CHALMERS

The Future of the Retail Spotlight Zone

Development of a Facelift and Future LED Solutions

Master of Science Thesis [in the Master Degree Programme, Industrial Design Engineering]

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Department of Product and Production Development
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Abstract

This master's thesis focuses on further developing Fargerhult Retail's retail spotlight family called Zone. Zone is one of Fagerhult Retail's oldest products and the company felt a need for a new direction and inspiration for the future development of the product family.

The development work was divided into two parts. The first part focused on a quicker solution, a facelift, where only the ballast box and the front ring of the spotlight were considered for change. The second part focused on implementation of LED technology. The purpose was to examine what characteristics a new product family based on LED, replacing the existing one, would have.

The development work consisted of an initial analysis phase where the present situation was analysed. This analysis formed the foundation for the future work. Findings from the analysis phase stated that the Zone product family did not express the Fagerhult core values and this, together with the functionality of the front ring was the focus of this part of the project. The result of the facelift phase was three functional concepts and three visual concepts, together spanning the range of possibilities of a facelift. This was presented on a realistic level, taking cost and manufacturing aspects into consideration.

In the second part of the project, the LED implementation, the focus was on how LED could be used in luminaires in a retail context in ten to fifteen years. To deal with the uncertainties of the future, scenario planning was used to focus the product development work. The result of the LED phase was four future scenarios of LED in retail environments and conceptual LED products; a LED spotlight system, a LED control system and suggestions of OLED implementations.

The methodology and theory used within this thesis is a part of the methodology and theory taught at Industrial Design Engineering at Chalmers University of Technology, Gothenburg, Sweden. Examples of used methods and theory are: branding theory, design format analysis, interviews, mock-ups, moodboards and scenario planning. However, when methods were lacking the project group produced their own methods such as the Google probability method and Visual benchmarking.

This report is written in English

Keywords: Spotlight, Luminaire, Fixture, Retail, LED, Facelift, Scenario planning

Preface

This is the master's thesis of Alexander Andersson and Charlotta Skoog. It has been carried out as a part of the master in Industrial Design Engineering at the division of Design and Human Factors at the Department of Product and Production Development at Chalmers University of Technology in Gothenburg, Sweden. This thesis has been conducted in collaboration with Fagerhult Retail AB in Bollebygd, Sweden where most of the work has been carried out. The project ran from February to May and September to October 2010 and consisted of 30 ETCS.

First of all we would like to thank everyone at Fagerhult Retail for answering all our questions and for being our colleagues for four months. We would especially like to thank Mathias Oskarsson for giving us direction and the courage to trust our ideas.

At Chalmers we would like to thank our tutor and examiner, Ulrike Rahe, who has supported us and given us valuable advice throughout the project. Special thanks also to Stephan Mangold and Harald Merkel from Stiftelsen Chalmers Industriteknik who were tremendous assets to the project.

Finally we would like to thank our opponents, Christofer Alvenby and Sara Renström for giving valuable comments on this project, and thank Taina Flink for proofreading.

Thank you!

Gothenburg, October 2010
Alexander & Lotta

Terms and Abbreviations

The following definitions of terms and abbreviations have been used in this report.

Fagerhult Group: A lighting company
Fagerhult Retail: A company within the Fagerhult Group
Fagerhult: A product brand within Fagerhult Retail

Glare: The difficulty of seeing in the presence of bright light
Luminaire: A light fixture: the complete unit, including lamp, reflector, ballast, socket, wiring, diffuser, and housing. (http://www.sylvania.com/BusinessProducts/Glossary/)
Rectifier: A piece of electrical equipment that changes alternating current (ac) to direct current (dc) (http://www.macmillandictionary.com/dictionary/british/rectifier)

LED: Light Emitting Diode
OLED: Organic Light Emitting Diode
MT: Metal halide light source, used for high wattages
STH: Metal halide light source, used to enhance red colours in products
MTC: Metal halide light source, used for medium wattages
MTm: Metal halide light source, used for low wattages
HMG 111: Halogen light source

The Zone family: A family of spotlights produced by Fagerhult Retail
ZonePoint: A track bound spotlight within the Zone family
ZoneSingle: A recessed spotlight within the Zone family
ZoneBeam: A recessed spotlight within the Zone family, used in the Zone systems
Zone systems: Modular systems of several spotlights, using ZoneBeam

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1. Introduction

Light is an important part of our everyday lives. A warm and cosy light can make us feel calm and relaxed while a bright bluish light can make us feel energetic and active.
There is an intuitive relationship between light and feelings and this relationship is used within retail lighting.

Retail lighting is an important part of today's stores. Together with the interior decorations it builds up the ambiance in the stores. The created ambiance is an important part of the communication of a brand and of brand values between the store and the customer. By creating a feeling within a store, a company can communicate what kind of company they are; young and trendy, environmentally oriented or price focused. It is often possible to tell what kind of products you will find in a store just by looking at the interior and lighting. Retail lighting is also used to direct the customers' attention inside the store. By illuminating a product, customer focus is directed towards it and sales are increased (Martinsson, 2010).

The initiator of this thesis, Fagerhult Retail offers complete lighting solutions for retail environments, like grocery stores and chain stores. One of their most popular product families is called Zone. The Zone product family is found in numerous stores and this vast usage has now evolved into a problem. When the stores want to update their lighting they do not want to use the same product again. Even though the performance of the Zone family is satisfactory there is a demand for something visually new.
Fagerhult Retail identified two alternatives to meet these new demands: an update of the current product family, i.e. a facelift, or replacing the current products with a new product family.

Traditionally, so called metal halide light sources have been used within retail lighting but with the emerging LED technology the retail lighting business is facing a paradigmatic shift. Since the LED technology differs a lot from the currently used technology this introduces a new framework for developing luminaires. However, most companies that develop luminaires for the retail business are not using these new possibilities that the LED technology offers. LED is often used the same way as today's light sources are used. If the luminaires were developed with the LED technology as a starting point, instead of trying to configure the LED to fit the existing luminaires, more innovative luminaires could be developed.

1.1 Purpose

The purpose of this thesis is to give inspiration and to suggest a new direction to Fagerhult Retail in their development work with the Zone family.

Firstly, the possibilities of a facelift should be investigated. The analysis of a facelift should make it possible for Fagerhult Retail to decide whether the necessary change is achievable within a facelift, in relation to development time and costs, or if a totally new product family is preferable. Furthermore, the current products should be analysed from a user's perspective and it should be investigated if the identified problems, if there are any, could be solved within the span of the facelift.

Secondly, the future for the LED light source should be investigated and visualised to give Fagerhult Retail inspiration and guidance of what can be possible in the future within the LED area. By developing a new product range, focusing on this new emerging technology, Fagerhult Retail has the opportunity to enhance their reputation of being experts within lighting. Additionally, LED is considered to be a more sustainable technology and venturing into this area is a natural continuation of the energy saving work that Fagerhult Retail conducts today.

1.2 Goal

The goal of the project is to:

1. Enable Fagerhult Retail to decide whether to develop a new product range or to make a facelift of the existing Zone family. This should be done by examining and evaluating the range of possibilities that a facelift could include.

2. Examine how a future LED armature could function and what it could look like, taking technical, lighting and societal trends into consideration. This should be achieved by developing one or several LED concepts.

1.3 Limitations

General
>>The customers of the stores have not been taken into greater consideration, only in the form of the authors' own experience as customers. Within this area the knowledge that Fagerhult Retail holds was considered sufficient.

>>The outcome of this project has not included specific recommendations on how Fagerhult Retail should continue with the development work of the Zone family. This decision is too intertwined with strategic decisions on a company level to be included within this project.

Facelift project
>> The facelift has focused on the track bound and recessed spotlights

>> The facelift has only included changes to the front ring, ballast box and surface treatment.

>> To maintain the performance of the products, electronic components that Fagerhult Retail uses today and have experience in, have been used.

>>The Zone systems have not been redesigned. However, all the changes to the spotlights are compatible with the systems.

LED concepts
>> The future LED concepts were developed to be basic products of their time, in order to fit in the future equivalent of the market segment that Zone belongs to today.

1.4 Project setup

This project was divided into four parts; the facelift, the LED concepts and two analysis parts corresponding to these. Together the four parts make up a good representation of the competence that has been acquired during five years at Industrial Design Engineering at Chalmers. The project spans from analysis and concept generation to manufacturability and branding.

The first analysis part was an analysis of the current situation that formed the basis for the project. This part also generated the necessary knowledge about light, lighting, luminaires and the retail business to proceed with the following parts.

The facelift project focused on feasibility, especially from an economic and time perspective. The facelift was also characterised by limitations. For example most of the components were to be left untouched. The dimensions and features of these components limited, to a great extent, what could be achieved.

The second analysis focused on future LED technology and what society might look like in ten to fifteen years. This part laid a foundation for the LED development phase.

The characteristics of the LED project was much more conceptual. This part was carried out on a system level and the result was ideas and examples of focus areas, instead complete products.

1.5 Sustainability

Lighting is responsible for a large portion of the energy consumption world wide, e.g. the U.S Department of Energy states that "retail stores in the United State use 37% of their total energy for lighting" (Taylor, 2010). One of the areas Fagerhult Retail works with is energy efficiency. The main way of reducing energy consumption today is by reducing the wattage and number of luminaires used in the lighting concepts (Gärdebäck, Lighting Education, 2010). However, this is not possible in all store concepts. During the lifetime of a luminaire the energy consumption during use has the biggest environmental impact (Månsson & Schönbeck, 2003), especially in retail applications where the nature of the most used light source, the metal halide, makes it hard to dim or turn off the light (See Chapter 3, Metal Halide). One step further for Fagerhult in their energy efficiency work would be to replace the more energy consuming light sources for more energy efficient ones. Using the emerging LED technology is one possible way to go. By making LED light sources the natural choice for lighting applications huge savings in energy could be made according to the U.S. Department of Energy (2010). The aim of the LED part of this master's thesis project was to research the possibilties of a future LED luminaire and by doing this preparing for a more sustainable way of producing light. The LED light source offers great opportunities for saving energy both by using less energy when producing light and by enabling more advanced control making it possible to have light only when and where you need it (See Chapter 3. Light Emitting Diodes).

1.6 Disposition of the report

This report begins with a chapter describing the Zone product family and its context. This chapter is called Current Product and Context. It is followed by a chapter called Theory, describing the theoretical framework of this thesis. The theory chapter contains information on light and light sources as well as relevant design and branding theories. The next chapter describes the methods used in this thesis and is called Methods. The aim of these first chapters is to give the reader enough information to be able to follow the descriptions and reasoning in the rest of the report. These chapters could also function as mini-encyclopaedia for the reader. Further, there is an analysis chapter that lays the foundation for the subsequent development work follows. A chapter describing the facelift called Development of Facelift Concepts precedes a second analysis chapter that lays the foundation for the LED development. The LED development is described in the chapter Development of LED-Concepts that follows. The report ends with a discussion chapter and references and an appendix.

2. Current Product and Context

2.1 Fagerhult Retail

Fagerhult Group is the biggest lighting company in the Nordic countries with 1800 employees and sales offices in fifteen countries. The Fagerhult Group develops and produces lighting solutions for public environments and has companies specialized in the different market areas. The Fagerhult Group has an annual turnover of 2.4 billion SEK. (Fagerhult Retail, n.d)

Fagerhult Retail is a company within the Fagerhult Group. Fagerhult Retail combines development and sales of luminaire with a division of lighting design to offer high quality lighting solutions, both the lighting concept and the actual luminaires, to fit the customers' specific needs. Fagerhult Retail also offers a service solution to maintain the high quality of the light during the whole lifetime of the luminaires. The company Fagerhult Retail has three product brands: Fagerhult, Catwalk and Waco (Figure 2.1).

Within the Fagerhult product brand there is a product range called Zone. The Zone family contains recessed spotlights and track bound spotlights as well as systems for combining these in larger groups. The Zone family is one of Fagerhult Retail's first products and has been their greatest success and money-maker. Other products within the Fagerhult product brand are Strato, Marathon and Sinus.

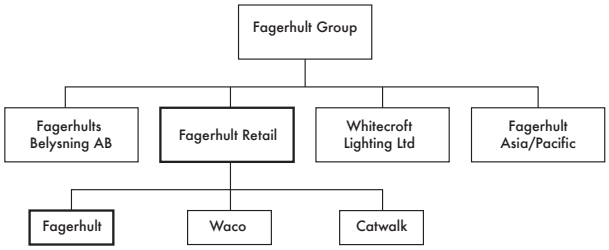


Figure. 2.1 *Layout of Fagerhult Group organisation*

FAGERHULT RETAIL LIGHTING

Figure. 2.2 *Fagerhult Retail logotype*

2.2 Lighting Design for Retail

There is a difference between light and lighting. Lighting is what you do with the light, how you plan where the highlights and the shadows should be, how many luminaires you need to get a well lit working environment and how you create dramatic sceneries in a store.
Light is important; it directs what we see and how we see it. Products change colour depending on the light and rooms appear to shrink or expand due to how they are lit (Fridell, 2006). Humans react to light, we automatically look at the brightest spot in a room (Gärdebäck, Lighting Education, 2010) and poor lighting can make us feel uncomfortable (Månsson & Schönbeck, 2003).

Lighting design is the discipline that handles these issues. Lighting design in a retail context focuses on how products look and how to fit the lighting into store concepts (Figure 2.3-2.4). But different markets have different prerequisites. Super markets for example often want the light to be functional and guide the shoppers through the store and points of interest. Clothing shops on the other hand generally want an emotional light, using colour and contrast to help set the mood of the brand (Gärdebäck, Lighting Education, 2010).
A trend within lighting design today is to use less light and let shadows help accentuate the parts that need to be highlighted (Stömberg, 2010). This trend goes hand in hand with being energy efficient, since less light and less wattage is needed.

Two kinds of lighting are used in lighting design, accent lighting and general lighting. Accent lighting is directional and used for highlighting objects and places or to direct the attention to an area (Osram Sylvania, 2000-2010). General lighting or ambient lighting is used to provide a uniform illuminance in an area (Osram Sylvania, 2000-2010).
Through the use of accent lighting it is possible to increase the customer's desire to approach and pick up a product (Summers & Hebert, 2001).

Figure. 2.4 *Retail environment by Fagerhult Retail*

Figure. 2.3 *Retail environment by Fagerhult Retail*

2.3 The Retail Luminaire

Two kinds of spotlights are mainly used within retail; recessed spotlights and track bound spotlights. Recessed spotlights are recessed into the ceiling (Figure 2.5), which makes them less attention-drawing and also appropriate for lower ceilings. Track bound spotlights are mounted on a track (Figure 2.6-2.7); the track supports the spotlight with power and it is possible to move the spotlights on the track. This makes track bound spotlights ideal for retail environments where the interior is changed regularly, clothing shops for example.

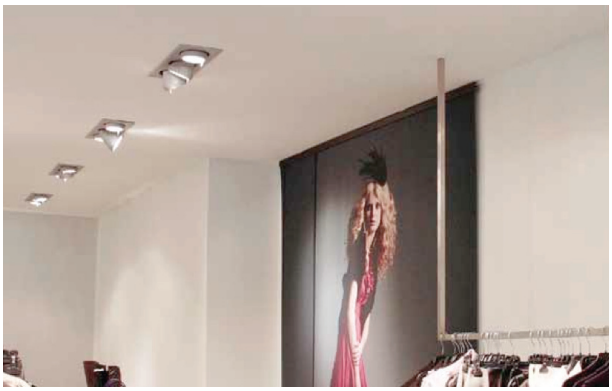


Figure. 2.5 *Recessed spotlights*

Figure. 2.6 *Track bound spotlights*

Figure. 2.7 *Mounting a track bound spotlight*

Most retail luminaires consist of the following parts (Figure 2.8):

Lamp housing - Contains the reflector (see Chapter 2.3.1) and the light source.

Ballast box - Contains the ballast (see Chapter 2.3.2)

Ventilation - The ballast is sensitive to heat, therefore proper ventilation is crucial to avoid breakdown.

Track connection - Connects the spotlight to the track system.

Front ring - Contains the front glass; can be removed for maintenance such as cleaning and change of reflector or broken light source.

Figure. 2.8 *The parts of the luminaire*

2.3.1 Reflector

The reflector (Figure 2.9) is the part that directs the light. It spreads the light in the desired angle and mixes the colours evenly to produce a white light. A poor mixture of the colours could result in rainbow being visible around the light circle produced by the spotlight. A spotlight might come in several different versions with different reflectors inside. The reflectors may turn the spotlight into a wide spotlight, where the light beam is wide, or a narrow spotlight where the light beam is narrow.

Figure. 2.9 *A reflector*

2.3.2 Ballast

The ballast (Figure 2.10) is the component that contains all the electronics controlling the power to the light source.

Figure. 2.10 *A ballast*

2.3.3 Baffle

A baffle (Figure 2.11) is an extended nozzle on a spotlight and is used to shield the light and reduce the risk of glare. Not all spotlights have a baffle.

Figure. 2.11 *A baffle*

2.3.4 Accessories

Many luminaires have accessories (Figure 2.12-2.13) that can be attached to them. The accessories most often help to enhance and change the light. There are honey-comb-grids to reduce glare, filters to change colour and barn doors for shielding of the light, among others.

Figure. 2.12 *A honeycomb filter*

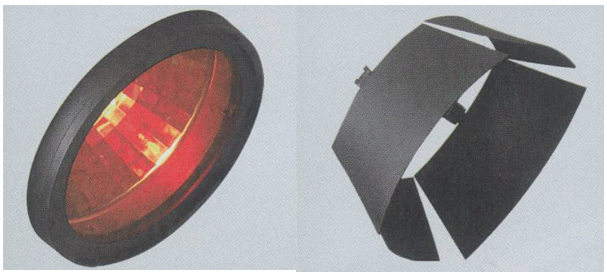


Figure. 2.13 *A colour filter and barn doors*

2.4 The Zone Family

The Zone family is based on a spotlight, which is a directional luminare for accent lighting, modified for different applications. The family consists of a track bound spotlight called ZonePoint (Figure 2.14), a recessed spotlight, called ZoneSingle (Figure 2.15) and a spotlight adapted to be placed with other luminaires in different systems, called ZoneBeam (Figure 2.16). The systems (Figure 2.17 and 2.18, for examples) can be recessed into the ceiling or suspended.

The many parts of the Zone Family helps the lighting design department at Fagerhult Retail to give the customers what they want, something that fits their needs, brand and interior. Because of the modularity and ability to adapt, Zone is the most used and sold fixture of Fagerhult Retail (Gärdebäck & Strömberg, Lighting Design, 2010).

Figure. 2.14 *ZonePoint*

Figure. 2.15 *ZoneSingle*

Figure. 2.16 *ZoneBeam*

Figure. 2.17 *The ZoneExpo system using ZoneBeam*

Figure. 2.18 *The ZoneBox system using ZoneBeam*

3. Theory

This chapter contains the theoretical background for the project; light theory in a retail context and design theory is presented here.

3.1 Light

Light is electromagnetic radiation within certain wavelengths. Radiation with wavelengths between 380 and 780 nanometres is visible to the human eye (Fagerhult Lighting Academy, 2007-2010a). The different wavelengths are perceived as different colours (Figure 3.1), for example, radiation with a wavelength around 400 nanometres is perceived as violet and radiation with a wavelength around 780 nanometres is perceived as red (Fagerhult Lighting Academy, 2007-2010b). The light from our main light source, the sun, contains all wavelengths in the visible spectra producing a continuous spectrum with the colours red, orange, yellow, green, cyan, blue and violet (Fagerhult Lighting Academy, 2007-2010b). Mixing these colours produces the warm white light we humans are most used to.

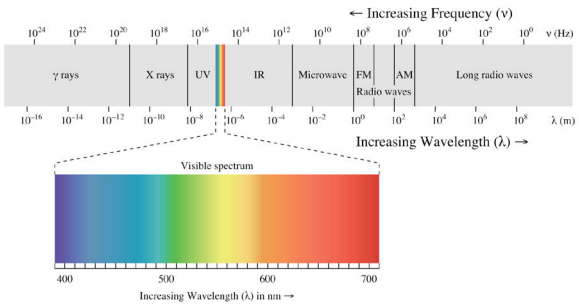


Figure. 3.1 *The Electromagnetic Spectrum with the Visual Light Spectrum Highlighted*

3.1.1 Producing Light

There are many methods for producing light. The two that are most commonly used in commercial applications, are presented below.

Heated Bodies

When heating up a body it will first only emit infrared radiation i.e. heat, but will with increased heating start to emit visible light, first red light then white and finally blue (Fowler, 2008). Both the sun and a regular light bulb are examples of heated bodies. 44% of the radiation the sun emits is visible light (Encyclopedia of Earth, 2008) but only 10% of the radiation of an incandescent light bulb, the rest is heat. If light is produced through heating of a body the result is a continuous spectrum that reproduces colour very well since such a light contains all colours (Lighting Research Center, 2003-2005). This is considered one of the benefits of using incandescent light sources.

Excited Atoms

Another way of producing light is to make atoms emit energy at specific wavelengths. Atoms emit light when an electron is moved between different energy levels, the energy difference between the two levels correspond to the wavelength of the light emitted (Carpi, 2003). The light produced will have a specific wavelength and not a continuous spectrum of colours (Carpi, 2003), this means that the colours that are found in between the emitted wavelengths will not be reproduced accurately.

3.1.2 Measuring Light

Light can be seen in many ways, therefore it can also be measured in many ways and many different units are used. Below are the most important units and notions used in retail lighting.

Intensity

One way of measuring the intensity of light, common in retail lighting, is luminous flux, measured in lumen. The luminous flux is the total amount of photons emitted from a light source per time unit. The unit lumen is weighted against how well the human eye sees different wavelengths. Two light sources, with the same photon flow but different colours, are therefore able to emit a different amount of lumen. A common unit for efficiency used within lighting are lumen per watt (lm/W), which means the light output of the light source in relations to the energy consumption per second, the wattage.
(Fagerhult Lighting Academy, 2007-2010c)

Colour Temperature

Colour temperature is measured in Kelvin and is one of the characteristics of light that is easiest to notice. The concept of colour temperature is derived from the light that is emitted from an ideal black body when it is heated; think of this as a piece of black metal. The colour temperature of 2500°K corresponds to the surface colour of this heated metal when it is heated to a temperature of 2500°K. When the black metal is heated to 2500°K it becomes red or yellow, but when heated to 5000 °K it becomes blue instead. This means that warmer temperatures result in "colder" or bluer colours.
(Fagerhult Lighting Academy, 2007-2010b)

Colour Rendering Index

Colour Rendering Index or CRI is a measure of how well a light source reproduces the colour of an object. Humans are most used to sunlight and therefore is it stated that this light source reproduces colour ideally and is given the CRI value of 100 (GE Lighting, 2010).
The CRI value of a light source is determined by measuring the colour rendering for eight specific colour samples and the CRI value for a light source is an average of these eight values (Fagerhult Lighting Academy, 2007-2010d). For example, the CRI value of an incandescent light bulb is 100 and the CRI value for a fluorescent lamp is around 60. This is why we sometimes perceive colours as non-saturated when being indoors (Figure 3.3).
The CRI value is, however, not a complete measuring system. Bad rendering qualities in one part of the light spectrum can be compensated by good ones in another part of the spectrum since the value is an average of eight different measures. The CRI value will give an indication of the colour rendering characteristics of a light source but to know the exact characteristics of a light source it must be tested in real life (GE Lighting, 2010)

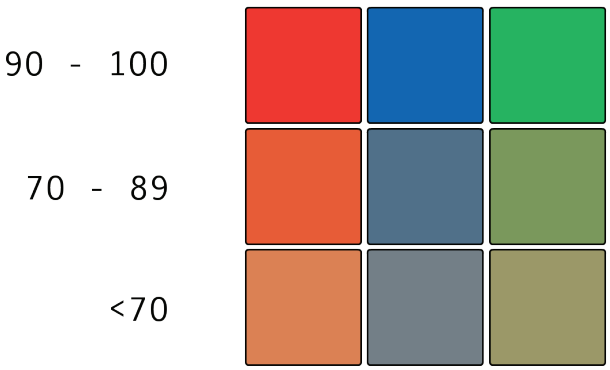


Figure. 3.2 *Visualisation of how the saturation decreases with low CRI values*

3.2 Light and Well Being

During the last 30 years the connection between light and well-being have been investigated and proven. The finding of a third photoreceptor in our eyes, sensitive to light in the bluish register, has shown a close connection between light and a large number of biochemical processes in our bodies (Månsson & Schönbeck, 2003). It has been proven that light affects our body-temperature and the production of sleep hormones and stress hormones, wich in turn affect our sleep and alertness, blood sugar levels and our immune system(van den Beld & van Bommel, 2003). This means that light has a large influence on our well-being and health.

Figure. 3.3 *An incandescent light source (a halogen)*

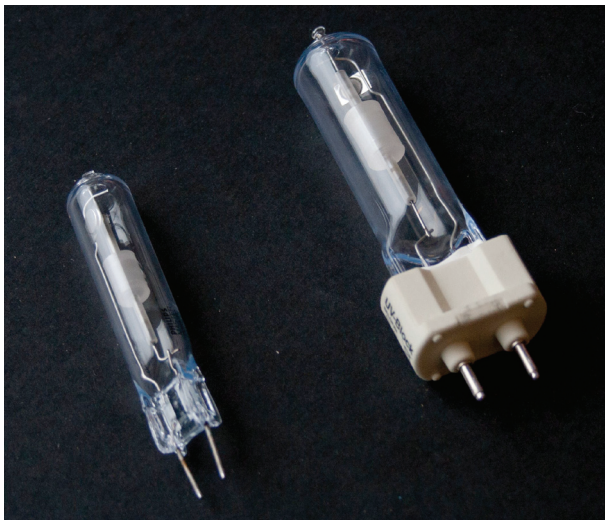


Figure. 3.4 *Two discharge light soures (metal halides)*

3.3 Different Light Sources

Within retail, different light sources are used for different applications. In this section the most relevant ones for this project are presented.

3.3.1 Incandescent Light Sources

There are two types of incandescent light sources; light bulbs and halogen lamps (Figure 3.3). In incandescent light sources light is produced by heating up a metal thread. The modern light bulb has a tungsten filament through which a current is sent with an incandescent light as a result. The light bulb is filled with an inert gas or vacuum to reduce the vapourisation of the tungsten. (Fagerhult Lighting Academy, 2007-2010e)

The halogen lamp also has a filament of tungsten but the bulb is filled with a halogen instead of an inert gas. The halogen actively re-deposits the vapourised tungsten on the filament. This process requires a high temperature around 2700° C (Fagerhult Lighting Academy, 2007-2010f).

The incandescent light sources are characterised by good colour rendering, low prices, low efficiency and that they are possible to dim. Incandescent light sources have a low efficiency since they only produce around 5-10% light and 90-95% heat. A light bulb produces around 13 lm/W and has a lifetime of around 1000 hours and a halogen lamp produces around 20 lm/W and has a lifetime 4000 hours (Håkansson & Renström, 2004).

3.3.2 Discharge Light Sources

The discharge lamp (Figure 3.4) produces light by discharging electrons in a mercury vapour. The mercury vapour is sealed in a ceramic burner inside a glass bulb. In order to emit light the vapour needs to maintain a high temperature and pressure and the discharge lamps therefore have a start-up time of about twenty minutes before emitting at maximum levels. Discharge lamps are known for long lifetime and high light output, but they have a cold colour temperature. By adding metal halides to the mercury vapour you can change the spectrum to a warmer colour and increase the CRI values to very good levels.
(Fagerhult Lighting Academy, 2007-2010g).

