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Title: The best lighting solution for everyday dining in the Nordic countries

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Frederikskaj 12,

DK-2450 Copenhagen SV

Semester Coordinator:

Secretary:

Supervisor(s):
Michael Mullins
Arthur M. van der Zaag

Members:
Sara Therese Løvengreen

Abstract:

The interesting challenge, which this thesis investigates, is to design and develop a lighting design (luminaire) that is both aesthetically in line with the Nordic design culture and functionally fits the general citizens needs. The research question for this master thesis is as follows: *What is the best lighting solution for the general citizens' dining area, in Nordic countries?*

Several approaches are used to unfold this research question: Literature review, case studies and in relation to design approach, the thesis mostly follows Bill Buxton's design approach of sketching and prototyping. Bill Buxton's approach is used in the development of my own design solution. Specifically two prototypes and four sketches are developed during this thesis. The prototypes and sketches are evaluated and discussed together with other existing design solutions. The method for this analysis is both the comparative analytical method and thematizing. The analysis is based on empirical data. The data is collected through expert interviews, questionnaires and the photo-voice method. The conclusion is in short that the best lighting solution is a combination of flexible, functional and aesthetically beautiful lighting. This means stimulating light, consisting of both direct light, ambient light and a play of brilliants. This thesis ends up suggesting a final design solution that works with both Nordic sustainable materials and three flexible lighting scenarios, to accommodate the design criteria, which intends to be the criteria for the best lighting solution.

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MASTER THESIS

AALBORG UNIVERSITY - COPENHAGEN
Faculty of Engineering Science
Department of Architecture, Design and Media Technology
MSc in Lighting Design

THE BEST LIGHTING SOLUTION FOR EVERYDAY DINING IN THE NORDIC COUNTRIES

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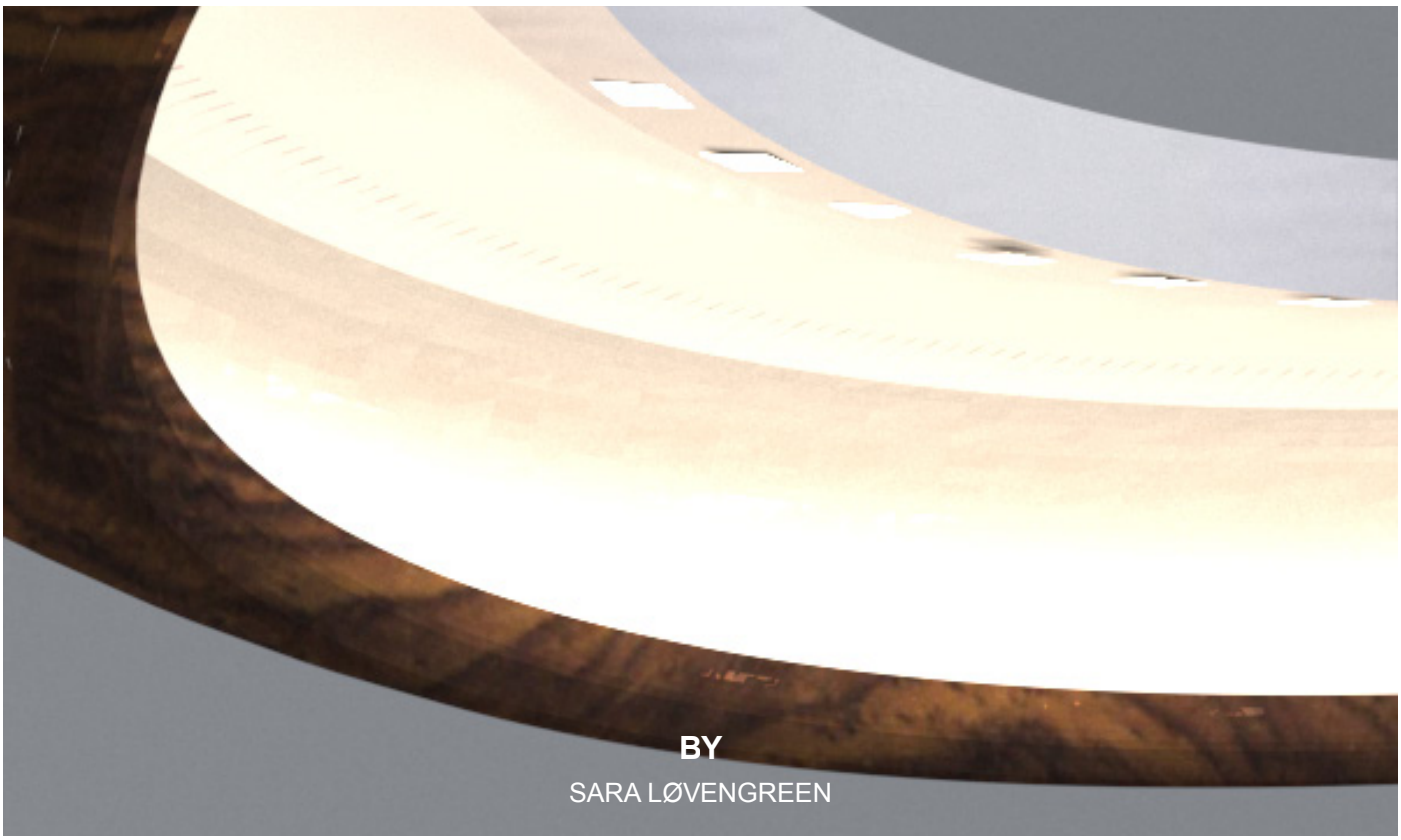
SUPERVISORS:
MICHAEL MULLINS
ARTHUR MICHIEL VAN DER ZAAG

