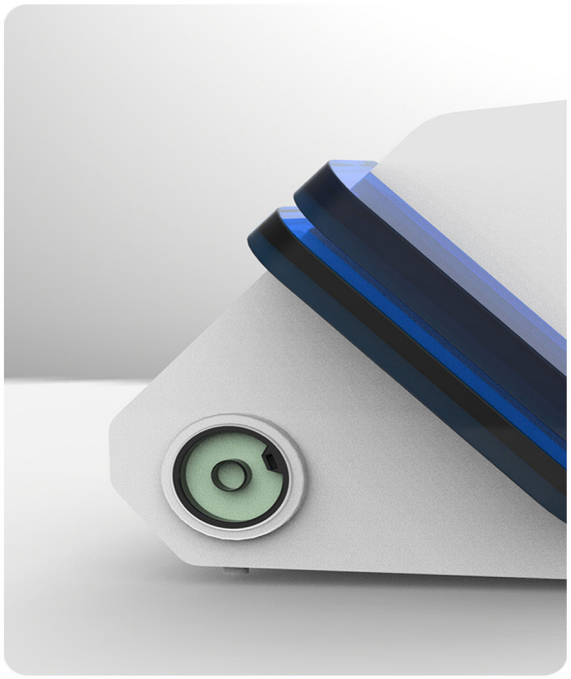
PRODUCT EXPERIENCE OF MEDICAL APPLICATIONS

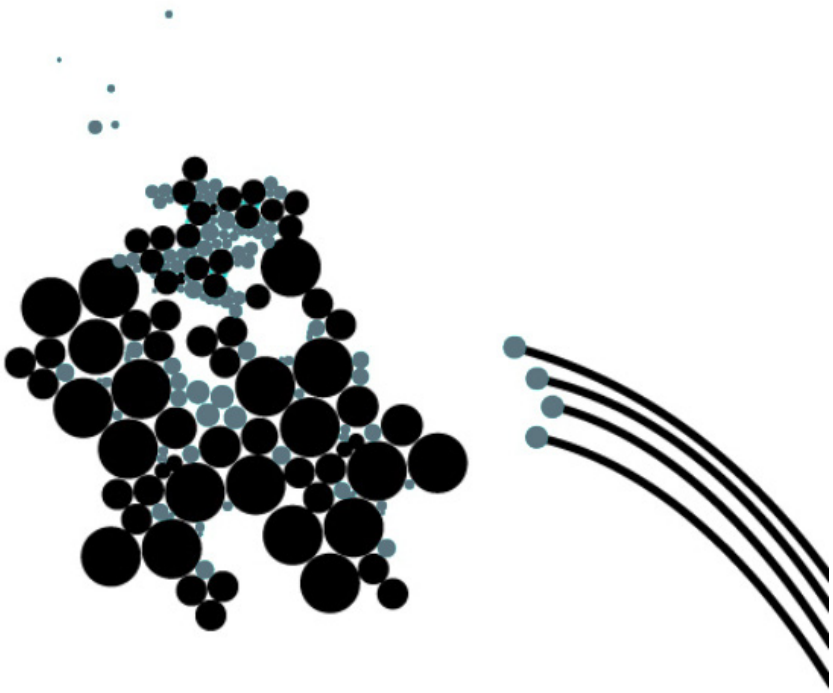
BY T.T.H. NGUYEN



BACHELOR ASSIGNMENT

UNIVERSITY OF TWENTE.

▶ Benchmark



Bachelor assignment

Product Experience of Medical Applications

Date of publication: 21 October 2015
no. of copies: 2
no. of pages: 89
no. of appendices: 20
Benchmark Electronics
Lelyweg 10
7602 AE Almelo
+31 (0)546 535 111

This design report was written as part of my bachelor assignment on the research of product experience of medical application conducted at Benchmark electronics located in Almelo during July until October 2015.

STUDENT
T. T. H. Nguyen [Huong]
s1206842

SUPERVISOR AT BENCHMARK
C. Suurmeijer

BACHELOR SUPERVISOR
J.A. Garde
M. B. de Rooij

University of Twente
Industrial Design

Preface

This assignment is the graduation project for the bachelor Industrial Design at University of Twente. For this purpose I have been given the great opportunity to work alongside experienced engineers and designers at Benchmark Electronics in Almelo. I would absolutely recommend doing internship at Benchmark due to a "gezellig" and friendly atmosphere.

I would like to express my thankfulness to everyone who advised and supported me. Some people I want to mention in particular:

First of all I would like to thank Benchmark's lead designer **Christian Suurmeijer** for giving me the opportunity for doing my thesis at Benchmark Electronics. Despite a high amount of work at Benchmark he was always a very kind and patient supervisor.

Julia Garde, for her advice and guidance during the project.

Special thanks to my **coworkers** at Benchmark who showed me that time can pass really fast by through having a good time with playing table tennis.

Although I was not able to see my **family** during the three months I appreciate that they always believe in and support me in everything I do.

Last but not least I want to thank **J** for being the best support (euw).

All in all, I had a great time at Benchmark and learned a lot to become a better Industrial Designer.

Abstract

Background

Benchmark Electronics has many clients working in the medical sector. One of these clients is *Weinmann*. In medical products design is of lower priority than safety, efficiency, and quality. As a result, consumers will not always experience positive emotions regarding their relationship with a product. As such, Benchmark Electronics wishes to explore product experience in medical applications in order to explore the factors contributing to product experience. In general, product experience refers to the experience that can be perceived through all senses by the user in his or her relationship with a product. Out of all factors that determine product experience, the visual aspect is the most influential and is therefore the focus of this bachelor project

Approach

Literature studies will be done to explore product experience. This analysis comprises the role of product experience in design, the eliciting model of emotions in a product-consumer relationship, and how designers can use this knowledge to influence perceived experience through the appearance of a product. Simultaneously, the appearance of existing medical products will be analysed and the outcome of this analysis will be applied to a case study (chosen medical product: sleep apnea device). Three visualizations of potential sleep apnea devices will be generated for different applications: a) home, b) travel and c) hospital. By means of a test consisting of a pre- and post-test, conclusions for a guideline can be drawn.

Results

This guideline can provide designers with a direction on how to design medical products for the three previously mentioned environments (home, travel, and hospital). Three visualizations of sleep apnea devices are made based on this guideline.

Conclusions

The findings of this assignment can provide designers of medical products with an insight into product experience, the role of emotions in design, and a better understanding on how to influence visual product experience through different design elements of medical products.

Table of contents

Introduction

"The most important thing is to enjoy your life—to be happy—it's all that matters."

- Audrey Hepburn

Emotion is Experience

Everything around us has impact on our emotions. We surround us with products that make us feel good (Desmet, 2012). For almost every need there is a product. These products are made to solve our problems, to improve our lives or are created just for our entertainment. A good feeling comes in response to good design. But what is good design and how does it influence our emotions?

Benchmark's interests lie in providing good services for their clients. A good design is essential of good service. Exploring product experience through research will support the creation of guidelines for Benchmark considering visual design decisions.
This report is about product experience in medical applications and will give a direction on how designers can influence product experience through product appearance.

Industry	Electronics manufacturing services
Founded	1979
Headquarters	Angleton, Texas, USA
Employees	9, 985 (Dec 2011)
Website	*www.bench.com*

Industry	Medical solutions
Founded	1874
Headquarters	Hamburg, Germany
Employees	350
Website	www.weinmann-medical.com

Figure 1: Locations of Benchmark Electronics across the United States, Europe and Asia (www.bench.com)

Introducing Benchmark and Weinmann

" . . be the best" - Benchmark Electronics philosophy

Benchmark Electronics

This bachelor assignment has been done for *Benchmark Electronics* in Almelo.

Benchmark Electronics (BE) is an international electronics manufacturing services company (EMS) and headquartered in the United States. *Benchmark Electronics* offers all phases of product development from concept development to product manufacturing and product assembly for large companies all over the world. Sectors of product development are, for example Assembly Design, Automation Design & build, Engineering, Industrial Design, Logistics, Supply Chain Management, Medical Engineering and Robotics.

As the leader of top 10 EMS, *Benchmark Electronics* has around 10.000 employees in different locations (fig.1). Currently are 350 employees at Benchmark Electronics in Almelo.

Weinmann

Medical products varies in their forms, applications and functions. Therefore, the sleep apnea devices of *Weinmann*'s are chosen as the design case of this assignment. *Weinmann* is a client of *Benchmark Electronics*.

Weinmann is a German company which develops and produces diagnostic and therapeutic solutions for sleep treatment and ventilation. *Weinmann* purses the goal of expanding the market position around the world. The core principle of *Weinmann* is quality.

In 2014, the newest product line of *prismaLINE* was launched, a system solution for treatment of respiratory disorders. The body case of the *prismaLINE* products is produced in *Benchmark Electronics* Almelo.

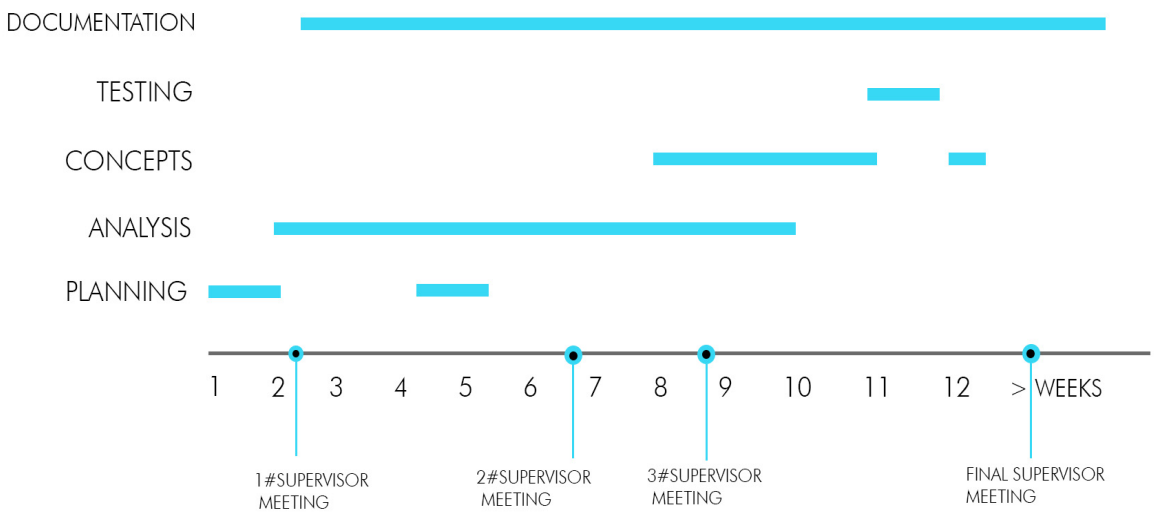


Figure 2: Final time schedule of the project

Project scope and assignment

Goal of the assignment

Benchmark Electronics develops predominantly concepts and services for large industrial companies and less for consumer products. Some clients, like *Weinmann*, offer consumer products in the medical sector. When developing business cases and running team projects, there is not much attention and time given to design and appearance in industrial products. This is because of the fact that manufacturing costs are bigger key drivers in industrial product developing. Product design and appearance are more important factors in consumer products than in industrial products. In medical product design, safety and quality are the most important factors. For this reason, their design is not as attractive as modern home products. How should designers design medical products to evoke aesthetics for different applications? Judgements about products are in general very subjective, varying between individuals. Are there guidelines or rules that designers can use to impact the perception of consumers and hence, influence product experience?

This graduation assignment was set to analyse (visual) product experience in medical applications and to display how product appearance in medical products can be designed for different applications. The focus of this assignment is experience through the visual product appearance. The sleep apnea devices of *Weinmann's* are used as a case study.

Goals for Benchmark Electronics

- Knowledge about (visual) product experience in products in general
- Knowlegde about emotional design
- Guideline for designing appealing in medical product design

Setup of the assignment

The assignment was subdivided in the following parts:

- Literature research about product experience and emotional design
- Application exploration of medical products
- Testing product relevant emotions
- Literature research about general elements in design
- Concept development of potential sleep apnea devices with the focus on product appearance
- Guideline development and testing

Structure of design report

Analysis
For a proper introduction about product experience literature researches were done during this bachelor thesis. Product experience occurs when emotions play a role in design. In the first chapter emotional design will be discussed. What does emotional design mean and why is emotion in design important for designers? Subsequently, the elicitation of emotions will be analysed. Among many psychological models the basic model of emotions of Desmet (2012) is chosen. This model gives a proper view on how emotions generally are elicited in people. Emotions are always experienced subjectively. Nevertheless there are some methods to measure emotions. These methods are discussed in the chapter of measuring emotions. Product experience happens in every kind of relation with a product - directly or indirectly. Product appearance appears through several different factors in design. This report shows how visual product appearance (design, shape, form, etc.) influences product experience in medical applications. Different medical products will be analyzed. When is a product defined as a medical device? What kind of characteristics do existing medical products have? To what extent is branding important in medical design?

Applications
Three applications are chosen in this assignment: home, travel and hospital. How are these environments characterized and to what extend
do they differ from each other? What is the design of the products in these environments? All results of the analysis will be applied to a case.

Case: Weinmann's sleep apnea devices
As medical product the sleep apnea devices of *Weinmann* are chosen. A sleep apnea device is for the most people not a familiar product therefore this report will also include an overview and description about sleep apnea, its treatments and about the market of sleep apnea products.

Concept: Design of sleep apnea devices
This phase is about designing three different sleep apnea devices through the results of the analysis. How should a sleep apnea device be designed for the three applications to elicit specific emotions in the end-user? In this chapter design factors of existing medical products will be focussed. Results of the analysis are summarized in a guideline and depicted as potential concepts in *Solidworks*.

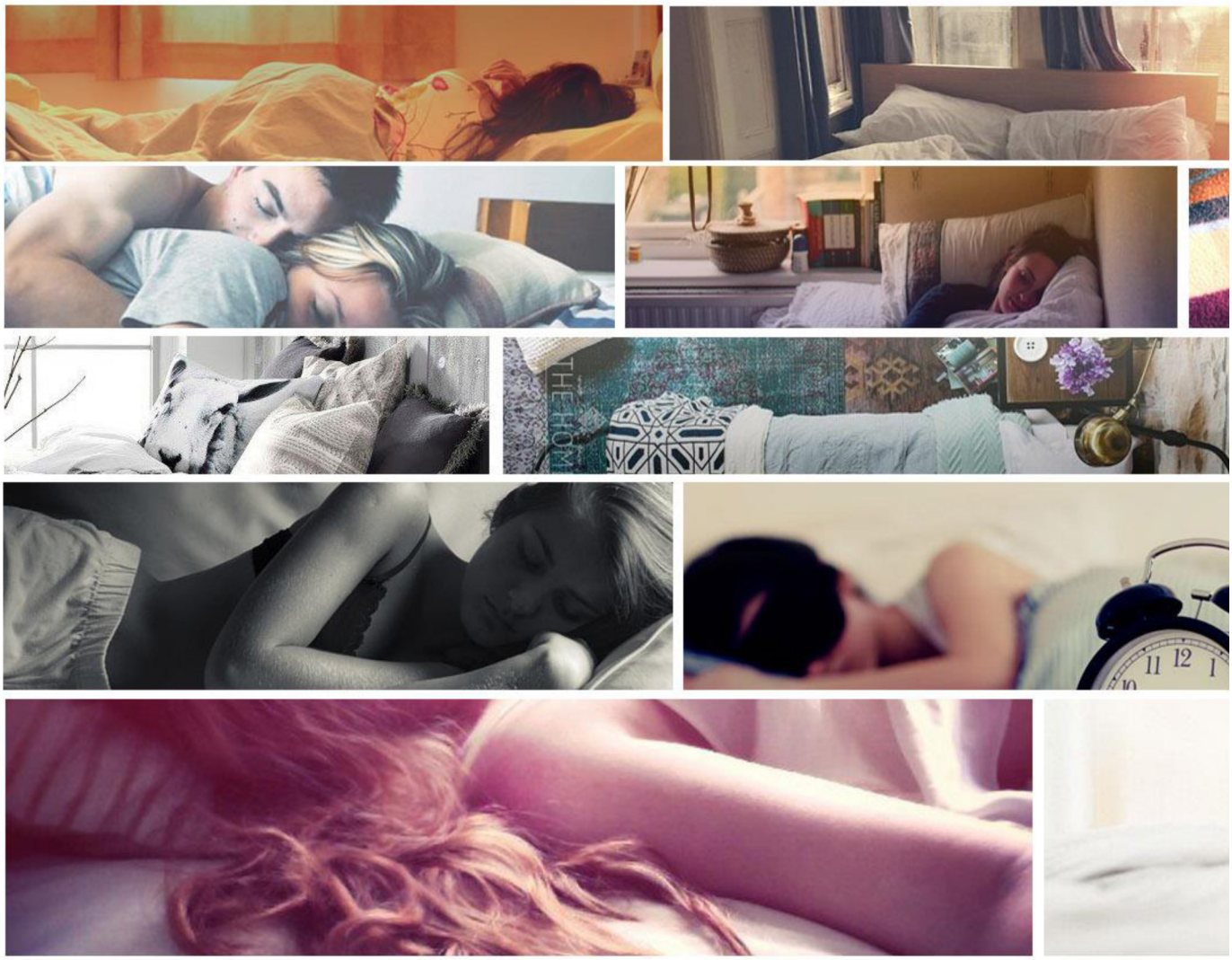
Pre-test
What do existing medical products elicits in consumer?

Test
Generated concepts of sleep apnea devices will be tested on roles of product appearance.

Guideline development
Results of the analysis and the test will be comprised in a guideline.

Post-test
The guideline will be given to a designer to test the function and content of the guideline.

Final: Conclusion and recommendations.



CHAPTER 1 | ANALYSIS PHASE

01 | Product and Emotion

"The experience makes the product, not the features." – UX magazine

"Consumers do not just buy a product, they buy value in the form of entertainment, experience and identity. " - Esslinger, FROG DESIGN

Emotional design

Emotional design has become more and more important. This is because that products are becoming very similar when comparing quality or price. However, functionality may not satisfy all of the users' expectations (Van Gorp & Adams, 2012).
Emotion in design has become important because how the consumer feels through the interaction with the product decides if he keep using it or not. As a result, emotions are often used in the advertisement sector to connect strong memories of products in consumers' minds (e.g. brands promise a certain lifestyle). Emotions often determine the customers' decision whether to purchase or to avoid a certain product (Van Gorp & Adams, 2012).

In the past, several conceptual frameworks about product experience have been developed in order to understand emotional design (Jordan, 1999; Desmet, 2002; Norman, 2004). In emotional design, the intention behind designing products is to evoke or to prevent elicitation of particular emotions (e.g. evoking interest through adding new features). Thus, designers need to know to what extent design can influence the consumer's perception and behavior.

Reasons for emotional design (Van Gorp & Adams, 2012)
1 | Emotional design is in all design
2 | Emotion is experience.
3 | Emotion dominates decisions
4 | Emotion commands attention and affects memory.

The main reason for designing emotions is that all design deals with emotion (fig.3). The emotion experienced determines the decision making toward a product. When a consumer experiences an unpleasant feeling toward a product, he will obviously avoid purchasing this product in the future. On the other hand, experiencing a pleasant feeling, such as desire or satisfaction, the consumer will likely tend to purchase and maintain the product more. The meaning of a product is influenced through the appearance (aesthetic/symbolic) of the product and through the interaction with that product (functional and ergonomic). People tend to perceive and interpret emotional responses in things unconsciously even though they are aware that electronic devices are not living things (Revers & Nass, 1998). Furthermore, emotion directs attention and evokes memories (attention drawing). Information that is bonded with emotion becomes more "memorable, resonant and actionable" (Power of Stories, 2011).