The metal halide lamp has an efficiency of around 70 lm/W and a lifetime of 15000 hours, making them more efficient than incandescent light sources but with poorer colour rendering abilities. They are also much more expensive.
(Håkansson & Renström, 2004)

The high-pressure sodium lamp is another kind of discharge lamp for special light applications. The light from a high-pressure sodium lamp produces red colours, and is very often used for highlighting meat, vegetables and other red objects.
(Håkansson & Renström, 2004)

3.3.3 Fluorescent Light Sources

A fluorescent lamp is a glass tube filled with mercury vapour and an inactive gas, fitted with an electrode in each end and coated with a fluorescent layer on the inside (Figure 3.5). When electrons are transmitted from the electrodes they collide with the mercury atoms that emit an ultraviolet light on collision. The ultraviolet light is converted to visible light by the fluorescent coating (Fagerhult Lighting Academy, 2007-2010h). Fluorescent lamps are most commonly used in professional environments such as offices; in retail they are most often found in large bright areas for example in super markets.
Fluorescent lamps are quite cheap, have a luminous output at around 75 lm/W and have a lifetime of about 15000 hours, however, the Colour Rendering Index is not as high as for metal halide lamps (Håkansson & Renström, 2004).

Figure. 3.5 *A flourescent light source*

3.3.4 Light Emitting Diodes

A light emitting diode, or a LED (Figure 3.6), is a semiconductor diode that emits light when a current passes through it. The diode is built by two conductive materials, the first is charged with electricity and the atoms in it are excited, i.e. they gain too much energy which they release to the atoms in the other material. Light is emitted in this exchange of energy. The colour of the light depends on the different materials in the diode.
(Philips, 2004-2010)
The most common LEDs produce a cold bluish light. In order to change this into a warmer colour a coating of phosphor is added to the diode. The phosphor changes the colour temperature of the light to a warmer white colour. Another way of producing warm white LED light is to have three diodes producing red, green and blue light. By mixing these three colours you can get any colour you like, including white.
(Fagerhult Lighting Academy, 2007-2010i)
The main benefits of LEDs are a long lifetime, up to 100 000 hours, the possibility of colour modulation, efficiency of 70 lm/W, small size and high durability (Håkansson & Renström, 2004). The LED is also a directional light source, thus sending light in one direction instead of all around as many conventional light sources. The biggest setback today is the high initial price. It is worth mentioning that LED is a light source under development and has not met its maximum potential yet. Many researchers believe that LEDs will become the dominant light source eventually (Freyssinier, Taylor, Frering, & Rizzo, 2009).

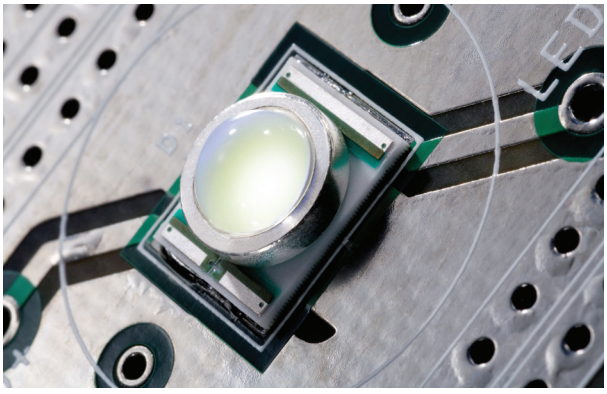


Figure. 3.6 *A LED light source*

A technology closely related to LED is OLED, Organic Light Emitting Diode. An OLED functions in the same way as a LED but the light emitting material is organic. OLEDs are manufactured as thin layers on top of each other in a stack (Ljuskultur, 2009). This means you can produce very thin light sources with a large area that can be attached to any surface and provide lighting in totally new ways.

3.4 Design Theory

The way humans perceive objects have been studied for a very long time, both in philosophy and psychology (Stanford Encyclopedia of Philosophy, 2010). The study of perception in psychology has resulted in the gestalt laws that explain how the human brain interprets certain phenomena (Rock & Palmer, 1990). Since how we perceive gestalts define how we interpret form it ultimately states how the form is charged with meaning (Monö, 1997). How the meaning of a form is interpreted helps designers understand how customers interpret the products a company manufactures.

3.4.1 Gestalt Laws

A gestalt consists of a number of parts that together appear and function as a whole that is more than the sum of the parts. This means that when an object is perceived, it is not the individual parts that are perceived but the whole object (Monö, 1997). To describe how we discern certain gestalts a number of laws have been created (Monö, 1997):

>>The proximity factor; objects close to each other are grouped into a unit subconsciously (Figure 3.7).

>>The similarity factor; objects that look similar are perceived as a unit (Figure 3.8).

>>The area factor; smaller areas are identified easier than large areas (Figure 3.9).

>>The symmetry factor; objects group symmetrically are perceived as a unit (Figure 3.10).

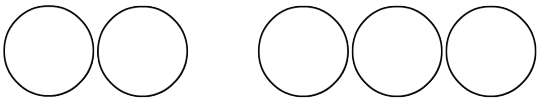


Figure. 3.7 *The proximity factor*

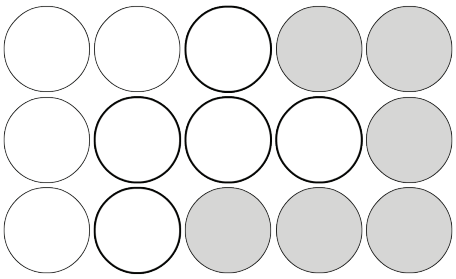


Figure. 3.8 *The similarity factor*

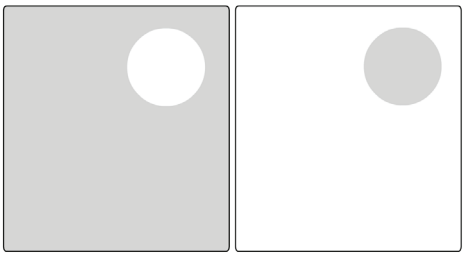


Figure. 3.9 *The area factor*

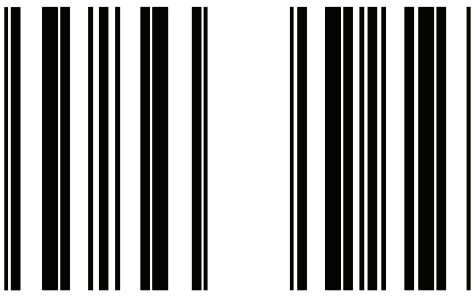


Figure. 3.10 *The symmetry factor*

>>The closure factor; closed areas are more easily perceived as a unit. Therefore are open areas sometimes perceived as closed areas as well (Figure 3.11).

>>The continuity factor; curves with continuity are perceived as a unit even if they are divided into many lines (Figure 3.12).

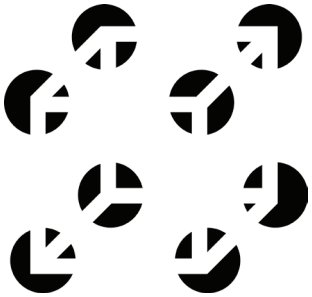


Figure. 3.11 *The Closure Factor*

Figure. 3.12 *The Continuity Factor*

3.4.2 Semantic Functions

Theory about how we perceive products and how they communicate with us has also been influenced by linguistic research about semiotics, which is the study of signs. In design theory the product is perceived as a sign that is created by the manufacturer and interpreted by the customer. (Monö, 1997)How the sign, or product, is interpreted is based on four semantic functions of the product. The functions are (Monö, 1997):

To describe – How the product describes its purpose or function influences the interpretation.

To express – How and which characteristics and values the product expresses has an impact.

To exhort – How the product demands a reaction or action: 'Use it like this' or 'do that are' examples of exhortations.

To identify – How the product shows its origin, that is where it comes from and what it is. Branding is one important tool used for identifying products.

3.5 Branding

The importance of branding has increased in order to become a successful manufacturer in many markets. Brands like Apple, Volvo and Toyota all use consistent design features throughout their product ranges in order to give a uniform image of themselves and to differentiate them from competitors. It is by being different from your competitors that you can become successful.
(Karjalainen, 2007)
Having a strong and recognisable brand also helps the customer choose which product to buy in the store. A brand can be loaded with expressions and symbolic meaning that shape the customer's expectations and desire of a product even before they have seen it.
(Karjalainen, 2007)
The relationship between brand and products is directed two ways; the expressions and symbolic meaning of the product affect the expectations of the brand as well, therefore well designed products is one step towards a successful brand.

The designer needs to take many aspects in to consideration when integrating a brand in a product's visual expressions. The current product's relation with historical models is important to consider, since the design continuity may have positive or negative effects on the brand (Monö, 1997). If the change in a new product is extensive, less design references to older models might be recommended to emphasise this change (Monö, 1997). The current product's relation to present product families also needs to be considered. A family of products with the same function or usage can benefit from a clear connection to each other. A consistent form language with similar design elements across a whole family of products makes the individual product more desirable, emphasising its identity in a context. (Monö, 1997)

4. Methods

In this chapter the methods used in this project will be presented, first with a short introduction and more thoroughly later in the chapter.

4.1 Summary of Methods

Method	Why was it used?
KJ Analysis	Used to sort and analyse large quantities of data.
Design Format Analysis	Used to find and weight design elements in a product portfolio.
Brainstorming	Used to create many ideas around a given subject.
Unstructured Interviews	Used to gather input from people verbally.
Google Probability Method	Used to quickly evaluate ideas and theories. (Developed in this project.)
Observations	Used to gather input from observing users and contexts.
Internet Survey	Used to gather written input from many persons at the same time.
Scenario Planning	Used to create plausible scenarios of what might happen in the future.
Mock-Ups	Used to quickly evaluate concepts and ideas.
Mood Boards	Used to visualise expressions and feelings in concepts.
Visual Benchmarking	Used to analyse competing products visually.
CAD Evaluation	Used to quickly analyse concepts and ideas in a CAD-software.

Figure. 4.1 *The methods used in this project*

4.2 Information Gathering

4.2.1 Internet Survey

A survey is a way of extracting information from the many actors associated with a project. A survey can contain closed questions i.e. when the participant chooses from different answers, and open questions i.e. when the participant is allowed to write a free answer. Open questions are good for acquiring detailed information from the participant but this might generate a lot of data that needs to be analysed. Closed questions are easier to analyse and to compare between different participants, but will not contain any additional information. Since open questions tend to acquire more effort from the participant there should be a mix of closed and open questions. (Karlsson, 2005a)

An Internet survey is a way of making the survey available to many people in an easy and resource efficient way.

4.2.2 Unstructured Interviews

Performing interviews is a method of extracting information from different actors associated to a project. When doing unstructured interviews the interviewers do not need to strictly follow a manuscript, the interviewees are allowed to discuss other matters that the interviewers had not thought of but an interview guide is often followed. By doing unstructured interviews there is a bigger chance of catching the interviewees own thoughts and opinions about the matter at hand. (Karlsson, 2005b)

4.2.3 Observations

Observations are used to examine users in action when using a product in the real context or in a laboratory. It is a good method to use as a compliment to other information gathering methods e.g. interviews, because what users say they do and what they actually do might differ. Another reason for using observations as a complementary method is that you cannot observe emotions or attitudes (Karlsson, 2005b). It is also important to consider the way of documenting the observation. Taking photographs and notes might be enough but using a video recorder gives the possibility to analyse the scenarios afterwards. (Karlsson, 2005b)

4.3 Analysis

4.3.1 Design Format Analysis

This method is used to identify, assess and rank visual design elements of different products within a product brand. The result is a number of elements that are considered to be the most characteristic for the product brand. The method consists of four steps; Element Identification, Element Ranking, Element Typicality and Format Assessment.

>> The first step is to identify the visual design elements present in a number of products in a product brand. The observed elements are noted and described.

>> In the second step the design elements of each product are ranked by how much they contribute to the visual characteristics of the whole product.

>> Step three handles the assessment of each element's typicality in the product brand. The most typical design elements are ranked higher.

>> In the forth and last step, the most typical elements of all the product are compared to assess which are the most characteristic for the whole product range.

After these four steps the outcomes are the most typical and most characteristic design elements of the product brand, as well as which products best represent the whole product brand. (Warell, 2006)

4.3.2 KJ Analysis

The KJ analysis is named after its developer, Jiro Kawakita, and is a method for analysing vast quantities of data from information gathering methods. The KJ method is used to create an overview of the data collected by grouping information from different sources by a common denominator. The

first step is to place each statement on a piece of paper and then group the pieces of paper that have a common denominator. This is done until all the pieces of paper are placed in different groups. Then the groups are named in a descriptive way to get an overview of all the statements in the analysis. (Karlsson, 2005a)

4.3.3 Visual Benchmarking

Visual benchmarking is a method used for evaluating the visual character of competing products. It is based on the KJ Analysis method but was developed further by the project group. The first step is to find as many competing products as possible and acquire images of those. The second step is to mark each image with the product brand and shuffle all the images. Then the images of competing products are sorted by their visual appearance in to different groups and the groups are named appropriately. Now you have the visual characteristic of the competing products categorised and you can compare these to the current product portfolio of the company in order to find threats or areas of expansion.

4.4 Evaluation

4.4.1 CAD Evaluation

CAD evaluation is done early in the concept development phase. By creating low detail CAD-models of the different concepts the visual characteristics can be evaluated quickly. Adding the dimensions of the components needed in the product also provide a useful tool to evaluate the size. To develop the concepts further small alterations to proportions, style and layout can easily be carried out and evaluated. The concept CAD-models can then be used as sketching underlays in the future work of making the concepts more detailed.

4.4.2 Mock-Ups

A mock-up is used early in a design project to quickly evaluate concepts and ideas. A mock-up is a rough prototype with some functionality and it is generally made of inexpensive materials such as cardboard or clay. These ”low-quality” prototypes allow a higher degree of criticism and can easily be adjusted to evaluate new ideas (Interaction-Design.org, 2004).
Mock-ups are also especially good for illustrating aspects of a product that are hard to describe in a specification of requirements. For example visual aspects such as design proposals or layouts of interfaces (Karlsson, 2005a).

4.4.3 Google Probability Method

The google probability method is a method developed by the project group during this project. The main idea is to quickly evaluate if a concept or technical solution is viable. By searching for keywords representing the idea or technology and doing a subjective weighting of the number of hits and the relevance of the hits it is possible to get a hint if the idea or technology is plausible or not.

4.5 Creative Methods

4.5.1 Brainstorming

Brainstorming is one of the most simple and widespread creative methods in the world. The purpose of a brainstorm is to stimulate a group of people to generate many ideas. The group should be consist of different people, not only by experts of the matter at hand. The procedure is quite simple; the participants should come up with as many different ideas as possible to a stated problem. The ideas are presented and written down. Then the participants can continue working on each other’s ideas or get new ideas, inspired by the first ideas.
Some rules are crucial for a successful brainstorming session:

>> No criticism is allowed.

>> Quantity is the goal.

>> Crazy ideas are most welcome.

>> Brief descriptions of the ideas are preferred.

>> It is allowed to combine other's ideas.
(Karlsson, 2005a)

4.5.2 Mood Boards

A moodboard is a collage describing feelings and expressions for a product or a brand. It is used to convey the intended feeling to other actors as well as to give the project group a uniform feeling of what it is they are striving towards (Baxter, 1995). It is a useful technique to use visual collages to express intangible feelings instead of just describing them in words, because words might have different meaning for different people. (Wagner, 2008)

4.5.3 Scenario Planning

Scenario planning is a method that can be used when developing products for an uncertain future context. The goal is not to predict the future but to explore the range of possibilities. By creating several images of possible futures, the imagination is triggered and it is easier to think out of the box. The scenarios can also be a way of evaluating product concepts. Will the product function in the first scenario, and in the second? (Wilkinson, 2009)
The first step in scenario building is to analyse driving forces, the forces that direct the context of the product. The second part is to identify the key driving forces and to further investigate these. The key driving forces are those forces that are both high on impact and uncertainty. Often two drivers are chosen and varied. The result is four scenarios represented in a two-by-two matrix. The four scenarios are not each representing one possible future that might come true but it is important to acknowledge that the real future might hold a little bit of each scenario. The scenarios are the four extremes of what might possibly happen in the future. When designing a product that will have a function and a demand in each scenario you make the product more prepared for the future. (Lugt, 2004)

5. Analysing the Current Situation

To create a foundation for the project an analysis of the company and the current product was carried out. The different aspects of the current situation had to be identified and analysed.

The goal with this part was to establish a starting point for the development of the facelift and the LED concepts. The current situation was analysed to be able to make decisions on what to keep and what to change regarding product expression, technology and interaction. To achieve this, three different areas to work with were identified by the project group; Branding and Product Expression – What Fagerhult Retail want the products to express and how they are identified by the customer (see Chapter 3.4 for Design Theory), Usage – How the products are used and by whom, and Summary of Technology – How the product functions and the relation of the components. These areas were considered to cover all the important aspects of the present product. The branding functioned as a starting point both for the facelift and the LED concept while the usage and technology parts were mainly used in the development of the facelift. The result of the analysis was summarised and the aspects that were important for further work were identified.

5.1 Analysis

In this section the procedure is presented together with the result. The implications the analysis had on the development of the facelift and the LED concept is presented in Chapter 5.2 Implications for the next phase.

5.1.1 Branding and Product Expression

The first part was an analysis of the product expression and the perception of the brands Zone and Fagerhult. The product expression is the physical attributes of the product while the brand perception is the associations that are created by the brand.

The goal was to get a full picture of the Zone family, both explicit characteristics like form language and implicit values and associations.

Perception of the brand

Fagerhult Retail has three product brands; Fagerhult, Waco and Catwalk. The Zone family is a part of the Fagerhult brand and consequently it was necessary to define the Fagerhult brand to make sure that the facelift and the new LED-concept were designed for this brand. It was also important to define the other two sub-brands to make sure that the

new designs did not interfere with these in order to keep Fagerhult Retail's positioning of the brands.

To visualise the differences between the three sub-brands a tree diagram was constructed (Figure 5.1). Every brand was visualised with a picture, four core values, a product and a quote that symbolises the feeling of the brand. The information was taken from internal marketing material and from Fagerhult Retail's product catalogue.
The Fagerhult brand is the most basic one out of the three brands. It is meant to fit in any store without being obtrusive. Its core values are Functional, Technical, Natural and Clear. In comparison to this, Waco and Catwalk are more stylish brands with a more narrow brand expression. Waco is trendy and edgy while Catwalk is fashionable and classy.

To create a clearer picture of the Fagerhult brand within the group as well as towards the company an imageboard visualising the core values of the brand was put together. The imageboard could then be used to evaluate if the Zone luminiares expressed the Fagerhult brand (Figure 5.2).

>>The dog sleigh was chosen as a metaphor of working together, performance and the connection to Scandinavia. To this, products that illustrated the core values were added.

>>The thermos for its simple but characteristic shapes, it is also a very functional product, something you trust.

>>The compass was chosen for its exactness and because it expresses its functionality.

>>The chair was chosen for its effortless style and simple and pure form language.

>>The watch was chosen for its simplicity but at the same time functional appearance.

In addition to this, the perception of the Fagerhult and Zone brands was investigated further. Interviews with staff and a web-based survey were conducted to get a picture of the in-house perception of the two brands, see appendix I for the whole survey. Twenty-six professionals from Fagerhult Retail answered the survey. Among other things they were asked to rate the following words on a scale from one to six; Clear, Natural, Technical, Functional, Professional, Discreet, High Performance, Simplicity and Effortless Style. One indicated that the word did not describe the brand at all and six indicated that the word described the brand very well. The words were taken from Fagerhult Retail's marketing material where they were used to describe the two brands, Fagerhult and Zone.
The results showed that the perception of the Fagerhult brand and the perception of the Zone brand were closely related. They were both perceived as High Performing, Technical, Functional and Professional. They were not perceived as very Clear or Natural and they were almost not at all perceived as Discreet or having an Effortless Style.

Design expression

The product is an important communicator of the brand (Stompff, 2003). It was therefore important to analyse the product expression and form language of the current Zone products. A decision could then be made on whether to try to keep it or not.

Figure. 5.1 *Tree diagram showing the visualisations of the product brands Waco, Fagerhult and Catwalk*

Figure. 5.2 *The Fagerhult product brand imageboard*

The first part of the expression analysis was to investigate the relationship between the Zone family and the other products within the Fagerhult brand. Was there such a thing as a specific Fagerhult form language? This analysis was made through a design format analysis (see Chapter 4.3.1 for method description). Characteristic form elements of the different products where identified and then the presence of these elements in all of the products was evaluated (Figure 5.3). It was clear from this analysis that there is no coherent form language for the Fagerhult products.

Secondly an analysis of the form language was carried out. As the internal survey showed, the Zone family was not associated considerably with Clear and Natural however it concluded that Zone was associated with Functional and Technical. The characteristic form elements from the design format analysis were investigated in order to find out why Zone did or did not express these words. A few points were identified:

>>The lamp house and the ballast box do not form a unity; the result is a more cluttered product, i.e. not clear.

>>The appearance is edgy and has very tense surfaces. These features make it look very technical.

>>The tense surfaces also make the product look bigger and clumsier than needed, this is not an expression of clear and natural.

>>The ventilation holes are very distinct which gives the luminaire a very functional impression.

When comparing the luminaires to the products in the imageboard, the products in the imageboard are much more clean in the way that they have less details. This was something to consider for future work. Another conclusion was that the functional and technical aspects are already expressed by the luminaire itself, only because it is a luminaire. A luminaire is such a functional and technical product.

As a result of this, and the result of the survey, it was decided that the expression of the future products should be focused on Clear and Natural.

A third thing to investigate was the design heritage. If there was such a thing as a connection with previous products this could be important to keep in future products (see Chapter 3.5 for Branding Theory). Zone was compared to its predecessor, a spotlight called Sync, no longer produced by Fagerhult Retail, and it became clear that the two luminaires share many design elements. (Figure 5.4 and 5.5) The tensed surfaces and the prominent ventilation holes are the most apparent examples.

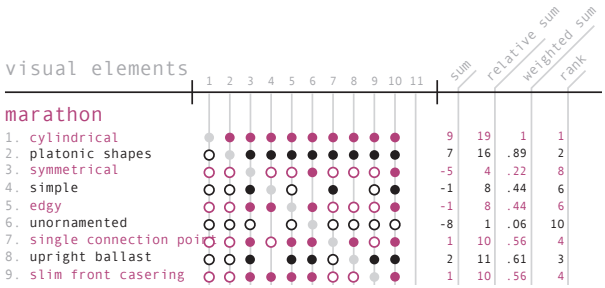


Figure. 5.3 *An Example of a Design Format Analysis Matrix*

Figure. 5.4 *The Related Spotlights ZonePoint and Sync*

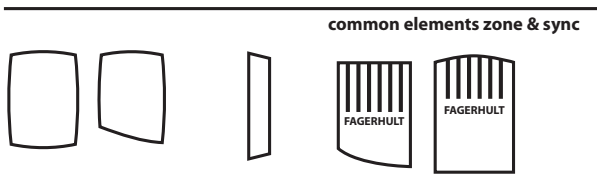


Figure. 5.5 *The Common Design Elements of ZonePoint and Sync*

5.1.2 Competition

An analysis of the competitors' luminaires was also conducted. This was done to get a better understanding of the luminaire market in order to avoid making a product that already exists. Another reason was to understand if there was anything distinguishing with Zone and the Fagerhult brand.

To get a good overview of the competition pictures of the competitors' spotlights were printed and divided into groups according to their form language (Figure 5.6 and 5.7). Different groups were created and they were named after their looks; Cylinder, Star Wars, and so on (see Appendix II for full analysis). This method was named Visual Benchmarking (see Chapter 4.3.3 for method description). It became quite obvious that the competitors all had spotlights in a lot of the groups, for example almost all the companies had a cylindrical spotlight. Since many competitors have many different variations of luminaires another conclusion was that it would be really hard to do something unique. Another reasons for this is that most of the companies, including Fagerhult Retail, only manufacture the housing of the luminaires. This means that they all use the same components inside and all have the same limitations in size and shape. The components used are developed and produced by Philips, Osram and General Electrics.

As a part of the competitor analysis, the lighting fair in Frankfurt, the furniture fair in Milan and a retail fair in Stockholm were visited. At these fairs a great deal of the competitors were represented and made this a good opportunity to study their designs and technical solutions in real life.

The Fagerhult Retail product brands are aimed at the higher segments of the European market. The Fagerhult product brand is the most basic of the Fagerhult Retail brands and is thus in the cheaper part of the professional, high quality market segment. It is more renowned in Sweden for its quality and performance than in the rest of Europe where it is struggling for market shares. The main competitors on the Nordic market are Swedish luminaire manufacturer Nordic Light and Finnish luminaire manufacturer Lival.

Figure. 5.6 *The visual benchmarking group called "Cylinder"*

Figure. 5.7 *The visual benchmarking group called "Cone-Box"*

5.1.3 Usage Analysis

An important part of the analysis of the present situation was to investigate the usage of the luminaire. Different users and usage situations have different requirements on a luminaire. The different users were identified and put into a flowchart representing the whole lifecycle of the product. Information was gathered through interviews with people from the different usage situations and observations of the product in its context (see Chapter 4.2.2 for method description). The flowchart was also a mean of making sure that no user was forgotten (Figure 5.8).

The different users were then interviewed about their usage of the Zone luminaires. The notes from the interviews were analysed through KJ-analysis (see Chapter 4.3.2 for method description). This created clear groups of information all dealing with a specific area. These areas were: Technology, Design, Future, Zone Family, Production, Market, Brand, Light, Concepts, Strategy and Process.

Important outcomes of this KJ analysis were:

>> Ventilation. There is a point on the ballast, called the TC-point and it has a certain temperature limit that is decided by the producers. For this point the temperature must lie below the given value, otherwise the functionality of the ballast cannot be guaranteed.

>> When cleaning the inside of the front glass the maintenance personnel cut themselves on protruding metal flanges.

>> Variations of the products are expensive due to stock keeping costs. As many components as possible should therefore be shared between the different products within the Zone family.

>> If you are not experienced the fastening of the front ring, for example after changing light source, is difficult.

>> The 70W luminaires are seldom used, but are sometimes needed for high ceiling installations.

>> The attachment of the accessories makes the lamp house bigger and this looks especially bad when used on ZoneSingle, the recessed spotlight, since the accessories stick out from the ceiling.

>> Some luminaire customers think that the finish of the Zone spotlights is dull and uninteresting.

>> The facelift should focus on the spotlight ZonePoint, since it is the most exposed product in the family.

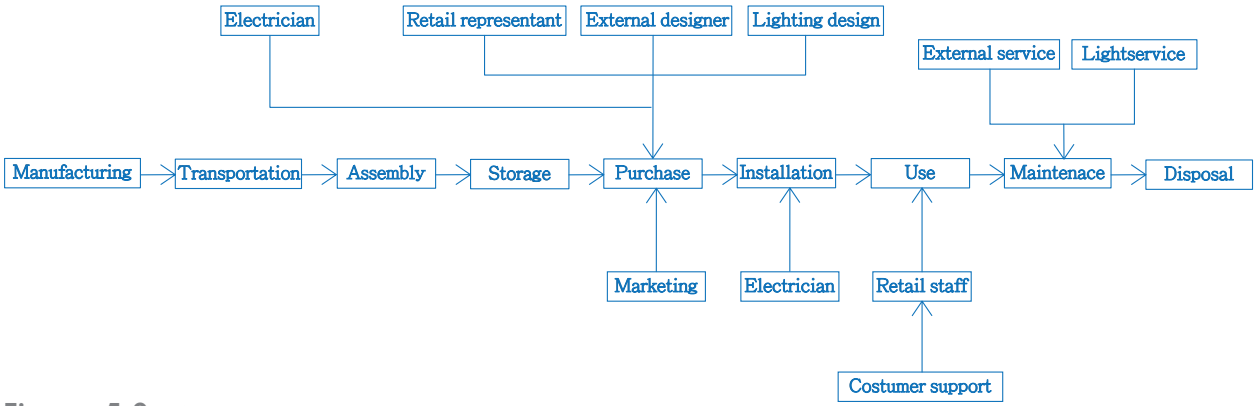


Figure. 5.8 *The ZonePoint user life-cycle flowchart*

5.1.4 Technology

Since the facelift would have its starting point in the present product it was very important to analyse the present product structure thoroughly. The components of the different models of ZonePoint were structured in different charts (Figure 5.9-5.12). The ZonePoint was chosen since it is the basis for all the other products in the family.

