		Observation	26 days	Mon 14.02.11	Sun 20.03.11	
8		Cleanup	3 days	Mon 16.05.11	Wed 18.05.11	
9		Rapport delivery	0 days	Wed 18.05.11	Wed 18.05.11	2;8
10		**Consept**	**38 days**	**Fri 28.01.11**	**Tue 22.03.11**	
11		Consept development	37 days	Fri 28.01.11	Sun 20.03.11	
12		Final decision	0 days	Sun 20.03.11	Sun 20.03.11	11
13		Consept rapport	2 days	Mon 21.03.11	Tue 22.03.11	
14		**Design**	**28 days**	**Fri 25.02.11**	**Tue 05.04.11**	
15		Design development	27 days	Fri 25.02.11	Sun 03.04.11	
16		Finnished design	0 days	Sun 03.04.11	Sun 03.04.11	15
17		Design rapport	2 days	Mon 04.04.11	Tue 05.04.11	
18		**Engineering**	**10 days**	**Mon 11.04.11**	**Sun 24.04.11**	
19		Production methods	4 days	Mon 11.04.11	Thu 14.04.11	
20		Material choice	3 days	Thu 14.04.11	Sun 17.04.11	
21		3D engineering	11 days	Mon 11.04.11	Sun 24.04.11	
22		**Modelling**	**15 days**	**Mon 25.04.11**	**Sun 15.05.11**	
23		Physical modell	16 days	Mon 25.04.11	Sun 15.05.11	
24		**Presentation**	**5 days**	**Fri 10.06.11**	**Thu 16.06.11**	
25		Stand	3 days	Fri 10.06.11	Tue 14.06.11	
26		Exhibition	2 days	Wed 15.06.11	Thu 16.06.11	25

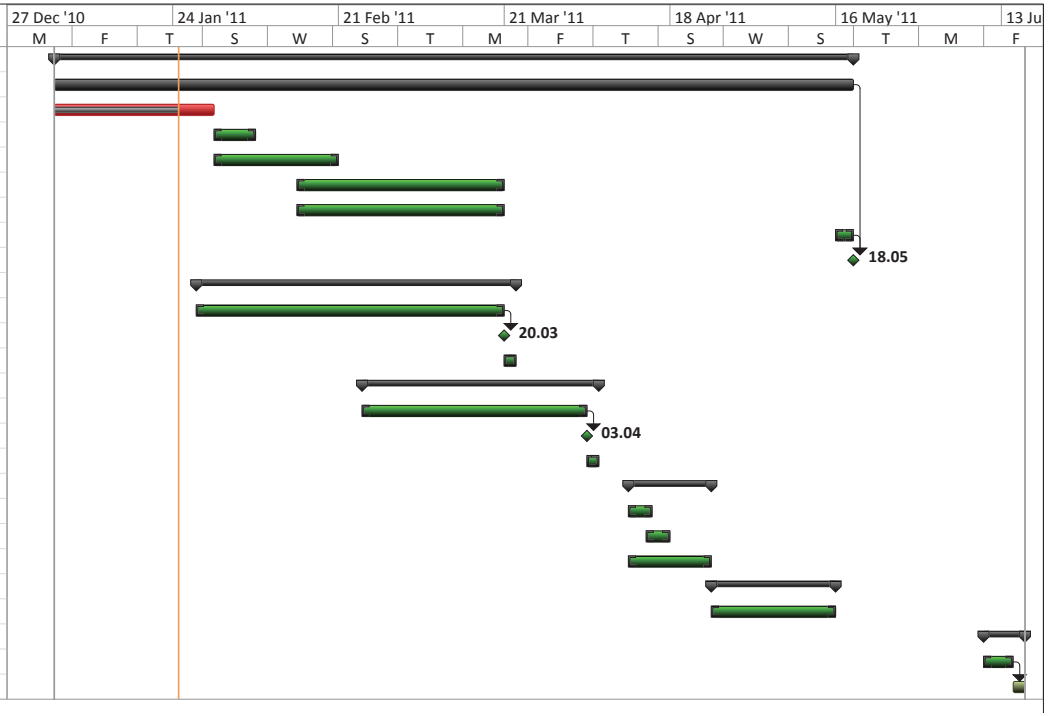


Figure 3. Project plan

Methods

Case study

Alongside the master project I have been working on a project for Eker Design AS. There I've been developing a bottle containing a capsule system for Injection Bottle Development AS.

The case has been closely related in the use of mechanics and marketing techniques. This has helped me in the master thesis, but has also been a hindrance in some parts where I knew of in-depth parts of the Eker project that I wanted to, but could not use in the master thesis, because of patent issues and a non-disclosure agreement.

Most of all it's been interesting having two works, that are so closely related, being conducted at the same time, while still having to be kept separate.

Through the project I've also looked into other cases that was related to either the marketing, design or concept of the Tersus. Among these is the Nespresso system which is closely related towards the Tersus project, both in terms of product and in marketing and sales strategies.

Field studies

By visiting the stores where Tersus will be sold I have gained a insight into the range of products it will be sold alongside. Both style and functions wise.

I've also looked at different contexts where Tersus will be most likely used and stored, both to see what requirements needs to be met in terms of storage capacity and style to fit into these locations.

Observation

During the project I have looked at how the end-user use already existing products as well as how they use conceptual models delivered by myself.

Most of this testing has been done to test out the ergonomic features of the designs and also to see how clearly the features of the design make the functions and user surfaces.

Interview & conversations

Through the concept I have been in contact with stores that would be potential sellers of Tersus to get their view on what, and why, their costumers actually buy what they buy.

I chose to talk to the storekeepers over the costumers since, in the stores in question the storekeepers usually have a good dialogue with the costumers about their wants and needs. This combined with their overview of actual sales made them perfect to talk to.

Survey

I initially wanted to do a survey regarding how much the users used existing products. But after doing some conversations with random groups of people regarding the matter, not one of them had any information to provide as they had no idea how much they used and how often they bought new detergents, even while being the head of their households and main purchaser.

Therefor I early on decided that a survey would result in mostly guesswork from the responders, wasting both mine and their time. So I chose to base my numbers for Tersus on conversations with professionals and on pure numbers taken from datasheets and testing of existing products.

Competitor analysis

I've looked into both how the competitors market their products as well as how they function mechanically. Seeing as I am developing a new system for connecting the capsule to the water stream I have been looking into using as many ideas from already developed products as I can to minimize unnecessary work load towards developing the bottle.

Verbal transactions

Close to all my communication with professionals, store holders, mentors and test subjects are verbal transactions. Because of this most of my sources cannot be placed in the source list.

This may put the report at a slight disadvantage, but I've valued getting information to make the finished product better over getting information in a way that benefit the report. The finished product should also speak volumes about the fact that the development is not done without proper input.

The reason for this choice is that from my experience, information given in a completely relaxed setting, with no band recorders or notes being taken during the conversation, is often the information that proves most usable.

I've gained allot of information I don't think I would otherwise have gotten from doing the information gathering in another way.

Literature

Market

Nestlés Nespresso brand has been a good source of information for this project, especially when it comes to marketing strategy. The Nespresso capsules have grown to be a brand most know about.

Their success in the coffee market is something I want to be able to copy into the detergents market. And by studying short cases on their development I have gained some knowledge for my own marketing plan in regards to Tersus.

I've also conversed with marketing and advertisement students that have directed me to other cases and interviews of interest to my project.

Design

Through the project I've found that products related to Tersus either by style, function or point of purchase, tend to be influenced by the simple forms of the Scandinavian design philosophy.

I've therefore looked into books and product related to Scandinavian style.

Part II - Market

Product, price, place and promotion

Introduction

The capsule refill concepts revolves heavily around getting the consumers to change their habits. This is not an easy task and besides making the form inviting and the mechanics simple to use, the marketing needs to be believable for the consumers to invest into the product and to be willing to try out the new way of purchasing and using detergents.

The product

The first real point of conduct to do in this project was to narrow the project down into one product. The system idea with the capsules can be implemented into a vide variety of different consumer markets. Even the final design can be used for things besides cleaning, just by changing the content of the bottle and capsules.

But a product that is made to work with everything usually works with nothing in the end. A product needs a specific purpose for it to be interesting for the consumer. So I chose to look into how different potential products, that fit the original research question, fit with some different criteria I set up.

Criteria	Beverage (Soda, coffee)	Industry (High octane gasoline)	Medical (Blood bags)	Sports (Ice packs)	Detergents (Cleaning supplies)
Design potential	Medium	High	Low	Low	Medium
Complexity	Low	Low	Low	Low	Low
User knowledge	Low	Medium	High	Low	Low
Similar solutions	High	Low	High	High	Medium
Regulations	High	Low	High	Medium	Low
Competitors	High	Low	Medium	Medium	Medium

Figure 4. Product area overview and evaluation

Product areas

There is an abundance of product areas where using capsules to separate liquids from one another could be implemented. However, not all areas would, in my mind, be as interesting to work onwards with for my master thesis. Therefor I took a few of the product ideas I had floating around in my head onwards as potential product. Juice and soda bottles, gasoline mixture, blood bags, ice pack, detergents, all of which use liquids that is combined and could be an area of interest for me to design for. But as I am only one person and got a limited time frame I had to choose a product to go for onwards from here.

Deciding

After having looked over the potential difficulties and possibilities that each of the areas had to offer, I decided to produce a cleaning product. This was, as noted, based on a series of different criteria that allowed me to be free enough to design what I wanted to design within a frame that would allow me be creative, while also having some structure to be followed.

Design potential
The detergents market in Norway does not have that many players, and since most of these follow a standard for their products most of the products on the market now looks more or less like the same. This leaves me with a lot of room to design something new and exiting.

Complexity
Spray bottles with detergents have been around for a long time, and the mechanics they use for transporting and spraying their payload is easy enough to copy. This allowed me to focus more effort into tuning these systems to mesh with the Tersus capsule system.

Prior user knowledge
Anyone who intend to clean need to use a detergent and anyone who wants to use a detergent should be able to. There should not be a minimum requirement of previous experience from other cleaning products to be able to use the Tersus product.

This was my baseline for making all parts of the Tersus bottle as easy to use as possible.

Similar solutions
Within the range of cleaning products there are some that do something similar to what this project is about, naming a few are toilet bars and high pressure cleaners. Even though they are in the same category, cleaning products, as Tersus, these products are not in direct competition with Tersus and I've been able to use some of their features in the project.

Regulations
Any chemical that is used by and near humans are restricted in some sense, so I needed to create something that did not expose the consumer to any hazardous material in any way while handling the product, if they needed to be in contact with any of the content at all.

For Tersus that would be the highly concentrated detergent in the capsules.

Competitors
The largest producer of detergents for use in the home in Norway is Lilleborg AS. Their portfolio consist of some of Norways strongest brand identities. Therefore I worked towards making the Tersus system use this as an advantage by allowing co-branding, instead of going directly up against them.

Target group
The target group for the Tersus system is adults in the range of 25-60. They are settled individuals who like taking care of their own homes, and they are brand sensitive and willing to pay a little extra to get something that give them that little extra in functionality, form and build quality.

...the average buying costumer in here is between 25 and 60, with a slight balance towards men...

(Anne, store keeper at Christiania Glasmagasin, Lillestrøm Torg, personal communication(translated) March 29. 2011)

As I'll expand on later in the report I am aiming at selling the Tersus system through high end retailers of kitchen wear. This fits with the target group as the average consumer at these stores are often open to new things, want something that not everyone else have, and they value quality over quantity.

Price & production

Consumer value

To a product sold in stores like the ones Tersus will be sold in there are some requirements that needs to be in place for it to be a success. One of these is the style of the product, it needs to fit in with the rest of the style the consumer has in his or hers abode. Which style each consumer has as their home is impossible to tell, but by looking at the retail stores Tersus will be sold though, and in stores for interior design. One can get a sense of the norm of the average home of today.

Discussing with the shopkeepers in these stores and visiting the stores have been of great help with this.

These products are affected by the trend of the time, but some points seem to be returning values for this group. These values are among other; simple, sleek, functional and ethical production. Quite a lot of the products sold are heavily influenced by Scandinavian design as I will get back to in the design phase of the report.

The ethical part of the consumer value is quite interesting, as the consumers are willing to pay more for a product sold that can say that it's been produced in an environmental and ethical way. This is a strong point for Tersus as the capsule refill solution aids in reducing the full products carbon footprint. Existing refill solution for spray bottles from other producers already reduce the combined materials used in those products. Tersus aims at reducing it further while making the refill process more attractive.

Capsules

Suggested Retail Price: 20 NOK

The price of the capsules will vary according to the content and the producer, but the price should reflect the amount of finished detergent each capsule provide.

As mentioned on the previous page, under "competitors", Tersus aims at reaching a co-branding situation with existing detergent producers. These producers will be producing the capsules and marking them with their own brands under a leasing agreement from Tersus.

In Norway, Lilleborg already cater equally much to the rich and the poor. By joining in on the Tersus system, they will gain a product that aims for the high end market. This won't directly win them any extra customers, but they will please a larger part of their consumers. It will also give them a stronger hold on those consumers they have only because there is no better alternative for them on the market today. By increasing their hold on those consumers now, with Tersus, they put themselves ahead of any uprising competition in the market.

This also benefits Tersus, as they will get a leasing fee for the capsules produces. Also, their system will be connected to already existing and well known detergent brands, letting the Tersus company avoid having to produce both a new detergent and building a reputation around that brand of detergents.

Bottle

Suggested Retail Price: 400 NOK

The bottle will be priced comparatively to other items sold in the relevant stores. Items of similar size and complexity with Tersus will be the major deciding factors for the price of the bottle.

The bottles will be produced and branded as a pure Tersus product to build a strong brand sense towards their costumers, and make sure they know that they are buying a product that they can't get anywhere else.

Eventually competitors will follow and

produce their own bottles and system designs, but as Tersus is the first, they gain the advantage of being the first into an unutilized market. If played right, Tersus will manage to remain, in the consumers eyes, the original producer of capsuled detergent systems.

The logic behind why Tersus wont launch it's own brand of detergents is similar to the logic that drove Jean-Paul Gaillard, commercial director of Nespresso S.A. to implement his strategy in 1988-89 which turned the operation of Nespresso into the profitable enterprise it is today.

Gaillard introduced several changes, but the logic that drove all his actions was the belief that the coffee side of the operation had to be separated from the machine side. Since Nestlé was not in the machine business, he felt he had to focus on coffee.

Markidos (2000)

The Tersus system is not about detergents, it's about the bottle, the capsules and the system between them.

Financial viability

The Tersus bottles will be high end products that are sold at a high price compared to other detergent spray bottles. The profit of the bottles are effected by the high cost of making them in the materials which fit the quality requirements of the target group. But the pricing of the bottles are based more marketing matters than in pure profit per bottle sold. If the bottles are sold at a price equalling that of other detergent bottles the consumers expect that same material quality and the brand looses credibility, even though the materials and build quality is top notch. Therefor the price will mostly be set in to products of similar complexity already present in the retail stores.

Where Tersus as a company will make the majority of their money is from the leasing agreements, with detergent manufacturers, on producing the capsules. With their co-branded partners produce the cleaning agent going into the capsules, Tersus only need to supply these with the capsules and then profit. The cost/profit ratio will be dependant on the leasing agreement they make with the detergent producers and can vary between brands. The production price per capsule will be a flat cost for Tersus, calculated independently from the leasing agrement.

The production of the capsules can also be left to the detergent produces, but then with an added production fee for being allowed to produce the capsules, on top of the regular leasing.

Place

The sales channels used reflect the consumer group and the Tersus system. The plan is to sell Tersus through high end stores like the Designforevig-, Jernia- and Christiania Glassmagasin store chains. This goes for both the bottles and the capsules.

To ease the accessibility of getting the capsules, these will also be available through a web-store from which they will arrive by mail.

The webstore will also work as a stepping stone in getting into the professional market later, once the system is properly implemented, and tested, into the behaviour pattern of the average consumer.

For the professional market, the most viable retail option will be internet purchase, to gain access to bulk purchases. Here they will gain access to the separate professional ranges of both capsules and bottle solutions.

Promotion

Word of mouth

The Tersus brand will rely heavily on the company having a good dialogue with the shopkeepers in the retail stores, With the lack of dedicated sales representatives present from Tersus the ones that will make or break the sale to an indecisive costumer is the shopkeepers. By having a good and frequent dialogue with the shopkeepers they will have positive disposition towards not only the Tersus product, but also towards the brand itself. When that is present their threshold for recommending the brand is much lower.

This relationship is also extremely important for further developing the Tersus product range in the right direction. In the stores the Tersus products will be sold through, it is, compared to supermarkets where most other cleaning tools are sold, an high degree of communication between the shopkeepers and the costumers. So to get the best possible insight into the wants and needs of the consumers, Tersus need to let the know that Tersus is interested in hearing what they have to say.

> *For most companies, salvation isn't just the web or mobile solutions. The best way to navigate the landscape is to realize that people's habits are ever-changing and to pay close attention to customers' ongoing discussions and behavior.*
>
> Kramer (2010)

This is one of the reasons why it's so important for Tersus to have a good relation to their retail store shopkeepers. Optimally a Tersus representative should be present at the point of purchase to get first hand information from the costumers, but as that would require a tremendous amount of time and resources it is easier to get the information from a unbiased third party. This willmost likely also give the most honest feedback, since a store costumer replying directly to a Tersus representative would probably feel obligated to giving the "right" feedback.

By marketing and selling the product to those that follow the trends in the market exclusively it will become a product that others want to have. It is not a need product, you can get the exact same result, a clean home, in other ways that the consumer is already aware of, know and trust. Therefore it is important to reach out and convince those that others look up to that Tersus is the future.

This type of word of mouth marketing serves another important purpose as well. The Tersus system carries with it a certain change in routines with the consumer. Even though the use of the product is simple, it require some getting used to. The high entrance price for buying the bottle might also put some of. Therefore it is vital that the shopkeepers and those who are already Tersus owners explain how simple and ingenious it really is. Getting the idea of the Tersus system through in a normal advertisement campaign might make it seam more like a novelty item than a solid investment.

By selling it through the stores that cater to those that are looking for that special something to set them aside from the rest of the consumer market, and that want that special something else, the customers will also be more likely to ask the key question that open up for a sale, "How does this work?".

Co-branding

The largest and most influential producer on the cleaning supplies market, as it is in Norway, is Lilleborg. Since this project is not about creating a new and improved detergent there is no reason why this product should aim at interfering with Lilleborgs brand and market. With that as a basis the project works towards achieving a co-branded product where Lilleborg produce the content which goes into the Tersus capsules. These again are then sold alongside the Tersus bottle.

By this cooperation Lilleborg is gaining a foothold into a new part of the detergent market that is to now, untapped. And Tersus will gain from having a detergent brand that is already highly regarded by the consumers.

For the first few years Tersus will probably have to give a sole leasing agreement with Lilleborg, which secures Lilleborg the position of being the only detergent supplier producing capsules for the Tersus system.

But as that agreement runs out the Tersus brand will be free to lease their system out to other detergent brands, as well as to continue their relation with Lilleborg. Some brands will most likely develop their own responses to the Tersus system by then, but if not, or if they failed, they might purchase a leasing agreement with Tersus. To cover the gap that the nonexistence of a Tersus equivalent leaves.

The Tersus does not fill a gap in the market where there are no competitors, as it is today. But by launching into the market, it creates a new segment within the old. One that detergent brands not associated with Tersus need to fill to be properly competitive in the detergent market.

Expansion potential

As noted in the co-branding scenario the Tersus brand will be able to lease out their system to different detergent suppliers over time. But that is not the only expansion potential of the brand.

Previously mentioned is also the potential of taking the system into the professional market with professional detergent brands, with bottles and capsules that have a larger capacity and are more directed into long term continuous use instead convenient in the now, and attractive in ones home.

After the initial release of the bottles the design of the bottles for coming years will be varied to follow the development in the market, both function- and form wise. The original design of the bottle will need to, at the very least, keep it’s main features and design lines as it goes though the years, but additions and changes will of course come once feedback and mass consumer testing is done.

For a few this will result in purchasing the bottles though several year, potentially making it collector items in the long run. As with the Statoil coffee mugs.

Part III - Concepts

How it all works

Intro

This part of the report take up the different technical solutions that have been considered for making the system work.

The concept for the system itself is already in place and only needs to be refined for the chosen user group.

Basic concept

For the Tersus system to work it needs a capsule containing the cleaning agent, water that will mix with the cleaning agent, a piping system with a nozzle to carry the water to the capsule and out through the nozzle and a pressurizing system with a trigger to make the water be pumped through the pipes.

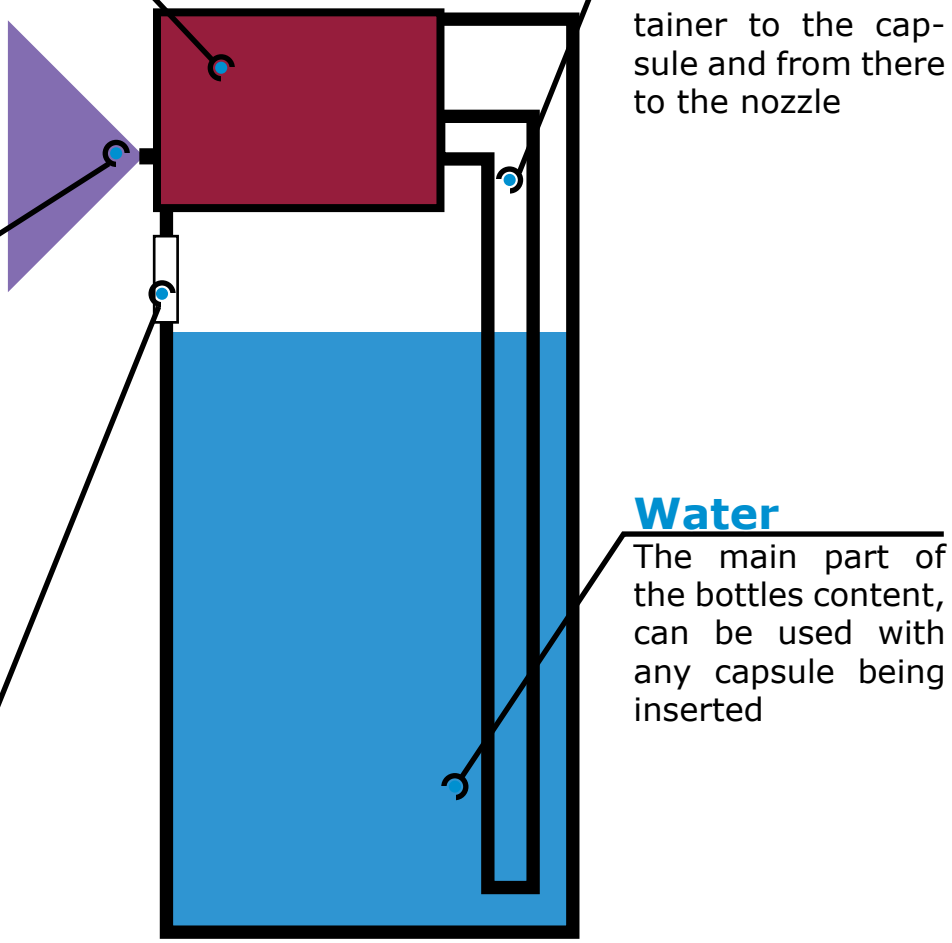


Figure 5. Basic explanation of the Tersus principal

Capsule principals

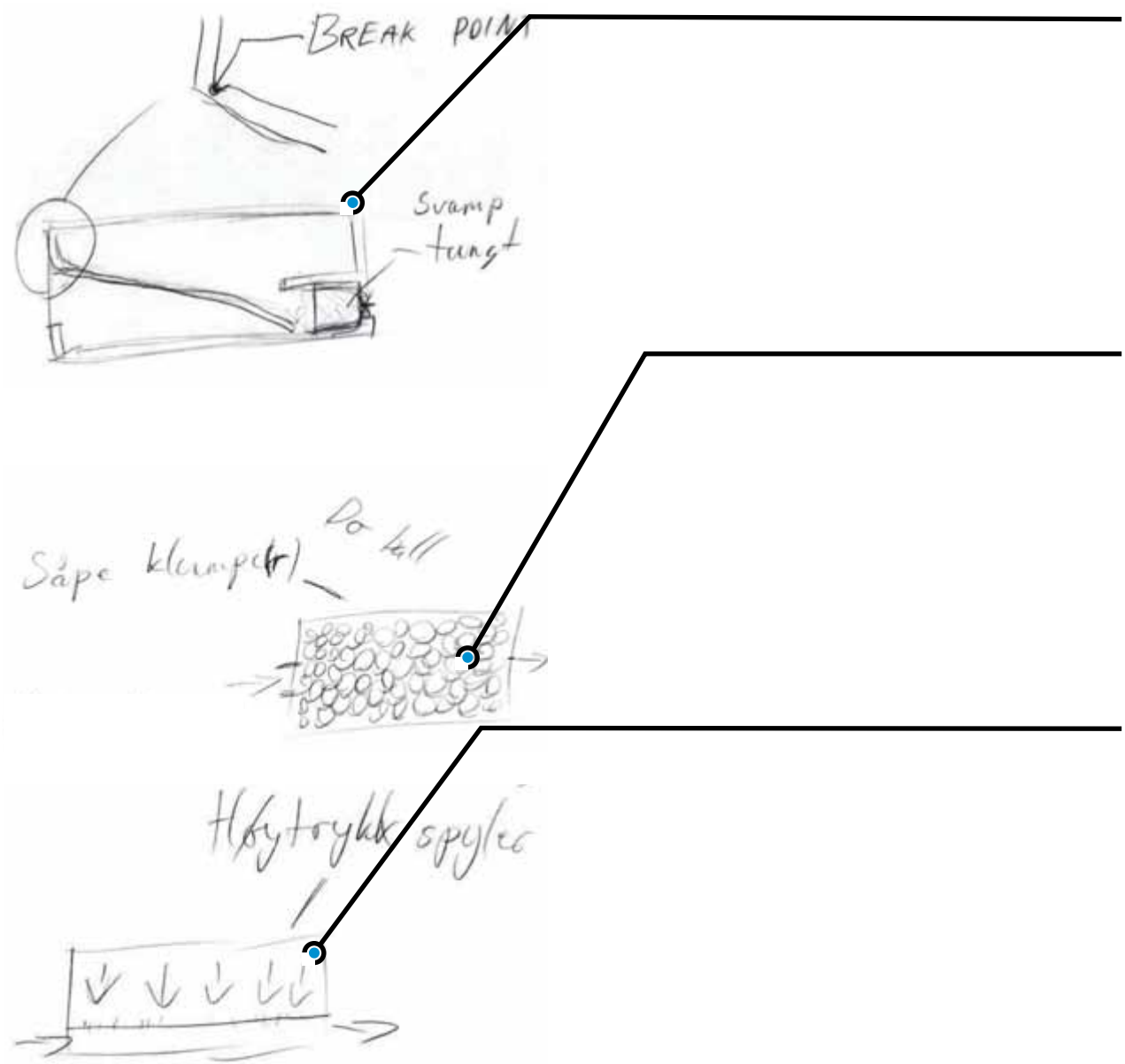


Figure 6. Capsule concept sketches

Mechanical

The mechanical capsule works with a mechanical flip which separates the detergent in the capsule that is going to be mixed from the spare detergent in the capsule which won't be mixed. This happens seamlessly within the capsule once water presses on the flap.

