Appendices

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Appendix A | Full list of Trends & Developments

1. Demographic
1.1 Growing population (UNFPA, 2017)[1]
Advances in modern medicine and improvements in living standards are the reason for a fast growing (world) population. Because of this, child and maternal mortality rates have reduced significantly and are there more women of reproductive age. This will result in a large number of births, even though these women will have less children.

1.2. Urbanization (UNFPA, 2017)[1] (Henry et al., 2015)[2]
There is a trend of urbanization. 2007 was the first year in which more people lived in cities than in rural areas. This will only continue to grow. It is expected that by 2050 about 66% of the world population will live in cities. This is not just negative, but could also have positive effects, since sustainability solutions can be focused on a smaller area. This trend could also have an effect on immigration, since the high-income countries will also have more jobs and less people to execute them.

1.3. Immigrants and refugees (Tjin-a-Tsoi, 2016)[3]
Since 2015 the Dutch population is growing faster due to immigrants (200.000) than because of birth (170.000). These immigrants are a combination of asylums and people searching for work, of which the largest part is coming to live in urban areas.

1.4. More smaller households (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2015)[10]
The number of single person households is increasing and the number of children living with their parents and the number of children in general is decreasing. This causes that the households are getting smaller, but the number of households is getting bigger; around 50.000 a year.

1.5. Globalization (Johnson, 2016)[14]
Borders are becoming less visible. People and companies are connected with everyone in the world because of social media, increased transport and communication developments, but also because of increased trade as the production of goods and services has become international.

1.6. Ageing population (UNFPA, 2017)[1] (Henry et al., 2015)[2] (Arcon, 2013)[19]
High-income countries have a large, growing population of older people. These elderly will stay at home longer. This may have implications for the bathroom, since the mobility of these people decreases and for instance the toilet seat has to be moved up.

2. Economic
2.1. More paper exported to China (Henry et al., 2015)[2] (Lalkens, 2015)[4]
Due to the poor Euro, more paper is exported to China. CAN, the world's biggest export company, delivers most of its paper to the Chinese paperboard producer Nine Dragons Paper. From 500.000 tons in 1995, the amount of imported paper rose to 30 million tons in 2014. Rotterdam counts around 27.500 containers full of old paper to be shipped to China.

2.2. Hospitality cleaning (CleanTotaal, 2009)[12] (Lemmens, 2015)[15]
People and companies are increasingly aware of the value of money. This results in efforts to keep improving on efficiency

including cleaning. For instance, this means a difference in cleaning of the public washrooms in hospitals with a focus on appearance in comparison to operations rooms, where hygiene is at the top of priorities. This is called hospitality cleaning.

2.3. Inequality resulting from globalization (Berger, 2014)[13]
Through globalization, the average income in a country increases. But for one segment of the work force, this increase is higher than that of other segments of work, resulting in an increase in the gap between wages.

2.4. From liquid to foam (Shuster, 2017)[21]
There is a move going on from liquid towards foam based hand cleansers and hygiene products. Mainly because they typically dispense 50% less product per push, but also because of its cosmetic appeal.

2.5. Water-conserving amenities (Brereton, 2015)[23]
Waterless urinals have been catching on in recent years. They don't require flushing and thereby save water use and expense.

2.6. Flex working spaces (Virgin.com, 2017)[36]
Flex working is already implemented a lot in offices and companies. But the next thing, as an extension of this trend, is the rise of remote working, open plan offices, co-working spaces, increased connectivity, hot-desking, and third spaces.

2.7. Growing middle class (Pezzini, 2012)[39]
An increase of average incomes and a decline in levels of poverty, suggest that there is an increase in the population that are neither rich nor poor by national standards and thus living in the middle of the income distribution.

2.8. Hotels and AirBnB (Rabobank, 2017)[51]
For the last couple of years, there is a rise going on in the number of tourists. This has as a result, a growing number in hotel reservations. However, it is expected that AirBnB will play an increasing role in the competition.

3. Political
3.1. Regional networks (Mey, Feuler, & Stevens, 2017)[9]
Regions feel more and more the need for cooperation, because the government is decentralizing more tasks. This is not only evident between regions, but also between regions and municipalities, and municipalities and civilians.

3.2. Smaller and Local (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2015)[10]
People are voting more for smaller, local parties than for the traditional large ones (VVD, CDA, PvdA). This is because people are losing their trust in the government and political institutions, resulting in a low voters percentage and a decreasing amount of political memberships.

4. Ecological
4.1. Urbanization and Health (WHO, 2017)[5]
As a result of the growing population and the exponential population growth in large cities, health and hygiene will become

more important. With more people living close to each other, epidemics and environmental pollution are at stake.

4.2. Circular economy (Henry et al., 2015)[2] Joustra, 2015)[6]
Circular economy is not a trend as such, but more an adaptation to other trends, such as large variations in price for and finite availability of raw materials. To adapt to these trends, reuse of materials and closed material cycles can be the answer to a more sustainable business.

4.3. Anti-vaccinate (Sepers, 2016)[7] Fox, 2017)[43]
Currently there is a lot of discussion about vaccinating children. Parents read on the internet and social media about dangers regarding vaccination, and decide not to vaccinate their child. Although the rate of vaccination is still above 90% and there is no need for immediate action, a further drop might do so in the long haul. In Minnesota, US, there is the first sign of the consequences of not vaccinating your children, with the worst outbreak of measles in 30 years.

4.4. Growing health awareness (Henry et al., 2015)[2] (Hartman Group, 2015)[8]
People are becoming more and more aware of their health and the healthiness of products. Gym memberships are growing and already a lot of people are earning their living with sharing about healthy food and exercising on social media.

4.5. Antibiotic resistance (CDC, 2016)[32]
The use and prescription of antibiotics is getting out of hand. In the United States alone there are 47 million unnecessary antibiotic prescriptions each year, which cause bacteria to become immune and therefore untreatable.

4.6. Allergies rise (Moskvitch, 2015)[33] (Pongdee, 2017)[34]
As we are getting better and better in getting and keeping ourselves clean, scientists are now questioning if we aren't getting too clean. There is a rise in allergies and they think it's because kids aren't exposed to germs and thus don't train their immune system to tell the difference between harmful and harmless irritants.

4.7. Workplace wellness and well-being (Schawbel, 2016)[35]
Company executives recognize the benefit of wellness and well-being in the workplace. Less absenteeism, attracting talent, and savings on healthcare costs are the direct result of it. Another positive consequence is the rise in health consciousness of employees.

4.8. Self-monitoring (Paddock, 2013)[37]
People love information. And they love to talk about themselves. With all new technical gadgets as heart rate monitors, the iPhone sport fitness tracker, and healthy smartphone apps, this has become an everyday subject of conversations.

4.9. Telecare (BMI Research, 2015)[38]
Travelling is a waste of time and money, and new communication ways result in a trend that is called telecare. "BMI defines telecare as the use of mobile and internet technology to provide clinical care and non-clinical services such as health education, disease surveillance, and drug monitoring."

5. Social

5.1. Locally produced goods (Goller, 2016)[28] (Kasriel-Alexander, 2014)[29]
Although people don't exactly define what local is, consumer describe local as within 100 miles from the point of sale. This trend is not only visible in restaurants (where people are referred to as "locavores"), but also with other products. This is mainly the result of globalization and thus asks for a regional and local identity.

5.2. Pain relief products (Johnson, 2016)[14]
Because of the aging population, an increase in pain relief products is evident in the marketplace. This is important for (industrial) hygiene, since pain management falls under its responsibilities.

5.3. Networking takes off (Johnson, 2016)[14]
Where networking used to be informal and less organized, nowadays whole expo's and organizations are centred around this phenomenon. Think of LinkedIn.

5.4. Gender neutral (Spoorenberg, 2016)[17] (Van Loon, 2016)[18]
Gender neutral is a new phrase that is being integrated in society at a running pace. And this is most obvious in toilets, where the separation between men and women is most probably the biggest. Already in the municipality of Utrecht there are gender neutral toilets.

5.5. Less ownership (TuhisComfort, 2016)[20]
People are getting tired of having stuff and paying for stuff that they only use a couple of times a week or even in their whole life. Businesses are hopping on to that trend and offer all kind of products and services that people can lease instead of buy. For instance power drills, but also light might be one of the options.

5.6. Hectic and comfort (Noij, 2016)[24]
The lives of people are getting busier and thus, people are looking for comfort and convenience. This can be seen in the rising number of gym prescriptions, but also in the fast-casual trend of restaurants and cafes. People have more moments for eating, want to eat faster and are spending less money on it.

5.7. Feeling at home (Hercaadviesbureau, 2016)[25] (Combrink, 2017)[26]
No matter where you are, you want to feel at home. Whether it is in a restaurant, your work, a hotel, or the washroom. Feeling at home makes people feel welcome, more relaxed and (when at work) more productive.

5.8. Leisure-land (Rabobank, 2017)[27]
The Netherlands is becoming a leisure-land. The Dutch will eat more away from home, on more moments of the day, and are taking more short holidays like weekends. This does mean that location is becoming more important and if you are not at an A-location as entrepreneur, you have to stand out in some other way.

5.9. Gender equality
“More women in high-paying jobs.” “Women still get 17% less paid for exactly the same job.” Phrases that you here regarding gender equality. Although it is not perfect, gender equality is coming and gets integrated into society.

5.10. Human need for interaction (Cook, 2013)[41] (Sweat, 2017)[52]
The need for interaction is one of the fundamentals of being a healthy person. It helps us tell the difference between a friend or an enemy. And this is not just via social media to other humans, but also connections to other things like animals or the environment are important.

5.11. Smartphone addiction (Archer, 2013)[44] (Brody, 2017)[45]
You can see it everywhere, anytime: people watching at or checking their phone. Over dinner, while driving, in church, and even when in a face to face conversation with a good friend. Women used to go to the bathroom in pairs, but that is history. Now, they bring their smartphones with them. And men as well. This is a serious trend. The 2013 Mobile Consumer Habits found that more than 50% of people text while driving, despite the fact that this is six times more dangerous than driving drunk. This trend has been given a name: nomophobia (no- mo(bile) phone-phobia. In other words, the fear of not having a phone with you.

5.12. Cell phone free (Archer, 2013)[44]
There was a time when cigarettes were not only allowed, but encouraged during air flights. In this time, smoke-free zones were popping up. The same thing could happen with the smartphone. Already, restaurants are answering the demand and enforcing a “no-cell policy”.

5.13. Experience, experience, experience (Morgan, 2015)[46] (Newman, 2015)[47] Schultz, 2015)[48]
People are looking for an experience. And not just users or customers, but also employees. Where the power used to be in the hands of the employer, it is now in those of the employee. Employers need to create a workplace where people want to work, instead of need to work. And this also counts for customers, who’s spending is not influenced by brand messages as much as by the experiences they get. People, and not just millennials, are looking for experiences and not just things.

5.14. Loneliness (Worland, 2015)[53]
A very dangerous trend that is more the result of the digitalization trend, is that of loneliness. Many social scientists say that technology and housing trends are increasing the risk of loneliness. More people living alone, which is 32% more devastating to a person’s health than feeling lonely.

6. Technological
6.1. Digitalization (Henry et al., 2015)[2] (Mey, Feuler, & Stevens, 2017)[9]
More and more companies are aware of the damaging consequences of using paper. So they switch to more digital work and converging old documents into digital ones. This causes a reduction in paper to be recycled by Van Houtum.

6.2. Smart washrooms (Hoyler, 2016)[11]
More and more products are equipped with electronics to give the user a better experience with the product. This also goes for

washrooms. At the ISSA/INTERCLEAN North America 2016 conference, SCA and Kimberly-Clark Professional both presented a IoT system the allowed visitors to track every aspect of the local washrooms.

6.3. Automation (Johnson, 2016)[14]
Industrial automation is not something new, as the first production line of Henry Ford was already an automation process. However, the level of automation is increasing with the increased level of integration of sensors that are getting better and better.

6.4. Sustainable and smart buildings (Lammers, 2016)[16]
With all kind of sensors, buildings are getting more sustainable. Unused spaces aren't lit and hardly ventilated, until someone enters the room. Rain water is used for toilets and solar cells on roofs and facades produce (most of) the electricity the building uses. The increase in technological development and application, causes this development to progress.

6.5. Big data is getting bigger (ThuisComfort, 2016)[20]
The amount of data collected in the current world is already huge, but this is getting even bigger. In the next couple of years, the collected data will be quadrupled to 100 Zettabytes. This is 1021 bytes.

6.6. 3D printing (ThuisComfort, 2016)[20]
Already now is 7.1 billion dollars spend on 3D printing of products. Even though this manufacturing process is relatively expensive. Where it started with just plastic, there is now the first steps towards the printing of food and houses.

6.7. No toilet paper? (Dutch-IT Channel, 2015)[22]
Geberit and Grohe are two brands that produce a toilet with an integrated tap, so there is no need for toilet paper. Instead of paper, water is used for cleaning which should result in a cleaner and better cleaning experience. The company Decos has implemented this type of toilet, aiming for a paperless office.