There are five versions of the spotlight ZonePoint; MT, STH, MTC, MTm and HMG 111. The names of the models are based on the light source that is used. MT, STH, MTC and MTm are all metal halide lamps in different sizes while the HMG is a halogen lamp.

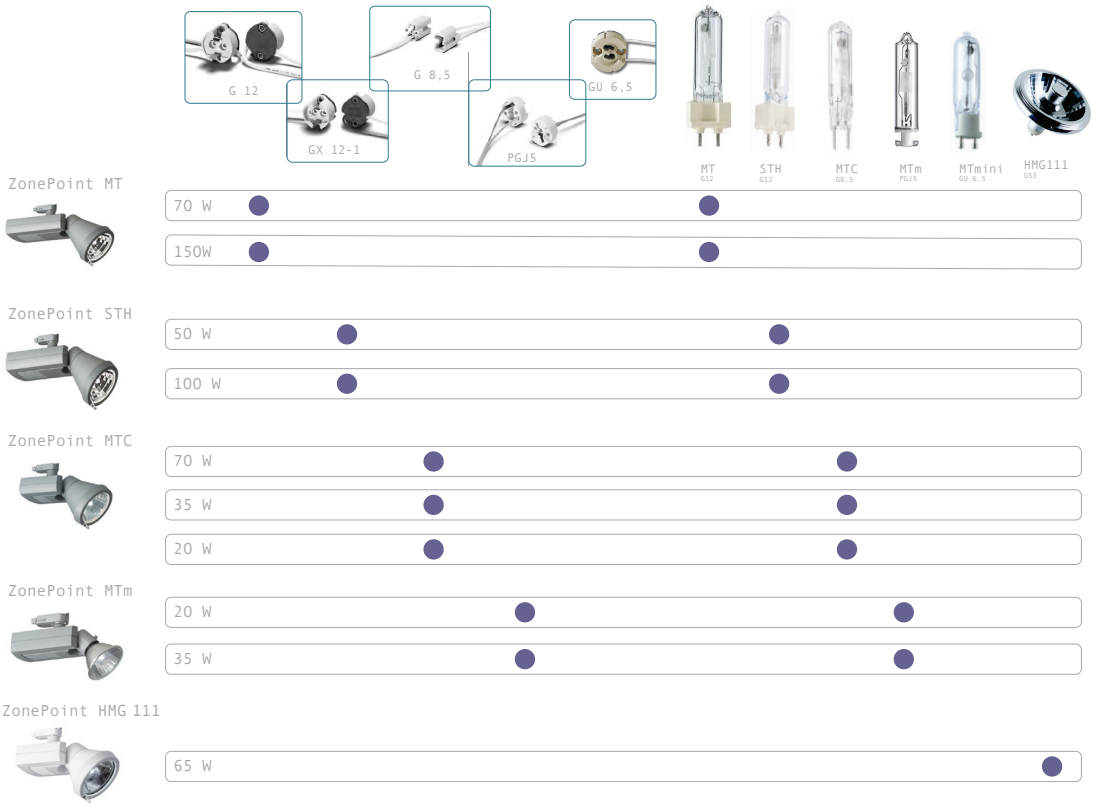


Figure. 5.9 *The light source and socket relation chart*

Within four of the five models there are also two versions of wattage available, which makes the total number of versions nine. However, there are only three different ballast boxes and three different lamp houses since the models share components (Figure 5.10). All the models share the front ring and the joint that connects the lamp house to the ballast box. This means that the upper and lower dimensions of the three lamp houses are the same, only the depth and the angle of the cone varies. The exception is MTm that does not share any components with the rest of the models except for the global track connector.

Considering the ballasts there are nine different models (Figure 5.11), only two ZonePoint versions share the same ballast. This is due to the fact that the wattage of the light source dictates what ballast to use. However, the size of the ballast is the same within each model except for MT. This is indicated with a frame around the pictures of the ballasts in figure 5.11. A result of the different sizes of the ballast for MT is that the ballast for the 70W luminaire is still encased by the same ballast box as the one for the 150W luminaire. Since the 70W ballast is a lot smaller than the 150W ballast this make the 70W luminaire a lot bigger than it has to be. To make matters worse the 150W luminaire is hardly ever used. As seen in the figure 5.11, the 70W ballast is also used for the 70W version of the MTC luminaire, and it has the same size as the 35W version. A conclusion is that the MT 70W could share the same ballast box housing as the MTC version.

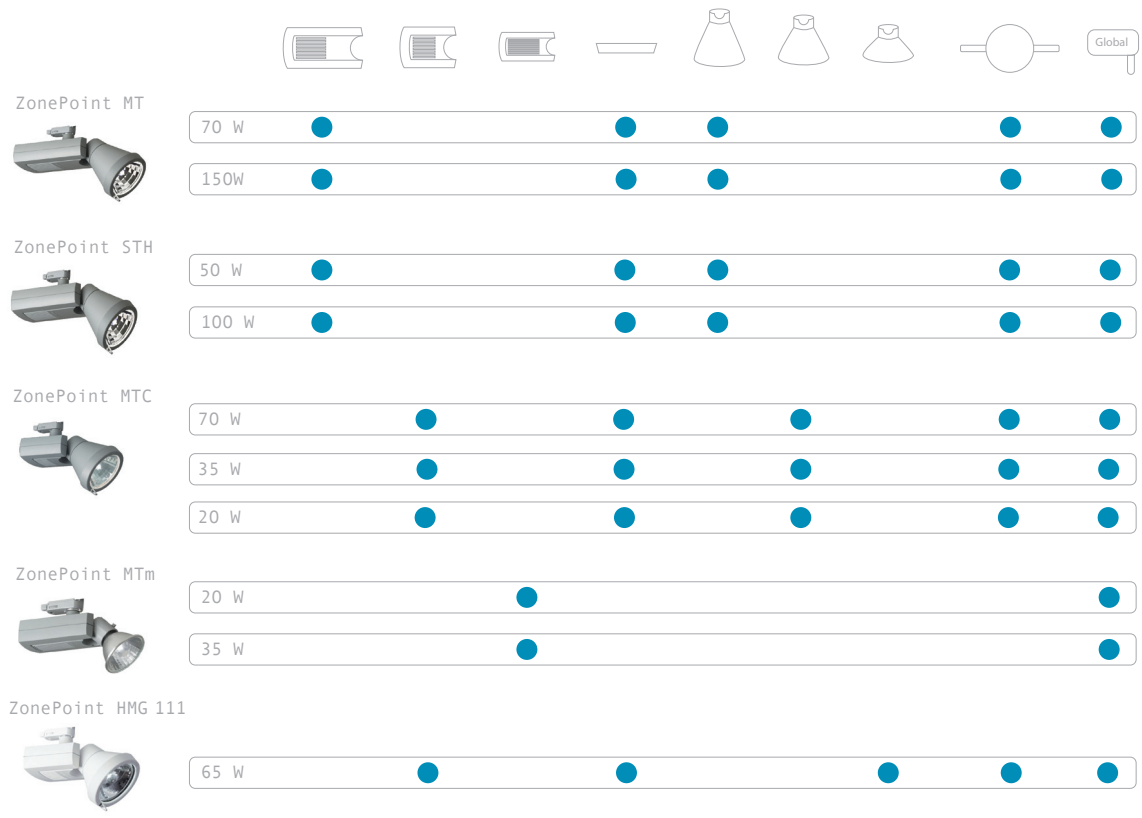


Figure. 5.10 *The housing relation chart*

Figure. 5.11 *The ballast relation chart*

The reflectors all have the same diameter at the big opening (Figure 5.12). This is due to the fact that this is where the reflector is fastened to the front ring. The front ring is then attached to the lamp house and the reflector is kept in place. And, since the same front ring is used for all the models, all the reflectors need to have the same diameter at the opening. The other measures however vary depending on what light source that the reflector is optimised for and depending on which angle the light beam should have, for example wide or narrow.

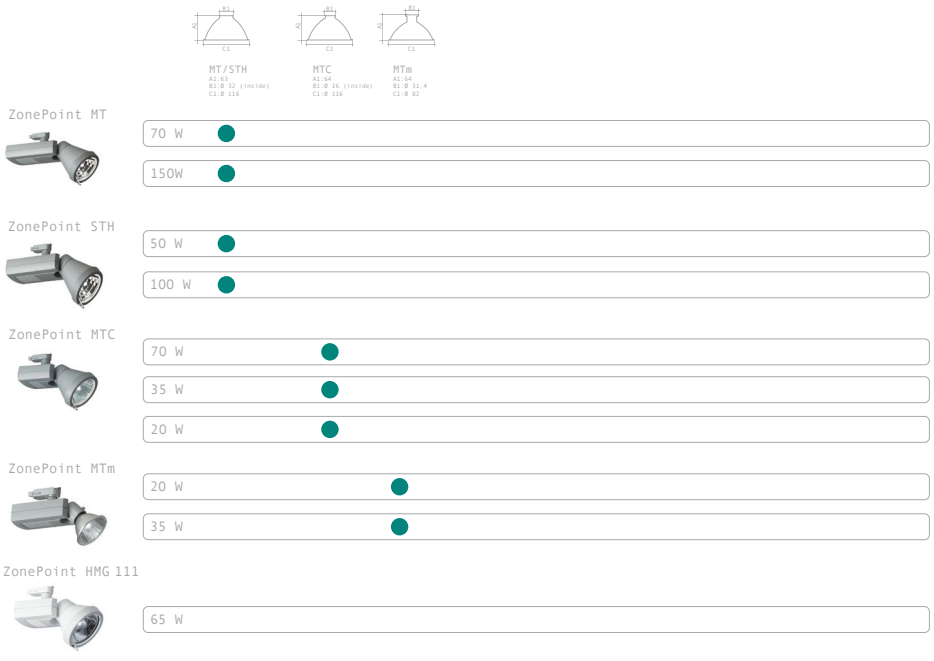


Figure. 5.12 *The reflector relation chart*

As mentioned above, the ZonePoint forms the basis for the whole product family and this means that the different products within the family share many components. To get a good overview and understanding it was necessary to investigate how the different parts were shared. This way it would become clear which products that would be affected if a component was changed.

The result was presented in a matrix-like picture that gave a good overview and was a good summary that could be consulted whenever questions arose (Figure 5.13).

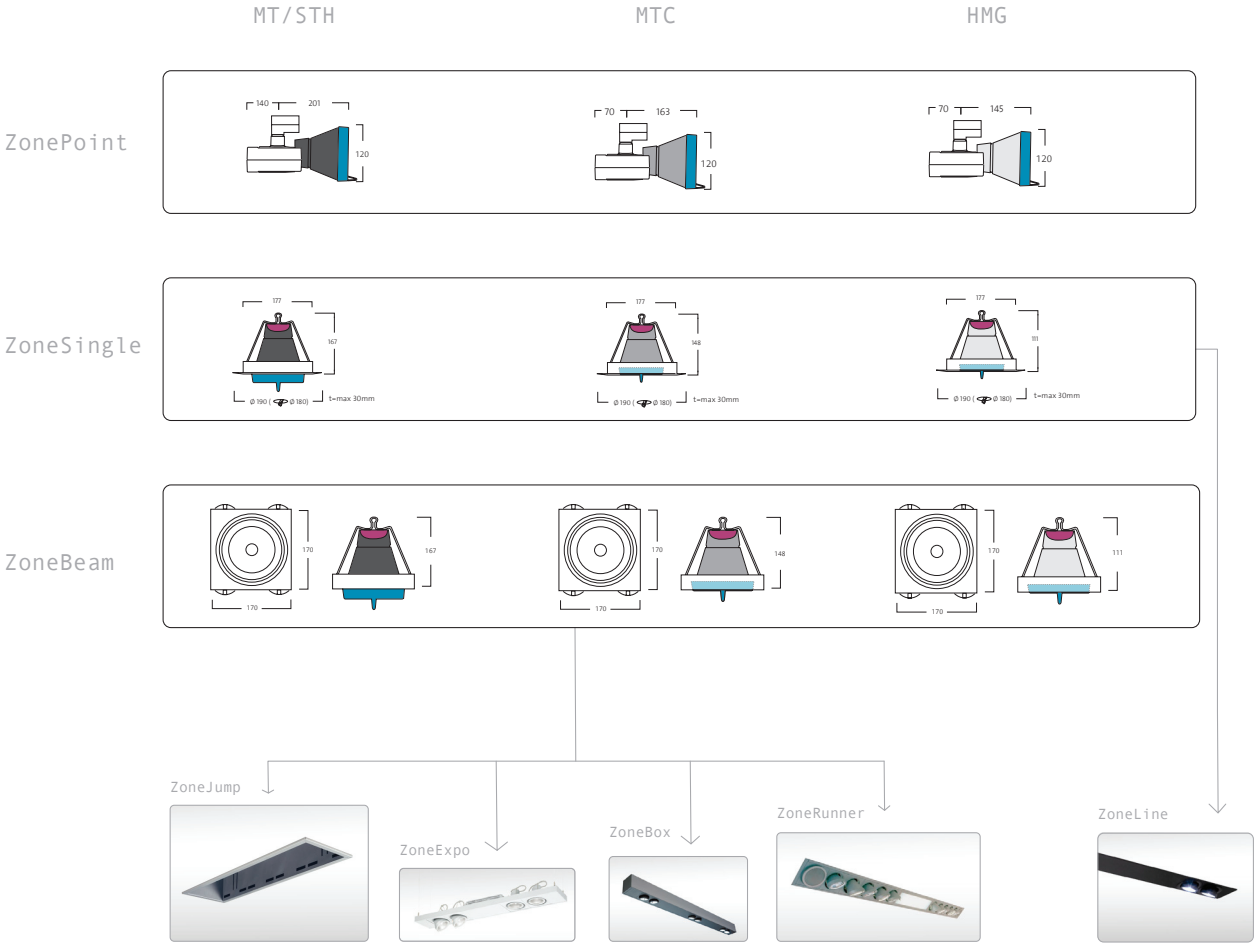


Figure. 5.13 *The ZoneFamily Relation Chart*

5.2 Implications for the Next Phase

This chapter summarises the analysis phase and highlights the important aspects that should be taken into consideration in the facelift and in the LED concepts. This section is divided into the same sub categories as the analysis section but a forth category is added. This forth category summarises insights and more implicit information that emerged during the analysis phase.

5.2.1 Branding and Product Expression.

>>The Fagerhult brand is not well expressed by Zone. To make Zone express the core values Technical, Functional, Clear and Natural, emphasis should be on Natural and Clear since Zone already expresses the other two. This could be achieved through creating a unity between the ballast box and the lamp house, and by making sure that details, like the ventilation holes, fit the overall form language of the product, i.e. a more coherent form language.

>> The prominent ventilation holes that were found both in Zone and Sync can be used as a design element in the facelift to create a connection to previous products (see Chapter 3.5 Branding).

>>There is no coherent form language for the Fagerhult brand to build on (see Chapter 3.5 Branding).

5.2.2 Competition

>> The facelift should fit in the market segment of Zone.

>> Even if it is hard, the facelift should differentiate Zone from its competitors.

>> The quality and performance of the luminaire must not be impaired.

5.2.3 Usage analysis

>> The front glass should be attached in such a way that maintenance is possible without injuries.

>> Ventilation must be taken into consideration. The limits for the TC-point must be kept.

>> Attachment of accessories should be easier and more functional.

>> Make the fastening of the front ring, for example after changing light source, easier.

>> Consider the finish of the spotlights.

>> Focus on ZonePoint, since it is mostly exposed and used.

>> Investigate the possibilities of including a LED-spotlight.

5.2.4 Technology

>> The front ring is used in all models, including the recessed spotlight and the system. To change this component would have the biggest impact.

>> The MT 70W spotlight is unnecessarily big.

5.2.5 Insights

>> What Fagerhult is selling is competence and knowledge, in both light and lighting design, but they are not expressing this competence in their luminaires. They look very functional and professional from a technical point of view but from a design point of view they do not express professionalism.

>> Making a luminaire that takes full advantage of the LED technology is a possibility to do something new and show this competence.

>> The facelift could clear the way for future products and be the starting point of a new form language for the Fagerhult brand, since there is not a clear brand heritage today and no good starting point.

6. Development of Facelift Concepts

The general idea of a facelift is to make rather small changes to a product to make it last longer on the market. It is important that the solution is cost efficient and possible to implement within a short period of time.

Fagerhult was in a position where they were going to decide whether to make a facelift of Zone or replace it with a new product family. To make this decision there was a need to investigate what a facelift could result in, both visually and functionally. The project was divided into two parts; one concerning visual aspects and the other concerning functionality. For each one of the parts, three concepts were developed to span the range of possibilities. In addition to this, a structural change was also developed.

6.1 Project Limitations and Set Up

The facelift development project started with a discussion with the Fagerhult Retail development team about what would fit in a facelift. Delimitations were stated regarding which parts to change. The outcome of the discussion was that a facelift should include a change of the front ring and the ballast housing without altering the performance of the fixture as a whole. Only changing the front ring or the ballast box should also be taken into consideration. The lamp housing should be left as it was since it holds most of the functionality of the luminaire and altering it would have consequences on the lighting performance. Furthermore, it was decided that the surface treatment of the whole spotlight should be included. It was also desirable to remove as many of the problems found in the original Zone as possible with the facelift.

The ZonePoint MTm does not share any parts with the other members of the Zone Family but should be included in the facelift in such a way that it is possible to give it the same expression as the other ZonePoint products.

A project goal was also that the facelift would add as few new parts as possible, ideally reduce the number of parts, in order to facilitate logistics, assembly and production as well as keep costs down. The aim was to achieve maximal visual change with minimum effort, i.e. cost and time.

When developing functionality concepts, the relationship between the amount of change and implementation time and money needed is somewhat

linear, which means that if you increase the amount of change you increase the costs and implementation time as well. Therefore it was important to find and an appropriate level where the change was big enough while the implementation time and costs were affordable. In order to help Fagerhult Retail in this decision it was decided that the facelift solution should be divided in steps with a small change and a small cost as a start and then increase the change and the cost gradually.

The time perspective of the facelift was that it should be implementable as soon as possible and produced with the resources available to Fagerhult Retail today. This meant using production methods known and used by Fagerhult Retail, using materials and finishes available in their current products and not making any major changes to the internal components.

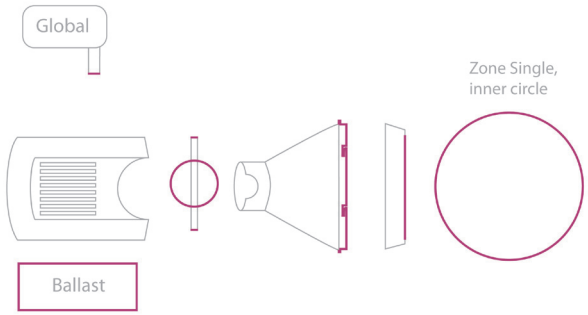


Figure. 6.1 *Visualisation of technical limitations*

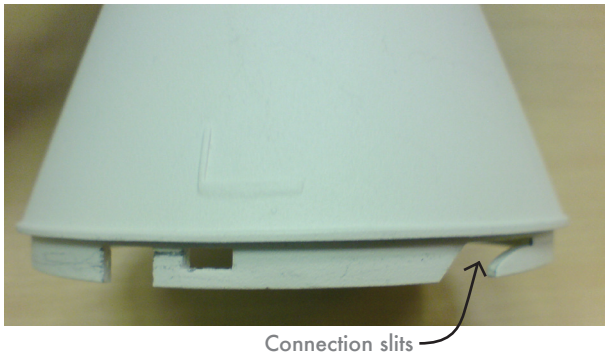


Figure. 6.2 *Connection slits in the lamp housing*

6.1.1 Physical Limitations

Since the lamp housing was supposed to be left intact, there were some measurements that could not be changed (Figure 6.1). The outer diameter of the lamp house is the same for all Zone products except ZonePoint MTm that does not have a lamp house, and is 112 mm, and the inner diameter of the fittings of the ZoneSingle is 130 mm. The dimensions of the new front ring should therefore lie between these two measures. Since the slits that are used to connect the front ring to the lamp house are not changed it is necessary to use a similar connection method as the one used today (Figure 6.2).

In the discussion in the beginning of the facelift project it was also decided that none of the internal components; ballasts, transformers, joints, connections or reflectors should be changed. This meant that the minimum measures of the ballast box were given by the components that were supposed to be fitted inside (Figure 6.3).

What was left to change was the front ring and all parts inside it, the two halves of the ballast box, the layout of the components and the finish. Another aspect to investigate was whether to change only the front ring, only the ballast box or both.

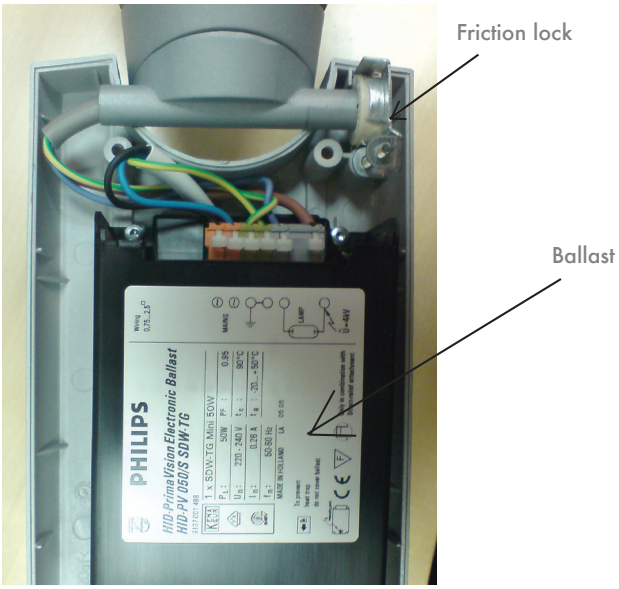


Figure. 6.3 *Inside of the ballast box, showing ballast and friction lock*

6.2 Development work

6.2.1 New Structure of Sizes

A new structure for the sharing of components was developed. As mentioned in the analysis, the MT 70W spotlight is a lot longer than it needs to be. A solution to this was to introduce a fifth spotlight type. This could be done without adding any components; instead the components were arranged in a new way. The lamp house of the MT70W spotlight had to be kept since the lamp house is adapted to the light source. However the ballast box of the MTC spotlight could be used (Figure 6.4). This would create a new smaller spotlight. An advantage of this solution is that the MT70W can be used together with the MTC spotlights without the difference in size being significant. The disadvantage is that it will be harder to see, from just looking at the spotlight, which light source that is used.

6.2.2 LED Implementation

A good solution for implementing LED light sources in the Zone lamp housing was not found. Today active cooling is needed to keep the LED light source at appropriate temperature levels but the lamp housing is not built for this. It has no air vents in the back for the air flow and in addition to this, it is not big enough to fit the passive cooling needed since the standard cooling is cylindrical and the lamp house is conical.

This means that a LED light source might fit in the biggest lamp housing but that contradicts one of LED technology's biggest advantages, being small (See Chapter 3.3.4 Light Emitting Diodes). One solution is to prepare the new MTm spotlight to support LED, but then the spotlight needs to be redesigned completely.

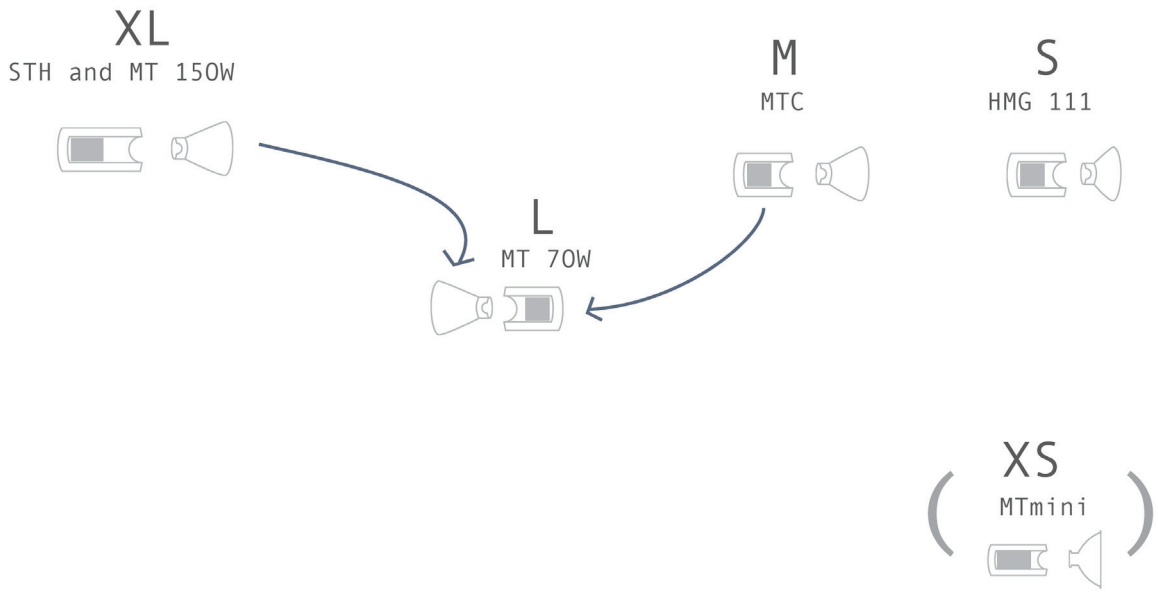


Figure. 6.4 *Visualisation of the new size structure*

6.2.3 Functionality concepts

The aim with the functionality development was to create functionality concepts that made the attachment of accessories and the fastening of the front ring to the lamp house easier. There was also a wish for including a baffle from the product development team of Fagerhult Retail.

The main problems of the original Zone products were related to the removal of the front ring for maintenance or production reasons. A new technical solution for the front ring could eliminate many of these problems.

Firstly, the front ring of Zone was analysed to see what parts it consisted of and what functionality they had.

The Zone front ring consists of three parts (Figure 6.5); the major part is the plastic ring. Inside the plastic ring is the front glass and a metal ribbon. The front of the reflector is then placed inside the front ring before attaching the ring to the lamp house. The reflector is kept in place between the edge of the lamp house and the metal ribbon. Zone does not have a baffle.

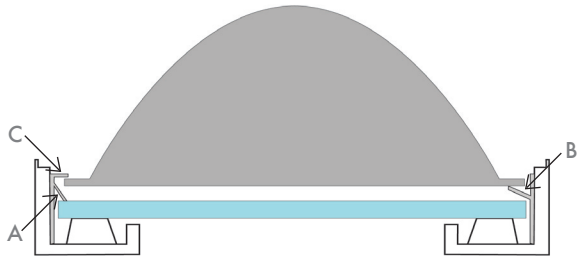


Figure. 6.5 *Cross section of the ZonePoint front ring with reflector and metal ribbon*

The metal ribbon is fastened inside the plastic ring and has many functions (Figure 6.6). Firstly, it is the part that attaches the whole front ring to the lamp house. Secondly, it keeps the reflector and glass in place when the front ring is detached from the lamp house. This is a wanted feature though on the other hand a tool, like a pen or a screwdriver, is sometimes used by the service staff, to lever, when the reflector is replaced.

Secondly, two other Fagerhult products were investigated to see how the fastening, the baffle and the accessories were designed for these products.