Solid

Based on the same principal as regular soap blocks and toilet fresheners, the water is pressed through the capsule, which contains a solid block of detergent which gradually mixes with the water that passes by. This happens for as long as the water is in direct contact with the block of detergent.

Hydro

Working in the same way as an airbrush or a high pressure cleaner with a soap add-on. The capsule connects to the water pipe and when the water passes by the opening in the capsule, the water creates a back draft. That draft makes the detergent follow and mix with the water before it hits the nozzle.

Initial evaluation

Before starting to refine any of the ideas I did a quick run through of the concepts, to look for points of interest and for their technical feasibility.

A mechanical flip relies heavily on material -thicknesses and -qualities. It is a very simple design to manufacture in general, but the tolerances needs to be tight. Being a self containing unit that has its own nozzle and was self closing even while connected gave it enough going for it to undergo more in-depth evaluation.

The solid detergent option is the most simple solution of all the concept, but seeing as it fails on one major point, the water gathered within the capsule will dissolve the solid detergent a little at a time until its a high percentage liquid detergent solution that will empty out of the capsule instantly, because of, it wasn't included in further evaluations.

A product using the hydro solution can be implemented without the capsule having it's own nozzle as the detergent that exits the capsule is contained in the water stream between the capsule and the nozzle. The capsule can also be removed without breaking the pressure between the water tank and nozzle. It continued to be developed.

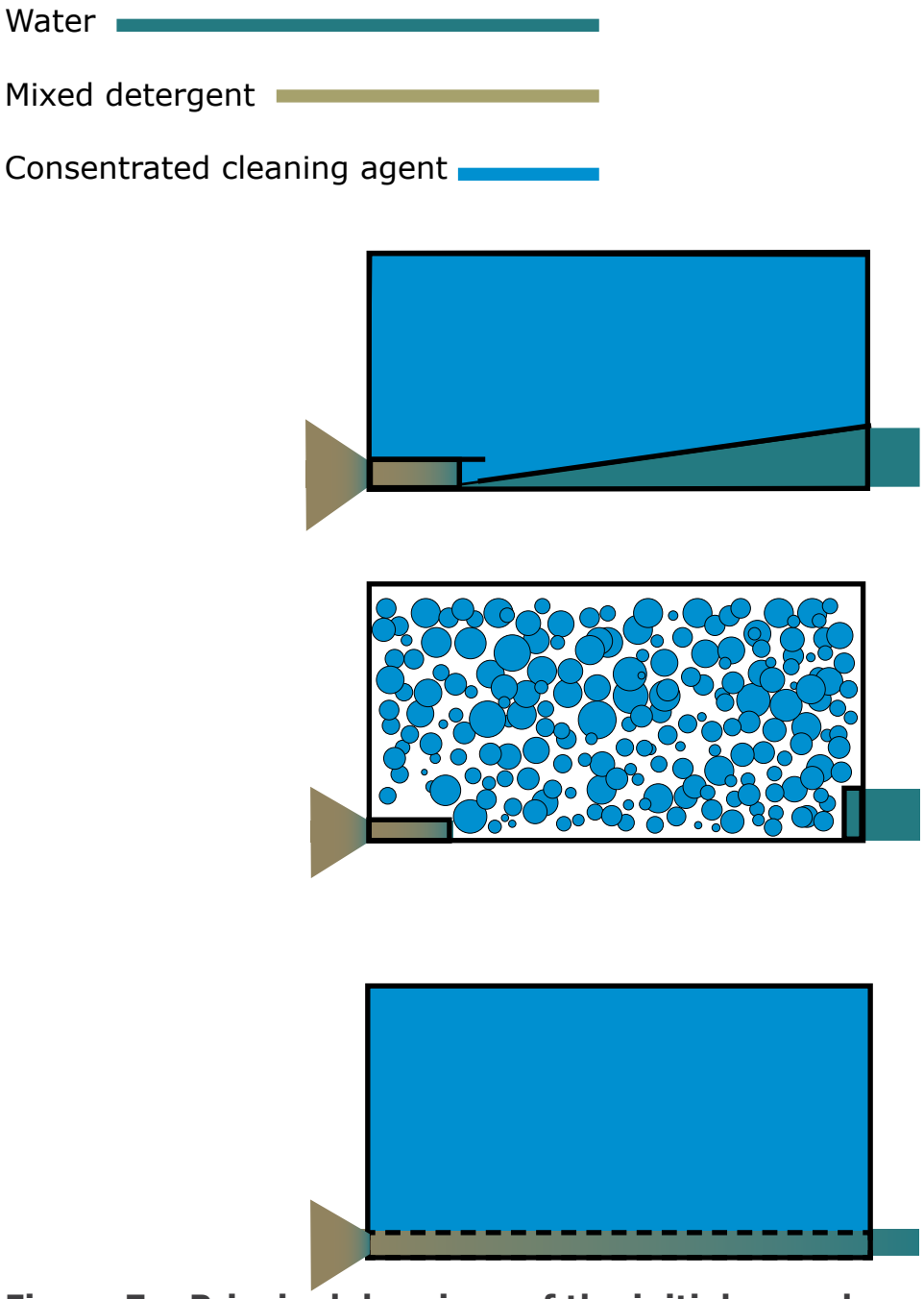


Figure 7. Principal drawings of the initial capsule concepts.

Mechanical principal

The mechanical capsule works so that a part of the capsule wall works like a on and of flap. It separates the detergent in the capsule that is going to be mixed from the spare detergent left in the capsule. This happens seamlessly within the capsule once water presses on the flap. Once under pressure, the flap moves inward in the capsule, sealing the slot leading from the nozzle and to-be-mixed chamber to the cleaning agent reservoir. By adjusting the angle of the flap in the machining tool the dosage of cleaning agent going into the water stream is adjusted.

Pros:

- Simple parts to manufacture
- Self contained with its own nozzle
- Stable dilution over time
- Easy to change dilution from capsule to capsule

Cons:

- Contains water after detachment
- The bottles shape is dependant on the capsule because of the nozzle
- Hard to make a magazine function for the bottle
- Requires allot from the materials for the flap to be stable through continuous use.

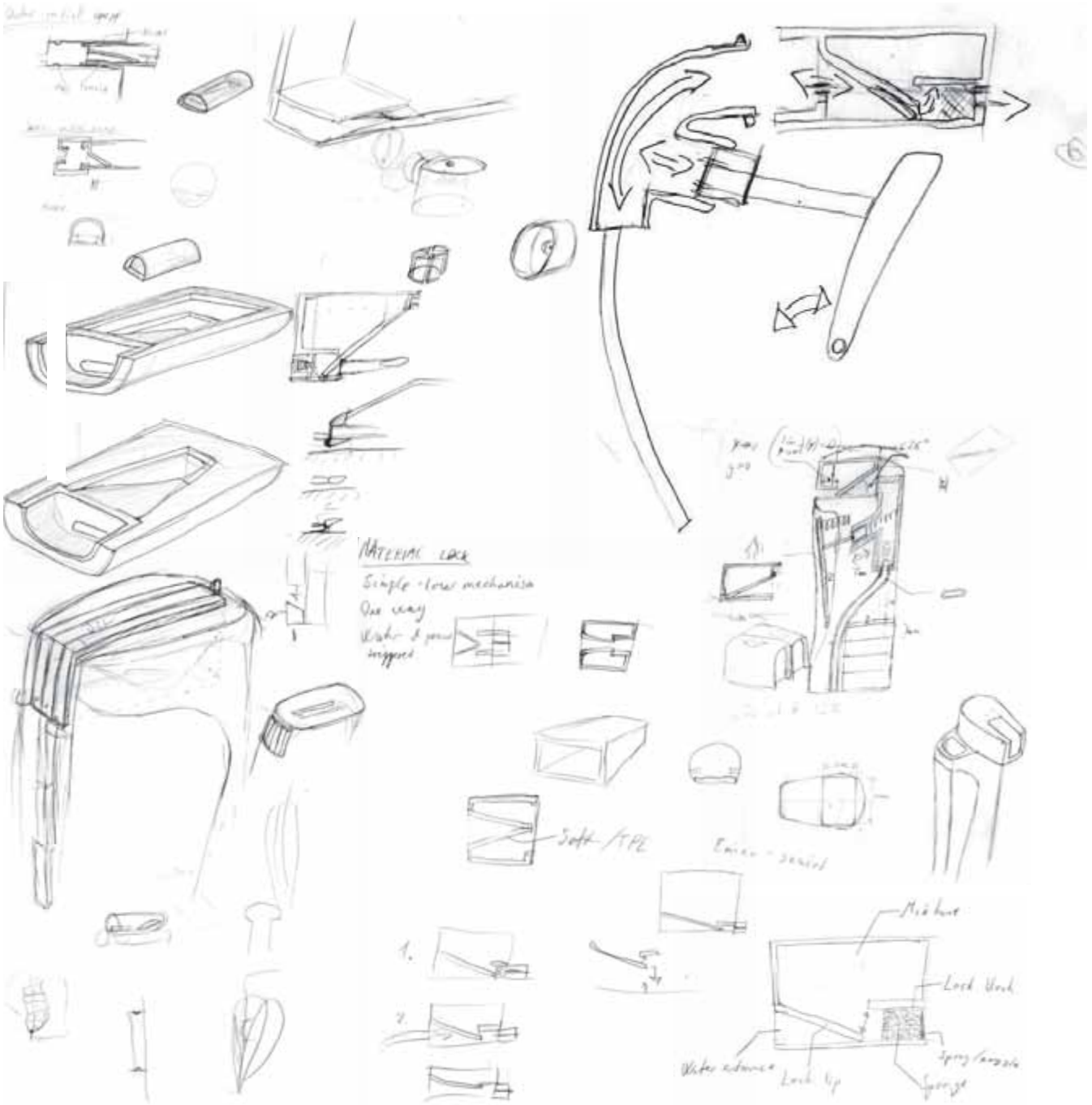
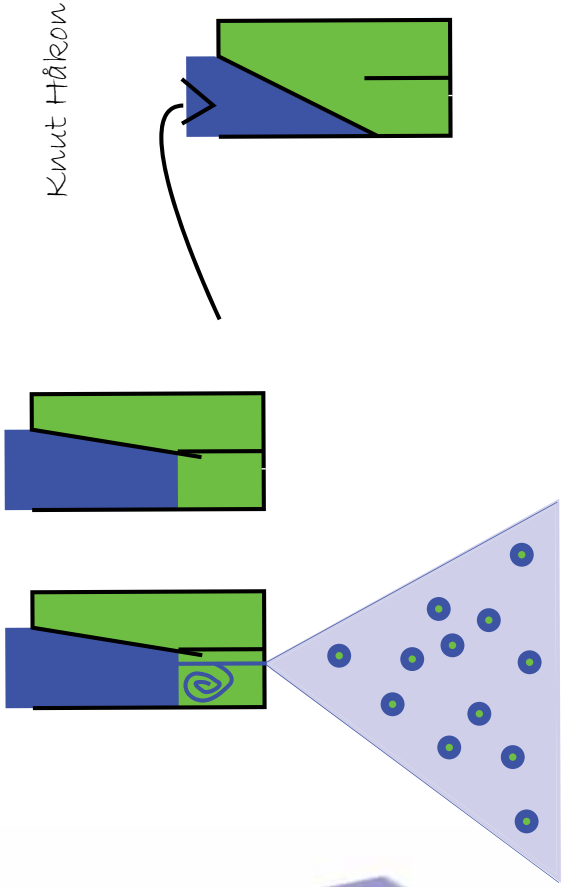


Figure 8. Mechanical principal concept sketches



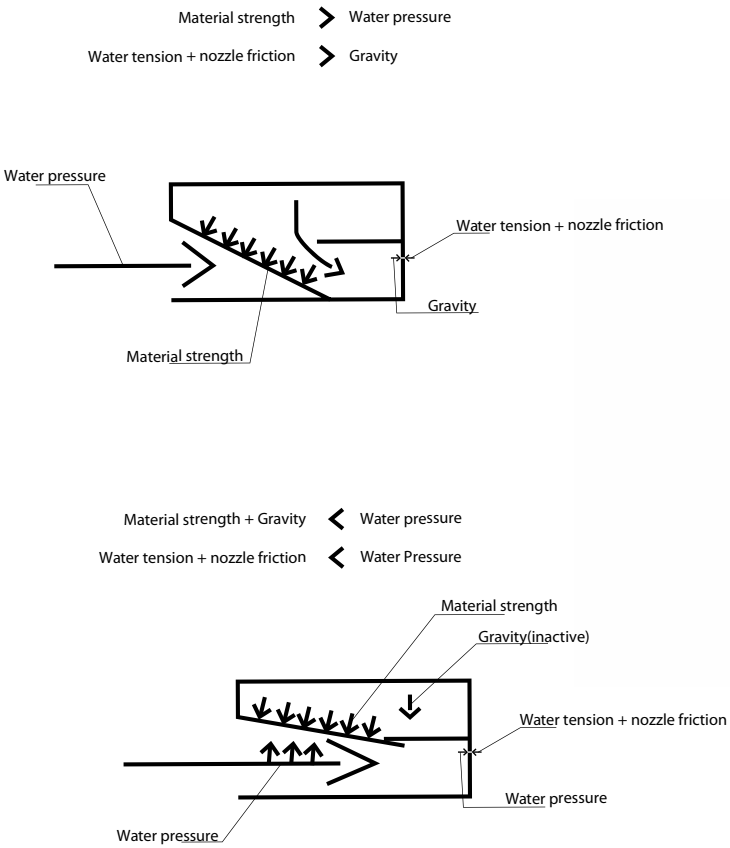


Figure 10. Principal draiwings of mechanical principal capsule

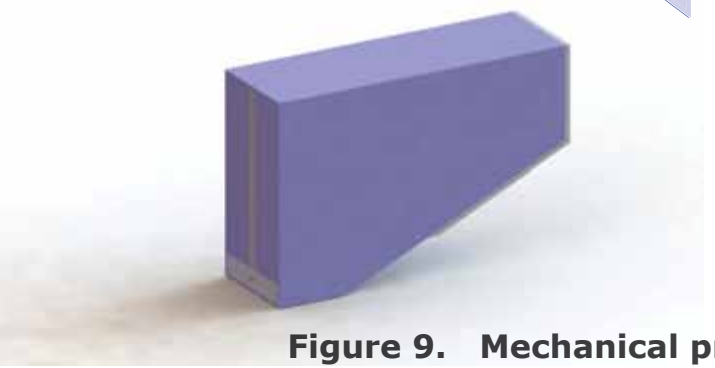


Figure 9. Mechanical principal rendings

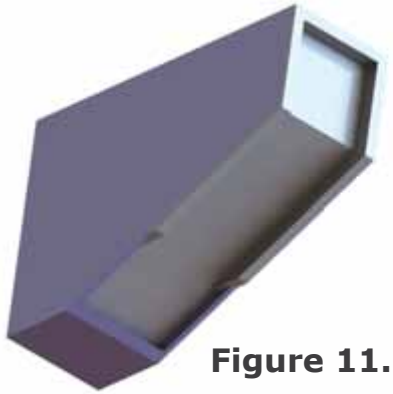


Figure 11.

Figure 12.

Flip switch

When the water is pressed against the capsule wall as illustrated with an arrow above, the entire wall will slightly bend and hit the edge within. When this happens the wall seals of supply of more cleaning agent from the capsule and the water will push itself and the cleaning agent trapped between the water and nozzle out through said nozzle.

Hydro principal

Working in the same way as an air-brush or a high pressure cleaner with a soap add-on. When the water is pressed past a opening in the capsule the water creates a back draft that makes the detergent follow and mix with the water.

Pros:

- Can be placed anywhere along the water pipe
- One way valve, no water remains in the capsule
- Easy to manufacture
- Stable dilution over time
- Easy to change dilution from capsule to capsule
- Possible to have a magazine

Cons:

- Between the capsule and the nozzle the water stream will have traces of the detergent
- Will require a special capsule for using the bottle at an upward angle

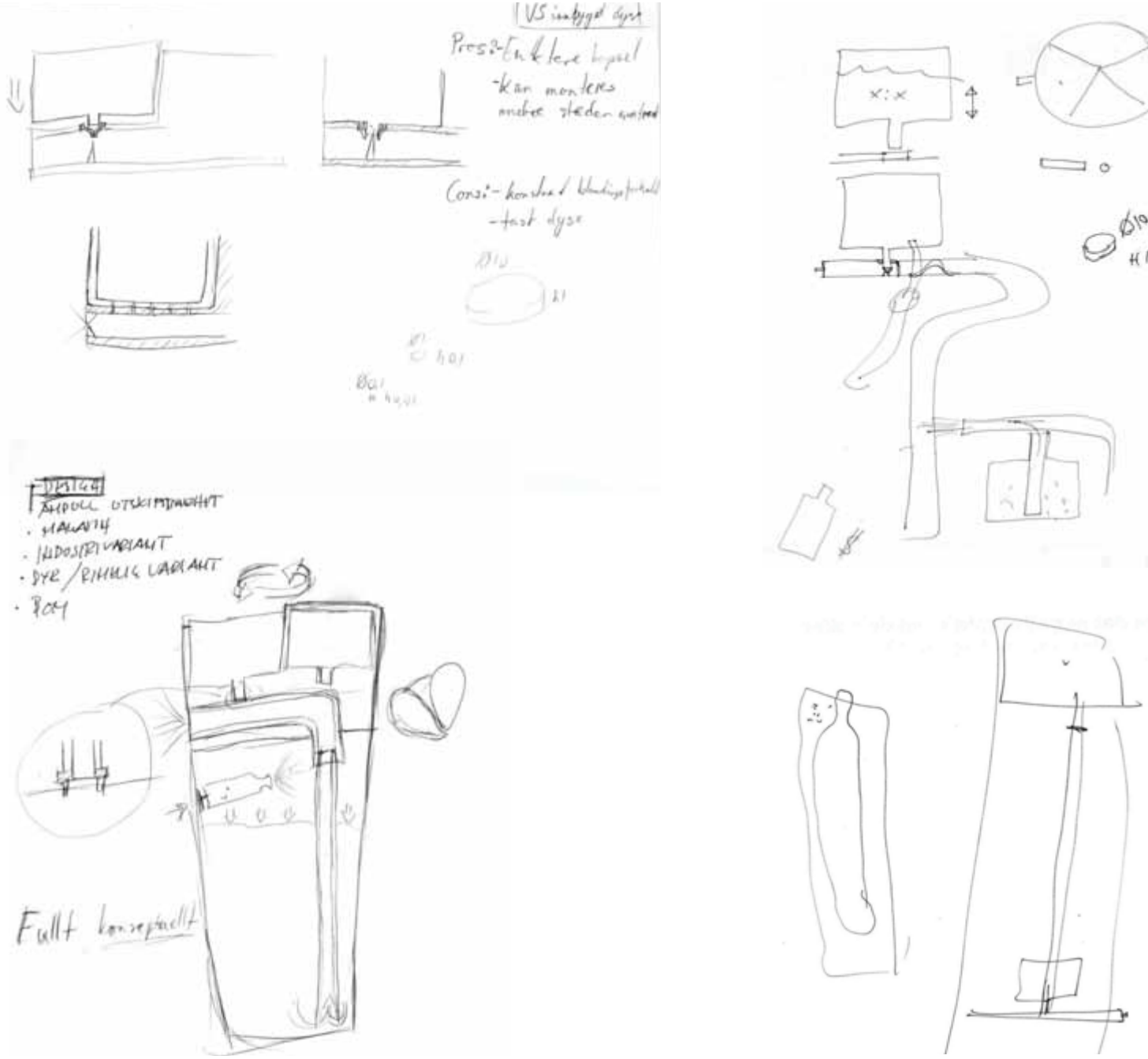


Figure 13. Hydro principal concept sketches

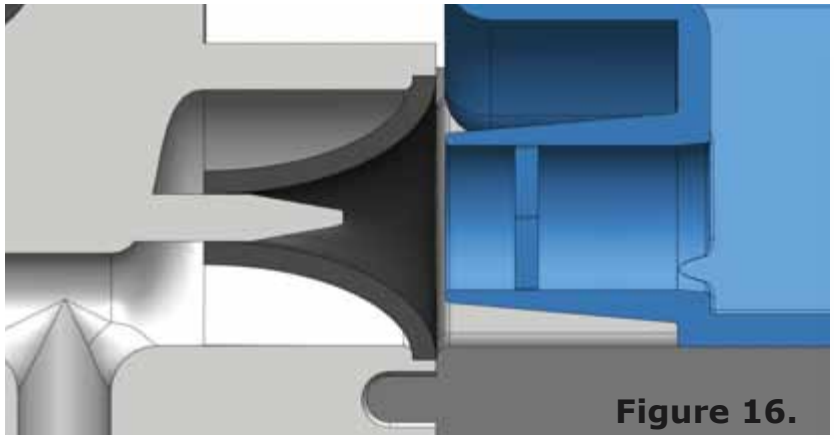


Figure 16.

Flow and drag

When a capsule like this is activated, the thin wall in front is pierced by a needle attached to the bottle. The cleaning agent will then slowly begin to pour from the gap in the front wall created by the needle and when water rush past the capsule it will create a slight drag force pulling cleaning agent with it. The constant water pressure from the bottle keeps the detergent from mixing all at once into the water stream.

