Sweepy

by PHILIPS

by order of

PHILIPS

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Project Report

THE MISSION:

"The development of a concept of a floor cleaning robot that is able to cross the chasm."

GROUP 18

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This product report is destined for Philips, for the tutors and examiners of the studies Industrial Design, Industrial Engineering and Management and Mechanical Engineering at the University of Twente.

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SUMMARY

This section contains a summary of this product report. It is recommended to read this summary before reading the remainder of the report. This will provide the reader with some basic knowledge about Sweepy and will help the reader to understand the report better.

ANALYSIS

In recent years, the market of robot vacuum cleaners has been growing. This growth is mainly due to the robot vacuum cleaners. One reason for this is that people have busier lives. From this one can conclude that one of the market needs is that people need to gain time. Another need is that people want to live in a clean environment, without spending a lot of time on cleaning.
The robot vacuum cleaner market is a quite new market, so it is a market with a lot of potential. The forecasted growth of robot vacuum cleaner sales is about 85% in number of units sold between 2012 and 2017 for Western Europe.

Most robot vacuum cleaners which are currently sold are quite autonomous. They can recharge themselves and some of the robots can empty themselves. There are also a few robot vacuum cleaners which can be controlled with a remote controller.

Keys to succes are good advertising in order to make potential customers aware of the existence and the excellence of Sweepy and make them feel attracted to buy Sweepy, so that the sales will increase and meeting the expectations of the users, based on the advertising about Sweepy.

MARKETING STRATEGY

The market opportunities for the robot
vacuum cleaner, named Sweepy, consist of the possibility for Philips to increase its market share in the robot vacuum cleaner market, a fast growing market. Sweepy can also contribute to Philips' brand equity by meeting the potential customers' expectations and wishes. In order to optimally make use of these opportunities, a good marketing strategy is indispensible.
The marketing strategy for Sweepy is in line with the mission and vision of Philips, which are to improve people's lives through meaningful innovation. Sweepy will do so by being an autonomous robot, as it comes with an advanced docking station and a mobile application, and by delivering a superior cleaning quality. The targeted market consists of Dutch professionals who are part of family-households, two-person houseoulds or who are single.
The first-year objectives for Sweepy are to increase Philips' market share in robot vacuum cleaners, to reach at least break-even, increase the market potential of the robot vacuum cleaner market, maintain positive growth of sales, optimize production and distribution channels.

STATEMENT OF REQUIREMENTS

The statement of requirements is subdivided in three categories: the price of the robot vacuum cleaner (weight 17.31%), the usability of the robot vacuum cleaner (weight 22.46%) and the (cleaning) quality of the robot vacuum cleaner (weight 60.23%). The weights were determined by taking into account the results of a survey which was carried out.

DESIGN PROCESS

The design process consists of three main stages. The first stage was to decide whether to make use of dry or wet cleaning. The second stage was to choose between seperation or integration of various functions. The third stage was about the way of cleaning. The resulting concept was named "Sweepy". Sweepy had a round shape with two brushes, to clean the floor, in the middle of the robot. It uses normal wheels to move forward. Sweepy has been created as a robot which does not look like a very technical robot but it got a pet-like look and a changeable cover. This was the concept which was presented to Philips.

FINAL CONCEPT

After receiving feedback from Philips the final concept was developed. The final concept consists of three products:

- An autonomous cleaning robot
- A base station
- A mobile application

The main function of the robot is to navigate smartly through a room while collecting dirt and leaving a clean floor. It does this by vacuuming, mopping and drying. It recharges its batteries and empties its dirt tank autonomously by connecting with the base station. The base station supplies the robot with fresh water & detergent, gathers dirt in a dirt tank. Additionally it recharges the batteries of the robot.
The mobile application allows the user to schedule and control the behavior of the robot independent of his or her location. For a more direct control there are is still a user interface on the robots exterior.

FINANCIALS AND CONTROLS

Sweepy's cost price is estimated to be about €194. Its retail price will be €799 and its wholesale price will be €775. Break-even sales are estimated to be about €23,000,000 (about 30,000 units). The expected number of units that will be sold is about 65,000, with an expected profit of about €20,000,000. The marketing budget has been set to €4,500,000.
The objectives set in the marketing strategy will be monitored by making use of performance indicators.

RECOMMENDATIONS

The following recommendations are made to Philips:

- User manual: A user manual should come within the packaging of Sweepy. Important information, like "Where to download the app?" and "How to connect to the station?" should be explained. Detailed information about the robot and its maintenance can then be delivered in the form of an instructional video via the mobile application.
- The package of the robot has been designed visually without considering material choice or designing protective styrofoam. Further research and design are required.
- All non-standard parts of the robot, such as the airflow guidance, the cover, the brushes etc. are conceptual and have not been optimized foor manufacturing and assembly. Most of the parts can be optimized for injection moulding, which is suitable for mass production.
- The brushes that were designed are inspired by the AeroForce Brushes of the Roomba 500 series. It should be verified whether they are protected with a patent or not. This holds as well for many other parts of the robot.

INTRODUCTION

This product report contains the result of the process of designing a robot vacuum cleaner for Philips. The goal of designing this robot vacuum cleaner is to develop the next generation robot vacuum cleaner that can cross the 'chasm', which means that the new robot vacuum cleaner should be adopted by the bulk of the market. This involves a lot of challenges which have to be faced. During the design process for instance, one should not only think about how the product will function and how it will look, but also about what should be its use context and how the product should be introduced on the market. A good marketing strategy is required for the robot vacuum cleaner that has to be designed, so that the introduction on the market will be smooth and successful. This report shows how these challenges have been faced and how that resulted in a final concept, named Sweepy.

The following approach has been followed in order to design a concept: Firstly a market analysis has been performed to analyze the product environment and get some knowledge about existing robot vacuum cleaners and how they function. Besides that, a survey was conducted in order to get some insight in the customers wishes. Based on the results of these analyzes and the survey results, a marketing strategy was developed. After that a statement of requirements was composed. Finally, subject to the requirements and the marketing strategy, many ideas were finally put together into one concept.

The first part of this report is about the market analysis. The second part is about the marketing strategy, with a strategic part which was made before designing the robot, and a tactical part which was made after the robot was designed. The third part contains the statement of requirements and the description of the design process. The fourth part of this report describes the final concept. The fifth part contains the roughly estimated financials involved in bringing Sweepy to the market and a description of how management can control and monitor the objectives set in the marketing strategy. The last part contains the recommendations for Philips for further developement.

ANALYSIS

In this chapter analysis of the current market for robot vacuum cleaners will be performed, in order to understand the robot vacuum cleaner market better. Besides that a technical analysis will be made, in which some technical functions of robot vacuum cleaners which are currently available on the market will be analyzed.

MARKET SUMMARY

Market trends

In the past year the market growth for vacuum cleaners was mainly due to robot vacuum cleaners, according to a report of Euromonitor.[1] A reason for this can be that one can distinguish a trend in the current market that people have busier lives than before and that they have less time available to spend on their hobbies and maintaining contact with their families and friends, which might explain the growth of sales of robot vacuum cleaners.

Market Needs

The major general market needs are the following:

- The potential customers have a need to gain time, in order to be able to spend more time on activities they like to do. This follows from the trend that people have less time available.
- Besides this need for time, potential customers also experience the need of living in a clean environment, without having to spend a lot of time on cleaning themselves.

Market growth

The robot vacuum cleaner market is a relatively new market compared to markets of different types of vacuum cleaners. Therefore this market has a lot of potential. An indication of the growth of the robot vacuum cleaner market in The Netherlands can be given by taking the forecasted growth of the robot vacuum cleaner market in Western Europe. This growth was estimated to be about 50% in sales value between 2012 and 2017 and about 85% in number of units sold in the same period.[2] Sales in 2012 were about $434 million and the number of units sold was about 800,000 units for Western Europe, the size of the market in The Netherlands was of course only a fraction of this.

Common complaints

In order to get to know what current owners of robot vacuum cleaners think of their robots, many reviews on comparison websites have been analysed. In general, owners are very happy with their devices. Of course the robot vacuum cleaners are not perfect yet, so the owners also had some complaints about their robot vacuum cleaners. Some of the most encountered complaints are the following:

- The robot keeps bumping into objects.
- The robot sees carpets as an obstacle and does not clean them.
- The robot does not work efficiently.
- The robot gets stuck in cables and other tiny obstacles.
- The robot makes too much noise, which can be annoying while watching tv.
- The robot has a too large security distance.
- The lifespan of the battery is only 7 months.
- The robot does not clean properly.

1) Euromonitor, 2014, Vacuum Cleaners in the Netherlands, http://www.euromonitor.com/vacuum-cleaners-in-the-netherlands/report, accessed 8 Jan. 2015

2) Della-Santa, L., 2012, Robotic Vacuum Cleaners: Where There's Savings, There's Hope, http://blog.euromonitor.com/2012/12/robotic-vacuum-cleaners-where-theres-savings-theres-hope.html, accessed 8 Jan. 2015

SWOT-ANALYSIS

In the previous paragraph the market was described with a neutral point of view, this paragraph will be from Philips' point of view.[3] Some of the main strenghts and weaknesses of Philips as a company will be described. Furthermore, the main opportunities and threats involved in bringing a new robot vacuum cleaner to the market will be discussed.

Strenghts

- Due to a large market share in electronic devices and a high brand equity Philips has a lot of negotiating power. This can result in cheaper components for a new robot vacuum cleaner.
- Dedication to research and development gives Philips the opportunity to be highly competitive and innovative and it gives Philips the possibility to join new markets.
- Philips has a lot of technological knowledge available, so Philips can more easily meet the wishes and the needs of the customers by making use of the right technologies than many competitors can do.

Weaknesses

- Legal problems which Philips has can damage the brand image.
- The advertising for the current robot vacuum cleaner from Philips is quite bad, the robot vacuum cleaner is not actively promoted.
- Philips' profit margin is usually higher than the profit margins from their competitors, resulting in a relatively higher price.

Opportunities

- By adapting the new robot vacuum cleaner to the potential customer's wishes, it can positively contribute to Philips brand image.
- The robot vacuum cleaner market is a growing market as stated before, so introducing a new robot vacuum cleaner to the market may increase Philips' market share in robot vacuum cleaners.
- As the new robot vacuum cleaner will be produced with big lot sizes, Philips can benefit from economy of scale.
- By carrying out a good marketing program and good advertising, the new robot vacuum cleaner can become a successful product.

Threats

- There is a possibility that people will not accept a robot nearby them in their comfort zones.
- Innovative features of the new robot vacuum cleaner might not work well because they are very new. This might be a cause for a failure of bringing a new robot vacuum cleaner to the market.

3) McHugh, M. S., 2013, Philips SWOT analysis, http://www.slideshare.net/ms_mchugh/digital-cooperative, accessed 14 Jan. 2015

- People might prefer to have a cleaning lady because they think the cleaning lady can clean their house better.

COMPETITION

Most robot vacuum cleaners which are sold at the moment, are quite autonomous. When the battery level is low, many robot vacuum cleaners return automatically to their charging point to recharge. Some robot vacuum cleaners are able to empty themselves. Other robot vacuum cleaners can be controlled with a remote control. Furthermore, a number of robot vacuum cleaners have an integrated mopping function.

The following part contains a more detailed description of some of the biggest future competitors of the new robot vacuum cleaner. These competitors were selected after a preliminary concept was made and were considered the most relevant competitors for this concept. Detailed descriptions of other competitors were not considered relevant for this report.

- *iRobot Scooba 450*[4]: iRobot is a big technology company that specializes in making robot vacuum cleaners. One of the designed robot vacuum cleaners is the Scooba 450. The Scooba 450 has as main advantage that it can vacuum and mop. This is resulting in a very clean floor. A disadvantage of the Scooba 450 is that it does not automatically recharge itself.
- *Samsung NaviBot SR8980*[5]*:* Samsung is a very large company that does not specializes in robot vacuum cleaners. One of the designed robot vacuum cleaners by Samsung, is the NaviBot SR8980. This robot vacuum cleaner is quite unique. It is just able to vacuum, but it can empty itself. At the moment the robot vacuum cleaners is recharging, it is automatically emptying.
- *LG Hombot Vcarpetx*[6]*:* LG also has the robot vacuum cleaner not as their main target to sell. LG makes a lot of different types of products and the robot vacuum cleaners are one of them. The Hombot Vcarpetx is almost unique in its kind. It can vacuum and mop on hard floors, and it can also continue cleaning on carpet. So it can almost get anywhere and the cleaning quality is high.
- *Cleaning lady:* This may well be the biggest competitor of Sweepy. With a cleaning lady, people know that their floor will be properly cleaned. This can lead to a situation where people do not want to take the risk of buying an expensive robot vacuum cleaner. They may prefer to pay for instance €30 once a week for a cleaning lady.

4) iRobot, 2014, iRobot Scooba 450, http://www.irobot.com/For-the-Home/Floor-Scrubbing/Scooba.aspx, accessed 21 Jan. 2015

5) Samsung, 2012, Samsung NaviBot SR8980, http://www.samsung.com/sg/consumer/home-appliances/vacuum-cleaner/robotic-type/VCR8980L3R/XSP, accessed 21 Jan. 2015

6) LG, 2013, VCARPETX, Effortless cleaning with LG, http://www.lg.com/nl/stofzuigers/lg-VCARPETX-hombot , accessed 21 Jan. 2015

TECHNICAL FUNCTIONS

In this paragraph an analysis will be described of the technical functions of some of the robot vacuum cleaners currently available. Only parts of the analysis are included in this report.

Propulsion

The Dyson 360 Eye[7] has a new developed digital engine. A strong engine was needed, but those normally are a lot bigger. This is a small and light V2-engine.

The Irobot Roomba[8] uses four different engines. Every compartment has a single engine. This vacuum cleaner has two engines to power each wheel, one tho power the vacuuming and the last one is used to power the brushes. The two separate engines used to drive the wheels have as advantage that the robot is more movable.

Movement

The engine delivers power for the movement of the robot vacuum cleaner but also for the airflow. The movement can be done in various ways, wheels, caterpillars can be used. Most robot vacuum cleaners use three wheels. One in the front of the robot vacuum cleaner and two on the back. An example is the Dirt Devil RoomMate.[9] The two wheels on the back are fixed and can only move forward or backward. The wheel in the front has no propulsion and is completely free in its movement, this wheel is only there to make sure the robot vacuum cleaner is stable. The robot vacuum cleaner can make a turn when the wheels do not have the same rotation speed. Other options for movement are robot vacuum cleaners with caterpillars. Caterpillars are used in the Dyson 360 Eye model[10], still this model uses a completely propulsion-free front wheel.

Transmission

The transmission between the engine and the movement system can be done in various ways. It can be done by gears, V-belt, or a direct transmission. If every device that needs power has a different engine then the transmission is most efficient when a direct transmission is used. If only one engine is used to drive the complete vacuum cleaner a lot of transmissions and gearboxes need to be made.