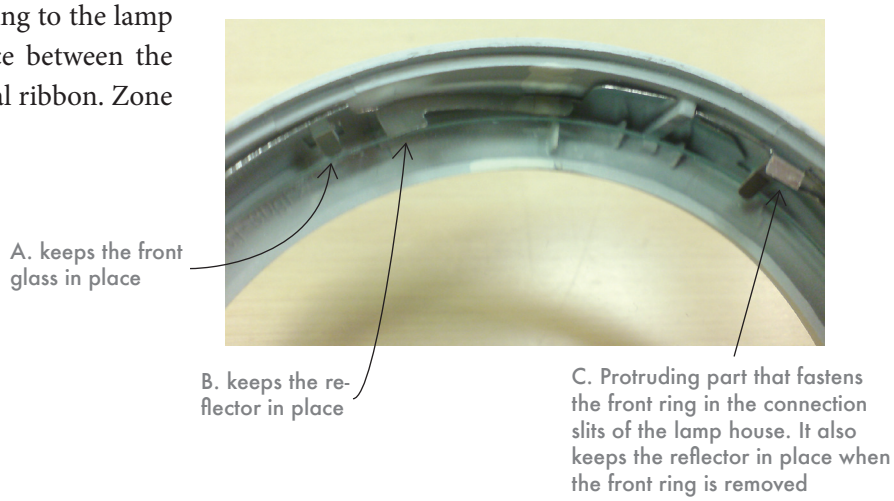


Figure. 6.6 *Close-up showing details of the metal ribbon*

The big version of the Sinus spotlight has a metal ring as its main part and inside it, a plastic ring that functions as a baffle since it sticks out from the metal ring (Figure 6.8). The plastic ring is fastened into the metal ring with screws (Figure 6.7). The screws also fasten the reflector. The front glass is kept in place between the reflector and the plastic ring. A result of this is that the front glass will be loose when the reflector is removed for cleaning or when replacing it.

The Strato spotlight consists of one metal ring and one plastic ring (Figure 6.10). The plastic ring is fastened into the metal ring with screws while the front glass and reflectors are fastened with flexible plastic clips on the plastic ring (Figure 6.9). A disadvantage that is also found here is that when the reflector is removed, the glass is loosened. The clips are a nice solution to be able to remove the reflector without a tool, however the usage of six clips makes it hard to achieve even with two hands.

Figure. 6.7 *The front ring of the spotlight Sinus with reflector attached*

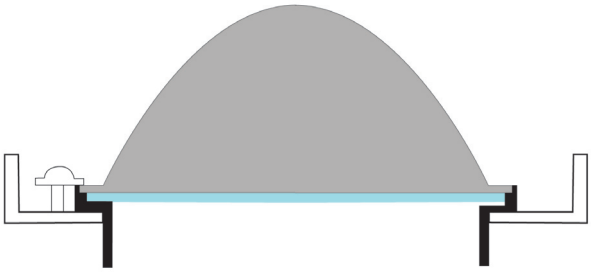


Figure. 6.8 *Cross section of the Sinus front ring with reflector*

Figure. 6.9 *The spotlight Strato front ring with reflector attached*

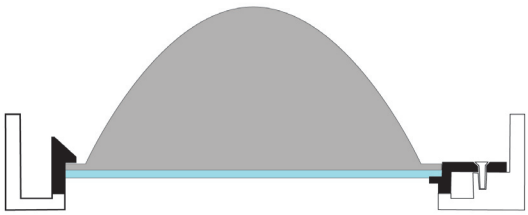


Figure. 6.10 *Cross section of the Strato front ring with reflector*

The analysis of the different kinds of front rings led to the following conclusions:

>> It will be hard to substitute the metal ribbon in Zone without adding any components since it has so many functions.

>> A tool is needed to remove the reflector in the Zone spotlight. This should not be necessary.

>> The flexible plastic clips are a nice solution but they should be fewer to make it easier to open them.

>> In the Zone spotlight the front glass is still fixed when the reflector is removed, this is positive for maintenance reasons and should remain unchanged.

>> If a plastic ring is used inside the main ring it can be extended and used as a baffle.

As mentioned above, there was also a wish for a more functional way of fastening the accessories. Today the accessories are fastened outside the front ring (Figure 6.11). In ZoneSingle this adds to the part that stands out from the ceiling, making the lamp house look bigger and more obtrusive. From this point of view a solution where the accessories are fastened inside the front ring is to prefer.

In the next phase sketching was used to evaluate different ideas. When it was hard to evaluate the ideas two dimensionally on paper, take-away coffee mugs were used as paper models (Figure 6.12) (see Chapter 4.2.2 Mock-ups for method description). The best ideas were evaluated in a CAD-software to see if they fit the spatial limitations that were set by the lamp house and the opening of the front ring (see Chapter 4.4.1 CAD Evaluation for method description). Three functional concepts were developed and as decided they represented a gradual increase in complexity.

Figure. 6.11 *The attachment of accessories on the Zone front ring*

Figure. 6.12 *Paper cup mock-ups*

Final Result Functionality Concepts

Here are the three function concepts presented in an increasing order of complexity. The first concept has no new functionality, it only includes a visual change in the facelift, the second adds some functionality to the existing components and the third concept is a completely new way of attaching the front ring to the lamp house solving the functionality issues from the analysis phase.

First concept

The first function concept was to keep the functionality of the current Zone spotlight and only change the visual aspects of the front ring (Figure 6.13). The advantage of such a solution was that no new components needed to be developed.

Additionally, this would mean lower costs and faster implementation time. This is also a solution that is proven to work, so no additional testing of the functionality will be needed. However, this solution does not solve the problem with the accessories or that the maintenance staff cut themselves when cleaning the front glass. The news value of such a change is also low since only the appearance of the spotlight will be updated.

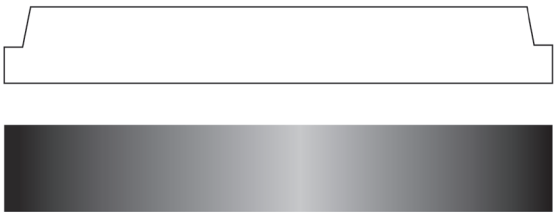


Figure. 6.13 *Schematic of the first function concept*

Second concept

The second concept was to keep the metal ribbon but to add a plastic ring that would function as a baffle (Figure 6.14). The baffle would be fastened underneath the front glass and as a result also be fastened by the metal ring. Inside the baffle the accessories could be fitted. This way the expression of the spotlight does not change when accessories are added. The advantages of such a solution would be that the functionality of the metal ribbon is kept, which means lower development costs and implementation time. The addition of a baffle was desired and this also solves the accessories problem. Still, the sharp edges inside the front ring remain an issue.

Figure. 6.14 *Schematic of the second function concept*

Third concept

The third concept is the concept that differs the most from the current solution. The metal ribbon is replaced with a plastic ring that functions as a baffle (Figure 6.15). Inside the plastic ring the front glass is kept in place by screws while the reflector is kept in place by two mini flanges in the metal ring and one flexible plastic clip. The reflector is first placed under the metal flanges and then the flexible clip is pushed aside making it possible for the reflector to fall into place. The metal flanges also replace the flanges in the metal ribbon that fasten the whole front ring to the lamp house. Between the front glass and the front of the metal ring there is an extra shelf where accessories can be placed (Figure 6.16).

The big advantage of the third concept is that it solves all the stated problems; there is a baffle, a better solution for the accessories and no sharp edges. It is also possible to make the front ring smaller with this concept. All in all the news value is high. The disadvantages of a totally new solution is that it introduces several new components, the functionality will need to be tested and as a result, the development time will be longer and costs will be higher. A rapid prototype of this concept was produced in order for Fagerhult Retail to easier evaluate the new functionality (Figure 6.17).

Figure. 6.15 *Schematic of the third function concept*

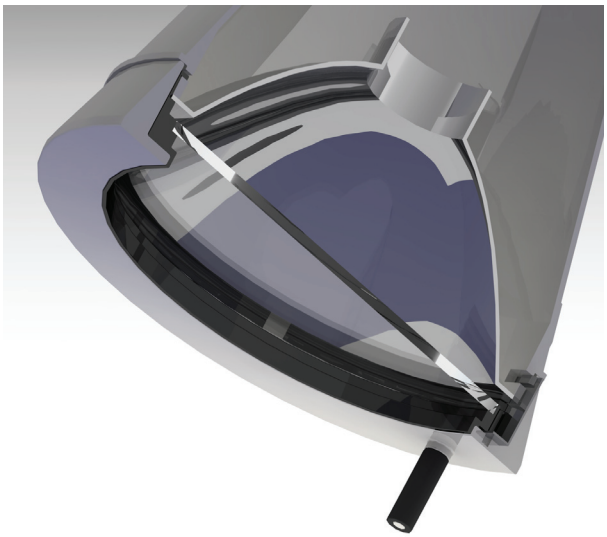


Figure. 6.16 *Cross section of the third function concept*

Figure. 6.17 *Rapid prototype model of the third function concept*

6.2.4 Visual Concepts

The goal with the new visual concepts was to find examples of how the Fagerhult brand could be expressed more clearly by the luminaire. The basis of the development of the design concepts was the imageboard of the Fagerhult product brand's core values.

In the first phase the initial limitations of the facelift were set a side in order not to interfere with the creative process. Sketching freely created a number of examples of a new expression (Figure 6.18). CAD-software was also used to try new proportions and to investigate how the expression changes with different proportions (Figure 6.19-6.21) (see Chapter 4.4.1 CAD Evaluation for method description).

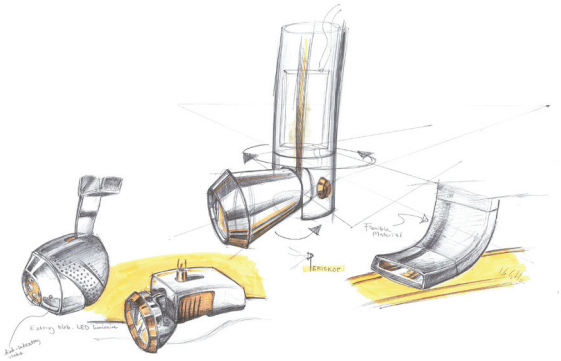


Figure. 6.18 *Freely made sketches*

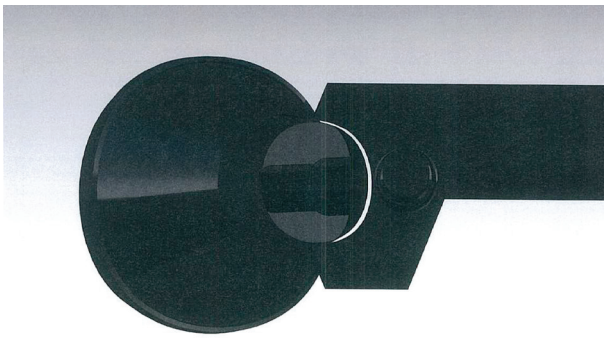


Figure. 6.19 *Early conceptual CAD model one*

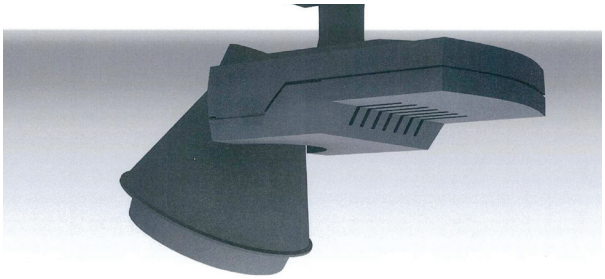


Figure. 6.20 *Early conceptual CAD model two*

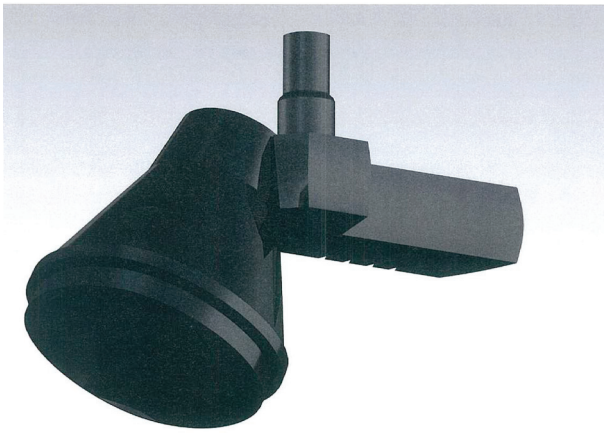


Figure. 6.21 *Early conceptual CAD model three*

To narrow down the degrees of freedom and to get more realistic designs, sketching was continued on printed underlays of the current luminaire. (Figure 6.22-6.23 and 6.25-6.26). When more plausible designs were created, some of these were further evaluated through creating new underlays (Figure 6.24) or throug paper models including the actual components of the luminaire (Figure 6.27 and 6.28) (see Chapter 4.2.2 Mock-Ups for method description).

Different combinations of the ballast box and front ring were evaluated; only changing the front ring, only changing the ballast box or changing both. It was however realised that changing only the ballast box was not an good alternative since that would not be a facelift for the recessed spotlight ZoneSingle. A rapid prototype of one of the concepts was produced in order to evaluate the visual change when only changing the front ring. (Figure 6.29)

Finally, the different concepts were adjusted to fit the technical limitations such as the size of the components that must be used and manufacturability. The result was three different visual concepts.

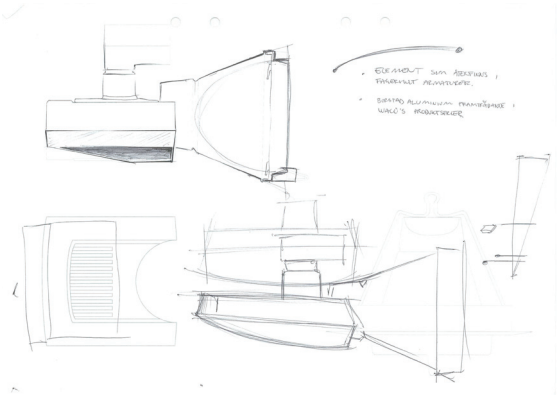


Figure. 6.22 *Underlay sketch one*

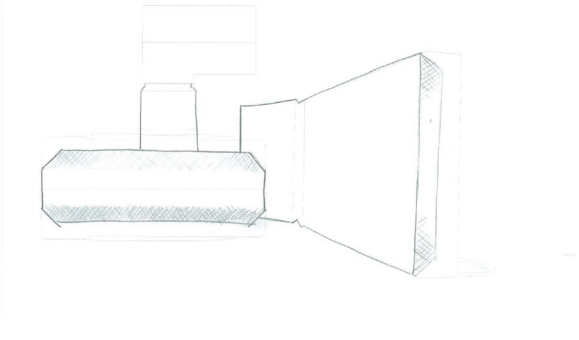


Figure. 6.23 *Underlay sketch two*

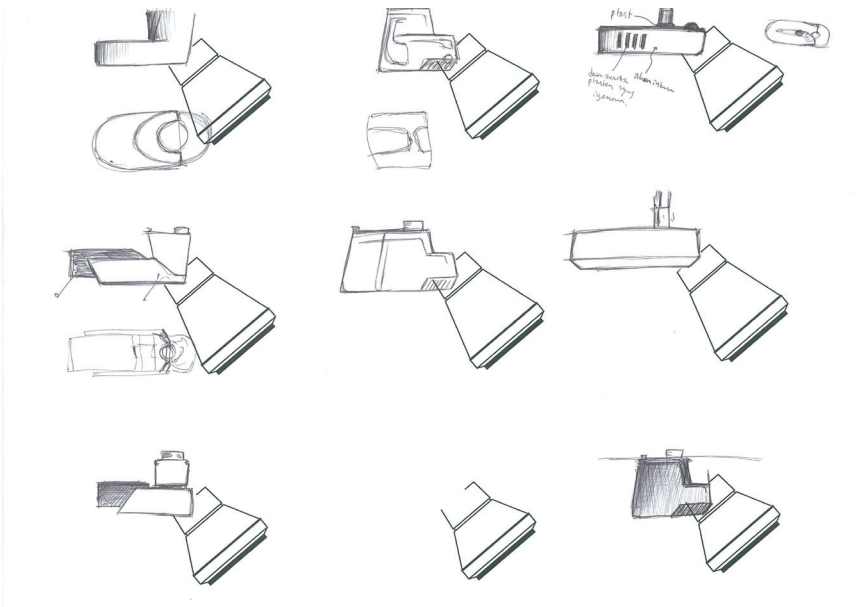


Figure. 6.24 *Underlay sketch three*

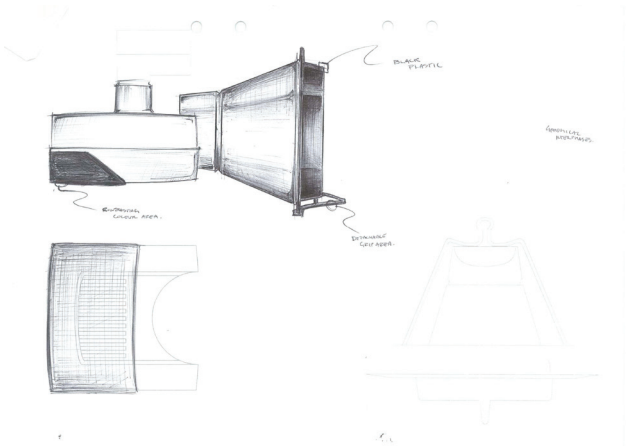


Figure. 6.25 *Underlay sketch four*

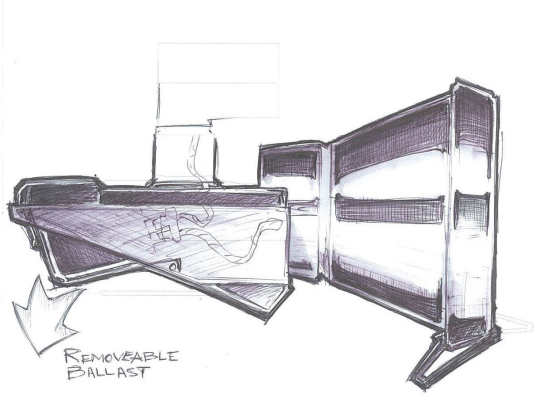


Figure. 6.26 *Underlay sketch five*

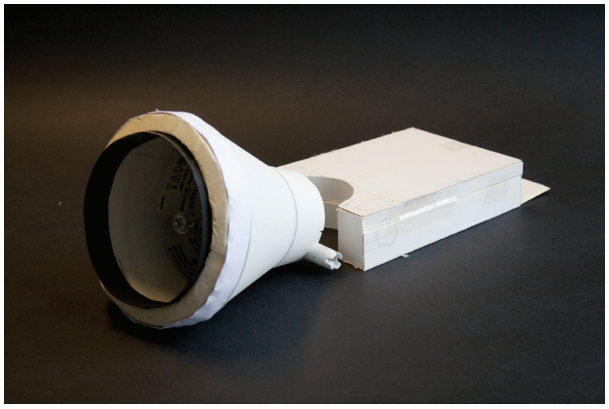


Figure. 6.27 *Mounted paper mock-up*

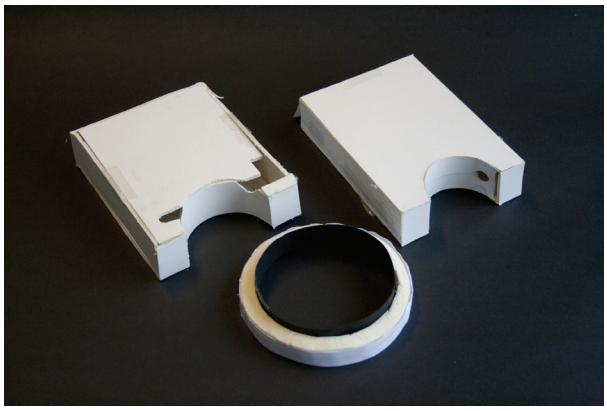


Figure. 6.28 *Paper mock-up parts*

Figure. 6.29 *Rapid prototype model attached to the original lamp housing*

Final Result Visual Concepts

Hat

The Hat concept is the concept that is the most similar to the present product. Only small changes are done in the design, and it is very much in line with the present Zone design language (Figure 6.30).
The surfaces are cleaned up; there is less visual noise and no tensed surfaces since this was thought not to fit with the lamp house. The front ring also has a connection to the present Zone front ring and other older Fagerhult products (Figure 6.31-6.34).
The straighter sides of the front ring and the ballast box fits the lamp house better and less visual noise makes the luminaire clearer.

The front ring of the hat concept was also tried out with the old ballast box. They go quite well together, the chamfers of the front ring are repeated in the ballast box (Figure 6.35).

The hat design concept is compatible with all the function concepts and fits the current form language well. However, this also means a rather low news value.

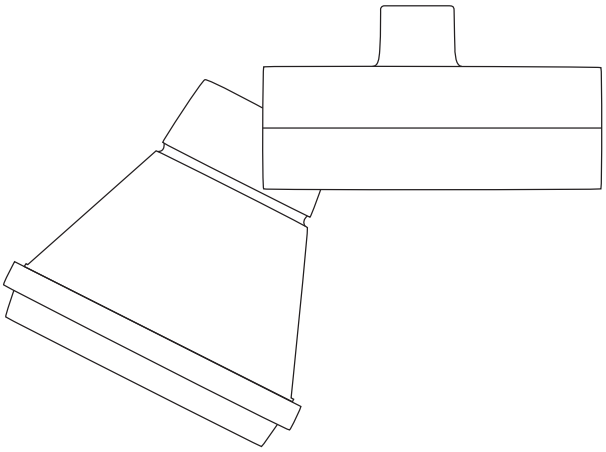


Figure. 6.30 *Outline of the Hat visual concept*

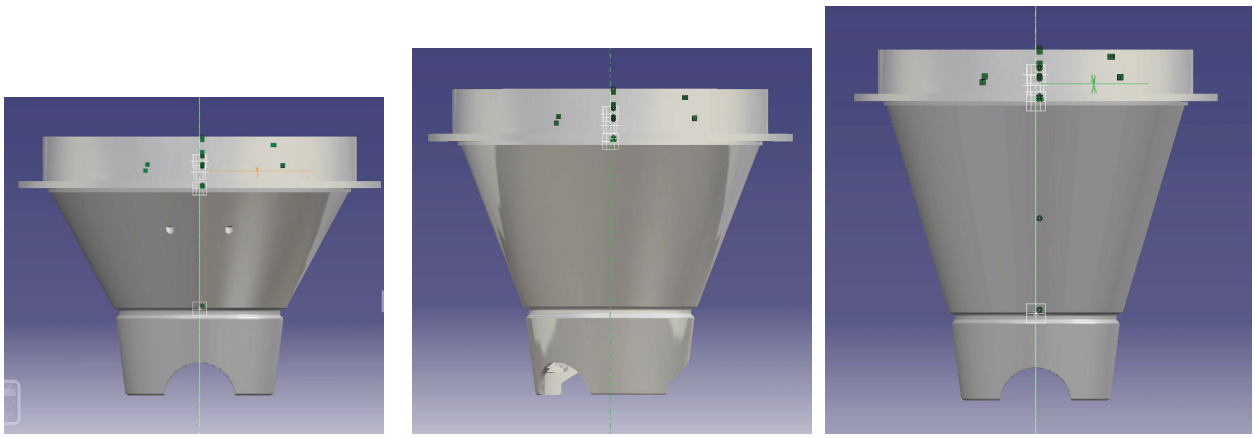


Figure. 6.31 *The Hat front ring on different lamp housings*

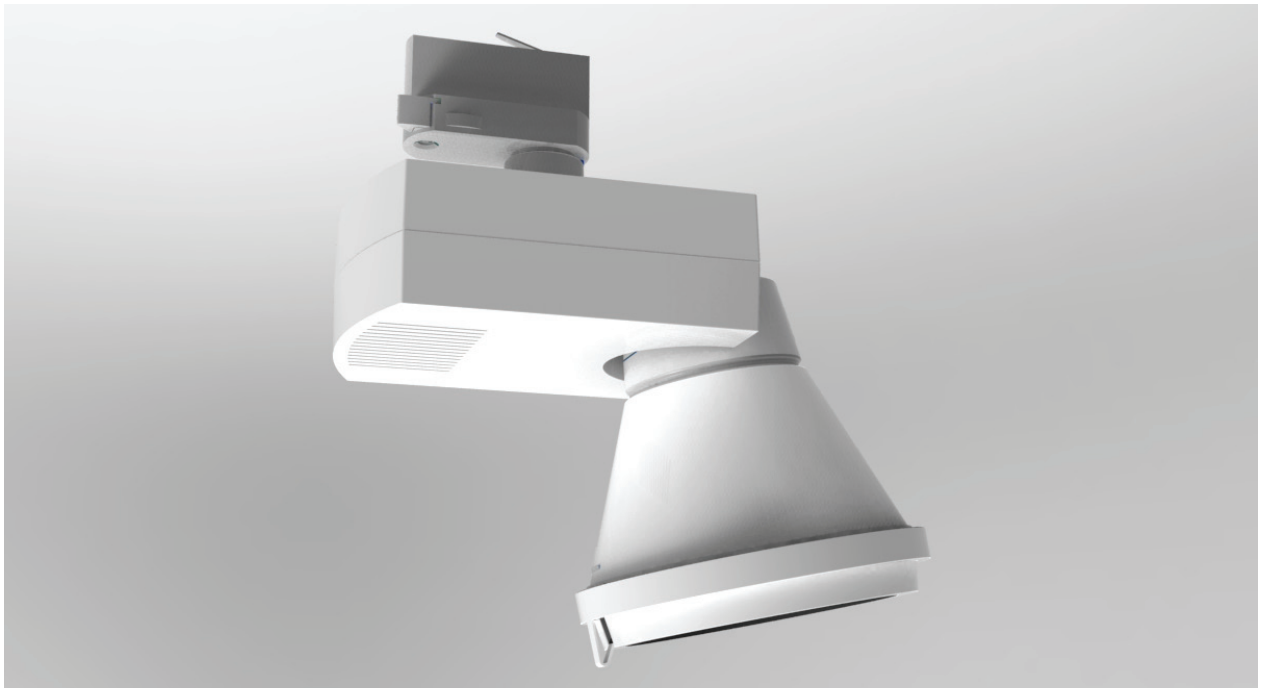


Figure. 6.32 *The Hat visual concept, side view*

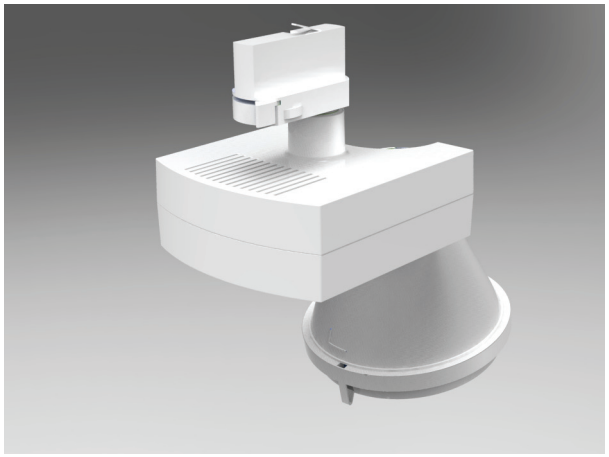


Figure. 6.33 *The Hat visual concept, back view*

Figure. 6.34 *The Hat visual concept, family view*

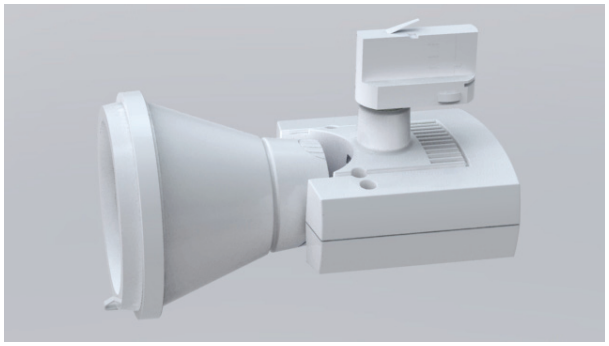


Figure. 6.35 *The Hat front ring and the original Zone ballast box*

Cone

In the Cone concepts the ballast was turned 90 degrees in relation to the ballast box. This makes the ballast box a bit slimmer yet longer. The ballast box is made up by two surfaces wrapping around each other. The Cone concept has a very clear and natural expression (Figure 6.36). The ballast box and front ring contains simple, understandable shapes (Figure 6.38). The circular shape of the lamp house is repeated in the ballast box (Figure 6.39-6.43). From underneath this concept looks like a rectangle with two half circles on two opposite sides (Figure 6.37).