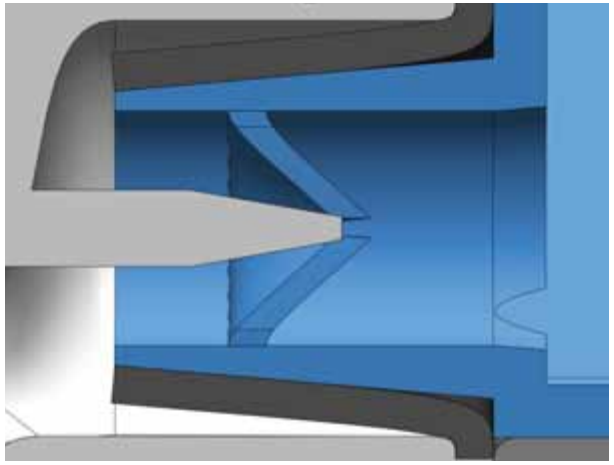


Figure 17. Hydro principal schematics

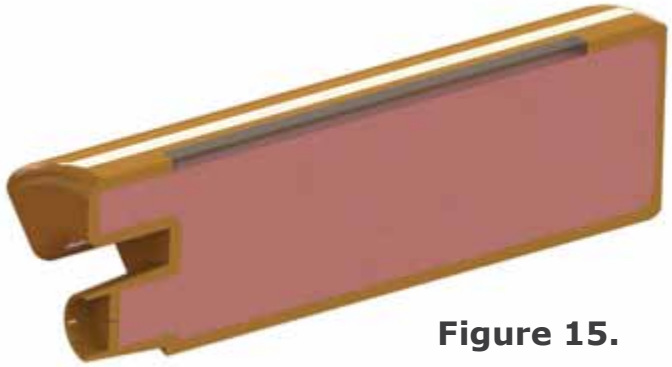


Figure 15.

Figure 14. Hydro principal capsule rendring

Final concept evaluation

Going over the two concept solutions I decided to work onwards with the hydro option, since it provided some very interesting opportunities for the bottle. The largest contributor for the decision came from the opportunity for having a magazine option which makes the whole product more viable to the target group as the product requires less maintenance and removes one of the largest problems with todays spray bottles, the storage. I tried implementing this with the mechanical capsule also, but made no real headway.

The hydro capsule also opened up for having a built in propellant which give the consumer the option of a continuous spray. This makes the product more viable in a sub-target group, the professional cleaner market.

Even though adding a propellant made product became more complex, having a propellant inside, the trigger and water transport system became a lot more durable.

Figure 18. Work sketches on magazine systems

Concept features

Each of the products features come with a back story, a reason to be chosen and most often, both upsides and downsides.

The hydro capsule

By using the hydro capsules, the user can store and use different types of detergents in the same bottle without having to worry about dosage, having to refill the bottle between operations or to have several bottles laying around. It also enables the user to use the bottle without a capsule to spray pure water.

It does however require the user to change their behaviour pattern from what they are used to into a new way of storing and utilizing detergents.

Refillable water tank

By being able to use the same water tank and bottle regardless of how many times you change capsules, the bottle can be made justifiably in a higher quality material, prolonging it's life span and making it an environmentally more viable solution.

Requires the consumer to keep a slight eye on the water level as well as the content level of the capsules.

Gas ampule

By using a gas ampule to propel the water through the bottles piping system, the spray can be kept constant for an extended period of time effortlessly. This reduces the strain on the user when applying detergent to a large cleaning area. It also simplifies the construction of the piping system within the bottle.

The area containing the water and propellant needs to be air tight,instead of just water tight, for the pressure to build up enough in the container for the water to be pushed up and out through the nozzle. It also adds another part to be replaced by the consumer.

Capsule magazine

Allows for storing and quick replacement of capsules in between cleaning operations, without the need to store backup capsules separate from the bottle.

Capsule opening

- Where the detergent is released into the water stream
- Anything after this point is ready mixed detergent

Detergent spray

- Finished mixed detergent
- Exits the nozzle in a high pressure arc

Container

- Holds all the mechanics together
- Airtight to stop the gas from the co2 capsule from exiting the container without pushing the water through the nozzle

Trigger

- Punctures the gas capsule, starting the reaction that makes the water go through the system
- Starts the reaction once the trigger is pressed
- Pressure sensitive, more force applied to the button results in a higher water pressure throughout the system

Water pipe

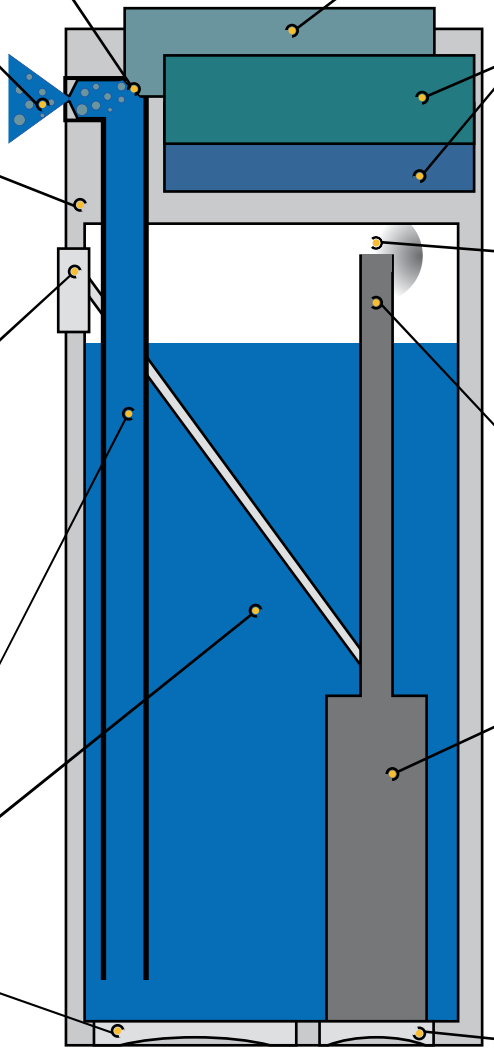
- Transports water from the water chamber, past the capsule and out the nozzle

Water

- Clean water that is to be mixed with the detergent in the capsule which is active at the time

Water refill

- Screw in lid, with airtight gaskets attached, that can be opened to refill the container with water when it is needed



Active capsule

- Contains the actively available detergent
- Releases content into the water streams which passes by with high speed

Passive capsules

- Contains spare amount of detergent
- Allows for different types of detergent

Co2 gas

- As the gas expands into the container it pushes the water down and into the water channel

Gas channel

- Transports gas from the co2 ampule into the open space above water level

Co2 ampule

- Contains the inert gas used as a propellant for the water
- High pressurized gas in solid form that expands into about 4 litres of gas when released.

Ampule opening

- Allows for quick and easy replacement of the co2 ampule once it’s empty
- Airtight seal

Figure 19. Concept explanation - part for part

Figure 20. Render of the final capsule and piping system

Part IV - Design and engineering

Where form battles function

Introduction

With the information gathered from the concept and market analysis phase as background, and some further information gathering done early in this phase lead to the final design and the engineering to back it up.

Before showing the actual form and engineering development the report shows some of the preparation work I did with evaluating ergonomics, material, volume, contexts and competitive products to set the standards for both form and function.

Design specifications

Market phase demands

From the market analysis the project got it's target group for the product, as well as some other interesting pieces of information that is vital to the designs development

- Competitors
  The product needs to stand out from the other competitors in the detergent market
- Price and production
  The bottle can afford to be produced at a rather high price as it will sell in a relative small scale and be sold at a high price.
  The capsules needs to be cost efficient as they are small and will be replaced at a frequent rate.
  The capsules needs to be seen while their in the bottle as they represent the capsule producers only marketing option, and the user needs to be able to see what type of detergent that is currently active.
- Point of purchase
  The product and its packaging needs to fit into the scene of the high end retailers that the system will be purchased from. This goes both for the bottle and for the capsules.
- Target group
  The target group is home owners between 20 and 50

Concept phase demands

The specification list over what the concept features demanded the design to take into consideration.

- Airtight water container
- Opening to replace spent capsules of detergent
- Room for capsule magazine
- Opening for filling water
- Opening for replacing gas ampule
- Nozzle built into the bottle
- Trigger for activating the gas ampule

Ergonomics

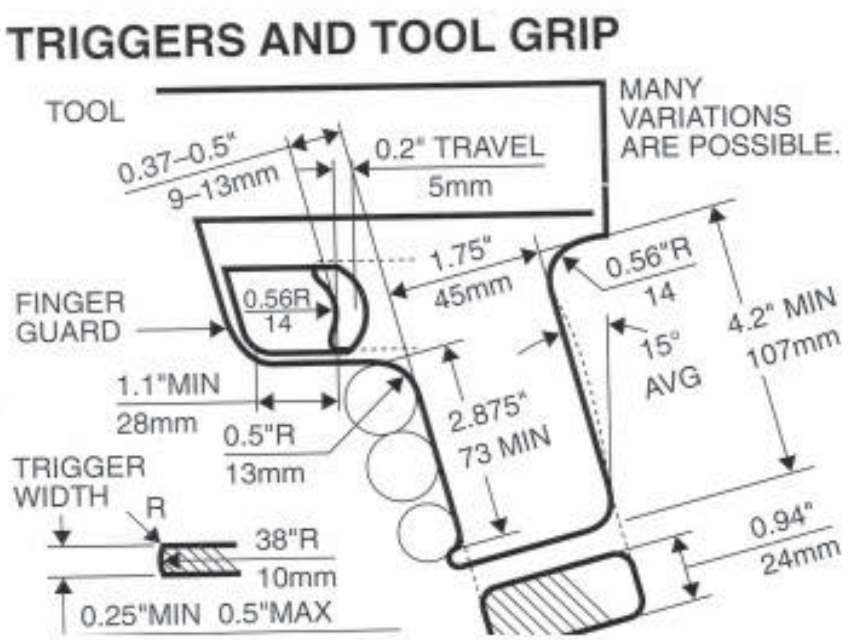
Some user testing, evaluation of cleaning products on the market as well as predefined standards for ergonomics were reviewed to get a clear understanding of the ergonomic needs of the spray bottle.

Literature

The book by Henry Dreyfuss Associates, The Measure of Man & Woman, contain measures of nearly all varieties of tools where ergonomics is involved. Triggers and tool grips included.

Gripping handles that are too large feels insecure. A diameter of 0,875-1,25” (22-32 mm) is the optimal range.

Tilley (2002)



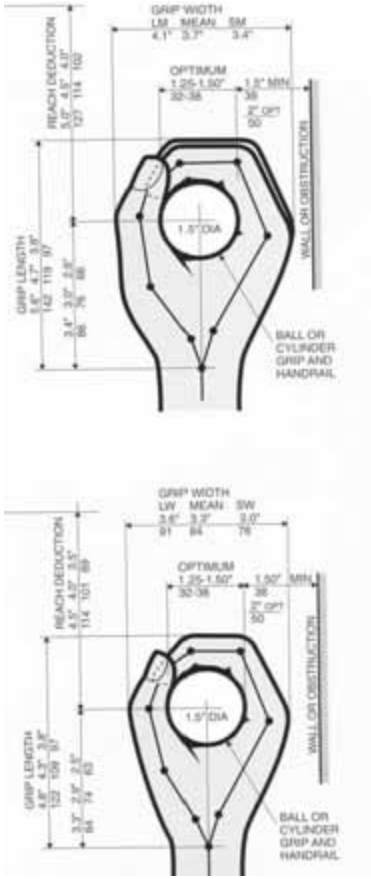


Figure 21. Ergonomic drawings

User testing

Primarily I used user testing to see how they felt my mock-up models worked, but also to see how they used existing products to find user wants, needs and frustrations.

In this test a standard Jif spray bottle was used. The purpose of the test was to find out at which angles the users actually hold the bottle when they cleaning.

Floor cleaning requires a heavily ti bottle at 62 degrees of the horizon

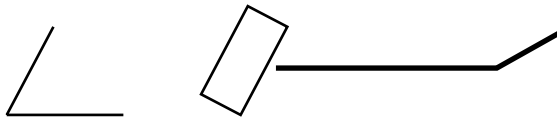
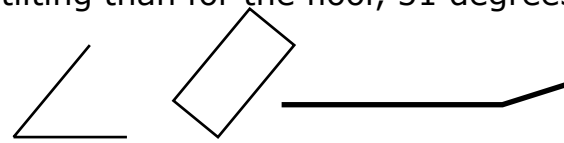
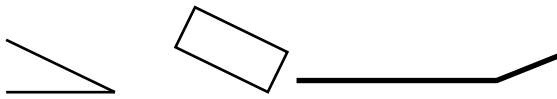


Table surface cleaning requires less tilting than for the floor, 51 degrees.



Cleaning high windows requires a ward tilt of the bottle, quite a lot than the downward tilted ones, 26 grees.



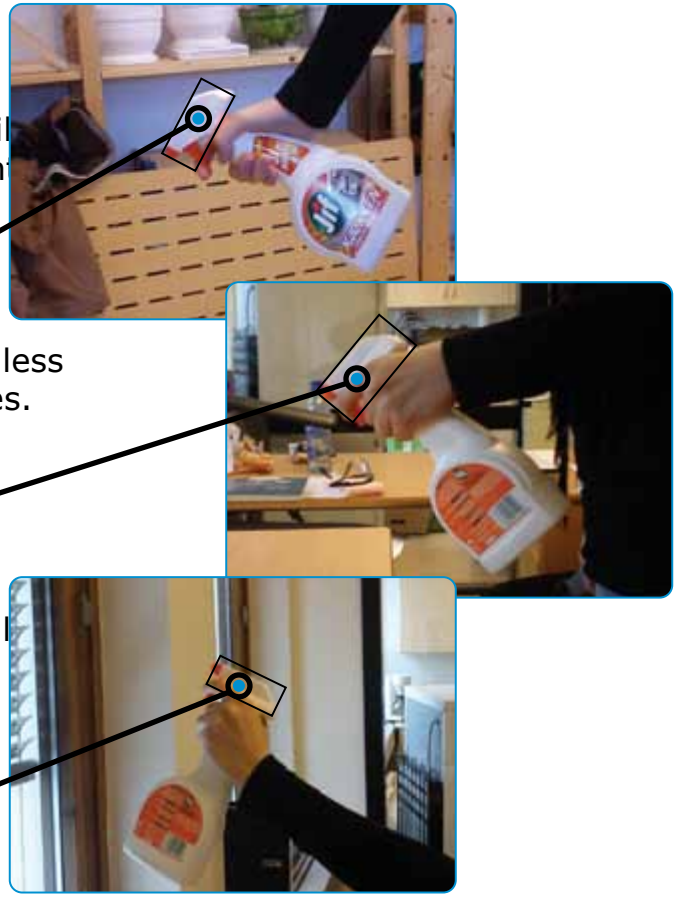


Figure 22. User testing of spray angles for different areas of use.

Competitive products

After having tested some competitive products (Jif and Ajax) I came across some results that contradicted what I found in The Measure of Man & Woman as the size of the handles on the tested bottles were quite a lot larger than that which is noted in the book. I tested these bottles on a small female to get a feedback on them and she did not find them at all discomforting.

By these findings I am led to believe that the size of the handle does not have that much to say in regards to the users comfort as long as it is done over a short period of time.

Another aspect of the bottles I tested which was interesting was that the top part of the bottle was extruded backwards for no mechanical reason. What I came to realise was that it serves as a support for the users grip as it helps support the weight of the bottle.

Considering the aspect of the hand support up against the models I had at the time I found it to be unneeded due to the Tersus bottles significantly smaller size and weight.

Materials

The bottle and the capsules have wildly different material demands.

Producer requirements

The bottle is a high end product that requires a high quality surface finish and materials that are both sturdy and give the users a sense of quality.

As a throw after use product the capsule needs to use as little material and be as simple to produce as possible. But as it is a major part of the overall image of the product it needs to maintain a high level of surface finish to keep in style with the bottle.

Mechanical requirements

The bottle needs to be made in such a material, and way, that is can be made air tight and withstand enough pressure in the water tank, without buckling, for the water to rise as the propellant in the gas ampule is released.

The capsule can be made in a light material as it will not be suffering from any pressure, internally nor externally, under use. The only part of it which is vital in regards to material strength and manufacturing precision is where it connects to the bottle and the content will be sucked out during use.

Environmental concerns

The Tersus concept is a step in the right direction towards getting refill solutions to become something that is "cool" and easy instead of cheap and cumbersome. To then use materials that are known to be environmentally harmful would be a step in the wrong direction.

Environmental impact from the bottle and from the capsules is on a very unbalanced scale. The bottle is designed to last nearly a lifetime whilst the capsules are meant to be thrown and replaced after everything from a month to a year depending on use and content. The bottle is in other words more free in the material choices then the capsules.

Materials suggestions

Therefor I suggest using polycarbonate (PC) in the bottles body to give it the strength and flex it need to sustain a long life as a day to day used product.

For the moving parts within, like the trigger, I think that either using polyoxymethylene (POM) or real metal parts would get precise and durable enough parts where there is a lot of motion.

The material in the co2 container is outside of Tersus' reach.

The rubber grip will be made in a thermoplastic elastomer(TPE). Both to get the right surface tension for a gripping surface and to let it work as a valve and gasket.

For the capsules, polyethylene (PE) or polypropylene (PP) should make be able to make the walls of the capsules both strong and thin enough, while allowing the opening to be opened and closed several times during the capsules lifetime.

Size and volume

The size and volume of the Tersus bottle and capsule depends on several aspects.

Dosage testing

For every second the trigger is pressed on the Tersus bottle a given amount of detergent will be expelled. To find the perfect amount will require quite a lot of user testing. But having access to the bottles used today a normal dosage equals 0,75 ml (averaged of a test range of 500). For the Tersus bottle this should be the same amount expelled from holding the trigger in for the same time it takes for the user to register pushing the trigger. Divide 0,75 ml by that reaction time and the dosage/time ratio is found.

Capsule

Market demands are what the customers are used to and expect from the product regarding how much bang for their buck they get in regards to the amount of total cleaning agent per capsule.

A regular bottle(Fig. 13) of detergent from Lilleborg contains 500 ml. Looking at the technical specification of one of Lilleborgs professional products, the Sactif Allrent, which is made for general cleaning of surfaces. The minimum dosage for Sactif is 0,1% for light cleaning. I'm aiming at a 1% dosage as a average level to have a percentage to base my numbers from. The dosage for the different capsules will vary depending on the different type of detergents they contain, but for volume measures I will be working with the 1% standard.

The amount of pure cleaning agent per capsule will be 2 ml which in turn gives the user 200 ml ready to use detergent at the 1% mixture grade. The mixing dosage is something the user will never have to deal with as the bottle and capsule connection does that by it self.

Bottle

The volume of the bottle decides how much detergent can be used in one session of cleaning, given that there is enough cleaning agent available in the capsules to mix with the water.

There really is no sense in making the bottle as big as the ones seen in stores today when using the Tersus system, as each session of cleaning usually just use a small fraction of the bottles total content. Therefor the size and volume of the bottle is more influenced by ergonomics and internal mechanics than it is by capacity issues.

It still needs to be large enough so that the users don't feels like they need to refill the bottle between every cleaning session, Tersus is suppose to be a product that is always ready for action.

Duration

How long the capsules and bottle content will last is rather hard to data mine and will require a large group of test subjects with the finished product over an extended period of time.

Figure 23. Jif Universal spray bottle

Context

The Tersus target group have a vide variety of backgrounds and live in widely different home. But something that binds them together is that they like the style and ingenuity of the products that are sold at the target stores.

Tersus will potentially be used in a variety of contexts, but the ones where it will most likely be stored are the kitchen and the bathroom, places that have a natural affiliation with water and cleaning.

Kitchen

Making food, doing dishes, eating, it all leaves its stains on the surfaces one way or the other and they need to be cleaned.

The kitchen is one of the most likely place for Tersus to be both stored and used. This is also the place for which most of those who visit the target stores purchase items for.

Figure 24. Example of a modern kitchenstaken at JKE Design - Lillestrøm

Lilleborg detergents used in context:
Zalo
Jif Kjøkken
Jif Ovn & Grill
Jif Universal
(Jif Spray & Mopp)

In the kitchen there is a large variety of surfaces that needs cleaning, this depends of course on the type of kitchen interior is present, but as a general rule the above detergents are all used.

The most likely place to store the detergents in the kitchen is on the kitchen counter, but most feel that this clutters the working space and hide the detergents in a cupboard.

The drawback from having the detergents in a cupboard is that they aren't as accessible as if they are stored on the counter.

Figure 25. Kitchen counter, private photo

Figure 26. Examples of modern kitchens taken at JKE Design - Lillestrøm

Bathroom

Another of those places where Tersus will be most used and stored are in bathrooms.

These are rooms where people actually do spend quite a lot of their time in, and also put effort into keeping clean and fresh.

Figure 28. Bathroom floor, private photo

Lilleborg detergents used in context:
Jif Baderom
Jif Universal

On the bathroom, the natural place to put detergents are, as with the kitchen, in a cupboard.

Putting the detergent on the bathroom counter or on shelves is something that is seldom done. I'm guessing that it is because the other items that are there are meant for personal hygiene and the detergents may seem crude and out of place, not only for their appearance but for their content as well.

Quite a few keep their detergents in a cleaning bucket hidden somewhere under a counter or inside a cupboard. This is both to hide away the cleaning articles and also to keep all of the items in one place for easy access.

Figure 27. Bathroom example from JKE Design - Lillestrøm

Figure 28. Bathroom examples from JKE Design - Lillestrøm

Point of purchase

As the Tersus system will be sold through high end stores like Christiania Glassmagasin the product should mesh in with the rest of their product portfolio.

The product portfolio of these stores are quite diverse, yet there are some returning styles which I'll get back to in the report later.

Maybe even more importantly than that the product itself fitting into the shelves of the stores, is that the products packaging fits in, while still stands out enough to make itself seen.

Figure 30. Product placement examples from Christiania Glassmagasin in Lillestrøm Torv.

Product form evaluation

During the designing of Tersus, products from other producers found in the target stores have been evaluated.

The evaluation of these have mostly been done mentally while drawing, making mock-ups or 3D modelling, but this is a quick overview of how I've thought of the products while working on the form.

Wide
The top of the bottle widens out towards the top, creating both a good pouring angle as well as giving the bottle an organic finish to the rest of its shape.

Clean & open
The majority of the bottle is a clean and sleek surface that's not broken by any ornaments.

Metal lid
Sturdy and heavy quality feel.

Thin waist
The thin waist located high on the bottle makes the bottle feel stable.

Figure 31. Decanter from Eva Trio

Form expression

As previously noted the Tersus system is composed of a bottle and a capsule which needs to mesh together design wise, as well mechanical wise.

Since the capsules will be in a variety of colour, and with a vide array of logos etc. the bottle should be simple as to not clash with the capsule.

Since the Tersus system in it self stand out, the bottle shouldn't try to be more than it is, a vessel for the system. Therefore I chose to look more into Scandinavian design and to the professional market for form, quality and materials.

Simplicity has always been a striking feature of Scandinavian design.

Sommar (2003)

One of Scandinavian designs key terms "beauty for everyone" is a factor that works well with Tersus. It's a tool for a everyday activity which everyone can relate to, and it should therefore strive to be attractive to the widest possible user group.

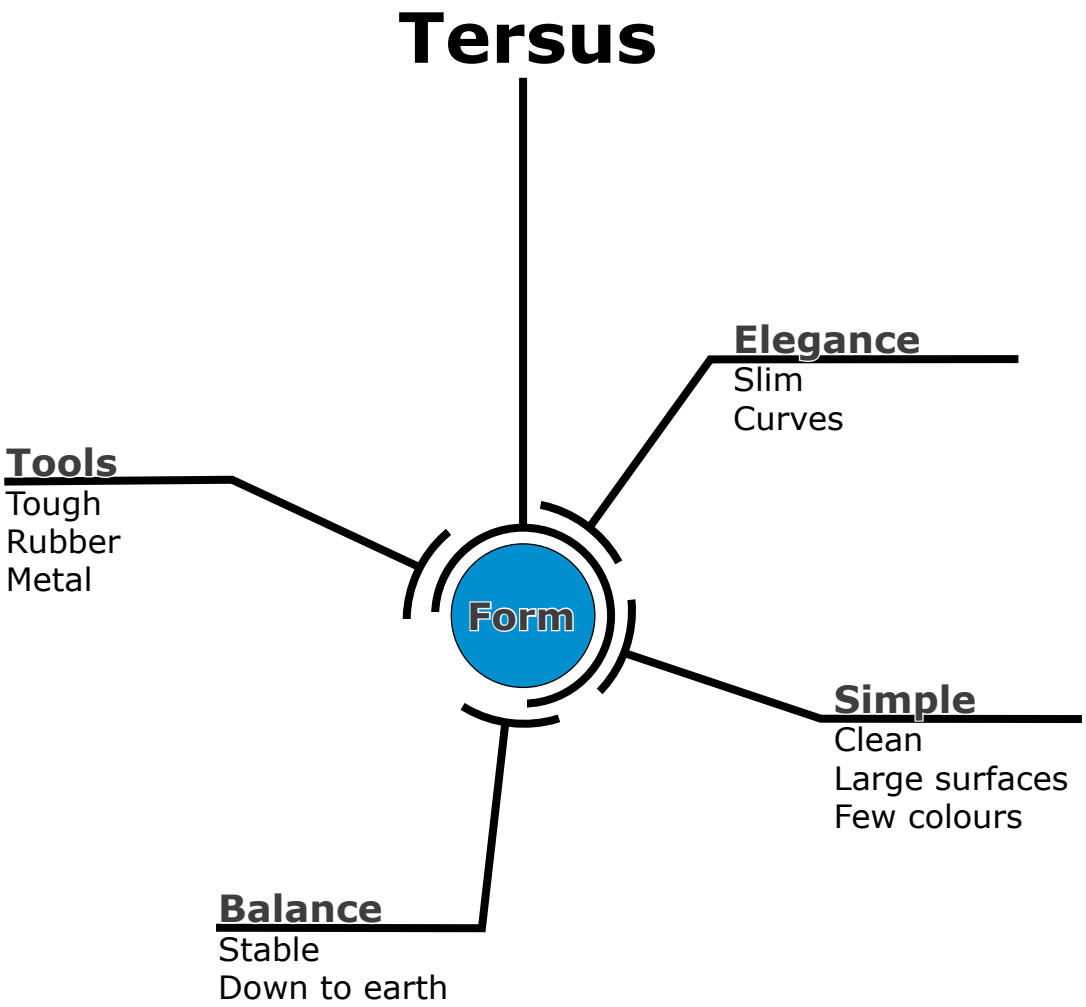


Figure 32. Form expression - Main themes

Product keyword map

Figure 33. Product keyword map

Inspiration boards

No design process is complete without some boards. In this projects I've concentrated them around physical objects that do and feel like the things the finished Tersus product should contain and represent.