6.8. I,Robot (Miller, 2017)[31]
The digitalization and automation trends result in yet another trend: the application of robots in the workspace. Already now it can be seen in the automotive, beer and other high volume industries. Although it is still limited to the easier, repetitive jobs, the intelligence of robots is increasing rapidly.

6.9. Growing popularity of social media (Morrison, 2014)[40]
Not just people, but also companies are using social media more and more. It is a great way for human recruitment to get a picture of who a possible candidate is and what his or her strengths are.

6.10. Internet of Things (Bronder, 2017)[42]
As data collection becomes more important for companies to provide services and optimize their production and expenses, devices and products get connected to the internet to send that data.

6.11. Customization
Although some might see this as a trend, it is really a development. Already in 2006 Nike had shoes that could be customized by colouring them. And they weren't even the first.

6.12. Augmented and virtual (Gaudiosi, 2016)[49] Graham, 2016)[50]
Augmented and virtual reality will take a much larger leap in the future. The benefits of augmenting reality is attractive in gaming, but very useful in space ventures, education, healthcare, and exploring yet-to-be-build homes. And members of the 2016 Consumer Electronics Show, predict that by 2030, head-mounted displays are a thing of the past or are reduced significantly in size.

Appendix B | Full list of different contexts

5.1. Context 1
A small washroom in a small restaurant in a Dutch city. This restaurant is aimed at providing extra and personal service towards its customers to stand out from the other, bigger restaurants in the city. Men and women washrooms are separated, both giving room to three people of which one is washing his/her hands.

5.2. Context 2
One of a couple of large washrooms in a Scandinavian office building with more than 50 people working there. It has more than one washroom, all of which are large. Men and women washrooms are separated and can occupy at least 10 people at the same time. The average level of education and hygiene awareness is high.

5.3. Context 3
A small washroom, next to the dirty workplace of industry workers in a Belgium factory, where the average level of education is low. It is dirty work, where employees are working with their hands. It is a typical men's job and only men are using the washroom.

5.4. Context 4
A large public washroom is an obese clinic in the Netherlands. Although it is a large washroom, it only provides room for 6 people; taking into account their size. Everything is specially designed for them to be able to move around and utilize the washroom. Men and women washrooms are separated.

5.5. Context 5
One of many average washrooms in a German public school for both high and low educations. The washrooms are separated by gender, including gender neutral, and provide room for maximal 6 people (four toilets and two hand washing facilities).

5.6. Context 6
A large public washroom in a Dutch theme park for people of 16 years and older. The theme park sells also all kinds of food and drinks in various packaging. Washrooms are gender separated, including gender neutral, and are located near a very popular attraction.

5.7. Context 7
A washroom for disabled people in a German city hospital. It only provides room for one person at a time and is located in or near the cafeteria. All kinds of disabled people need to be able to make use of this washroom, including wheelchairs and rollators.

5.8. Context 8
An average size, public washroom inside a Dutch church in a very religious country village. The washroom gives room for maximal 6 people at the same time and genders, (not?) including gender neutral, are separated. Disabled people have their own washroom.

5.9. Context 9
A small washroom in the public area of a Scandinavian retirement home. Because of various disabilities of the inhabitants, only one person at a time can make use of it. Wheelchairs and rollators should be able to be brought along. Also one of the staff fits within it at the same time as the occupant, to help him/her where needed.

5.10. Context 10
A large washroom in a Dutch office building where there are a lot of cultural differences. Many people from different backgrounds work here, but need to go to the same washroom. A maximum of 20 people can utilize this washroom. Men and women, including gender neutral, washrooms are separated.

5.11 Context 11
A large, Dutch hotel with four stars. Many different people visit the washroom when they arrive, planning to eat or drink something. Who is making use of the washroom is not clear, besides gender. A maximum of 10 people can utilize this washroom, of which 4 people wash their hands. Men and women, including gender neutral, washrooms are separated.

Appendix C | Global interview scheme (NL)

Doel van deze interviews
Wat ik wil bereiken met deze interviews, is een duidelijk beeld te krijgen omtrent het gebruik, gemak, hygiëne en de voor- en nadelen van dispensers in de toiletruimte. Door verschillende stakeholders/belanghebbenden te interviewen hoop ik een compleet plaatje hiervan te krijgen.

Verwachte uitkomst
Aan het einde van deze interviews verwacht ik van iedere stakeholder een duidelijk beeld te hebben van hun toekomstvisie over dispensers en waar verbeterpunten liggen voor de huidige.

Interview vragen
Eindgebruikers (bezoekers van horeca, werknemers, enz.)
Ik zal u een paar vragen stellen ten behoeve van mijn onderzoek naar grotere toiletruimtes, met in het bijzonder de dispensers. Deze bevinden zich in elk gebouw, maar waar ik wil dat u zich op concentreert is … (toiletruimte in een kantoorruimte, een bejaardencentrum, of het keukentje op werk).

- Tijdens het toiletbezoek, wat vindt u dan het meest storend bij het gebruiken van de dispensers? (Dit is dus niet bijvoorbeeld dat het papier ergens anders scheurt dan de bedoeling was, maar bijvoorbeeld dat moeilijk te zien is waar het papier begint) En wat vindt u heel prettig? (3min)
- De dispensers voor bij de wastafel zijn anders. Dit kunnen dispensers zijn met papieren handdoekjes, textiele rollen, hete lucht blowers of de wat nieuwere Dyson Airblades. Dus waar gaat uw voorkeur naar uit wat betreft: (2,5min)
  - o Gebruiksgemak?
  - o Snelheid?
  - o Hygiëne?
  - o Uitstraling?
- Dan richten we ons nu op de dispensers met papieren handdoekjes. Wat zijn daar uw grootste ergernissen? En wat vindt u bijvoorbeeld wel heel prettig? (2,5min)
- Het is bewezen dat het gebruik van papieren handdoekjes de meest hygiënische manier van het drogen van de handen is. Wist u dit? Verandert deze kennis uw kijk op het gebruik van papieren handdoekjes? (3,5min)
- Wat zijn uw grootste ergernissen wat betreft de zeepdispensers? En wat vindt u wel heel prettig? (2,5min)

Workshop:

- Ik heb hier een aantal afbeeldingen waarmee ik uw mening in kaart wil brengen. Dit wil ik samen met u doen. Dit doen we aan de hand van een drietal contexten. Dit zijn een kantoor, een bejaardentehuis en een hotel. Nu wil ik dat u aangeeft welke dispenser je bij welke context vindt passen en waarom. Ik wil dat u dit omschrijft aan de hand van de afbeeldingen die voor u liggen.

Schoonmakers
- Hoe vaak per week/dag maken jullie de dispensers in toiletten schoon? (1min)
- Komen jullie ook in andere gebouwen? (3min)
  - o Zo ja, wat zijn dan de grootste verschillen?

Dispensers specifiek:
In de toiletruimtes hangen dispensers voor toiletpaper, zeep en systeemrollen. Deze moeten onderhouden, schoongemaakt en bijgevuld worden.
- Over het schoonmaken
  - o Wat vindt u prettig en/of storend? En waarom? (3min)
  - o Zit er veel verschil in het gemak van schoonmaken tussen dispensers? (3min)
  - o Welke middelen gebruikt u voor deze taak? En waarom? (3min)
  - o Ziet u deze als de meest ideale middelen of gebruikt u liever andere? (3min)
- Over het bijvullen/vulling vervangen
  - o Wat vindt u prettig en/of storend? En waarom? (3min)
  - o Zit er veel verschil in het gemak tussen dispensers? (3min)
  - o Welke middelen gebruikt u voor deze taak? En waarom? (3min)
  - o Ziet u deze als de meest ideale middelen of gebruikt u liever andere? (3min)

Bedrijfseigenaren (facility managers)
Dispensers specifiek (voor toiletpapier)
- Wat is de reden dat deze dispensers in uw bedrijf hangen? (1min)
- Waarom bent u (niet) tevreden met deze dispensers? (3min)
  - o In het geval u niet tevreden bent, wat zou u dan graag veranderd zien? Welke verbeterpunten zijn er volgens u?
- Wat zou een reden zijn om over te stappen op andere dispensers? (3min)
- Wat verwacht u in de toekomst van dispensers? (3min)

Dispenser specifiek (voor bij wastafels)

- Wat is de reden dat deze dispensers in uw bedrijf hangen? (1min)
- Waarom bent u (niet) tevreden over dit systeem? (3min)

o In het geval u niet tevreden bent, wat zou u dan graag veranderd zien? Welke verbeterpunten zijn er volgens u?

- Wat zou een reden zijn om over te stappen naar andere dispensers? Of misschien wel een compleet ander systeem? (1min)
- In het geval er geen papieren dispensers worden gebruikt: wat is voor u de reden om geen dispensers voor papieren handdoekjes te gebruiken? (3min)
- In het geval er geen papieren dispensers worden gebruikt: wanneer zou u naar een dispenser overstappen die gebruikt maakt van papieren handdoekjes? (2min)
- Het is bewezen dat het gebruik van papieren handdoekjes de meest hygiënische manier van het drogen van de handen is. Wist u dit? Verandert deze kennis uw kijk op het gebruik van papieren handdoekjes? Zou dit bijvoorbeeld een reden zijn om over te stappen? (3min)

Zeepdispensers specifiek

- Wat voor soort zeep heeft u in het toilet hangen? Foam? Gel? (3min)

o Bent u daar tevreden mee? En waarom?

o Zijn er verbeterpunten wat betreft deze dispensers?

Workshop:

- Ik heb hier een aantal afbeeldingen waarmee ik uw mening in kaart wil brengen. Dit wil ik samen met u doen. Dit doen we aan de hand van een drietal contexten. Dit zijn een kantoor, een bejaardentehuis en een hotel. Nu wil ik dat u aangeeft welke dispenser je bij welke context vindt passen en waarom. Ik wil dat u dit omschrijft aan de hand van de afbeeldingen die voor u liggen.

Groothandelaren

Algemeen:

- Welke invloed heeft een goed verhaal achter een product op de verkoop ervan? (3min)

o Is deze invloed significant te noemen? Met andere woorden, zouden sommige producten verloren gaan zonder verhaal? (2min)

o Hoe duidelijk moet dit verhaal volgens u naar voren komen of duidelijk gemaakt worden aan de klant? Alleen door het zeggen, of is het pas voldoende met harde feiten, bewijzen en certificaten? (3min)

o Hoe denkt u dat dit nog versterkt kan worden of beter naar voren gebracht? (3min)

- Is de klant op de hoogte van het verhaal, of moeten jullie dat wel vertellen? (3min)
- Waar moet u allemaal op letten bij het opslaan van dispensers? (3min)
- Hoe verloopt de installatie? Doen jullie die zelf of huren jullie een extern bedrijf daarvoor in? (3min)

Dispenser specifiek:

- Bent u tevreden over de huidige verpakking van de dispensers? (1min)
- Tegen welke dingen loopt u aan bij de dispensers? Bijvoorbeeld de slagvastheid of ruimte die ze innemen. (3min)
- Verkoopt u ook vaak combinaties van dispensers en papier? Waarom wel/niet? (3min)

o Indien niet, hoe denkt u dat dit zal verkopen?

- Wat verwacht u in de toekomst te zien? (3min)
- Welke dispensers verkoopt u het meest? (3min)
- Wat vindt u van de gebruiksvriendelijkheid van de dispensers? (3min)

Workshop:

- Ik heb hier een aantal afbeeldingen waarmee ik uw mening in kaart wil brengen. Dit wil ik samen met u doen. Dit doen we aan de hand van een drietal contexten. Dit zijn een kantoor, een bejaardentehuis en een hotel. Nu wil ik dat u aangeeft welke dispenser je bij welke context vindt passen en waarom. Ik wil dat u dit omschrijft aan de hand van de afbeeldingen die voor u liggen.

Appendix D | Consent form

(English version)

Dear participant,

I, the participant, hereby give permission to the use of a photo camera and voice recorder during this research for use in a greater student research from the Delft University of Technology. I agree that the footage may be edited and used in whole or in part, but that the overall message stays the same. During the research, the student may take notes and photos and it is up to me, the participant, to check those before the end of the research. I agree that this research and data will only be used for educational purposes of the students and for nothing else.

“The information that I can retrieve with this research is of great importance for my progress and end results of my greater research on the washroom. Therefore, I am very grateful for your participation and thank you in advance.”

By signing this form, either in English or Dutch, I agree that I understand everything that is mentioned above by writing down my name, today’s date and signature at the appropriate places below.

Name (first and last):_____

Today’s date (dd/mm/yyyy):_____

Signature:_____

(Dutch version)

Geachte participant,

Hierbij geef ik (de participant) toestemming voor het gebruik van foto- en geluidsapparatuur tijdens dit onderzoek voor het afstudeerproject van Kai Smit, student Industrieel Ontwerpen, Tu Delft. I stem ermee in dat het materiaal aangepast en in zijn geheel of deels gebruikt mag worden, zolang de algehele boodschap hetzelfde blijft. Tijdens het onderzoek mag de student (Kai Smit) notities en foto’s maken en ben ik, de participant, de eindverantwoordelijke om deze voor het einde van dit interview te controleren. Ik stem ermee in dat dit onderzoek en data alleen gebruikt gaat worden voor onderwijskundige doeleinden van de student.