The ventilation is kept on the top and front in order to keep it as invisible as possible (Figure 6.40). This makes the underside, the most visible part of the armature, clean and simple and further emphasises the Clear and Natural characteristics of the design concept.

The combination of the Cone front ring and the old ballast box is not to prefer. The straight simple shapes of the lamp house are not emphasised with the tensed shapes of the ballast box (Figure 6.41).

When seen from underneath the exact rounds and sharp radii of the ballast box creates a professionalism connected to aesthetics and design knowledge. The professionalism of functionality and technology is still connected to the parts inside.

The Cone concept is compatible with all the function concepts and has a high news value. However, it is the concept that uses the most material.

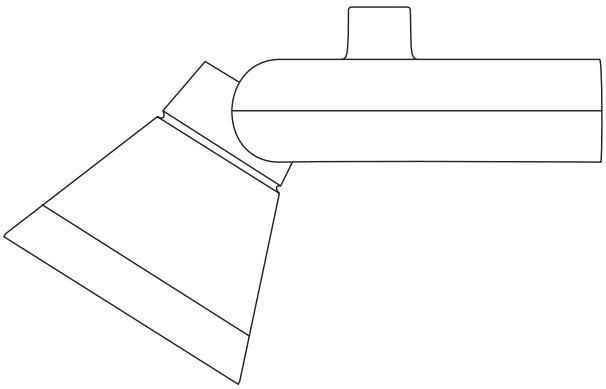


Figure. 6.36 *Outline of the Cone visual concept*

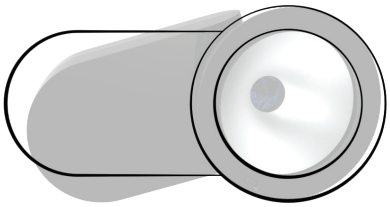


Figure. 6.37 *The Cone visual concept from underneath*

Figure. 6.38 *The Cone front ring on different lamp housings*

Figure. 6.39 *The Cone visual concept, side view*

Figure. 6.40 *The Cone visual concept, front view*

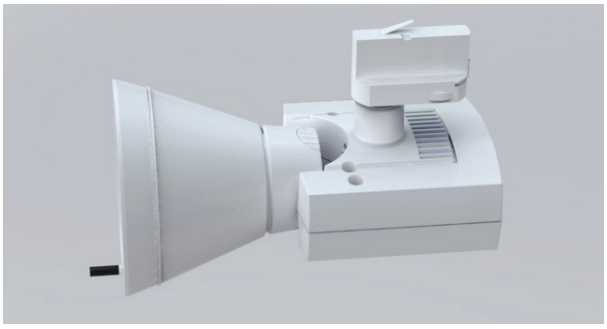


Figure. 6.41 *The Cone front ring and the original Zone ballast box*

Figure. 6.42 *The Cone visual concept, family back view*

Figure. 6.43 *The Cone visual concept, family front view*

Slim

The slim ballast box is the thinnest concept since the friction lock of the joint (Figure 6.45), that connects the lamp house with the ballast box, is rotated 180 degrees. As a result the screw hole is visible on the underside (Figure 6.48). The Slim concept is Natural and Clear since it is constructed out of simple shapes. The visible baffle gives the lamp house a prominent direction and the chamfers on the ballast box make it look more technical (Figure 6.46-6.51). This expression is enhanced by the visual ventilation holes.

The front ring of the Slim concept fits quite well with the present ballast box (Figure 6.50). The chamfer on the front ring is connected to the tensed surfaces of the ballast box.

The Slim concept has a high news value, much due to the prominent baffle (Figure 6.51). However, the thinner front ring makes this concept compatible only with the third and most advanced function concept.

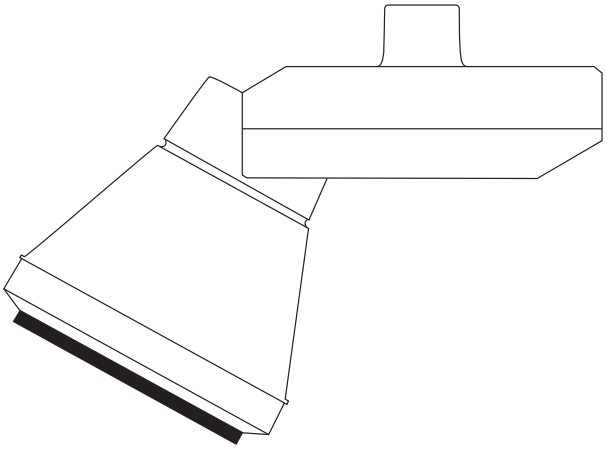


Figure. 6.44 *Outline of the Slim visual concept*

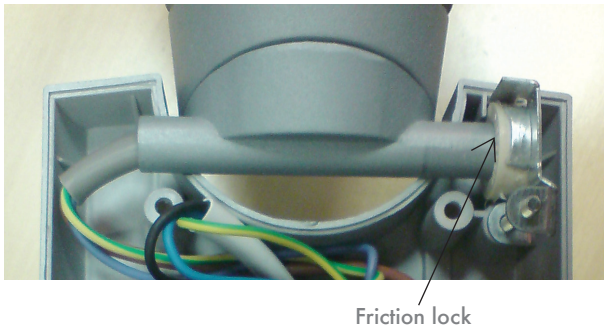


Figure. 6.45 *Close-up of the friction lock*

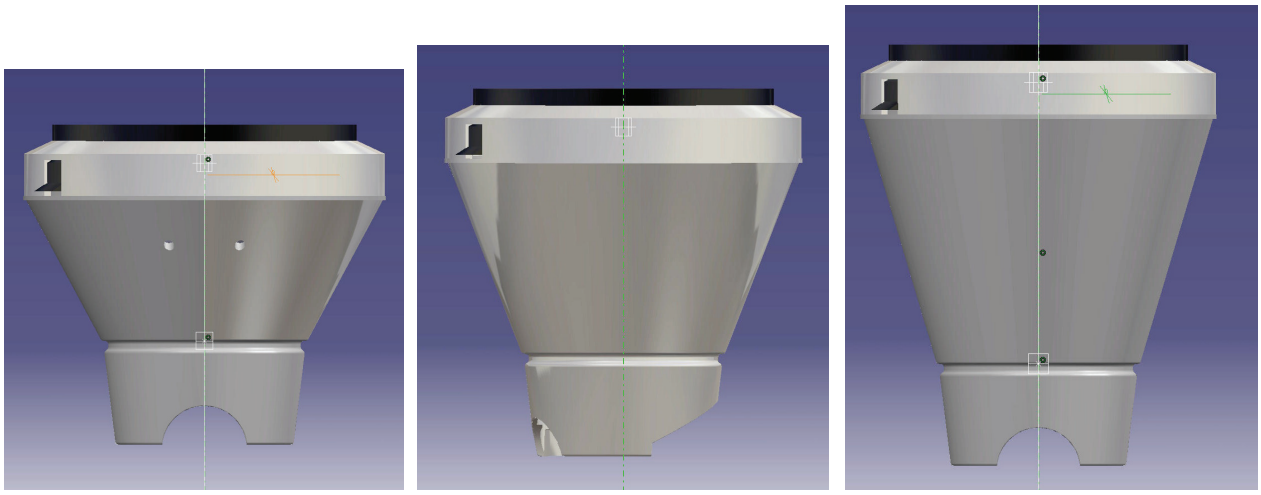


Figure. 6.46 *The Slim front ring on different lamp housings*

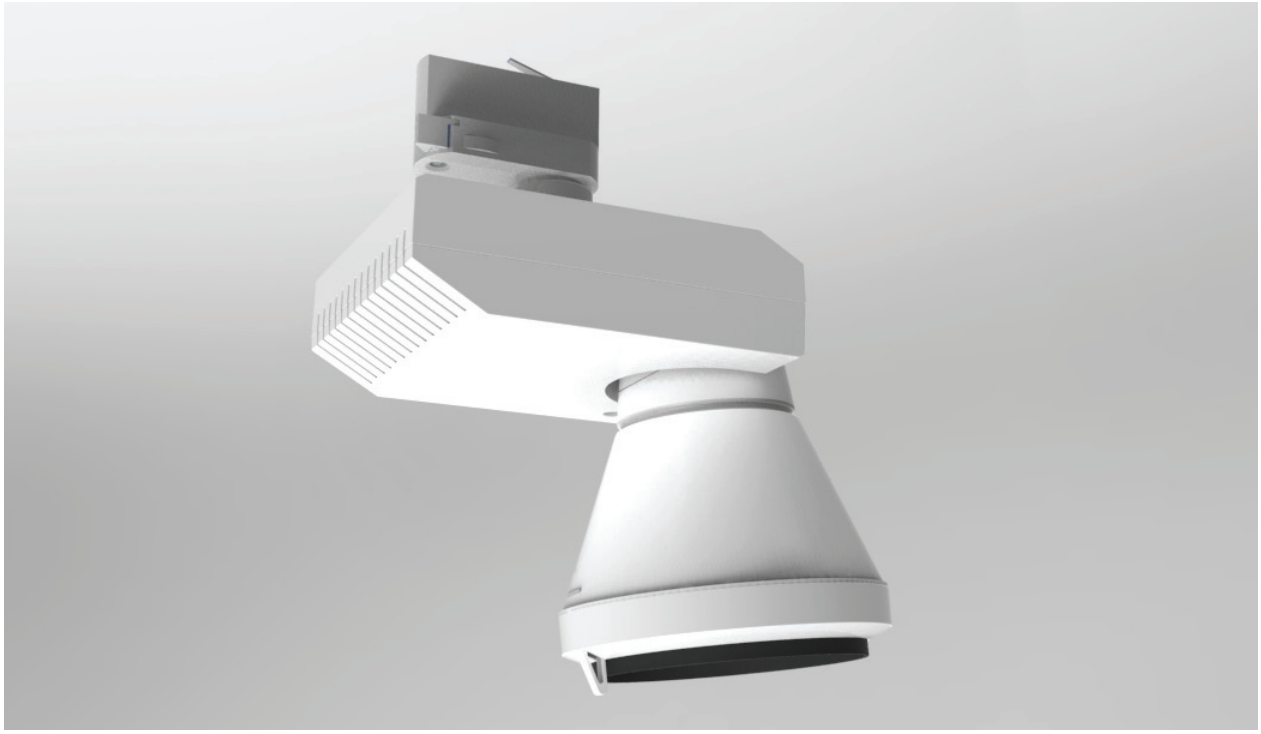


Figure. 6.47 *The Slim visual concept, side view one*

Figure. 6.48 *The Slim visual concept, back view*

Figure. 6.49 *The Slim visual concept, side view two*

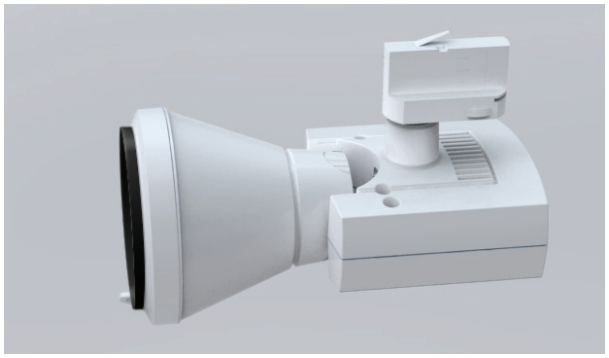


Figure. 6.50 *The Slim front ring and the original Zone ballast box*

Figure. 6.51 *The Slim visual concept, family view*

6.2.5 Colour and Trim

Material

The main colour and trim issue with the present luminaire is the use of both aluminium and plastic in the housings and that the two materials are supposed to look the same. The lamp housing is made of moulded and powder coated aluminium and the ballast box and front ring are made of plastic with a coating, which should resemble the structure of moulded and powder-coated aluminium. This results in colour variations because the materials age differently as well as that the plastic feels fake when holding the luminaire i.e. it looks like aluminium but feels like plastic. This contradicts the Fagerhult core values since trying to be something you are not is neither Natural nor Clear. This means that all parts that should look the same in the facelift should be made of the same material. Aluminium was chosen since it has superior heat conducting and recyclability properties and the weight and durability of a high quality product. The lamp housing, which is not changed in the facelift, is made of aluminium today and this was also an important factor.

Colour

The present luminaires are available in the colours white, grey and black. There are few colour alternatives to minimising the logistics costs but in order to heighten the news value of the facelift an additional colour could be used in small volumes. This colour should stand out and exaggerate the characteristics of the facelift.

Surface

The surface treatment of all the concepts presented should be smoother than the one used today. This would enhance the Natural and Clear expressions. To keep the manufacturing costs low, paint from Fagerhult Retail is present product range should be used. The luminaires Strato and Marathon have paints that fulfil the requirements of the facelift.

6.2.6 Manufacturing and Cost

The same manufacturing methods as today should be used for the new components of the facelift. This means moulding the aluminium parts, the ballast box and outer front ring, and the plastic parts, the inner front ring of function concept three. Tooling costs and material costs for the different concepts were estimated with help from Fagerhult Retail's product development team. This was done by comparing the size and complexity of the facelift components with components from present Fagerhult Retail products. The costs were compared to the cost of the original ZonePoint and between the different visual concepts. The increase in tooling costs was marginal compared to the old ZonePoint. The Cone concept was the most expensive since it uses the most material; still it is barely more expensive than the original luminaire. The use of materials in the concepts was not a priority and optimising the designs could therefore lower the cost.

6.3 Summary of Results

Below a matrix is presented that represents the range of possibilities that a face lift can contain. On the horizontal axis, the different functionality concepts are found and on the vertical axis the different visual concepts are found. The matrix shows which combinations are possible; for example function concept one is possible to combine with the visual concept Cone but not with Slim (Figure 6.52)

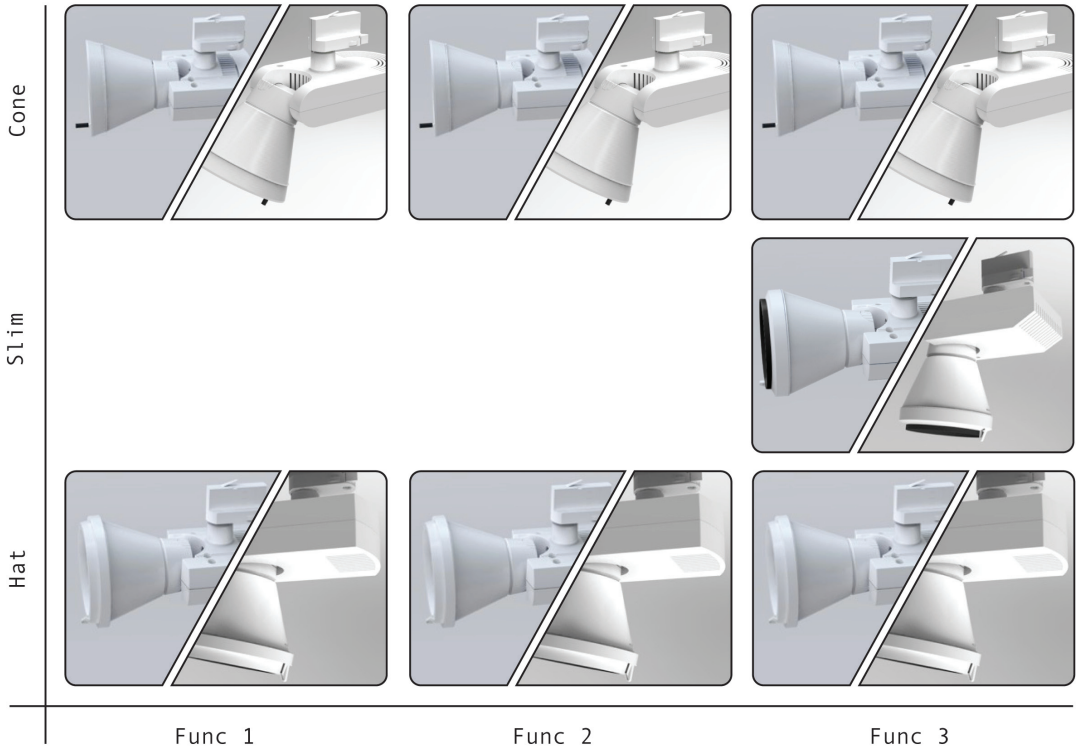


Figure. 6.52 *Summary of facelift results*

6.4 Recommendations

Together the concepts show the possibilities of a facelift. As mentioned before there are two ways to go further with the facelift; only changing the front ring or changing both the front ring and the ballast box.

If only the front ring is to be changed, the Slim concept is best suited (Figure 6.53). The Slim concept front ring works well aesthetically with the original ballast box and since it only functions with the most advanced function concept this concept will be used as a consequence of that. Still, if only the front ring is changed, it makes sense to use the advanced functional concept. Otherwise the total change will not be big enough.

If both the front ring and ballast box are changed, the Cone concept should be used (Figure 6.54). The Cone concept has the biggest visual change; it represents a new expression and is Clear and Natural. It is a well-designed and balanced luminaire that could function as a starting point for a common Fagerhult form language.

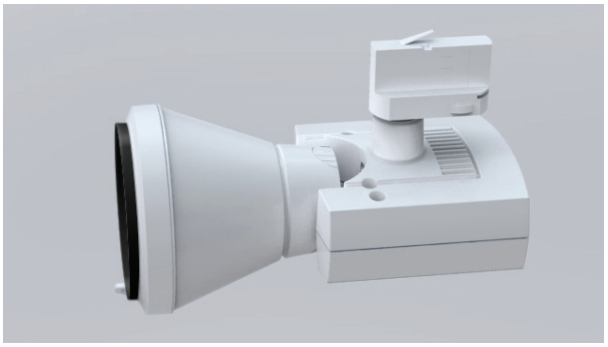


Figure. 6.53 *The Slim front ring and the original Zone ballast box*

Figure. 6.54 *The Cone visual concept*

7. Analysing the Future of LED

In this chapter the analysis phase for the LED concept development is described. The analysis covered both what is expected from LED technology in the future as well as the future context, the future society and retail environment, of the future LED concept.

The objective was to look at LED in the future, to give an example of what can be done and give a direction for Fagerhult Retail's future work with this emerging technology. Since the LED technology differs somewhat from the lighting technologies used today there is a window of opportunity to change the expression and composition of the luminaire as well as the way light is used in lighting concepts. The goal of this part of the thesis was to explore these possibilities.

As the LED technology grows more and more important all big retail lighting companies have started to work with LED. The big advantage with this new technology is the energy consumption. Today the energy consumption of LED is less than the energy consumption for light bulbs, halogen lamps and fluorescent lighting and about the same as the consumption of metal halide lamps.

7.1 Analysis

A weakness with most of the LED luminaires today is that they are based on luminaires for metal halide light sources. Instead of using the new characteristics of LED as a basis for new luminaire design, the focus has been on adapting the LED modules so that they fit in the current luminaires and lighting concepts. To avoid this in this project, the unique characteristics of LED had to be identified and used as a starting point when developing a concept for a new LED luminaire in the Zone product segment. To define what can be expected from LED technology in ten to fifteen years, information of LED development and research was gathered, analysed and summarised.

Another important parameter when exploring the future possibilities with LED is society. As society and behaviours change, the shops will as well and as a result the lighting, and in the end also the luminaires will change. Future LED products will not only be a result of what is possible from a technical point-of-view but also a result of what the stores will look like and what kind of functionality and form language that implies.

Scenario planning was used for a more structured approach to what a future society could look like (see Chapter 4.5.3 Scenario Planning). Scenario planning makes it possible to focus the product development on a certain scenario instead of trying to come up with a product for an undefined future. Four scenarios were developed, each of them having different demands on lighting and luminaires.

7.1.1 Premises

The basis of this part of the project was that LED at some point will dominate the retail lighting business. It was therefore assumed that the biggest setback today, the high initial price, would have been taken care of and that LED technology is economically superior compared to all other light sources.
The result of the LED development project should be ideas or concepts for a future LED product. The main focus of the concept development was on a system level. What the system can do and how it might look is more important than how it will function in detail.

7.1.2 LED Technology

LED is by many deemed to be the light source of tomorrow, but how come? In order to answer this question a literature study was performed concerning how far LED technology has come today and how far it can go. In addition to this, information about LED was also gathered by observations and interviews at lighting fairs and through discussions with LED experts.

Expert consultation

Two experts in the LED and electronics field were consulted many times throughout this third part of the project, Stephan Mangold and Harald Merkel from Stiftelsen Chalmers Industriteknik. These meetings provided an opportunity to discuss ideas and concepts, see the different components in real life and confirm facts.

Field Trip to Lighting Fare

At the lighting fare Light+Building in Frankfurt LED products were presented from every luminaire manufacturer. Most of the manufacturers have used LEDs as just another light source and placed them in their regular metal halide luminaires, but there were some exceptions. Belgian luminaire manufacturer Modular presented their LED spotlight SPOCK (Modular Lighting Instruments, 2010), that differ from normal spotlights by its thin profile and unique LED light source. Philips presented many different innovative LED luminaires, for example LivingColors (Philips Electronics, 2004-2010) a LED general lighting luminaire with the ability to change the colour and the intensity of the light with a remote control. These two luminaires indicated that the development of LED luminaires has come further than was first assumed. LED producers like Cree, GE and Toshiba were also represented at the Light+Building were. They displayed, among others, new LED light sources with a focus on exchangeability with older light sources e.g. LED that looks like a normal light bulb and fits in normal sockets. This shows that the demand for LED also draws the technology back in old tracks and not in the direction of new innovative solutions, it could be argued that this is a necessary step in order to make LED the standard light source used in all applications and that the new innovations will come after this. New technologies were also at display, such as OLED panels. Still in its cradle, this technology has great potential to revolutionise retail lighting. This first encounter showed that OLED had to be taken into account in the future work.
At the fair interviews were carried out with LED experts Willem Sillevis Smith from Philips Lumileds (Smith, 2010) and Robert Gray from GE Lighting (Grey, 2010). The focus of these interviews were "LED in the future" and provided a good base for literature studies.

Literature Study

The literature study contained research reports from the U.S. Department of Energy (2009, 2010), articles from the Lighting Research Centre (Freyssinier, Taylor, Frering, & Rizzo, 2009) (Taylor, 2010), Illuminating Engineering Society (Brodrick, 2010) (Lowe, 2010) (Hall, 2010) and Ultimate Home De-

sign (Rizzo, 2007). The most useful resource was the U.S. Department of Energy's report "Solid-State Lighting Research and Development: Multi Year Program Plan" (US Departement of Energy, 2010) which handled LED research supported by the Department of Energy. The report stated how far the research had come and what was expected in the future. It also provided some barriers that needed to be overcome before LED would reach its breakthrough. OLED was also mentioned many times in the report as a future light source that large funds were put to.

When reading the reports and papers, parts relevant to the future with LED were highlighted. The studies resulted in many highlighted statements that needed to be analysed and the KJ method (see Chapter 4.3.2 KJ Analysis for method description) was used for this. The information from all the sources was sorted in different groups depending on the content and context (see appendix III for the KJ analysis.) These groups were named and are presented below:

>> Pros
>> Cons
>> Market
>> Health
>> Energy
>> Applications
>> Heat
>> Comparison with other Light Sources
>> Cost
>> Light Quality
>> Lumen
>> Lifetime
>> Lighting Design
>> Research
>> Roadblocks

From the KJ analysis a summarised version of the most important parameters were derived consisting of the most frequent information and the data most relevant to this LED development project. These parameters where sorted again in three categories:

>> Positive Aspects
>> Negative Aspects
>> Future Promises

This final sorting gave a good overview of the opportunities and barriers for LED (see appendix IV for complete list).

Literature Study Outcome

The barriers were considered in order to find indications of when LED might be the natural choice of light source. This was no easy task and it was very hard to estimate when these barriers would have been overcome. It is also a matter of effort and habit, if the funds are provided LED will develop faster but only if there is a demand.

A subjective weighting of the opportunities by the project group resulted in four points of special interest for the future LED development. These were:

>>OLED - because OLED will be the next big thing after LED with the possibility to change retail lighting.

>>Efficiency - since this is why LED and OLED will dominate the retail lighting business at some point.

>>Controllability - this is one of the biggest differences between LED/OLED and conventional light sources. With OLED and LED intensity and colour can be changed very easily by altering the current to the diodes while for example metal halides are very complicated to dim. OLED opens up another dimension to controlling as well since it can show images and animations like a computer display in addition to lighting applications.

>>Size - LED and OLED have the potential to be much smaller than all conventional light sources.

This means that the designer has a lot more freedom when designing luminaires and does not have to consider the size of the components in the same way as today. Luminaires that are more integrated

in architecture and other objects are also made possible and provide more flexibility for the lighting designer.

7.1.3 Societal Aspects

The societal research was based on a method called scenario planning (see Chapter 4.5.3 Scenario Planning for method description). The first phase was finding parameters and the second was building the scenarios. Last in this chapter the scenarios are presented.

Finding Parameters

In scenario planning you search for underlying parameters that affect the uncertain future you want to investigate. The parameters are what define the future and by varying them you get different possible scenarios of the future. According to scenario planning theory, it is by identifying the most influential and uncertain parameters that you can find the most useful scenarios. It is not hard to make up hundreds of scenarios but on the other hand it is not useful either (Wilkinson, 2009). To identify the important parameters, which will define the future of LED, information from different trend institutes was gathered but also more scientific material on climate change and material scarcity was gone through. In addition to this a workshop was carried out together with lighting designers from Fagerhult Retail. The lighting designers were asked to create a vision of the shopping centre Nordstan in 2020. To stimulate creativity the participants were given pictures, pens and paper and were asked to make a collage of their vision (see appendix V for examples of collages).

From the written material together with the workshop the following parameters were identified as important (When no reference is found, the theories are the project group's own):

Resource Depletion

Scarcity of oil and materials will affect how much we can consume. There are indications that many metals already are almost depleted (Diederen, 2009).

Increasing Population

With an increasing population the amount of consumers grow and with them the demand on goods and products. By 2027 the world's population is expected have passed 8 billions (U.S. Census Bureau, 2010)

Increasing Wealth

When wealth increases the consumption of energy and materials increases and speeds up the resource depletion (Wouters & Bol, 2007).

Climate issues

The climate is changing; carbon-dioxide emissions have increased since the industrial revolution and the global temperature along with them. A temperature increase of more than 2°C will start irreversible climate change. In order to stay under that limit carbon-dioxide emissions need to be reduced drastically before 2020 (Allison et al., 2009) The threat of climate change might change our behaviour, proactively. People will change because they do not want climate change to happen or else they will be forced to change because climate issues alter their surroundings.

Local cocooning

Local cocooning is a trend predicted by the trend institute Faith Popcorn (Faith Popcorn's Brainreserve, 2009). Globalism and an increased and more accessible flow of information has made the world too complicated for humans to grasp. People therefore turn towards their local communities that they can see and trust. They build stronger connections and return to their roots in order to feel secure. The demand for local goods and services will flourish when the trust in big multi-national corporations fail.

The attitude of people

All the growing threats around us forces us to take a stand, will we do something or not? We can either be forced to change when resources are depleted and when we are facing climate change or we can

decide to take action and change before. Either way it will affect our future considerably.

Eco-engineering
When the threats of climate change approaches there is the possibility to engineer ourselves away from the problems of global warming. Capturing carbon-dioxide in the seas or underground while boosting renewable energy resources might buy some time. But putting too much faith in quick technological fixes might prove risky. (Institute of the Future, 2009)

All these parameters were connected to consumption in some way and how we consume will affect how our stores look, our stores will define our lighting and what lighting we want will influence what luminaires we need.
The next question to answer was: what influences consumption? To answer this question, the parameters from the technology and society investigations were summarised in two underlying parameters of consumption; Availability and Mind-set.
Availability is the amount of resources we have, materials, energy, oil etc. This will affect how many products that can be produced and consumed.
Mindset means the societal approach to what we prioritise in life, the individual or the collective i.e. everyone is thinking of themselves first or people have started to prioritise the common good, an example of this is making sacrifices to prevent or limit the effects of climate change.