Water

Wet, organic and refreshing. Water is what keeps all of us, and everything around us, alive.

For Tersus, water is the primary ingredient and as still water, it should be there, unseen but ready to act at the slightest disturbance. In motion, water is flowing and moves without stop. When using the Tersus bottle the operations should all flow into each other as well.

Figure 34. Mood board - Water

Professional tools

Even through Tersus is primarily meant for the home market, professional tools are a source of inspiration due to their high regard of functionality, durability and ergonomics. All properties which are highly regarded among the Tersus target group.

Figure 35. Inspiration board - Professional tools

Capsules

While products in themselves, they are usually part of a larger context where they carry a payload to be used by another product. Capsules are often small containers that are used for a limited amount of time before they are replaced. The sense that the capsules are replaceable should come through in the Tersus capsules as well.

Figure 36. Inspiration board - Capsules

Form - step 1 - sketches

Quite a few of my sketches came during the earlier stages of the project as I was constantly wondering how my final bottle would look like, so some were impossible to implement in the final design because they didn't allow some of the features that were later on decided in the product spesifications.

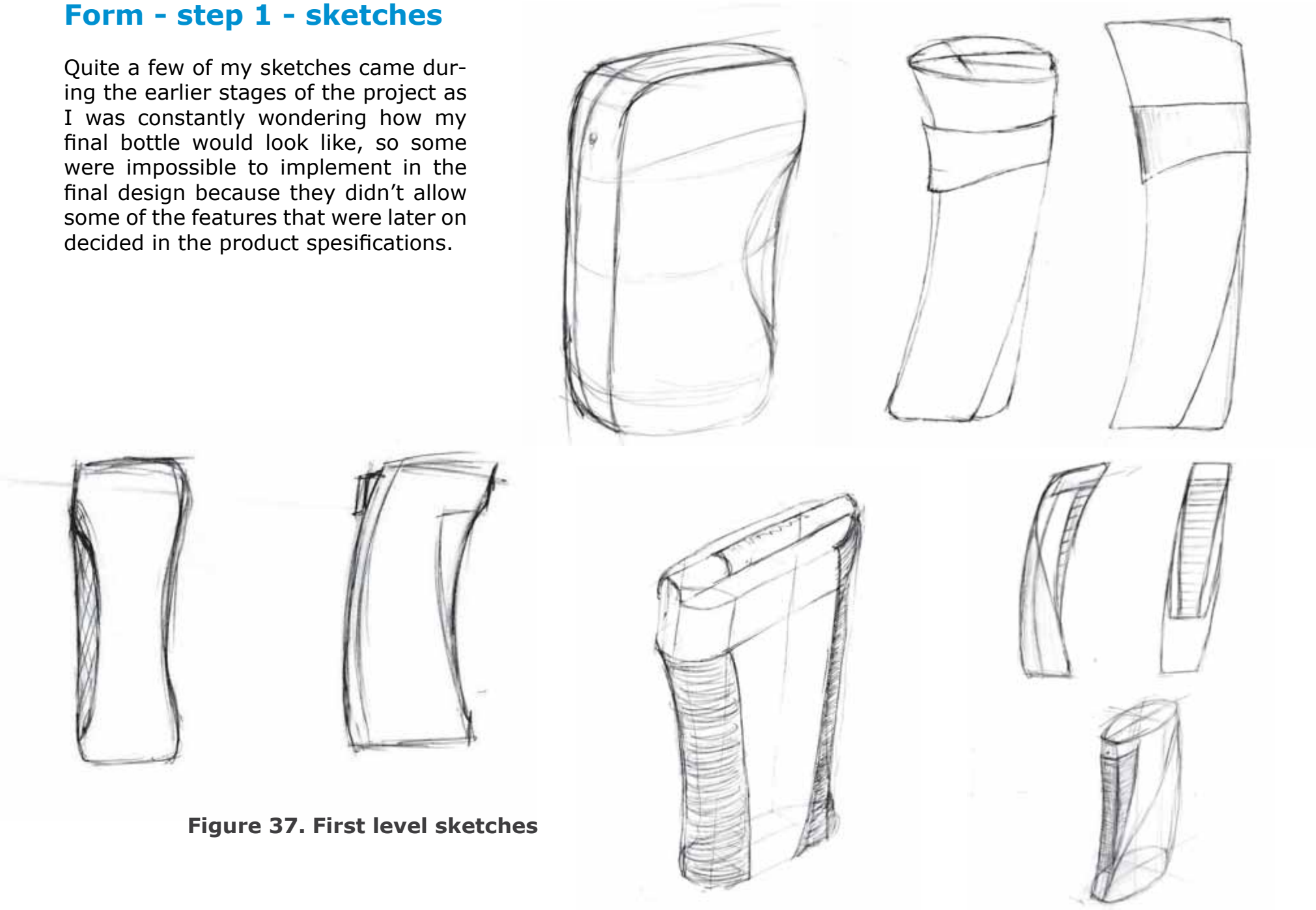


Figure 37. First level sketches

Figure 38. Second level sketches

The gunslinger

The gunslinger design that came up as part of a joke while trying to explain to some fellow students how a magazine could be implemented into the design.

Later on the gunslinger design has actually had quite an impact on the final design, mostly regarding the horizontally revolving capsule magazine.

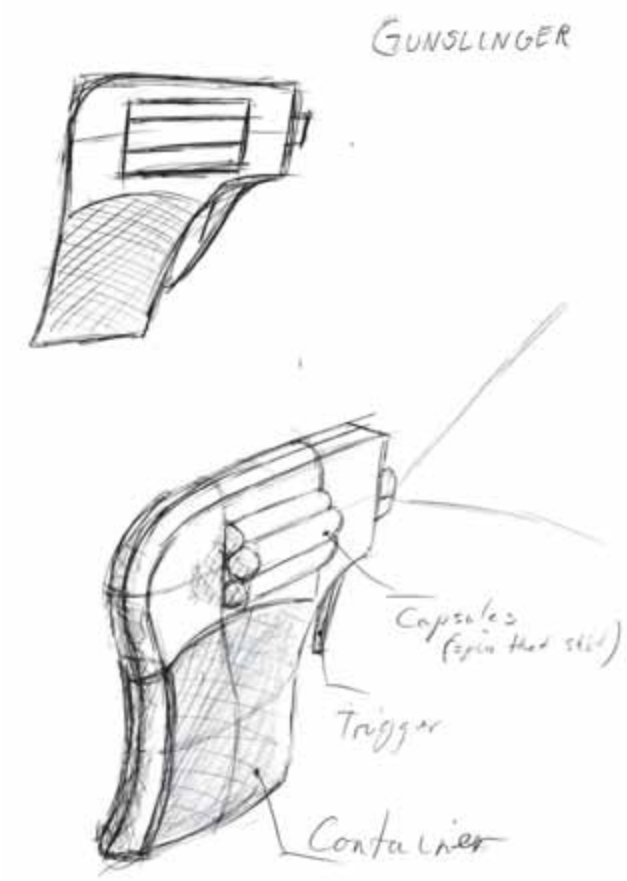


Figure 41. The Gunslinger

Compact

The main idea behind the compact design is basically to make the bottle and the capsule as compact as possible, integrating them both into the handle and letting the shape be formed mostly by ergonomics and function.

The final design pulled a lot of the simplicity from the compact design onwards.

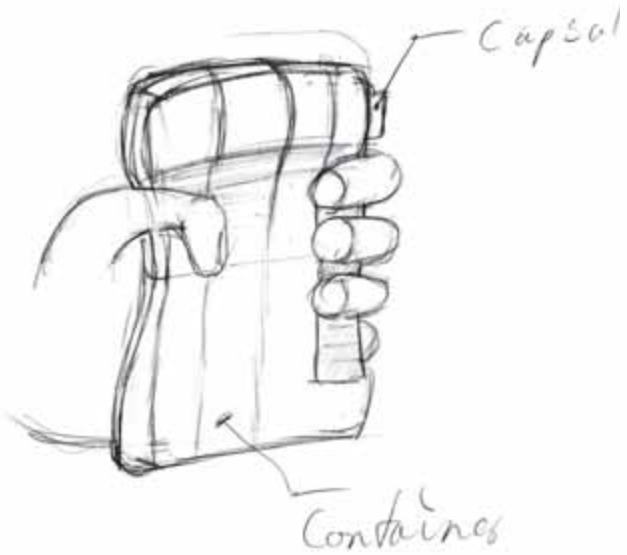


Figure 39. Compact

Curves

No process is complete without making a design as curvy as possible, vide hips, a slim waist and a top to topple over for.

The final design pulled just a fraction of the curves onward to liven up the otherwise strict forms it was based on.

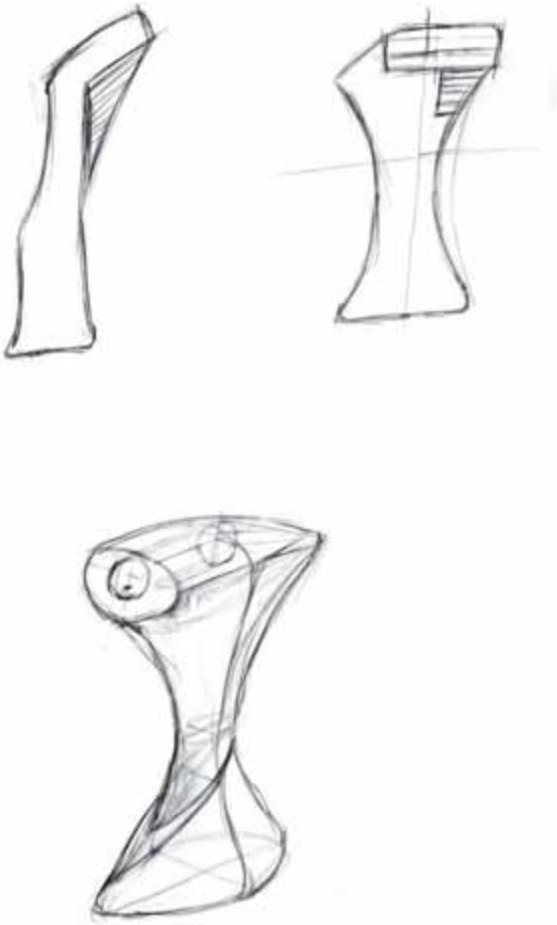


Figure 40. Curves

Spray canister

The only one of the first designs to contemplate using a propellant instead of a mechanical suction pump to expel the fluids into and through the system.

The design was contemplated to be brought back for a single capsule bottle with a minimalist feel but was scrapped when the magazine function came up. The propellant on the other hand was brought forward in the design process.

Standard spray bottle

A standard design of spray bottles like they are found in stores today was discarded early on even if they are practical.

The reason is that with the Tersus system there is no need for a large tank to store the mixed detergent, and since the Tersus system needs a strong brand identity to be successful. The design needed to stand out more from what's on the market today.

Squeezy

A simple yet oddly elegant solution. Part hard plastic and part rubber, the user would simply need to squeeze the bottle itself to get the pressure needed to expel the detergent.

The downside, and what made the design become absolute, was that the force of the spray was highly dependant on the users individual strength.

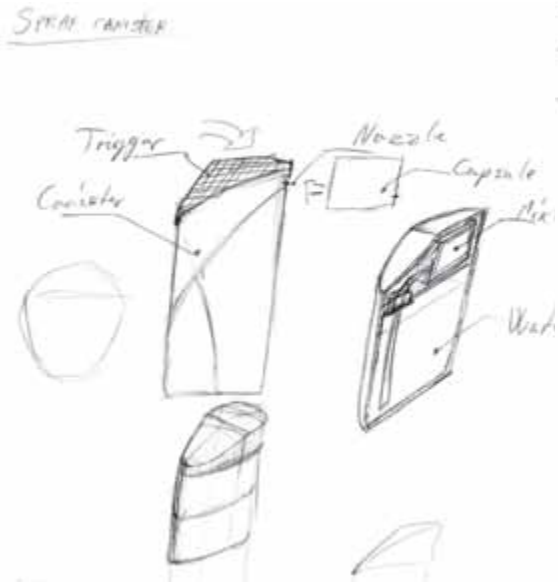


Figure 42. Spray canister

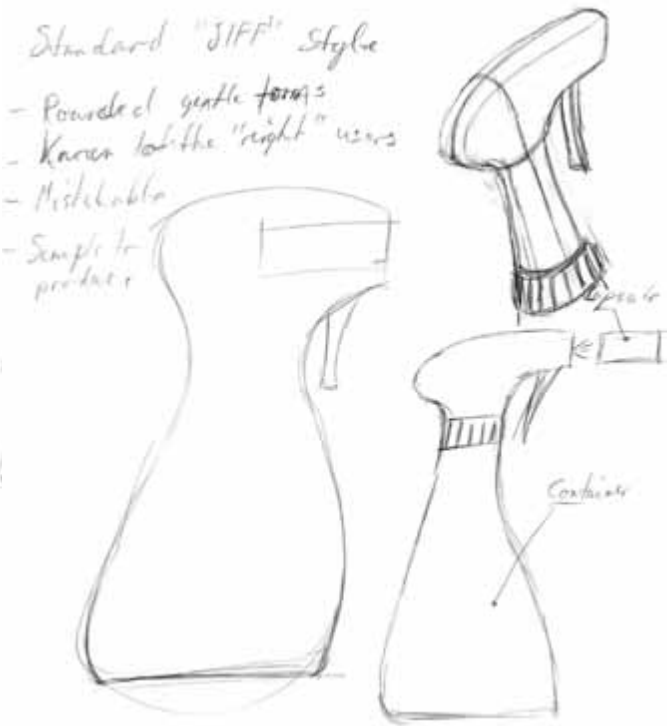


Figure 43. Standard spray bottle

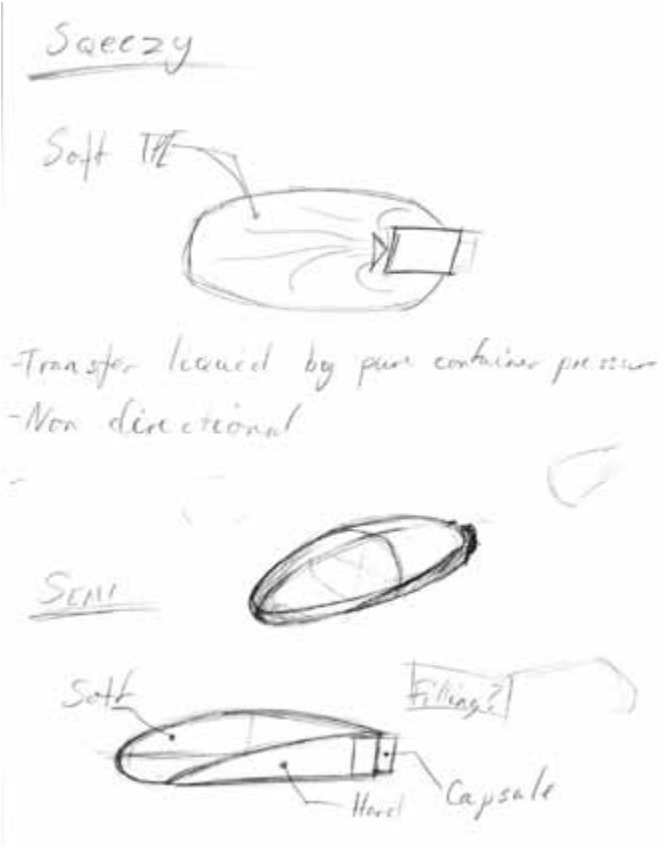


Figure 44.Squeezy

Form - step 2 - mock-ups

Easy going

This is the shape that goes for an organic and vivid approach. It is also heavily influenced by the ergonomic studies I had done previously. Quite some ergonomic testing was done in this period with all those I could muster to come and test while making the clay models, since it was made in clay I could make changes after each test. The shape seems slightly out of balance to create some life in the design.

The market segment has a high use of plastic and lively colours.

Products in this range are often purchased by young people or as funny and interesting gifts for others.

Figure 46. Easy going product examples

Figure 45. Easy going mock-ups

Simple forms

Most of the products sold in the target stores are heavily inspired by Scandinavian design, with it's simple forms these products fit into most modern homes. The type of products vary a lot, but the foundation is simple forms that stay close to the basis shapes like, squares, circles and triangles.

Steel, rubber and glass are heavily represented within this style.

Simple styled products like these are often best sellers in the stores where Tersus will be sold.

Figure 47. Simple form product examples

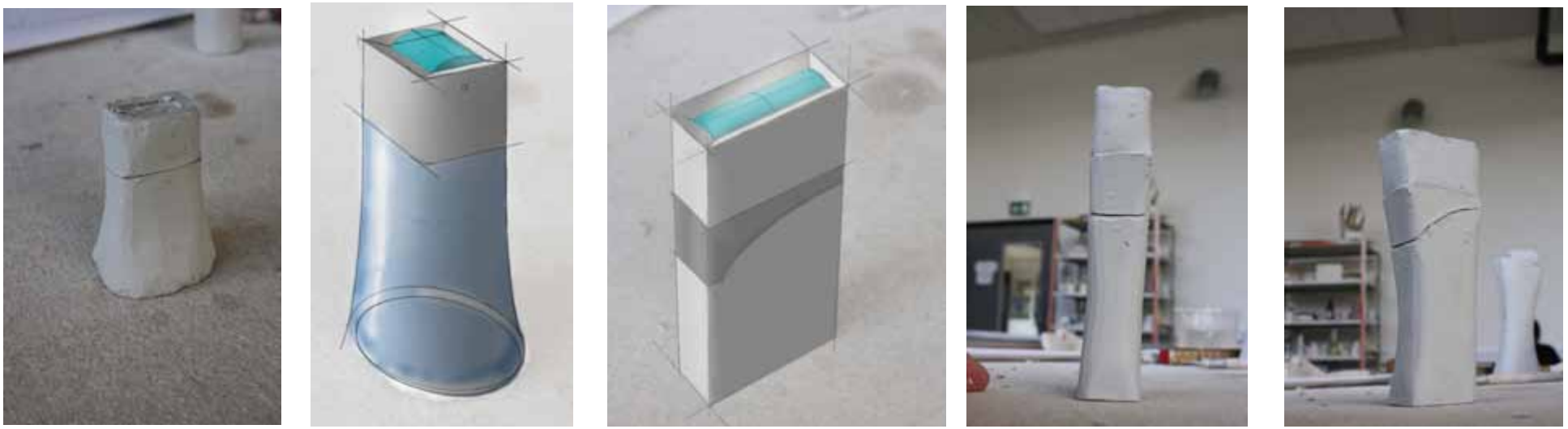


Figure 48. Simple form mock-ups

Strict

Once again simple forms, yet these are more influenced by strict and direct forms that put emphasis on the of the material and functions of the product.

Steel is a favourite within this group.

These object are appreciated by professionals due to the heavy focus on functionality and have easy to clean and maintain surfaces and materials.

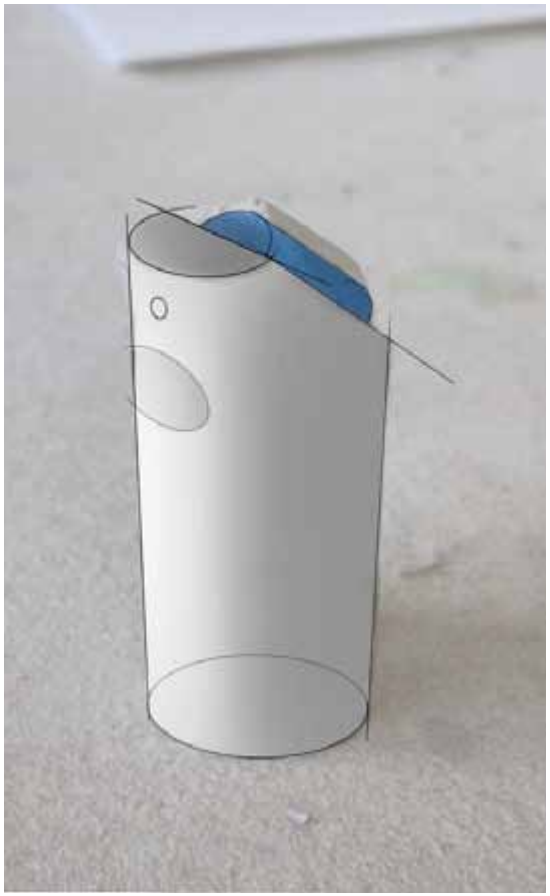


Figure 49. Strickt product examples

Figure 50. Strickt mock-ups

Evaluation

After having worked with some mock-up models, more photoes from my model making process can be found in the appendix, and sketches I chose the forms that should go onwards in the form process.

For the work onwards in the Tersus project I chose to work with a very simple shape which takes a little out of all the three categories I looked into.

The two models that made it into becoming 3D models where the one from the easy going group, and the slim and simple form pictured here.

From the easy going style I took the colour scheme into the capsules. The capsule system in itself is enough to give the product that little extra, but with a vivid colour scheme they highlight the unique capsule function even more. Also the material choice of plastics is taken onwards.

The simple forms group heavily influenced the design decision, and continued to do so throughout the design process. Another thing that added to the decision was a quote from a shop administrator.

> *Our costumers tend to purchase and collect products with simple and classic styles, like those of Rosendahl. Most of these costumers are between 25-40 and buy the bulk of the itemss for themselves.*
>
> Jessie Forsberg, På Kjøkkenet - Torvbyen Fredrikstad, personal communication (translated)

The strict style highlighted something that is very important for the Tersus system, the functions. They should be simple and accessibly, yet highly accurate and they should work at all times under any condition. The point of having easy to maintain surfaces and simple but efficient ergonomics also got brought onwards.

All in all the product will aim to please the lion's share of the costumer groups in the Tersus retailers.

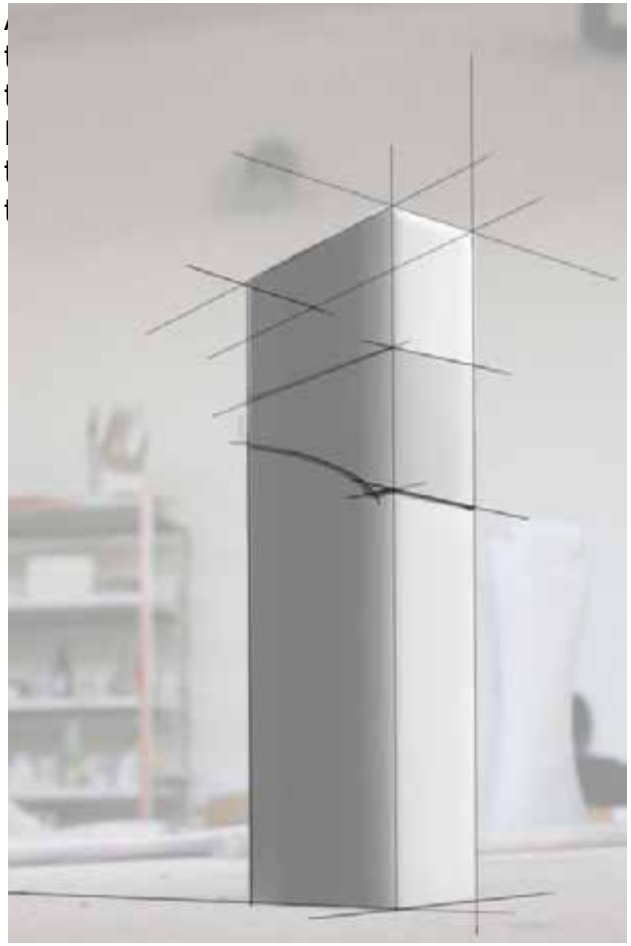


Figure 51. Form step II final

Form - step III - 3D

Quite a lot of time was spent in SolidWorks tweaking and adjusting the finished product to get form and function to work properly together. The model went through several different versions, some were dummies meant only to test the form and others were used to test mechanics.