“De informatie die hieruit volgt is van groot belang voor de progressie en eindresultaten van het onderzoek naar de toiletruimte. Daarom ben ik (de student) u erg dankbaar voor uw deelname en wil u alvast op voorhand bedanken daarvoor.”

Door dit formulier, de Engelse of Nederlandse versie, te tekenen ga ik akkoord en begrijp ik alles wat hierboven is besproken. Dit geef ik aan door mijn naam en de datum van vandaag op te schrijven en mijn handtekening te zetten op de daarvoor aangegeven plekken, onderaan dit formulier.

Naam (voor en achter):_____

Datum van vandaag (dd/mm/yyyy):_____

Handtekening:_____

Appendix E | Consensus maps visitors

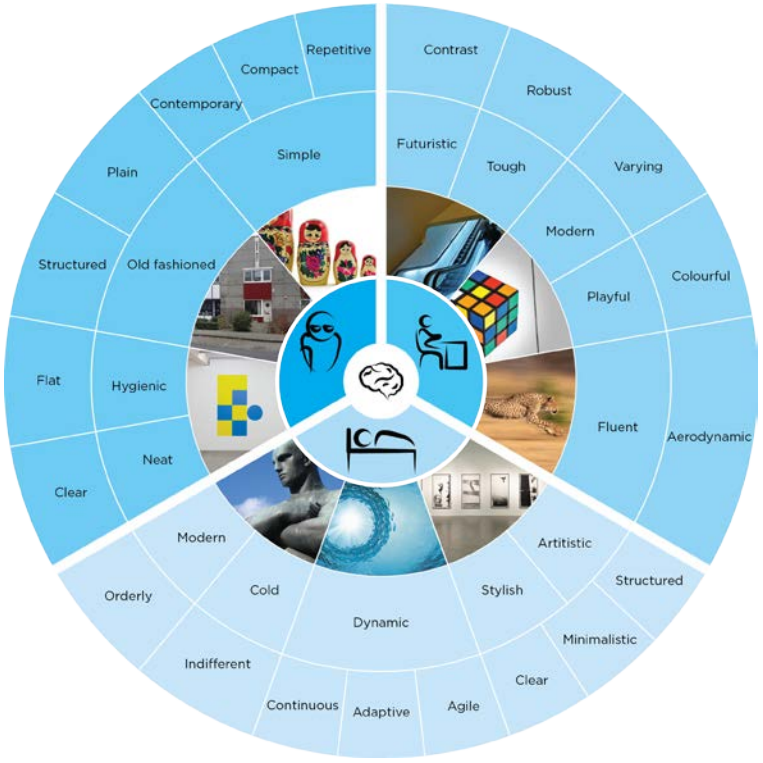


Figure 96: consensus map of Falko Hage

Figure 97: consensus map of Ingrid Wisse

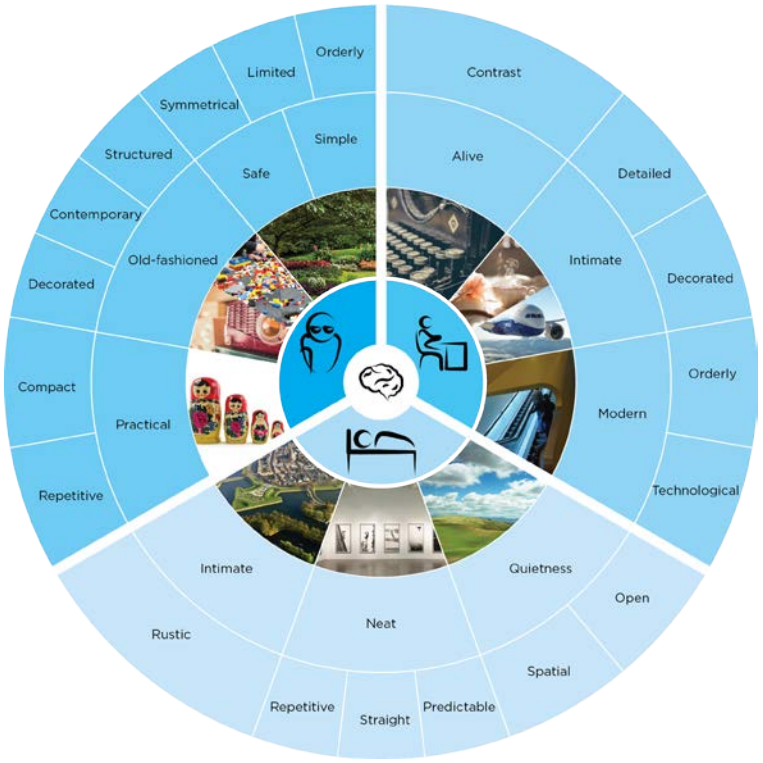


Figure 98: consensus map of Jennifer van der Cammen

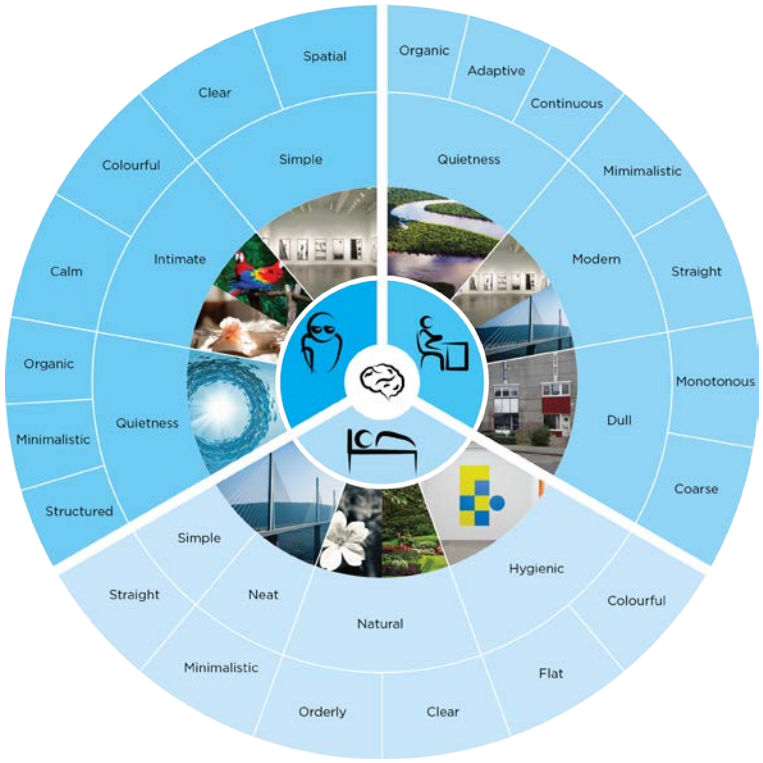


Figure 99: consensus map of Marieke and Marion

Figure 100: consensus map of Marc van der Helm (sensitivity analysis)