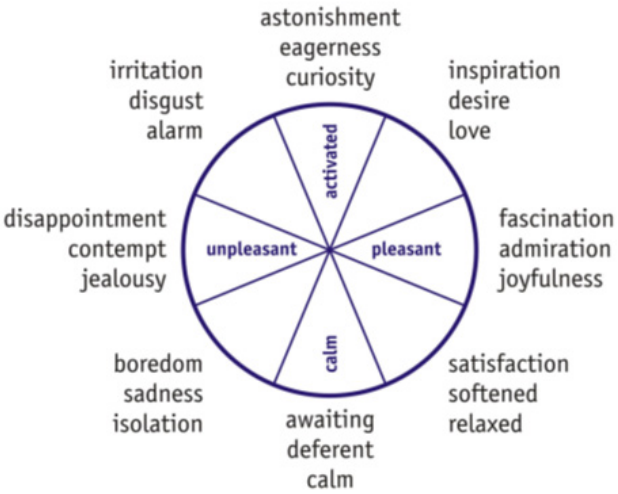


Figure 4: Circumplex model of core affect with product relevant emotions (Desmet, 2008; adapted from Russell, 1980).

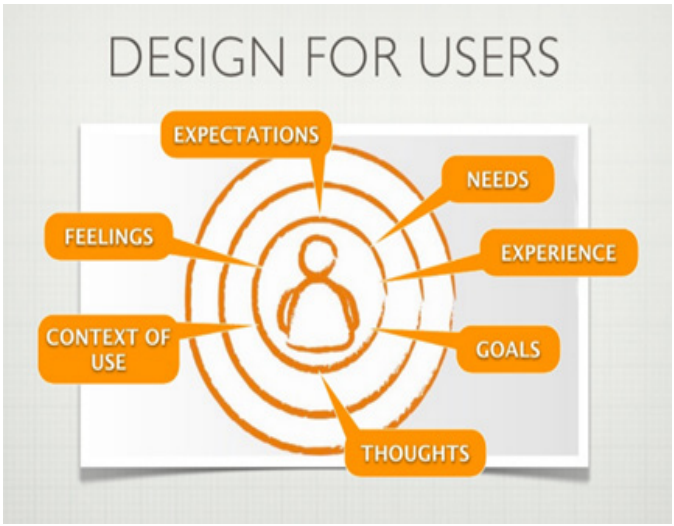


Figure 3: Emotion in design for users

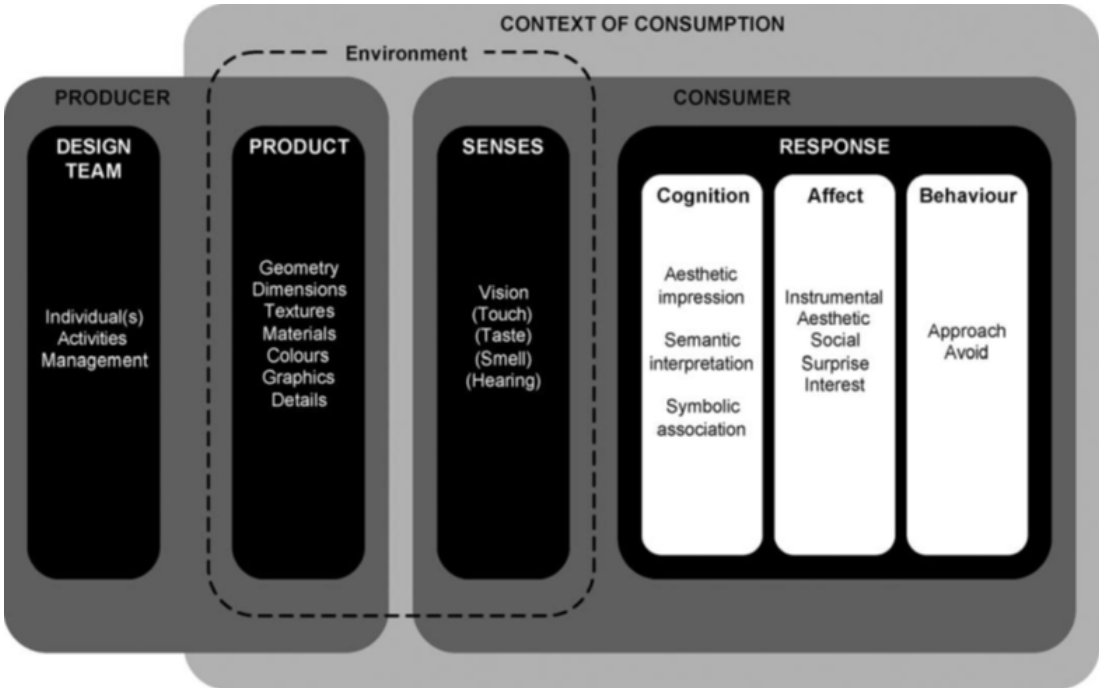


Figure 5: Communication through design (Crilley, Moultrie, Clarkson, 2004).

Product experience

According to Desmet "product experience" refers to all possible affective experiences that are included and experienced in human-product interaction. These affective experiences are psychological states such as emotions, moods, sentiments and emotional traits (Desmet & Hekkert, 2007). Of these states, emotions are the most relevant to product experience because only these imply a one-to-one relationship between the person and a product. The other affective states, such as sentiments and moods, do not involve a specific product but may be caused by internal or external reasons.
In general, product experience is formed by both, the characteristics of the person / consumer (e.g. motives, skills, background, cultural values, and personality) and those of the product (e.g. shape, color, material, dimensions). All actions and processes (physical, perceptual and cognitive) will form the experience. Additionally, experience is always influenced by the environment in which the interaction with the product happens. A person is able to feel constant experiences but not all emotions are relevant to product experience. The *Circumplex model* of Russel's (1980) shows several affective responses that can be experienced in the user-product interaction (fig. 4).

Communication through design (fig.5)

Figure 5 depicts a model of visual influence of product appearance on the consumer. Through a product designers can indirectly communicate to the end-user. How should the design appear? Elegant or bulky? A product's appearance has influence on the consumer and its behaviour.
The perception of a product's appearance is predominantly subjective and intuitive. Nevertheless, there are general factors and elements on what people perceive as appealing. These factors will be discussed later in this assignment.

Cognitive experience
Similar to Crilley et. al (2004, fig.5) divides Desmet (2002) the cognitive experience also into three levels:

Aesthetic experience/ Aesthetic impression
The product aesthetic relates to what the product delivers to the senses (especially vision). A product can look aesthetic, make fine sounds and feel good to the touch or even smell nice. In most cases, products are designed to please the senses. The user will judge the product through the information received by the senses.

Experience of meaning / Semantic interpretation
This level involves the ability to assign personality or other characteristics and value, personal or symbolic, to products. Studies of Govers and Mugge (2004) indicated that people become more attached to products that match their own personality. A significant amount of value assigned to products are attributed to their utility. This comprises practical characteristics such as functions, efficiency, ergonomics and performance of the product.

Emotional experience/ Symbolic impression
Positive emotions attract us to products that are beneficial, whereas negative emotions keep people from products that are not beneficial (Desmet, 2002). Because emotions are subjective, appraisals of the same products will differentiate between two different people. In most consumer products, symbolic experience is experienced:
- Social value of products
- Self-expression: products express aspects of one's personality
- Categorical: products express certain social positions and status of groups

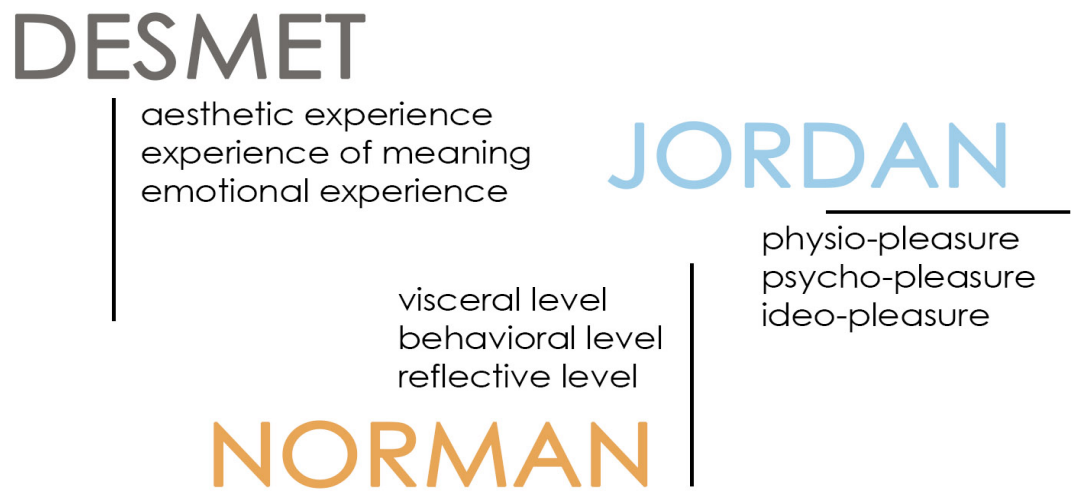


Figure 6: Experience levels of Desmet, Jordan and Norman

Aesthetic and symbolic experiences are of lower priority in medical product design because medical products are first and foremost, designed to be used for a purpose. Therefore, they have semantic experience through factors such as safety, efficiency and quality more value for consumers

These three mentioned categories of cognitive responses to product appearance are similar to Norman's (2004) and Jordan's (1999) proposed models (fig. 6).

Norman's product experience model

Norman (2004) divides experience into three levels. The three levels come from, inner instincts, visceral, from use, behavioral, and from outside influence, reflective.

Visceral Design
At the visceral design level emotion evokes inner instincts and human drives. As Norman (2004, p. 67) states "The principles underlying visceral design are wired in, consistent across people and cultures. " When something triggers an emotion at a visceral level it has an unknown impact to a person. At the visceral level, physical features – looks, feelings and sounds dominate (Norman, 2004). Attractiveness is a visceral-level phenomena" (Norman, 2004, p.87).

The visceral level is similar to Jordan's (2002) Physio-pleasure.

Behavioural Design
The behavioural level itself is predominantly about the use of the product. Appearance is less relevant. However, the appearance in context of the use is still an important component because the appearance implies how the product can be used. As Norman (2004, p.70) states, "What matters here are four components of good behavioral design: function, understandability, usability, and physical feel."
The behavioral level is similar to Jordan's (2002) Psycho-pleasure. "This deals with people's reactions and psychological states during the use of products." (Norman. 2004, p.105)

Reflective Design
The reflective level refers to the meaning and culture norms of the person (Norman, 2004).It is how you see the product reflecting your self-image to others. Additionally it can be in relation to the personal meanings of products, our memories or associations.
The reflective level is similar to Jordan's Ideo-pleasure.

Why attractive things work better
The three elements of good design are: usability, utility and desirability. Products need to be usable in order to solve problems. Therefore products are made for a need. Their features should be useful to the user. Desirability means that the consumer likes the product on basis of its appearance. All three elements are of high importance because without utility and usability, desirability cannot be gained. According to Norman attractive things work better because like them and know how to use them.
Norman (2004, p. 77) states: "Negative emotions kick in when there is a lack of understanding, when people feel frustrated and out of control – first uneasiness, then irritation, and if the lack of control and understanding persist, even anger. If the user feels happy, from the appearance, they are more likely "to find solutions to the problems they encounter."(Norman, 2004, p19) and so they appear to work better.

Affective response
The affective response of a product is the combination of emotions evoked by a product. This is subjective and depends on various factors of the person such as:
- *Age*
- *Gender*
- *Education*
- *Culture*
- *Previous experience with that product*
- *Context and environment*

Desmet and Crilley (fig.5) proposed five categories for emotions that products may elicit: **instrumental, aesthetic, social, surprise** and **interest**. These emotion categories result from an appraisal of the product:

- *Instrumental emotions* (disappointment/ satisfaction) from perceptions of whether or not a product will assist the user in achieving their goals

- *Aesthetic emotions* (disgust/ attraction) relate to the potential for products to "delight" the senses.

- *Social emotions* (indignation/ admiration) result from the extent to which products are seen to comply with socially determined standards.

- *Surprise emotions* (amazement) are driven by the perception of novelty in a design

- *Interest emotions* (boredom/ fascination): are elicited by the perception of challenge combined with promise.

Behavioural response
Cognitive responses (aesthetic, semantic and symbolic level) and affective responses (emotions) together influence the behavioural response of the consumer. Subsequently, the consumer will approach or avoid the product regarding on the product experience (negative/pleasant).

Roles of product appearance of consumer choice

Creusen & Schoormans (2005) identified six different roles of product appearance:
(1) Communication of aesthetics
(2) Symbolic
(3) Functional
(4) Ergonomic information
(5) Attention drawing
(6) Categorization

In most cases the appearance of a product has an aesthetic or symbolic value for the consumer. Aspects of functionality will give the impression of quality. The ease of use will be perceived through ergonomics. Product appearance also plays a big role when it comes to attention-drawing and categorization. Characteristics such as size, colour and shape decide the attention drawing of a product and categorizes one. A product that has a different shape than other products of a category will be easier seen than products that are similar. The influences of various factors in product appearance will be discussed later on.

Figure 6-3 Basic model of product emotions.

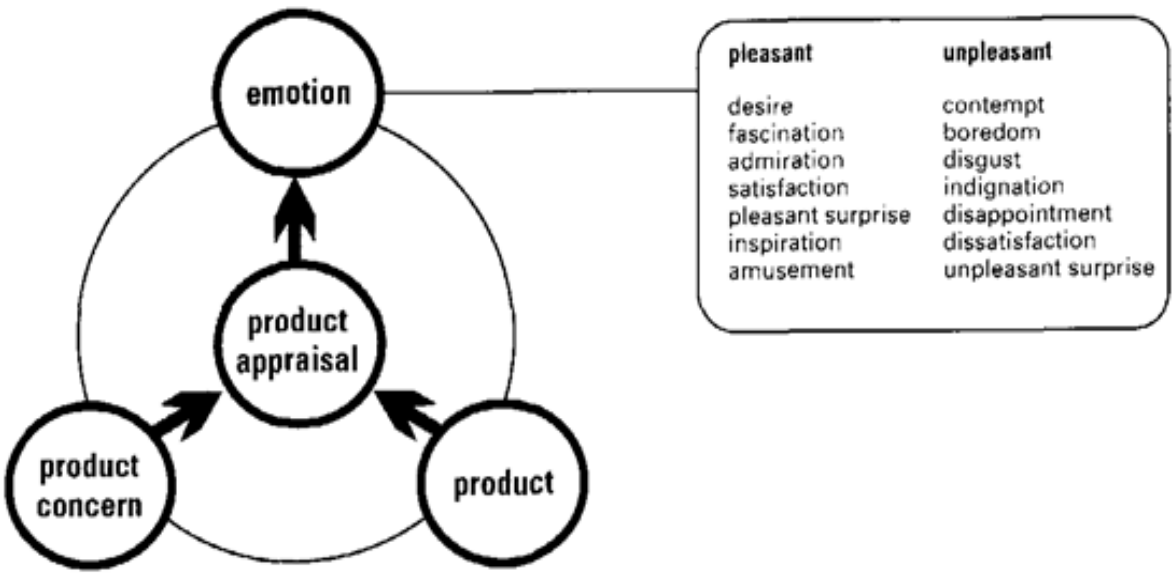


Figure 7: Basic model of product emotions with the stimuli "product" (adapted from Desmet, 2002)

Basic model of emotions

Even though the emotional responses towards a product differ, the way in which emotions are elicited is universal. The appraisal theory of Desmet (Desmet, 2002) describes the process of emotion and how people make evaluations (appraisals). Appraisals are made when a person judges a design against a concern he has. The result is an emotional response (e.g. good feeling). Without an appraisal there will be no emotion. Desmet's basic model (fig.7) of emotions consists of three universal key factors in the process of emotion elicitation: (1) concern, (2) stimulus and (3) emotion.
It is important to identify the users' primary concern for a certain situation and then to design in order to satisfy that concern. There are several types of concerns such as attitudes, goals, motives, values, needs and instincts. Universal concerns are concerns for love, for safety and for self-esteem.

Types of appraisal

1. The appraisal of appealingness
There are many attitudes that a person could have. Some of these attitudes are innate and some are learned. People can have attitudes towards specific aspects of products, such as the color or the material. These attitudes are the reference in the appraisal of appealingness. If the design of a product corresponds with the attitudes appraised as appealingness, the emotion desire will elicit. If a design conflicts with our attitudes that are appraised as unappealingness, the emotion disgust will elicit.

2.The appraisal of motive compliance (goals)
The appraisal of motive compliance results when the concern is the goal. A goal is something that people want to achieve. Goals can be abstract (e.g. I want to be happy) or concrete (e.g. I want this watch). Many goals are related to consumer products. People buy, own and use products because they believe that these products can help to achieve things or fulfil a need. A product that satisfies or promises to satisfy a goal will elicit emotions such as satisfaction.

3. The appraisal of legitimacy (belief, norms or conventions)
Beliefs, norms or conventions of thoughts are standards. Whereas goals are relevant for the personal well-being, standards are relevant for social structures. People approve of things that fit such standards and disapprove of things that conflict with them. This is based on information surrounding the product (e.g. commercials, brand knowledge) or on signals emitted by the product itself (e.g. appearance).

4. The appraisal of novelty (knowledge and expectations)
Novelty appraisal differs from the other three types of appraisal because it is not related to a particular type of concern but related to knowledge and expectations.

Conclusion
Of these three types of appraisal the appraisal of appealingness is the most important one in this assignment because it will be elicited through considerations about product appearance.


CHAPTER 2 |
MEASURING EMOTIONS
FEELING

02 | Measuring emotions

Emotions are not always obvious and thus, difficult to measure. How should emotions in product experience be rated?

As mentioned before not all emotions are relevant to product experience. Universal emotions such as fear will probably not be elicited very often through design because products are designed to pleasure the consumer. Other universal emotions such as shame and guilt are also not comprised in the category of product relevant emotions because those are only relevant in the context of purchasing and owning a product. In order to know to what extent product appearance can influence the consumers' perception, it is necessary to find out how product related emotions can be measured.

Measurement instruments
There are several methods to measure emotions that are evoked by the appearance of a product. Several instruments measure facial and vocal expression of a participant but only the self-report method is able to measure subjective emotions. In these self- reports, respondents rate their emotions on a certain subject. Non-verbal instruments have been developed that use pictograms instead of words to represent emotional responses (e.g. Desmet's prEmo, fig.8).

Characteristics of product emotion
In the previous section the process of elicitation of product emotions are described. Subsequently, characteristics of product emotions can be stated.

- *Product emotions are personal*
- *Product emotions are temporal*
- *Product emotions are mixed*

Product emotions are related to the personal concerns of someone. The appraisal process towards the same product differ depending on their personal concerns. Some product emotions are experienced by almost everyone, some by only a few (e.g. related to personal memories attached to the product). This is especially in aesthetic and symbolic experience. Most of the time many emotions can be felt at the same time (mixed).

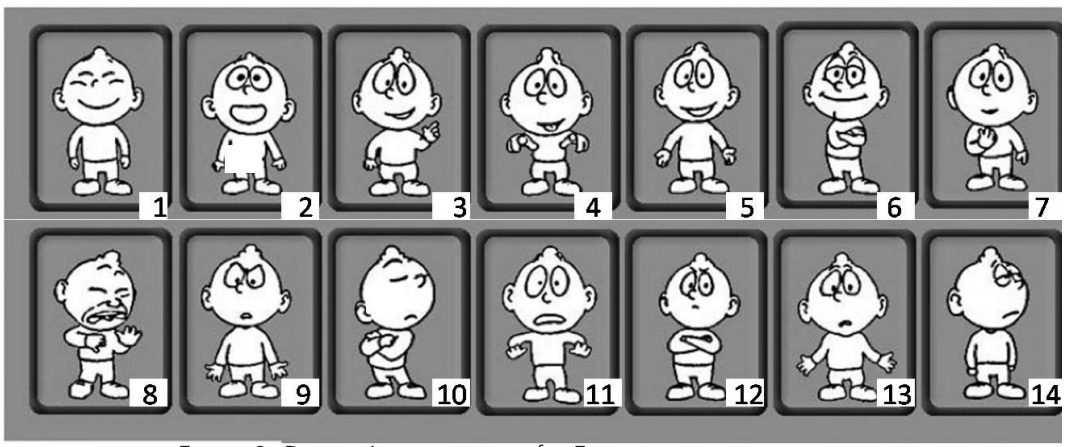


Figure 8: Desmet's pictograms of prEmo

Figure 9: Different designs of sleep apnea device

Figure 10: Part 2 of the test, rating the appearance of a blood pressure device.