After time the 3D models contained both and the work went over to tweaking the final form and the functions to mesh together.

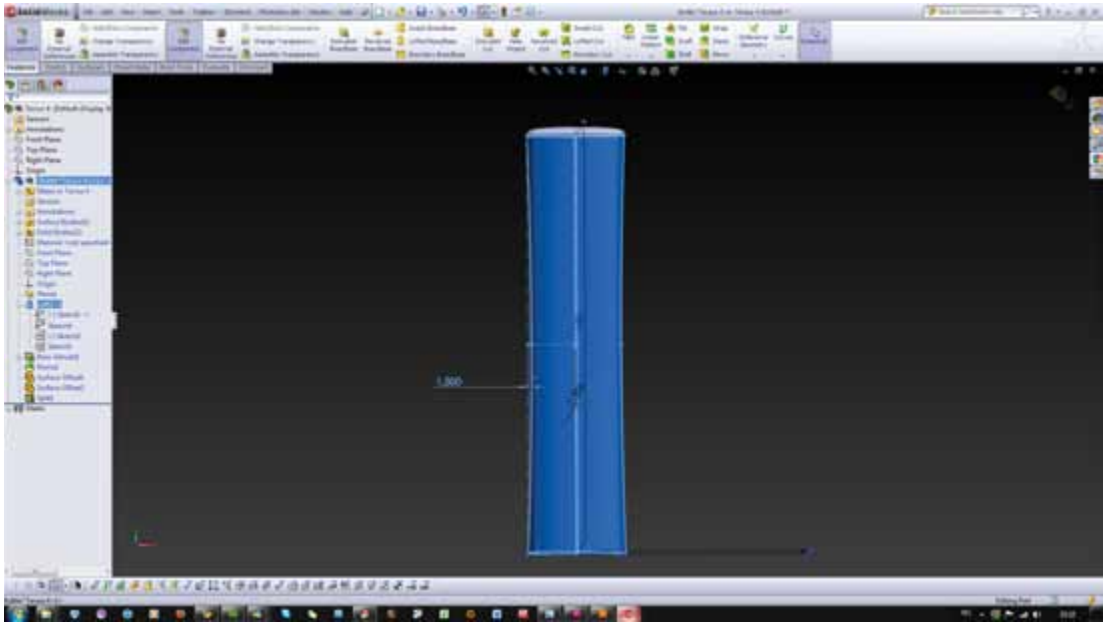
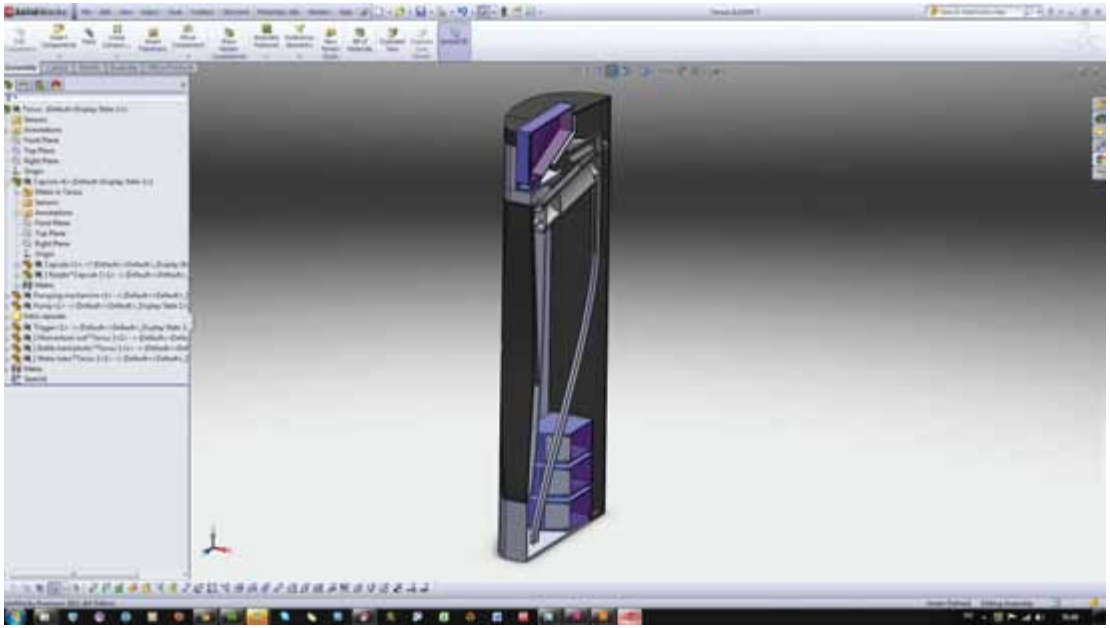


Figure 53. Screenshot of 3D modelling

Figure 52. Screenshot of 3D modelling



The first 3D model made was using the mechanical concept capsule which was later discarded. Even though the model was discarded, it made a good basis for calculating the needed space for the different components in the bottle. Some of these were discarded when the hydro capsule was introduced, but the model still proved its use.

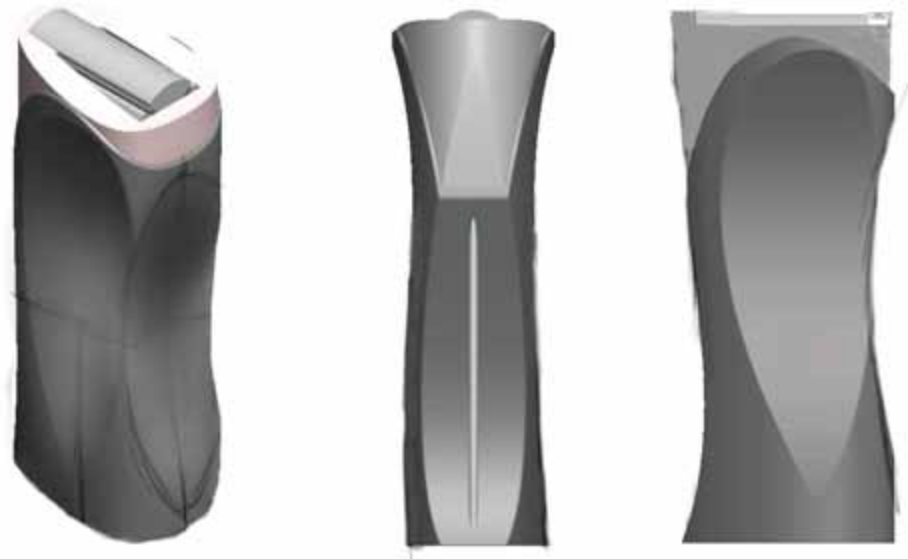


Figure 54. Sketch on

Some of the 3D form modelling was done with nothing but an mental picture as a basis, others had sketches and some did mixtures of the two.

As the example above(fig 51) shows there is a 3D model as a basis for further sketching. Here the 3D model was made around the internal components, then printed and worked on with 2D tools before it was sent back into the 3D world again.

During the choosing of the different basic forms 3D models and renderings of these were used to get a proper look at how they would look with different materials and textures.

Two of the concepts from step two of the form development was also made into 3D models (fig. 52, 53 and 54.) to make it more representable when getting feedback from test subjects and mentors about both form and materials.

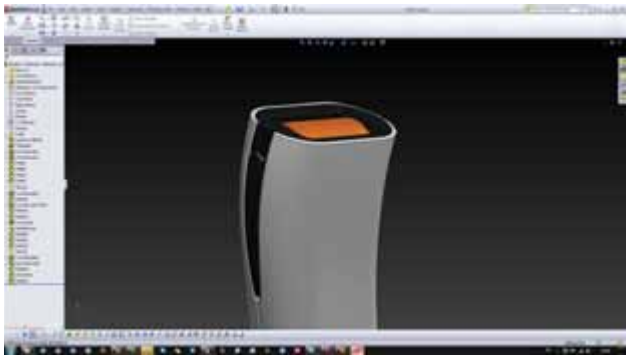


Figure 55. 3D screenshot

Figure 56.

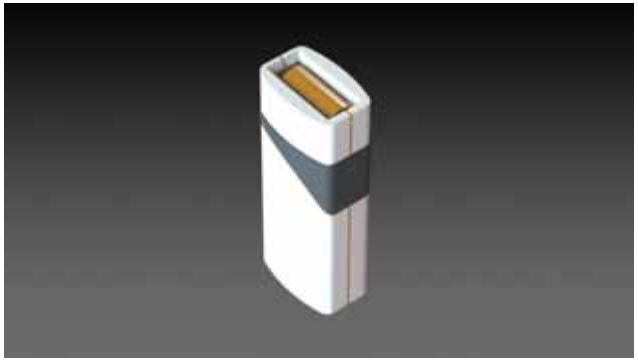


Figure 57.

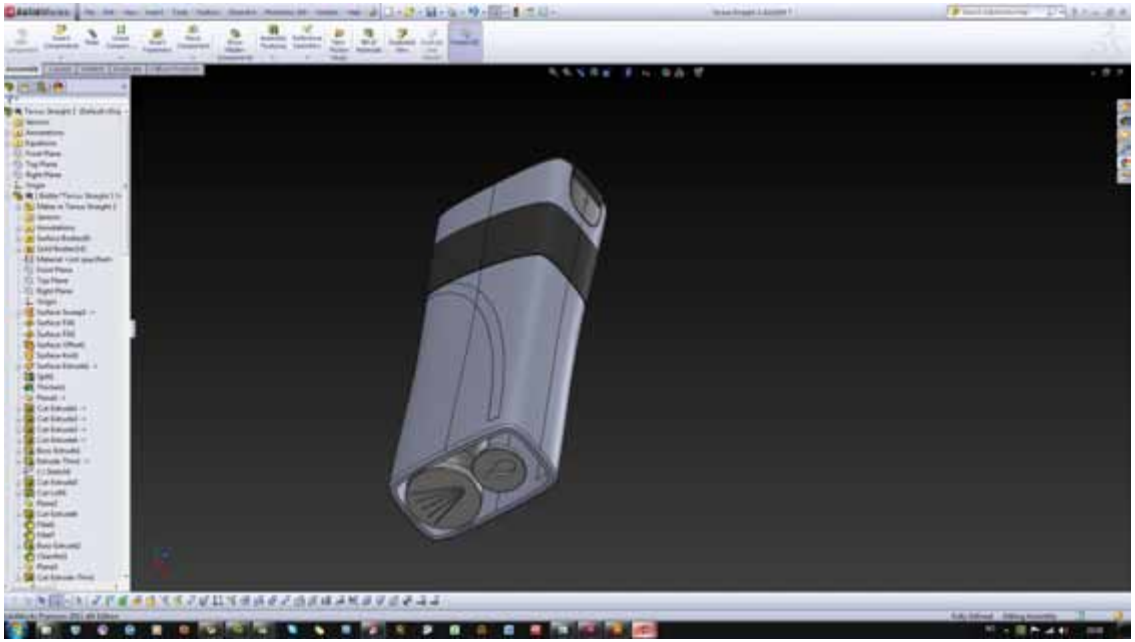


Figure 59. Screenshot of 3D modelling

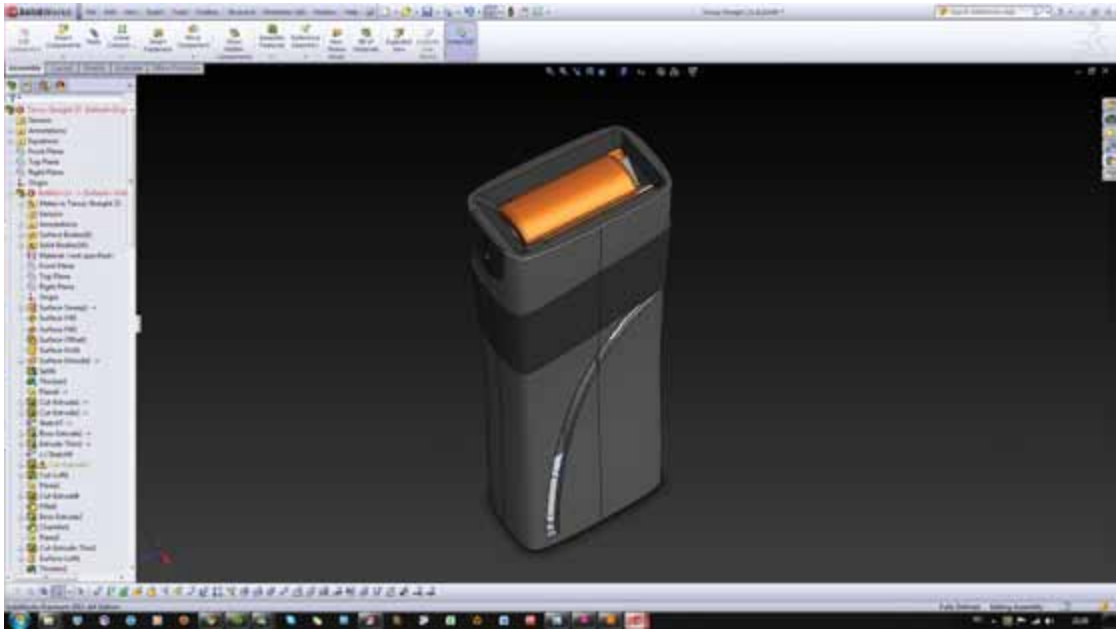
A few features came through pure tinkering in SolidWorks. Items like the nozzle guard became clear that it should be implemented through a 3D model.

The nozzle guard is the little piece in front of the internal pipe and nozzle in the bottle. It can be customised to give the bottle different spray arcs as well as it allows for more thorough cleaning.

Wether or not the lid should be present on the model was a great deal of mental back and forth. In the end the lid won through because, it transformed into having a function besides concealing the capsules. The movement from opening and closing the lid was made to work towards the capsule between its different states.

Conventionally lids are hinged in the back of the product, but to ease the access to the capsules the lid on the Tersus bottle is placed in front. This also helps hide the seam where the nozzle guard connects to the rest of the bottle.

Figure 58. Screenshot of 3D modelling



Quite a lot of time was spent in section view of the models to get a good view into how the internal parts were affected with the changes to the outer form. The internal components have been developed alongside the outer form at all times to make sure that the end product will be functional.

Safety features and fastening features has been modelled as well. For producing a final production model of these parts additional engineering, and real life testing, needs to be done to make sure each part works as intended. But they are at least in place in the model.

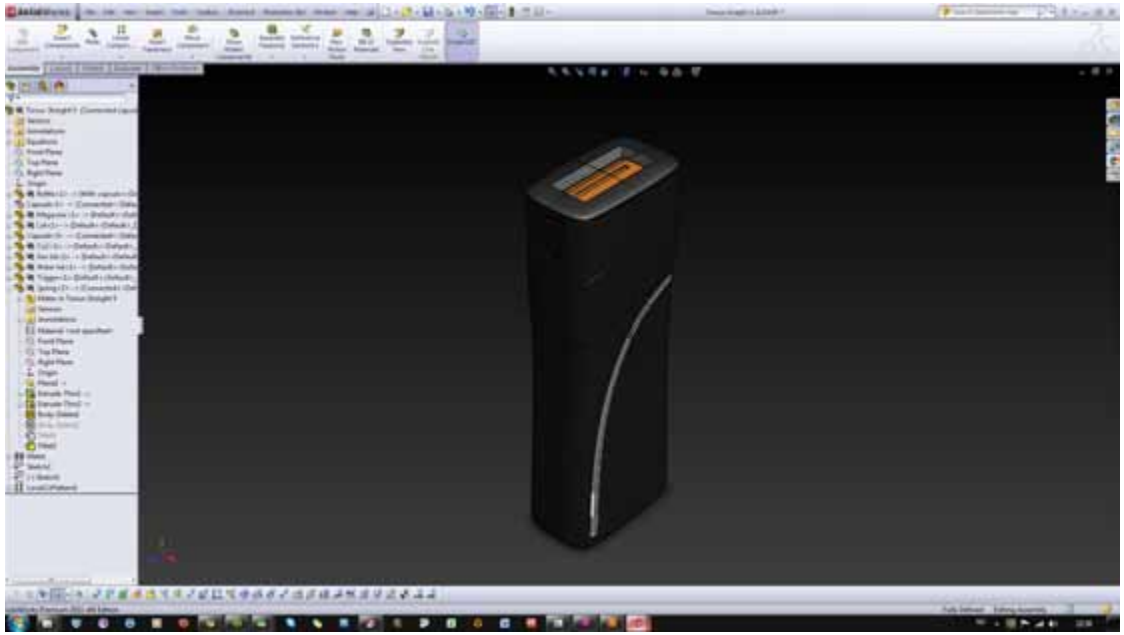
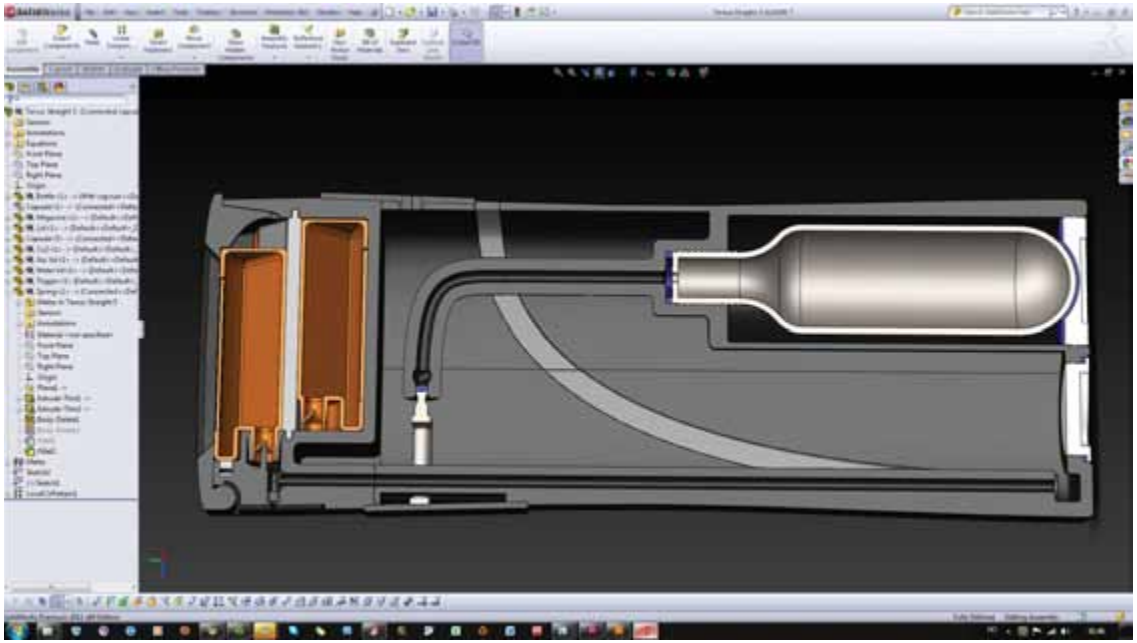


Figure 61. Screenshot of 3D modelling

Figure 60. Screenshot of 3D modelling



As a quality assurance in regard to the mechanical and hydro mechanical principals used in the model I've used my mentor at Eker Design, Victor Rosenvinge.

With his feedback I've made sure the principals are viable not only from a conseptual stand point, but also from a practical engineers stand point.

Form - step IV - results

Front hinge
The front placed hinge give room for the nozzle guard to stand out.

Slim curves
The bottle has a simple design with slight curves on the top and bottom.

High waist
The rubber belt around the top of the bottle clearly signals where the user surface is.

Flowing water measurer
The bottles water reservoir can be checked through the window that flows down the side of the botle

Stable design
By going out towards the bottom the bottle maintains a steady posture.

Figure 62.

Frosted glass top
The frosted glass window on top of the lid goes with the rest of the lids material and obscures the bottles content until the user is close enough to use it.

Intuitive materials
The low profile lid has a rough surface to seperate it from the sleek surface of the holding area.

Figure 63.

Figure 66.

Variety

While the Tersus system prides it self on it simple design and materials, a few variations can be made, for those who swear that black is a sinners colour.

Figure 65.

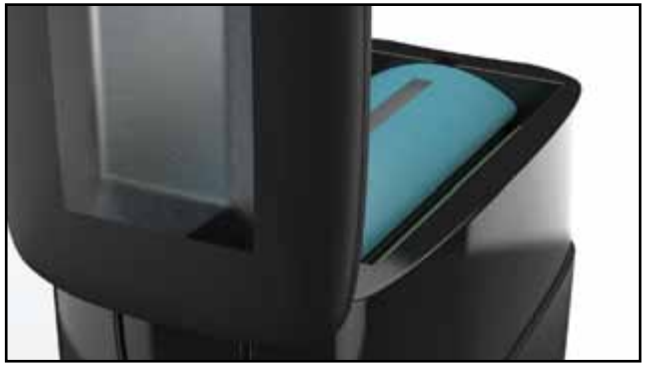


Figure 69.

A dash of colour
While the rest of the bottle is simple, sleek and neutral the capsules look like splashes of paint on a canvas inside the bottle.

Figure 68.

Few and elegant colours
The components under the lid is is using the same simple colour scheme from the rest of the bottle, reflecting the bottles Scandinavian design influence.

Breaking the surface
The area around the nozzle stands out from the rest of the bottle as the one place where edges are allowed.

Figure 67.

Figure 70.

That little something

While laying down on the counter or standing up, there is allways that little extra with Tersus to break up the strict lines, all by using a simple colour scheme.

Standing, it’s the colourfull capsules. Laying down, it’s the easy to see and handle plugs at the bottom of the bottle.

Engineering

As previously mentioned in the report, the design and engineering of the Tersus bottle happened alongside each other. Therefore the outside gives way to the internal parts, and the internal parts give way to the design where possible. And it also lead to the engineered part to get a little design touch here and there.

Figure 71.

Hand in hand

Nothing with the Tersus product is purely designed or engineered. It is all made with a purpose of making a product that looks and works well, both from the outside and the inside.

None of the parts in the system is there just to please the eye, it has a purpose for being there. And no edge is just made to provide support, it flows with the lines of the bottle.

As few parts as possible has been put into the bottle to keep the design tidy for the eye, the use simple for the mind and hand and the structure efficient for the production.

Figure 74.

Trigger happy

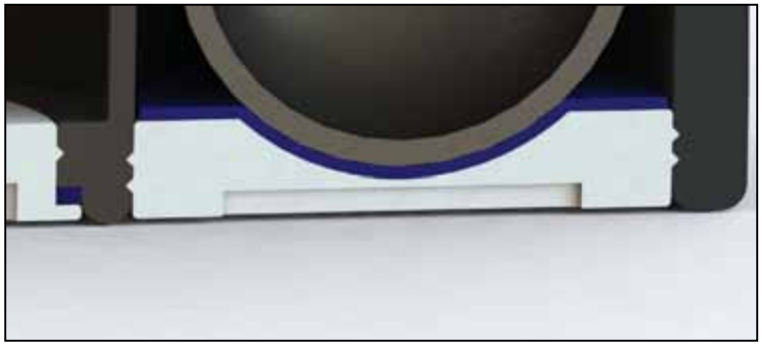
The bottles trigger works simply enough in such a way that when it is pressed, the shapes inside the pipe leading to the co2 capsule and the shape on the trigger part create a open room for the Co2 gas to escape through. The gasket is there to make sure that no gas escapes during storage.

Figure 73.

Gasket branding

As a added contrast to the white lids underneath, all the gaskets that keep the bottle sealed are made in Tersus logo blue.

Figure 75.



No rattle

When the Co2 capsule expels its payload, the capsule turns really cold and the surrounding material may move as a cause of this. that is why the capsule have gaskets in both top and bottom, making sure the seal remains intact and the that the capsule stays in place.

Figure 72.