Figure 101: consensus map of Yvo Waalewijn

Appendix F | Consensus maps clients & wholesalers

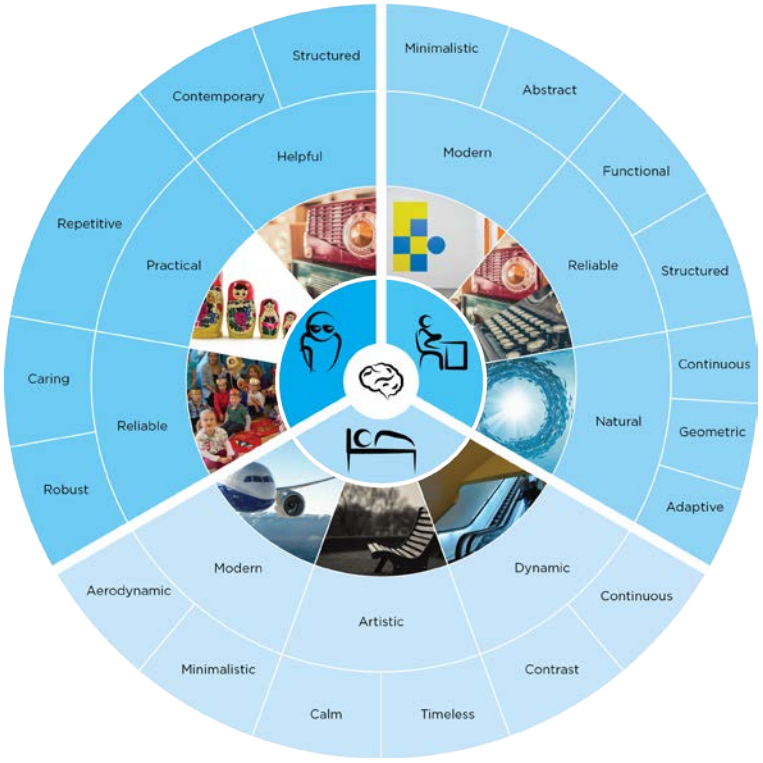


Figure 102: Client - Arjan van Eck - Buma/Stemra

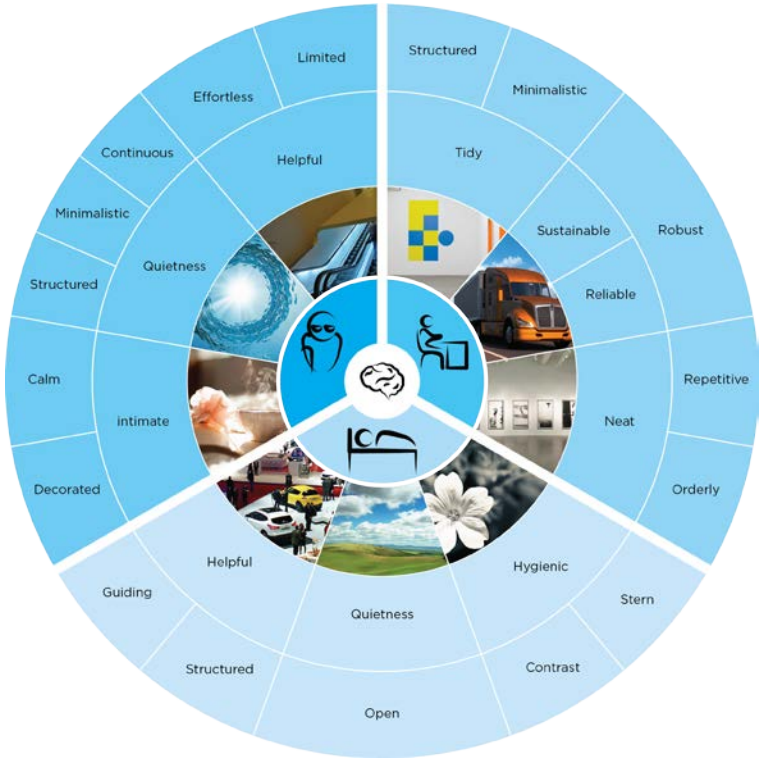


Figure 103: Client - Stefan Peelen - Arval

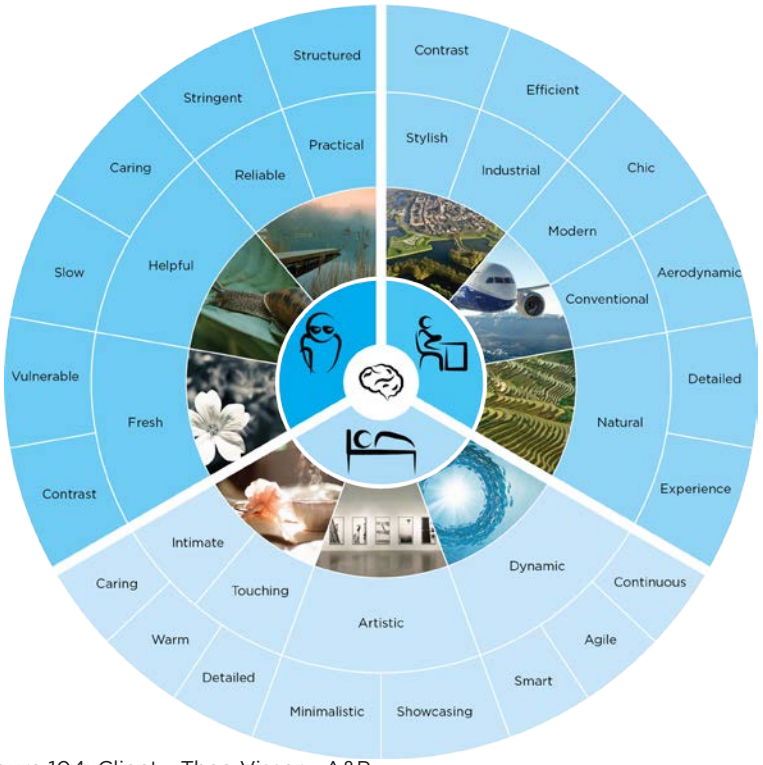


Figure 104: Client - Theo Visser - A&P

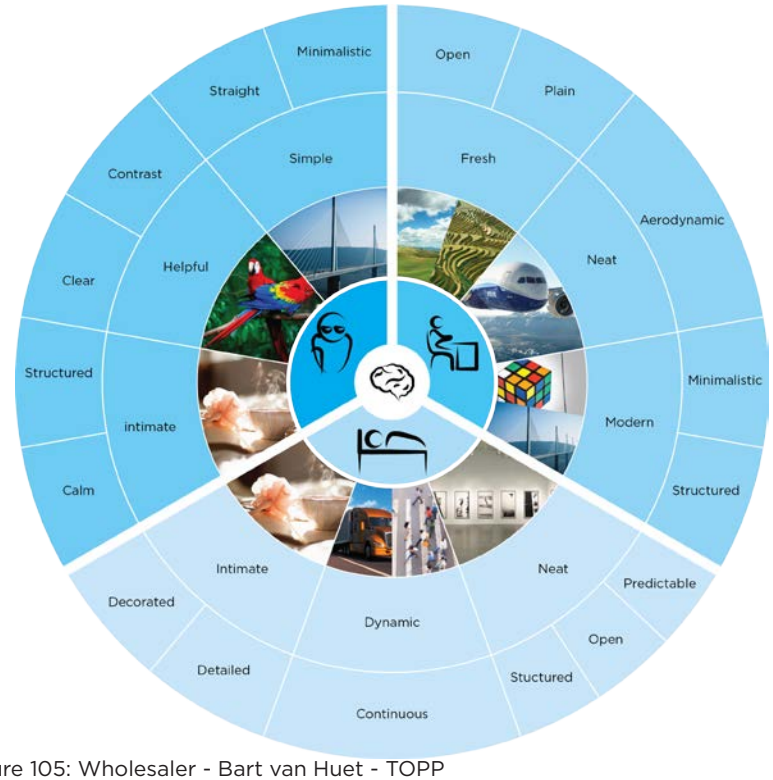


Figure 105: Wholesaler - Bart van Huet - TOPP

Figure 106: Wholesaler - Sander de Kroon - Ological

Figure 107: Wholesaler - Wim Verberne - Peijs

Appendix G | Full list of requirements

The list of requirements according to the Delft Design Guide (Van Boeijen, Daalhuizen, Zijlstra & Schoor, 2013). This list focuses on 2 different levels. The level concerning the hand towel dispenser (indicated with *T), and the level of the wrap (indicated with *W). Requirements should be able to be checked. Therefore, some requirements actually concern the whole range, but are now only available for the towel dispenser and are thus marked by *T.

1. Performance

a. *T It should be able to hold at least the same amount of product or refill as the current Satino Black towel dispenser.
b. *T A force of 500N should be able to be handled*[1]
c. *T A pulling force of 100N should be able to be handled
d. *W There may not be any wrinkles in the wrap
e. *W A minimum elongation of 150% (Van der Straaten, 2017), to run smoothly over edges with fillets of 2mm.

2. Environment

a. *T & *W need to withstand sanitary solutions and scale remover
b. *T & *W need to withstand an average humidity of 70% (95% peak) (Van Den Bossche, Janssens, Heijmans & Wouters, 2007).
c. *T & *W The dispenser need to be able to cope with temperatures rising to 35 degrees Celsius, with an average of 29,5 degrees Celsius (Kanda, Tsuchiya, Seta, Ohnaka & Tochihara, 1995).

3. Life in service

a. *T should last at least 21 years*[2] with 120 uses per working day*[3].
b. *T Opening should be able regardless of mounting position.
c. *W a lifetime of at least 5 years is needed*[4].
d. *W The wrap should be able to cope with 120 uses per working day.

4. Maintenance

a. *T All parts need to be accessible instantly for cleaning
b. *T All but the back plate should be able to be removed or replaced without complete dismounting.
c. *T & *W Cleaning should be able to be done with hospital agents

5. Target product cost

a. *T The price shouldn't exceed the 37,59EUR (current price, excluding the wrap)
b. *T & *W A margin of at least 40% should be made possible
c. *W The wrap may add a maximum of 250EUR for a standard office washroom dispenser range*[5] (Van Eck, 2017).

6. Transport

a. *T Transportation shouldn't be more damaging to the environment than current dispensers.

7. Packaging

a. *T The packaging should protect against damage and stains.
b. *T It should be made from recycled or to be recycled material.
c. *T The packaging should be stackable for convenient transport.
d. *T It needs to have clear indications about its contents and opening
e. *T It should protect against dust during long-term storage.

8. Quantity

a. *T Production runs in batches
b. *W Production runs in batches

9. Production facilities

a. *T The production can be outsourced

10. Size and weight

a. *T The weight cannot exceed the current dispensers, as this would be the result of more material use.
b. *T The overall size may not exceed the current towel dispenser.
c. *T There should be enough room for filling the dispenser with paper towels

11. Aesthetic, appearance and finish

a. *T The dispenser should comply with a minanic appearance
b. *T It should come in at least black
c. *W The Satino Black logo should be clearly visible
d. *T & *W It should have features, relating to the minanic moodboard
e. *T & *W It should be suitable in all washroom shapes and sizes.
f. *T & *W It should be able to comply with the rest of the context.
g. *W It should facilitate at least 6 different colours (more than Berendsen), but preferably over 34 colours*[6], as this gives an unlimited feeling.
h. *W It should come in at least 3 finishes.

12. Materials

a. *T & *W All materials that will be used should be recyclable
b. *W It should be a PVC free wrap

13. Product life span

a. *T Production should run at least 18 years*[7].

14. Standards, rules and regulations

a. *T The same sustainable certificates should apply at the minimum.
b. *T Paper sizes of 250 x 114 in C-fold should be facilitated as filling

c. *T The dispensers should facilitate standard paper folding manners.

15. Ergonomics

a. *T Opening requires a universal key
b. *T Opening should be able to be done at the cleaner's own speed
c. *T Disassembly should be able without a manual
d. *T Opening should be able to be done by people with a height ranging from 1,558m to 1,954m*[8].
e. *T Users should only have one way of using the dispenser
f. *T & *W The amount of content should be visible from the outside
g. *T Usecues should be placed at the side that is looked at most.
h. *T Operation should not be dependent on the user's background
i. *T The dispenser may not make a distinction between sexes.

16. Reliability

a. *T Opening may only occur by means of the appropriate key
b. *T An end customer may have one broken dispenser a year maximum after the first two years
c. *T The dispenser may not come from the wall unwanted at any time
d. *T The dispenser should be able to open with a key all the time.
e. *T It should be able to cope within a high traffic washroom.
f. *W Only the first application may go wrong at a client, meaning that the maximum error is the warranty a client has on the installation of the wrap.
g. *W Unauthorized removal may not be possible

17. Storage

a. *T The packaging should be stackable
b. *T When stored, the dispensers may not undergo any stress or strain.

18. Testing

a. *T Material properties should be new in new and recycled state

19. Safety

a. *T No sharp edges at the dispenser mouthpiece
b. *T No sharp edges inside the dispenser where paper lies on or cleaning staff comes close to when refilling.
c. *T The cleaner may not overshoot when opening the dispenser

20. Product policy

a. *T The dispenser should be made from recycled material
b. *T A universal key is mandatory
c. *W The wrap, including adhesive and possible laminate layer, should be able to be recycled

21. Societal and political implications

a. *T & *W It should be clear that all materials are recycled or recyclable
b. *T Certificates achieved with the dispensers should be communicated in such a way that visitors understand them

22. Product liability

a. *T The dispenser should have only one way of mounting
b. *T The minimum and maximum amount of filling should be indicated

23. Installation and initiation of use

a. *T The dispenser should be opened with a special and universal key
b. *W The wrap should be able to stick to the dispenser's material
c. *W A pressure sensitive adhesive is needed for repositioning the wrap and easy removal

24. Reuse and recycling

a. *T No permanent connections that cannot be recycled
b. *T All aspects should be recycled or reused for at least 4 cycles
c. *W The wrap may not contain PVC
d. *W It should have a pressure sensitive adhesive for complete removal
e. *W If laminated, this should also not contain PVC
f. *W The adhesive should be recyclable
g. *W Removing the wrap should not leave any rest material.

*1 Based on a person of 150kg, leaning against the dispenser

*2 The range is designed for 2035. 21 years is this period including an extra contract duration.

*3 Based on 1 dispenser for every 60 workers and 4 visits per person in a 50-50 male/female environment division. This requirement is different throughout the range, since not every dispenser has the same use scenario.

*4 Based on contract duration and the period in which mission statements are revisited (Stuecher, 2016).

*5 A standard office washroom dispenser range consists of 4 paper towel, 6 soap, 6 air freshener, and 6 system roll dispensers and 2 waste bins.

*6 Based on the amount of metaphors used in the ZMET stipulation

*7 Based on the period between this project and the domain, which is set in 2035.

*8 Based on the 5% Dutch adult female of 20-60 years old and the 95 percentile Dutch adult male of 20-60 years old (DINED, 2017)

Appendix H | Material comparison

Not to use plastics

Unlike ABS, which is a thermoplastic, thermoset plastics cannot be reheated after primary production. This means that they cannot be recycled and can only be burned. They wouldn't make suitable alternatives for an environmentally conscious company like Van Houtum.

There are biodegradable plastics out there, which are good for the environment. Something that Van Houtum values a lot. However, as the name says it, they degrade under influence of (forced) natural processes. So, it is not recycling in terms that it can be reused. With a mass produced product like dispensers, this is economically unattractive.

Engineering plastics

There are a couple of engineering plastic; plastics that have better mechanical and/or thermal properties than commodity plastics such as PP or PE. ABS is in this paragraph compared to PLA, SAN, LCP, PBT, PC, PMMA, POM, PEEK, PA, PSU, PPA, PVDF, and UHMWPE. PLA (Polylactide) can be an interesting alternative as it's made out of plant-based resources and its mechanical properties are better. It can also be recycled and has a lower embodied energy and CO_2 footprint in primary production and recycling. However, the material is more expensive and less suitable for injection moulding than ABS. The same goes for SAN (Styrene Acrylontrile), although this is roughly just as expensive and suitable for injection moulding as ABS.

LCP (Liquid crystal polymers) is better in terms of material properties except for elongation. However, the price for LCP is at least 3 times as high as for ABS, which is very unattractive when the material properties of ABS are sufficient already. Also, the primary production is much more polluting.

In general the same applies to PBT (Polybutylene terephthalate), PC (Polycarbonate), PMMA (Polymethyl methacrylate acrylic), and POM (Polyoxymethylene) but these lie closer to ABS than LCP. Mainly the primary production and recycling of PBT and PC results in a larger carbon footprint. PMMA's, PVC's and POM's main drawback is that it's less practical to injection mould, which is necessary for high volume products like dispensers. Furthermore, both primary and recycled carbon footprints are significantly higher.

PEEK (Polyetheretherketone) and PI (Polyimide) are easy to dismiss, as PI costs roughly 34,4 EUR/kg, PEEK 88,8 EUR, where ABS costs maximal 2,54 EUR/kg.

PA (Polyamide) has a lot of different grades, where most of them are at least 3 times as expensive than ABS. The others that come close to the price of ABS, have a higher embodied energy, a larger carbon footprint, use a lot more water (PA410: 4,44e^3 l/kg, ABS: 167 l/kg) or are unacceptable for weak acids; an important aspect for cleaning.

PSU (Polysulfone) and PPA (Polyphthalamide) are also a lot more expensive than ABS and more polluting. Needing twice the amount of water or have the double as large carbon footprint in both primary production as well as recycling.

PVDF (Polyvinylidene Fluoride) is more expensive, although it has comparable mechanical properties, but just like PMMA and POM it is less suitable for injection moulding. Even when the "moulding and extrusion" version is selected in CES.

UHMWPE (Ultra high molecular weight polyethylene) is approximately just as expensive, but at lesser mechanical properties and a limited use of injection moulding, although the sustainability aspects are comparable with ABS.

Metals

The washroom is a wet environment. Meaning, there is a higher risk at high levels of humidity in the air. In such an environment, stainless steel is desirable. This is already a line within the dispensers of Van Houtum. Compared to the ABS versions, this line is very expensive and only for the exclusive washrooms. Other metals will not be necessary to investigate, as they will rust in the humid washroom. Or even worse, a new line of metal dispensers will make the stainless steel line purposeless, leaving Van Houtum with less segment. Which is one of their advantages over a lot of their competitors.

Of course wrought aluminium 6061 T6 would also be interesting when looking at its resistance to water. However, its price is almost double compared to the most used wrought stainless steel AISI 316 according to CES. With stainless steel

Wood

In this section, the most popular hardwoods in home improvement are presented that are grown and harvested sustainably (Kolich, 2009). These woods are grown in forests aimed to maintain a natural balance of tree and plant diversity. These wood types are FSC certified. It is chosen for hardwoods, as softwoods are better suited for construction (Woodford, 2017).

Black cherry (Prunus Serotina) is brittle and cannot withstand impact well. The result is that it splits. With installers working long hours, it isn't without doubt that dispensers will be dropped occasionally.