STUDENT:
SARA THERESE LØVENGREEN



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ABSTRACT

The title of this Master Thesis is: **“The best lighting solution for everyday dining in the Nordic countries”**. The thesis takes its starting point in both a personal interest and a gap in research, found through evaluation of already existing solutions. The interesting challenge, which this thesis investigates, is to design and develop a lighting design (luminaire) that is both aesthetically in line with the Nordic design culture and functionally and technologically fits the general citizens needs. The research question for this master thesis is as follows:

What is the best lighting solution for the general citizens’ dinings area, in nordic countries?

Several approaches are used to unfold this research question. The approaches are: Literature review, case studies and in relation to design process and approach, the thesis mostly follows Bill Buxton’s design approach of sketching and prototyping. Bill Buxton’s design process approach is used in the development of my own design solution for this thesis. Specifically two prototypes and four sketches are developed during this thesis. The prototypes and sketches are evaluated and discussed together with other existing design solutions. The method for this analysis is both the comparative analytical method and thematizing. The analysis is based on empirical data. The empirical data creates a baseline for the whole project. The data is collected through expert interviews, questionnaires and the photo-voice method.

The conclusion of this thesis is in short that the best lighting solution is a combination of flexible, functional and aesthetically beautiful lighting. This can be achieved in many ways, but following e.g. Poul Hennings and Richard Kelly, then beautiful light is stimulating light, consisting of both direct light, ambient light and a play of brilliants. This thesis ends up suggesting a final design solution that works with both Nordic sustainable materials and three flexible lighting scenarios, to accommodate the design criteria, which intends to be the criteria for the best lighting solution.

PREFACE

I have always dreamt about getting the opportunity and having the resources to design my own luminaire. During this thesis I got this opportunity, but it only became a reality because of the many helping hands and general support. Therefore, I would like to give an extra thank you to the many people who helped and supported this project. First of all thank you to Michael Mullins and Arthur M. van der Zaag for the great supervision and not at any time doubting, whether my ideas for this thesis was possible or not. Secondly, I would like to thank Anne Qvist and Marianne Tuxen for participating in interviews. Your great knowledge has inspired to an even better final design. In addition I would like to thank you the many craftsmen for your expertise and guidance in relation to the specific design proposal. This includes: Knud Hansen, Anders Raad, Maria Sparre-Petersen, Sia Mai, Annemette Kissow, Tim Elkær, Jesper Greve, Tage Pedersen, Mikkel Karlshøj, Glenn Auker, Richard Saaby, Hans-Henning Pedersen and also Esben H. Litch for being available if help was needed. A special thank you to Jonas Fehr for the many hours of support and teaching in the workshop, while building the prototypes. Last, but not least I would like to thank my family, Pernille Løvengreen, Rolf Hansen, Andreas Løvengreen, Nina Løvengreen and Kristoffer Arnfeldt Mattisson for the economic and emotional support and for always believing I would succeed.

INTRODUCTION

This thesis is a master thesis project written as the final thesis for the master's degree in Lighting Design at Aalborg University Copenhagen. The master's degree in Lighting Design is a two year long education, which in my case builds upon a three years long bachelor's degree in Digital Media and Design from the IT University of Copenhagen. The education in Lighting Design is an transdisciplinary education both including architecture, engineering and media technology. This thesis is therefore also transdisciplinary including all three academic fields. The theme of this thesis is lighting for the dining area and the project title is as following: **"The best lighting solution for everyday dining in the Nordic countries"**. The vision for this thesis is clarified below.