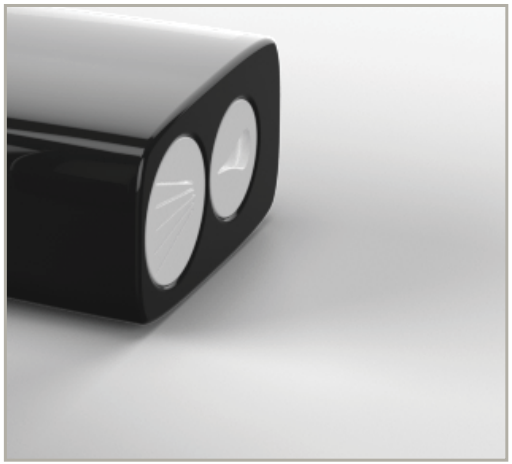


Figure 78.

Figure 77.

Lids, lids and lids

On the underside of the Tersus bottle there is two lids which are raised ,2 mm from the bottom of the bottle to give it a stable bottom to stand on.

Every threaded lid needs a slot for screwdriver or finger nail to fit into. On Tersus' lids these slots also function as pictogram for the users.

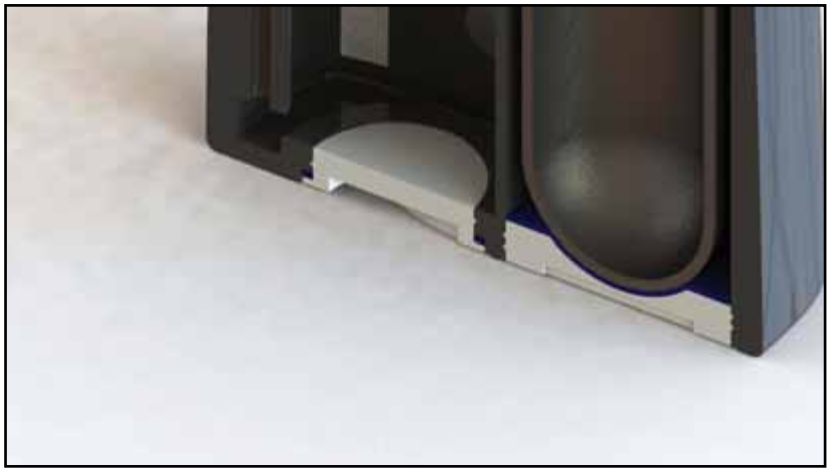


Figure 76.

Tolerance heaven

Under the magnifying glass the nozzle looks just like a easily patterned body, but when the whole thing is 2 mm long and has a 2 mm diameter things become quite differently. The tolerances are really strict for the nozzle to behave as it should.

Since the nozzle is part of the bottle instead of the capsule, as previously intended, it will be easier to get these tolerances to hold.

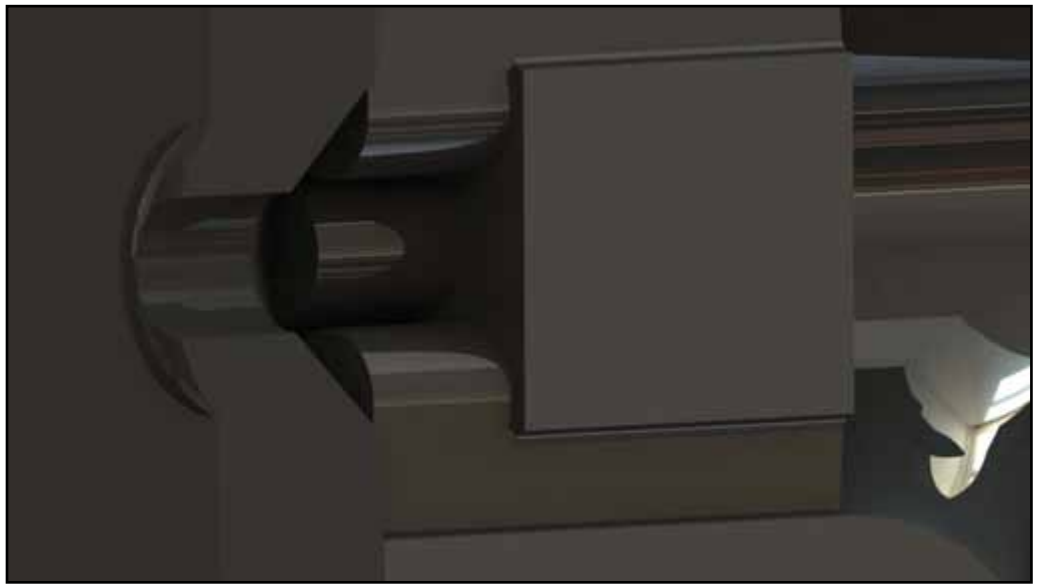


Figure 79.

Figure 80.

The guardian

Making sure that the detergent get the right arc from the bottle and that nothing harms the tolerances in the nozzle chamber. The Nozzle guard is basically a thin piece of plastic with a funnel in it that directs the detergent arc. But without it the bottle wouldn’t be worth anything. Each part of the Tersus bottle has its own unique role.

Easy activation

The fin at the back of the lid is designed so that when the user closes the lid, the capsule is pushed forward into its activated position. The user will never have to figure out how the system works to be able to use the bottle. It is designed and engineered to be as simple as possible. Open the lid, change to the capsule of your choice, close the lid and spray away.

Closest to the capsule on the rendering, the fin turns from an arc into a vertical line, this edge in the fins construction make the capsule stay in place until the lid is once again closed. It does this since the force working from the capsule to the fin goes horizontally. This force then presses the lid back- and downwards.

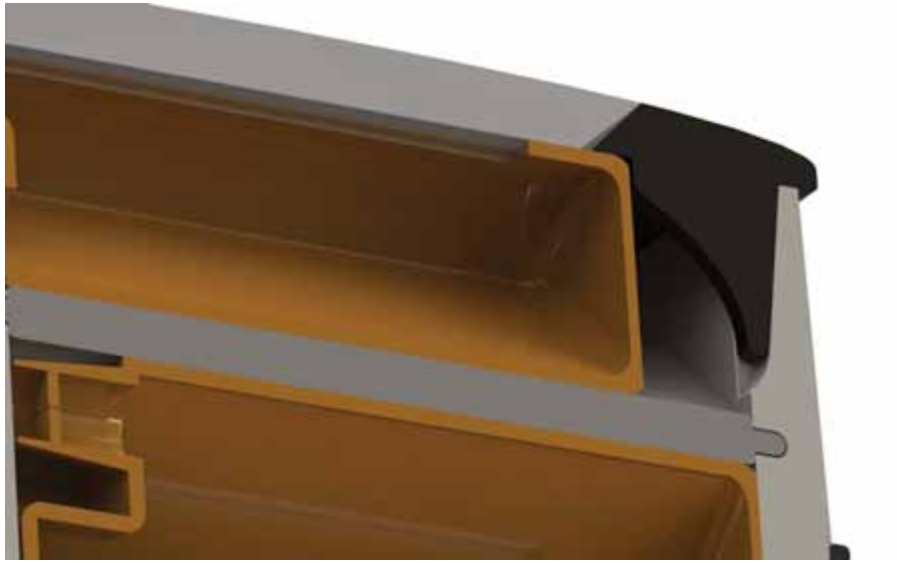
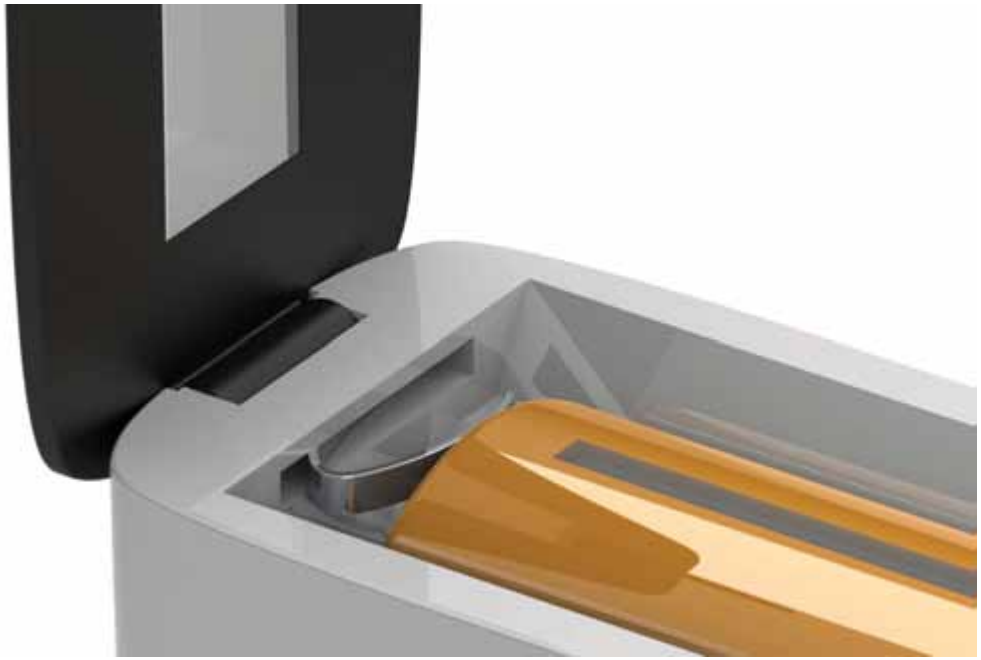


Figure 81.

Figure 82.



Easy de-activation

As with the fin on the lid, there is a little metal profile attached underneath the hinge of the lid. The profile works as a spring, putting pressure on the capsule that is activated so that when the user pops open the lid, the capsule will be pushed into a passive posture. The fin on the lid will now be pushed from the other side and as soon as the lid is opened past the little edge in the fin that is keeping it down, it will snap open because of the force the capsule exert on it.

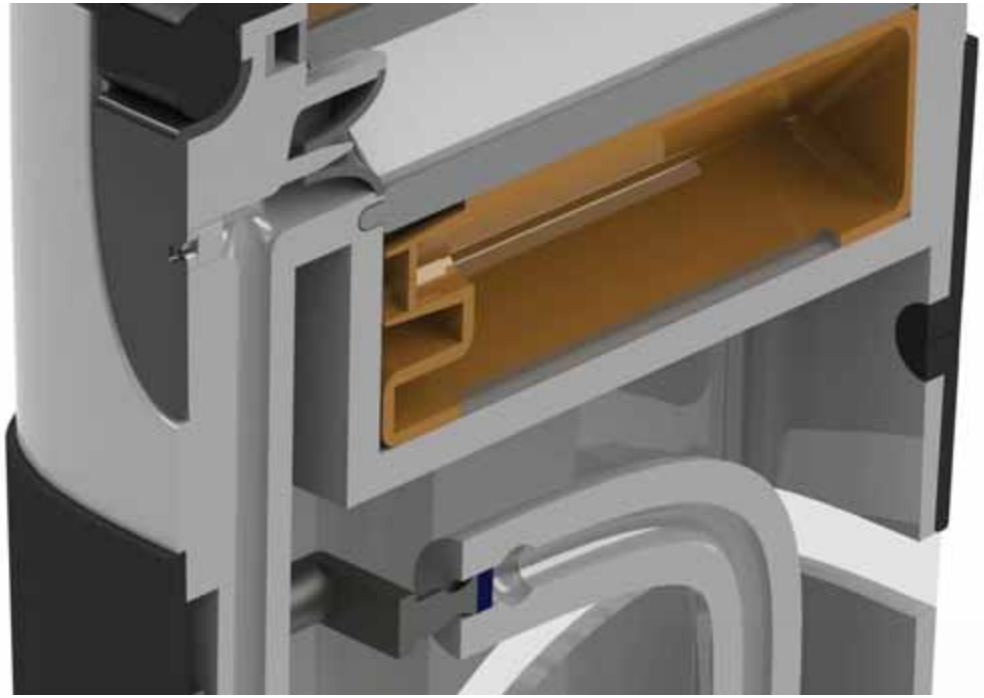


Figure 83.

Safety valve

The rubber band that makes up the friction part on the outside of the bottle, have a couple of internal features as well. One of these are the safety valve in the back. If for some reason the water pipe gets clogged and the Co2 gas builds up pressure inside the bottle, the safety valve will cave in and let the gas out that way.

Keeping it in

A feature of the rubber band is to keep the trigger in place. The trigger leans on the rubber band at all times, and without it the trigger would be pushed out of the pipe leading down to the co2 container. This would cause the gas to escape freely. This feature needs to be tested properly prior to release as more safety features may be needed around the trigger.

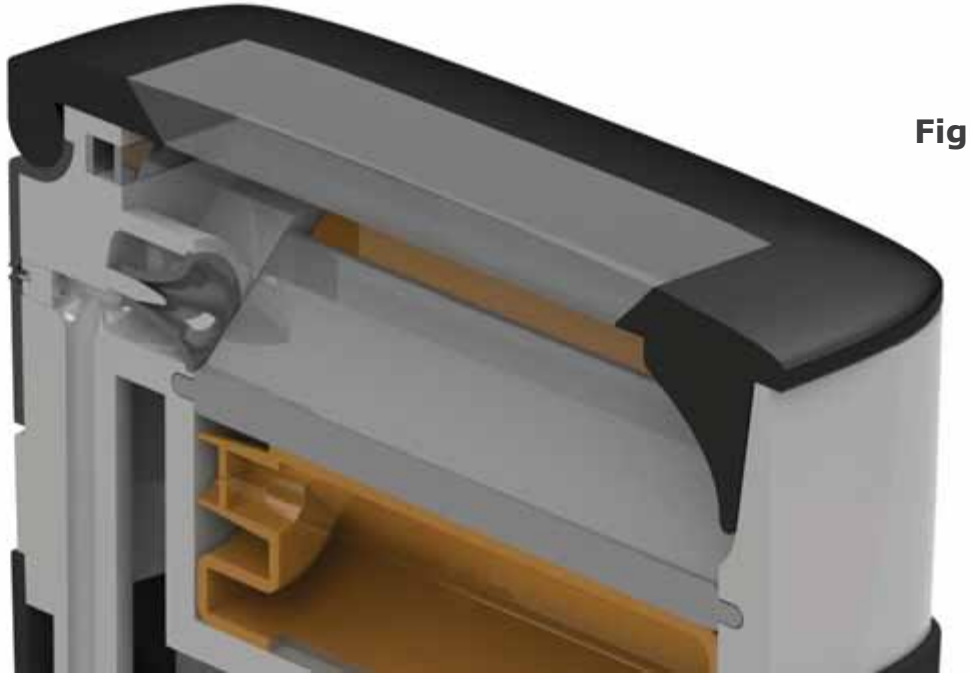


Figure 84.

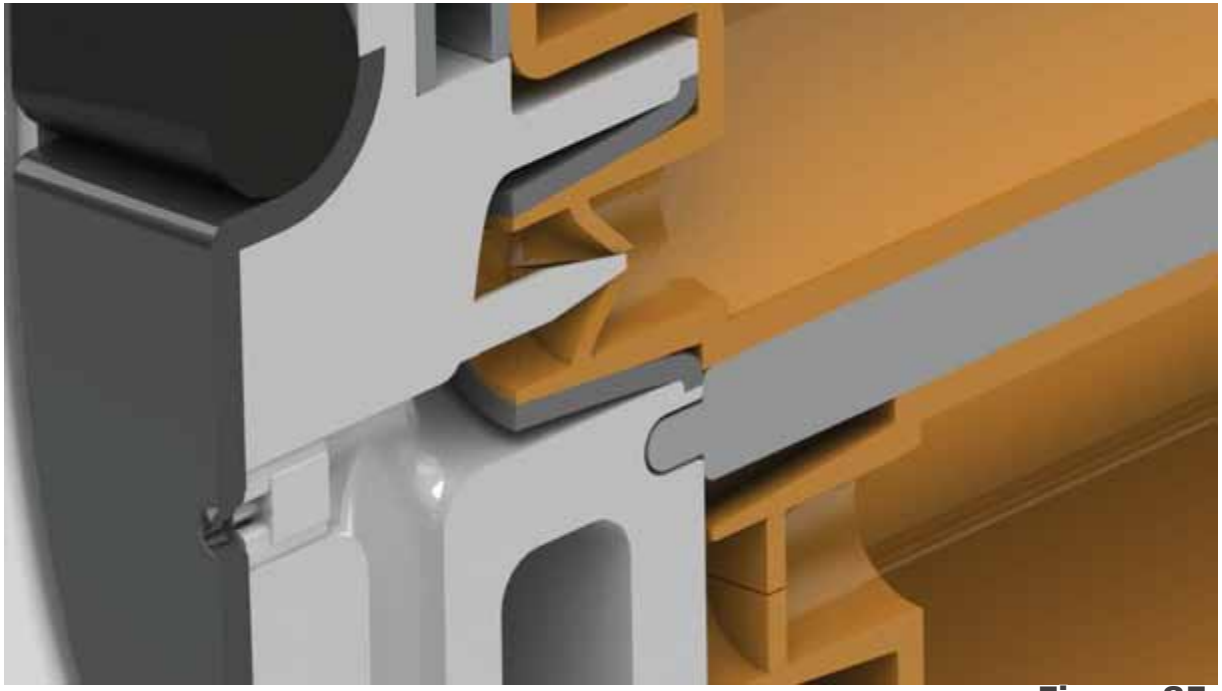


Figure 85.

Smart materials

The connection between the capsule and bottle is made when the capsule is pressed into the rubber funnel attached to the bottle. When this happens the funnel opens up, while still maintaining its water seal around the capsule tip.

Once the capsule is far enough in, the flaps in the capsule tip gets pushed open by the spike coming out of the bottles pipe wall. The further inside the capsule tip the flaps are, the less they will open and less fluid will be mixed into the water stream. This is how the different capsules can have different dilution ratios without having to change the outer shape of the capsule.

Self closing

When the capsule leaves the funnel the capsule flaps will close first and then the funnel will close after it, resealing the water pipe.

The shape of the funnel makes the pressure from the water result in the funnel tightening around the spike. This efficiently means that if there is no capsule connected to the system, pressing the trigger will result in pure water being sprayed out through the nozzle.

This can be beneficial since between capsule changes, there is a miniscule amount of cleaning agent left from the previous capsule in the system. So pressing the trigger with the lid open will clear the system out.

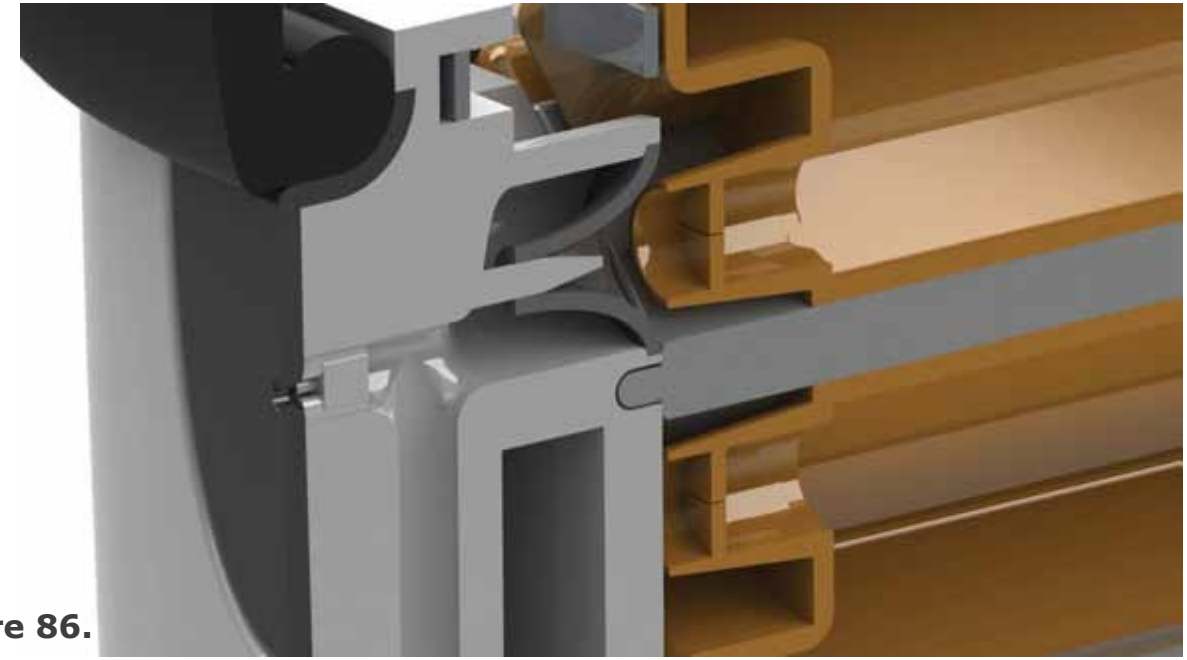


Figure 86.

Physical model

With the finished design in hand, I made a physical model that used the finished 3D model as a basis for construction.

The models is a dummy version with imperfect surfaces, and it contains no gas capsule. It was created to test the feel of holding the product, getting the feel of the size and testing how the flow of the operations with replacing and shifting between capsules work.

Figure 87.

Figure 88.

Figure 89.

Figure 90.

Part V - Branding & packaging

Getting it out to the people

Logo

Name

Tersus - Latin for clean

The namesake is a direct link to the products task. The reason why the brand does not have the same name in English, "Clean", is that for the brand to be able to distinguish itself enough in the market it needs a name which is remembered.

Once the competitors start flooding the market the Tersus brand name needs to be strong enough to be remembered as Tersus, and not as "that capsule bottle" or "the Jif bottle"

Slogan

Be prepared works with what the Tersus system does best, keeping the user on top of any cleaning task needs doing, all within one easy to use framework.

The slogan also works well to play on in advertisements and for packaging concerns.

Graphics

The graphical logo of the Tersus brand represent the bottle and its content.

A simple and elegant logo which fits with the simplicity of the rest of the design.

The bulls eye shape draws the costumers attention and it can be recognized easily even when standing without the Tersus name.

tersus
be prepared

Figure 91. Tersus logo

Point of sale

When the costumer come into one of the Tersus retail stores, he or she will probably not be looking for the Tersus bottle. Therefor the logo and packaging needs to make it easy to notice and to grasp the concept behind the system.

It's small size is one of Tersus' key features, but when it comes to the capsules the tiny size is a slight problem, at least marketing wise. They are so small that to sell them individually shrink wrapped would often result in them disappearing under shelves, in bags, pockets or where ever one would put them after buying them.

They would also be so small that they would be hard to spot in the shop. Therefore the capsules will be sold in packages similar to those used when selling batteries. Hanging the packages on the wall makes them easy to spot and to sort through.

The packages will contain a different amount of capsules, ranging from one to four, allowing the consumer to get precisely those capsules that are empty. This is a vital point as the capsules in the bottle work independently and if the consumer would have to purchase more than needed to fill their Tersus bottle, they would need to store the spare capsules somewhere and part of the idea behind the entire system is gone.

The text on the packaging will clearly note that this is a Tersus product, what area the package is meant for, and what the content of the individual capsules in the package is.

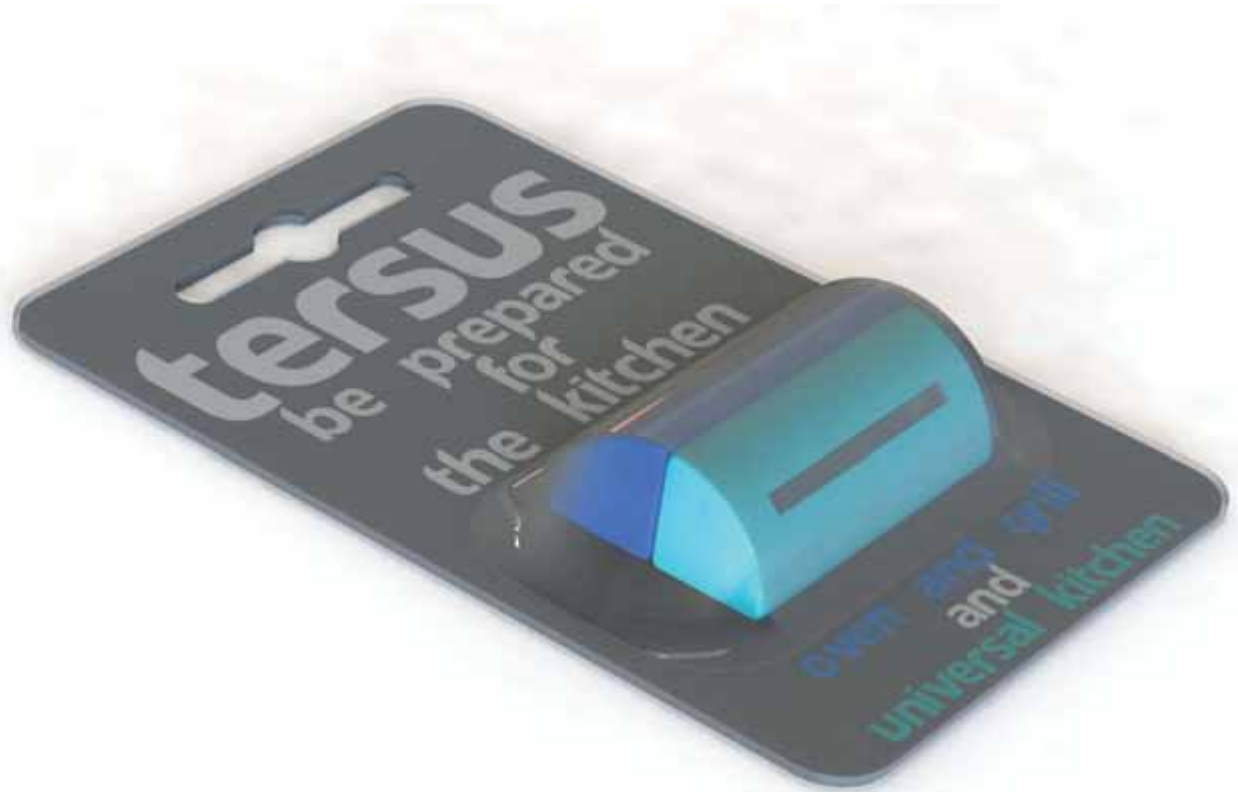


Figure 92.