Mahogany (Swietenia Macrophylla) is very popular in the choice for fine

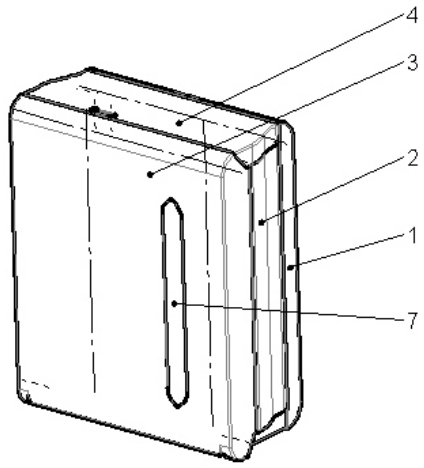
furniture and really adds something to the environment. It is also widely used for decking material around pools and hot tubs and thus can withstand moisture.
Maple (Aceraceae) and white ash (Fraxinus Americana) are sustainable hardwoods as well, but they don't accept stain very well, so at least a clear coat for a suitable finish is needed. Just like the adhesives in plywood and glulam, this doesn't fit within the sustainable image of Van Houtum.
(White) Oak (Quercus) is very interesting as it is naturally water-resistant (although to a limited use). But as with the rest of the mentioned woods, it is much more expensive than ABS. According to CES, the price for this material is3 to 4 times higher, excluding the extra fee you have to pay for certified wood. As is in this case. Ash and maple are the cheapest with similar prices, again without certification.

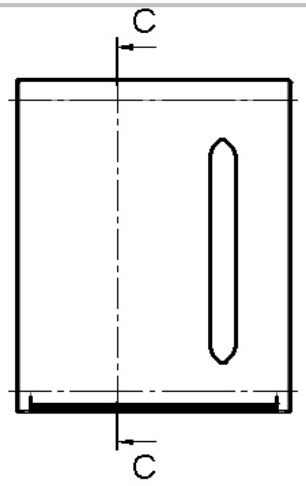
Wood-like materials
Various of these types are available in CES. For instance glulam and plywood. But these types of wood need multiple layers to be as strong as required. And adhesives are essential, which are not at all sustainable. Although only small amounts are needed when applied to something as small as a dispenser, it doesn't fit within the sustainable image and storytelling of Van Houtum.
What is an interesting wood type, is bamboo. Although there is a limited use possible for water and can thus cause problems with cleaning, the price and mechanical properties are better than those of ABS. This is however dependent on the direction of the fibres. In this case longitudinal. Of course, it is not recyclable, but an extremely low carbon footprint (max. 0,00214 kg/kg, ABS: 3,81 kg/kg) and good opportunity for energy recovery, may compromise on this point. It does however need a lot of water for primary production.
Palm has lesser mechanical properties than ABS. Especially the Yield strength is much lower (29,4 MPa, ABS: 49,6 MPa), but palm is also 2.5 times as cheap. As with bamboo, it has a low carbon footprint, however not as low as bamboo (0,633 kg/kg), and needs a lot of water for primary production.

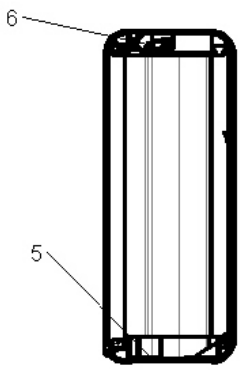
Other materials
Also completely different materials are looked at. For instance different types of cork board. However, this material is way too weak and 4 times as expensive than ABS. The dispensers need to have a considerate strength especially during transport, where impact might occur. With cork's Young's modulus of maximal 0,0557 GPa (ABS: 2,76 GPa) and Yield strength of maximal 2,42 MPa (ABS: 49,6 MPa) its resistance to impact and plastic deformation is too low.
Ceramics are also looked at. Alumina for instance. As with most engineered ceramics, it has better mechanical properties and a better durability. Alumina in particular is approximately as expensive as ABS and has a little lower fracture toughness. However, like all of these ceramics it cannot be recycled, nor energy recovered or biodegraded. Therefore, it will end in landfills or it will be down cycled.
Next to these disadvantages, ceramics have a high brittleness due to their specific atomic bonds which only act in very specific directions. The difficult material property design is another drawback. The exact same manufacturing process can create different properties.

Future materials
Research is done in materials that will be more accessible in the future or are in the process of being developed. From this research, two materials popped up as something worth looking at: Karta-Pack and ReWall Ceiling Tiles.
Karta-Pack is made from recycled cotton fibres. Discarded jeans and shirts are the prime source, which makes it a 100% post-consumer material. It feels luxurious when used for packaging applications or furniture. However, making a dispenser out of it, might not get that same effect as it is unnatural for most people. Besides this, it is a biodegradable material, making it just as unsuitable as biodegradable plastics. For packaging it could have been promising when the company itself would unpack the dispensers. However, the installers from the wholesalers don't really care how the packaging looks like as long as it is functional and helps with their job. So as a substitute for recycled paper, it is not very attractive. Especially since another stakeholder comes into play when applying Karta-Pack.
ReWall Ceiling tiles are made from recycled beverage containers. It is a mixture of cardboard, plastic bottles, and aluminium. It has the same structural integrity and processing abilities as wood and strand board, but is better resistant to moisture. Something very present in a washroom. As a recycled material, it is attractive for Van Houtum and in contrast to bamboo, it is not reliable on fibre direction for strength. However, the mechanical properties are too low to withstand the forces determined in the list of requirements.

Appendix I | Technical drawings of parts







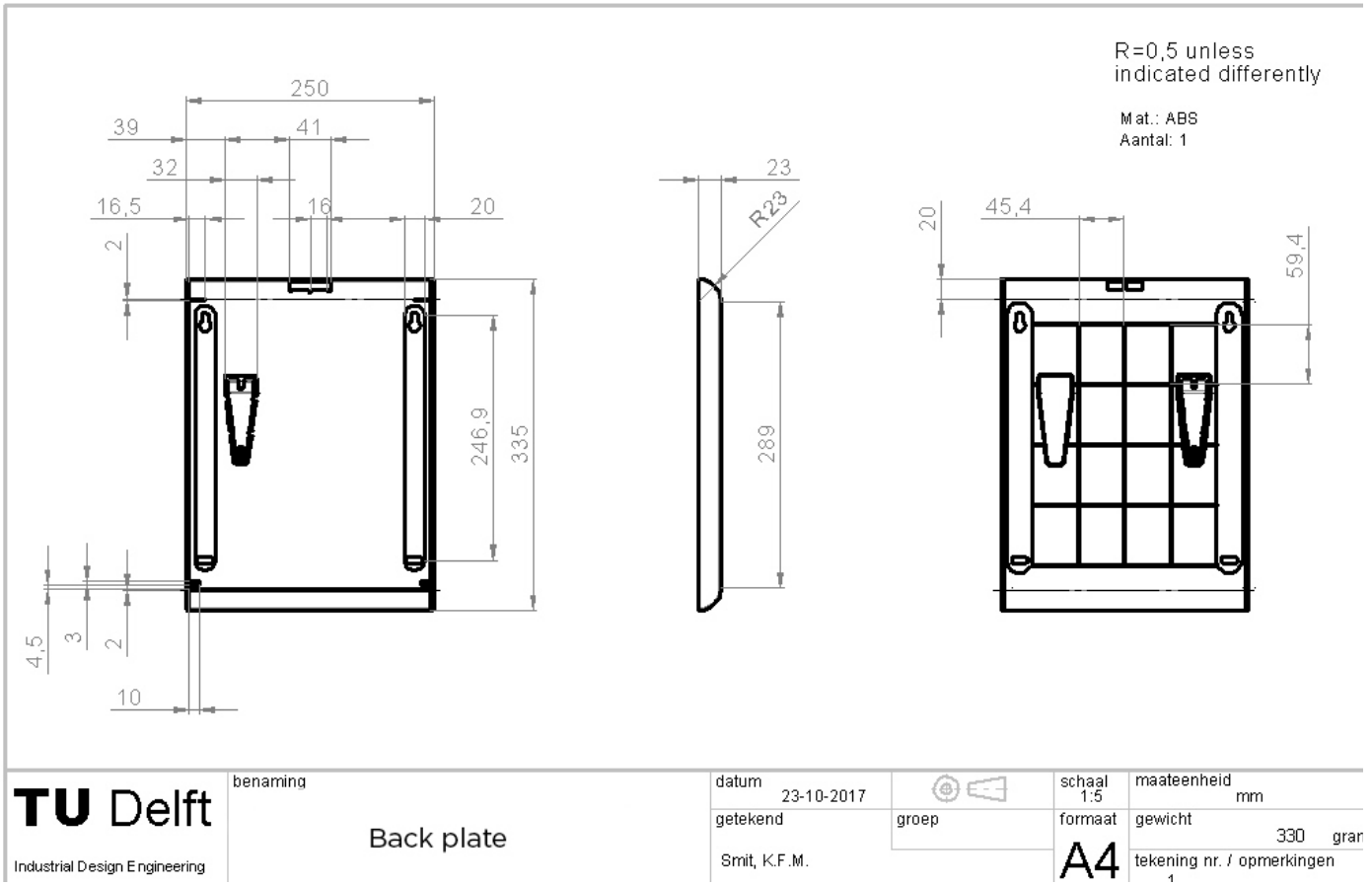
C-C

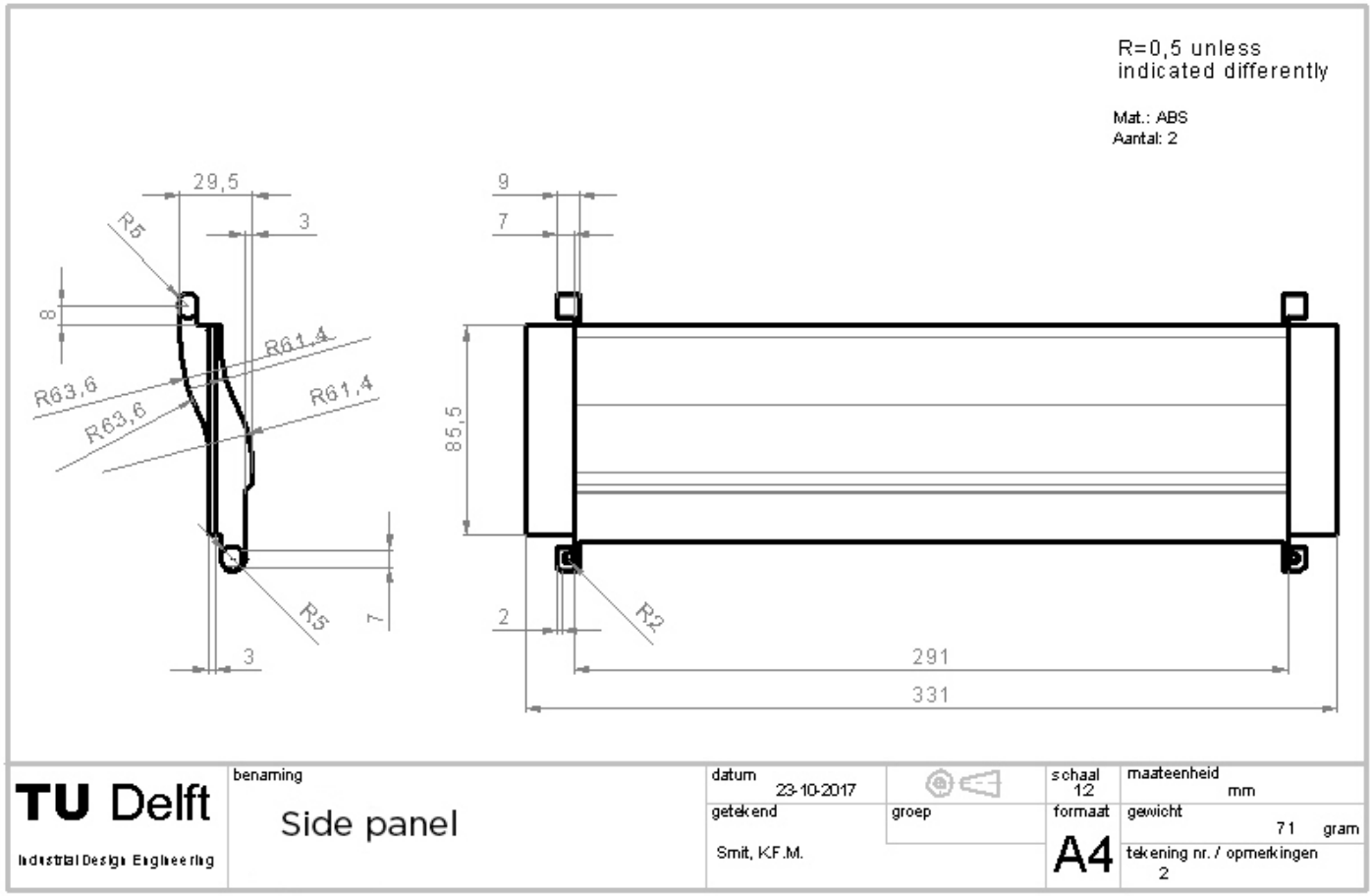
Item No.	Qty.	Name	Material	Weight [grams]	Standard	Remarks / Drawing. No.
7	1	Window	ABS	18		
6	2	Clickfinger	ABS	5		
5	1	Mouthpiece	ABS	61		
4	1	Top plate	ABS	72		
3	1	Front plate	ABS	361		
2	2	Side panel	ABS	71		
1	1	Back plate	ABS	330		