Building Scenarios

The availability and mindset parameters were varied, to create a coordinate system with Availability on one axis and Mindset on the other. It ranged from High Availability to Low Availability and from Individual Mindset to Collective Mindset (Figure 7.1). The extremes of this coordinate system created four different scenarios. For each scenario a rather extensive description was made, explaining the road there, the society, the store and the lighting. In order to visualise these scenarios moodboards were created (see Chapter 4.5.2 Mood Boards for method description), they were focused on catching the feeling of the scenario. The moodboards were discussed in the project group in order to reach consensus about the scenario characteristics. In order to further capture the feeling of the scenarios, a story was written about a girl called Emma. In each scenario Emma is buying a jacket and the same situation was used for all scenarios to more explicitly point out differences between them (see appendix IV for all the stories).

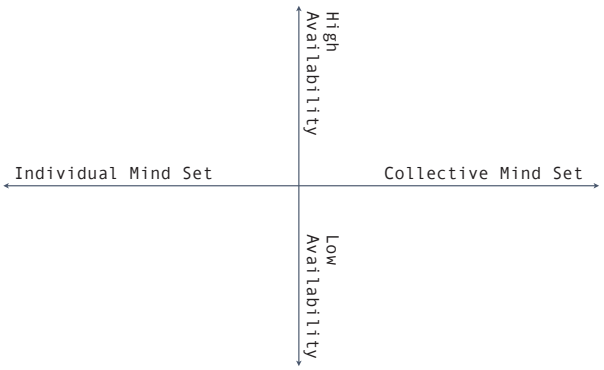


Figure. 7.1 *The coordinate system of the future*

To test and evaluate the scenarios a brainstorming session was conducted with design students from Chalmers University of Technology.
In the session the scenarios were presented with moodboards and stories and these were used as a base for a further discussion about the scenarios. The brainstorming resulted in thoughts and opinions around the scenarios, which were used in the refinement of the moodboards, and some concept suggestions for the LED luminaire development.

Below the final scenarios are presented:

7.2 Scenarios of the Future

7.2.1 Defined by Shopping

This scenario is characterised by a high Availability with focus on the individual (see Figure 7.2 for moodboard).

Road

People have ignored material and environmental concerns and over the last decade consumption has increased and there is no tendency of a decline. People define themselves with what they buy, "what you buy is what you are". Everything you buy from apples to shoes is a statement. Companies have become the biggest economies and rule the world.

Society

Trend cycles are short and since everybody needs to keep up the personal shopper has become the profession of the decade. People are bombarded with commercial messages and personalised commercials show people wearing the latest clothes before they even bought them. Shopping has become a health issue since more and more people get stressed out from trying to keep up with the fast changes and by trying to live up to unreachable ideals.

Store

The stores are huge entertainment parks were the interior design changes during the day depending on the customers in the shop. Different products are highlighted at different times to maximise the sales. In the changing room you can change the background picture and lighting to visualise what the clothes will look like in different environments. Stores want to provide the ultimate shopping experience.

Lighting

The light is very dynamic, characterised by changes in colour and intensity. Visual effects such as animations and changing in-store-posters have become the norm. The purpose of the lighting is to stand out, exaggerate and first and foremost to sell.

Figure. 7.2 *The imageboard for "Defined by Shopping"*

7.2.2 Consume Better

In this scenario the Availability is still high but the Mindset of people has changed to a focus on the collective and the common good instead of on the individual (see Figure 7.3 for moodboard).

Road

Reports on climate change, population growth and material scarcity have changed the way people consume, people consume better products but just as much as before. A combination of legislation and behaviour changes started a continuous process to substitute "bad products" with "good products". People realised the need for change and changed by their own will, the green revolution.

Society

As a part of the green revolution almost all unsustainable energy sources were substituted with renewable energy sources. In this society the common good is often prioritised over personal reasons and production ethics and environmental issues dominate the agenda.

Store

The stores are characterised by transparency, by whom, when and where are questions that need to be answered for every product. The handling of all this information has become a new challenge when developing new store concepts. As the search for the genuine and personal connections have grown in importance local brands prosper. Shopping should be a pleasant experience and the store should guide the customer into taking the right decisions.

Lighting

The light is calming and is often combined with daylight, both to save energy but also since daylight makes us healthier. With the boom of small stores of local brands the demand for small and cheap lighting solutions has increased.

Figure. 7.3 *The imageboard for "Consume Better"*

7.2.3 Limited Edition

This scenario is characterised by low Availability and an individual Mindset (see Figure 7.4 for moodboard).

Road

Limited Edition is a future scenario where material scarcity and oil depletion has forced people to consume less. The first indications that something was wrong were ignored and when the energy prices rose due to oil scarcity the production of metals rapidly declined. Since then, prices have risen and production of new products has been significantly reduced. As the world's population is approaching 8 billion, products made of virgin materials are expensive and exclusive.

Society

Despite the lack of consumable goods people still define themselves through shopping. But every product gets more important since people have fewer things to define themselves with. The focus is still on the individual and sacrifices for the common good are few. Everyone is trying to get the most out of this unwanted situation. Since material is scarce, craftsmanship and decorations have a renaissance. However, functionality is what the common person buys, everything non-functional is considered a luxury. Also the second hand market and the market for recycled products flourish. Most products bought by normal people are second hand or recycled. When buying expensive virgin goods the waiting list is long. Virgin products are seen as investments and are bought for long-term usage.

Store

The stores try to convince their customers that their purchase is the best purchase, most thought through, analysed and compared. The lack of goods has turned the store into a showroom where only a few products are on display. If different colours and styles are available these are shown on displays. Quality and lifetime are what the customer is looking for and many products are sold together with a maintenance service.

Lighting

The lighting concepts focus on the store and the brand rather than on the products. Light is however used to evaluate the products. Daylight control is also important to save energy.

Figure. 7.4 *The imageboard for "Limited Edition"*

7.2.4 We'll Get Through it Together

This scenario is based on a low Availability and a collective Mindset (see Figure 7.5 for moodboard).

Road

This scenario is furthest away from the reality of today. When humanity was facing the threat of climate change and material and oil depletion people started to act. These actions did not prevent these issues from happening; products and energy are scarce due to depletion. However, the severity of these issues was reduced and maybe most importantly, values were redefined. What you do and people around you define who you are, people are no longer defined through what they buy. Shopping has become an action of getting only what you need. There is a shared feeling of struggling together, of rebuilding the society but with new values as a foundation.

Society

The increasing information flow and globalism has also led to reaction. All the possibilities and information has made people turn away and seek comfort in a smaller context, local communities and relationships that are trustable and graspable. Strong personal brands have substituted most global brands. Lifetime, functionality and reliability have become the most important parameters when buying goods. Waste is reduced to a minimum, everything that can be reused or recycled is.

Store

The stores are there to provide what people need, not to sell as much as possible. Services like renting and co-owning bloom and people share things among each other instead of competing of who got the most.

Lighting

A functional lighting is what dominates the stores. Energy efficient lighting as a complement to natural light is the standard. General lighting dominates and directional lights like spotlights are rare. During the darker part of the year opening hours are reduced to save energy.

Figure. 7.5 *The imageboard for "We'll get through it Together"*

7.3 Implications for the Next Phase

The next step in the LED-concept development process was to combine the functional demands on a future luminaire from the scenarios with the technical properties that were thought to be the most important. Below the influencing functions from the technological and societal research are presented.

Scenarios

As mentioned before, the purpose of the scenarios was not to try to predict the future but to concentrate the development work. The scenarios should be regarded as extremes and the most probable future might be a combination of several of the scenarios. A consequence of this was that any concept developed would ideally meet the demands of all scenarios.

OLED

It was rather quickly realised that the LED technology is similar to the technology used today since it is still a point light source. The real innovation step will be when OLED becomes commercially viable. To enhance the innovation level of the result it was decided that also OLED should be included in the final concept. Since OLED technology lies further into the future than LED technology, it was decided that both LED and OLED product concepts were to be developed. Another overall understanding, that the scenarios generated, was that even though technology and society change the way humans react to light will be the same. An interesting lighting will be a combination of directional and general lighting. This understanding resulted in the decision to make not only an OLED-general lighting luminaire concept but also an OLED-accent lighting luminaire concept.

Controlling

Controlling is one of the biggest changes between the luminaires of today and the luminaires of tomorrow since LED and OLED technology makes it possible to control colour and intensity very easily. If this feature is to be of any use, the interaction between the user and the luminiare must be intuitive and easy to handle. Because of this it was decided that a control system should be looked into as well.

When

Since it is very hard to estimate when the different technologies will have their breakthrough it was decided that a number of products should be developed, in line with a possible LED technology development. A time line was constructed and three product concepts were placed on it (Figure 7.6). The three products were a LED spotlight, an OLED panel and an OLED spotlight. Each of the products corresponded to a step in LED/OLED technology development. A fourth product was also added, a control system. This product will be important to all the other three products and was therefore placed alongside them in the time line.

Now the development work was divided into four LED concepts:
>>LED Spotlight
>>OLED Panel
>>OLED Spotlight
>>Controlling System

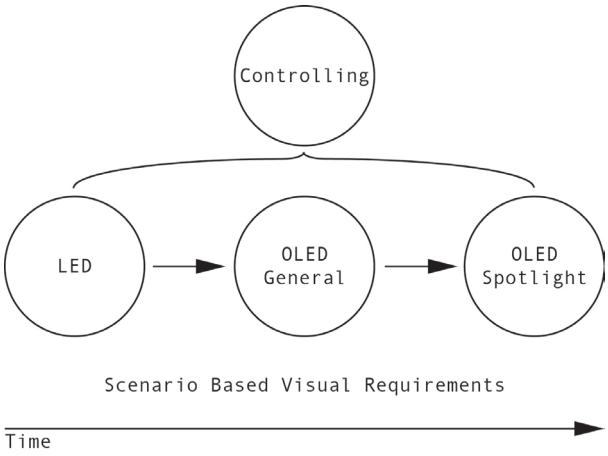


Figure. 7.6 *The LED time line*

8. Development of LED-Concepts

This chapter presents the development and result of the LED-concepts. The development processes of the different concepts have been driven parallel to each other from a common starting point. The first step was to define the functions the product needed to have in the store, the scenarios were used as an aid in this step and the result was the following functions:

>> Decoration
>> Atmosphere
>> Accent lighting
>> Feel Good
>> Guidance
>> Integration
>> Interaction
>> Large Surfaces

These functions were used as a base for idea generation and sketching. For each function solutions of each LED-concept were generated. Many different ideas and solutions were generated in this process (See Figure 8.1 for example of sketches).

Through the idea generation process, the project group considered some ideas and solutions more interesting than others. These ideas and solutions were added to each of the LED-concepts and became the characteristics of that concept. The idea generation process changed direction due to these concept characteristics. The concept characteristics of each LED product concept are presented in the following chapters together with the final result.

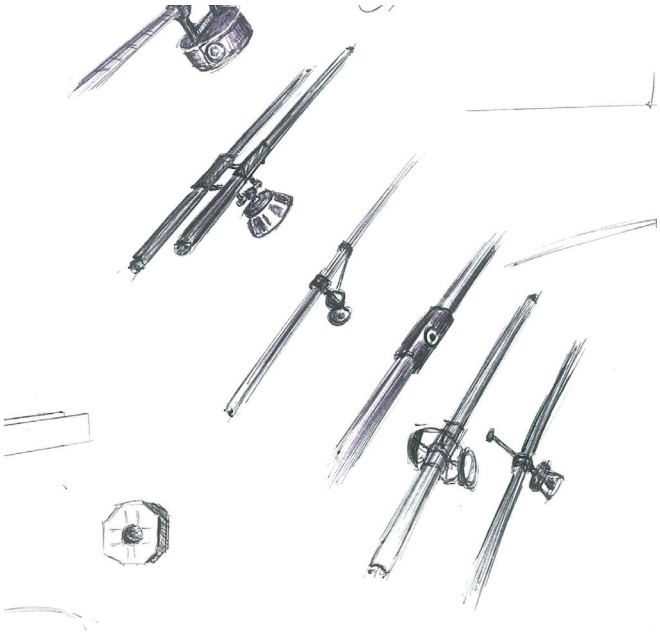


Figure. 8.1 *Initial LED sketches*

8.1 LED Spotlight System

The development of the concept characteristics of the LED Spotlight is presented in this chapter along with the final result. The LED Spotlight is the first product concept on the time line and closest to what is available today. Because of this, much effort was put on making this concept realisable.

LED Zone Spotlight

The aim was to make use of the two biggest advantages of LED technology, size and controlling. Energy efficiency is of course also a big advantage but it is more of a condition for the LED breakthrough than something that will influence the design. Another important consideration was that the product concept was going to be a part of the Fagerhult brand, a LED version of Zone, hence a basic product. The core values of the Fagerhult brand, Technical, Functional, Natural and Clear, were therefore to be expressed by this new product.

System Layout

The most used Zone product today is the ZonePoint, the trackbound spotlight. It is used on a track since this enables easy relocation of the spotlight while the track also supplies power to the luminaire and you can supply many spotlights with the same track. This system had many benefits that were wanted in the LED Spotlight concept, the modularity of placing the track on the ceiling or suspended and the easy installation of mounting one track instead of many luminaires. It was decided that the LED Spotlight concept should be a LED System combined by luminaires and a track system providing support and power.

Direct Current

An important technological parameter that was emphasised during an expert consultation meeting is that LEDs run on direct current. This means that to use the electricity delivered from the power grid, the alternating current from the grid needs to be rectified to direct current, this is done by a rectifier. The voltage also needs to be transformed to a lower voltage, from 230V to somewhere between 20-30V. In LED spotlights today these components are part of the luminaire. This makes the size of the luminaire not only dependant on how small the LED technology can be made but also dependant on the size of the components. By moving the transformator and the rectifier to a central this can be avoided (Figure 8.2). Instead of having one transformator and one rectifier for each LED luminaire all this can be taken care of by one or just a few components in the central. Another advantage of this is that the system would become an extra-low voltage system. An extra-low voltage direct current system is an electrical system that runs on a voltage under 120V. If the voltage is below 60V the use of a non-insulated conductor is possible (Elsäkerhetsverket, 1999). An example is the halogen systems where the wires that are used to fasten the halogen luminaries also functions as conductors. In addition to all this, using a direct current system also enables the advantage of sending information in the power cable making advanced controlling possible with only one cable (Merkel, 2010). By adding small fluctuations in the current, digital information can be transported with few components making the track system very simple (Merkel, 2010).

It was decided that the planned LED Spotlight System should be a low voltage, direct current system with a power and controlling unit separated from the track since this reduces the number of components making the installation and controlling easier and the spotlights even smaller. When using a direct current system the only electrical components needed in the luminaire are the LED light source and a receiver (Merkel, 2010). The receiver consists of a transistor that registers the fluctuations in the current and a microcomputer that interprets the information and controls the current to the light source, enabling colour mixing and dimming (Figure 8.2).

Integration

When most of the electrical components of the LED Spotlight are moved from the luminaire to the central unit, the luminaire can be much smaller. This makes a higher level of integration of the track and luminaire possible. A higher level of integration is wanted to make the expression of the system more clear and uniform. The track today looks like an electrical component that only supplies power to the luminaire, the aim was to change this and make the track equal to the luminaire visually and more like an interior design element. With a direct current system the only thing needed in the track is two wires, this means a higher level of freedom for the designer. More emphasis can be put on the visual appearance instead of fitting components.

Furthermore, a general lighting luminaire should be possible to integrate with the track. Other systems used in a store such as audio, surveillance, daylight control, smoke detectors and guiding systems should also be possible to integrate. The direct current system also makes it possible to connect the lighting system directly to a solar panel and battery, creating a self-powered light-cycle system.

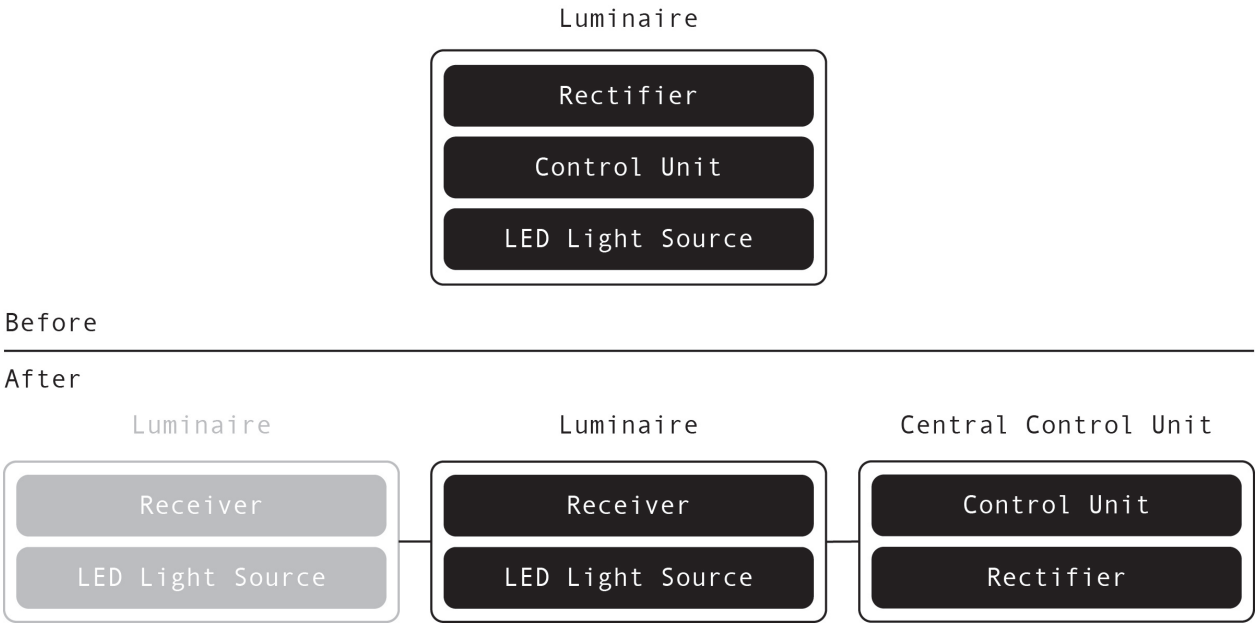


Figure. 8.2 *New structure of components*

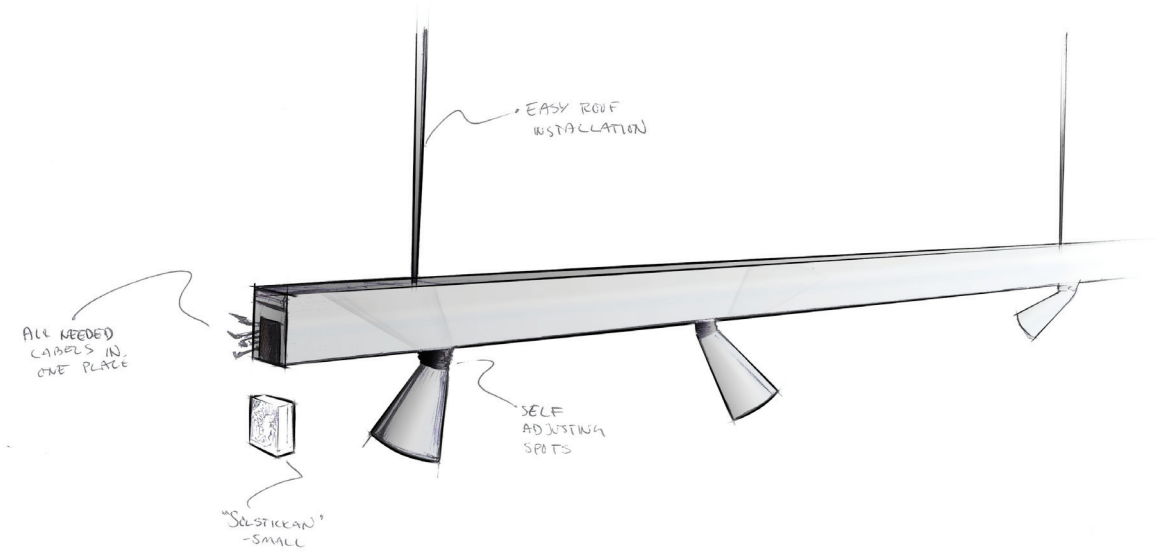


Figure. 8.3 *LED luminaire concept*

Figure. 8.4 *Suspended LED luminaire concept*

Figure. 8.5 *LED luminaire concept with general lighting*

8.1.1 Final Result

The concept developed is a LED Spotlight System consisting of a track with integrated accent and general lighting luminaires (Figure 8.3-8.5). The system is powered by direct current and low voltage creating a highly controllable, easy to install LED System. The tracks are prepared for integration of other applications needed in a store as well in order to provide an architectural interior element supplying all systems.

The LED Spotlight System can be used in all scenarios but with different main functions. In the scenarios where the mindset is individual there is a higher demand for accent lighting and colour control but in scenarios with a collective mindset the general lighting application will be more used and controlling will be mainly for daylight control application.

8.2 OLED Panel

In this chapter, the development of the OLED Panel is presented along with the final result. The OLED Panel is the second product concept in the time line and will be realisable later then the LED Spotlight System.

Surface

The OLED Panel is more a surface than a product (Figure 8.6) and this effected the development work a lot. Less emphasis could be put on the physical design of the luminaire and more was put on the applications of the OLED Panel.

One of the biggest differences between LED and OLED is that OLED is a surface light source and LED is, as all other light sources, a point light source. Since OLED is a surface light source it will emit a very diffuse general light, like being outdoors a cloudy winter day. But the colour of the light can be changed just as with LED. OLED will be ideal to change the mood of a store by changing the colour of the surfaces.

Display

The OLED technology is used today as displays in mobile devices and televisions. The OLED Panel will therefore also have the ability to show high-resolution images and animations. This means that a light source can also be a display and the other way around. The OLED Panel can be mounted to the ceiling and simulate moving clouds on a bright blue sky even if it is raining outside (Figure 8.7).

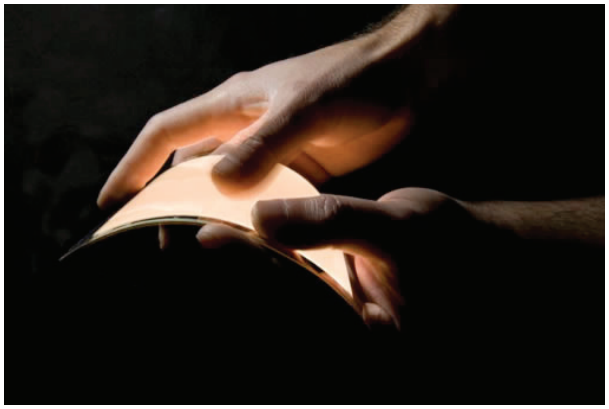


Figure. 8.6 *Flexible OLED panel*

Integration

Because OLED can be produced in flexible, thin films the possibilities of integration are endless. It can be used as a wallpaper and applied to the walls, floor and ceiling of a store and enable dynamic changes of lighting and colour. With the ability to function as a display the OLED Panel can also show different sceneries and make changes as easy as pressing a button. One minute you are on the savannah in Serengeti and the next you are in downtown New York. OLED films can be integrated into any object in the store making every interior element a luminaire.

8.2.1 Final Result

The OLED Panel will be realised further in the future and since OLED is more of a surface than a luminaire the emphasis of the result is more on the applications then the visual appearence. The OLED Panel has the potential to revolutionise how we see lighting when erasing the limits between lighting and display. It can be integrated into surfaces and objects and provide controllable lighting everywhere.

The OLED Panel will be used in the scenarios for energy efficient general lighting applications and for its advanced display abilities when there is a need for information presentation or visual effects.

Figure. 8.7 *How an OLED panel could be used in a store*

8.3 OLED Spotlight

In this chapter the development and result of the OLED Spotlight will be presented. The OLED Spotlight is the last part of the LED development in the time line and is presented on a very conceptual level.

Accent Lighting

It is hard to make dynamic and interesting lighting concepts without accent lighting. If OLED prove to be more energy and resource efficient than LED there will be a need for an OLED accent lighting luminaire.

Prism Film

Prism films are micro-optic films that redirect light. In LCD displays today they are used to broaden the field of view and there are films for computers that narrow the field of view instead. This technique could be used to direct the diffuse light of an OLED and make it appropriate for accent lighting.

Thin Light Source

An OLED Panel with a prism film to direct the light will make a spotlight about two millimetres thick. These spotlights could be integrated into the walls or ceilings and be virtually invisible. When there is a need for changing direction or suspending the spotlight a structured frame could be provided.

8.3.1 Final Result

The OLED Spotlight (Figure 8.8) is more an idea of what could be possible with OLED technology in the future than an OLED product concept. OLED technology could make ultra thin spotlights possible and present a new way of designing luminaires. The OLED spotlight might be used in all scenarios where a mixture of accent and general lighting is requested. Consequently it is best suited for the scenarios where shopping is still important. However, the use of prism film might entail energy losses and this is not consistent with the scenarios where energy saving is important. On the other hand, if the OLED spotlight becomes more energy efficient than a normal LED spotlights, it can replace them.

Figure. 8.8 *Sketch of OLED spotlight*

8.4 Advanced Control Unit

This chapter handles the development and result of the control unit. The control unit will be used together with all the other product concepts in the time line.

More Advanced Controlling Needs Better Interfaces

As mentioned above, one of the biggest changes between the current light sources and LED is the ability to control the light. With the introduction of LED more controlling will be available and adjustments can be made several times a day. This will require better day-by-day interaction interfaces to be able to take advantage of the new technology the most. Daylight control is another important factor. By using as much daylight as possible the energy usage is reduced. It is possible to decide a light value for a certain part of a store and tell the system to always keep this level. If the daylight is not enough the system will compensate with artificial lighting. This kind of technology is available already today and should be included in any control system where the goal is to save energy. With LED there is also the ability to produce light that affects our hormone levels in different ways. Blue light at different times of the day tune our cortisol and melatonin levels and influences if we feel tired or alert in the morning or in the evening (See Chapter 3.2 Light and Well Being). By controlling this there are new possibilities in changing our well being with light.

Redirecting the Luminaire

By changing the current in the LED it is possible to control the intensity and colour of the light from the luminaire. However, this does not apply for redirecting the luminiare. Today directing the luminaire is done by hand with the help of for example a ladder. This is a bit troublesome, especially if there are customerss in the store. By placing a small engine in the luminaire that can be controlled from the floor this action can be avoided.

Everyday Use

As the employees of the store make this daily controlling, the control system must be adapted to their level of knowledge. It must be possible to make the daily adjustments such as redirecting the luminaires and changing the colour or themes and animations without having any education in lighting design. An intuitive and easy to understand system would also facilitate for more experienced users. A solution to this is that the employees in the store can choose from different themes. A lighting designer can plan these themes and the employees only have to launch them.

8.4.1 Final Result

The final result of the Advanced Control concept is two units, one remote control (Figure 8.10) and a lighting control software (Figure 8.9). The remote is for controlling individual luminaires while the software controls the total system.

The software controls the overall themes of the store. It can be loaded into a personal computer or some kind of a handheld display or device. The thought is to not add an extra product or material but to only deliver the function needed.

The remote is a small device that is used to control the direction of the spotlights and it can also be used if it is desired to change the colour and intensity of a specific spotlight outside the pre-programmed themes. It functions with a pick and place system. First the remote is pointed towards the desired spotlight, keeping the left big button down (Figure 8.11). The spotlight indicates that it is activated by changing colour (Figure 8.12). When the spotlight is activated the remote is aimed at the point were the spotlight should direct its light (Figure 8.13). The big right button is pushed down again until the spotlight has taken the desired position (Figure 8.14). The smaller buttons are used to change the intensity, colour and saturation of the light (Figure 8.10).