Suction

The iRobot Roomba[11] uses two brushes which are rotating in opposite direction and grabbing dust and other debris, breaking it down and storing it in the storage bag, to guide

7) Dyson, 2014, Dyson 360 Eye robot, https://www.dyson360eye.com/, accessed Nov. 2014.

8) Woodford, C., 2014, Roomba Vacuum Cleaning Robots, http://www.explainthatstuff.com/how-roomba-works.html, accessed Nov. 2014

9) Robotvacuumcleaner.org, 2011, The Dirt Devil RoomMate Robot Vacuum Does the Job, http://www.robotvacuumcleaner.org/2011/12/the-dirt-devil-roommate-robot-vacuum-does-the-job/, accessed Nov. 2014

10) Wollerton, M., 2014, Deluxe brand Dyson creates its first robot vacuum, the 360 Eye, http://www.cnet.com/products/dyson-360-eye/, accessed Nov. 2014

11) iRobot, 2014, iRobot Roomba Vacuum Cleaning Robot, http://www.irobot.com/For-the-Home/Vacuum-Cleaning/Roomba, accessed Nov. 2014

the dust particles the right way and to clean efficient. This way the bigger and smaller particles will be removed.

Navigation
One way of navigating through a room is to use a camera. The Dyson 360 Eye uses a camera which can look around 360 degrees[12] and can detect what objects are in the room and where the robot is, already has been and where it stillneeds to go. This way the robot knows at all times where it is and where objects are which can get the robot stuck and thus will be avoided.

Another way of navigating is by making use of infrared sensors. The Roomba uses the iRobot's Aware(tm),[13] which is a system that scans the room first with an infrared signal and in the time in which it returns the Roomba can estimate the room's size. When it is cleaning, it also uses infrared sensors at the bottom to avoid holes in the floor and object sensors to know when it can not go further and needs to turn.

Energy Storage
A battery is used in the Neato XV Signature Pro.[14] The material is a NiMH (Nickel metal Hybride). 110V or 220V is used to charge the battery. The battery takes three hours to be fully charged and has an operating time of one and a half hour. The operating time is a lot shorter than the charging time.

The Roomba 880[15] also uses a battery. An advantage of this vacuum cleaner is that it will return to its docking station after cleaning. This means the users do not have to think about charging the Roomba and can use it every moment it is needed. The battery takes two hours to be fully charged and has an operating time of 4 hours.

Dust Storing
Dust collected by cleaning the floor needs to be stored somewhere. When the vacuum cleaner would blow the dust directly out, the room will not get clean. For conventional vacuum cleaners this is done with a removable dust bag which can be thrown away after it is filled. Also vacuum cleaners without dust bags exist, these cleaners have a dustbin, which has to be emptied once in a time.

The larger the dust bag or dustbin is, the longer the vacuum cleaner can clean. There are possibilities to let a robot vacuum cleaner work with a depot for dust at the docking station of the robot. So it is possible to work with a smaller dustbin. In Figure 1 the storage capacity of some (robot) vacuum cleaner is displayed.

Vacuum Cleaner	Brand	Storage Capacity (Liter)
Dust bag, conventional	Miele Hy-Clean	6
	Miele Vacuum Cleaners average	4
No dust bag, conventional	Dirt Devil DD 5500 rebel 50	1.7
Robot	Dirt Devil M607 Spider	0.27
	Dyson Eye 360	0.4
	The Phillips EasyStar FC8800/01	0.2

Figure 1: Storage capacity of some vacuum cleaners

Internal Software
Science of today can make a robot pretty smart. Also a vacuum cleaner can be pretty smart. For example a Dyson 360Eye this vacuum cleaner can orientate to several objects in the room, and makes a squared spiral walk so that everything gets clean.
There are also dumb robots, which walk with a random pattern through the room. The problem with this is that not everything will be cleaned. Also something between a smart and a dumb system can be used.

KEYS TO SUCCES AND CRITICAL ISSUES

The following issues are considered as critical in order for the new robot vacuum cleaner to be a successful product:

- Good advertising in order to make potential customers aware of the existence and the excellence of Sweepy and make them feel attracted to buy Sweepy, so that the sales will increase.
- Meeting the expectations of the users, based on the advertising about Sweepy.

12) Miltenburg, O. van, 2014, Robotstofzuiger Dyson krijgt 360-gradencamera, http://tweakers.net/nieuws/98230/robotstofzuiger-dyson-krijgt-360-gradencamera.html, accessed Nov. 2014
13) Layton, J., 2005, How Robotic Vacuums Work, http://electronics.howstuffworks.com/gadgets/home/robotic-vacuum.htm, accessed Nov. 2014
14) Buck, K., 2014, Robot Vacuum Review, http://robot-vacuum-review.toptenreviews.com/neato-xv-12-review.html, accessed Nov. 2014
15) iRobot, 2013, iRobot Roomba 880 stofzuigrobot, http://www.irobot.nl/Winkel/Robots/Roomba/800-Series/iRobot-Roomba-880-stofzuigrobot?gclid=COey65SVm8MCFXQatAodp0cAYA , accessed Nov. 2014

Marketing Strategy

In this chapter the marketing strategy for the new robot vacuum cleaner will be discussed. Whenever something is said about the new robot vacuum cleaner, its name ‘Sweepy’ will be used, because this chapter contains a specific marketing strategy for Sweepy. The reader should keep in mind that some parts of this chapter describe decisions which were made after designing the concept. Nevertheless, this chapter also contains decisions which were made before composing the statement of requirements and designing the concept and for that reason this chapter comes before the chapters which are about these subjects. A good marketing strategy is very important for Sweepy. In the relatively new market for robot vacuum cleaners a well carried-out marketing strategy can really make a difference and give Philips a competitive advantage.

MISSION AND VISION

As Sweepy is a Philips product, it must fit the mission and vision of Philips. Philips' current slogan is "Innovation and You", and is supported by the following mission and vision[1]:

Mission

"Improving people's lives through meaningful innovation."

Vision

"At Philips, we strive to make the world healthier and more sustainable through innovation. Our goal is to improve the lives of 3 billion people a year by 2025. We will be the best place to work for people who share our passion. Together we will deliver superior value for our customers and shareholders."

This mission and vision imply that Sweepy should contribute to the improvement of people's lives through meaningful innovation.

OBJECTIVES

For the first year, the following objectives will be set:

- Increase Philips' market share in robot vacuum cleaners, such that Philips will become market leader in this market.
- Reach the break-even point for Sweepy, so that from the second year on profit can be made.
- Increase the market potential of the robot vacuum cleaner market by contributing to the crossing of the 'chasm' by the robot vacuum cleaner. The 'chasm' is the gap between the early adopters of a product and the early majority who buys a product.
- Maintain positive growth of sales each quarter.
- Optimize production and distribution channels, in order to make the delivering of Sweepy to the market more efficient and minimize the costs involved.

TARGET MARKETS

The ideal target market would consist of all consumers in all market segments. This would be in accordance with Philips' mission and vision, as stated before. As it is close to impossible to fulfil the wishes of all these 3 billion people mentioned in Philips' vision with only one product, a somewhat smaller target market has been chosen, as displayed in Figure 2.

Figure 2: Possible target markets

Definition of the target market:

"Dutch professionals who are part of family-households, two-person households or who are single"

1) Philips, 2013, Vision and Strategy, http://www.philips.com/about/company/missionandvisionvaluesandstrategy/index.page, accessed 8 Jan. 2015

The geographic area where Sweepy initially will be available is set to The Netherlands in order to make it easier to adapt the robot to cultural factors. The size of the targeted segments is roughly estimated to be 5 million households. This estamation is based on data of the Dutch CBS for the year 2013.[2]

The customers who typically would buy Sweepy have the following characteristics:

- Their age varies from 18 to 65, with most of them in the age group of 25 to 50 years old.
- They do not experience a permanent lack of money and they have a substantial budget for luxury goods.
- There is no reason to assume that one of the genders will be more attracted to Sweepy than the other gender, so it is likely that the genders will be equally distributed among the customers.
- The lifestyles of potential customers are such that they are a lot away from home, because their lives are filled with lots of activities, such as doing business, maintaining their hobbies or many other possible activities.
- They want to maintain their houses clean, without having to spend a lot of time doing so.
- They do not like cleaning the floor themselves.
- Their houses have hard or carpeted floors, which they clean regularly by vacuuming or mopping.

The primary focus will be on Dutch professionals who live in houses with mainly hard floors and who have an income which is above average. The remainder of the target market, consisting of Dutch professionals who have an average income and/or whose houses have mainly carpeted floors. The marketing strategy will not be adapted to segments which are not included in the target market, such as students, retired people and companies, but of course that does not mean that Sweepy cannot be a valuable product for these groups.
The target market is restricted to the Netherlands for the first year, but after the first year the target market will be expanded to different countries in Western Europe and the US, and on the longer term even more countries all over the world will be included, if Sweepy turns out to be successful and if an expansion of the target market would be beneficial for Philips.

POSITIONING

Sweepy will be positioned by making use of a differentiation strategy. Sweepy distinguishes itself from its competitors with the following points of difference or unique selling points:

"Sweepy is the most autonomous and time-saving robot vacuum cleaner on the market, thanks to the posibility to set its behavior in advance or from a distance by using the application and thanks to the docking station."

2) CBS, 2014, Gemiddeld inkomen; particuliere huishoudens naar diverse kenmerken, http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=70843ned&D1=a&D2=0-18&D3=0&D4=l&HDR=G2,G3,T&STB=G1&VW=T, accessed 7 Jan. 2015

"Sweepy delivers a superior cleaning quality compared to its competitors by combining vacuum cleaning and mopping the floor."

"Sweepy's appearance can be customized by the user."

The main points of parity which Sweepy has in common with its competitors are the following:

- Sweepy cleans the floor of the user's home.
- Sweepy moves through its operating environment on its own.
- Sweepy is very easy to use for its user.

Sweepy's positioning can be summarized by the following slogan, which will be used when advertising about Sweepy:

"Sweepy, cleaning up your time!"

STRATEGIES

Product[3]

Sweepy will be part of Philips' vacuum cleaner product line. It will be sold using the Philips brand, as it can in this way benefit from the brand equity already created by Philips. Sweepy will be customizable by enabling the customer to buy covers in different colors, apart from the standard white-colored cover with a Philips logo on it, which comes with Sweepy. The customer will also be given the opportunity to buy additional docking stations according to the customer's preference. The warranty period with which Sweepy will be sold will be five years. Most warranty periods of competitors are between two and five years, and because it is important that the customers have the impression that the product quality is high and that Sweepy is a durable product, the warranty period should be defined accordingly.

The package of Sweepy will contain the robot itself with a standard cover and one docking station. It will be shaped in such a way that it is easy to transport. The package will be labeled with all the relevant information (such as the warranty period, most important specifications and the product slogan etc.) for the customer's choice whether to buy Sweepy or not. The package also will be labeled with an image of Sweepy in its use context, as well as the logo of Philips and Philips' slogan "Innovation and you".

Pricing

The wholesale price at which Sweepy will be sold will be €775. This price was set using the mark-up pricing method, with a profit margin of approximately 75%. The paragraph "Cost Price Estimation" on page 52 contains a more detailed description of how Sweepy was priced. Sweepy will be sold for €799 in Philips' webshop, retailers will be adviced to sell Sweepy for this price as well. Additional covers will be sold for €20, assuming a cost price of about €5. Additional docking stations will be sold for €249, assuming that the docking station accounts for about 30% of the cost price.

3) In order to understand this paragraph better, it is recommended to have read the summary at the beginning of this report, as this paragraph was written after the concept was designed.

In the first year there will be no promotions. The price will not be lowered as a response to competitors' actions, because Sweepy's price should give the customer the idea that they are really buying a product with a superior quality.

When the geographical area of the target market is expanded in the future, the price will then be adapted by taking into account relevant factors for the area in which Sweepy is to be sold. This means that the prices do not necessarily have to be equal in different geographical regions.

Distribution

Sweepy will be distributed by making use of the current distribution channels of Philips for the robot vacuum cleaners. This means that Sweepy will be produced in China and sold in Philips' webshop, by online retailers such as bol.com and by retailers with physical shops like for instance Media Markt and BCC. As Philips does already sell their current robot vacuum cleaners this way Philips can benefit from these already existing relationships with retailers. Ordering additional covers for customizing Sweepy or ordering additional docking stations can only be done at Philips webshop. Initially, for the first year, Sweepy will be distributed only in The Netherlands.

In order to support channel relationships external sellers of Sweepy will get detailed information about the product so they can optimally inform the customer about Sweepy. This will be done by distributing 3D-models, demonstration products and a visual explanation of the robot vacuum cleaner. Besides that leaflets with specifications and a functional explanation of Sweepy will be distributed.

Marketing Communications

The marketing communications will be divided in two parts, namely communications to the marketing channel members and communications to potential customers.
Marketing channel members will be addressed in a personal way, by sending a representative of Philips to their offices whenever consultation is necessary. The aim of this communication method is to maintain good relationships with marketing channel members, so they will see Philips as an important partner and that they will put extra effort in selling Philips' products.
The potential customers will be addressed via several channels. Commercials will be broadcasted on a regular basis on popular TV channels and will be uploaded to Philips' Youtube channel. Besides that, there will also be spots on the radio and advertisements on the Internet. Furthermore, advertisement space will be bought in popular lifestyle magazines, business magazines and newspapers.

MARKETING PROGRAMS

In the first year the following marketing programs will be carried out in order for Sweepy to become a successful product:

- The month before Sweepy will be released external sellers will be provided with all the information and materials as stated in the distribution strategy. Besides that, Philips representatives will visit the external sellers and other marketing channel members in order provide them with any additional information if necessary and will continue to do so for the rest of the year.
- In the first month, in which Sweepy will be released, advertising time will be bought on popular television channels and a short commercial will be broadcasted for two months, so that the potential customers will get to know Sweepy. The commercial will also be uploaded to Philips' Youtube channel. The commercial will show the main points with which Sweepy differentiates itself from its competitors.
- After two months Philips will start advertising on the Internet and on the radio. These advertisements will contain the same message as the commercial in the first and the second month did and will last for two month.
- In the fifth and the sixth month another television commercial will be broadcasted, again emphasizing Sweepy's points of difference.
- In the sixth month a new advertising campaign will be initiated by buying advertising space in magazines and newspapers. These advertisements will also point out the main points of difference of Sweepy. This campaign will last for the rest of the year, by regularly buying advertising space.
- After ten months again new commercial will be released for broadcasting on television, with basically the same message as in the first commercial, but now within a new 'skin'. This commercial will also be broadcasted for three months.

MARKETING RESEARCH

Marketing research has been conducted in order to adapt Sweepy to the customers wishes. The survey which was used and the survey results can be found in Appendix A. Further marketing research will be done in order to determine and to monitor Philips' market share, total market potential of the robot vacuum cleaner market and customer satisfaction. Besides that marketing research will be done in different geographical areas, in order to prepare for expanding the target market by including different geographical areas.

Statement of Requirements

In this chapter the statement of requirements for the robot vacuum cleaner will be discussed. The requirements guided the design process, as they indicate the borders of what can be considered admissable regarding the design of the robot vacuum cleaner. This means that they are very important, and for that reason all requirements will be motivated and explained in this chapter.