TU Delft
Industrial Design Engineering

benaming: Assembly Satino Black Fold

datum: 23-10-2017
getekend: Smit, K.F.M.
groep:
schaal: 1:5
formaat: A4
maateenheid: mm
gewicht: gram
tekening nr. / opmerkingen: 1

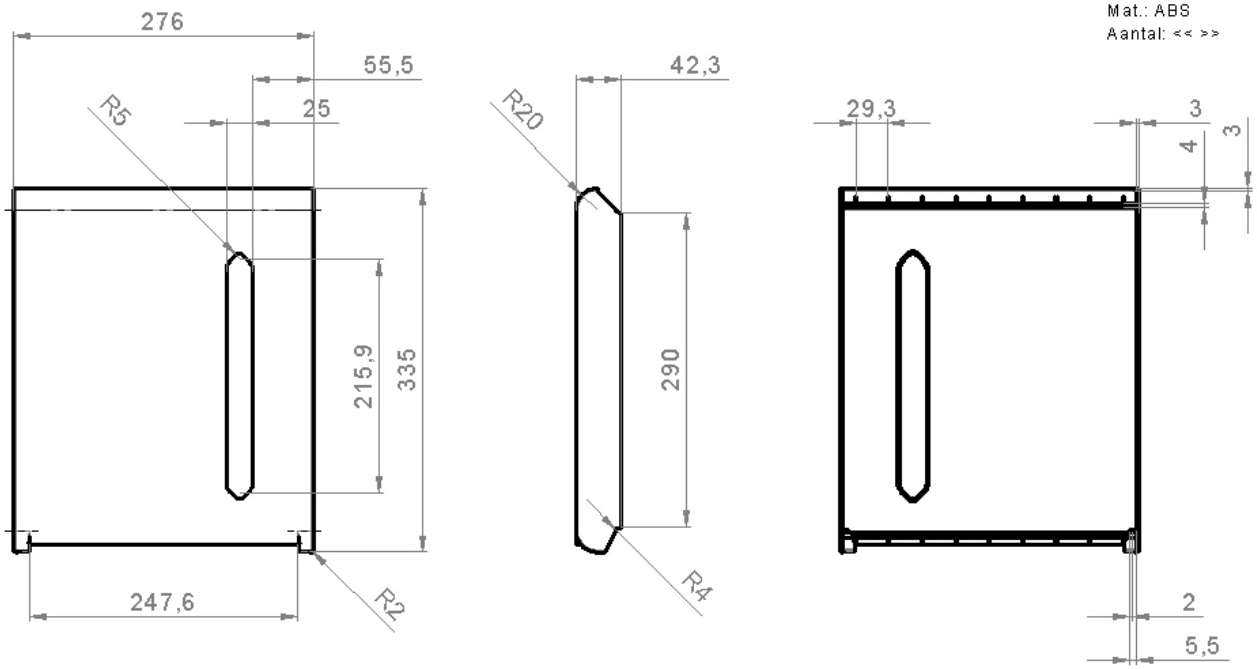

R=0,5 unless
indicated differently
Mat.: ABS
Aantal: 1
250
39
41
32
16,5
16
20
2
246,9
335
4,5
3
2
10
23
R23
289
20
45,4
59,4
TU Delft
Industrial Design Engineering
benaming
Back plate
datum
23-10-2017
getekend
Smit, K.F.M.
groep
schaal
1:5
formaat
A4
maateenheid
mm
gewicht
330 grar
tekening nr. / opmerkingen
1


R=0,5 unless
indicated differently
Mat.: ABS
Aantal: 2
29,5
3
R5
8
R61,4
R63,6
R63,6
R61,4
R5
7
3
9
7
85,5
2
R2
291
331
TU Delft
Industrial Design Engineering
benaming
Side panel
datum
23-10-2017
getekend
Smit, K.F.M.
groep
schaal
12
formaat
A4
maateenheid
mm
gewicht
71 gram
tekening nr. / opmerkingen
2

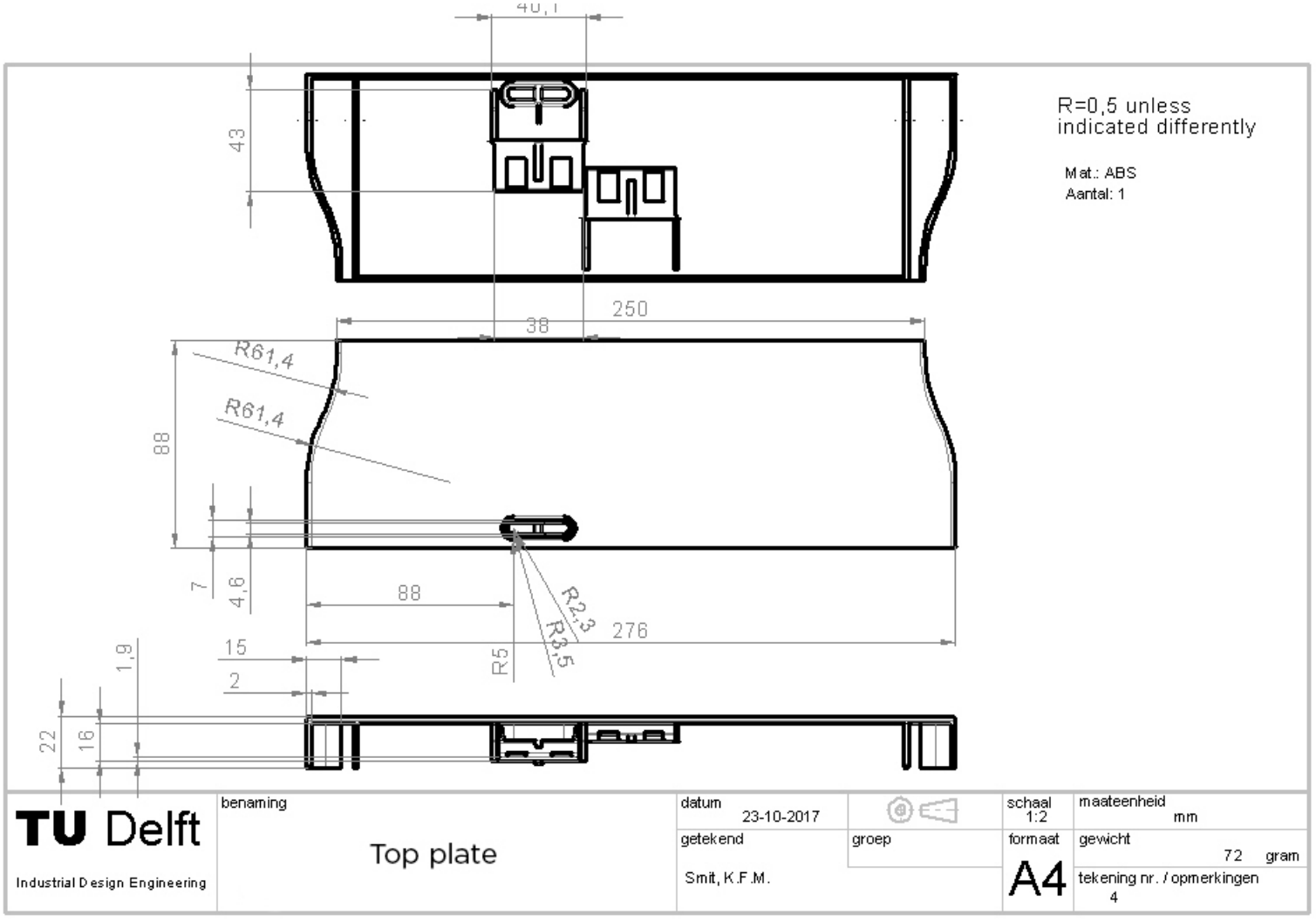
R=0,5 unless indicated differently

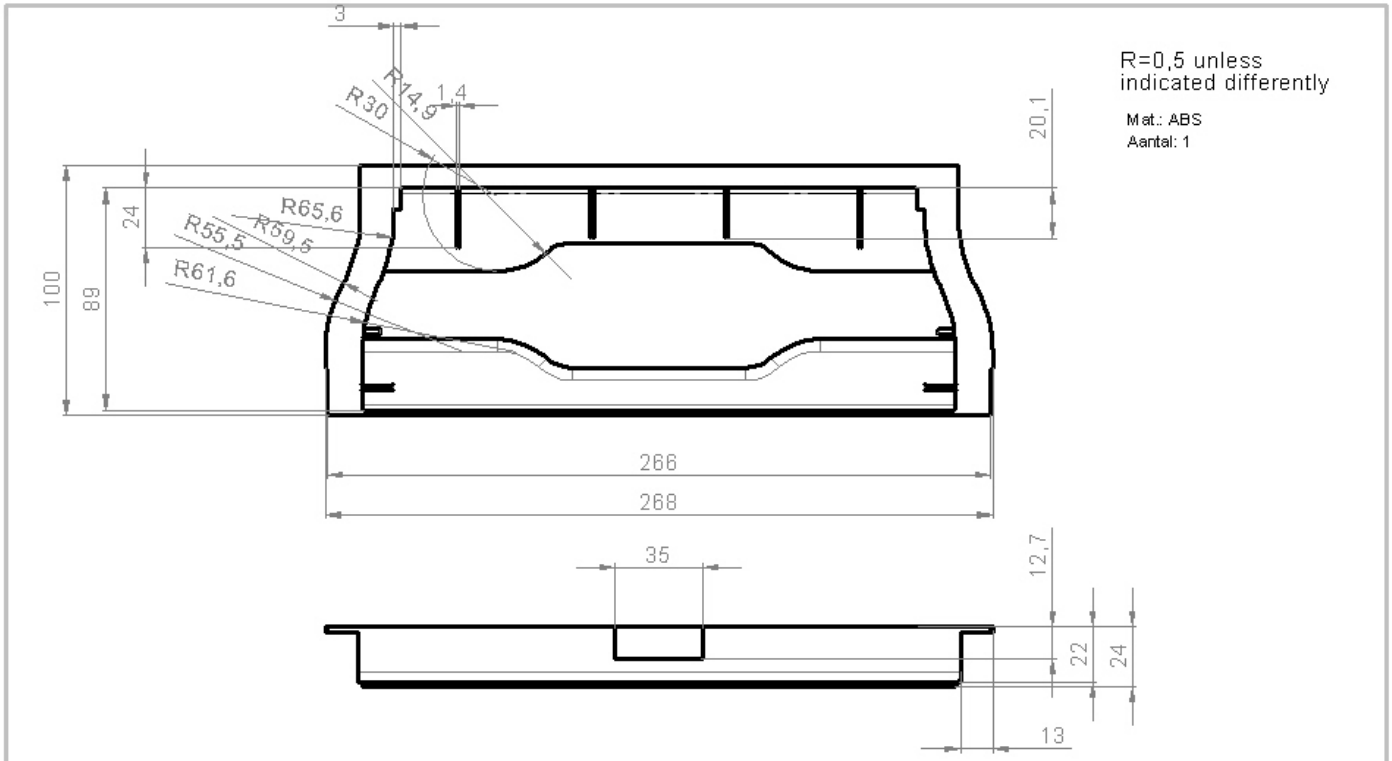
Mat.: ABS

Aantal: << >>



TU Delft Industrial Design Engineering	benaming Front plate	datum 23-10-2017		schaal 1:5	maateenheid mm
		getekend Smit, K.F.M.	groep	formaat A4	gewicht 361 gram
					tekening nr. / opmerkingen 3


40,1
43
250
38
R61,4
R61,4
88
7
4,6
88
R2,3
R3,5
276
R5
15
2
1,9
22
16
R=0,5 unless
indicated differently
Mat.: ABS
Aantal: 1
TU Delft
Industrial Design Engineering
benaming
Top plate
datum
23-10-2017
getekend
Smit, K.F.M.
groep
schaal
1:2
formaat
A4
maateenheid
mm
gewicht
72 gram
tekening nr. / opmerkingen
4



TU Delft Industrial Design Engineering	benaming Mouthpiece	datum 23-10-2017		schaal 1:2	maateenheid mm
		getekend Smit, K.F.M.	groep	formaat A4	gewicht 61 gram
					tekening nr. / opmerkingen 5

Appendix J | Tables for grab & align and assembly by hand

Times for grab and align - seconds

ONE HAND

measurements in mm

Grabbing and handling possible without hand tools		grab and handle simple					grab and handle difficult				
		thickness > 2			thickness < 2		thickness > 2			thickness < 2	
		length > 15	6 < length > 15	length < 6	length > 6	length < 6	length > 15	6 < length > 15	length < 6	length > 6	length < 6
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
$\alpha + \beta < 360^\circ$	**0**	1,1	1,4	1,9	1,7	2,2	1,8	2,2	2,6	2,4	3,0
$360^\circ < \alpha + \beta < 540^\circ$	**1**	1,5	1,8	2,2	2,1	2,5	2,2	2,6	3,1	3,0	3,4
$540^\circ < \alpha + \beta < 720^\circ$	**2**	1,8	2,1	2,5	2,4	2,8	2,6	2,9	3,4	3,2	3,7
$\alpha + \beta = 720^\circ$	**3**	1,9	2,2	2,7	2,5	3,0	2,7	3,1	3,5	3,3	4,0