The control of the colour and intensity will be more important in the individual scenarios. In the collective scenarios it might be more important with automatic daylight control for saving energy. The control could also be used for "feel good"-reasons by altering the spectra to help our hormone levels tune in and to increase when people who need extra lighting approaches a product.

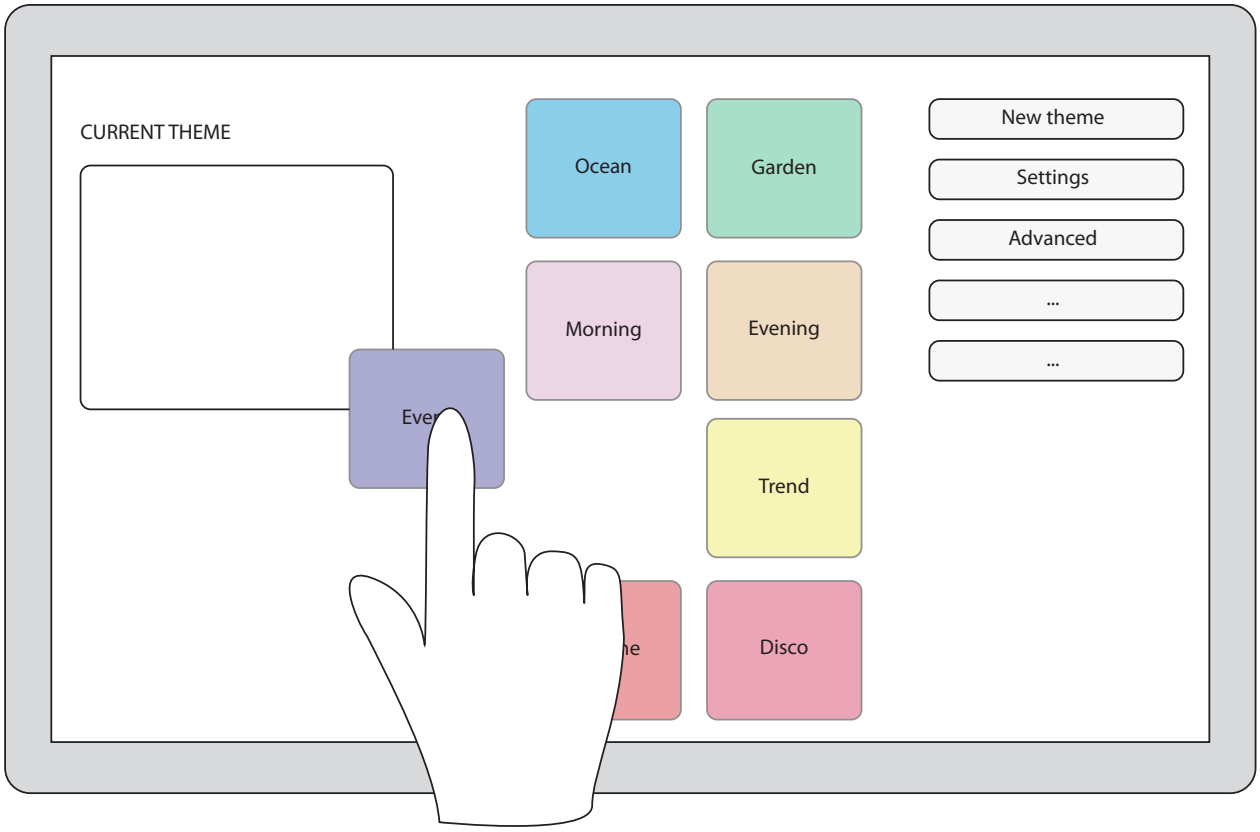


Figure. 8.9 *Lighting controlling software*

Figure. 8.10 *Spotlight remote control*

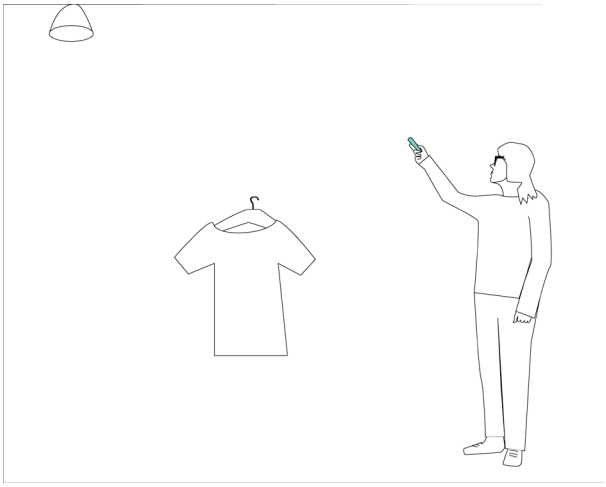


Figure. 8.11 *First step of redirecting a spotlight with the remote control*

Figure. 8.12 *Second step of redirecting a spotlight with the remote control*

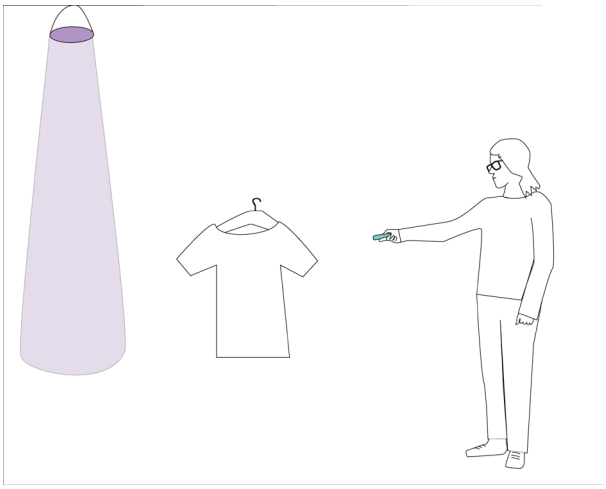


Figure. 8.13 *Third step of redirecting a spotlight with the remote control*

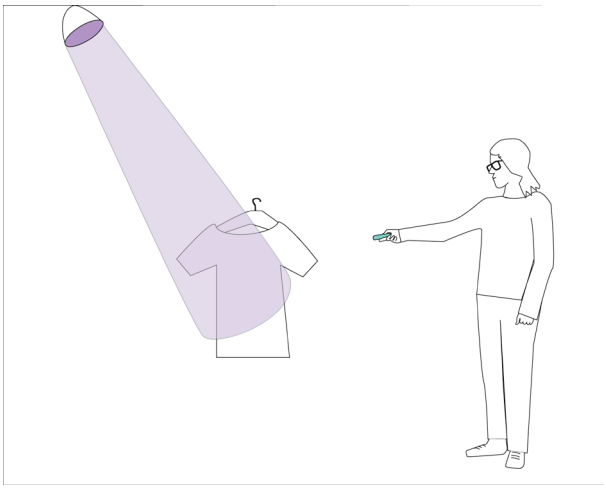


Figure. 8.14 *Fourth step of redirecting a spotlight with the remote control*

9. Discussion and Conclusion

This chapter will present our opinions of the project, if the results fulfilled the goals and what could have been done in another way. It is divided into four parts, the Project as a Whole, the Procedure, the Result and Conclusion.

9.1 Project as a Whole

This has been a very interesting project to work with. It has introduced us to many new areas and ways of thinking. Overall we feel pleased and satisfied with the process and the result of the project.

9.1.1 New Fields of Knowledge

The project evolved around different aspects of light, which we had not encountered before. This was very interesting and educating. Everything around us is defined by the light we see it in, and to see examples of how light changes our environment have been a lesson for life. There have been many subjects to relearn and be introduced to such as the physics of optics, which affect the design of a luminaire. Many hours have been put into learning these new fields but it was vital to the project.

Another field that is crucial for the design of luminaires is electronics. Since we have no formal education in this field of knowledge we have learned a lot during this project. The experts consulted in the area have been a great asset and helped us understand and learn the relationships.

9.1.2 Diverse Work

The different phases of the project have covered very diverse parts of the product development process, from very early and free concept development in the LED development to component fitting, cost analysis and manufacturability in the Facelift development. This has been an opportunity to use our competence in many different areas and it has been very rewarding.

While the processes have been diverse the product has been lucid. The relative small size and the number of parts have made it possible to map the components and relations and get a good overview. This has been interesting since we could take the whole product into account and did not have to make any delimitations to only look at some parts.

9.2 Procedure

In the Analysis of the Current Situation we used charts to visualise the relations between the components and the models of ZonePoint. This was useful and worked very well. The relations helped to investigate the effect of changing components and what structural changes might result in among other things.

A result from the brand analysis was the absence of a coherent design language. This could be a result of that many external design consultants have been involved in the development of the Fagerhult luminaires. The relation between the different brands sold by Fagerhult Retail is also unclear. All this clouds the brand expression of Fagerhult. This affected our work with the Zone product range because we had to create our own opinion of what the Fagerhult core words expressed. In the end this means that it is hard to know whether the expressions we created reflect the true meaning of the Fagerhult brand or our interpretation of the Fagerhult brand.

The nature of the luminaire market has affected our design process. The luminaire market is very tough. The different actors try to make their customers satisfied even if it means making a luminaire very close to a competitor's. And since many luminaire manufacturers only make the housing there are few opportunities to differentiate from each other. There is also the matter that what you sell is actually the light and not the luminaire. All this together makes it hard to design something new.

The usage of the product was also hard to investigate. Today the luminaires are almost never interacted with when they are in place; except when they are turned on and off, it is a very passive product. The only physical interaction is maintenance every second year if any. This complicated user-product relations made it difficult knowing who to design for.

The Internet survey did not give the result it was intended to, we think this was because of inaccuracy in the questions and the difficulty of formulating good questions in a survey. We did send out the survey for reviewing twice, still it was hard to predict how the participants would interpret the meaning.

The scenario workshop performed at Chalmers did not meet its goal. We wanted it to generate product ideas for the different scenarios but we got more opinions and verifications of the moods of the scenarios. This was probably due to the setup of the workshop with too much emphasis on the scenarios instead of giving the participants a concrete design problem to solve. The Workshop with the lighting designers from Fagerhult Retail was more of a success, perhaps because they were more familiar with the subject and already had the right mindset. The setup of the workshop was also more in line with their profession and this surely influenced the result in a positive way.

Working with Scenario Planning was a good experience. Since it was new to us we had to learn the procedure first but it proved to be a useful method for mapping the future. The most time consuming part was the search for parameters but as they set the ground for the rest of the scenario creating it was done thoroughly.

9.3 Result

The results of this project are wider than from other product development projects we have participated in. This is because the goals of the project were of an investigating nature. The result of the Facelift development is built up of many concepts because we wanted to show a width of what can be done with a facelift. The result of the LED concept development contains a time line of concepts to cover a large span in time because there is an uncertainty in when the LED concepts will be feasible. It has been an interesting and different process to keep this many con-

cepts until the end of a project and present them all without choosing between them. Perhaps this has been more time consuming but consequently more in line with the goals.

During the project two stages in the future of the Zone family have been investigated. The future of LED in retail contexts is a very important area and needs more research in order to prepare Fagerhult Retail for the technological paradigm shift that will come. This project has outlined some of the challenges with designing LED luminaires but more will come when the development actually starts. The questions that need to be answered before are what should Fagerhult Retail provide their customers with? Luminaires or lighting? In a future with less resources stores might lease a lighting solution instead of buying a luminiare. Strategic decisions like these need to be taken into account when planning the future of Zone and Fagerhult Retail and this project has hopefully made the company look further ahead.

9.4 Conclusion

The purpose of this thesis was to give inspiration and to suggest a new direction to Fagerhult Retail in their future work with the Zone retail spotlight family. The project has been divided into two different areas; a facelift and future LED solutions.

Facelift
The goal of the Facelift development project was to present a material which helped Fagerhult Retail to make the decision if they were to go on with a facelift or a new product family. A number of different Facelift suggestions, both functional and visual, were presented along with manufacturing costs. The goal was fulfilled and Fagerhult made a decision on how they will proceed with the Zone family.

LED Concept
The goal of the LED concept development project was to present different suggestions of what a future LED luminaire might look like and what applications it might have. We presented a time line of four product concepts following a plausible LED technology development. In addition to the goal OLED luminaire concepts were also included in the result but did not reach a concept level, only an idea level. The concepts are spread out on the time line and some of the concepts presented are technologically today possible already but is not economically viable while some will be feasible in the future. The goal was fulfilled.

10. References

Allison, I., et al., 2009. *The Copenhagen Diagnosis: Updating the World on the Latest Climate Science.* Sydney: The University of New South Wales, Cimate Change research Center.

Baxter, M., 1995. *Product Design: Practical Methods for the Systematic Development of New Products.* London: Chapman & Hall.

Brodrick, J. 2010. *LED Testing & Application: Hits and Misses.* [Online] Illuminating Engineering Society. Available at: http://www.ies.org/lda/HotTopics/LED/2.cfm [Accessed 17 May 2010]

Carpi, A. 2003. *Atomic Theory II.* [Online]Visionlearning. Available at: http://www.visionlearning.com/library/module_viewer.php?mid=51 [Accessed 25 October 2010]

A.M.Diederen. 2009. *Metal Scarcity: A Sobering Perspective* [Lecture Slides] Delft University of Technology, Faculty Industrial Design Engineering, The Netherlands.

Elsäkerhetsverket. 1999. *Starkströmsföreskrifterna* [Online] Available at: http://www.elsakerhetsverket.se/Global/Föreskrifter/Äldre%20föreskrifter/1999-5.pdf [Accessed 25 October 2010]

Encyclopedia of Earth. 2008. *Electromagnetic radiation.* [Online] Available at: http://www.eoearth.org/article/Electromagnetic_radiation [Accessed 25 October 2010]

Fagerhult Lighting Academy. 2007-2010a. *Luxipedia: Lighting.* [Online] Available at: http://www.fagerhultlightingacademy.com/display/LUXIPEDIA/Lighting [Accessed 22 September 2010]

Fagerhult Lighting Academy. 2007-2010b. *Luxipedia; Lighting and Colour.* [Online] Available at: http://www.fagerhultlightingacademy.com/display/LUXIPEDIA/Lighting+and+Colour [Accessed 22 September 2010]

Fagerhult Lighting Academy. 2007-2010c. *Luxipedia: Lighting and Units* [Online] Available at: http://www.fagerhultlightingacademy.com/display/LUXIPEDIA/Lighting+and+Units [Accessed 26 October 2010]

Fagerhult Lighting Academy. 2007-2010d. *Luxipedia: Colour Reproduction* [Online] Available at: http://www.fagerhultlightingacademy.com/display/LUXIPEDIA/Colour+reproduction [Accessed 22 September 2010]

Fagerhult Lighting Academy. 2007-2010e. *Luxipedia: Electric Light Bulb*. [Online] Available at: http://www.fagerhultlightingacademy.com/display/LUXIPEDIA/Electric+light+bulb [Accessed 22 September 2010]

Fagerhult Lighting Academy. 2007-2010f. *Luxipedia: Halogen Lamp*. [Online] Available at: http://www.fagerhultlightingacademy.com/display/LUXIPEDIA/Halogen+lamp [Accessed 22 September 2010]

Fagerhult Lighting Academy. 2007-2010g. *Luxipedia; Mercury Vapour Lamps.* [Online] Available at: http://www.fagerhultlightingacademy.com/display/LUXIPEDIA/Mercury+vapour+lamps [Accessed 22 September 2010]

Fagerhult Lighting Academy. 2007-2010h. *Luxipedia: Flouorescent Tubes.* [Online] Available at: http://www.fagerhultlightingacademy.com/display/LUXIPEDIA/Fluorescent+tubes [Accessed 22 September 2010]

Fagerhult Lighting Academy. 2007-2010i. *Luxipedia: Light Emitting Diodes.* [Online] Available at: http://www.fagerhultlightingacademy.com/display/LUXIPEDIA/Light+emitting+diodes [Accessed 22 September 2010]

Fagerhult Retail. (n.d.). *Fagerhult koncernen.* [Online] Available at: http://www.fagerhultretail.se/pages/about/fagerhult_group.html [Accessed 17 August 2010]

Faith Popcorn's Brainreserve. 2009. *Culture Pulse: 2010 Predictions.* [Online] Available at: http://www.faithpopcorn.com/ContentFiles/PDF/FPBR%202010%20Predictions.pdf [Accessed 28 October 2010]

Fowler, M. 2008. *Black Body Radiation.* [Online] Modern Physics. Available at: http://galileo.phys.virginia.edu/classes/252/black_body_radiation.html [Accessed 25 October 2010]

Freyssinier, J., Taylor, J., Frering, D., & Rizzo, P. 2009. *Considerations for Successful LED Applications*. Proceedings of China SSL2009, 6th China International Forum on Solid State Lighting (pp. 206-209). Shenzhen, China: China Solid State Lighting Alliance.

Fridell, A. K. ed., 2006. *Forskare och praktiker om Färg, Ljus, Rum.* Stockholm: Forskningsrådet Formas.

Grey, R. 2010. *Discussion on LED with GE employee at Frankfurt lighting fair* [Conversation] (Personal communication, 14 April 2010)

Gärdebäck, L. 2010. *Lighting Education*. [Conversation](Personal communication, 17 February 2010)

Gärdebäck, L., & Strömberg, A. 2010. *Lighting Design Education.* [Conversation] (Personal communication, 2 March 2010)

GE Lighting. (2010). *Learn About Light:Color Rendering.* [Online] GE Lighting. Available at: http://www.gelighting.com/na/business_lighting/education_resources/learn_about_light/color_rendering.htm [Accessed 22 September 2010]

Hall, E. 2010. *Sustainable Design: Heir Apparent?* [Online] Illuminating Engineering Society. Available at: www.ies.org/lda/HotTopics/sd/1.cfm [Accessed 17 May 2010]

Håkansson, P., Renström, K. 2004. *Ljus & belysning: en handbok om ljus, seende, ljusplanering och belysningsteknik.* Stockholm: Liber.

Institute of the Future. 2009. *2009 Ten-Year Forecast: Research Materials.* [Online] Available at: http://www.iftf.org/node/2749 [Accessed 28 October 2010]

Karjalainen, T. 2007. It looks like a Toyota: Educational Approaches to Designing for Visual Brand Recognition. *International Journal of Design*, 1 (1), pp. 67-81.

Karlsson, M. 2005a. *Lyssna till kundens röst - Method Appendix.* [Handout] Chalmers University of Technology, Gothenburg, Sweden

Karlsson, M. 2005b. *Course Compendium:Lyssna till kundens röst.* [Handout] Chalmers University of Technology, Gothenburg, Sweden

Lighting Research Center. (2003-2005). *the National Lighting Product Information Program: Lighting answers.* [Online] Available at: http://www.lrc.rpi.edu/programs/nlpip/lightinganswers/fullspectrum/claims.asp [Accessed 1 November 2010]

Ljuskultur. 2009. *Värt att veta om LED.* [Online] Available at: http://www.ljuskultur.se/files/Senaste_nytt/Vart_att_veta_om_LED.pdf [Accessed 20 October 2010]

Lowe, R. 2010. *LED Testing & Application: Updriver with an Architect.* [Online] Illuminating Engineering Society. Available at: www.ies.org/lda/HotTopics/LRE/3.cfm [Accessed 17 May 2010]

Lugt, R. v. 2004. *A quick and dirty introduction to scenario learning.*

Martinsson, C. 2010. *Lighting Education*. [Conversation](Personal communication, 17 February 2010)

Merkel, H. *Discussion on LED technology* [Conversation](Personal communication, 20 September 2010)

Modular Lighting Instruments. 2010. *Spock-track-led*. [Online] Supermodular. Available at: http://www.supermodular.com/en/products/surface/spock/spock-track-led-1200lm-gi.php [Accessed 28 October 2010]

Månsson, L., Schönbeck, Å. 2003. *Ljus & Rum: Planeringsguide för belysning inomhus*. Stockhom: Ljuskultur.

Monö, R. 1997. *Design for Product Understanding: the aesthetics of design from a semiotic approach.* Stockholm: Liber.

Osram Sylvania. 2000-2010. *Glossary* [Online] Available at: http://www.sylvania.com/Business-Products/Glossary/ [Accessed 22 September 2010]

Philips. 2004-2010. *Vad är LED?* [Online] Philips Lighting. Available at: http://www.lighting.philips.se/lightcommunity/trends/led/what_are_leds.wpd [Accessed 22 September 2010]

Philips Electronics. 2004-2010. *Living Colours.* [Online] Philips Lighting. Available at: http://www.lighting.philips.com/microsite/living_colors/ [Accessed 28 October 2010]

Rizzo, P. 2007. Lighting for Universal Design. *Ultimate Home Design* (07), pp. 50-59.

Rock, I., Palmer, S. 1990. The Legacy of Gestalt Psychology. *Scientific American*, 263 (6), pp. 48-61.

Smith, W. S. 2010. *Discussion on LED with Philips employee at Frankfurt lighting fair* [Conversation] (Personal communication, 14 April 2010)

Stanford Encyclopedia of Philosophy. 2010. *Aristo-*

tle's Psychology. [Online] Available at: http://plato.stanford.edu/entries/aristotle-psychology/ [Accessed 2 November 2010]

Stompff, G. (2003). The forgotten bond: Brand identity and product design, *Design Management Journal*, Winter 2003 (14), pp. 26-32.

Summers, T. A., Hebert, P. R. 2001. Shedding some light on store atmospherics influence of illumination on consumer behavior. *Journal of Business Research*, 54 (2), pp. 145-150.

Taylor, J. 2010. An application approach to achieving success with LEDs. *Lighting India*, 5 (2), pp. 48-55.

U.S Census Bureau. 2010. *Total Midyear Population for the World: 1950-2050* [Online] Available at:http://www.census.gov/ipc/www/idb/worldpop.php [Accessed 31 January 2011]

U.S Department of Energy. 2009, January 9. *Using Light Emitting Diodes*. [Online] Energy Efficient & Renewable Energy. Available at: http://www1.eere.energy.gov/buildings/ssl/using_leds.html [Accessed 29 March 2010]

US Departement of Energy. 2010. *Solid-State Lighting Research and Development: Multi-Year Program Plan.* [Online] Available at: http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_mypp2010_web.pdf [Accessed 26 October 2010]

Wagner, M. 2008. *Why Mood Boards Matter*. [Online] Webdesignerdepot. Available at: http://www.webdesignerdepot.com/2008/12/why-mood-boards-matter/ [Accessed 13 October 2010]

van den Beld, G., van Bommel, W. 2003. Lighting for Work: Visual and Biological Effects. *Lighting Research and Technology,* 2004, 36(4), pp. 255-269.

Wilkinson, L. 2009. *How to build scenarios.* [Online] Wired. Available at: http://www.wired.com/wired/scenarios/build.html [Accessed 13 October 2010]

Wood, M. (n.d.). *About Lighting*. [Online] High End Systems. Available at: http://www.highend.com/support/training/colortemp.asp [Accessed 22 September 2010]

Wouters, H., Bol, D. 2007. *Material Scarcity An M2i study*. Stichting Materials innovation institute (M2i).[Handout] Delft University of Technology, Delft, the Netherlands

List of Figures

11. Appendix

Appendix I

In this appendix are all the questions in the Internet survey presented. The Internet survey was used to investigate Fagerhult Retail's internal opinions about the Zone and Fagerhult product brands as well as gathering general information about the luminaire market and Zone.

Internet Survey

1. What position do you have at Fagerhult?
   Open question.

2. In which country/countries do you operate?
   Open question.

3. What experience do you have of Fagerhult Retail's products?
   - None at all.
   - I am familiar with the products but have not worked with them.
   - I work with them on a regular basis
   - I work with them everyday.

4. How are Fagerhult Retail's products sold to the end customer in your region? Through...
   - ...Fagerhult Retail directly.
   - ...another Fagerhult company.
   - ...Fagerhult distributor or agent.
   - ...wholesaler.
   - ...electrician.
   - ...other channel.

5. How much impact on the customers purchase decision do you have?
1-6.

6. To what extent do customers on your region seek advice from the following representatives when buying lighting fixtures? (Score the following from 1-6)
- Lighting designers from Fagerhult Retail.
- Key account managers from Fagerhult Retail.
- Electricians.
- Architects or interior designers.
- Internal advicers.

7. From a customers point of view, how important are the following parameters when deciding to purchase a lighting fixture? (Score the following from 1-6)

- The aesthetics of the fixture itself.
- The quality of the fixture.
- The energy performance of the fixture.
- The price of the fixture.
- The life span of the fixture.
- That all fixtures in a lighting concept look the same.
- That the lighting fixture's design support the overall store concept.

8. What lighting fixture brand do you consider to be best in practice today? Considering... (open question)

- ...value for money.
- ...product design.
- ...quality.
- ...lighting concepts.

9. What is most perferable? Discreet designed fixtures (1) or prominent designed fixtures (6).
1-6

10. Which type of lighting fixtures do you use/sell the most?

- Track bound spotlights.
- Downlights.
- Systems (combination of downlights and fluorescent lights).
- Other.

11. Do you use/sell light sources with an effect over 70 W?

- Yes.
- No.

12. To what extent do you use/sell light sources with an effect over 70 W?

- Less than 10 %.
- Between 10 % and 50 %.
- More than 50 %.

13. Do you think this will change in the following 5 years?

- No.
- Yes, we will use less.
- Yes, we will use more.

14. Do the customers use or have they asked for LED-lights?

- Yes.
- No.

15. In what applications do they use or have asked for LED-lights?

Open question.

Appendix I

16. To what extent do the following words characterise the Fagerhult Retail product portfolio?
    - Clear.
    - Natural.
    - Technical.
    - Functional.
    - Professional.
    - Discreet.
    - High performance.
    - Simplicity.
    - Effortless style.

17. Have you cooperated with lighting designers from Fagerhult?
    - Yes.
    - No.

18. Have you worked with the Zone product family?
    - No.
    - I am familiar with the products but have not worked with them.
    - I work with them everyday.

19.

20. To what extent do you associate the following words with the Zone product family? (1 = not at all, 6 =

    - Clear.
    - Natural.
    - Technical.
    - Functional.
    - Professional.
    - Discreet.
    - High performance.
    - Simplicity.
    - Effortless style.

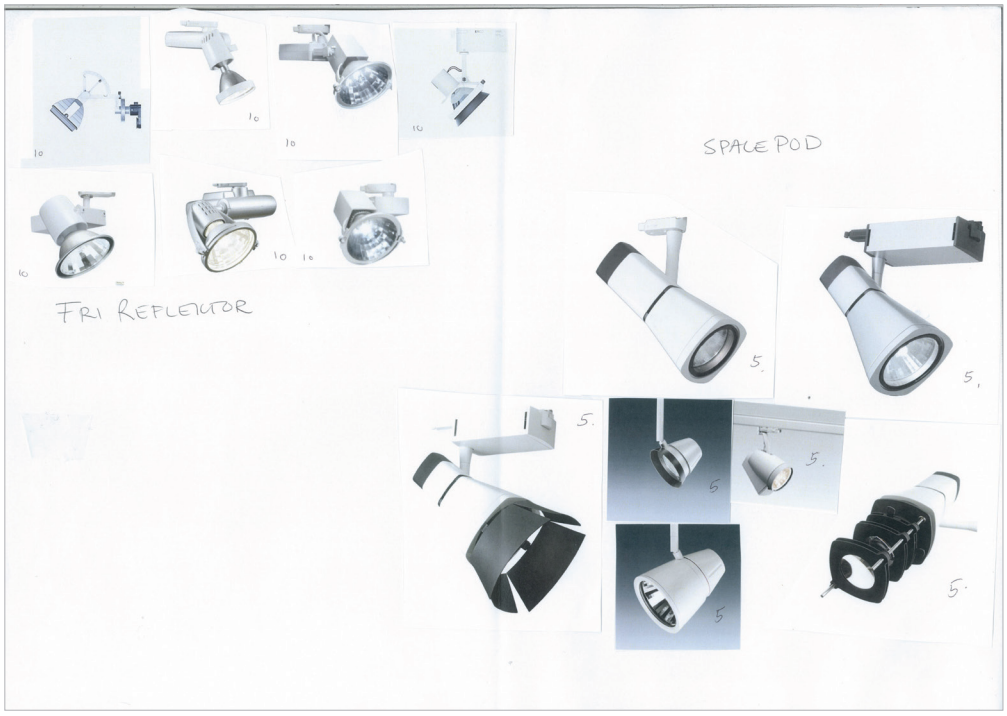
21. What do you appreciate in today's Zone family?
    Open question.