Figure 93.

Colour coding

Each of the different capsules in the Tersus series will be colour coded to correspond with the type of detergent they contain.

The detergent supplier will need to adhere to this when they brand the capsules. The producers logo will be present on the capsule, and as far as possible the colours they use on their existing product range will be kept up into the Tersus system. When they purchase the license to produce capsules for the Tersus system they also buy the colours from the Tersus colour library, this makes sure that none other get the same colour as them later on. So if a new Tersus candidate has a colour that clash with those that are already in the Tersus library on the market, they will need to purchase another colour or make a deal with the producer that own that Tersus colour.

This colour regiment is important for the Tersus brand, as the capsules that are bought for use in the Tersus system is not only going to represent the producer of the detergent inside the capsule, it will most of all represent Tersus as a whole. So by making sure that no capsules with different content have the same colour coding, Tersus makes sure no consumer can complain about using the wrong capsule.

Starter kit

When first purchasing a Tersus bottle the user will be provided with the essentials to start cleaning. The package contains a Tersus bottle, a 8 gram threaded co2 capsule and four different detergent capsules.

The user might want some other detergents than is in the starter kit. But with having the most used ones there the kit seems more like a finished product for the majority of the buyers.

Since the user gets all the items needed for assembling a ready to use bottle at once, there won't be any surprises for the user later when he or she runs out of either, water, detergents or gas. As they've assembled it themselves with the instructions in the box the first time they use the bottle they should be familiar enough with the product to replace any part later on.

Had the product come ready assembled the user might have stumbled onto a problem they didn't know how to solve, and since they threw away the box after they got the bottle out of it, there is no way to find any instructions for disassembly.

Figure 94.

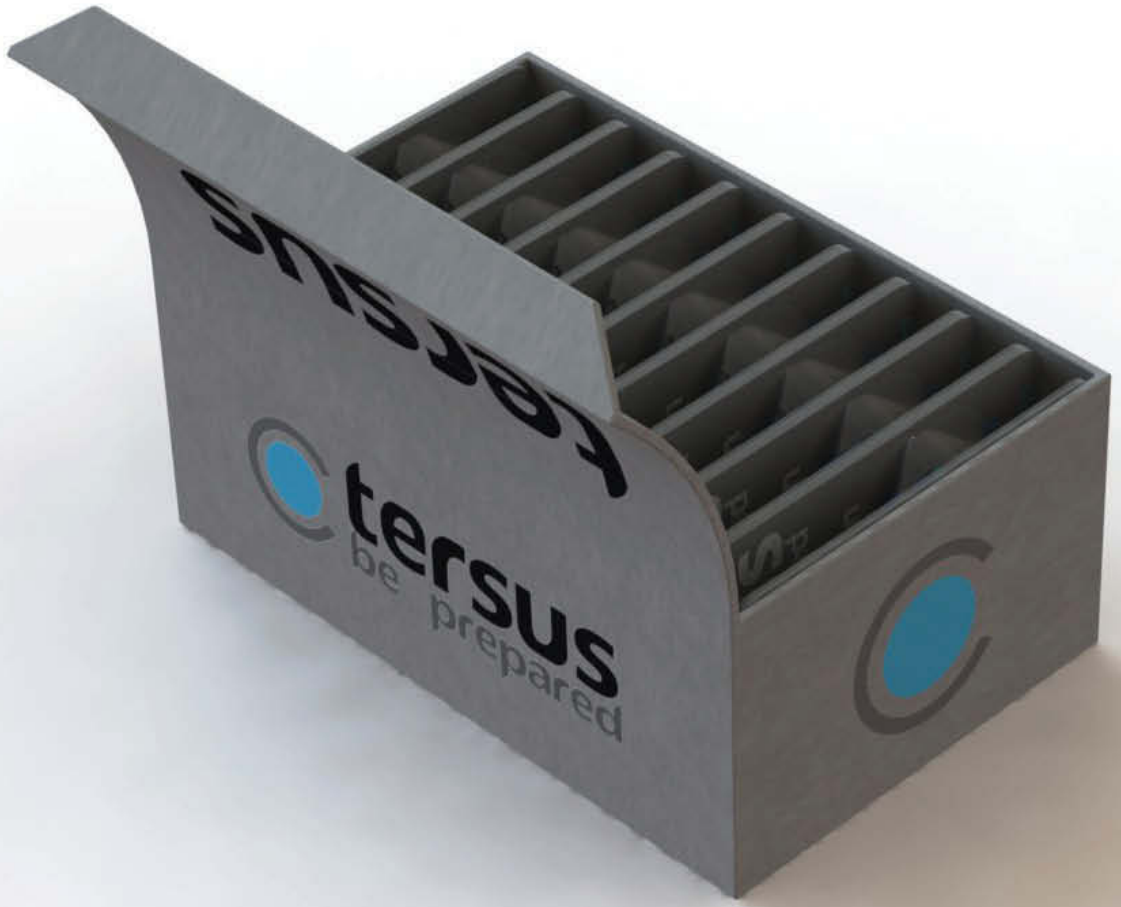


Figure 95.

Transport package

Under cargo transportation the Tersus packages will be shipped in their own Tersus branded boxes. It is an added cost, but it makes sure that the shop-keepers see the box and can find it again if they store it for a time.

Another reason is that for smaller stores, it is often needed to keep some of the transportation packages stored on top of shelves. When this is done the shopkeepers tend to stack them with one of the end faces out so that they can use all the depth of the shelves.

So by having the bullseye logo placed where it is, any costumer comming into a small specialty store will be able to notice the brand logo and know that the store has the Tersus brand availi-ble in storage.

Inside the transportation box every other capsule package is stacked face to face so that they use as little space as possible during transportation.

Part VI - Results

Tersus recaptured

Features

Simple and elegant

The simple and elegant design of the bottle allow it to pass into any kitchen, without ever being out of fashion. Your Tersus bottle will outlast not only your current, but also your every future kitchen design.

Figure 96.

Refillable water tank

The Tersus bottle has a 100 ml water reservoir with a window for checking the current water level. The water in the reservoir constitute the amount of water the user has access to at any given time to mix with whatever type of capsule is active at the time.

By being able to simply refill the bottles water reservoir at any time with regular tap water, there will never be a real reason for ever replacing the Tersus bottle.

Figure 97.

Simple colour scheme

The Tersus bottle come in three variants, black on black, black on white and white on white. These really simplistic design palettes are there because of the wide range of capsules with cleaning agents that the system will cater to.

Each of the different brands and types of detergent that gets associated with the Tersus brand will be given their own colour.

When the simple colours of the bottle is combined with the bright coloursof the capsules they help highlight both the capsule system and the sleek design of the bottle itself.

Figure 99.

Figure 98.

Capsule based system

Instead of working like a regular spray bottle for detergents that are filled with a ready mixed detergent, the Tersus bottle come without any liquid in its basic form. Instead it has a water tank and a system for mixing that water with capsules which are placed inside the bottle.

Unique capsules for every task

The high concentrated cleaning agent in the capsules allow for the capsules minimal size. Each capsule contain a cleaning agent with a varying dosage level (The capsules design adjusts this mechanically by itself), but as a rule of thumb each capsule can be mixed with water to achieve 200 ml*2 of ready to use detergent.

Capsule magazine

With room for four (4) different capsules in the bottles magazine the user has immediate access to which ever type of detergent is needed, whenever it is needed.

Figure 100.

Proprietary capsule system

A simple yet efficient connection system, much like that used in airbrush paint pistols, takes care of mixing and correcting the ratio of cleaning agent to water for every active capsule in the system. If there is no capsule currently activated the water pressure in the bottle self-closes the valve leading to the capsule compartment and if the trigger is pressed there will only be clean water exiting the bottle.

Figure 101.

Propellant based system

Instead of using a conventional siphon system to transport the liquid throughout the bottle, Tersus uses high concentrated carbon dioxide(dry ice) as a propellant for pushing the water throughout the bottle.

Stepless trigger system

The users can adjust the amount of detergent leaving the nozzle dynamically by adjusting the pressure they put on the trigger.

Continuous spray

By using a high pressured system, the user of a Tersus bottle can keep the trigger held in and spray continuously instead of in short bursts as with a normal spray bottle..

Figure 102.

Bigger than it seems

Bigger is not always better, with its small size a Tersus bottle take up about a quarter of the space of a normal 500 ml spray bottle. Taking into considering the fact that a Tersus bottle has access to four different cleaning agents at any time, it frees up even more storage space. The small size also makes it a perfect companion to bring along on trips.

But with the amount of capsules in the magazine and the ability to refill the water tank, the little Tersus bottle carry allot more cleaning punch than one would think.

Figure 103.

Figure 104.

Low maintenance

The Tersus bottle requires next to no maintenance. With a classic bottle system a user would sometimes need to clean the nozzle of bottles that are seldom used, but since Tersus uses the same nozzle for all it's different capsules the nozzle will constantly be washed through and no old left over cleaning agents will get a chance to clog the system.

Easy to clean

The Tersus bottle consists of several outer user surfaces, these are as clean and simple as possible while still maintaining their functionality.

Those places that would normally be hard to clean are made as open as possible, and where they are not the covering parts can be removed, as with the nozzle guard in front.

Replaceable nozzle guard

For those with extreme precision demands the replaceable nozzle guard can be replaced for one with a wider or narrower arch. For the extremely rare scenario of the nozzle being clogged after a long period of not being used the front of the nozzle, the nozzle guard, can be taken of and cleaned separately to reach all parts of the small channels in the water tube.

Quick switch

Changing between capsules is as easy as opening the protective cover on top of the bottle and spinning the capsule magazine to the right capsule is shown and then closing the lid. The bottle does the rest.

Easy set up and reload

Setting up the bottle for the first time, or replacing a spent capsule, is as simple as opening the lid, reaching into the top of the bottle, take out the spent capsule (if any) and then place a new capsule into the top slot of the magazine. If more slots needs refilling one only needs to spin the magazine to the next slot and repeat the previous actions.

Figure 105.

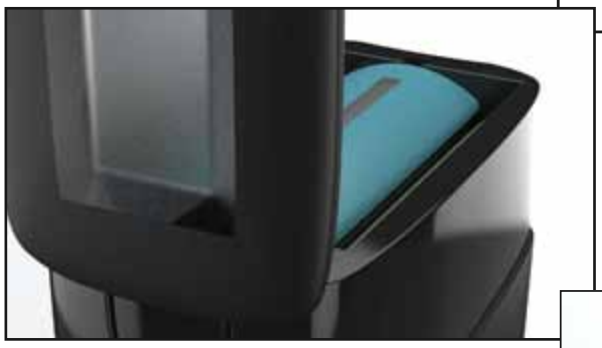


Figure 106.

Figure 107.

Figure 108.

Technical specifications

Bottle
Water reservoir - 100 ml

Height: 143 mm
Width: 30 mm
Depth: 53 mm

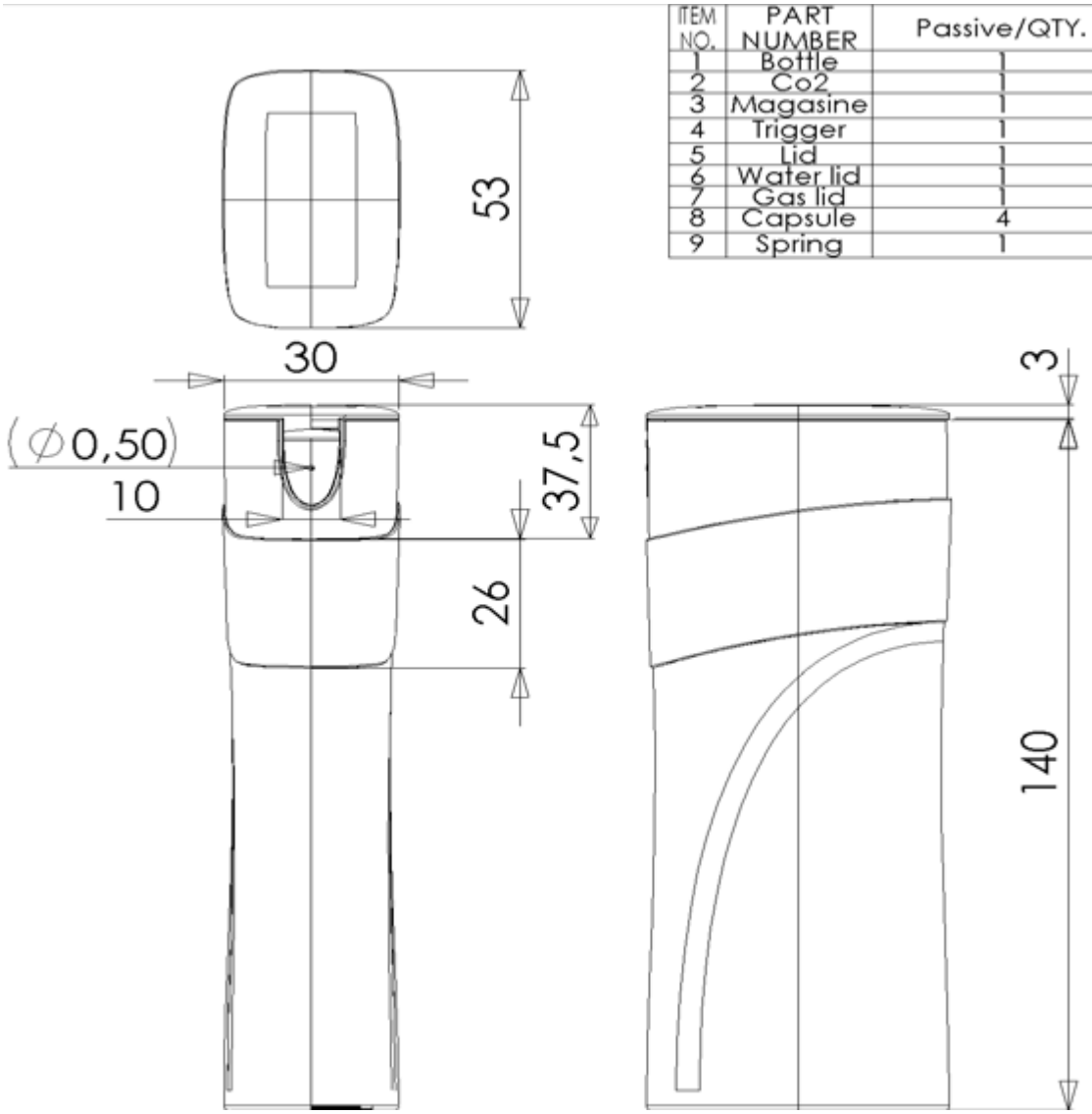
Capsule

Capacity - 2 ml cleaning agent

Height: 11 mm
Width: 12 mm
Depth: 35 mm

Magazine
4 capsules (1 active,3 passive)

Propellant
One 8 mg capsule of pressurized co2 is enough to propel 4 litres of detergents out of the Tersus bottle, that amounts to 20 Tersus-capsules*2 or 8 normal detergent spray bottles*1. The amount of carbon dioxide that escapes into the atmosphere from one high pressured co2 canister is equal to that which escapes from opening three 33 cl tins of soda.



ITEM NO.	PART NUMBER	Passive/QTY.
1	Bottle	1
2	Co2	1
3	Magasine	1
4	Trigger	1
5	Lid	1
6	Water lid	1
7	Gas lid	1
8	Capsule	4
9	Spring	1

Figure 109.

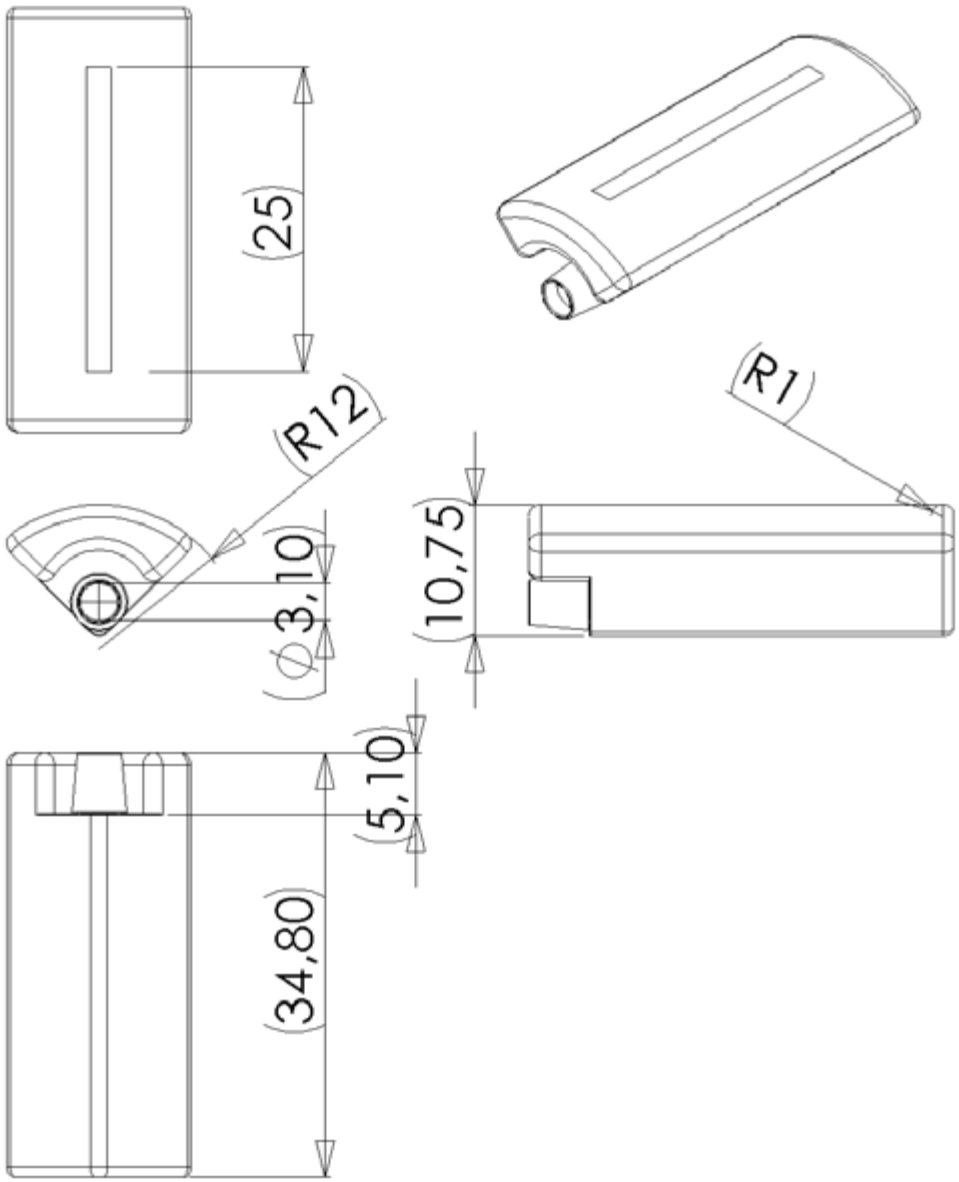


Figure 110.

Part VII - Conclusion & reflection

What was hot and what was not

Conclusion

The research question

"How can a capsule system for cleaning products be developed to make refill solutions simpler and more attractive to the end user?"

By developing the Tersus system to its current state, I've uncovered numerous ways for how a capsule based system can make refill solutions more attractive on the cleaning market. Through the project I have followed the path I've seen as the most viable one with the input I've gotten from the methods I've used. All of this results in the product presented in this report.

In other words, the result of this project is not the only way for the research question to be answered, but it is an answer that works and that I have faith in.

The final result

The implementation of the hydro capsules, the capsule magazine and the gas propellant system, combined with the simple Scandinavian inspired design, makes the product both simpler and more attractive than any other cleaning product, refill or not, that is currently on the market today.

Effect goals

The effect goals I set for my self when I set out on the master thesis work was to "create a cleaning product that I think can be viable to enter and succeed on the Norwegian market"

I think I have succeeded with reaching my own goals for the project, as I have faith in the fact that if the Tersus project got the founding it needs to finishing the work started in this project, it will become a success.

Potential for the future

As with any product there is always a potential for improvements. For the Tersus system the main area of improvement is in setup for production. As an intended high end product my time on the project has gone into creating a product that was technically possible on a academic level. For Tersus to be produced, a whole range of features need to be redesign to allow for efficient production techniques etc.

The way I've looked at it is that, the bottle is going to be a high end product at an appropriately high end price, while not requiring a high profit margin, the Tersus bottle can be produced with complex tools and methods without it being a major financial problem.

With enough dedication and money anything is possible.

Reflection

Looking back on a seemingly both too long and too short process, it has been a good but tough run. I've discovered allot regarding my own talents and limitations during the process. I've learned allot from the work done, and I've cursed it and myself all equally much.

I've discovered the difference between academic and professional projects. I've also discovered how much more I like working in a team than working on my own. Even with being social outside of school, having a girlfriend and family close by, I've often felt like I have had no one to talk to. There is nothing like the feeling of accomplishing something as a team, and I can feel now, that delivering this thesis feels, how ever relieving, somehow hollow, without anyone to share the joy with.

Regarding the time frame I let my self stay still for too long during parts of the project I struggled with, instead of making some hard choices and rather go back on them if they failed, and therefore I ran out of time at the point where the product really started to come together and I begun to have fun.

I'm glad I did spend as much time as I did to think through the concepts and designs though, as I feel like all the pondering and head scratching paid out into a really good product, the project should just have been a little longer, or I more efficient.

The thing that I really do regret, is not taking the time to write down all the things I've thought and asked people about. In the start of the report I write that I like doing verbal communication with people to get the most honest opinions as possible, and I still stand by that notion. I just would have wished I could have shown you, the reader, all the help I've gotten in terms of input from fellow students, friends and complete strangers.

When making a product that everyone can relate to, it is easy to ask for opinions on everything from their personal opinion on spray bottle detergents and to how often they clean their home. And while for them the answers they give seem unusable, for me it has been audible gold.

I'm also hopeless at keeping track of where I read things, making it impossible to find back to the sources for references in a report.

Result wise I feel that I've created the beginning of something that can, with some more work, become a really great product. It has the potential of becoming not only great in it self, but it has the ability to trigger a whole new segment inside a large market.

With the potential of the system, the product range going under the Tersus umbrella can grow way outside of the boundaries of cleaning tools. It can become everything from medical equipment to drink mixers.

Just imagine a bottle with rum and a capsule with cola concentrate, blending the ultimate Rum and Coke at the press of a button, the party will never end.

To finish of the reflection, I'll sum it up by saying that I'm happy with the result of what I've done, I just should have done it faster, and get it further.