2b | Pre-test

In order to test what kind of emotions are elicited by medical products a small study has been done. An online questionnaire was used to measure subjective feelings. In this test Desmets' 12 most to product experience related emotions (fig.8) were used.

In the beginning of the study it was stated in a written explanation that respondents should consider only emotions evoked by seeing, not those evoked by external situations such as buying, owning or using the product.

Hypothesis
Products for hospital use will elicit negative emotions (boredom, disgust) and consumer products will elicit positive emotions (desire, interest).

Method

Respondents
n= 36 with 24 male respondents and 12 female respondents.
The sample comprises primarily students and staff members of the University of Twente.

Material
An online questionnaire was made with *typeform*. The questionnaire consists of 15 different questions. The first part (A) comprises of three open questions. The subsequent part (B) consists of seven rating question where the respondents were asked to rate their emotion against a particular medical product. In the final part it was asked to select products which would fit in two different environment (home – hospital).

Procedure

Part A | The respondents were shown three different medical products (fig.9). The design of these devices differs strongly from each other and will likely elicits different emotions. These products differ in their product appearance in many factors such as dimension, shape, color and material. As an introduction task the respondents were asked to describe the design of the shown products.

Part B | In the second part the respondents were shown a picture of one medical product (fig. 10). The chosen product was a blood pressure monitor which might be familiar to some respondents. Subsequently, they were instructed to rate on a scale a particular emotion regarding on whether that emotion had risen through the design or not. Beside a pictogram which expresses the particular emotion a written explanation was shown (fig.10).

The scale started from 0 to 10 and relate to the following statements:
0: I do not feel the emotion expressed by this figure.
5: To some extent I feel the emotion expressed by this figure.
10: I do feel the emotion expressed by this figure.

The depicted emotions were:
Indignation, Desire, Sadness, Dissatisfaction, Disgust, Amusement/Joy, Unpleasant surprise, Satisfaction, Pleasant surprise, Fascination, Inspiration, Boredom.

Choose as many as you like

A Pleasant surprise	B Dissatisfaction
C Disgust	D Unpleasant surprise
E Satisfaction	F Amusement/Joy
G Sadness	H Boredom
I Desire	J Inspiration
K Fascination	L Indignation

Figure 11: Part C, selecting emotions

Which design would suit the environtment "home"?*

Choose as many as you like

Figure 12:Choosing products into environments

Part C | In part C respondents were asked to select their emotions by seeing different medical devices (e.g. fig.11). The function is in these devices not obvious (special medical instruments).

Part D| In the final part of the respondents were asked to select the products which would suit in the environment "home" and which one in the environment "hospital"(fig.12).

Results

Despite that the results are measured subjective depending on several external factors such knowing the product or subjective taste the results show the same trend with some residuals. The most elicited emotion through medical products is boredom. Medical products look very old fashioned, serious but professional. The more complex a product, the more functions is has. A large amount of respondents felt disgust towards medical products because these products reminded them of experience in a hospital. The factor colour indicates cleanness and professionalism because medical products are designed to provide high functionality and utility. Design has an inferior role than safety and functionality. Products with shapes that remind of familiar product (e.g. of an ipod, mobile) elicit a more pleasant emotion than product which look different. The sleep apnea device *Resmed Airsense* has a compact design which reminds of an alarm clock which people are familiar with.

Discussion

The test was set as a pre-test to get the first impressions of what kind of emotions are elicited in medical products. The study consist of some limitations that require further research.

Because of the limitation of online tests the respondents were only shown pictures of products. This limits the experience of product appearance because respondents might be influenced by the presentation of the product in the picture. Respondents cannot relate the real dimension, size and form because they do not see a real product in front of them. In some pictures products names

are revealed that may have influenced the emotions of the respondents. Depending on the subjective experience with some specific brand the appealing of a product will influenced. For a second research the brand names of the products should be removed to avoid the influence of brands on the product appearance relationship. The respondents were asked to rate their emotions. Emotions are difficult to measure because it depends on the person how he/she feels a specific product. The respondents were not trained emotion expert so consequently not every respondents is able to describe his emotion at that moment. Even though it was asked to consider only emotions that are elicited by the design of the seen product one cannot avoid emotion that would elicit by the imagination of purchasing, using or owning them. The results show that it was difficult to discern these different situations. This is because that people think and feel a lot of things at the same moment.

Most medical products do not differ much regarding their design because qualities such as high functionality and optimal utility have higher priority than design. The most medical products are white and are complex in order to function properly. For non-professional usage this design is mostly boring and too complicated.

In the last two questions respondents were asked to select products that would suit in the environments "home" and "hospital". It was necessary to let respondents first define these environment. What is their definition of "home" and "hospital" and why do they think that those products would fit there. In general this study only shows what kind of emotions are elicited but do not give precise answer of the reasons of the elicited emotions.

For further research, it is advised to focus the reasons of elicited emotions and not only which product relevant emotions are evoke by the design of medical products.

Fig. 13: Forms of shapes

03 | Designing emotions

Appealing through product appearance

Through a literature research factors of appealing in design were explored. Most products are designed to pleasure the consumer, hence, pleasant emotions should elicit. This chapter will list factors which people usually perceive as appealing in design.

Designers can influence the affective responses of a product through many ways (Brunel, 2006).

Visually
through the choice and use of color, material, texture, dimensions, reflection, shape and form, proportion and detailing of the product

Auditory
through sounds emitted by the product

Olfactory
how the product smells during and outside usage

Kinematic
the feeling of the product

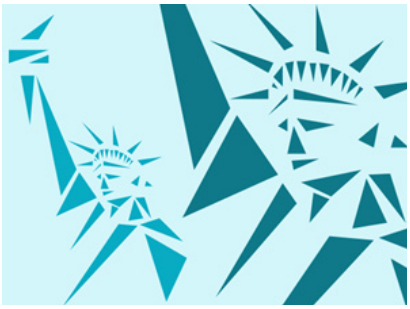
This bachelor assignment focuses on the visual influence on affective responses through product appearance of a product. In this report all research refers to the visual appearance of a product. This is different to the term *design* because design also includes the interior, not visible parts of a product.

Visual influence on affective responses

In order to determine to what extent product appearance impacts the consumer and to test the roles of product appearance (Creusen & Schoormans, 2005) general factors of appealing in design are explored. These are factors which people usually perceive as appealing in design in general. Based on literature research various models and general design "rules" are found. The most important ones will be stated below. These principles are not only commonly used in product design but also in graphic design, branding and art. An overview and a description about design elements are listed in the appendix X.

General appealing elements (Creusen & Schoormans, 2005)

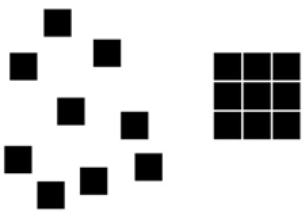
- **Symmetry, proportion** and **unity** are normally perceived as appealing in design
- The appearance of the product has impacts on the consumers' perception of ease of operation, stability and weight.
- A **"prototypical"** appearance is perceived as pleasant because the product seems familiar but small differences from the prototype are sometimes preferred as well.
- Obvious functionality of a product contributes to an idea of quality.
- New functionalities should be designed atypical to be noticed easier.
- A design and form language should fit with the symbolic value of a product (e.g. curve lines for friendly character)



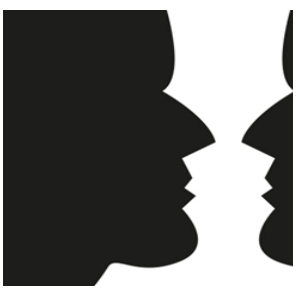
Principle: Similarity

Principle: Continuation

Principle: Closure



Principle: Proximity



Principle: Figure/Ground

Figure 14: The Gestalt principles, pictures adopted from http://www.creativebloq.com/graphic-design/gestalt-theory-10134960

The Gestalt principles
(visual organization principles)

The German term "gestalt" means "unified whole." According to the Gestalt theory people tend to organize visual elements into groups or thus, into unified wholes.

- **Similarity:** When objects looks similar to one another single elements will be seen as part of a group, category or pattern. Similarity can occur between all kinds of elements such as shape, texture and colour.
- **Continuation:** Continuation occurs when the eye follows a path, line or curve preferring to a single continuous figure than single lines.
- **Closure:** The human eye is able to perceive a complete shape when an object is incomplete or a space is not closed, thus, "missing" information will be filled in our brains automatically.
- **Proximity/ grouping:** when elements are closely arranged to each other, they are perceived as a group.
- **Figure/ ground:** this principle refers to positive and negative elements. The eye discern an object from its surroundings.

Design factors for a specific style

Soft, friendly and protective style
(Schmitt & Simonson, 1997)

- *Round shapes* evoke harmony, softness and femininity
- *Curved lines:* are perceived as feminine, soft and continuous
- *Symmetry:* creates balance, order and relieve tension
- *Short angular shapes* seem more timid and meek
- *Circular shapes* create harmony, softness and perfection
- *Small, shorter shapes* appear delicate
- *White color:* pure, innocent, happy, active

Sharp, hard and aggressive style
(Schmitt & Simonson, 1997)

- *Angular shapes*: evokes masculinity, aggressiveness, dynamism
- *Straight lines:* are perceived as masculine, sharp, abrupt and choppy
- *Asymmetry:* creates agitation and tension
- *Long angular shapes:* create dominant design
- *Large (tall or wide) shapes* are perceived as strong and powerful

Other general principles of design

Unity/harmony: According to many designers visual unity is a main goals of design. When all elements are in agreement, a design is considered unified.
Methods: Similarity, continuation, repetition, altering

Bloch (1995) found in a study that a consumer may like a product's appearance but will not purchase it because it does not fit with their home environment.

Conclusions
Gestalt and other design principles (e.g. Schmitt and Simonson, 1997) can give designers the opportunity to understand how to influence design and thus, visual product experience. Consumer products for home or travel use should evoke pleasant emotions so that the consumer will purchase and use a certain product. Therefore, designers should design these consumer products for appealing. The design should consider general appealing factors, the gestalt principles and the design factors for soft and friendly style.

Figure 15: Medical products of different environments

04 | Medical products

Before analyzing the design elements in medical products a brief definition of medical products will be given.

According to the WHO a medical device refers to any instruments, implement, machine or similar product that is intended for human beings for one or more medical proposes. Medical purposes are for example diagnosis, prevention, monitoring and treatment of disease, investigation, replacement, support of the anatomy or sustaining life support. Common medical devices in daily life are e.g. blood pressure monitor, thermometer, asthma inhaler or sleep apnea device.

Whereas medical products for home and travel environment are designed to be compact and have a sleek design, design in hospital products plays an inferior role. High functionality, precision and safety are more important factor in the context of hospital usage. These products are used more often, need to be reliable in every situation and have a longer product life cycle than consumer products. As seen in the fig. 15 hospital devices are often large, multifunctional and have features for being transported (e.g. on wheels).

Medical applications

There are a lot of applications of a medical products in the healthcare sector. The specific application areas of a sleep apnea device are: diagnostics, monitoring, respiratory conditions and ventilation.
Sleep apnea devices are used in sleep labours and in hospitals but can be purchased for home use as well. In this assignment three environments a) home b) travel and c) hospital will be analysed in order to find guidelines on how to design a sleep apnea device that fits in the specific environment. For example, a product that is designed for home use should evoke desire and satisfaction toward a consumer so that the product will be purchased. In different environments are different conditions that design of products should meet in order to fulfil the six roles of product appearance. Environmental factors affect the user performance directly and need to be considered in the design of medical products to achieve optimal usability and functionality. Therefore, designers need to be aware of the consequences of design decisions. A description of the environmental conditions will be given.

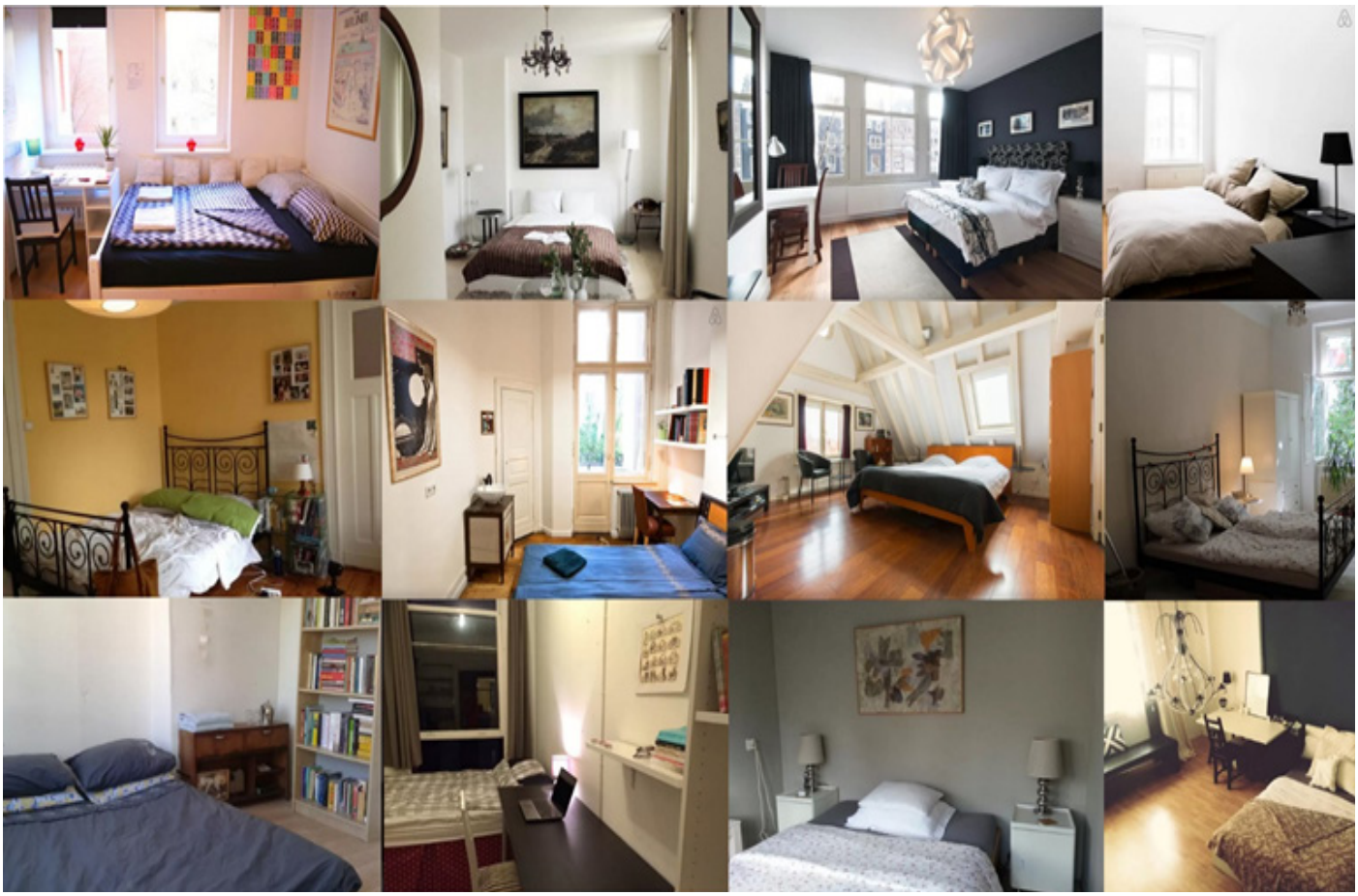


Figure 16: Collage of bedrooms in Amsterdam and Berlin (source: Airbnb)

Design implications

Home -use

More and more medical products enter the consumer market for home applications. A common medical device is for example a blood pressure device. A consumer as a layman without a medical training will make his own diagnosis about their health at home. In a home environment, the device will be operated by someone with an illness or by a caretaker which means that the medical device needs to be designed with more caution. The patients may not have assistance or may suffer from restrictions such as decrements in vision and hearing. Therefore it is of high importance that medical devices for home-use are accessible and easy to operate so that a less experienced user can operate it properly. The possibility of user errors needs to be limited. The target group of sleep apnea devices has a wide range, from young children to older people. Research (see in appendix) has shown that people with obesity have a higher chance of sleep apnea but in general patients from all ages and weight can suffer from sleep apnea.

Sleep apnea devices are mostly used in the bedroom during sleep (fig.16). The device will be placed next to the bed, preferably on the night stand. A sleep apnea device is in most cases used by one person and therefore a personal and much customized device.

Home

- *Impression:* cozy, friendly, personal, interior and style depends on the taste of the person and on the gender
- *User:* a person with one or more illnesses that need to be cured by that medical device, less experienced user
- *Location of use:* bedroom; on a night stand next to the bed
- *Common electronics products:* alarm clock, lamp, smartphone, laptop

Figure 17: Collage of hospital environment

Professional use

In this assignment professional use refers to the implications in hospitals and special sleep labours.
In general, medical devices are becoming smarter and capable, thus also more complex. These devices perform complicated computations that the practitioner and medical staff need to understand. This means that a good design in medical products is important for effective use.
Medical devices are considered to be used and carried to multiple environments such as patient rooms, operating rooms and emergency rooms. A sleep apnea device will be used for respirations and ventilations of patients. Due to all kind of severity and types of sleep apnea the device needs to capable of performing all kinds of measurements and different performance settings.

Hospital and clinics are often characterized as hectic environment. Professional medical employees need to react to every possible situation fast and error-free. Hence, medical devices need to be of high quality to perform efficiently. In addition, safety plays an important role in the use of the device. In an environment with many operating employees (e.g. staff member, doctors) and other people (e.g. patients, guests, visitors) medical devices should be easy to move due to space issues and not contain sharp edges or small breakable components. Hospitals are collecting spots of illnesses and bacteria, hence, medical devices will be cleaned regularly in order to avoid risks of infections. The form and shape of medical devices should take consideration of cleaning. Physical interfaces are becoming touch screens instead of a screen with many buttons. Due to lots of measurements and medical treatments, many medical devices are used in a room. The similarity between surrounding devices and the lack of standardization can cause confusion easily and needs to be considered when designing medical products (fig.17). In hospitals are many medical devices of different brands. These devices differ not only on the basis of their function but also on the way of use. Same products of different brands can discern in their usage which limits the learnability of medical products.

Hospital

- *Impression:* professional, multi- functional, sterile, clean, old-fashioned, complex
- *User:* experienced medical staff, doctor who assists the patient with the medical device
- *Location of use:* on a portable wheel next to the patient in a patients rooms or operating room
- *Common electronics devices:* wide range of medical devices such as thermometer, blood pressure, device, electrocardiogram etc.

Figure 18: Collage of travel environment

Travel-use

Most patients are depending on their medical equipment depending on the illness and treatment. For example, in case of an asthma attack an asthma inhaler needs to be in close proximity at all times. When considering travel for some amount of time patients can consult specific medical equipment that are convenient and suitable for travelling. Travelling includes for instance, the transportation to another location with the car, bus, train or air plane or going on a camping, and sitting in a wheel chair. Travelling with medical devices should always be considered with the general practitioner beforehand.

Travel environments are less convenient and less comfortable compared to home situations. Travelling is always connected to some stress and hectic rush. Due to limited amount of space travellers store their medical equipment in their baggage or may carry it (fig.18). Furthermore, the access to electricity is limited so medical devices need to be charged before or one should consider carrying extra battery packs for a sufficient energy level. During travel using in a public transportation patients are aware that they can be observed by surrounding strangers.