Times for assembly by hand - seconds

NOT SECURED DIRECTLY

the part itself (1) or other parts aren't assembled immediately		not necessary to hold after assembly to maintain position and orientation (3)				necessary to hold after assembly to maintain position and orientation (3)			
		placing and aligning simple (4)		placing and aligning difficult (4)		placing and aligning simple (4)		placing and aligning difficult (4)	
		no resistance at plugging in	resistance at plugging in	no resistance at plugging in	resistance at plugging in	no resistance at plugging in	resistance at plugging in	no resistance at plugging in	resistance at plugging in
		0	**1**	**2**	**3**	**6**	**7**	**8**	**9**
assembly location easy to reach	**0**	1,5	2,5	2,5	3,5	5,5	6,5	6,5	7,5
	1	4,0	5,0	5,0	6,0	8,0	9,0	9,0	10,0
assembly location hard to reach: obstruction in space or vision (2)	**2**	5,5	6,5	6,5	7,5	10,5	10,5	10,5	11,5
assembly location hard to reach: obstruction in space and vision (2)									

Times for assembly by hand - seconds

SECURED DIRECTLY

the part itself (1) or other parts are assembled immediately

			no screws or plastic deformation directly after plugging in (clicking, pressing, etc.)		plastic deformation directly after plugging in						screw connection directly after plugging in	
					plasticly bending or wrenching			riveting etc.				
			placing and aligning simple, no resistance	placing and aligning difficult, resistance at plugging in (5)	placing and aligning simple (4)	placing and aligning difficult (4)		placing and aligning simple (4)	placing and aligning difficult (4)		simple to position, no wrenching resistance (4)	difficult to position, and/or wrenching resistance (5)
						no resistance at plgging in	resistance at plugging in (5)		no resistance at plgging in	resistance at plugging in (5)		
			0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
assembly location easy to reach		**0**	2,0	5,0	4,0	5,0	6,0	7,0	8,0	9,0	6,0	8,0
assembly location hard to reach	obstruction in space or vision (2)	**1**	4,5	7,5	6,5	7,5	8,5	9,5	10,5	11,5	8,5	10,5
	obstruction in space and vision (2)	**2**	6,0	9,0	8,0	9,0	10,0	11,0	12,0	13,0	10,0	12,0

Times for assembly by hand - seconds

PROCESSES

assembly process where all parts are already placed, no addition of part of sub-assembly

		mechanical connection, parts are placed but not directly connected				non-mechanical connection, parts are placed but not directly connected				no connecting process	
		none or local plastic deformation				metallurgical process					
							adding of materials				
		bending etc.	riveting etc.	screwing or other process	biggest part of part is deformed plastically	no addition of material (i.e. resistance)	soft soldering	welding, hard soldering	chemical process (i.e. glueing)	manipulations (i.e. fitting, adjusting, aligning	other processes (i.e. fluid dosing)
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	9	4,0	7,0	5,0	12,0	7,0	5,0	12,0	12,0	9,0	12,0

	back plate - side panels	time
	$\alpha + \beta < 360°$	
2	grab and handle simple	1,1s
	thickness >2	
	length > 15	

	back plate - side panels	time
	directly secured	
2	assembly location easy to reach	2,0s
	no screws or plastic deformation	
	no resistance	

	side panels - front plate	time
	$\alpha + \beta < 360°$	
4	grab and handle simple	1,1s
	thickness >2	
	length > 15	

	side panels - front plate	time
	not directly secured	
	assembly location hard to reach	
4	obstruction in space or vision	8,0s
	necessary to hold	
	placing and aligning simple	
	no resistance	

	top plate - mouthpiece	time
	$\alpha + \beta < 360°$	
7	grab and handle simple	1,1s
	thickness >2	
	length > 15	

	top plate - mouthpiece	time
	not directly secured	
	assembly location easy to reach	
7	not necessary to hold	1,5s
	placing and aligning simple	
	no resistance	

	top plate - click fingers	time
	$\alpha + \beta < 360°$	
19	grab and handle simple	1,1s
	thickness >2	
	length > 15	

	top plate - click fingers	time
	directly secured	
19	assembly location easy to reach	2,0s
	no screws or plastic deformation	
	no resistance	

	top plate - back plate	time
	$\alpha + \beta < 360°$	
20	grab and handle simple	1,1s
	thickness >2	
	length > 15	

	top plate - back plate	time
	directly secured	
20	assembly location easy to reach	2,0s
	no screws or plastic deformation	
	no resistance	

	dispenser - wall	time
	$\alpha + \beta < 360°$	
21	grab and handle simple	1,1s
	thickness >2	
	length > 15	

	dispenser - wall	time
	processes	
(2)	mechanical	2,0s
	none or local plastic deformation	
	screwing	

	dispenser - mouthpiece	time
	$\alpha + \beta < 360°$	
22	grab and handle simple	1,1s
	thickness >2	
	length > 15	

	dispenser - mouthpiece	time
	directly secured	
22	assembly location easy to reach	2,0s
	no screws or plastic deformation	
	no resistance	

Appendix K | Moodboards

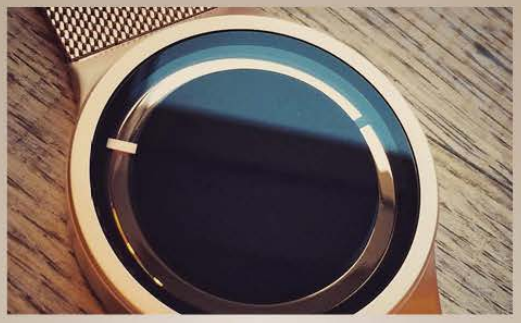
From the concluding consensus map, a number of terms were used most often by respondents. For most of these words, separate moodboards were created to capture the overall image of what is meant by those words. These moodboards are presented in this appendix, starting with minimalistic. Straight and tensed lines with repetitive elements on detailed level form the basis for this. Products have limited variation is shape and material, and consist of single curved surfaces. A continuous feeling forms the basis.
The moodboard for modern aesthetics consist of products and images with filleted corners, most of the time are two materials used that create contrast, and also in here are single curved surfaces.
For quietness, there are two moodboards. One to capture the atmosphere and the other more on product level. The atmosphere is characterized by being alone and in balance with your surroundings. It has an endless feeling and contrast only appears on detail level.
The products are a combination of these characteristics. The products have a soft and warm appearance and yet are robust. Clear fillets and almost organic shapes. Surfaces are clean and smooth and details belong to and follow the overall shape.
Detailed means a well-cared for product or environment. Every element is thought of but nothing can be taken out without changing the image. There is a rithm going on. The overall colours are brown and gold as this creates a warm and caring feeling.
Almost hypnotizing images describe the calm moodboard. The images create a relaxed and no-stress feeling by their matte materials and finishes. The extremely thin parting lines within products result in a clear structure. Large fillets and double curved surfaces add to the calmness.
The images in the structured moodboard have a clear position like what is portrayed in these images. Separations within the structure are done by means of differences in material or colour, which can be seen easily by the consistently returning patterns. Robust and continuous shapes define this moodboard.


Minimalistic

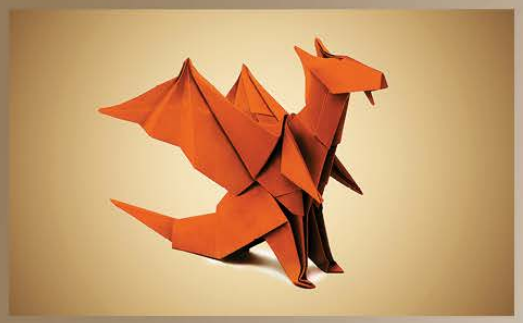

Modern

Quietness atmosphere

Quietness products



Detailed



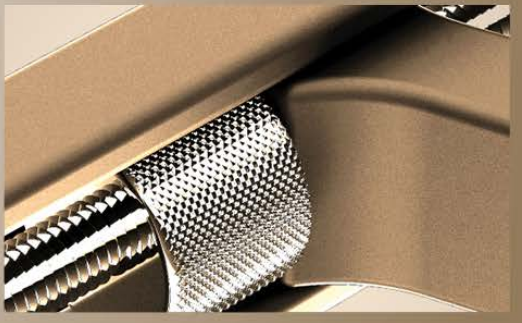



Calm









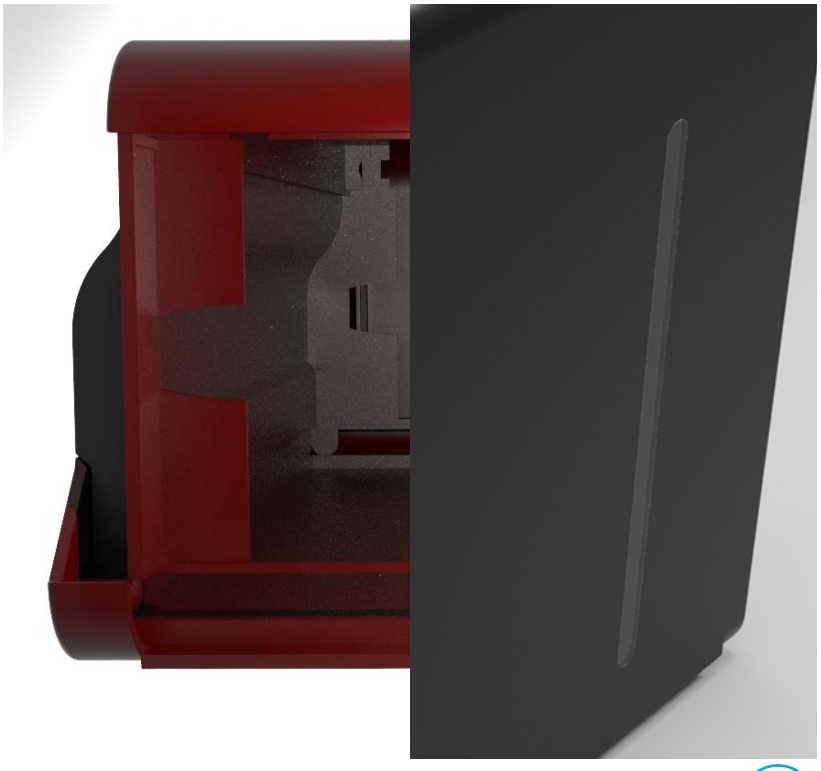
Structured

Minanic

Appendix L | Dispenser model iterations

The final model was not constructed instantly. This appendix shows a couple of renders from in-between models. The first model was still in the development phase, as can be seen by the holes at the sides. The embossments were necessary as, in this model, the top plate was attached to pins from the side panels. It would automatically raise when the dispenser is folded. This feature was later dismissed as it was too complicated for production. Which made the embossments also unnecessary.

The second model was already developed much further. In this model it was still the impression that no mouthpiece was needed and the paper could be dispensed by a combination of the side panels and front and back plate. Therefore, it can be seen that the side panels have gaps in them, where the paper should come from. As said in the report, a mouthpiece was needed. Which, through a number of optimizations, resulted in the final Fold.
Another focus point was the positino and dimensions of the window. There are almost endless possibilities for this part. At this stage, the window was designed to also funciton without wrap. However, due to consistency the wrap should always be applied, so the window was designed partly for the wrap.



Appendix M | Proof of wrapping application

To make sure that even complex shapes can be wrapped smoothly, the Satino Black BriQ Single dispenser was wrapped with Avery SWF wrapping foil. This foil was able to elongate 200% up to break according to the data sheet provided by Avery Dennison's website, instead of the 150% of the chosen 3MTM EnvisionTM Print Wrap SV480Cv3. However, this limit was not reached at all during application.

How the application proceeded
Applying the wrap was done using a squeegee, a hair dryer, and a lot of twisting and uncertain hand movements. First, the top plate was fully covered as the start needed to happen somewhere. Then, the half of the front was covered, so the wrap would stay in place, while the opposite top corner was dealt with. A lot of stretching and reheating took place to achieve this result. As the focus was to prove it could be bent smoothly around a corner, the rest of the side was done less carefully (bottom left image).
The other corner was done in a different manner. By cutting the wrap in half, first the side and later the front could be covered. This resulted in overlapping wraps. The next step was to create a double cut so both the wraps were cut through. Then, the overlapping parts could be removed and a smooth transition between side and front was created. The corner was not that smooth (bottom right image), but could have been done differently with a nicer result.

Appendix N | Business model variations

As said, there were multiple business models generated from which to choose from. This appendix shows the other two models and the reasons why they were dismissed.