The statement of requirements is subdivided in three categories: Price (including requirements related to production and distribution), (Cleaning) Quality (including requirements related to the behaviour of the product) and Usability. In the statement of requirement 'the product' refers to the robot vacuum cleaner which is to be designed. Firstly the statement of requirement will be given and after that the requirements will be motivated.

PRICE

1. The product must be suitable for mass production.
2. The package of the product must be rectangular.
3. The profit margin must be 75% of the selling price or more. (Wish)
4. The selling price of the product should not exceed €600. (Wish)

(CLEANING) QUALITY:

1. The cleaning quality must be better than the cleaning quality of similar products currently sold by Philips.
2. The product must be able to avoid or resist situations which are harmful to people, property or itself.
3. The product must be able to navigate smartly through its operating environment.
4. The dimensions of the product should not exceed 100x350x350 (height x width x length in mm).
5. The product must be able to recognize heights, widths and distances of obstacles and objects in its way.
6. The product must be able to gather dirt and debris at a central place.
7. The product should be durable, such that one can use the product for at least as long as the warranty period under normal circumstances.
8. The product recognises different surfaces and adapts its behavior accordingly. (Wish)

USABILITY

1. Under normal circumstances, the product can operate autonomously for 7 cleaning sessions.
2. One should be able to use the product without reading an elaborate user manual.
3. The product's behavior should be adjustable to one's preferences, such as starting time and cleaning mode.
4. The product's noise level should not exceed 70 dB. (Wish)

MOTIVATION OF REQUIREMENTS

In order to adapt the statement of requirements to the consumers' wishes, a survey has been conducted, as mentioned before (the survey can be found in Appendix A). The survey results show that the respondents give the following weights to the three categories:

- Price: 17.31%
- (Cleaning) Quality: 60.23%
- Usability: 22.46%

From this, one can draw the conclusion that in the design process the main focus should be on cleaning quality, according to the respondents of the survey. As also clearly explained in Appendix A, the survey results cannot be taken as completely representative for the whole target market. Thus the requirements are supported both by logical reasoning and the survey results, instead of using the survey results as the one and only truth. Besides that of course also the results of the market analysis will be taken into account, as well as the marketing strategy.

PRICE

The product must be suitable for mass production.
The aim of designing this product is to cross the 'chasm', as already mentioned in the introduction. This means that the product should be suitable to be served to the bulk of the market. If that would not be the case, it would be hardly possible to cross the 'chasm', as one wants to sell the product to as many consumers as possible in order to cross this 'chasm'. If one wants to serve the bulk of the market, it would be very costly to produce the product if it is not suitable for mass production and the selling price would become unnecessary high. Thus it should be taken into account during the design process that the product will be produced in bulk quantities.

The package for the product must be rectangular.
This requirement has to do with transportation and storage costs. For instance if the package of the product would be cylindrical, it would not be stackable at all sides of the package. Thus a lot of space cannot be used although the space must be paid. So in order to minimize costs, especially when it comes to large quantities which are to be shipped or stored, the package of the product should be stackable at all sides of the package in order not to pay for space which is not actually used.

Wishes

The profit margin must be 75% of the selling price or more.
This profit margin is very important to Philips. Philips has a very strict policy when it comes to adding value. But in the end, as the goal of designing this product is to cross the 'chasm', as stated before, it is not desirable that the members of the target market will be deterred because of the price of the product. Completely ignoring Philips' policy would also not be desirable, and for that reason this target is formulated as a wish. An advice to deviate from the standard policy and use a lower profit margin should of course always be backed by strong arguments which should be based on the wishes of the target market.

The selling price of the product should not exceed €600.
The target market consists of people whose income is above average (especially the business people) according to the Dutch CBS, as referred to in the previous chapter. Despite this, from the survey followed that a main reason for not buying a robot vacuum cleaner was the price. That is why this wish to limit the price is expressed. This must clearly be seen as a wish though, because one can question the possibility to meet all the requirements without exceeding the target price of €600. This target price was set at €600 because that price is still not very far above the average robot vacuum cleaner price.

(CLEANING) QUALITY

The cleaning quality must be better than the cleaning quality of similar products currently sold by Philips.
In order to cross the 'chasm', it is very important that the users of the product are pleased with its cleaning quality. As it is almost impossible to measure beforehand whether the majority of the users will indeed be pleased with its cleaning quality or not, this requirement has been formulated differently and more measurable. From the survey results one can conclude that the cleaning quality of similar products currently on the market would be a major reason not to buy this product. This stresses the importance of this requirement. The reason why this requirement is so important is that if the cleaning quality of the product is not good enough, potential customers would stick to their current cleaning products and will not buy this product.

The product must be able to avoid or resist situations which are harmful to people, property or itself.
This requirement is of great importance. If the product is not able to resist harmful situations, it will damage itself, people or their property. This is something which would be unacceptable, so it is very important that the product has the tools to protect itself from harmful situations. This is supported by the outcome of the survey, which shows that especially the members two-person households and singles see the possibility of harming their interior as a major disadvantage of similar products. Besides this, some of the common complaints from users of similar products (mentioned in the paragraph "Market Summary" on page 12) show that these products keep bumping into objects and that they get stuck in cables and other tiny obstacles. These complaints and the survey results show that this is an important requirement.

The product must be able to navigate smartly through its operating environment.
In order to realize a good cleaning quality, the product should not be allowed to skip parts during the cleaning process without any reason. Also the analysis showed that current users of similar products have complaints about the efficiency of their products. For these reasons the product should be able to navigate smartly through its operating environment, in order to clean every spot that can be reached and do so efficiently.

The dimensions of the product should not exceed 100x350x350 (height x width x length in mm).
The product must be able to reach as many places as possible in order to be able to achieve a good cleaning quality. If the size of the product would be too big, it might have difficulties to reach narrow spots or spots below furniture. These are the main reasons for setting this requirement concerning the size of the product.

The product must be able to recognize heights, widths and distances of obstacles and objects in its way.
This requirement is of great importance for the product when it comes to doing its work appropriately. The product should for instance be able to distinguish a chair leg from a wall, otherwise the danger exists that the product skips certain spots during the cleaning process, which would reduce the cleaning quality. Another example would be that when one does not want the product to cross a threshold of a certain height, the product must be able to recognize that height and distinguish it from other objects (cables for instance) with a smaller height. If the product would not be able to do so, it might see a different object as a threshold and quit the cleaning process without finishing it as the product actually should.

The product must be able to gather dirt and debris at a central place.
If the product is not able to gather dirt at a central place, it is actually impossible to achieve a good cleaning quality, as it would then only spread dirt and debris instead of clearing it away. Therefore the product should meet this simple but indispensable requirement.

The product should be durable, such that one can use the product for at least as long as the warranty period under normal circumstances.
This requirement is very important for the maintaining of

the cleaning quality. If the product is not durable, this may affect the cleaning quality after some time because certain functions cannot be fulfilled appropriately anymore. This can be very annoying for the user. This is underlined by complaints from current users of similar products which for instance state that the batteries of these products have a short lifetime. Furthermore, if the product would not be durable enough to last at least for the warranty period, it wouldn't only harm the cleaning quality, but it would also increase the company's service costs related to repairing or replacing defect products.

Wishes

The product recognises different surfaces and adapts its behavior accordingly.
To ensure a good and complete cleaning quality it is important that the product can recognize different surfaces, in order to clean the surface in such a way that the surface is not harmed. This might require reliable techniques which are currently not yet available, for example the ability to reliably distinguish carpets from hard floors in the context in which the product will be used. On the other hand current users of similar products have complaints about the fact that these products do not clean carpets as they see them as an obstacle. For this reason this ability of the product to recognize different surfaces is formulated as a wish.

USABILITY

Under normal circumstances the product can operate autonomously for 7 cleaning sessions.
This requirement has to do with the goal of saving time for the product's user. Nowadays many people are very busy and lack lots of time, and are therefore not able to do everything they would like to do. The product should be able to operate autonomously in order to really save the user time and increase usability. This autonomy involves for instance that the user does not have to clean the product after each cleaning session by throwing dirt away, which is inconvenient for the user. The importance of this requirement is also stressed by the fact that the survey respondents indicate that a major advantage of buying the product would be the ability of the product to save them time, which they than can invest in other activities.

One should be able to use the product without reading an elaborate user manual.
It is very important that the product is easy to use. If there are too many complicated matters to which the user has to pay attention regarding the product, the user might not get the impression that the product really saves time. As time-saving is an important goal of the product, this requirement should be met in order to give the user a product which is as easy to use as possible and thus really saves the user time.

The product's behavior should be adjustable to one's preferences, such as starting time and cleaning mode.
In order to increase convenience and autonomy, it is required that one can communicate its preferences to the product. This is important because within the target market there will be many potential customers, who all may have different preferences when it comes to cleaning. For this reason there should be some possible customization of the products behavior.

Wishes

The product's noise level should not exceed 70 dB.
One of the complaints of current users of similar products is about the noise these products make. As a low noise level is not a main focus point for the product this statement is formulated as a wish. An average vacuum cleaner has a noise level of 70 dB, so it would be desirable to at least not exceed this level in order to increase convenience for the user, for example when the user watches TV during the cleaning process.

Design Process

In this chapter the design process will be described. The result of the design process was a provisional concept, which was presented to Philips in a milestone meeting. The final concept will be described in the next chapter.

As described earlier, the design process started with analysing the market, developing a marketing strategy and conducting a survey. From this a statement of requirements followed. Besides that a morphologic scheme was created, which can be found in Appendix B. From this morphologic scheme the ideas which were considered to be the best ideas (with the statement of requirements in mind) were selected and put together in such a way that they were complementary with eachother. It would be too elaborate to explain every single decision, and for that reason the most important decisions will be explained here. These most important decisions can be divided in three stages. In the first stage the decision whether to make use of dry or wet cleaning was made. In the second stage it was decided whether the robot should integrate or seperate several functions. The third and last stage was about the way of cleaning. For all these stages the options will be described and it will be argued why a certain option has been chosen.

STAGE 1 - DRY OR WET CLEANING

There were three options in this stage:

- Only vacuum cleaning. (1.1)
- Vacuum cleaning and mopping the floor. (1.2)
- Only mopping the floor. (1.3)

Sweeping was not an option for dry cleaning, because the cleaning quality is not good enough if the floor is only swept. As the results of the survey showed that the user wants to save time and wants a good cleaning quality, the decision was made to combine dry and wet cleaning (1.2). This ensures that the user does not have to either mop or vacuum the floor because the robot cannot do it for the user.

STAGE 2 - INTEGRATION OR SEPARATION

After the choice was made that the robot vacuum cleaner will have two functions, vacuum cleaning and mopping, it had to be descided how the robot vacuum cleaner is going to combine these functions. The following options were considered:

- Two seperate robots for vacuuming and mopping and two complementary docking stations, one for each robot. (2.1)
- One robot for vacuuming, one robot for mopping and one docking station for both these robots. (2.2)
- A robot which integrates vacuuming and mopping and one docking station for this robot. (2.3)

The reason that a docking station was added to the robot had to do with the requirement to make an autonomous robot. With a docking station this is more likely to be realised than without, for instance because the robot vacuum cleaner can recharge itself automatically. In order to make a good decision for this stage, a few points that have an influence on the choice were considered:

- The robot vacuum cleaner should really save the user time, as follows from the survey and as implied by the statement of requirements. Having several docking stations and robots implies that the user will have to spend more time maintaining the product. Besides that, it will also increase material and thus production costs and thus the selling price. These consequences are not desirable, as follows from the statement of requirements.
- On the other hand, the robot vacuum cleaner needs to deliver good cleaning quality, as many requirements imply. One robot for each cleaning function might improve the cleaning quality but creates additional parts.

With these points in mind the decision was finally made to choose the option of designing one robot which integrates both vacuuming and mopping, and a complementary docking station for this robot. (2.3) The cleaning quality is of course very important, but it cannot be taken for granted that the other two options will finally provide a better cleaning quality. On the other hand, one can be sure that the chosen option will at least involve less material costs, and this option is also much more likely to save the user time than the other two options.

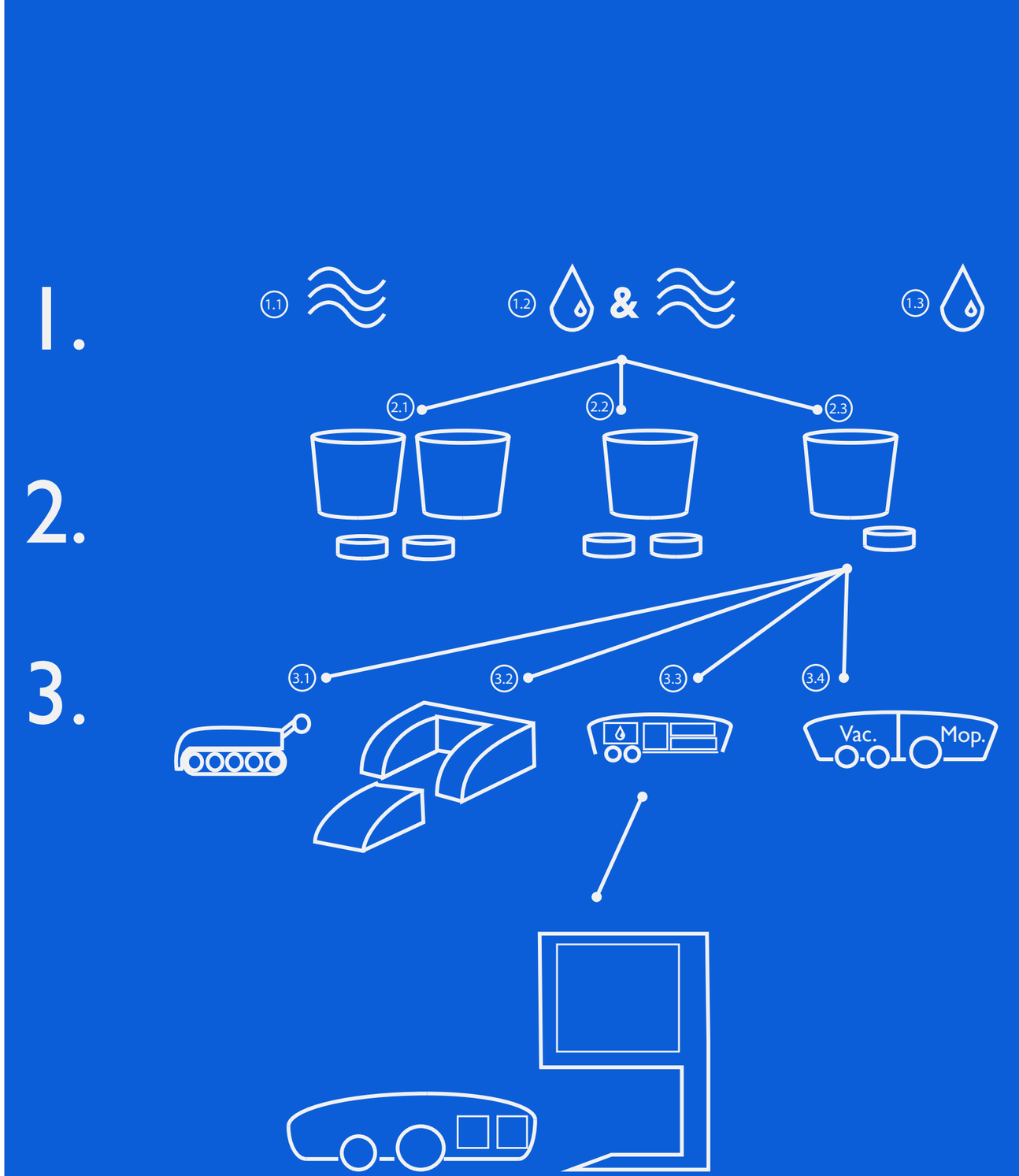
STAGE 3 - THE WAY OF CLEANING

Now that it is clear that there will be one robot that can vacuum and mop, the question remains how it will be done. It is important that the integration of vacuuming and mopping works well, because the two functions should not interfere with each other because that might damage the surface. Four options were considered in this stage (all of them have complementary docking stations which are not displayed in the drawings):

- A robot with a rotating brush at the back with which it can mop the floor, so that after it is done with vacuuming it pushes the brush on the ground and starts mopping. Besides that the robot has caterpillar tracks, in order to be able to pass small obstacles. (3.1)
- An extension for the robot with a mopping function. The small robot can vacuum and when it needs to mop it picks up its extension. (3.2)
- A combination of wet and dry. The robot vacuums and then mops right after finishing vacuuming without having any extensions. All the dirt will be collected in one compartment. (3.3)
- Full separation of both the functions in one robot. There is one compartment for the dirt collected while vacuum cleaning and one compartment for the wet dirt collected while mopping. (3.4)

Basically all of the options in this stage can deliver good cleaning quality, as required by the statement of requirements, but not all of the options are efficient. The rotating brush at the back of the robot (3.1) will require a lot of power to push the brush on the floor while mopping, due to its location. It would also be complicated to collect the dirt from this brush.