Travelling

- *Impression:* hectic rush, inconvenient, less comfortable, less space, changing locations, public
- *User:* less experienced user, traveller
- *Locations of use:* can be everywhere except home, in public transportation, in a tent, on a hotel
- *Common electronic devices:* smartphone

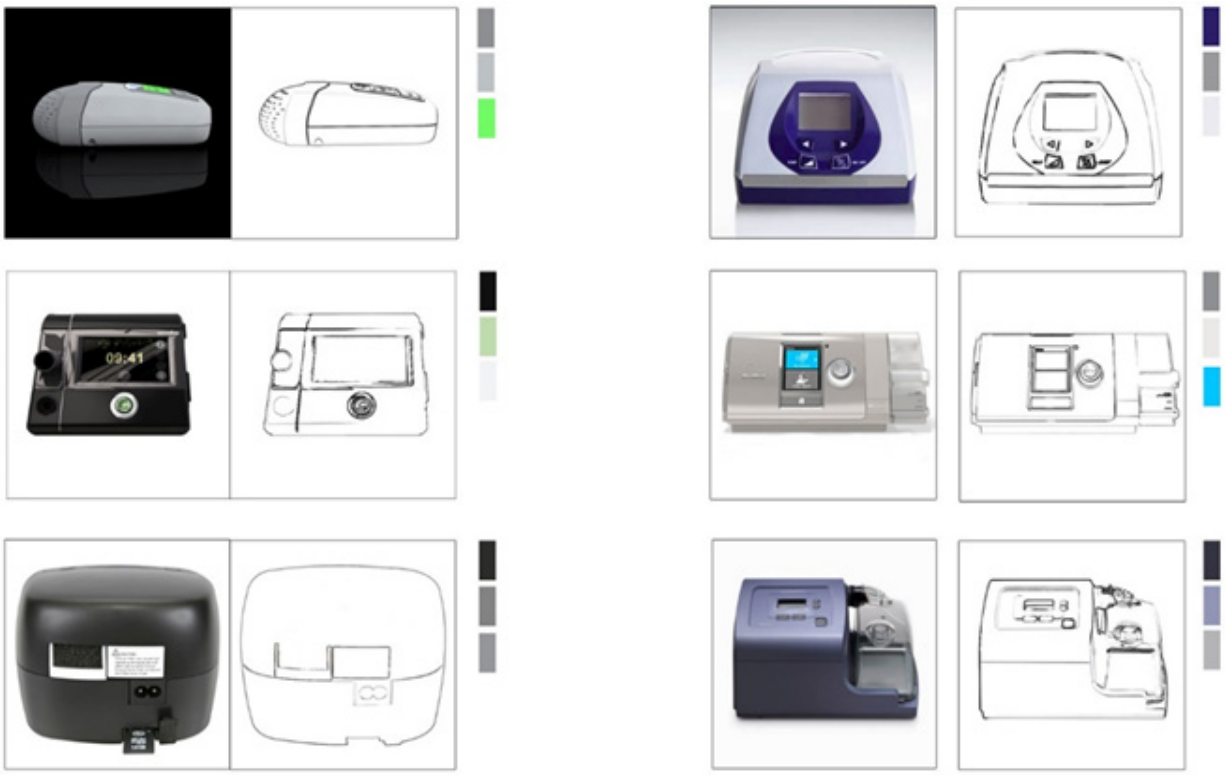


Figure 19: Shape and color of home/travel sleep apnea products

Figure 20: Shape and color of hospital sleep apnea products

04b | Design elements
in medical products

The following segments detail important design elements in medical products: shape, color, size.

Shape

In this section shapes of medical products (here: sleep apnea devices) are evaluated. Images will be transferred to line sketches and silhouettes. When analysing line sketches and silhouettes, other design elements like colour, material or texture will not be studied. Here, the position, orientation and dimensions of different parts are visible.

The range of shapes in medical products vary from small, round shapes to big-sized, rectangular shapes. The body design of smaller products for **home use** is likely round and curved because of safety purposes to avoid injuries by sharp edges (fig.19). In addition, these round products are compact and small for the ease of transportation. When a product has a round shape its features also tend to be designed symmetrically and rounded or curved, because this repetition creates harmony in the design (*principle of harmony*). Whereas buttons and parts of a product are also designed using round shapes, the display is in almost every case rectangular. Adding a small display to a device allows the user to interact with the product. Display are often rectangular so display information can easily be read and understood. This increases the usability of a product (Nielsen & Mack, 1994). The shapes of medical home and travel products are similar to other that are present in the same environment. The sleep apnea device of *ResMed (Airsense)* looks similar to an alarm clock. Alarm clocks have often a round and compact shape. These shapes can be found in other familiar products/ things as well (figure 22).

Medical products for **professional use i**n hospitals are often large and rectangular shaped. Figure 20 shows ventilation devices for professional use. Compared to the home and travel devices (figure 19) these products are a lot bulkier. Due to a ample amount of buttons, features and options the design appears complex with many sub parts or additional components (e.g. hoses, tubes). Besides multi- functionality medical products in hospitals are designed to be portable. The hospital staff can transport these medical devices easily from patients to patients on wheels or with a handle.

Figure 21: Silhouettes of common portable products for home and travel

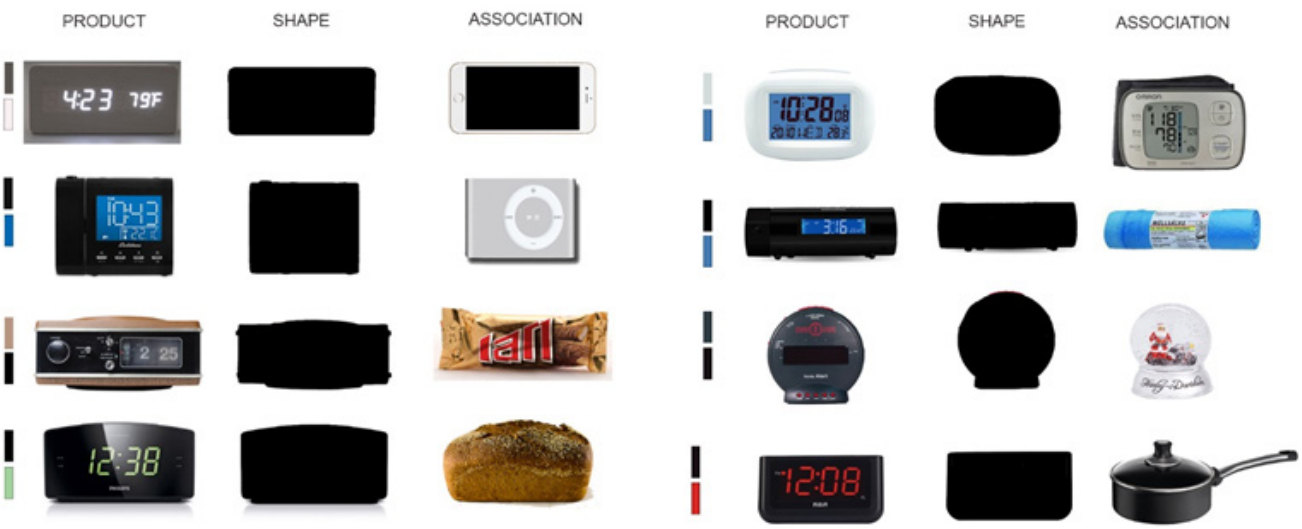


Figure 22: Silhouettes of electronics home devices and their possible association

Figure 23: Silhouettes of medical devices and their possible association

Figure 24: Colours in medical devices

Colour

In medical product design colour is used for the following reasons (forma, 2015):
1. Increase functionality by making the device easier to use and more intuitive.
2. Encourage the desired emotional response in user.
3. Emphasize recognition of a company's brand/ style.

Increasing function
Colour can be used to increase the functionality by making it easier and more intuitive to use. Contrast tracks attention – usually contrast in value, and colour. By highlighting with colour, it can help the user to understand how to interact and use the product. In addition, colour provide organization and a system in a product. Colour can be used to divide a form and define different areas of function and importance.
Objects with light colours encourage that they be kept clean. That is one reason why light colours and pastels predominate in medical devices.

Colours' influence on emotion

Decisions are predominantly guided by emotions (Van Gorp & Adams, 2012). They have a strong influence on how people think and react, even though most people are unaware of the power of emotions. Colour is one of the factors to which people react the most. When addressing colour's influence on emotion, the overall desired end result should be known. Should it calm the patient?
The effect of certain colours is connected to association of colour symbolism. Symbolic associations differ among cultures, emotional effects differ between people. Certain colours do seem to evoke more or less common response (Forma, 2015).

- **White** has a strong connotation of cleanliness/sterility and purity; therefore it is appropriate in medical setting. Because any colour contrasts with white.
- **Light grey** is not as pure as white is. Bright white can be overpowering and feel too sterile, whereas light grey is softer and calmer.
- **Blue** has a soothing effect. It is one of the most serene and calming hue.
- **Green** is also calming, and is associated with balance and harmony. Using soft tones of green or blue on accent area of devices will make them feel less threatening.
- **Black** connotes seriousness, sophistication and excellence.
- **Red** is an energizing colour. Because it is a primary colour, it can be appropriate in pediatric setting. Its association with blood makes it a colour to avoid for clinical devices, except in small amounts and for functional reasons to attract the eye to important areas.
- **Violet** is a calm colour with feminine associations.
- Y**ellow** is optimistic and associated with happiness and therefore ideal for pediatric products.

In addition to hue, the saturation also influences emotional response. Bold, saturated colors can be fun and refreshing. Soft, tinted colors, are more subtle and calming.

Figure 25: Medical products on comparison to each other (size/ scale).

Size and proportion

Size, along with the prior design element colour is one of the most important element to which consumers refer. A person will estimate the possible use and function of a function through its dimensions and shape. Smaller products are likely to be held and used whereas bigger products are too heavy and cumbersome. Most consumer products are designed in small sizes. The portability allows the product to be used in every situation (e.g. smartphones). Smaller products appear less threatening than large, bulky ones. Especially in new innovative products, size matters when the function is at sight unknown. A larger product, as opposed to smaller ones, will more readily catch the eye as it falls in the area of attention (Wickens et al., 1998). In design evaluation a reference model should be given for estimation of dimensions, so people can compare the size of unknown products to those they are familiar with.

.

Products can be split into body and subparts. These proportions may help the consumer to organize the product as larger parts attract the consumers' attention (brands are often placed on the body surface, e.g. on a water bottle). Medical products are available in small sizes (e.g. measurement equipment) and in large sizes (e.g. electrocardiogram). Due to multi-functionality, varying performance features, and numerous additional components, medical products in hospitals tend to be large and heavy. These devices often come with a big display to provide accurate information to its examiner.

Figure 26: Product lines of medical brands

05 | Branding

The role and influence of branding in medical design

This chapter will give a short introduction in branding and its influence in product experience.

Branding plays an important in product experience. Besides the design and the price a brand will influence the customer indirectly. A known or unknown brand will evoke different emotions in a person. This are related to prior experiences and to expectations of the product. A brand is defined as "a set of mental associations, held by the consumer which add to the perceived value of a product or service". A brand system consists of a brand concept, the brand name and symbols and the product.
A brand is a shared desirable and exclusive idea embodied in products, services, places and/ or experiences. The more this idea is shared by a large number of people, the more power the brand has.

Branding in medical design is very important in order to create trust. The most important qualities of medical products are safety and quality. Brands that give the impression that their products are safe, work and fulfil the users' need (valued benefit) are more trusted than brands that do not. Emotional appeal such as trust, admiration and respect will arise when the person can identify with the brand (emotional bonding).

The brand's deepest values must be reflected in the external signs of recognition. These must be apparent at first glance.

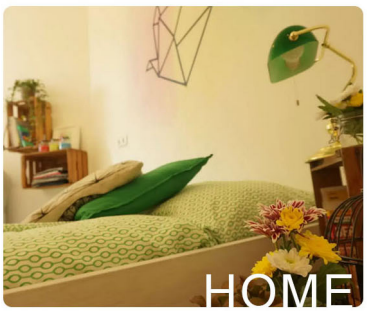
A brand can be embodied in its products and services. Products of one brand can look and be different. This may be an issue of brand extension or band stretch.

Some functions of the brand for the consumer are (Kapferer, 2012) :

Function	Consumer benefit
Identification	To be clearly seen, to quickly identify
Practically	To allow savings of time and energy through identical repurchasing and loyalty
Guarantee	To be sure of finding the same quality no matter where and when you buy the product
Optimization	To be sure of buying the best product in its category
Continuity	Satisfaction created by familiarity and intimacy with the brand that you have been consuming for years

Design of a medical product for home use

- Compact, small, light-weight
- Attractive design and usability
- Symmetry, curved line, round shape for friendly and soft appearance
- Prototypic shapes with small differentiations for familiarity and trust
- Colours: neutral such as white, black, grey in combination with a medical colour (blue/ green)
- Important functions should be obvious
- Easy to operate: display, touchpad, limited amount of buttons
- Polished surface to express home use



06 | Guideline
for medical design applications

This guideline comprises the results and outcome of the prior analysis and can give designer a direction in designing appealing in medical products.

Design of a medical product for home use

Medical products for home use are designed to be **compact, small and light-weight**. A small compact product is more convenient and handier and does not take much space on night stands. Night stands are mostly already covered with other electrical devices such as a mobile phone or alarm clock (fig. 16). **Usability** and **design** are both important to fulfil the users' need and to pleasure the user. **Appeal** in home products is important because no one want to purchase ugly products. According to the general design rules concerning appeal, the design should comprise of **symmetry, curved lines** and **round shapes** and **polished surfaces**. A **modern** and **sleek design** suits a home environment more than bulky forms. People tend to like **prototypic shapes with small differentiations** (Creusen & Schoormans, 2005). Thus, the design should look familiar to other consumer products such as radio alarm clocks, music installations or game console. The product line of a medical device should offer **multiple colours** to cover the preferences of consumers. The taste of aesthetic differs strongly. Common colours in consumer products are **neutral colours** such as white, grey and black. A good combination would be a neutral colour with colour that is associated with medical settings such as g**reen and blue**. In not all cases a home medical device should be identified for medical purposes. In other words, they just look like normal electronic home products. Nevertheless should their **important functions be obvious** (e.g. on/off button or button for ventilation) to avoid user errors and frustration. A medical device for home use should be **easy to operate** to avoid user errors. A display with a **limited choice of buttons** will not confuse the user with too much options and allows the user to operate fast through less clicks on the interface.

Design of a medical product for professional use

Medical devices for professional use need to be designed differently than medical consumer products. Hospital products need to appear **professional**. Professionality implicates high quality of material, efficiency of treatment and safety of use. Hospital products often contain more than one function, such as different possibilities for measurements and treatments. Due to the fact that one device will be used for many patients the medical device should be **portable** (e.g. on wheels or with a handle).

White has a strong connotation of cleanliness/ sterility and purity. Therefore, it is appropriate in medical setting. A medical devices will be surrounded with many other medical devices which can cause confusion. Adding **accentual colours** helps to organize and **highlight functions.** Most hospital devices have an **oldfashioned and bulky** appearance. These products are **large, rectangular and heavy.** Most people associate negative association with these designs. The designer should therefore include some **principles of appealing in design** to hospital products (e.g. symmetry).

Due to the fact that in hospitals devices need to be cleaned regularly, the product should contain attributes that are **easy to be cleaned.** (e.g. touch screen, touch pad instead of big buttons). Medical devices have a longer life cycle than a consumer electronics device. It is the role of the designer to find the **right balance between utility, usefulness and trend.** Safety, performance and efficacy are key drivers, whereas aesthetic comes to second place. But the look and feel of a device can improve the patient experience

Design of a medical product for travel

The shape and size of travel products do not differ strongly from home products. Travel products are as home products **small** and **compact** enough to be taken on travel (**portable**). These products should be designed due to **appealing and ease of use as lightweight, portable and round products with symmetry.** A travel product should be, if possible, in a compact size which **fits in hands**. The material and form should be **rugged** so avoid breaking when the product falls out of the bag. When going on a travel or trip patients need to take their medical device with them. Because of electricity **additional components** such as extra battery packs are needed as well. These components should be easy to attach and not include many subparts. Some products need to be approved by the airline to be allowed on the plane. Sleep apnea devices, for instance, work with air pressure. Therefore, not all sleep apnea devices are allowed on the plane.
Travelling is connected with hectic and stress. **Bright colours or highly saturated colours** are easier to be noticed in a bag when searching for the medical device. The medical device should be robust and not break easy. Small forms allow the device to be carried in **one hand.**

Figure 27: Features of Weinmann's sleep apnea device prismaLine

Figure 28: Applications of sleep apnea devices

07 Sleep apnea device

The case study of this project

Medical devices offer different solutions and are available in all kind of applications and forms. In this assignment all results from the analysis will be applied on a sleep apnea device to test product experience. As case and example model the sleep apnea devices of *Weinmann* were chosen.

A sleep apnea device is machine which provides constant air through a hose that keeps the breathing passages open during sleeping. Figure 27 shows the important functions of *Weinmann's* prismaLine sleep apnea that are necessary to know for the design of a sleep apnea device. The prismaLine is ideal for home- and travel-use due to its compact size and its small form. An integrated handle allows the user to carry it with him. The prismaLine is very light and works very quiet. This prevents patients from waking up during sleeping. More information about sleep apnea, its symptoms and treatment can be found in the appendix.

Types of sleep apnea products

Sleep apnea devices are used for home-use and in professional settings (fig. 29). The amount of use differ between the environments (fig.28). When a patient is diagnosed with sleep apnea he can test a sleep apnea device in the sleeping labour first. This would count as single event use. At home the user will use his sleep apnea device regularly every night during sleep (continuous use). Sleep apnea devices are also needed in hospital when patients stay over night. *Weinmann* offers different products depending on the type of sleep apnea of the patient (fig.30).

Figure 29: Sleep apnea device in different environments

Figure 30: Overview of Weinmann's sleep apnea devices

Figure 31: Concept 1, sleep apnea device for home-use (front view)

Design of a sleep apnea device for different applications

The beginning of this report describes to what extent emotions play a role in product experience. Subsequently, a pre-test was conducted to test whether certain emotions were evoked through existing medical products. General factors of appealing in design were explored and principles were listed in order to design specific styles. In the two previous chapters characteristics of medical products were discussed and different environment were analysed in order to design the appearance of a sleep apnea device that evoke certain emotions.

Based on the previous guidelines for medical products, three design of sleep apnea devices were made. Concept 1 is for home-use and should evoke appealing and desire towards consumer. Concept 2 is a typical medical device for professional environment and should appear as professional. Consumers will probably dislike its appearance. Concept 3 is a travel device for consumers and should evoke desire through its friendly and easy to use- appearance. All concepts are made in Autodesk Solidworks and will be used in the user test in order to test visual product experience. Depending on the results a redesign will be considered if necessary.

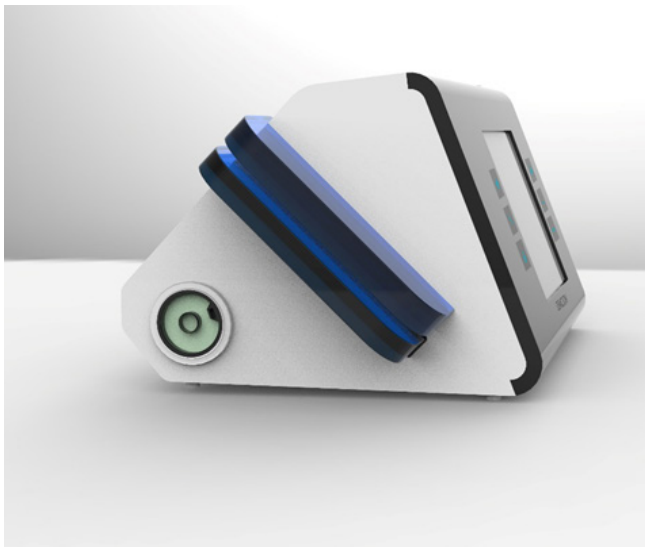


Figure 32: Concept 1, sleep apnea device for home-use (side view)

Concept 1 - home use

This concept is has a similar form to an alarm clock which may evoke familiarity toward concept 1. Furthermore, concept 1 has similarity with an existing sleep apnea device (Redmed Airsense, fig. 33). The shape is based on the prototypic shape of the Resmed with some small differentiations. Sleep apnea patients will probably know the Resmed's variant and will likely recognize the similarity between them. Concept 1 is designed to be compact, small and light so that it would fit on a night stand. Concept 1 is predominantly symmetric to create balance and harmony. A small touch display with some buttons are added for easy routine use every night. The water departments are made from blue transparent plastic material to be associated with water easier. Two neutral colours are added to divide the shape into two components. This creates the impression of smaller form.