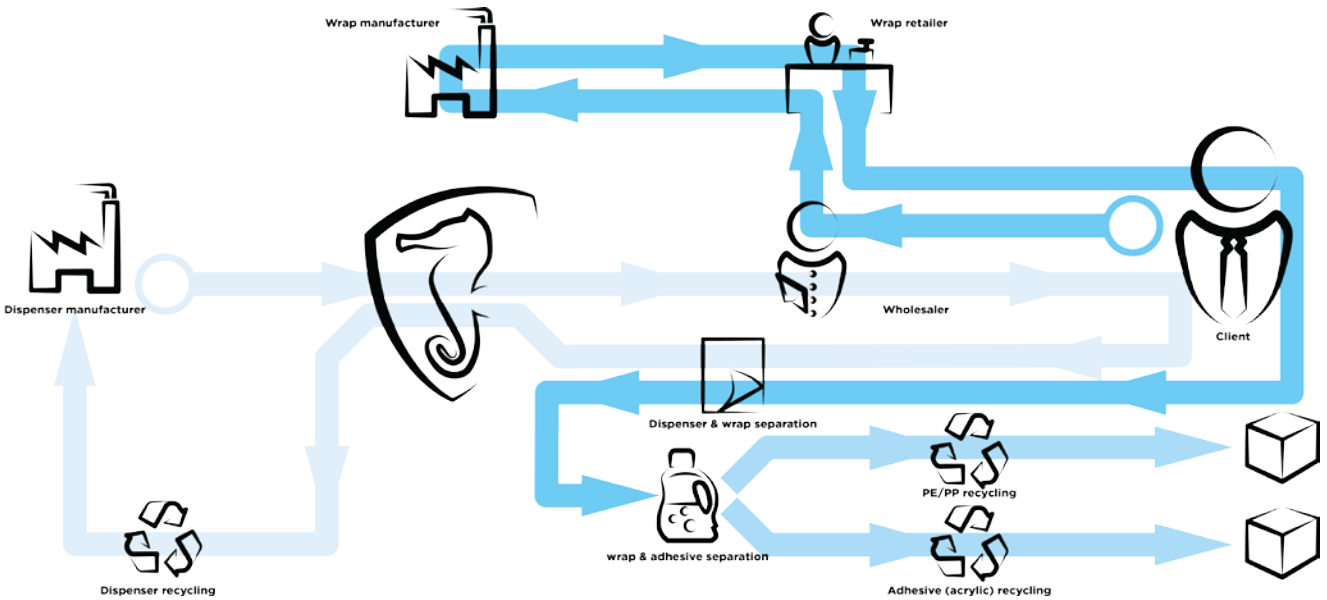
The first business model that was designed is visualized in the figure below. In here, the wholesaler is in direct contact with the client and the wrap retailer to communicate the wishes of the client. The custom wrap is then made and delivered back to the wholesaler. He brings the dispensers and the wrap to the client and the dispenser installers assemble, wrap, and mount the dispensers. Looking at the pros and cons, it appears that this is an attractive business model. However, the cons weigh a lot. Especially the bargaining power of the wholesalers and the wrapping knowledge of the installers are not attractive. Wrapping is a delicate process and it is likely that dispenser installers do not have these skills and perhaps are unwilling to achieve these.

Pros

- The wholesaler is the only contact person for the client
- Dispensers and wrap are delivered together to the client
- It is simple and clear to the installers
- The least amount of extra parties for the client
- Not an extra party in the form of a wrap installer

Cons

- Everything happens through the wholesalers, giving them a lot of bargaining power and control
- The quality of the wrap application is not guaranteed
- Removal quality is not guaranteed, which may cause a risk in recyclability of the dispenser
- Dispenser installer need to become wrap experts, which is not easy nor likely to become



The other model (the figure below) is where the client is in contact with Van Houtum about the wrap, while the dispensers are sold still through the wholesaler. Via a representative at Van Houtum, the client can discuss its wishes regarding the wrap design. This representative makes contact with a wrap installer, which order the wrap at the wrap retailer and finally installs the wrap at the client. In here, it is much easier to see why this model is not chosen. It is very cumbersome and coordination is

difficult

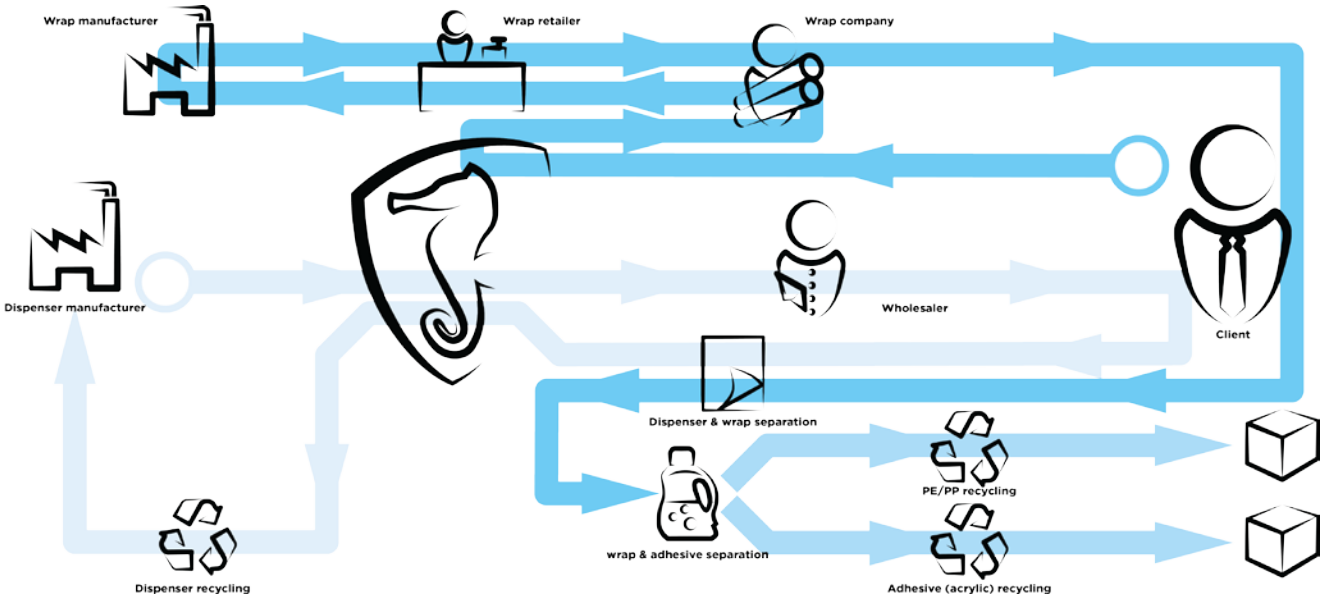
Pros

- The wholesaler is not involved in the wrap at all
- There is full control over the design of the wrap
- There is a personal tough for the client, having direct contact

with Van Houtum

Cons

- Van Houtum needs to keep in contact with the client, which is time consuming and thereby costly
- Client are getting a second contact person, making it more difficult to coordinate
- Delivery of the wrap at the same time as the dispensers is hard to control
- The wholesaler can feel like he is passed
- A representative at Van Houtum is needed
- It is hard to check whether the wrap designs fit the chosen selection of dispensers



Appendix O | Cost build-up

General information
Name: **Front plate**
Quantity: 10.000
Material: ABS
Envelope X-Y-Z (mm): 276 x 335 x 40
Weight (kg): 0,361
Max. wall thickness (mm): 3
Projected area (mm2): 92.460,00
Projected holes (mm2): 4.000
Volume (cm3): 354
Tolerance (mm): not critical (>0,5)
Surface roughness (um): Not critical (Ra>0,8)
Complexity: complex

Process parameters:
Defect rate (%): 5,00
Run quantity: 10.527
Part weight (kg): 0,361
Material price ($/kg): 2,84
Material mark-up (%): 10

Production
Machine clamp force (kN): 6,450
Hourly rate ($/h): 80,00
Machine setup time (h): 8,00
Machine uptime (%): 95,00
Production rate (parts/h): 97
Post-processing time (hrs.): 0
Production mark-up (%): 10

Tooling
Number of cavities: 1
Tooling material: Class 104
Mould-making rate (EUR/h): 20

Cost summary
Material costs: $12,842 ($1,284 per part)
Production costs: $9,771 ($0,977 per part)
Tooling costs: $27,735 ($2,774 per part)
Total costs: $50,345 ($5,035 per part)

General information
Name: **Back plate**
Quantity: 10.000
Material: ABS
Envelope X-Y-Z (mm): 250 x 335 x 20
Weight (kg): 0,330
Max. wall thickness (mm): 3
Projected area (mm2): 83.750,00
Volume (cm3): 324
Tolerance (mm): not critical (>0,5)
Surface roughness (um): Not critical (Ra>0,8)
Complexity: complex

Process parameters:
Defect rate (%): 5,00
Run quantity: 10.527
Part weight (kg): 0,330
Material price ($/kg): 2,84
Material mark-up (%): 10

Production
Machine clamp force (kN): 6,450
Hourly rate ($/h): 80,00
Machine setup time (h): 8,00
Machine uptime (%): 95,00
Production rate (parts/h): 99
Post-processing time (hrs.): 0
Production mark-up (%): 10

Tooling
Number of cavities: 1
Tooling material: Class 104
Mould-making rate (EUR/h): 20

Cost summary
Material costs: $11,753 ($1,175 per part)
Production costs: $9,625 ($0,963 per part)
Tooling costs: $26,378 ($2,638 per part)
Total costs: $47,756 ($4,776 per part)

General information
Name: **Side panel**
Quantity: 20.000
Material: ABS
Envelope X-Y-Z (mm): 113 x 331 x 29,5
Weight (kg): 0,071
Max. wall thickness (mm): 3
Projected area (mm2): 37.403,00
Volume (cm3): 69
Tolerance (mm): not critical (>0,5)
Surface roughness (um): Not critical (Ra>0,8)
Complexity: complex

Process parameters:
Defect rate (%): 5,00
Run quantity: 21.053
Part weight (kg): 0,069
Material price ($/kg): 2,84
Material mark-up (%): 10

Production
Machine clamp force (kN): 2.447
Hourly rate ($/h): 45,00
Machine setup time (h): 8,00
Machine uptime (%): 95,00
Production rate (parts/h): 100
Post-processing time (hrs.): 0
Production mark-up (%): 10

Tooling
Number of cavities: 1
Tooling material: Class 104
Mould-making rate (EUR/h): 20

Cost summary
Material costs: $5,398 ($0,270 per part)
Production costs: $10,285 ($0,514 per part)
Tooling costs: $20,436 ($1,022 per part)
Total costs: $36,119 ($1,806 per part)

General information
Name: **Top plate**
Quantity: 10.000
Material: ABS
Envelope X-Y-Z (mm): 276 x 88 x 22
Weight (kg): 0,072
Max. wall thickness (mm): 3
Projected area (mm2): 24.288,00
Projected holes (mm2): 75
Volume (cm3): 71
Tolerance (mm): not critical (>0,5)
Surface roughness (um): Not critical (Ra>0,8)
Complexity: complex

Process parameters:
Defect rate (%): 5,00
Run quantity: 10.527
Part weight (kg): 0,071
Material price ($/kg): 2,84
Material mark-up (%): 10

Production
Machine clamp force (kN): 1,779
Hourly rate ($/h): 40,00
Machine setup time (h): 8,00
Machine uptime (%): 95,00
Production rate (parts/h): 100
Post-processing time (hrs.): 0
Production mark-up (%): 10

Tooling
Number of cavities: 1
Tooling material: Class 104
Mould-making rate (EUR/h): 20

Cost summary
Material costs: $2,713 ($0,271 per part)
Production costs: $4,764 ($0,476 per part)
Tooling costs: $17,133 ($1,713 per part)
Total costs: $24,610 ($2,461 per part)

General information
Name: **Mouthpiece**
Quantity: 10.000
Material: ABS
Envelope X-Y-Z (mm): 268 x 100 x 24
Weight (kg): 0,061
Max. wall thickness (mm): 3
Projected area (mm2): 26.800,00
Projected holes (mm2): 9124,5
Volume (cm3): 60
Tolerance (mm): not critical (>0,5)
Surface roughness (um): Not critical (Ra>0,8)
Complexity: complex

Process parameters:
Defect rate (%): 5,00
Run quantity: 10.527
Part weight (kg): 0,061
Material price ($/kg): 2,84
Material mark-up (%): 10

Production
Machine clamp force (kN): 1,779
Hourly rate ($/h): 40,00
Machine setup time (h): 8,00
Machine uptime (%): 95,00
Production rate (parts/h): 100
Post-processing time (hrs.): 0
Production mark-up (%): 10

Tooling
Number of cavities: 1
Tooling material: Class 104
Mould-making rate (EUR/h): 20

Cost summary
Material costs: $2,332 ($0,233 per part)
Production costs: $4,761 ($0,476 per part)
Tooling costs: $19,184 ($1,918 per part)
Total costs: $26,278 ($2,628 per part)

Wrapping
Wrapping roll (50m): 746EUR
Necessary length: 7,25m
Wrap costs: 108,17EUR
Printing: 15EUR
Wrapping time (per dispenser): 0,1667h
Amount of dispensers: 24
Total wrapping time: 4h
Amount of installers: 2
Installer wage: 9,03125EUR/h
Installing costs: 72,25EUR

Total wrapping costs: 195.42EUR