The second option, an extension for the robot with a mopping function, is also not the best option. It may be difficult to navigate through the house when the robot



has to carry a large extension with it. Besides that, the integration might be lost, because the extension can be considered like a second robot (which is not desirable as explained before), the only difference is that the second 'robot' can form one big robot together with the first one.

The last two options are full integration or full separation of the two functions within one robot. These two robots have their mopping part at the bottom of the robot. In this way it is easier to put pressure on the mopping part, so that the mopping quality will be better. The drawback of the fourth option is that it requires a more complicated docking station, because two types of dirt have to be taken out of the robot, so it would be more efficient to store all the dirt in one place. For this reason the choice was made to design a robot with full integration of both vacuum cleaning and mopping. (3.3)

SWEEPY

After these decisions had been made a more detailed concept which is complementary with the statement of requirements was created. This concept was named "Sweepy".
The shape of Sweepy is a very dynamic shape with a clean and modern style. At the back of Sweepy there is a little "tail" so you can see in which direction it is moving. It also creates a pet-like look that emphasizes emotion towards the robot. The outside layer of Sweepy is a rubber case. This has a few benefits.

- It is easy to clean. You can take the rubber case of, clean it and then put it back on the robot.
- Not only does it give protection to the robot itself but it also makes the design look more like one entity.
- Because it is made of rubber it prevents the robot of getting scratches or the furniture when the Sweepy is driving too close to objects in the room.
- One can customize the robot easily by simply changing the case of the robot.

The style of the docking station matches with the style of Sweepy. It has a simple round shape with the appearance of a futuristic garbage can.

THE TECHNICAL DETAILS

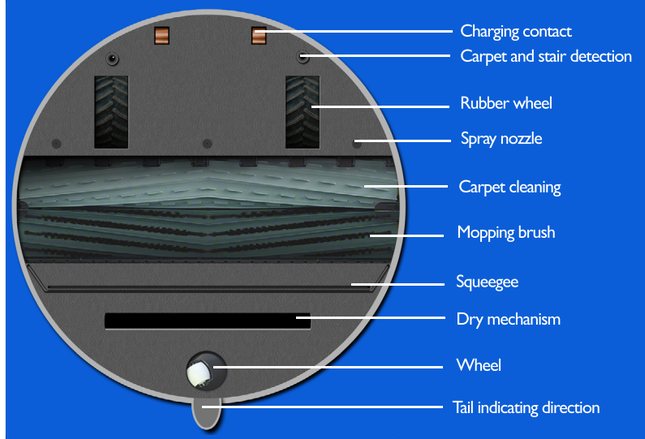
In Figure 3, Figure 4 and Figure 5 the bottom and the inside of Sweepy are visible, as well as the docking station and a scene of Sweepy and the docking station.

Figure 3

Charging contact: In the front of the robot there are charging contacts so it can charge while it is in the docking station.
Carpet and stairs detection: With these sensors the robot can detect stairs or other things it could fall off. With the carpet sensor it can detect what kind of floor it is driving on. If it is driving on a carpet it switches the mopping function off so that it would not make the carpet wet.
Rubber wheel: It uses rubber wheels to drive forward. The grip of the wheels is increased because the wheels are made of rubber.
Spray nozzles: The spray nozzles spray the clean water from the robot onto the floor.
Carpet cleaning: This is a special brush to clean carpets and create a strong airflow.
Mopping brush: A brush that mops the floor with the water from the nozzles.
Squeegee: This part collects the dirty water from the mopping process which is then sucked up from the floor so the floor does not stay wet.
Dry mechanism: The dry mechanism dries the water that still remains on the floor after the vacuum cleaner and the squeegee did their work. It uses the air that comes out of the motor.
Wheel: This is a small wheel in the back that can rotate freely. This way the robot is not scraping the floor and it will be able to navigate better.
Tail: This is the tail of the robot so one can see in which direction it is moving. It does also give more emotion to the product.
Bumper: If the distance sensor does not see an object then the bumper makes sure that the robot feels the object and does not keep bumping into it.
Computer: The microchip that manages software, sensors and actuators.
Bumper sensor: The bumper sensor detects when the bumper collides into something.
Wheel: This is the same rubber wheel as described before.
Electric motor: This electric motor drives the wheels of the robot.
Accu: The accu powers the electric motor and the sensors and chips.
Airflow guidance: A small "chamber" where the air and the dirt go through.
Vacuuming motor and filter: This is the motor that is being used for the vacuuming.
Water and detergent: This is the part where the clean water is stored.
Dirt storage: This is the part where the dirt and the used water is stored.
Refill opening: This is the opening where the docking station connects to the robot so it can fill and empty the robot.

Figure 4

Infrared sensor: The infrared sensor checks if Sweepy approaches the docking station. The docking station prepares the filling- and emptying process.
Pump: The pump sucks out the dirty water out of the robot into the dirt storage and pumps the clean water into the robot.
Dirt storage: The dirt storage is the compartment where the dirty water is placed, at the other side of the dirt storage is the clean water storage.
Refill tube: The refill tube is the tube that goes into the robot. The dirt and clean water go through the tube into the docking station and/or robot.
Charging point: The charging points are the points that connect to the charging contacts from the robot.



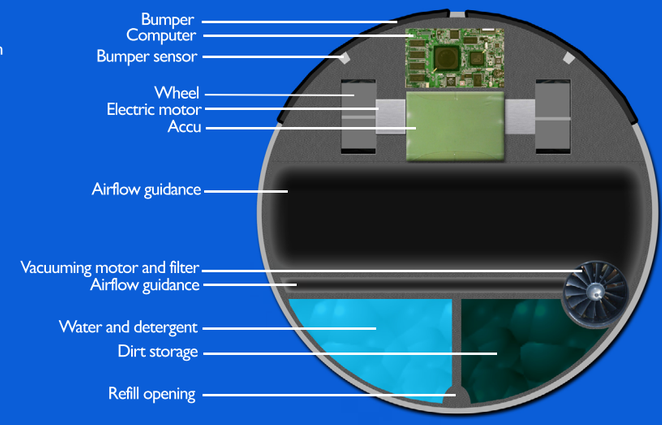


Figure 3: Sweepy bottom view (left) and section view (right)

The docking station can empty, refill and recharge the robot. The compartments are releasable so it is easy to empty and refill the docking station once the dirt storage is full or the clean water compartment empty.

Figure 5

Refill point: This is the point which connects to the docking station and where the dirty-water storage gets emptied and the clean water is refilled.
Camera: The camera at the top of the robot vacuum cleaner is used for smart navigation through the room.
User interface LED icon: The buttons that light up so you can control the robot directly.
Soft rubber: The rubber case over the robot to protect the robot and give it a more personal style.
Distance sensor: The distance sensor makes sure that the robot does not drive into objects in the room.

Sweepy is a smart robot which can adjust its settings to his environment. It has a clean and swift appearance and it can deliver a good cleaning quality and is able to do its job right.

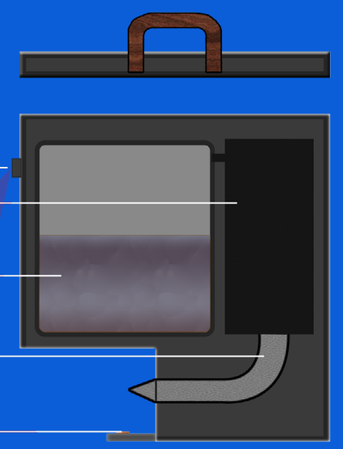
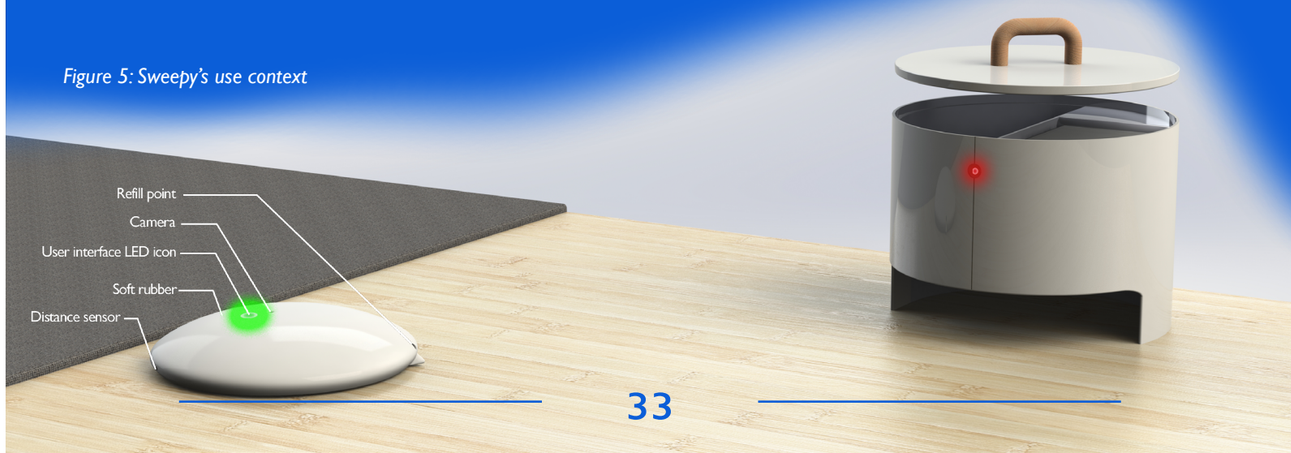
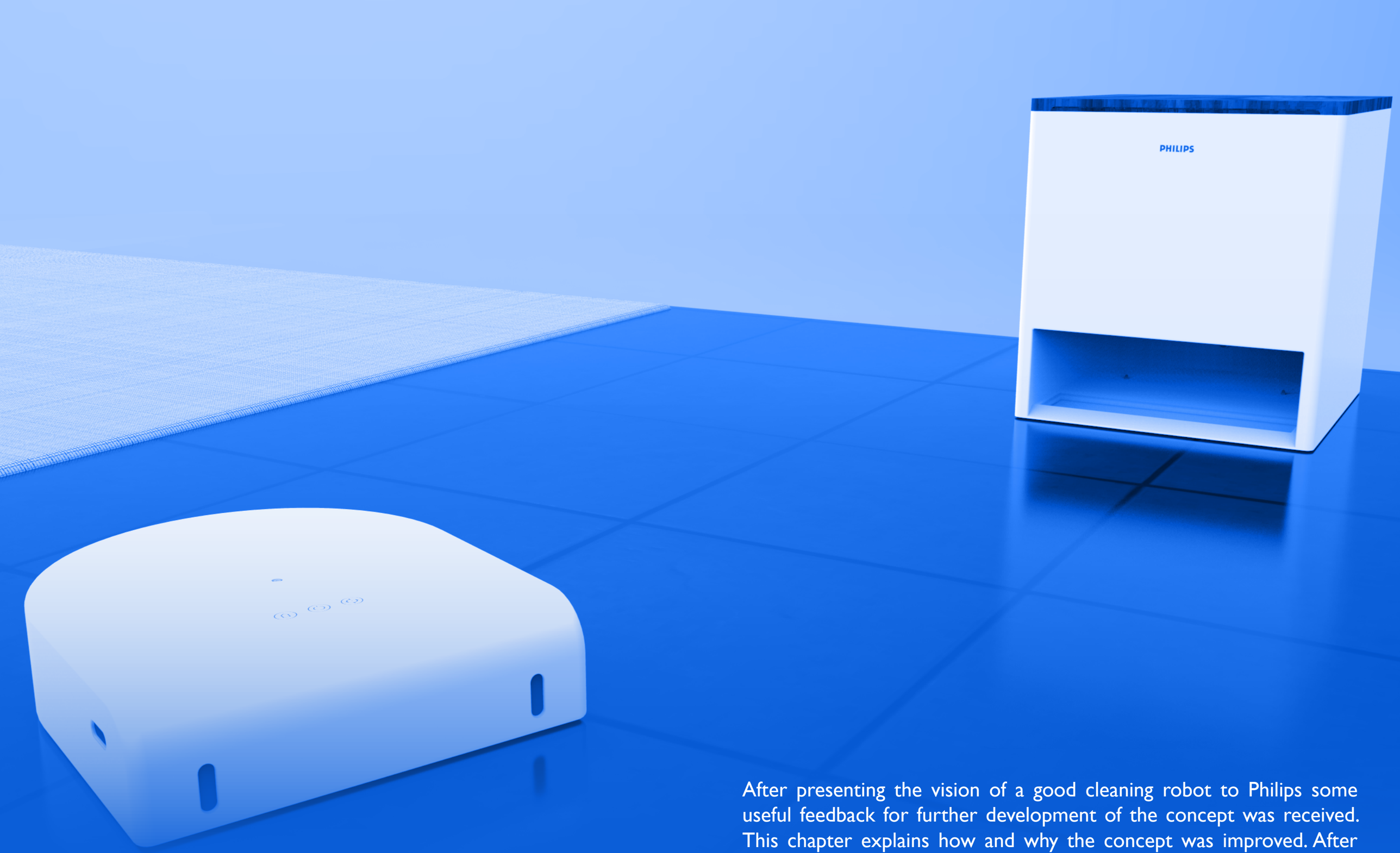


Figure 4: Docking station

Figure 5: Sweepy's use context





Final Concept

After presenting the vision of a good cleaning robot to Philips some useful feedback for further development of the concept was received. This chapter explains how and why the concept was improved. After that the final concept will be presented, consisting of Sweepy, a docking station and a mobile application. Besides that also the appearance of the package will be described.