Figure 33: Resmed Airsense

Figure 34: Concept 2, sleep apnea device for professional use

Concept 2 - professional use

Concept 2 is a sleep apnea device or ventilation machine for hospital and professional use.

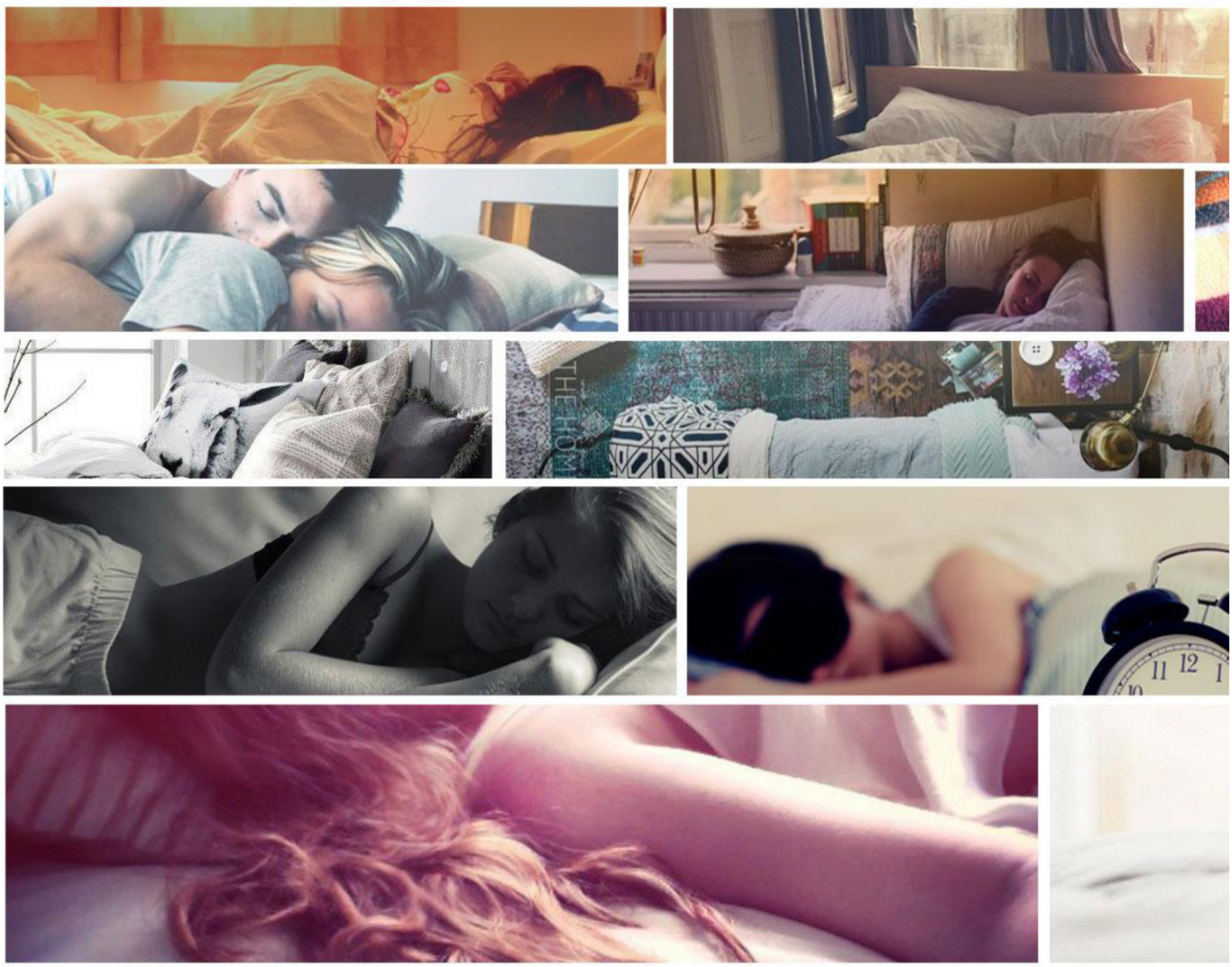
It should evoke the association of hospitals. Therefore, it is designed to be rectangular, bulky and stable. Its composition is asymmetric so that some features stand more out than others (the more important ones). Concept 2 is a compact sleep apnea device in which the functionality is obvious, it seems to be a measurement device which can be hung on a bed or be carried. Due his form and colours, concept 2 will likely reminds of other hospital products like a heart monitor. This device has a big display and many buttons which allows medical expects to perform every kind of measurement or treatment that is needed regarding on the patients. Concept 2 has no loose components or breakable parts and will be therefore suitable in the hospital environment. This concept is not made for consumers and will, thus, evoke negative emotions such as boredom or disgust. Consumers are in no need to use it; there will be no appraisal of concerns towards this concept.

Figure 35: Concept 2, sleep apnea device for professional use

Figure 36: Concept 3, sleep apnea device for travel-use

Concept 3 - travel use

Concept 3 is a small and compact sleep apnea device that can be used by one hand. Due to a round shape, symmetry and curved lines concept 3 appears friendly and soft. A small display with few buttons allows the user to operate fast within some clicks. Concept 3 is supposed to be used when travelling. This concept takes in account travelling conditions: rugged design, unlock button, small and compact design, hold able with one hand and easy to use.



CHAPTER 8 | TESTING

08 | Testing appearance

Three concepts of sleep apnea devices were made to serve as test materials. In this test I want to if designers can influence visual product experience and which factors are the most important ones.

A test was conducted to find out whether the participations' perception of the functional, symbolic, aesthetic and ergonomic value of a product on the basis of its appearance are positive and correct. This can be done by performing an interview or by questionnaire (self-report). In the test the participants will be asked to judge the functionalities, ease of use, quality and symbolic and aesthetic values of the product only on the basis of its appearance. If a product appearance does not communicate the right effect, the opinion of the participant will be demanded (e.g. W*hy do you think the quality of the product is low?)*. The expanded version of the questionnaire can be found in appendix.

Test question
Can designers influence visual product experience through the appearance of a product?

Hypothesis
Consumers are able to recognize the roles of product appearance in medical applications.
Colour has the most influence on the perception of product appearance.
White and blue are often identified as medical colours.

Subquestions
- To what extent can a person recognize the communication of aesthetic of a product through design elements?
- To what extent can a person recognize information about functions and ergonomics of a product through design elements?
- To what extent can a person recognize symbolic and categorical value of a product through design elements?

Method

Respondents
A total of 12 respondents (3 female, 9 male; mean age=30 with SD=10.2) were asked to participate in a questionnaire. They received a small gift for their participation. 11 of the respondents have no prior experience with a sleep apnea device whereas one respondent is a sleep apnea patient with his own sleep apnea device. All respondents are not colorblind.

Stimuli
Stimuli consisted of 15 pictures of medical products: renders of solidworks models and photographs of existing sleep apnea devices were used as stimuli material. For the final part of the questionnaire brands were removed in order to prevent the influence of a certain brand.

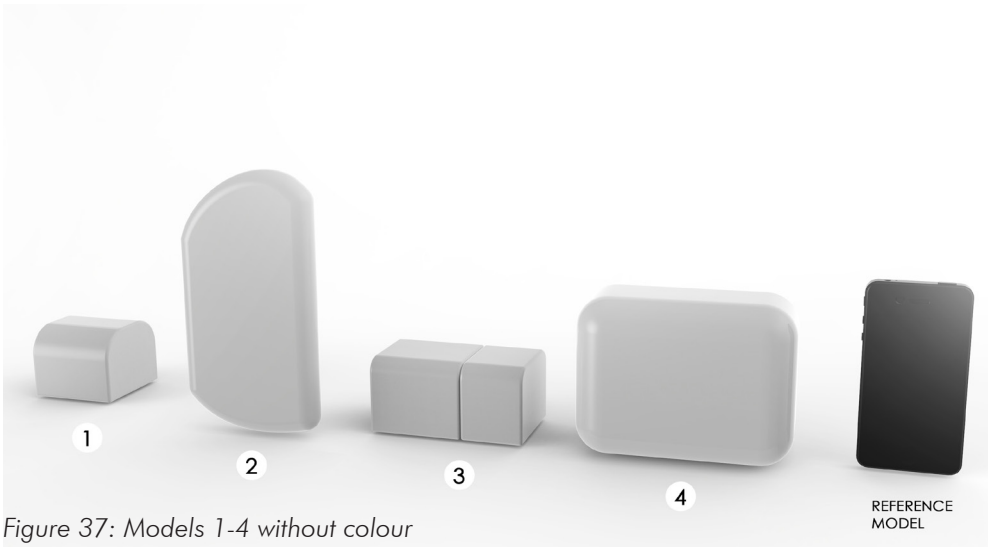


Figure 37: Models 1-4 without colour

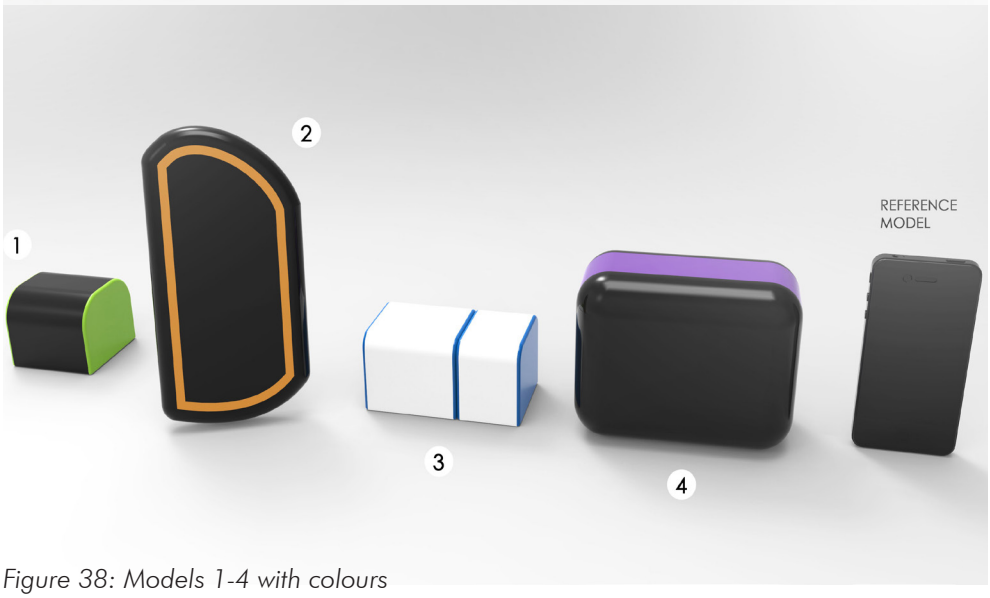


Figure 38: Models 1-4 with colours

models 1-12 with no color				*models 1-12 with color*		
M1	home	4.00		M1	home	4.08
M2	hospital	3.75		M2	home	3.17
M3	home	4.42		M3	home/hospital	4.33
M4	hospital	4.58		M4	travel	3.83
M5	hospital	4.00		M5	home	3.17
M6	hospital	4.67		M6	home	4.42
M7	home	3.83		M7	home	4.42
M8	hospital	3.75		M8	hospital	4.00
M9	home/hospital	3.50		M9	hospital	3.58
M10	hospital	3.67		M10	hospital	4.08
M11	home	4.58		M11	hospital	4.08
M12	home	3.75		M12	hospital	4.00

Table X: Results of rated products fitting in specific environments (highest scores)

Procedure

11 Respondents (without prior experience) were individually invited to a testing room. All respondents received task instruction verbally. It was stated that all considerations of the questionnaire should be based on the appearance of the products. Next, all respondents were asked to fill in the questionnaire. The test leader was present in the room during the whole test for questions.

To the 12th respondent the questionnaire was sent online due to distance issues (United States). It was stated that all considerations of the questionnaire should be based on the appearance of the products.

Questionnaire

Filling in the questionnaire took approximately 30-40 minutes. In part 1 respondents were asked to rate 12 product models (fig. 37, without colour) on a 5-point rating (scale from 1-5; 1=I do not agree, 3= neutral, 5= I strongly agree) scale whether the shape and form would fit in the environments home, hospital and travel. Subsequently, respondents were asked to rate the same models again, but in this part colours were added (fig.38). It was asked if the perception would changed through the added colours. In the second part respondents were instructed to judge three concepts on the six roles of product appearance:

1. Aesthetics
2. Symbolism
3. Functionality
4. Ergonomics
5. Attention drawing
6. Categorization

In the final part it was asked to choose a preferred product of six given products which do not differ on basis of their function and price. Subsequently, respondents were asked to explain their decision.
A reference model was for dimension estimations of the products. All questions can be read in the appendix.

Results and discussions

Shape and Size

In the first part of the test respondents were asked to rate 12 models on the basis of their product appearance. These models were not Colored. Respondents needed to make assumptions on the basis of size, shape and form of the models. The depicted models vary from simple basic shape to more complex assembled products. The most referred factor was size. Respondents made assumptions especially on the size. Smaller, rounded products (e.g. model 1 and model 3) are often categorized as home products whereas bigger, bulkier products were rated as hospital products (e.g. model 8). Smaller products are likely in households are likely to be held and to operate with. Models with simple basic shapes (e.g model 1 and model 7) were classified to belong in the home environment whereas complex shapes were categorized hospital (e.g. model 5 and 10). Models with simple basic shapes reminds of similar shaped products (e.g. associations of model 7 may be an alarm or a gift box). It seems that it is easier to categorize home and hospital products than travel products. Only model 4 has a strong associating with travel because of its rugged design (rounded edged, compact form, rectangular shape).

Colour

Colours were added randomly to the models. Results changed through the added factor colour (table X). Colour increases the recognition of the functionality of the models and are easier to associate with a certain environment. For instance, model 7 (home) was rated higher than in the evaluation without colours (from 3.83 to 4.42). Model 5 was first rated as a hospital product (mean: 4.00). The added colours are more associated with home environment (very colourful colours, mean: 3.17).
The results shows that colour is a significant influence on the consumer's perception of product appearance (fig. 39). Colour increases the recognition of functionality of the product and can be associated

Figure 39: Color's influence on affective responses

with specific environments. Respondents were asked their opinion on colour would fit in the specific environment. White was mentioned as appropriate in hospital setting in all cases (n=12). It has strong associations of cleanliness. In contrast with light blue or green it would have a soothing and calming effect that is associated with balance. It was mentioned (n=1) that colorful products would also suit in hospitals when concerning children. Color preferences in home environment vary from neutral colors such as black, white and grey to soft and earthy hues. 30% of the respondents (n=4) explained that the color preferences in home environment depends on the taste of the owner. Soft colors and neutral colors are the most preferred ones for home products. The color preferences for travel differ strongly. It was mentioned that products for travel should be highly saturated in order to be recognized during unpacking after a trip. Apart from that, neutral colors (white, grey, and black) in combination with bright or neon colors are suggested. This may depends on the taste of the consumer.

Aesthetic and symbolic

In part 2 three concepts were judged on the six roles of product appearance (Creusen & Schoormans, 2005). Results show that judgements on aesthetical level and especially symbolic level differ strongly due to personal experiences. The most respondents described concept 1 (83,3%) and concept 3 (91,67%) as attractive design whereas concept 2 elicited predominantly disgust (83,3%). Concept 1 and 3 were designed as consumer products to evoke desire through their product appearances. These products have modern and sleek design (smooth surface, round shape, modern colors) which respondents perceived as appealing. Concept 1 was often associated with an alarm clock which is a familiar product. Concept 2 depicts a medical device for professional use and has a complex appearance. Components and functions of this product are not easy to identify which caused irritation and elicited dissatisfaction. The symbolic value of all products was different due to subjective associations. It was mentioned once that the quality of the products was doubted because the brand was not known. Although the same material (all shiny plastic) was applied to all three concepts the quality of the products were perceived differently. 75% of the respondents judged the quality of concept 2 as high quality due to the application (for hospital use). Through the shape, form and complexity of the product all respondents assumed that concept 2 was used for measurements in hospitals. The same judgement was made for concept 1 and 3. Because it was assumed that these products fit home environments their quality would be lower than for professional use where efficiency and quality are of high importance.

Functional and ergonomics

Most respondents could identify the concepts as medical devices.
Respondents searched for further descriptions and icons (e.g on the display) when the function of a product is unknown. They made assumptions on the icons that were added to the design. This distracts from the basic design elements such as shape, color and size and leaded to wrong assumptions. Concept 3 was often associated with a mp3-player (30%). Respondents got irritated when they could not identify the function of the product. In some cases respondents are able to identify cues (e.g. a handle has connotation to portable products). Nevertheless it was not for all respondents clear how to use the depicted products. For instance, all concepts contain a hole for an additional component (e.g. hose) which was not shown in the pictures.

Preferred product

In the final part of the questionnaire respondents were given a case. They were instructed to imagine that they suffer from sleep apnea and need to choose one of six sleep apnea device which do not differ on basis of the function or price. Model 4 and 3 were chosen as the most appealing ones but 66.67% of the respondents chose model 4. It was mentioned that they do like the appearance of model 3 but that they did not understand the function of the blue com-

ponents on the left side (these are for respiration) and that its material looked easy to break. Model 1 and 6 are described as "oldfashion" and look like a "brick" (unappealing design) and therefore not as preferred ones. As Norman (2002) stated, people will always refer to attractive design when functionality and price do not matter.

General discussion

The test demonstrated that consumers get irritated when they cannot identify the function of a product through its product appearance. When consumers are not able to recognize the function or application of a product consumers will search for more information (e.g. on the display, icons and assumptions over the button functions). In this assignment information concerning the display and the icons was not part of the central focus. Thus, functional information should be designed clearly in consumer products to avoid user errors. Medical products often have multiple functions which are not visible at the first sight. Medical devices for professional use will be used by trained professional users therefore chances of errors are lower but nevertheless the design of medical devices for professional use should not be too complicated especially when the device is use for important and risky operations. In other words, designers should aim for balance between good design and functionality. Results of the test underlined the results of the analysis and the results of the pre-test that hospital products elicit negative association such as illness and boredom. Besides appearing professional, these products should appear friendlier in hospital so that patients will associate them with caring and curing connotations.

It was difficult for respondents to judge about product appearance when concerning aesthetic and symbolic impressions. Someone will likely like or dislike a product for many reasons which are not always obvious. Some respondents do not know what they are feeling when they see the concepts because they do not need it. The test showed that evaluations about the appearance is very difficult because consumers are used to buying products in order to use it instead of decorative reasons. Even though product appearance gives an identification about the application and function, respondents tended to judge about their function to solve a specific problem. In most cases consumers likely do not buy a product that they do not need (no concern to elicit an emotion, compare Desmet's model of basic emotions). In some cases respondents made assumptions on the basis of the application. When the depicted product seem to be used in a hospital setting the material seems to be more stable than a product for home use ("cheap material from china"). Respondents were asked what colours would fit in the specific environments. These question can be interpreted for all products and not only for medical devices. For further research subjects should be divided between home products and medical home products.
Limitations in this test were for example the estimation of the size of the products compared to the reference model and the perception of the applied materials. The dimensions (11cmx7cm) of the used reference model are the same as these of a smartphone (here: iphone 4). It was assumed that respondents are able to estimate the dimensions of the seen concepts. Respondents can only estimate the weight (relating to ease of use) of these products through perceived size and perceived material. There will always be a difference between seeing products in real environment and depicted on pictures.