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Reference persons

Victor Rosenvinge, lead engineer, Eker Design AS

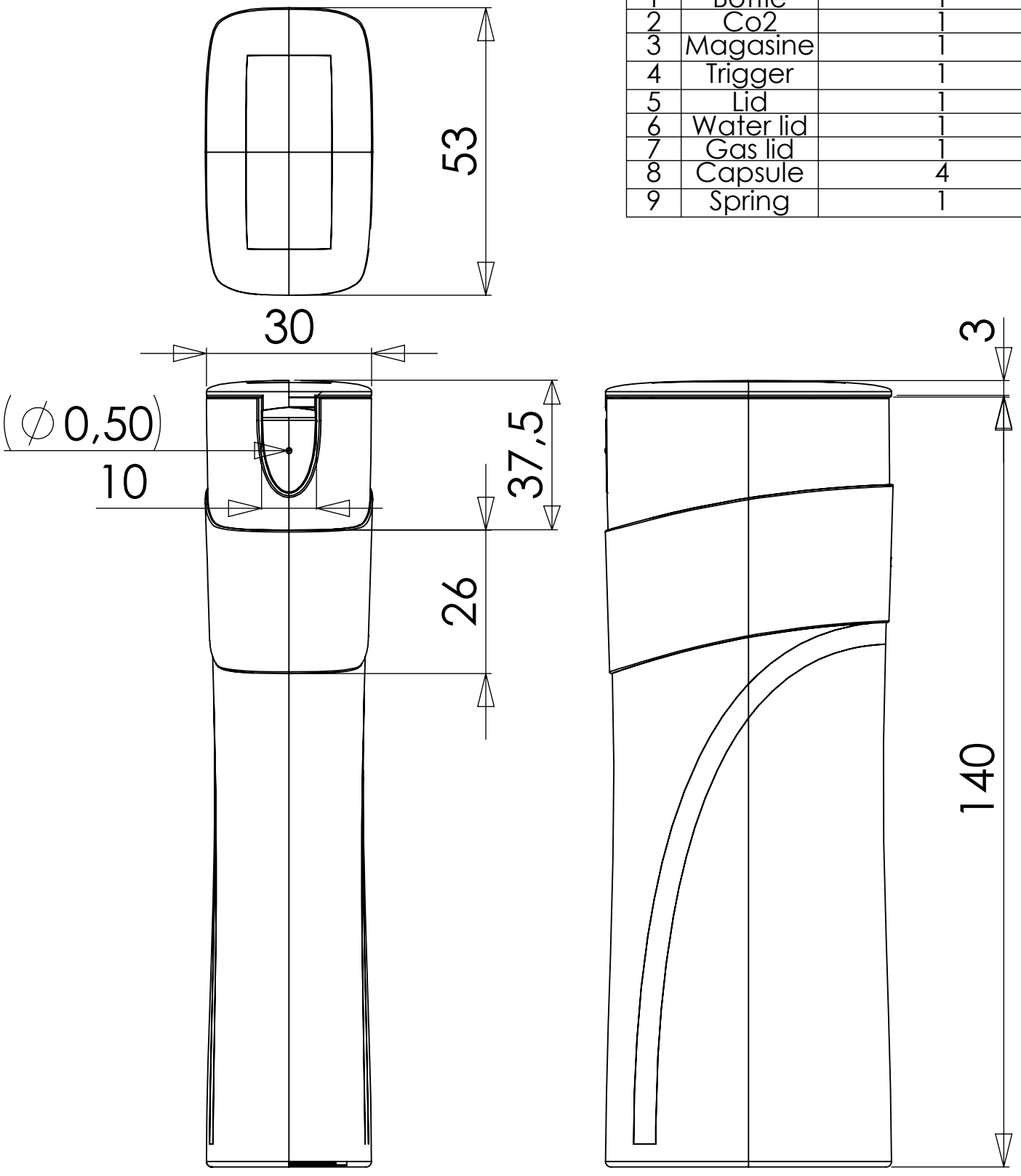
Nenad Pavel, lecturer, Akershus University College

Figure list

Part VIII - Appendix

That which was so dry it did not make the report

ITEM NO.	PART NUMBER	Passive/QTY.
1	Bottle	1
2	Co2	1
3	Magasine	1
4	Trigger	1
5	Lid	1
6	Water lid	1
7	Gas lid	1
8	Capsule	4
9	Spring	1



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CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL		DWG NO. Tersus	A4
				WEIGHT:		SCALE:1:1	SHEET 1 OF 2

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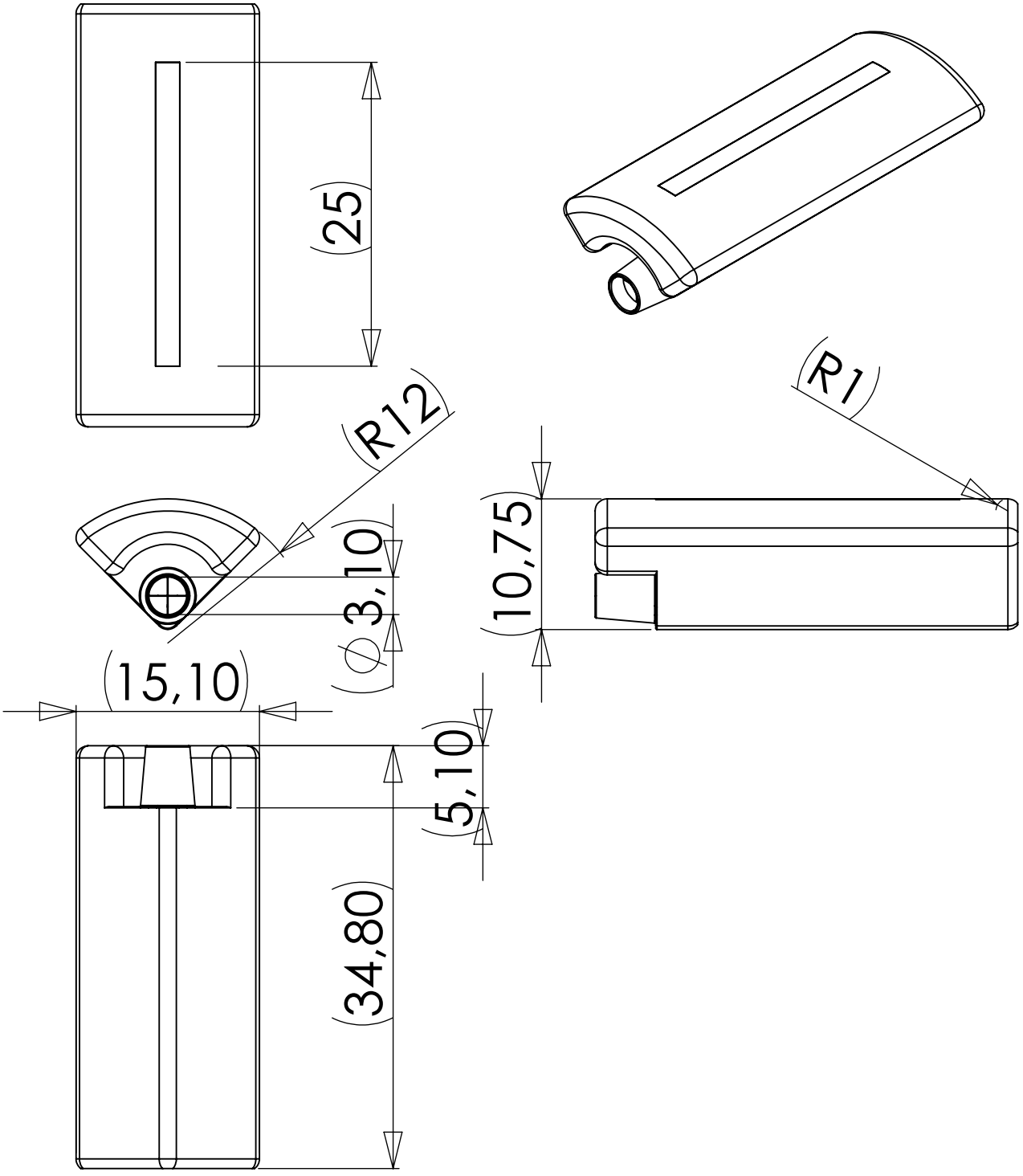

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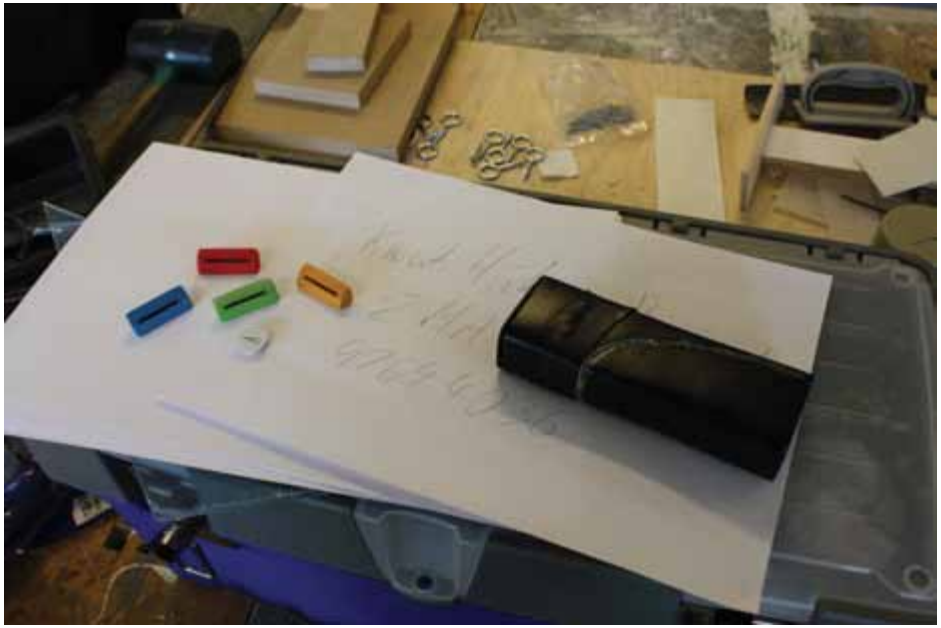
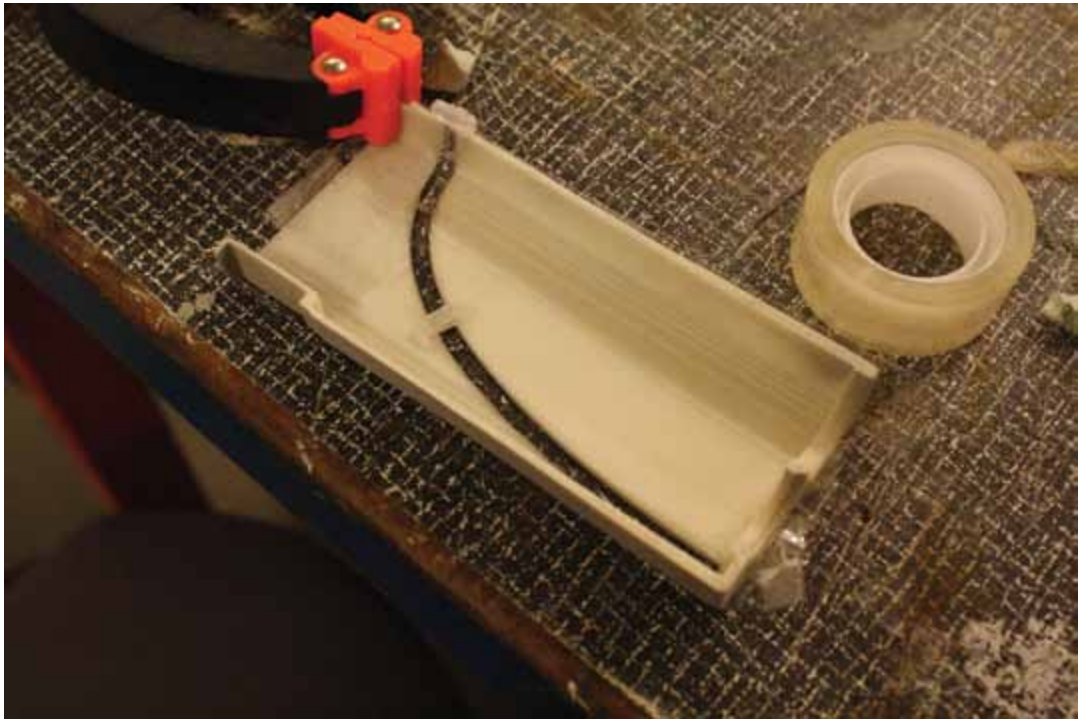
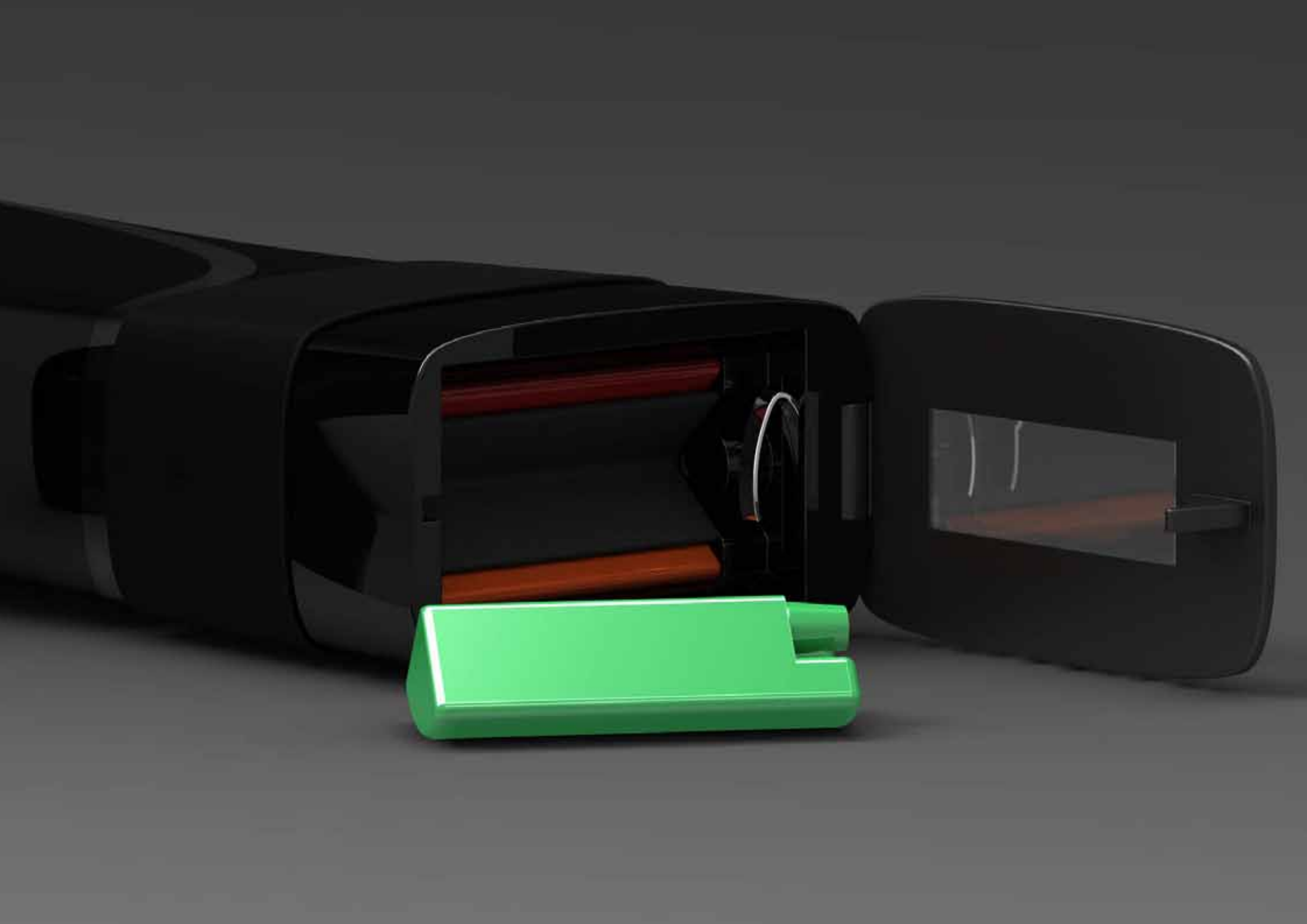
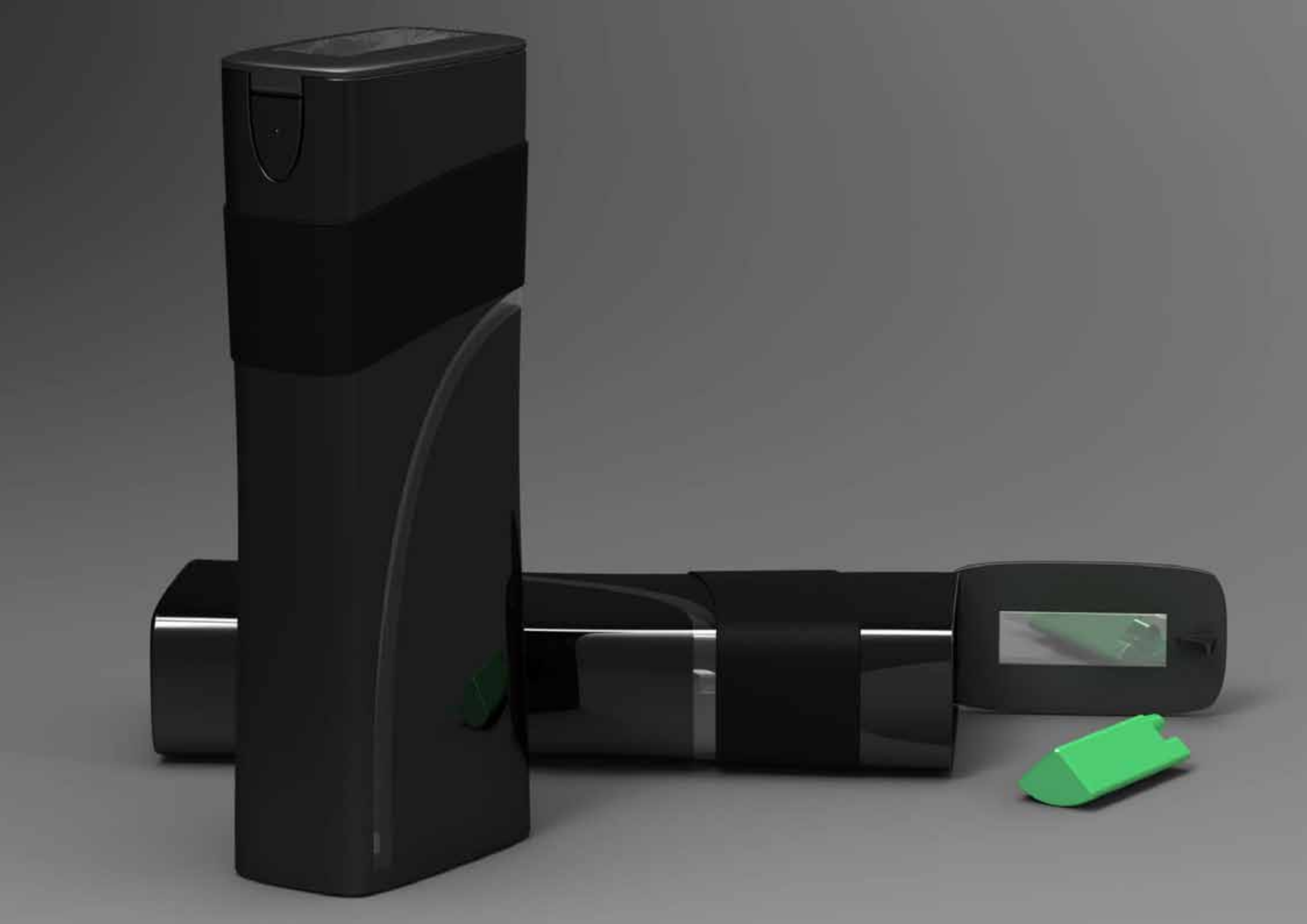
Model building

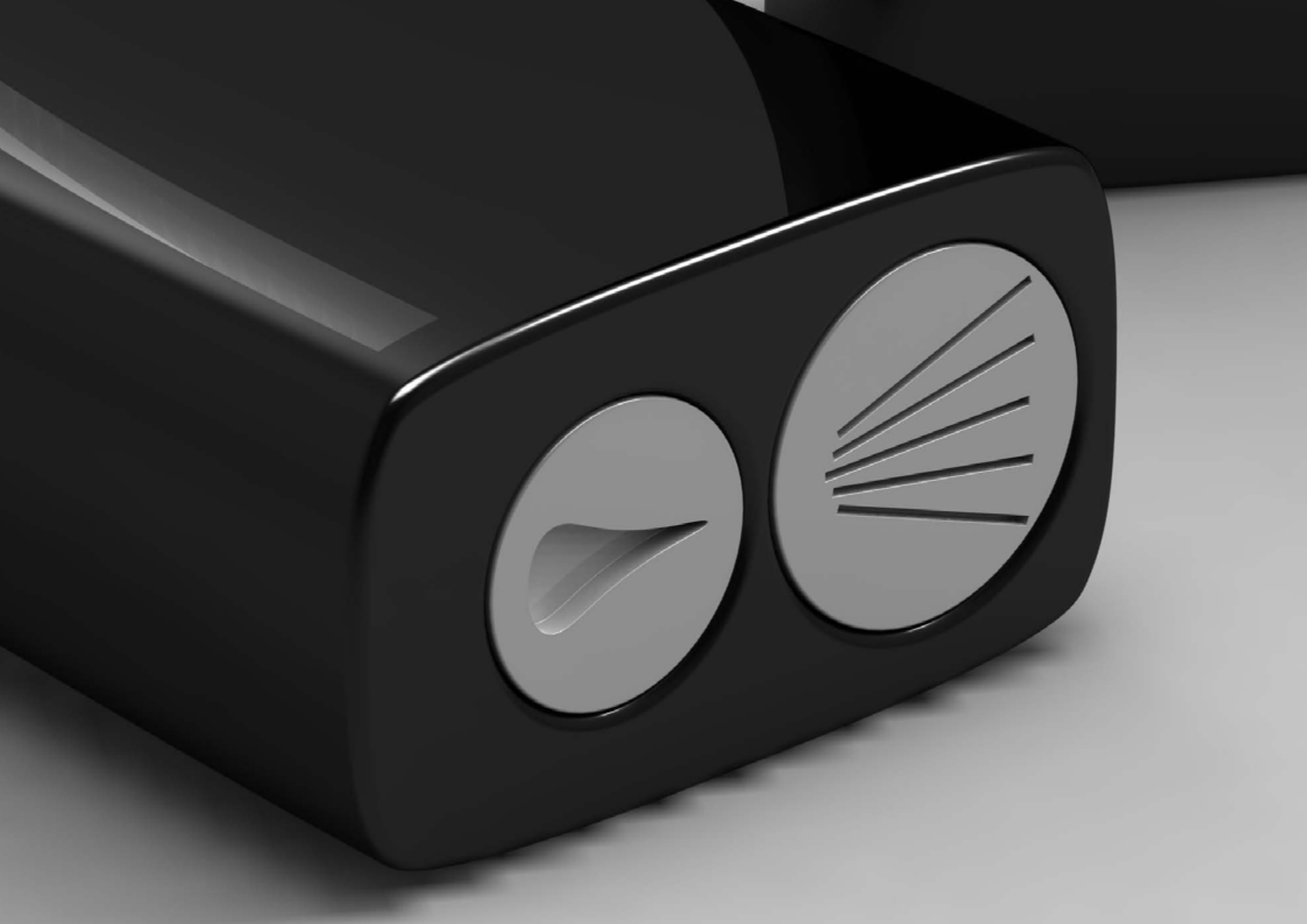


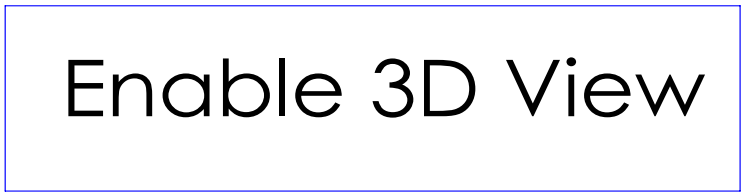


Catalogue computer renderings





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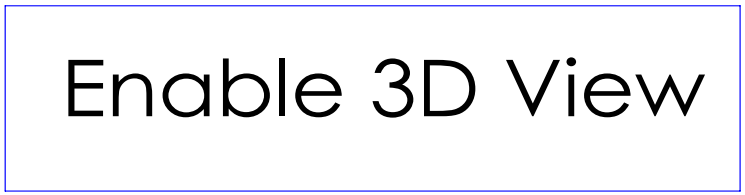
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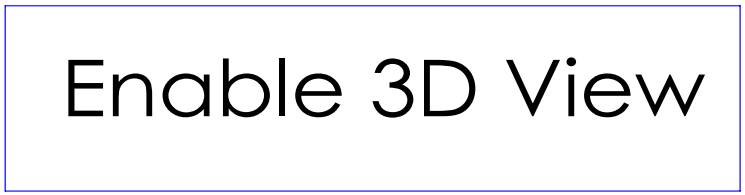
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