FEEDBACK PHILIPS

Form
The round shape of the robot results in two main problems. Firstly while moving around the robot can easily get stuck under furniture when distance sensors do not notice the obstacle. Secondly it would not be possible to reach and clean corners.

Carpet Cleaning
Due to the mopping option the robot possesses a mopping-brush. After some wet-cleaning cycles the brush might be dirty in such a way that they would still be sufficiently clean for hard floor cleaning but inappropriate for carpet cleaning.

Roughness sensor
Optical and mechanical roughness sensors do already exist. But they have not yet been used the way they are intended to be used in the concept. This requires development which costs extra money. The use of such a sensor and its realisability were conceived legitimate.

Rubber coat
The cover of the robot which is made out of rubber was perceived with interest. The advantages of a customizable look of the robot, which ensures protection and drives emotional connection are promising.

The improvements that were made are explained in the following text together with the rest of the concept.

FINAL CONCEPT

For a better understanding the whole concept will be explained in a few words.
The final concept consists of three main products:

Sweepy, an autonomous cleaning robot
A docking station
A mobile application

The main function of the robot is to navigate smartly through a room while collecting dirt and leaving a clean floor. It does this by vacuuming, mopping and drying. It recharges its batteries and empties its dirt tank autonomously by connecting with the base station. The base station supplies the robot with fresh water and detergent, gathers dirt in a dirt tank. Additionally it recharges the batteries of the robot.
The mobile application allows the user to schedule and control the behavior of the robot independent of his or her location. For a more direct control there is still a user interface on the robots exterior.

The visualizations of the robot and the station shall give a rough impression of the parts that are required, their----relative positioning and their functions. The parts are conceptual and do not implement optimal manufacturing or assembly. The colouring/transparency of some internal parts has been chosen to ease the understanding and not because of intended material choice if not stated otherwise.

Figure 6: Sweepy in the docking station

SWEEPY

Figure 9, Figure 10 and Figure 11 show Sweepy's parts.

Form
As a consequence of the feedback from Philips the basic form of the robot was changed in order to avoid that it could possibly get stuck under furniture. This was done by thickening the shape in such a way that a flat surface forms the top side of the robot.
Also the round shape prevented it from cleaning corners properly. So the initial shape was replaced by a combination of a rectangle and a half circle. The brushes are placed in the rectangular front while the wheels are situated in the rounded back. This change has several advantages. The placement of the brushes now allows corner cleaning. With its rectangular front the robot can easily reach corners of 90 degrees or more. The rounded back ensures that turning around its center without touching any walls or furniture is possible. Because of the new arrangement of the brushes the robot requires extra grip to the floor to handle the effect of the turning brushes. Caterpillar tracks were added to provide full steering control. This also results in the positive effect that the robot now can easily handle obstacles such as cables or carpet borders.

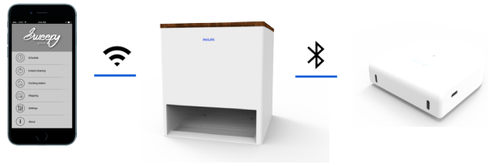


Figure 7: Communication

Communication Sweepy - Station
Sweepy owns a bluetooth module which is connected to its PCB (printed circuit board). This enables it to communicate with the station within a radius up to 15 meter. Sweepy can receive remote commands and can send data to the station. A direct bluetooth connection of the robot and a mobile phone is not possible to prevent errors. The users phone communicates with the station and the station with the robot.

Figure 8: User Interface

User Interface
The user interface consists of a mobile application and three buttons on top of Sweepy. The application offers many possibilities and gives the user full control of Sweepys behavior. For detailed information about the application read the paragraph "The Application" on page 46. The user interface on top of Sweepy makes it possible to interact with the robot without using a smartphone. The icons on the rubber coat are back-lit by some blue LEDs to make them visible and match the style of Philips. The functions of the three buttons are:

1. *Return to the station:* Sweepy stops with what it was doing, returns to the station and waits for the next scheduled task or command.
2. *On/Off:* Sweepy is completely switched off.
3. *Spot cleaning:* The robot can be carried to a dirty spot by its user. When the button is pressed the robot cleans this specific spot in a spiral movement. It then continues its normal cycle.

Navigation
Sweepy is able to navigate smartly through its environment. It avoids bumping into objects and collects data about its surroundings using the camera, a gyro sensor, an accelerometer and eight infrared sensors. The camera constantly films the ceiling. This allows the robot to locate itself and provides valuable data for the creation of a virtual map (location of doors, walls, tables, sofas etc.)
The gyro sensor is attached to the PCB of the robot and measures its angular movement for three axis. Together with the accelerometer it is possible to gather precise data about the position of the robot itself and its inclination.
Eight infrared sensors constantly measure their distance to objects. Four of them are placed under the bottom to measure the distance to the ground. They are placed in such a way, that neither the brushes nor the caterpillar tracks would go over a deep borders. They basically prevent the robot from falling down stairs. The other four infrared distance sensors measure the distance to objects such as walls, table-legs, cupboards etc. Two of them scan the front and the others are placed on the sides. This allows wall following and thus systematic cleaning. The data of all sensors is combined to create a virtual map of Sweepys operating environment.
With this map in mind the robot can easily calculate the most efficient cleaning strategy!

Carpet Detection
Philips feedback on the carpet sensor, which was part of the old concept, led to further research. Its function was to detect rough carpets to better control the wet cleaning process and to prevent users from wet carpets. Optical roughness sensors currently are very precise and not optimized for floor detection.[1] Mechanical/tactile sensors tend to be vulnerable to errors because they depend on the relatively harsh movements of the robot and require constant floor contact.
The additional cost and development time of a roughness sensor made it inattractive for its purpose. A different floor detection concept to prevent wet carpets was developed:
The robot's cleaning cycle starts with dry vacuuming. At this stage it can go over any kind of floor and any kind of obstacle without the risk of making any carpets wet. It uses the vacuuming cycle to explore its environment and to detect irregularities in the floor heights from 0.5 cm up to 5 cm high. It does this by using the information of the gyro sensor and the accelerometer when it rides over

1) Hohner Corp., 2008, Optical Sensors, http://www.instant-analysis.com/Data-Sheets/Rg/331.htm, accessed 10 Jan. 2015

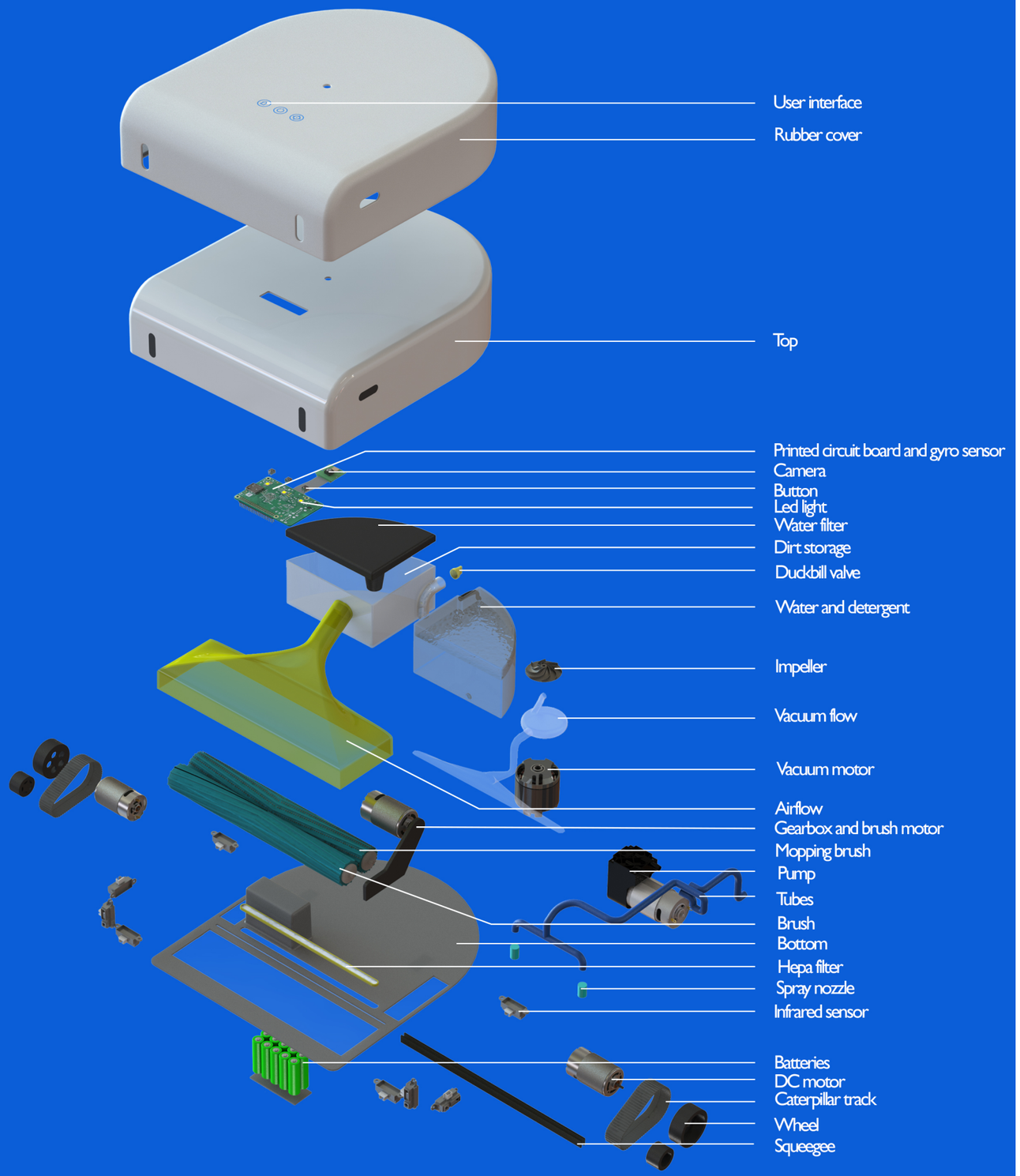


Figure 9: Exploded View of Sweepy

low obstacles. With the detected inclination it calculates the height of the object it just crossed. Those obstacles are added to the virtual map. At this point the robot cannot decide whether these obstacles were carpets or other irregularities (tiles, cables, small edges, etc.). Assistance is needed in deciding where the ground may get wet and where it should not. The virtual map including the potential carpet obstacles is send to the station via bluetooth. The station sends this data to the mobile application via the wifi connection. The user now can interact with the map and provide the robot with the information and restrictions it requires. In the paragraph "The Application" on page 46 this feature is explained in-depth.

Mopping

When the virtual map feature allows it, Sweepy is able to mop the floor. The parts which are important to this process and their function will be explained.

Fresh water in combination with a non foaming detergent is stored in the water tank. A pump sucks water out of this tank and guides it through flexible tubes to the nozzles which spray a fine mist of fresh water on the ground.

The robot possesses two brushes. One is a simple brush, the other is a mopping brush with small rubber filaments. Both of them are made of rubber and have triangular grooves. Because of their specific form, the choice of their material and their narrow placement relative to one another, a strong suction can be created when the brushes are turning. Also unlike other brushes they lack long filaments. This choice has been made to prevent dirt particles or hair from getting stucked. The mopping brush uses its small rubber filaments to get resistant dirt off the ground more effectively. All of those characteristics make the brushes robust, effective and easy to clean. In case they need to be replaced they can easily be removed by levering the brush clip.

The opening parallel to the brushes is surrounded by two squeegees. If there is any water left on the ground it will be trapped and sucked up.

All the water and the dirt are guided through the yellow airflow guidance. Finally the dirt is gathered in the dirt tank. The cyclonic water filter system then separates the air from the dirt. The tank can contain about 0.5 l of dirty water. A comparable part can be found in the Aquatrio made by Philips.[1]

A vacuum motor creates a strong vacuum to suck the clean air out of the dirt tank. This vacuuming force in combination with the suction of the brushes assures a strong cleaning power. The flowing air is finally guided through an exchangeable HEPA-Filter. Fine particles of dust that were able to escape the water filter are trapped. When the suction appreciably decreases, a notification is sent to the station and finally to the user's application that the filter needs to be replaced/cleaned.
The longish form of the filter assures that a smooth and warm airflow evenly blows along the humid floor and accelerates the drying process.
Once the water tank of the robot is empty, it returns to the station for a refill. The refilling/emptying process is described on page 43.

Vacuuming

The vacuuming cycle essentially works the same as the mopping cycle. The main difference is of course that no water is sprayed on the ground. In this case the cyclonic water filter system also should be able to work. This is possible because the dirt tank always contains a certain amount of water to assure full filtering. After the self cleaning process (page 43) some water stays in the dirt tank on purpose for this reason.

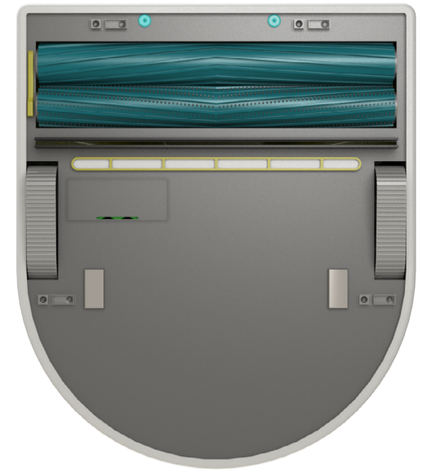


Figure 10: Bottom-view of Sweepy

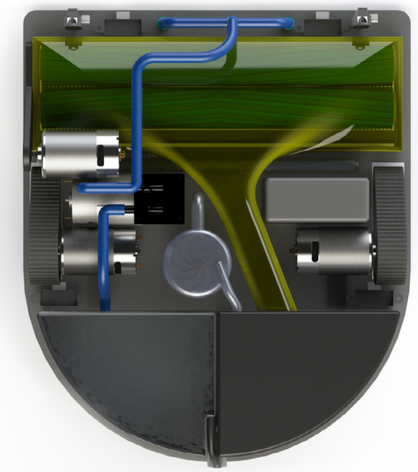


Figure 11: Cross-sectional view of Sweepy

1) See: http://www.p4c.philips.com/cgi-bin/dcbint/cpindex.pl?slg=en&scy=it&ctn=CRP252/01

3D-MODEL OF SWEEPY

THE STATION

Communication

The docking station uses a bluetooth module and a wifi module to communicate with the robot and with the application.
For more information about the communication with the robot read the paragraph "Communication Sweepy - Station" on page 37.
For more information about the communication with the application read the paragraph "Communication Application-Station" on page 46.