This research does not take colour blindness into account. It would be interesting how colour blind consumers perceive product appearance when colour does not play a role in appeal.

Conclusion

The aim of this experiment was to test if designers can influence affective responses of consumers. Therefore a questionnaire was conducted to indicate if consumers can recognize the six roles of product appearance (Creusen & Schoormans, 2005) through certain design elements. The design of the concepts incl. the design elements were decided on basis of results

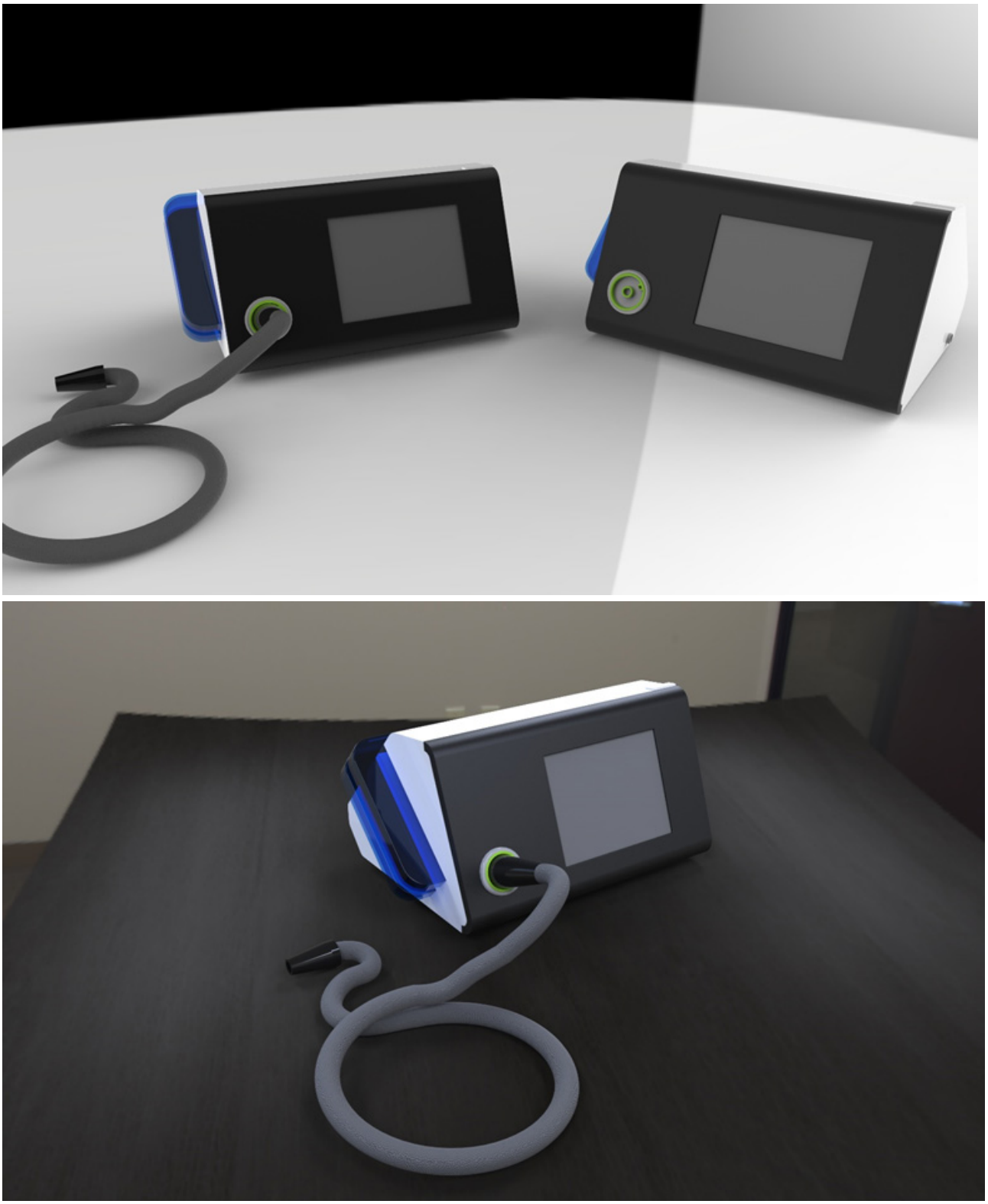


Figure 40: Redesign of Concept 1

of the prior analysis in appealing factors in medical product design.

Product appearance has influence on the consumers' perception. It can provide information about the function, usability and connotates an environment in which the product would fit. Colour has the strongest influence on affective responses. The colours white and blue characterize medical products the most. Products which do not fit a certain environment or in which the functionality is not obvious cause negative emotions such as irritation and disgust. Medical devices for professional are likely to evoke these emotions. Therefore, designers should find a balance between functionality and design in medical product design to create a caring and friendly appearance of these products. This might change the negative connotation with "oldfashion", "dull" and "bulky" hospital products. Consumers tend to like products with modern and sleek design and products that are related to their concerns. For instance, an employee in a medical setting will have different preferences toward a medical product than a consumer. Aesthetic and symbolic value in products, and also medical products, differs strongly due to subjective experiences.

Redesign Concept

A redesign of concept 1 is made on basis of the results of the conducted test. (fig. 40).

The material of function of the "blue things" were not obvious and seem to look easy to break. The appearance of the material was improved to show that this component is thick plastic. The intended function of this part is to store water for respiration during ventilation. The cable slot for the hose is located to the front surface to implicate that this is an important function. This slot connects the device with another component (hose) which is important for the use.

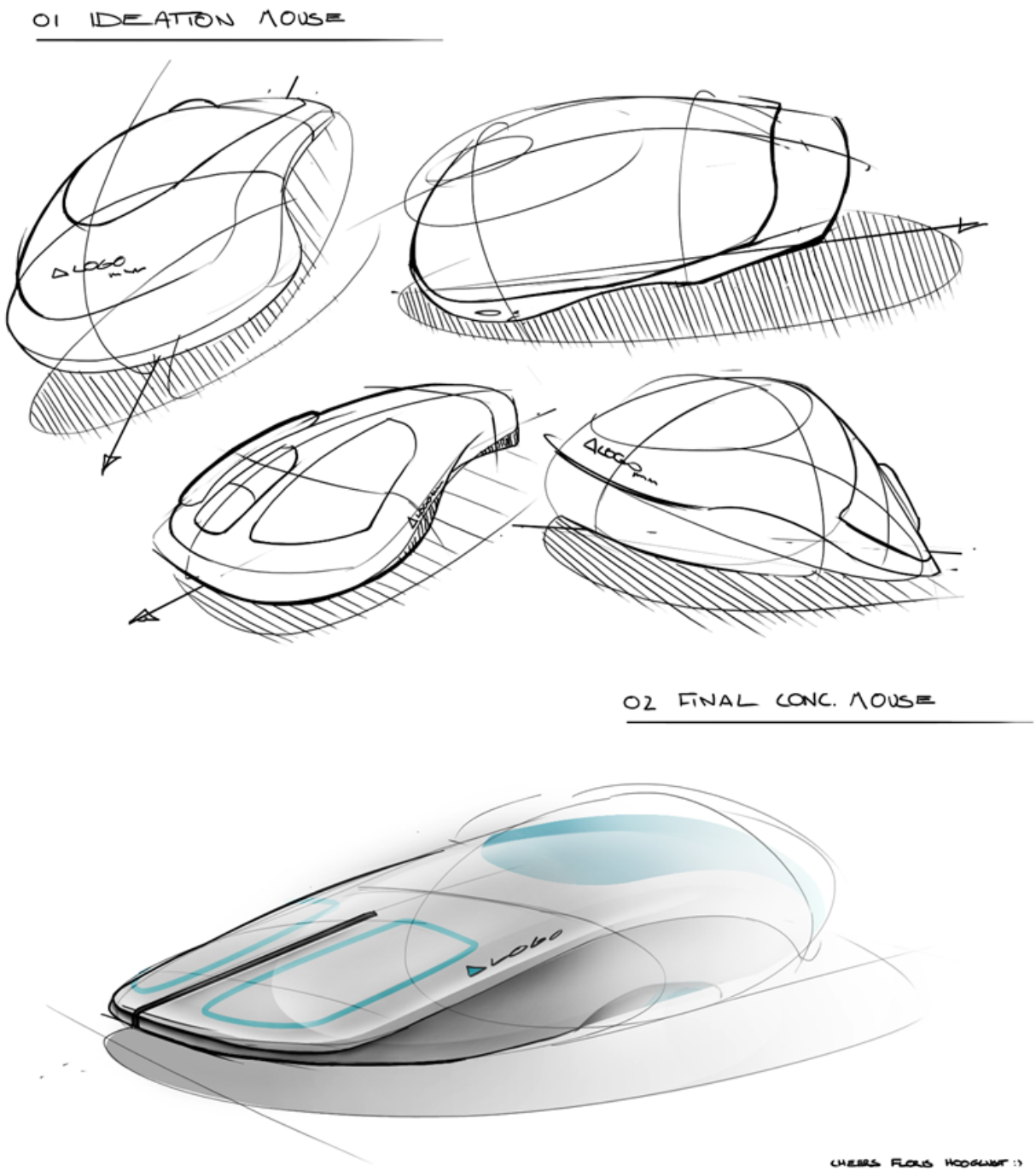


Figure 41: Results of guideline testing

09 | Guideline testing

Post-test

One of the guidelines were given to a design student in order to test whether he can use the guideline to design a product of choice with a medical appearance. It was not asked to design a medical device but to choose any prototypic *item to apply the guidelines.*

The design should include:

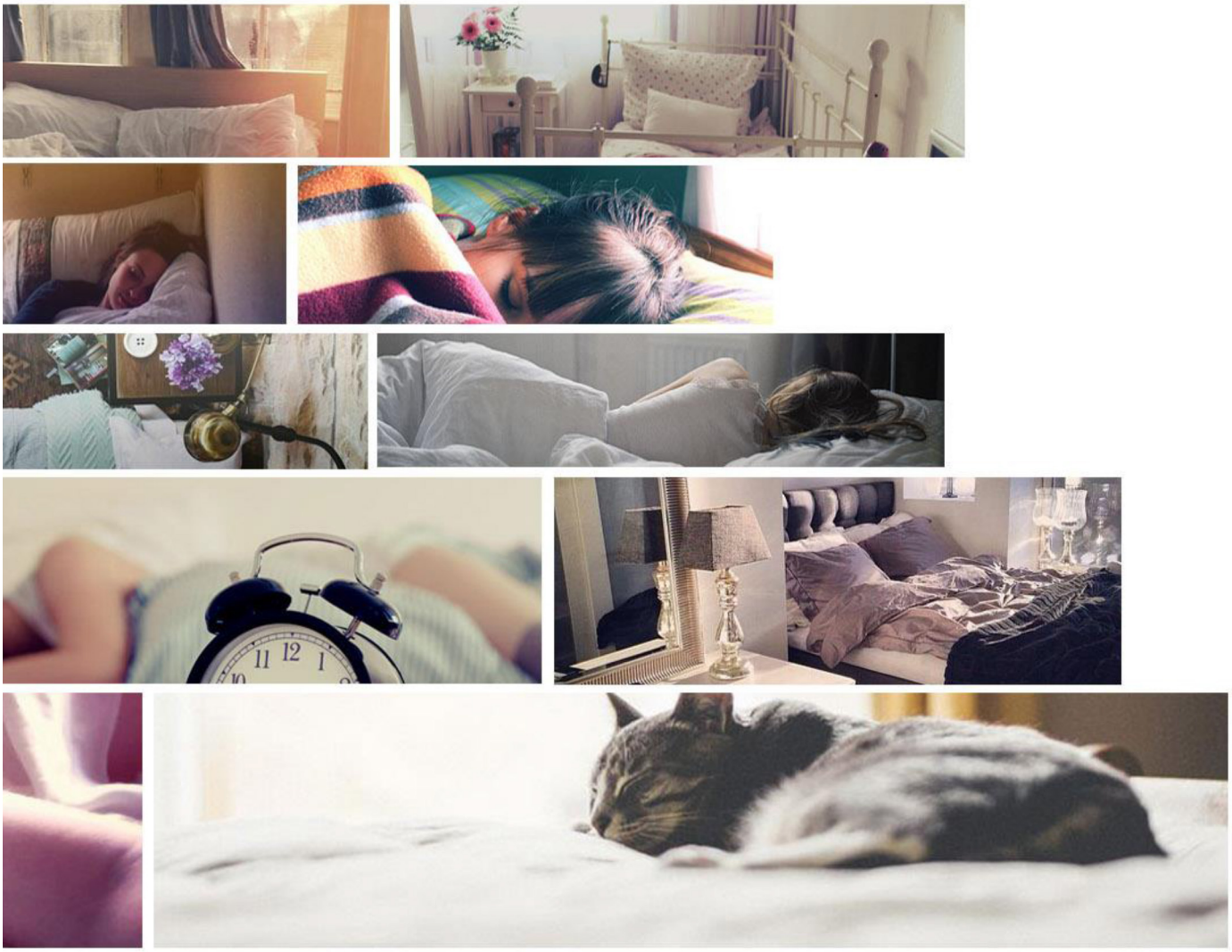
- *Rugged, compact design, light weight, portable, hand-sized form*
- *Round shapes, robust*
- *Curved lines*
- *Hand formed shaped*
- *Functionality should be obvious*
- *Ease of use: less buttons, intuitive design, common icons*
- *Ergonomics: portable*
- *Colour : black/ white with blue or green accent colour*
- *Characteristics: portable, handy, lightweight, rugged design, symmetric*
- *Friendly appearance*

Conclusions (my opinion)

Even though the concept is not a medical device, this computer mouse fits in the medical environment because of its colours. It has a medical appearance but will not be associated with the negative impressions of a hospital due the curved shaped and friendly appearance. This is a good example of how designers should find the balance between appealing in design and functionality like it is shown in this concept.

Reflection of the design student

According to the design student was this way of testing very interesting because the result is very explorative. Both, the test person and the tester do not know what the result will be. When he read the assignment he already had an idea in his mind but after 1 hours it turned out to be something different. All in all, is he content with his result because he fulfils the guideline but he would advised to clarify ambiguous terms such as “hand formed shaped” in before to avoid misunderstandings. A post-post test may be also interesting to confirm the guideline.



RECOMMENDATIONS |

10 | Recommendations

This section will reflect on the results of the assignment, followed by recommendations for further research.

Complete product experience
To analyse product experience as a total other influences on affective responses should be considered as well (auditive, kinematic, olfactory). Even though visual influence has the most impact on the consumers' perception, other influences such as tactile information and audio information contribute to product experiences as well. In stores prototypes of products allow the user to touch and feel it. Visual appearance will draw attention and gives impression of attractive design. Tactile experience can increase or decrease the possibility of purchasing a certain product. Feeling a material can provide more impression about the quality of a product whether it seems to be cheap or high quality.

Prototypes
During the test visual pictures of products were used. Although a reference model was given estimation of the dimensions might be too vague. It would be ideal to retake the test with real prototypes.

Buying, owning and using the product
This assignment considers only emotions evoked by seeing a product appearance but not those evoked by buying, owning or using the product. Medical products are purchased because of health reasons. The interaction with the product decides in the end if the user will continue using that product or not (positive vs. negative experience).

More test participants
Self-report is the only method to measure subjective emotions. More respondents are needed to achieve significant results. When more respondents perceive the same product experience the influence is more effective and will prove the visual effects on emotional responses.

Other cultures, gender and different ages of respondents
How does product experience differ between ages, gender and cultures of consumers? The conducted test does not consider these differences which have influences on the personal associations. It is recommended to divide respondents in different cultures, ages and gender in order to find evidence to what extent these differences have influence on visual product experience.

11 | Reflection

Three months of intensive work has passed very fast. My project started in the summer vacation with many problems. Firstly, it was not easy to find a suitable supervisor who could guide me during the whole three months. Secondly, my first project day was simultaneously the first day of the holidays at benchmark. As a consequence, I need to work the first two weeks on my own which was very difficult. I planned the next 12 weeks with a project structure strictly without knowing what was necessary for my assignment. The assignment was not very straightforward which meant that there was no clear defined goals from the beginning of my assignment. The assignment was more explorative which was on the one hand good because it gave me a lot of freedom to which direction I wanted to turn but on the other hand it was not satisfying to work on a project where the destination was not predictable. I tried to create a clear structure during the project because in the end a lot of additional research was done. In July I planned three weeks for my analysis phase which has to be expand to 9 or 10 weeks.

This assignment was the first time that I needed to read so much literature. The literature analysis gave me a good impression about design at general and confirmed my interest in design and emotion.

The testing moments were a fine variety to the research studies because the results are very explorative.

Overall I am satisfied with the result of my assignment. There were a lot of struggle moments during the three months especially when you got stuck in the analysis phase and had the feeling that you did not achieve anything. I feel that I have learned a lot as a designer and could improve my skills through this assignment.

Literature

Blijlevens, J., Creusen, M. E., & Schoormans, J. P. (2009). *How consumers perceive product appearance; the identification of three product appearance attributes*. International journal of design, 3 (3) 2009.

Chapman, J. (2015). *Emotionally durable design: objects, experiences and empathy*. Routledge.

Creusen, M. E., & Schoormans, J. P. (2005). *The different roles of product appearance in consumer choice**. Journal of product innovation management,22(1), 63-81.

Crilly, N., Moultrie, J., & Clarkson, P. J. (2004). *Seeing things: consumer response to the visual domain in product design*. Design studies, 25(6), 547-577.

Desmet, P. M. (2002). *Designing emotion*. TU Delft, Delft University of Technology.
Desmet, P. M., & Hekkert, P. (2002). *The basis of product emotions. Pleasure with products, beyond usability*, 60-68.

Desmet, P., & Hekkert, P. (2007). *Framework of product experience*.International journal of design, 1 (1) 2007.

Desmet, P., van Erp, J. & Karlsson, M. (2008). *Design & Emotion moves*. Cambridge Scholars Publishing

Eger, A., Bonnema M., Lutters, E. & van der Voort, M. (2010). *Productontwerpen*. Boom Lemma

Force, A. O. S. A. T., & American Academy of Sleep Medicine. (2009). *Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. Journal of clinical sleep medicine*: JCSM: official publication of the American Academy of Sleep Medicine, 5(3), 263

Grob, M., *Usability extrapolation for the non-invasive continuous blood pressure meter*, MsC. Thesis, Benchmark Electronics, 2012

Kapferer, J. N. (2012). *The new strategic brand management: Advanced insights and strategic thinking*. Kogan page publishers.

McDonagh, D., Hekkert, P., van Erp, J., & Gyi, D. (Eds.). (2004). *Design and emotion*. CRC Press.

Nielsen, J. & Mack, R.L. *Usability Inspection* Methods. John Wiley and Sons, New York, NY, 1994

Norman, D. A. (2004). *Emotional design: Why we love (or hate) everyday things*. Basic books.

Reeves, B., & Nass, C., (1998). *The media equation: How people treat computers, television and new media like real people and places*. Cambrigde: Cambrigde University Press.

Simonson, A., & Schmitt, B. H. (1997). *Marketing Aesthetics: The Strategic Management of Brands, Identity, and Image*. Simon and Schuster.

Van Gorp, T., & Adams, E. (2012). *Design for emotion*. Elsevier.

Wickens, C. D., Lee, J. D., Liu, Y., & Gordon-Becker, S. (1998). *Introduction to human factors engineering*.