22. What would you like to see in a future generation of Zone?
    Open question.

Appendix II

In this appendix is the result of the Visual benchmarking method presented. The procedure of the method is described in chapter 4.3.3 Visual Benchmarking

Appendix II

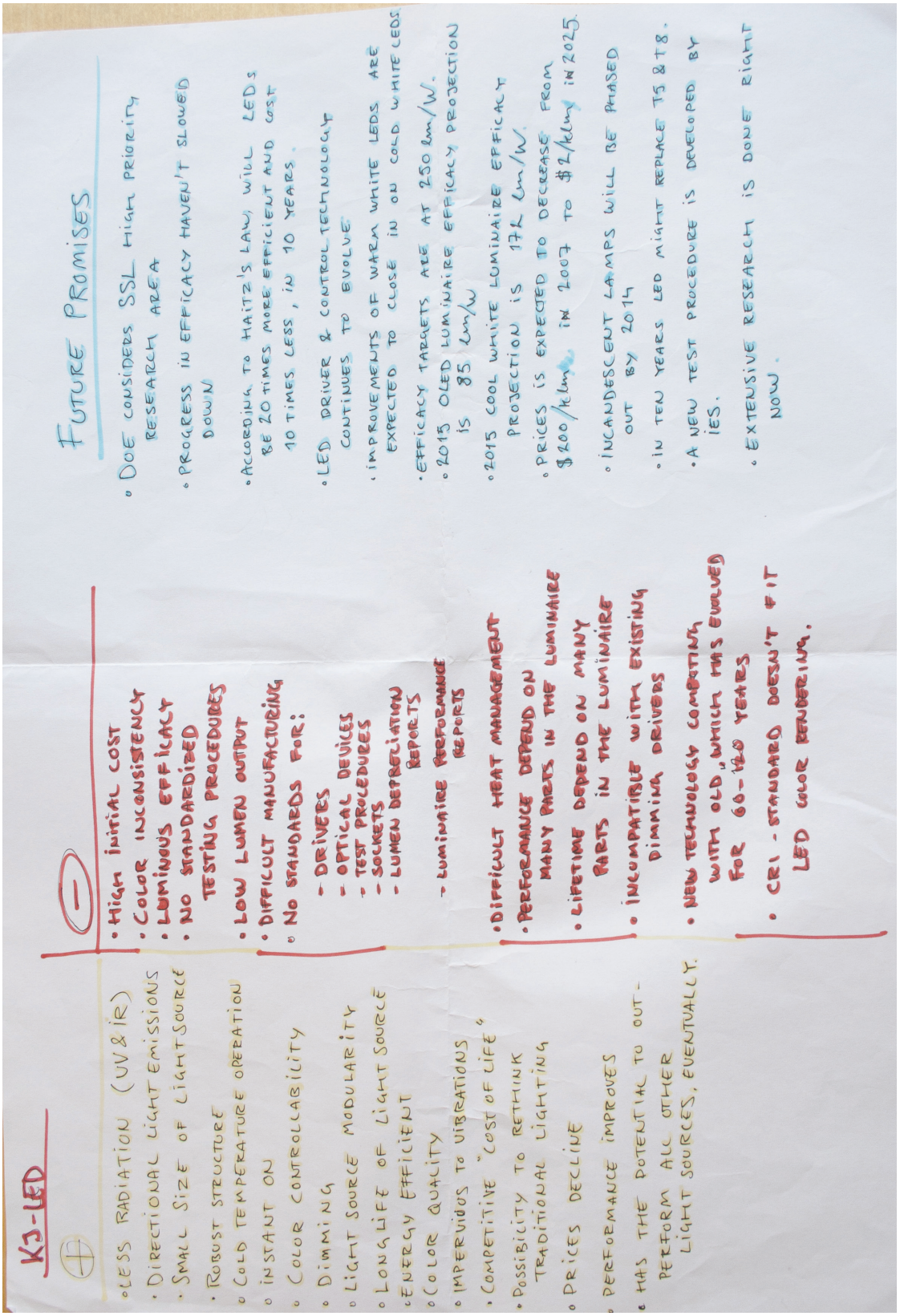


Appendix III

In this appendix is the KJ analysis of the LED literature study presented. The aim of the KJ analysis was to get an overview of the many technical aspects that would influence the development of LED light sources.

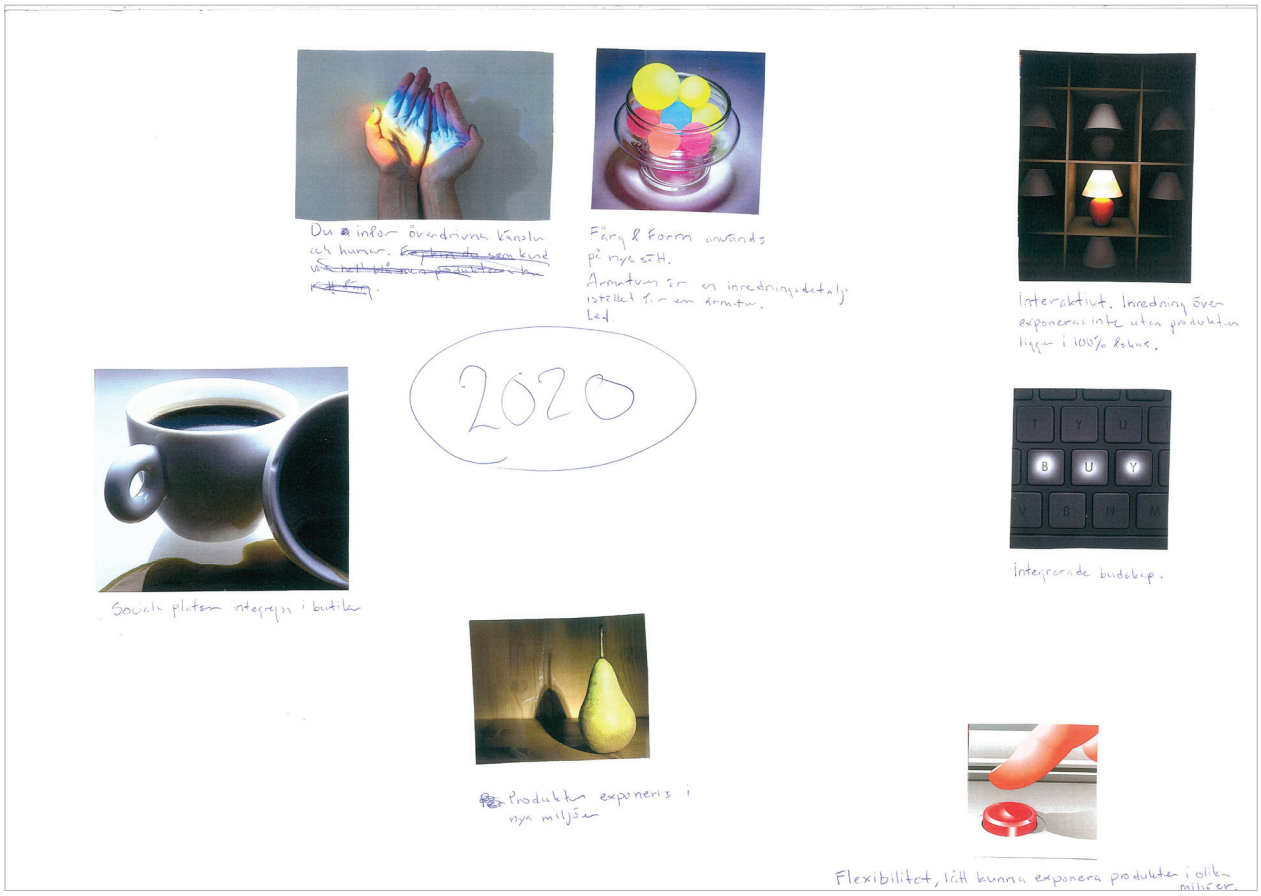
Appendix IV

This appendix presents the summary of the LED KJ analysis presented in Appendix III. Since the KJ analysis of the LED literature study was where extensive a summary was needed in order to get a good overview

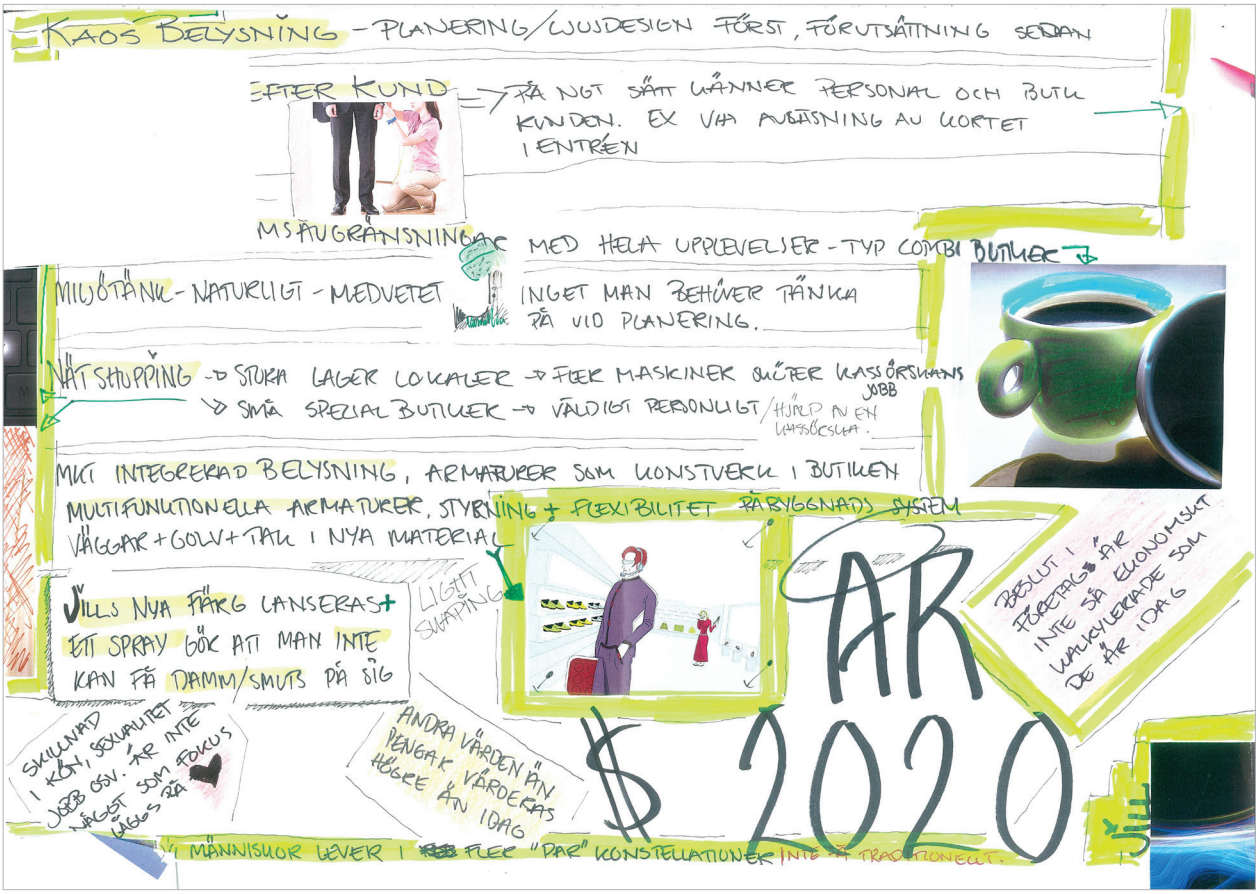


Appendix V

In this appendix are the collages made by the lighting designers from Fagerhult Retail during the workshop about the shopping center Nordstan in 2020 presented. The collages were used as an inspiration in the development of the characteristics for the future scenarios.

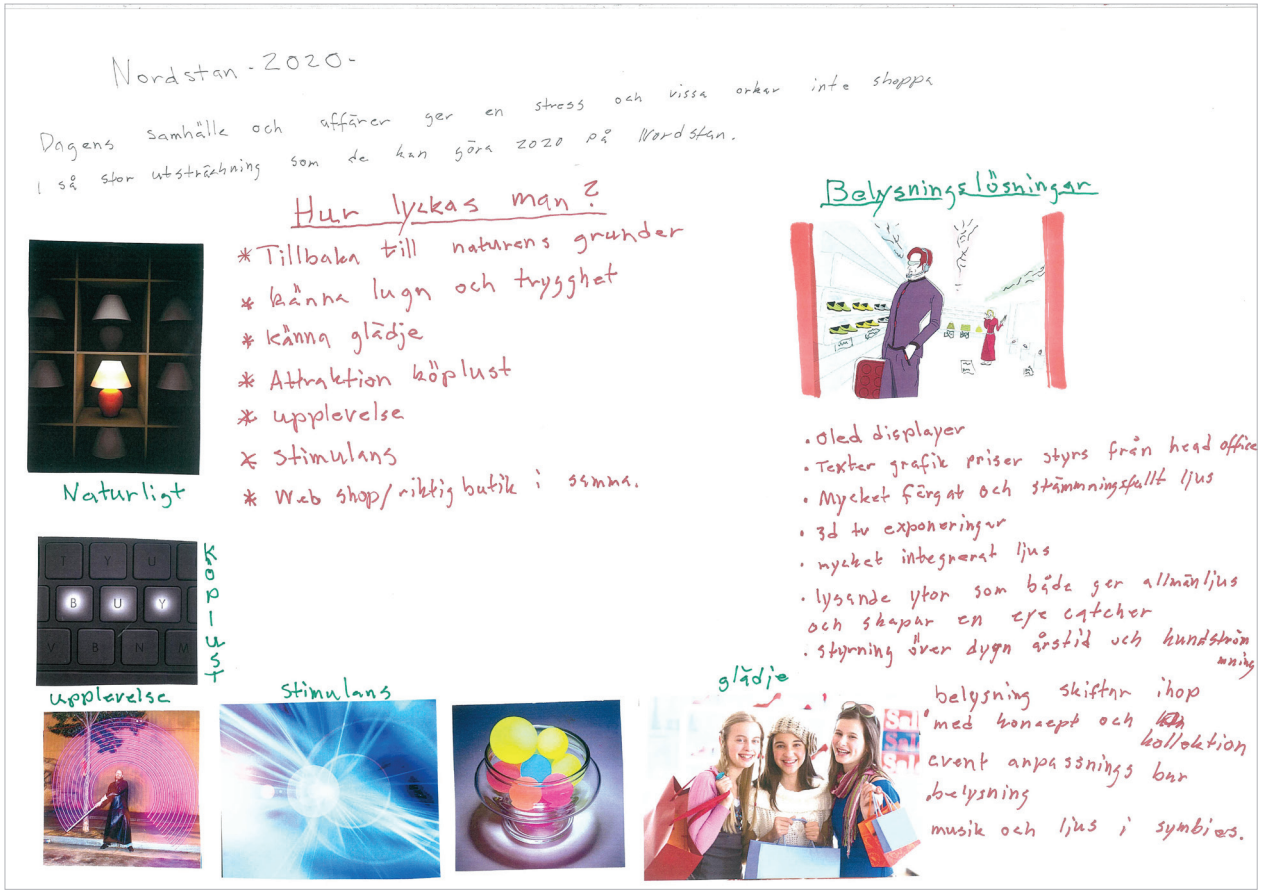


Appendix V


KAOS BELYSNING - PLANERING/LJUSDESIGN FÖRST, FÖRUTSÄTTNING SEDAN
EFTER KUND
MSÅTGRÄNSNINGAR
MED HELA UPPLEVELSER - TYP COMBI BUTIKER
MILJÖTÄNK - NATURLIGT - MEDVETET
INGET MAN BEHÖVER TÄNKA PÅ VID PLANERING.
NÄTSHOPPING
MKT INTEGRERAD BELYSNING, ARMATURER SOM KONSTVERK I BUTIKEN
MULTIFUNKTIONELLA ARMATURER, STYRNING + FLEXIBILITET
VÄGGAR + GOLV + TAK I NYA MATERIAL
LIGHT SHOPPING
BESLUT I FÖRETAG ÄR INTE SÅ EKONOMISKT VARIGENERADE SOM DE ÄR IDAG
ÅR
$ 2020
SKULLNAD I KÖN, SEXUALITET JOBB OSV. ÄR INTE NÅGOT SOM FOKUS LÄGGS PÅ
ANDRA VÄRDEN ÄN PENGAR VÄRDERAS HÖGRE ÄN IDAG
MÄNNISKOR LEVER I FLER "DAR" KONSTELLATIONER INTE SÅ TRADITIONELLT.

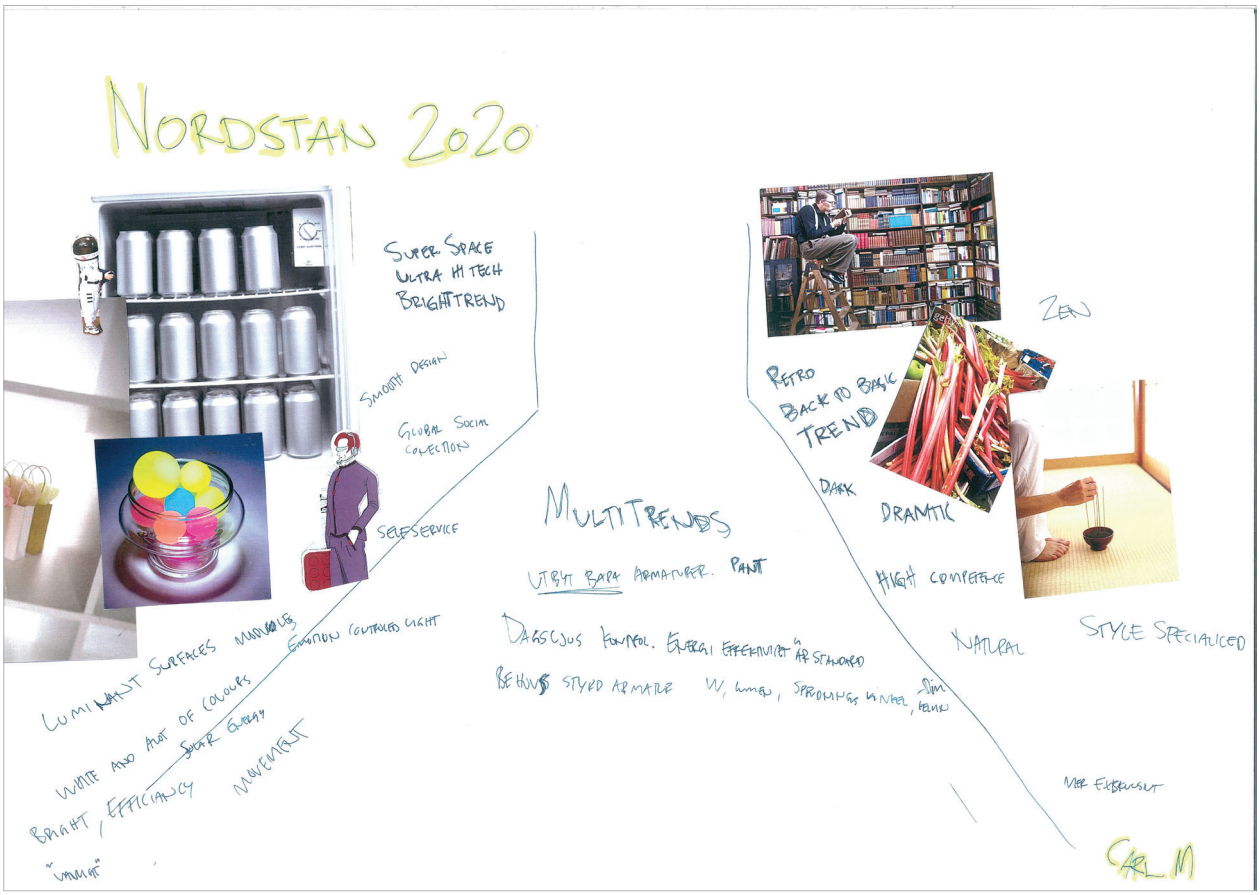

Nordstan 2020
"Hopp om en bättre framtid"
Troligen ser det dock mer ut så här...
Personlig service
Ingen stress
avslappnat shoppande
personlig omtanke
Revolution mot det moderna tänket, tillbaka till det mer personliga, avslappnade förslitningen där kunden är i centrum. Ökad omtanke för sina medmänniskor ökad miljötänk. Tillbaka till grundvärden
Energi & Miljötänk
Opersonlig service
Interaktivt
Digitalt
Datoriserat
Kallt, effektivt, hård miljö, kala butiker sparsamt möblerat Endast ett par i displayen alternativa färger i och dörrdisplay, interaktivt. Ingen personlig service Stressigt, pergafolierat klimat.
Psykologiskt marknadsföring
Stressigt
Kallt, effektivt, stilrent

Appendix V


Nordstan - 2020 -
Dagens samhälle och affärer ger en stress och vissa orker inte shoppa i så stor utsträckning som de kan göra 2020 på Nordstan.
Hur lyckas man?
* Tillbaka till naturens grunder
* känna lugn och trygghet
* känna glädje
* Attraktion köplust
* upplevelse
* stimulans
* Web shop/riktig butik i samma.
Naturligt
köplust
upplevelse
stimulans
glädje
Belysningslösningar
• oled displayer
• Texter grafik priser styrs från head office
• Mycket färgat och stämningsfullt ljus
• 3d tv exponeringar
• nyckel integrerat ljus
• lysande ytor som både ger allmänljus och skapar en eye catcher
• styrning över dygn årstid och kundström
belysning skiftar ihop med koncept och kollektion
event anpassnings bar belysning
musik och ljus i symbios.


TID...
Dagsljus
Store in Store
Minimalistiskt
Tids planera
shop i London
LONDON
Dagsljus
Dagsljus
Välj från hemmet
Visualaseringar
Dagsljus
styrd från hemmet


2020
Mycket integrerad belysning, stämningsfullt
Bländfritt, förhoppningsvis. Högre visuell kvalitet, behagligt att vistas i, mindre stress
Förhoppningsvis är funktionen god under förutsättning att kvalitativa produkter används och att projektering utförs av kvalificerade ljusdesigners. Styrning, flexibelt programvara, dagsljusstyrd, sensorer.
Förhoppningsvis mycket ljuvare, färger. Shopping skall vara mer inspirerande, mer glädje, mer kontraster, större upplevelse, Betydligt mer energieffektiva lösningar. Utveckling från år 2000 - 2010 i princip halverat effektbehov, utveckling kommer att fortsätta med minst en halvering eller förhoppningsvis ännu mer. Drömscenario är att vi får ta större ansvar och leverera helt mjukelfärdiga lösningar och komma in tidigare i processen.
Historia
Gåva Händer
Knappen
Styrning
Köpen
Mus


NORDSTAN 2020
SUPER SPACE
ULTRA HI TECH
BRIGHTTREND
SMOOTH DESIGN
GLOBAL SOCIAL COLLECTION
SELFSERVICE
LUMINÄRT SURFACES
WHITE AND ALOT OF COLOURS
BRIGHT, EFFICIANCY
SUPER ENERGY
MOVEMENT
EMOTION CONTROLED LIGHT
MULTITRENDS
DAGSLJUS FOKUSPOL. ENERGI EFFEKTIVITET
ZEN
RETRO
BACK TO BASIC
TREND
DARK
DRAMTIC
HIGH COMPETENCE
NATURAL
STYLE SPECIALICED
CARL M

Appendix VI

In this appendix are the stories describing the different scenarios from the scenario planning method presented.

Consume better

Emma has finally made her decision. She really wanted a new jacket and after much investigation she now found one that meets her standards. In front of her she has a nice red jacket. The label says that it is made from old PET bottles, that it traveled 300km to get into the store, and that it will be turned into a sleeping bag when it's returned to the shop for product recycling. The best thing is that it is environmentally neutral so that she doesn't have to pay any "waste taxes". She is heading for the counter when the girl working in the shop approaches her. " That's a very good choice. Can I tempt you with this pair of purple gloves that go very good with the red colour of the jacket? They are made out of recycled wool and will be turned into insulation in the next recycling step, and of course they are free from "waste-tax". Emma leaves the store, her new jacket on. As she passes the old and empty supermarket she's going through the list of things she needs to buy for tonight. She'll have to pass by the store specialised in hygienic products to buy a new multi-soap and and by the vegetable store to pick up her vegetable-subscription-box. As she imagining what seasonal veggies that it will contain this week, she's putting on her new gloves.

Defined by shopping

"I want another winter jacket", Emma is thinking while strolling through her favourite shopping district. You can't have too many jackets! She remembers the picture of herself wearing that jacket from American Apparel in the last personalised commercial. She gotta have that jacket!

Emma arrives to the shop during the hectic lunch hour, everyone seems to be out shopping today. Since she brought her members card the poster and mannequins change to her looks when she approaches and items fitting her previous buys are highlighted. Just a few minutes after she entered the shop-theme changes from loud and flashy to sophisticated and bright as the lunch-shoppers leave and the more calm afternoon-shoppers start dropping in.
Emma finds the jacket quickly with the interactive shop guide, and tries it on at once. She tries different environments and backgrounds and loves the jacket more and more, it's so perfect for her and fits so good. "It's really me!", she almost screams out. On the way to the counter a pair of gloves and a scarf that fits the jacket is highlighted, Emma gets them too without considering, "This shop knows me better than I do".

Outside the shop Emma sees a poster of her in a new pair of boots from Timberland and thinks "I want another pair of boots!"

We'll get through it together!

Emma needs a new jacket. It's mid-October and her new office is closer than before, she can finally go by bike to work but that requires a warmer jacket. She can stop by the Wardrobe-Exchange after picking up all she needs for tonight, she has invited some neighbours for dinner but her tomatoes are out and the bread is only good enough for the birds. Luckily her bakery is open on Saturdays and she can get vegetables from the community garden greenhouse. It's 5 hours until it's dark, she have plenty of time!

Now she got everything for tonight, she only have to get that jacket before she can go home and prepare. Emma walks in to the community Wardrobe-Exchange, it's been a while since she was here last time. "Hello, where can I find outer ware in size 36?", Emma asks the girl at the counter. "Hi, it's section O, row 4. Would you like some help over there?", "No, I'll manage, thank you". "Just shout if you need something." Emma search her way through the

rows of clothes. Back at the counter with an anorak the girl informs Emma that she already have used all her 10 slots for clothes and therefore needs to return one item before she can get the anorak. Emma hands in her old windbreaker, that she no longer needs, and leaves with the anorak. Now she can get back to preparing for her friends!

Limited edition

Emma is finally going to get that coat. She's been on the waiting list for 3 months now but yesterday she got a call from the store owner and they booked an appointment for next week. This is her first "virgin"-clothing in years, but she really needed it since they say the next winter is going to be extra harsh and cold. She has looked at all different models and finally decided which one she want. Every thing's going to be exactly like she wants it!

On the way down to the Metro Emma passes her regular Urban Outfitters Re-Sale. She says Hi to Eric the store-manager when going by and takes a quick glance at a new pair of jeans in the window, "Almost not worn!" says the sign.

Emma is fifteen minutes early for the appointment and strolls casually through fancy Urban Outer-Ware. There's different models of jackets and coats on display, Emma stops at a new windbreaker model she hasn't seen before, clicks at the touch display to change it to her size profile and a new cool HiTech material in two shades of blue. "Do you like?" Says the manager coming towards her. "It's a 6 months waiting time on that one. But life-time maintainence!". Not my kind of style or price-tag anyway, thinks Emma and follows the manager into the tailor's office.