Figure 12: Water and dirt storage

Storage

The station contains a storage for fresh water and one for dirty water.
The fresh water reservoir can contain up to 13 liter of water and detergent. The user is advised to add a certain amount of his or her favourite detergent, as long as it is not foaming.

A capacitive level sensor constantly measures the level of the water (Figure 14). The sensor consists of two long parallel metal bars that are connected to a low tension electric circuit. Capacitive sensors are simple, cheap and do not make use of any moving parts, which makes them ideal for this purpose.
When the water level is too low the internal software of the station sends a short reminder to the mobile application.

The dirt container stores the dirty water that has been collected by the robot. It is made of two parts: The body and the lid. A black rubber sealing around the opening makes the container tight. There are two holes in the lid. The big one allows dirty water to enter. The small one is used to create a vacuum inside the container using the vacuum motor. This negative pressure is used to suck the dirty water out of the robot. The dirt container has a volume of 5 liter which is enough for 10 complete emptying cycles (0.5 liter per full dirt tank x 10 = 5 liter). 0.5 liter of used water equals a mopped surface of about 42m^2. So the dirt container only has to be emptied after a mopping surface of 420m^2. This data has been estimated by comparing Sweepy to the average water usage of the Aquatrio of Philips.[1]

Once the dirt container is full, the user has to unplug and remove it by pulling it by its handle.
The clear plastic makes it easy for the user to estimate the weight of the container so that the right amount of force can be applied without accidentally pulling to hard. The lid can easily be removed by pulling the big yellow snap hooks apart. When the container has been emptied and rinsed by the user, the lid should be put back on. Then

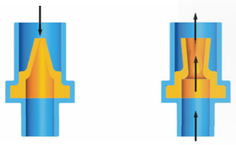
1) http://www.philips.de/c-p/FC7070_01/aquatrio-dampfbesen/technische-daten

Figure 13: Dirt container

the container has to be reconnect to the the station. This is done by slowly putting the container in its place and reconnecting the tubes to the holes.

Emptying, Refilling, Recharging

The robot measures the amount of water that it sprayed on the ground by measuring the operation time of its pump. When the calculated amount of water exceeds the 0.5 liter maximum fresh water capacity the fresh water tank is considered empty and the robot automatically returns to the station. Due to the smart navigation features the robot knows the position of the station and its relative position to it. By driving backwards it reverse-parks in the opening. The infrared sensors on the sides ensure accurate positioning.
At this point the opening in the back of the robot is precisely connected with one another.
The big dirty-water tube of the station fits on the slightly drafted counterpart of the robot.
The small pointed fresh water tube of the station fits inside the counter opening on the robot. To make sure that the robot is in place it checks whether all infrared sensors detect the right distance which is associated with the perfect parking spot. Also at this position the electrical charging contacts of the robot should detect a low tension because of their connection to the recharge points. Those two conditions need to be true before it continues.
To make sure that all the connections fit tightly the robot makes use of the high grip of its caterpillar tracks and pushes itself against the connection tubes for a moment.
At this stage a sealed connection has been established. The robot contacts the station via bluetooth and the refilling/emptying cycle starts.



The dirt is sucked through two duckbill valves into the dirt container. The duckbill valves operate as check valves. They prevent any dirty water from flowing back into the robot or on the ground of the station. In the CAD-model of the robot and the station they are both colored yellow. They are the cheapest, easiest and most effective valves for this purpose compared to many other check valves. They do not make use of any moving parts which are often prone to wear and rely on a simple principle. They also guarantee a high flow even for chunky dirt parts due to their relatively big diameter when opened.

Fresh water is released by the activation of a small pinch valve. This valve can block a flow of liquid by simply pinching a flexible tube. Then gravity pulls down the water and refills the fresh water tank until its completely full. The pinch valve blocks the flow again when the level sensor in the water reservoir of the station detects a discharge of 0.5 liter.

Of course electric recharging is a risky operation next to a water tank. Taking into account this danger, the electric contact points were placed relatively far away from one another. They are also surrounded by a plastic ring of 10 mm height. In case of a leakage this should lower the risk of a short circuit. Sweepy autonomously connects to the charging points when its battery level drops under 15% or when it's waiting for new commands.

Self Cleaning

To enable the robot to clean carpets and hard floors with a clean brush an easy brush cleaning method has been added to the station. It consists of a groove at the bottom of the station. After each refilling-/emptying cycle a brush cleaning process takes place.
Via its spray nozzles the robot sprays a reasonable amount of clean water into the groove. Now the robot simply turns its brushes to suck up the fresh water to free them from potential resting dirt. Additionally that flow of fresh water cleans the robot internally and rinses the dirt tank. The water will stay inside the robots dirt tank until the next refill/empty cycle. The water assures a good functioning of the water filter which is especially important for dry vacuuming.

After a certain drying time the robot is good to go for another vacuuming or mopping cycle.

Figure 14: Level Sensor and Self-Cleaning Groove

Figure 15: Refill/Empty opening

3D-MODEL OF THE DOCKING STATION

THE APPLICATION

The app for Sweepy will be available for free for Android, iOs and Windows. With the app the user can change the settings of the robot to his or her preferences. One can set a time schedule for the week or let the robot start cleaning immediately independent of the users position.
After opening the app a short loading screen is displayed. Then a main menu shows up which gives a quick and simple overview of the functions

Communication Application-Station
The station of the robot uses a wifi connection to communicate via internet with the application. But before the first use the station doesn't know which wifi network and which password have to be chosen. The application takes care of this problem. The user has to download the application and open it. The app automatically establishes a bluetooth connection with stations that are around. When a new station is found it's added to the apps inventory as a new docking station. Now the app offers the possibility to choose the right wifi network and to enter the matching password. After a few seconds the internet connection of the station has successfully been set up.

Docking station
With the docking station feature you have the ability to select the docking station that you want to control if you have more than one. Each docking station can be programmed independently.
For example, if the robot is placed upstairs it automatically recognises the other docking station and adjusts its cleaning behavior to its specific schedule.

Schedule
With the schedule you can choose at what day and what time you want the robot to clean. You can for example make different schedules for working days the weekend or the vacations. This way you can easily change the settings to the way that fits you the best.
Of course, one can also choose whether the floor should be mopped or simply vacuumed.

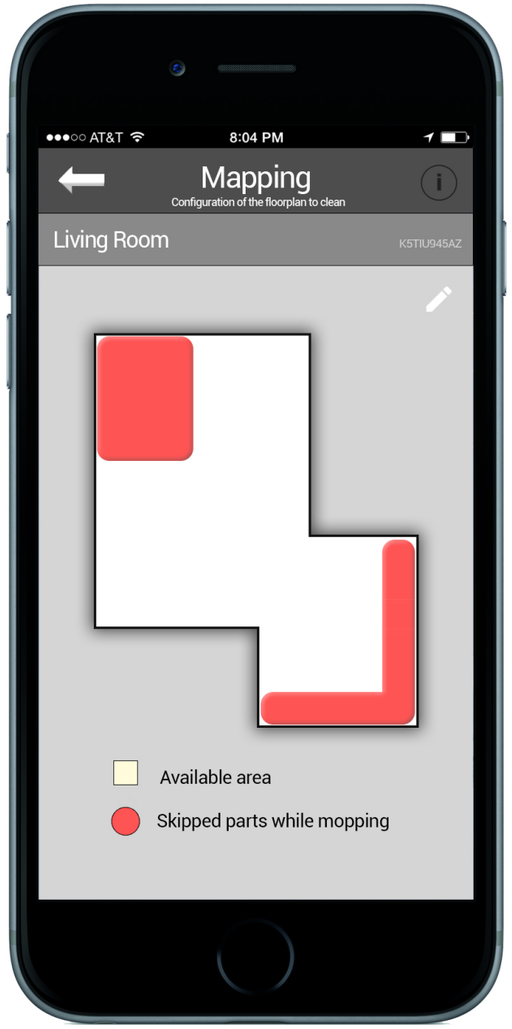
Turning device on
With "turning device on" you can immediately run Sweepy without changing the schedule. You can also choose to sweep and or mop.

Mapping
The robot uses a smart carpet-avoiding system for its mopping cycle. This feature uses the Virtual map. As already explained the robot can't decide whether small obstacles in its way were carpets or other irregularities (tiles, cables, small edges, etc..). Assistance is needed in deciding where the ground may get wet and where it shouldn't. So the application provides an interactive version of the robots virtual map. The user can see a automatically generated 2D map of Sweepys environment. Some areas are colored red and some are colored white. Red areas are obstacles which the robot will avoid. White areas represent places where the floor can be mopped. One can now simply press red places to make them white.

This gives the robot permission to mop those places. The user itself can also add red areas to the map to protect surfaces the robot didn't recognize as "unmoppable" in the first place. For example: Carpets that are on the same level as hard floors, Sensible hard floors. This way the user can also virtually close door entries by adding black boundary lines.
The user can save and adjust those mopping instructions/ virtual maps at any time thanks to the internet connection of the station.

Settings
This option allows the user to turn on/off the wifi connection the station uses.
Realtime notifications can be turned on or off.
The language can be set to the users preferences.

About
This shows info about the app like the version and the last updated version.



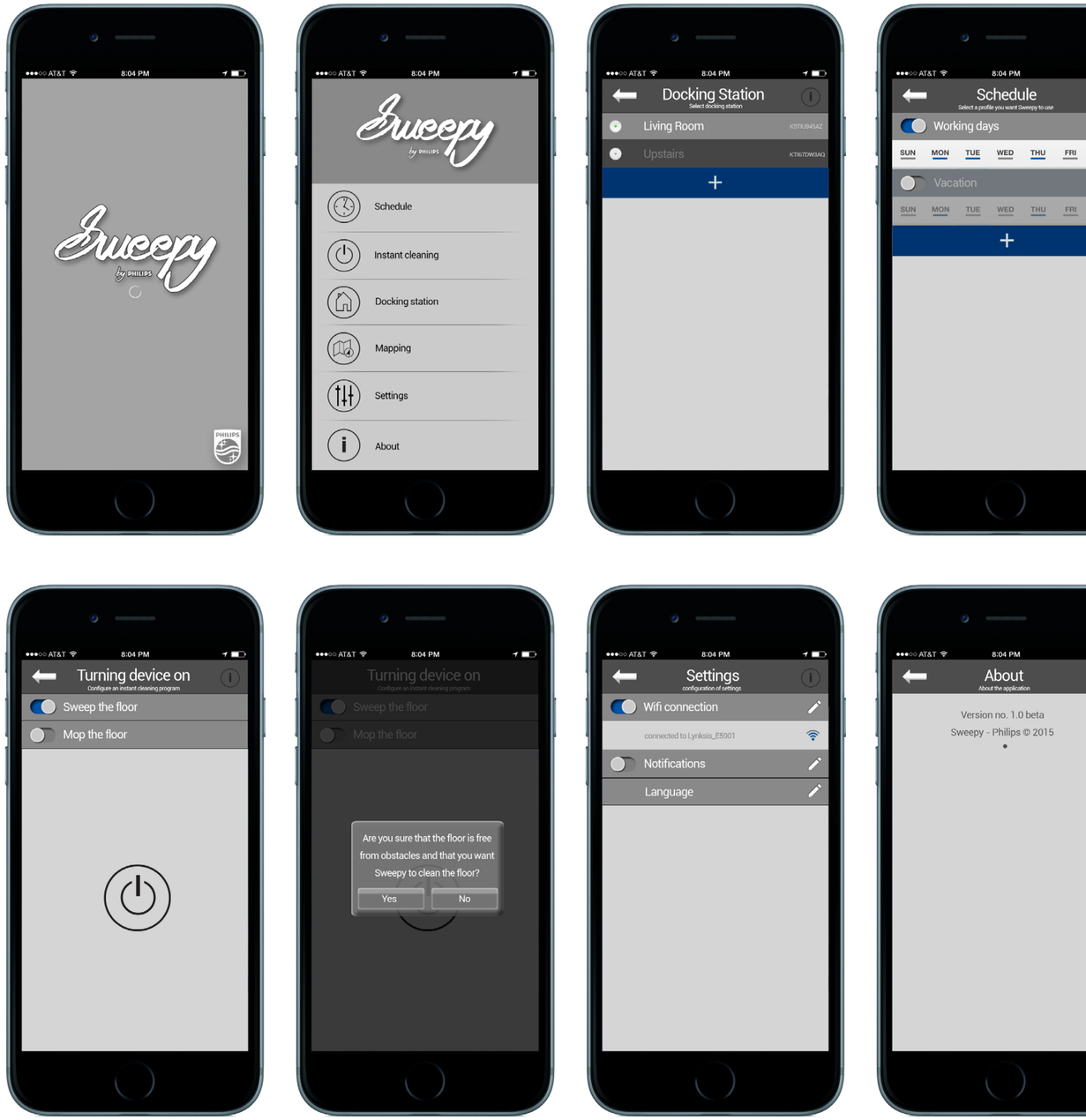


Figure 16: Mobile application

THE PACKAGE

The size of the package is 40 cm by 60 cm by 42 cm. Those dimensions assure that 8 packages fit on a standard euro-pallet (80cm*120cm). During transport, the robot is placed in the docking station. The space between the package and the docking station will be filled with styrofoam.
The front of the package displays Sweepy and its docking station. To the left the useful features of Sweepy are summed up. The unique selling point is: No. 1 time-saving solution.

Also the slogan of Sweepy is placed on the front of the package: "Cleaning up your time!".
At the side of the package different colored versions of Sweepys exchangeable rubber cover are displayed . Also the specifications of Sweepy are mentioned. Furthermore, a picture of the bottom of the robot and an insight into the opened station give the customer a good impression of what this product consists of.

PHILIPS

innovation you

Possibility to add colourful covers

Specifications:

Design
Exchangeable Cover: Different colors

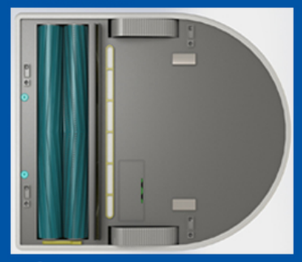
Usability
Cleaning modes: Spot Cleaning, Vacuuming, Mopping
Application: Wifi Connection, Personal Schedules, Virtual Map Assistance, Real time Notifications
Recharging: Autonomously
Refilling and emptying: Autonomously
Brush cleaning: Autonomously
Guarantee: 5 years

Performance
Navigation method: Systematic Cleaning Pattern, Virtual Map Assistance
Cleaning speed: 50m^2 per hour
Movement: 2 Crawler tracks
Autonomous Mopping Space: 850m^2
Autonomous Vacuuming Space: 4000m^2

Weight and Size
Robot: 350*85*305
Station: 400*400*360
Water Storage: 13 Liter
Dirt Storage: 5 Liter
Robot Weight: 4.5 kg
Station: 3.5 kg

Cleaning
Filter: Water Filter, Hepa-Filter
Brushes: 1 Scrub Brush, 1 Assistent Brush
Nozzles: 2 Spray Nozzles
Drying: 2 Squeegees, 1 Dryer Opening

Brushes



Dirt storage

innovation you

0 123456 789012

PHILIPS

innovation you

The ultimate autonomous and time-saving solution, due to:
- Spot cleaning
- Vacuuming
- Mopping
- Mobile application
- Autonomous docking station

No.1 time-saving solution!*

"Cleaning up your time!"