Reference list

A list of sources consulted in this assignment

Websites

Benchmark Electronics, our company, http://www.bench.com, retrieved on 21st July 2015

Weinmann, Medical Technology, http://www.weinmann-medical.com/, retrieved on 21st July 2015

Sleep apnea as illness
https://en.wikipedia.org/wiki/Sleep_apnea
retrieved on 20th July

Sleep apnea information
http://www.sleepapnea.org/
retrieved on 20th July

Sleep apnea treatments
http://www.mayoclinic.org/diseases-conditions/sleep-apnea/basics/treatment/con-20020286
retrieved on 21th July

Diverse concurrents sleep apnea devices, http://www.cpapsupplyusa.com/cpap-machines/cpap-machines/machine-type/auto.aspx, retrieved on 25th July 2015

Emotion in Product Design, http://www.slideshare.net/lukewoolfson/emotioninproductdesign?related=2
retrieved on 7th August 2015

Definition of Medical Device | World Health Organization, http://www.who.int/medical_devices/full_deffinition/en/
retrieved on 3rd September 2015

Medical design (in general)
http://www.fastcodesign.com/3023100/the-next-big-frontier-in-industrial-design
retrieved on 3rd September 2015

Design & Composition, Emphasis in Design,
http://daphne.palomar.edu/design/emphasis.html
retrieved on 14th September

Color in Medical Product Design, Forma, 2015
http://www.formamedicaldevicedesign.com/color-in-medical-product-design/, retrieved on 19th August 2015

Shape & Form, Categories of Shape and Form,
http://tcdsbstaff.ednet.ns.ca/cbuchanan/Visual%20Arts%2010/Unit%205/Categories%20of%20Shape%20and%20Form.pdf, retrieved on 19th August 2015

Design Principles, http://msfrankel.com/design_principles/elements/presentations/shape.pdf, retrieved on 19th August 2015

Resmed, Sleep devices, http://www.resmed.com/, retrieved on 22th August

Definition Archetype, Wikipedia, https://en.wikipedia.org/wiki/Archetype, retrieved on 17th September 2015

Archetypes & Design Principles, https://medium.com/@paulfarino/developing-archetypes-2db5ab34043c
http://www.doctordisruption.com/design/the-principles-of-design-16-archetypes/, retrieved on 17th September

Gestalt Principles, http://www.creativebloq.com/graphic-design/gestalt-theory-10134960
http://graphicdesign.spokanefalls.edu/tutorials/process/gestaltprinciples/gestaltprinc.htm, retrieved on 21st September 2015

Three elements of good design, http://zurb.com/article/1128/the-3-elements-of-good-design-usability-u, retrieved on 21st September

Images

Figure 3: http://www.slideshare.net/jaxinteractive/what-is-user-experience-design
Figure 8: prEmo pictograms, http://www.martyncatchpole.co.uk/wp-content/uploads/2015/01/premo-men.jpg

Appendix

Additional material used and created in this assignment

Figure X: Common causes of sleep apnea

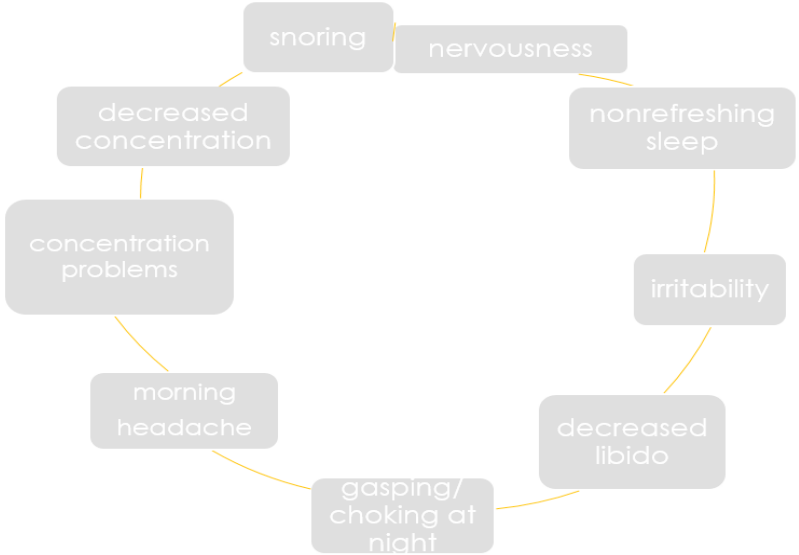


Figure .: Symptoms from sleep apnea

Sleep apnea

The sleeping problem, symptoms and treatments

Sleep apnea

"Apnea" characterized a pause in breathing or infrequent breathing during sleep. Each pause (apnea) can last for some seconds to few minutes. There are three forms of sleep apnea: central (CSA), obstructive (OSA), and complex or mixed sleep apnea (i.e. a combination of central and obstructive).

A | Central sleep apnea

CSA occurs by a lack of respiratory effect. The brain's respiratory control centers are imbalanced during sleep. The brain fails to transmit signals to the breathing muscles. The sleeper stops breathing for up to two minutes and then starts again.

B | Obstructive sleep apnea

In OSA breathing is difficult when the muscles in the back of your throat relax. This narrows the airway. At the same time, blood pressure and pulse are reduced. The sleeping person wakes up. This wake up reaction is called "Arousal". Common symptoms of OSA are snoring, fatigue, dry mouth or throat, observed breathing pauses during sleep. Obstructive sleep apnea is the most common type of sleep apnea.

Causes of sleep apnea

Sleep apnea can occur because of different causes, in the most case in combination of several causes. Risk factors for OSA include physical attributes, such as having a thick neck or enlarged tonsils or adenoids. CSA is often associated with serious illness, such as stroke, neurological disease or brainstem injury.

Symptoms

People who suffer from breathing disorders are often fatigue, have a slower reaction time and vision problems. This may increase chances of work related and driving accidents. In the worst case OSA leads to death because of lack of oxygen to the body.

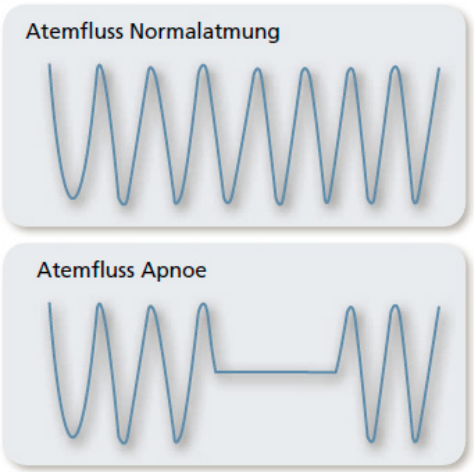


Figure X: (a) airflow of breathing without disorders
(b) airflow of breathing with sleep apnea

Patients of sleep apnea

Sleep apnea occurs regardless of age, gender or race. Studies have shown that overweight or obese male, over age 40 with having a large neck size are most affected by sleep apnea. In addition, smokers have sleep apnea at three times the rate of non-smokers (Epstein et al., 2009).

Figure X: Steps to good sleep

Common treatments for sleep apnea

A| Positive airway pressure therapy

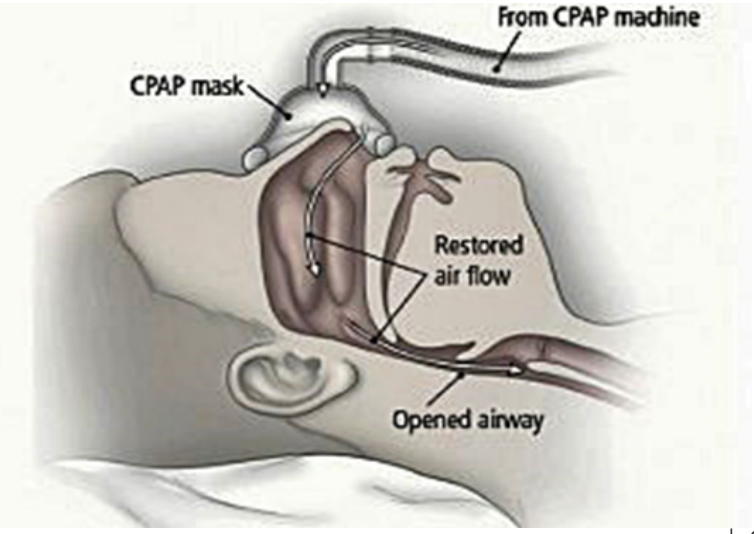
CPAP (Continuous Positive Airflow Pressure)
The most common treatment for different levels of obstructive sleep apnea is Continuous Positive Airflow Pressure (CPAP). The CPAP device is a "mask-like" machine which provides constant air that keeps the breathing passages open during sleeping. Sleep apnea is prevented by providing air into a mask that covers the nose and mouth.
BPAP (Bilevel positive airway pressure): This treatment is used when a higher pressure is needed. This device automatically adjusts the pressure. It provides more pressure when you inhale, less when you exhale.
APAP (Automatic positive airway pressure): This devices tracks the normal breathing pattern and automatically varies airflow pressure regarding on the patient's needs.

B |Oral appliance therapy
A mouthpiece holds the jaw in a forward position to expand the space behind the tongue to prevent sleep apnea, snoring.

C | Surgery
An invasive surgery can change the exact area of obstruction in the respiratory tracts.

The way to good sleep (fig.X)

If a person suffers from sleep apnea the first step is to clarify the symptoms with the general practitioner. The doctor will transfer him to sleep professionals. A diagnostics contains several steps. Usually a pre-examination will be done. Here the person gets a small diagnostic device for a pre examination at home for one night. This diagnostic device measures factors such as breathing, heart frequency, snoring sounds and oxygen saturation during sleeping. Furthermore it records the sleeping positions and if breathing breaks occur. If the patient is diagnosed with sleep apnea the patient will be transferred to a sleeping lab for further examination. This examination allows final diagnostic about the grade and type of sleep apnea in order to choose the right sleep apnea treatment.



Sleep diagnostic

SOMNOcheck micro

SOMNO lab 2

Sleep therapy

prismaLINE

SOMNOvent CR

SOMNObalace e

Ventilation

VENTIlogic LS

VENTIlogic plus

VENTImotion 2

Weinmann's sleep therapy

Weinmann's sleep therapy

Depending on the type of therapy Weinmann provides different sleep therapy devices.
The devices can be divided in three main applications area: sleep diagnostics, sleep therapy and ventilation.

Sleep diagnostics
SOMNOcheck micro: Screening Device for the Wrist
SOMNOlab 2: mobile Sleep Diagnostic System for professionals

Sleep diagnostics is about measuring the breathing rhythm during the night to examine sleep for signs of Sleep-Disordered Breathing.

Sleep therapy
When a person is diagnosed of sleep apnea he can choose for a sleep therapy to get better sleep. Regarding on the type and severity grade of sleep apnea an adjusted treatment will be chosen. Weinmann provides a wild range of sleep therapy devices for home treatment. Currently three product lines are offered within Weinmann:
- prismaLINE: for treatment of respiratory disorders
The primaLINE is the newest product line of Weinmann with subtypes for every sleep apnea types. The prismaLINE includes a modern and compact design.
SOMNOvent: this product line is the medicine solution for heart failure, complex sleep disordered breathing and obstructive sleep apnea or high or changing pressure needs.

Ventilation
A ventilation device for hospitals incorporate more technical solutions like more alarms or flow measurement (better accuracy) or backup battery in order to meet the needs of the patients with different diseases. Examples of ventilation products are:
- *VENTIlogic*
- *VENTImotion*

Benefits of a sleep apnea device
The purpose of a sleep apnea device is to take away the struggle between breathing and sleep. Reducing symptoms of sleep apnea increases energy and improves mental alertness during the day. Often, the bed partner of someone with obstructive sleep apnea has a sleep problem too, brought by the constant awakenings and snoring of the person with apnea. A treatment will likely improves their lives and the lives of those they love.

Design elements

The basics of design

Design elements are the basics of a design, painting, drawing or other visual pictures. A product will be judged based on its product appearance, thus on the elements of its design. In this section important design elements will be described in order to understand general design principles and their role in product appearance.

Archetype

A consumer is always confronted with products in which the function is more or less obvious. In most cases products are designed with obvious functionality. The consumer can see immediately how to the product can be used. Adding cues to a design helps consumers to make an estimation of the ease of usage and will avoid negative emotions such as irritating and frustration. Sometimes though, it is intended that the function is not visible. In some medical products the appearance is intended to look like a "normal" consumer product than to look like a medical operating device.

Common characteristics of a product determine the archetype. An archetype is the original pattern or model from which copies are made (gr. Arche: "beginning, origin", tupos: "pattern/ model/type").

Archetypes can be found everywhere (e.g. in themes of myth, characters in literature or in branding marketing). This depends on the century and on the region of the product. Designers always need to focus on archetypes (except totally new products). In this case the designer has the choice whether to refer to an archetype or whether to distance. Designing close to the archetype will create unconscious familiarity of products through form, function and emotional relationship of a product, experience or brand for the consumer and make it easier to identify

Shape and volume

The shape and volume of products are important characteristics of product design. The dimensions of the product decide in most cases the application of the product. Due to a high amount of possible applications products vary in shape and forms from small complex irregular shapes to big round shaped products.

Shape

A shape is a basis elements and is a form of an objects.

When a line curves around and crosses itself or intersects other lines to enclose a space, it creates a shape. Similar to silhouette or an outline, a shape is two-dimensional. It has height and width, but no depth.

Volume

A volume or a form has three dimensions: length, width, and depth. Forms can have one continuous surface like a ball or many surfaces like a pinecone. Designers can impact the perception of volumes in many different ways. Small changes such as chamfers, fillets or cuts of the product appearance can influence the volume appearance.

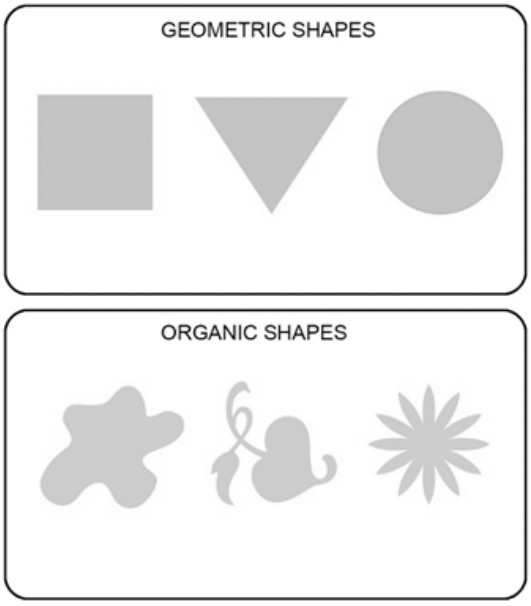


Figure X: geometric and organic shapes

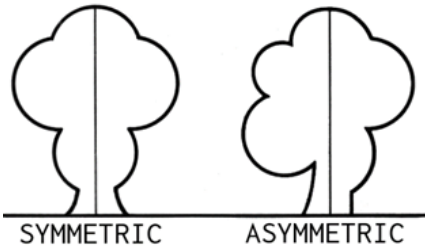
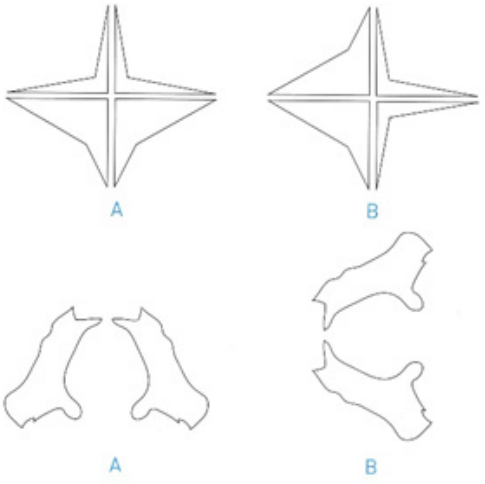


Figure X: Symmetric and asymmetric of a tree



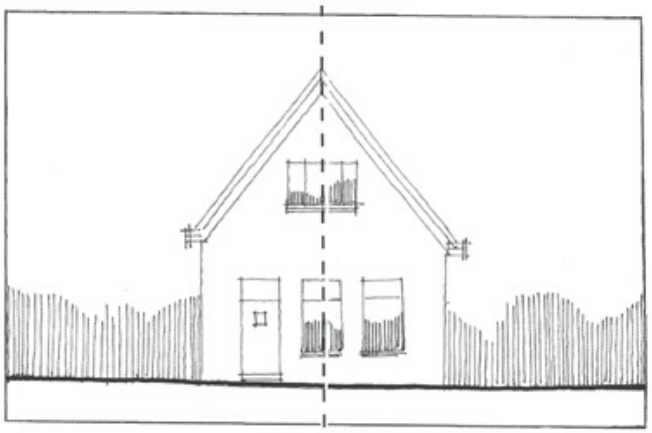


Figure X: Pictures A are stronger recognize then pictures B. Symmetry around the vertical axis appears stronger than symmetry around the horizontal axis.
A predominantly symmetric house appears symmetric even though the door and the windows are asymmetric.
(adopted from Eger et. al, 2010)

Categories: Geometric and Organic Shapes

Simple shapes can be put in two basic categories: geometric and organic.
Geometric shapes are sharp and precisely constructed. Geometric and organic shapes can be angular or curved. Curved shapes seem graceful and tend to imply movement.
Angular shapes are straight-edged and suggest strength and regularity.
Examples of geometric shapes are e.g. circles, squares, and triangles.
Most natural objects have organic shapes. Organic shapes vary in form and shapes. They are curved or rounded and appear in variety of informal and irregular shapes.

Symmetry / asymmetry
Symmetry is possible on the vertical and horizontal axis. Products and buildings are mostly ordered around the vertical symmetry axis. This is because symmetry around the horizontal axis will not be recognized as often as around the vertical axis. Symmetry provides the feeling of solidity and order which is something people tend to seek. By applying symmetry or asymmetry certain effects can be achieved:

Symmetry	Asymmetry
Static	Dynamic
Balance/ harmony	Instability
Without direction	Direction/ movement

Figure X: Effect of symmetry and asymmetry (adopted from Eger et. al, 2010).

In most cases products and elements are not fully symmetric but predominantly symmetric.

Direction/movement
The apparent orientation of forms and patterns depends on the viewing angle of the observer. In figure X it seems that the equilateral triangles point to direction 1. But depending on the focal point of the viewer the triangles can also point in the direction 3 or 2. This effect is weaker than the pointing to direction 1.

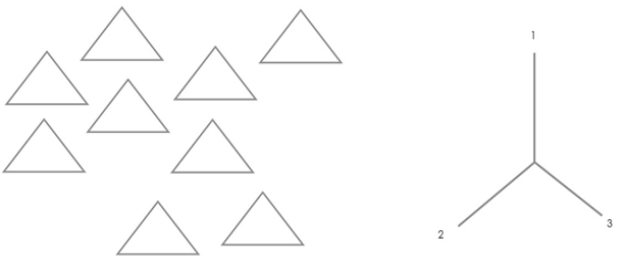


Figure X: Equilateral triangles

Texture
By applying texture in products their appearance can be changed. Smooth, even, polished surfaces tend to appear hard. A dull surface can evoke a soft form. The perceived volume of the products is smaller. Texture can also improve tactile experience (e.g. rubber surface on a toothbrush).

Color
Colors are one of the most dominant factors in design. The use of colors has many reasons: accentuating functions and options, association of the function etc. Products with brighter colors seem to have a bigger volume than products with dark colors. A good choice of the product color is very important. It can mean the difference between ugly and beautiful. Next to personal preferences color preferences and association are various in different cultures. For all product research the color analysis is essential.

Design test Questionnaire

PART 1
Do the following form models (scroll down) fit in the environments: Home, Hospital, Travel?
Please rate them whether you think that they would fit in the specific environments or not.
All you considerations should only be based on the appearance of the models
(1= not agree, 3=neutral, 5= strongly agree)

Note #1 : You do not need to know what that model/ product is.
Note #2 : And scroll down to see all pictures of the concepts.
Note #3 : The reference model is used for scale.