Sweepy by PHILIPS

Financials & Controls

When introducing a new product to the market, one is of course interested in the financial side of the story. Therefore, this section contains an estimation of Sweepy's cost price and its the first-year sales. Besides that a marketing budget will be set and a break-even analysis will be performed. Furthermore, this section explains how Philips' management can control Sweepy's introduction to the market by monitoring the objectives which were set in the marketing strategy.

COST PRICE ESTIMATION

Figure 17 contains a rough estimation of Sweepy's cost price. This estamition is based on a comparison of Sweepy's features with features of two robots from Philips' competitors Samsung and Irobot, from which the cost price is known. It has been taken into account that the two robots used for the estimation of Sweepy's cost price are already a few years old, and that in the mean time technologies have improved so that some parts can be produced for a cheaper price than before. Besides that the website from the Chinese company Alibaba has been used to estimate the price of certain parts of Sweepy, costs of machines in order to estimate fixed production costs, transportation costs and to verify the estimations based on the comparison with the two robots mentioned before.

Plastic costs for Sweepy will be higher, as Sweepy comes with a docking station which is larger than the docking stations of the two other robots. This causes the finishing costs to increase as well. Sweepy contains slightly more metal than the other two robots. The motors can be bought for a cheaper price, but Sweepy has more motors than the other robots. As the brushes are a little more complex, it is estimated that they will be more expensive as well. Sweepy contains a littlebit more wiring than the compared robots due to the docking station, so these costs also will be higher. The electronics will be about the same price as the Samsung robot. Sweepy contains about the same amount of sensors as the Samsung robot, but the assumption has been made that sensors have become slightly cheaper within the past years due to improved technologies. The packaging will be somewhat more expensive, as Sweepy comes with a larger docking station than the other two robots. This will also cause the labor costs to be higher as well as the tooling costs. The series of production will be smaller, in order to adapt the series size to the forecasted sales for the first year, with a growth margin for later years taken into account.

SALES FORECAST

The forecasted sales in the first year are shown in Figure 18. The forecasts take into account that sales realized by retailers imply a lower revenue for Philips than webshop sales. The forecasts are based upon an estimation that Philips can realize a 30% market share and a 5% growth per quarter and the size of the robot vacuum cleaner in Western Europe according to Euromonitor.[1]

MARKETING BUDGET

Figure 19 shows a marketing budget for the first year. This marketing budget is based on the activities as described in the paragraph "Marketing Programs" on page 20. The budget matches the marketing costs used in the break-even analysis.

BREAK-EVEN ANALYSIS

In order to be able to perform a break-even analysis, besides estimating the cost price, an estimation must be made of the costs which are not directly related to one unit of Sweepy. This has been done for the first year in the table shown in Figure 20. The production, distribution and holding costs were estimated taking into account the number of parts which have to be produced and the corresponding number of tooling machines required. Besides that the shipping costs from China to the Netherlands and holding costs as a percentage of the cost price were taken into account. Marketing costs have already been specified in Figure 19 and sales costs are mainly salary costs. Estimated other fixed costs are for instance costs for the developement of the mobile application, software for Sweepy and the docking station and customer support costs. With the estimated costs and the selling prices the break-even analysis can be performed. The results are displayed in and Figure 20 and Figure 21. The expected revenue is based on the sales forecast in Figure 18.

1) Della-Santa, L., 2012, Robotic Vacuum Cleaners: Where There's Savings, There's Hope, http://blog.euromonitor.com/2012/12/robotic-vacuum-cleaners-where-theres-savings-theres-hope.html, accessed 8 Jan. 2015

Cost price estimation	Samsung NAVIBOT VCR8895L3A	Irobot Roomba 630	Philips Sweepy
Plastic	€ 16.81	€ 16.12	€ 35.00
Finishing	€ 3.94	€ 1.04	€ 5.00
Metal	€ 4.22	€ 3.23	€ 4.50
Motor	€ 7.52	€ 9.87	€ 10.00
Pump	€ -	€ -	€ 5.00
Brushes	€ 2.26	€ 2.38	€ 3.00
Cordset/Wiring	€ 4.84	€ 0.76	€ 5.00
Filter	€ 0.57	€ 0.54	€ 0.55
Electronics	€ 65.41	€ 43.90	€ 65.00
Sensors	€ 11.20	€ 3.67	€ 10.00
Battery	€ 13.74	€ 15.18	€ 14.00
Packaging	€ 3.21	€ 1.81	€ 6.00
Paperwork	€ 0.81	€ 0.30	€ 1.00
Rubber	-	-	€ 5.00
Total variable costs	€ 134.53	€ 98.80	€ 169.05
Labor costs (China based)	€ 16.55	€ 9.69	€ 24.50
Tooling costs	€ 13,229.10	€ 11,238.40	€ 15,000.00
Series	200,000	200,000	80,000
Tooling costs/piece	€ 0.07	€ 0.06	€ 0.19
Total cost price	**€ 151.15**	**€ 108.55**	**€ 193.74**

Figure 17: Rough estimation of Sweepy's cost price

Forecasted Units Sold	Q1.1	Q1.2	Q1.3	Q1.4	Total year 1
Webshop	1500	1575	1654	1736	6465
Retailers	13500	14175	14884	15628	58187
Total	15000	15750	16538	17364	64652
Forecasted Sales Value	**Q1.1**	**Q1.2**	**Q1.3**	**Q1.4**	**Total year 1**
Webshop	€ 1,198,500	€ 1,258,425	€ 1,321,346	€ 1,387,414	€ 5,165,685
Retailers	€ 10,462,500	€ 10,985,625	€ 11,534,906	€ 12,111,652	€ 45,094,683
Total	€ 11,661,000	€ 12,244,050	€ 12,856,253	€ 13,499,065	€ 50,260,368

Figure 18: Sales forecast for the first year

Marketing Budget	Q1.1	Q1.2	Q1.3	Q1.4	Total year 1
Commercials Television	€ 600,000	€ 600,000	€ -	€ 600,000	€ 1,800,000
Radiospots	€ 100,000	€ 100,000	€ -	€ -	€ 200,000
Internet	€ 150,000	€ 150,000	€ -	€ -	€ 300,000
Advertising in Newspapers/Magazines	€ -	€ 100,000	€ 300,000	€ 300,000	€ 700,000
Support for Channel Members	€ 750,000	€ 250,000	€ 250,000	€ 250,000	€ 1,500,000
Total	€ 1,600,000	€ 1,200,000	€ 550,000	€ 1,150,000	€ 4,500,000

Figure 19: Marketing budget for the first year

Estimated cost price	€ 193.74
Estimated fixed production/distribution/holding costs	€ 7,500,000
Estimated marketing costs	€ 4,500,000
Estimated sales costs	€ 500,000
Estimated other fixed costs	€ 5,000,000
Total estimated fixed costs	€ 17,500,000
Wholesale price	€ 775
Webshop price	€ 799
Estimated % of sales sold by retailers	90%
Estimated % of sales sold at webshop	10%
Units break-even	29983
Revenue break-even	€ 23,308,947
Expected units sold year 1	64652
Expected revenue year 1	€ 50,260,465
Expected costs year 1	€ 30,025,678
Expected profit year 1	€ 20,234,786

Figure 20: Input data (first year) and results of break-even analysis

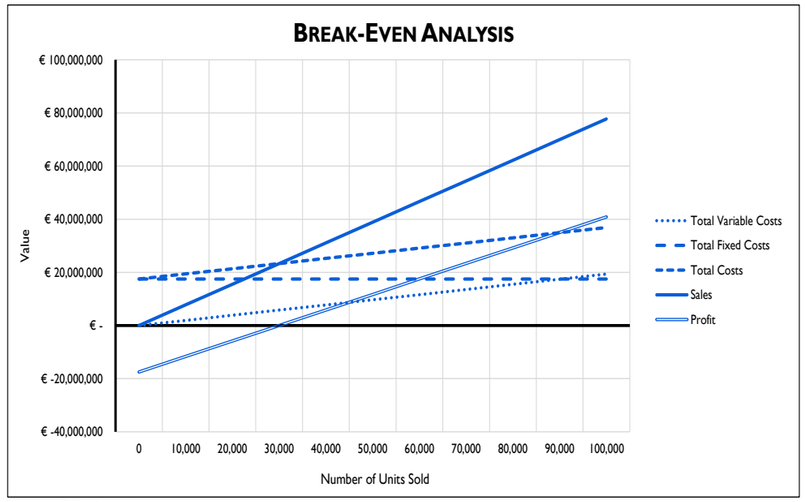


Figure 21: Break-even graph

CONTROLING AND MONITORING OBJECTIVES

It is extremely important not only to set objectives, but also monitoring them by setting performance indicators which determine whether an objective is met or not. Based on the values of these performance indicators managers can take measures if necessary. The first-year objectives for Sweepy were already discussed before. In Figure 22 for each objective a performance indicator and a target value for that indicator are selected. The data which is required for determining the values of these performance indicators will be gathered by doing marketing research, as indicated before.

Objective	Performance indicator	Target value
Increasing market share, such that Philips will become market leader in this market.	Philips market share (in %)	40%
Reach the break-even point	Profit (in €)	≥ €0
Increase the market potential of the robot vacuum cleaner market	Total current market potential - Total market potential when Sweepy was released	≥ 0
Positive growth of sales each quarter	(Sales current quarter - Sales previous quarter) / Sales previous quarter (in %)	> 0%
Minimize production and distribution costs	Production and distribution costs previous quarter - Production and distribution costs current quarter (in €)	≥ €0

Figure 22: Objectives and performance indicators to monitor them

RECOMMENDATIONS

After a short development time of about 10 weeks, as a group we are satisfied with the result of our work. However, the concept of Sweepy is far from being introduced to the market due to many characteristics of the product lifecycle management that were not taken into account or not needed further development. For this reason this chapter sums up a list of the most important future steps that should be taken.

- User manual: A user manual should come within the packaging of Sweepy. Important information, like "Where to download the app?" and "How to connect to the station?" should be explained. Detailed information about the robot and its maintenance can then be delivered in the form of an instructional video via the mobile application.

- The package of the robot has been designed visually without considering material choice or designing protective styrofoam. Further research and design are required.

- All non-standard parts of the robot, such as the airflow guidance, the cover, the brushes etc. are conceptual and have not been optimized foor manufacturing and assembly. Most of the parts can be optimized for injection moulding, which is suitable for mass production.

- The brushes that were designed are inspired by the AeroForce Brushes of the Roomba 500 series. It should be verified whether they are protected with a patent or not. This holds as well for many other parts of the robot.

Appendix

The appendix contains additional information, which might be interesting for the reader, but which is not necessary for understanding the report.

APPENDIX A: SURVEY

SURVEY QUESTIONS

1. **What is your living situation?**
   - *Student home*
   - *Single*
   - *Two-person household*
   - *Family household*
   - *Retired*
2. **Are you male or female?**
   - *Male*
   - *Female*
3. **Why would you buy/do you have a robot vacuum cleaner?**
   - *I have time left to do things I consider more important.*
   - *The robot can clean spots which are difficult to reach with a normal vacuum cleaner.*
   - *The robot can combine several functions (like mopping/sweeping/vacuum cleaning).*
   - *I can set its behavior to my preferences.*
   - *It's a fancy new product.*
4. **Why wouldn't you buy/didn't you buy a robot vacuum cleaner?**
   - *I didn't know I could buy one!*
   - *Nobody has one. Why should I have one?*
   - *I am considered lazy when I buy one!*
   - *A human being could clean the floor better!*
   - *They are too noisy.*
   - *It could harm my interior.*
   - *They look ugly.*
5. **What do you find more important when it comes to buying a robot vacuum cleaner?**

   Price [1] [2] [3] [4] [5] Cleaning quality
   Price [1] [2] [3] [4] [5] Usability
   Cleaning quality [1] [2] [3] [4] [5] Usability

   1: Left is much more important
   3: Left and right are equally important
   5: Right is much more important
6. **Do you have any suggestions?**

MAIN CONCLUSIONS FROM THE SURVEY

Before any conclusion is drawn, it must be made very clear that this survey is not completely representative for the whole target market. The conclusions drawn in this paragraph are all based on this survey only, and will also be treated like that. This means that the conclusions will be used as guidelines when making decisions, and not as restrictions. For this reason no extensive statistical analysis has been applied to the results. The conclusions will serve as support for logical reasoning, and only if logical reasoning is not possible the conclusions will be used as basis for decisions. Students and retired people will not be taken into account in this paragraph, as they are not part of the target market as described in the paragraph "Target Markets" on page 18.

Advantages

The major advantage of buying a robot vacuum cleaner is the time profit, according to the respondents. Especially singles find this advantage more important than other advantages.

After the time profit, the ability of the robot to combine several functions is a big advantage. Family households and two-person households find this a little more important than singles, according to the respondents.

From this we can conclude that, according to the respondents, the robot which will be designed really should be able to save time for the owner. This can be perfectly combined with the wish of the respondents that the robot is able to combine several cleaning functions.

Disadvantages

The disadvantage which was chosen most was that a human being could clean the floor better. Especially family-households and singles found this important.

The overall second disadvantage was the category other. From this other responses about 60% stated that the current price of robot vacuum cleaner is too high. For two-person households and singles another major disadvantage was the possibility that the robot would harm their interior. This could be regarded as the overall second disadvantage, because the category other also contained different responses than that the robot's price is too high.

A conclusion which can be drawn from this, is that the cleaning quality of the robot should be equal to the cleaning quality that a human being can achieve. Also, the price must be fair, people do not want to pay for quality they do not get. The fact that respondents state that the robot is too expensive actually does not necessarily imply that they are not willing to pay a high price for the robot, but it implies that the respondents think that the current robots do not have enough quality compared to their prices. This also follows from the weights they gave to the different categories, which will be discussed later. A last conclusion that can be drawn is that the robot should be smart enough not to harm the interior.

Weights

As was shown before, the weights of the three different categories are the following:

- Price: 17.31%
- Cleaning quality: 60.23%
- Usability: 22.46%

This ranking shows that the respondents belonging to the target market think cleaning quality is much more important than the price of the robot and its usability. The weights were determined using the Analytical Hierarchic Process. [1]

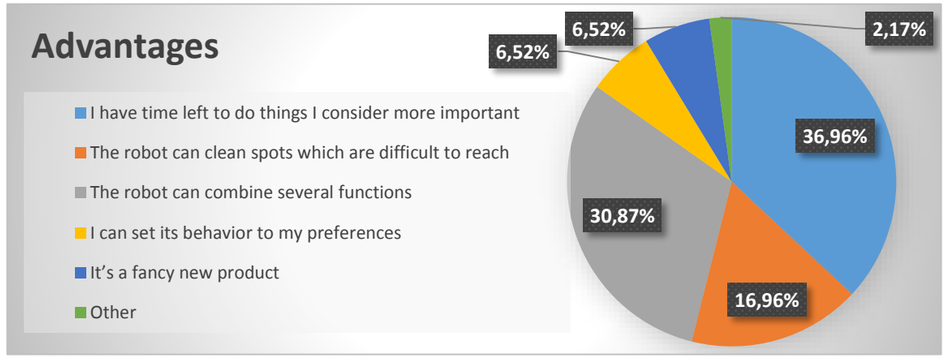
From this, it can be concluded that in the design process the focus should be on cleaning quality, and that usability should be given more attention than the (cost)price of the robot, according to the respondents.