Do the models fit in the specific environments?
(1= I don't agree, 3= neutral, 5= I strongly agree)

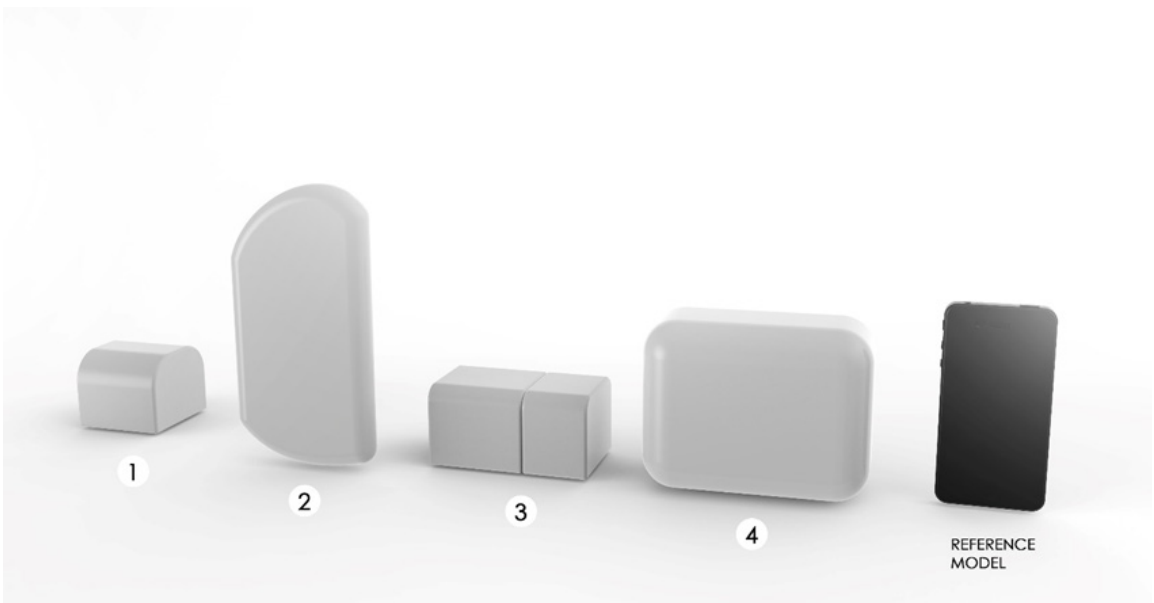
Model 1: Home _____, Travel _____, Hospital _____

Model 2: Home _____, Travel _____, Hospital _____

Model 3: Home _____, Travel _____, Hospital _____

Model 4: Home _____, Travel _____, Hospital

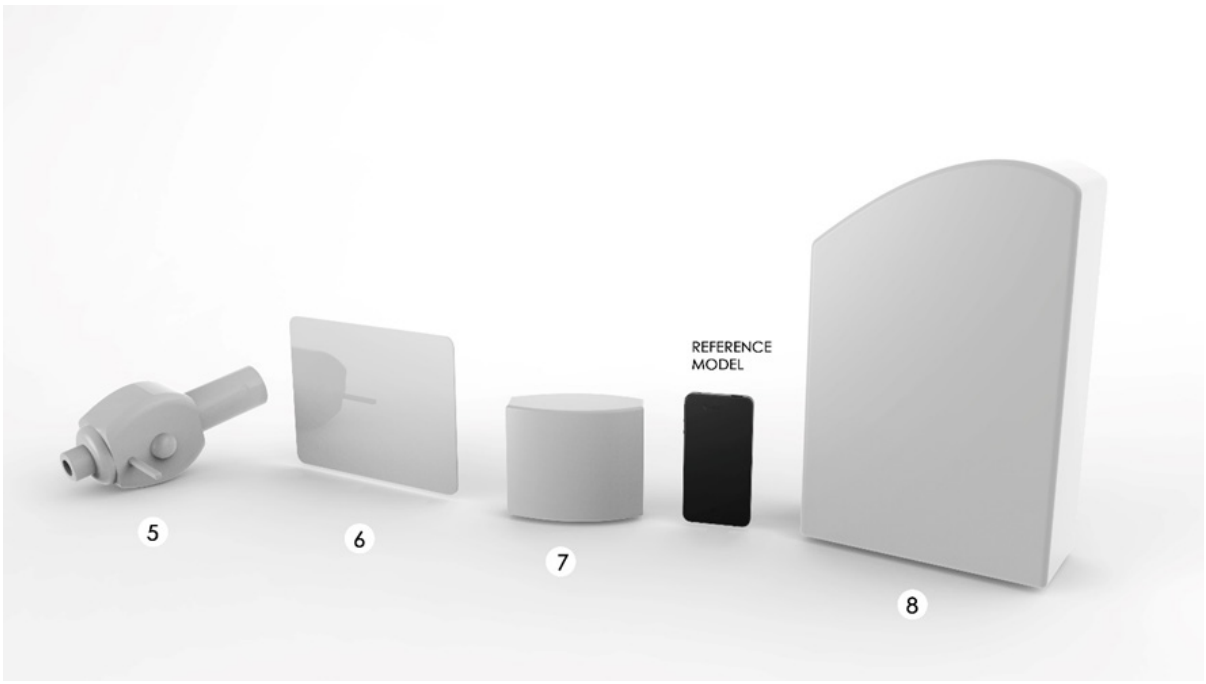
Model X: Home ____, Travel ____, Hospital

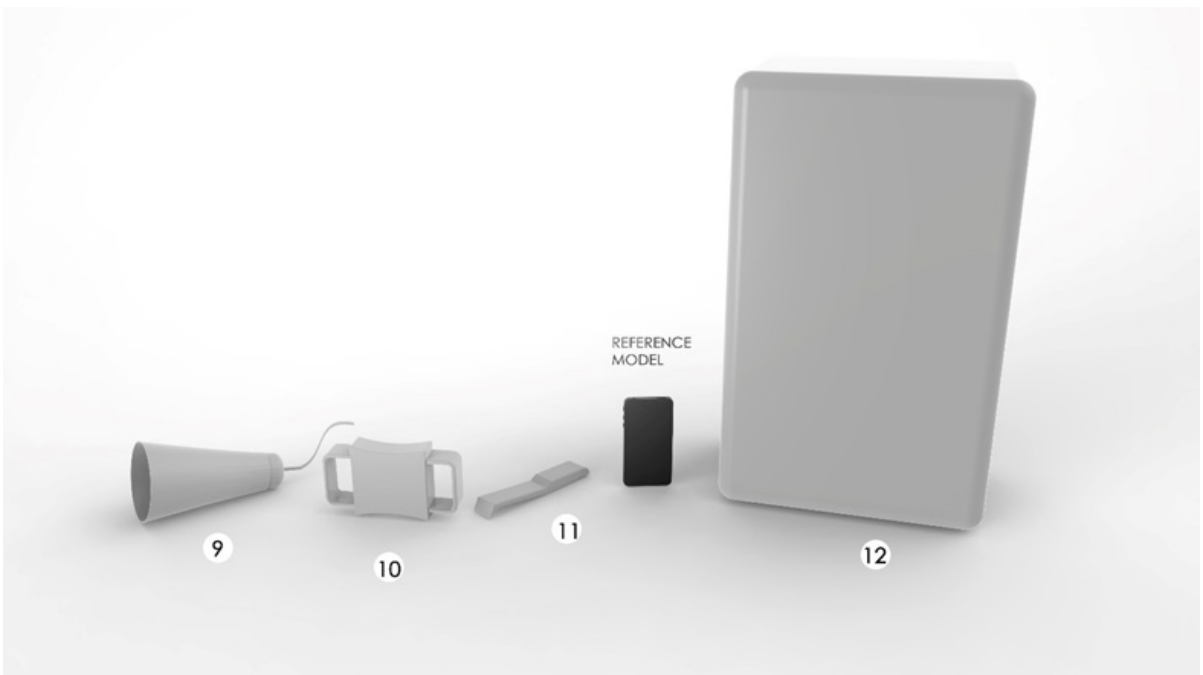


Models 1-4

Test questionnaire

Short-version of the test questionnaire



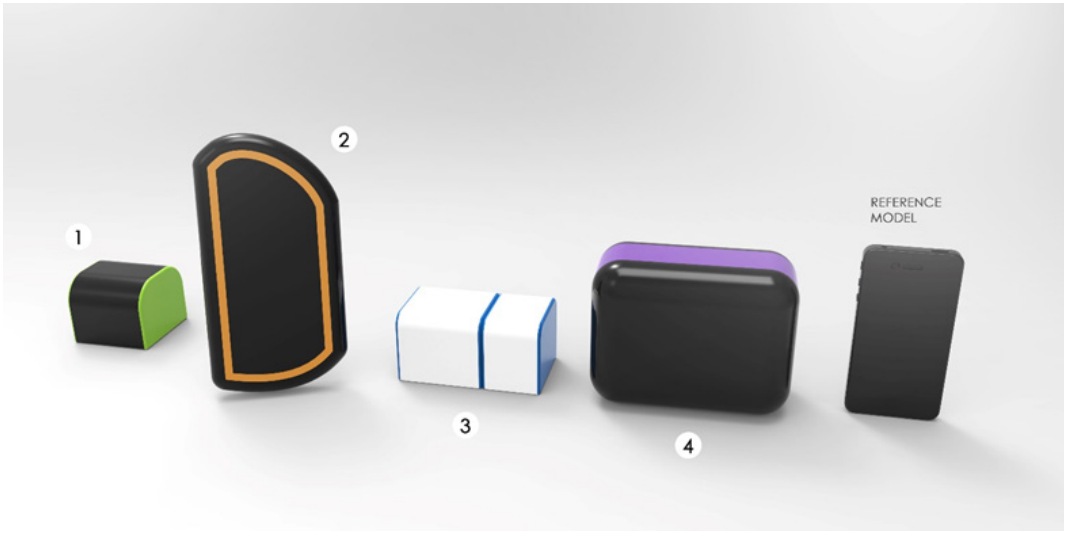


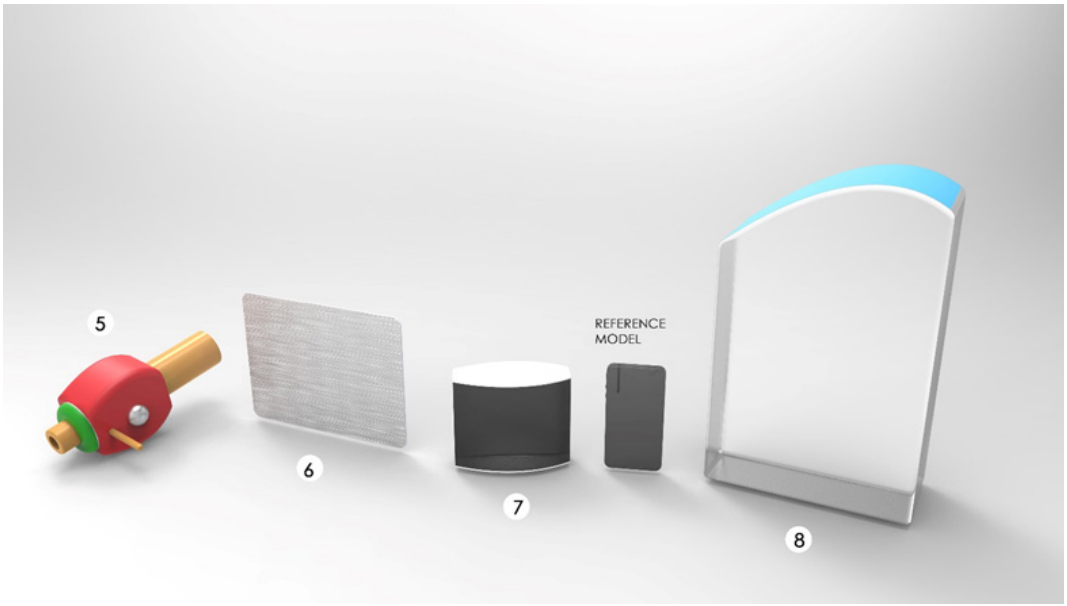
PART 2
Colors (+Materials) were added to the same models.
Please rate them whether you think that they would fit in the specific environments or not.
All you considerations should be based on the appearance of the models
(1= not agree, 3=neutral, 5 (strongly agree)

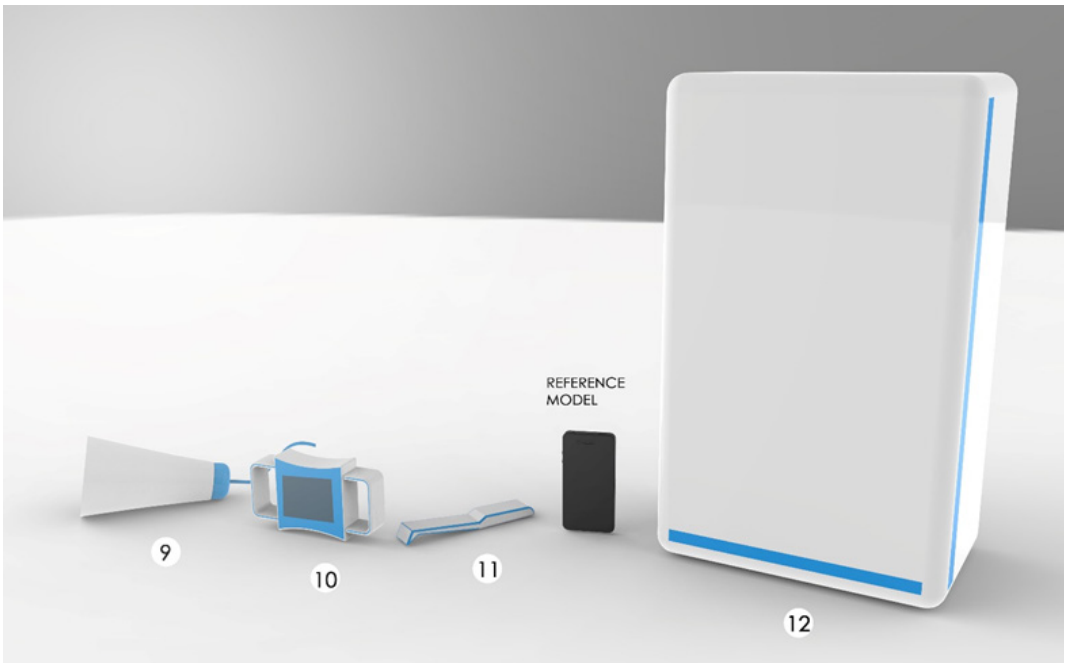
Do the models fit in the specific environments?
(1= I don't agree, 3= neutral, 5= I strongly agree)

Model 1: Home _____, Travel _____, Hospital _____
Model 2: Home _____, Travel _____, Hospital _____
Model 3: Home _____, Travel _____, Hospital _____
Model 4: Home _____, Travel _____, Hospital

Model X: Home ____, Travel ____, Hospital_____







PART 2B
Did your decisions changed through the added colors?
YES [ ] NO [ ]

To what extend did the color change your perception of product appearance?

Which colors are in your opinion characteristic for the specific applications home, hospital and travel?

Home:

Hospital:

Travel:

PART 3
The following questions are about concept 1

Do like the design of concept 1?
YES [ ] NO [ ]

Do you think that's is an attractive design?
YES [ ] NO [ ]

Why? _____

Why not? _____

When looking at this product what do you think is this product? _____

What is the application of this product? _____

What do you think it the function of this product? Why do you think that?

Do you think that the usage of the product is easy or not?
YES, EASY [ ] NO, NOT EAST [ ]

Does the product look safe?
YES [ ] NO [ ]

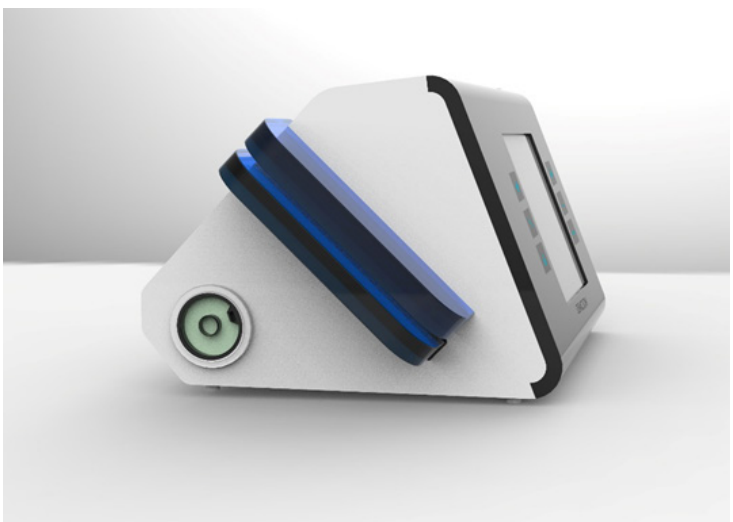
Why and why not?

Do you think that the product has a good quality?
YES [ ] NO [ ]

Can you explain your answer?

What are your associations with this product?

Does it reminds you of other similar products?
YES [ ] NO [ ] Which one: _____



PART 4
The following questions are about concept 2..

Do like the design of concept 2?
YES [ ] NO [ ]

Do you think that's is an attractive design?
YES [ ] NO [ ]

Why? _____

Why not? _____

When looking at this product what do you think is this product? _____

What is the application of this product? _____

What do you think it the function of this product? Why do you think that?

Do you think that the usage of the product is easy or not?
YES, EASY [ ] NO, NOT EAST [ ]

Does the product look safe?
YES [ ] NO [ ]

Why and why not?

Do you think that the product has a good quality?
YES [ ] NO [ ]

Can you explain your answer?

What are your associations with this product?

Does it reminds you of other similar products?
YES [ ] NO [ ] Which one: _____

PART 5
The following questions are about concept 3

Do like the design of concept 3?
YES [ ] NO [ ]

Do you think that's is an attractive design?
YES [ ] NO [ ]

Why? _____

Why not? _____

When looking at this product what do you think is this product? _____

What is the application of this product? _____

What do you think it the function of this product? Why do you think that?

Do you think that the usage of the product is easy or not?
YES, EASY [ ] NO, NOT EAST [ ]

Does the product look safe?
YES [ ] NO [ ]

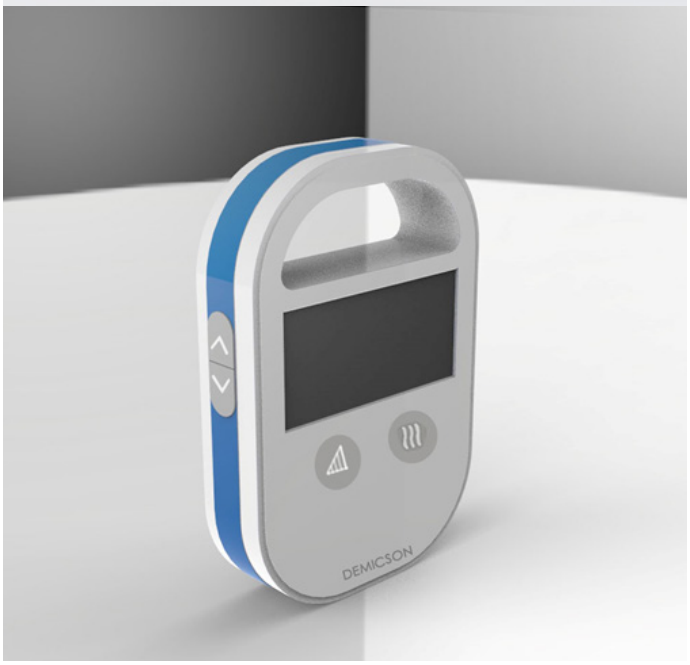
Why and why not?

Do you think that the product has a good quality?
YES [ ] NO [ ]

Can you explain your answer?

What are your associations with this product?

Does it reminds you of other similar products?
YES [ ] NO [ ] Which one: _____



FINAL PART

Imagine that you suffer from sleep apnea and need to buy a sleep apnea device for the first time.
When you have sleep apnea you cannot sleep at night properly. The doctor shows you these three kinds of sleep apnea devices.
A sleep apnea device provides constant air to keep the breathing passages open during sleep. They all have do not differ on basis of their function and their price.

Which one would you prefer on the basis of the product appearance?
Please explain why do you prefer that specific one and why not the other ones.
(Note: the products are not in the same scale).