1) As explained in the following document: http://bit.csc.lsu.edu/trianta/Journal_PAPERS1/AHPapls1.pdf

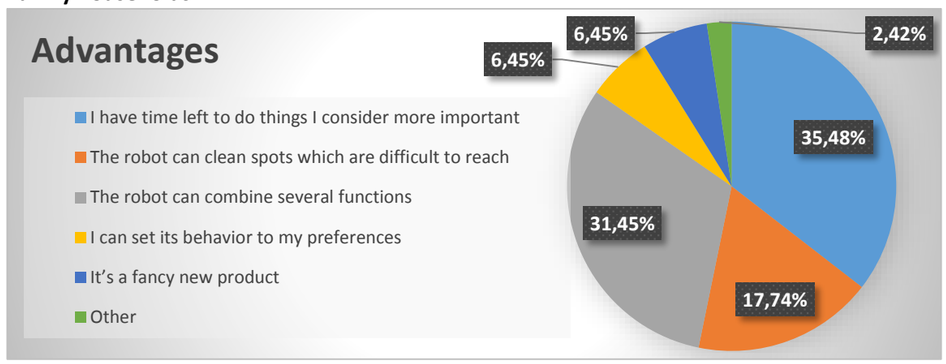
SURVEY RESULTS

In this paragraph the most important survey results will be displayed. The majority of the respondents were members of family households. As students and retired people are not part of the defined target market, the results of these groups will not be discussed here.

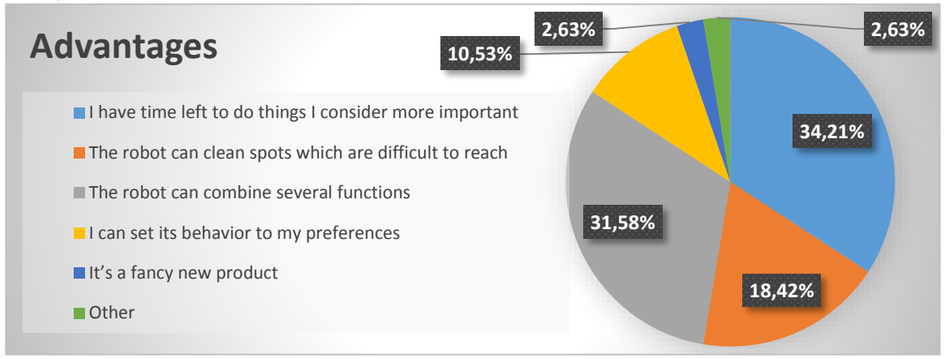
Overall



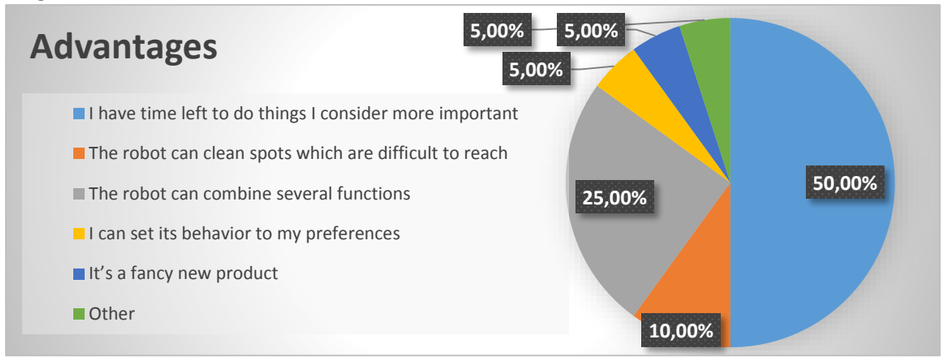
Family households



Two-person households

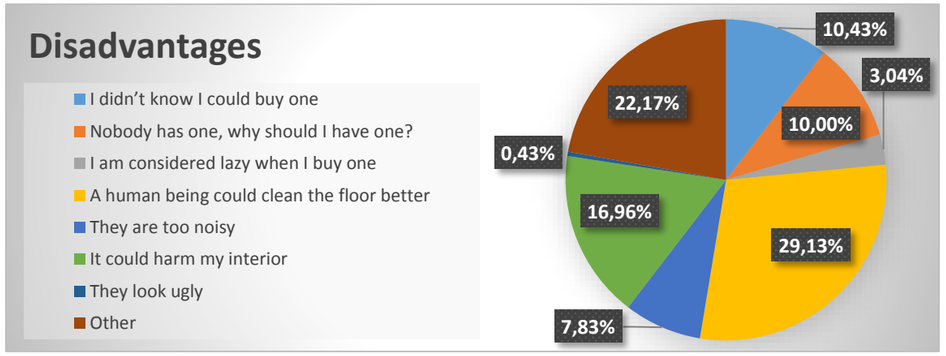


Singles

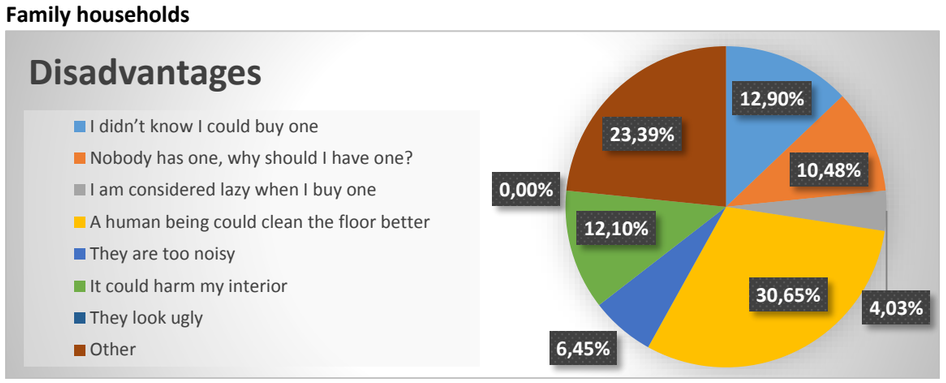


Disadvantages when buying a robot vacuum cleaner

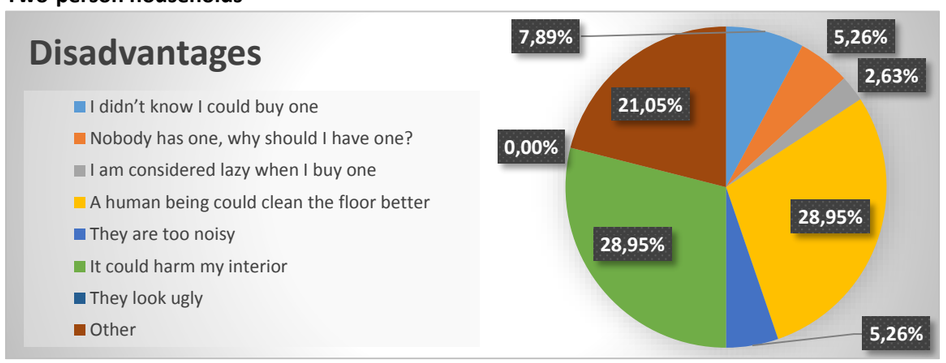
Overall



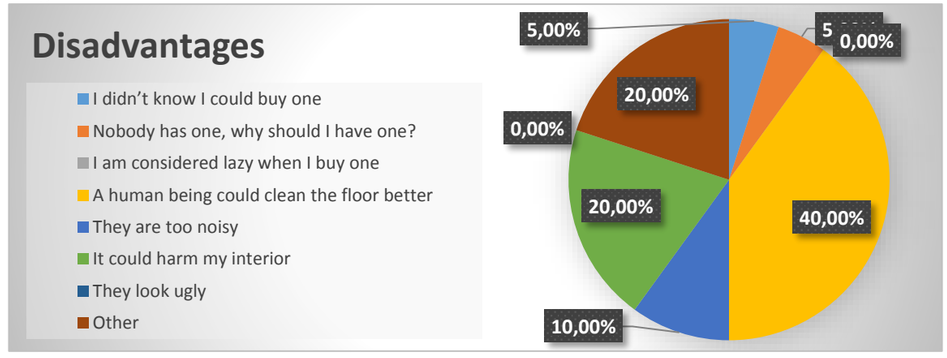
Family households



Two-person households



Singles



Weights for price, cleaning quality and usability

Single	Survey value	AHP value
Price vs. Cleaning quality	3.50	0.33
Price vs. Usability	3.10	0.71
Cleaning quality vs. Usability	2.60	2.60

Importance matrix	Price	Cleaning quality	Usability
Price	1.000	0.333	0.714
Cleaning quality	3.000	1.000	2.600
Usability	1.400	0.385	1.000
Sum	5.40	1.72	4.31

Normalized matrix	Price	Cleaning quality	Usability
Price	0.185	0.194	0.166
Cleaning quality	0.556	0.582	0.603
Usability	0.259	0.224	0.232

Weights	
Price	18.16%
Cleaning quality	58.01%
Usability	23.83%

Consistency check (CR<0.10)	
(Importance matrix)*(Weights vector)	0.545
	1.744
	0.716
Number of criteria	3
λmax	3.004
Consistency Index	0.002
Random Index	0.580
Consistency Ratio	0.004

Two-person household	Survey value	AHP value
Price vs. Cleaning quality	3.74	0.25
Price vs. Usability	3.00	1.00
Cleaning quality vs. Usability	2.05	4.79

Importance matrix	Price	Cleaning quality	Usability
Price	1.000	0.253	1.000
Cleaning quality	3.947	1.000	4.789
Usability	1.000	0.209	1.000
Sum	5.95	1.46	6.79

Normalized matrix	Price	Cleaning quality	Usability
Price	0.168	0.173	0.147
Cleaning quality	0.664	0.684	0.705
Usability	0.168	0.143	0.147

Weights	
Price	16.29%
Cleaning quality	68.44%
Usability	15.27%

Consistency check (CR<0.10)	
(Importance matrix)*(Weights vector)	0.489
	2.059
	0.459
Number of criteria	3
λmax	3.004
Consistency Index	0.002
Random Index	0.580
Consistency Ratio	0.004

Family household	Survey value	AHP value
Price vs. Cleaning quality	3.52	0.33
Price vs. Usability	3.13	0.66
Cleaning quality vs. Usability	2.66	2.35

Importance matrix	Price	Cleaning quality	Usability
Price	1.000	0.326	0.660
Cleaning quality	3.065	1.000	2.355
Usability	1.516	0.425	1.000
Sum	5.58	1.75	4.01

Normalized matrix	Price	Cleaning quality	Usability
Price	0.179	0.186	0.164
Cleaning quality	0.549	0.571	0.587
Usability	0.272	0.243	0.249

Weights	
Price	17.66%
Cleaning quality	56.89%
Usability	25.44%

Consistency check (CR<0.10)	
(Importance matrix)*(Weights vector)	0.530
	1.709
	0.764
Number of criteria	3
λmax	3.003
Consistency Index	0.001
Random Index	0.580
Consistency Ratio	0.002

Family household, single and two-person household	Survey value	AHP value
Price vs. Cleaning quality	3.56	0.31
Price vs. Usability	3.10	0.72
Cleaning quality vs. Usability	2.53	2.89

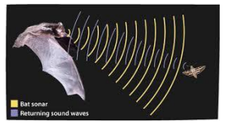
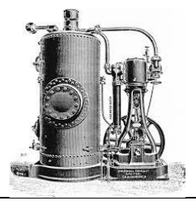
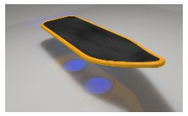
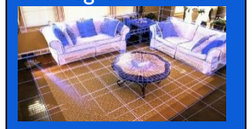
Importance matrix	Price	Cleaning quality	Usability
Price	1.000	0.308	0.717
Cleaning quality	3.242	1.000	2.890
Usability	1.396	0.346	1.000
Sum	5.64	1.65	4.61

Normalized matrix	Price	Cleaning quality	Usability
Price	0.177	0.186	0.156
Cleaning quality	0.575	0.604	0.627
Usability	0.248	0.209	0.217

Weights	
Price	17.31%
Cleaning quality	60.23%
Usability	22.46%

Consistency check (CR<0.10)	
(Importance matrix)*(Weights vector)	0.520
	1.813
	0.675
Number of criteria	3
λmax	3.005
Consistency Index	0.003
Random Index	0.580
Consistency Ratio	0.005

APPENDIX B: MORPHOLOGIC SCHEME

Look and Feel	Propulsion	Movement	Navigation	Dirt-Transport	Dirt-Storage	Energy--supply	Extra
Modern 	Electric motor 	Wheels 	Infrared sensor 	Hose 	Dirt sack 	Solar power 	Additional hose for corners 
Robotic 	Diesel engine 	Caterpillars 	Echo location 	Two rotating rolls 	Dirt Bin 	Fossil fuel 	Pet friendly 
ECO friendly 	Steam 	Hoverboard 	360 degrees scanner 	steam 	Dissolved in water 	Electricity 	Remote control for the robot (like a remote car) 
Vintage 		Spider legs 	Smart path seeking 	Brooms 			Wind energy 	An app for the robot. 
		Drone 	3 navigation points in the room that help with navigation 	Mob 			Height adjustable wheels 
		Snake 		Shoving 			nice smell 
		Ball wheels 					Docking station for recharging. 

For the morphologic schema all aspects were devided. The idea of this scheme was that no ideas do exist. Of course some aspects are more realistic than others but the most important thought was to think out of the box and name everything one can come up with. It is is also possible that more ideas from the same section can be used for a concept.

Look and feel:
Look and feel is the image the robot sends to the user. This could be modern, robotic, vintage or eco-friendly. There are lots of options for this aspect but these were considered to be most relevant to the robot vacuum cleaner.

Propulsion:
The type of engine that drives the robot vacuum cleaner. There were only a small amount of options.

Movement:
There are lots of ways that can be used to move the robot vacuum cleaner through an area. These are some possible technologies that exist.

Navigation:
The robot will have to navigate through an environment. Some of the sensors are essential and need to be in each concept but others can replace each other.

Dirt transport:
Dirt transport is the way in which the robot gets the dirt from the ground and gets the floor clean.

Dirt Storage:
After the dirt is gathered from the ground it needs to be stored somewhere in the robot.

Energy-Supply:
There are several ways for the robot to get its energy from for the propulsion.

Extra aspect:
Extra aspects are the unique selling points, these are unique aspects that (almost) none of the other robots has.


PHILIPS