VISION

Imagine if you could create the perfect luminaire for the dining area, both considering the Nordic design trends and the technical functionality

INTRODUCTION TO THE TOPIC

My passion for lighting design derives from the fact that it is a combination of design aesthetics and technology. You cannot just be a furniture designer with a love for beautiful lamp design from The Danish Royal Academy. You somehow need to acquire technological and engineering knowledge about lighting to become a good lighting designer. A great example of this is seen in the new Danish design TV show on DR called 'The next Danish design classic'[1] (DR TV, 2019). Here five talented Danish furniture designers are challenged to design a product of a specific archetype, within three weeks. What is interesting is, episode three, where the challenge is to design a pendant for over the dining table. The five design proposals are all very beautiful and they work as lamps, but none of the designers had the knowhow to actually design a luminaire, which functionally would fit the dining table. They had thoughts about the lighting they wished for in their design, but not the knowledge to either complete the idea or design the best-suited lighting design for the dining table. The judges in the competition underline this hypothesis by only commenting on the aesthetics of the five design proposals. To design a functional and aesthetic luminaire for the dining table is, as seen in the mentioned example, a challenge and not many lamp design companies have lamps specifically designed to fit the activities at the dining area.

This problem is not only the designers' responsibility. It is also the users, who do not choose the correct options, maybe because the most profiled lamps are not the ones suited for the dining area. Or maybe it is because the aesthetic value of the few luminaires, suited for the dining area, does not live up to the other lamp design classics, such as the PH 5 or Le Klint's series of lamps. Senior professor, Kjeld Johnson, from Statens Byggeforskningsinstitut states:

1. Translated from the Danish title "Danmarks næste klassiker".

> *"Too many people have bad lighting and use the wrong light sources in one or more rooms at home and they would get a better quality of life if they did something about it. It is typically in the rooms, where you spend the most time, such as the kitchen, the dining room and the living room".*[2] – Kjeld Johnsen, (Garde, 2018).

Kjeld Johnsen's statement is backed up by research by Coop Analytics in collaboration with Samvirk. Their research shows that every fourth participant had not or had in slight degree considered whether their lighting fits the activity in that area or not (Garde, 2018). What I can conclude is that there is a gap in the research of designing luminaires specifically suited for the dining area and that there is an open opportunity to create a design proposal for the dining area, where both the aesthetics and the functionality are considered.

LIMITATIONS AND PROBLEM FRAMING

To narrow down the field and specify the interests of this thesis I have deliberately made selections and choices concerning the content of this thesis. Most importantly I have chosen not to focus on the circadian rhythm. It is commonly known that disruption of the human circadian rhythm can course several medical disorders such as depression, insomnia, cancer and general sleeping disorders (Chepesiuk, 2009). The circadian rhythm is heavily discussed and a very trendy topic in terms of lighting design. It is a broad field, which in it self could be a whole master thesis. I have chosen not to focus on the cicadian rhythm, because throughout the research process I have concluded that the luminaire does not have to support the circadian rhythm to be successful, neither in the eyes of the user or in relation to acknowledged lighting designers (see the expert interview phrase).

Furthermore, the user involvement in this master thesis is limited. I have chosen not to include the users in the design process or in the testing, and only use a few statements from the users as indications and not for conclusions. This de-selection is because of the users lack of knowledge on the subject. The users are not experts in lighting design and have a difficult time explaining and discussing lighting design, since they do not know the terminology of this field of knowledge. Instead experts and craftsmen have been heavily included in this thesis. It is the statements from the experts and craftsmen, which are used to define the design criteria and thereby also dictate the user needs. In the future it could be of great value to also include the users in the evaluation of the design. Here it is though important to guide the users in terms of terminology, but the users are the experts in usability, which should in the future also be tested.

Lastly, it is important to state that my strengths and interests are within the aesthetics, use of materials and hands on craftsmanship. This is why the prototyping phase and testing phase have taken up as much time as the research and analysis phase, and even tend to overlap in the thesis. In this thesis I have worked with the combination of product development and lighting design, though with a starting point in the theoretical framework of lighting design.

2. Translated from the Danish to English.

RESEARCH QUESTION

WHAT IS THE BEST LIGHTING SOLUTION FOR THE GENERAL CITIZENS' DINING AREA, IN NORDIC COUNTRIES?

SUB QUESTIONS

What are the current Nordic design trends (especially concerning suspension lamps)?

What are the general citizens' needs in terms of lighting in the dining area?

What are the most common scenarios situated at the dining table?

What do other lighting design companies offer/suggest?

SUCCESS CRITERIA

ARCHITECTURE

The luminaire should be sustainable (both sustainable design wise and environmentally)

FUNCTIONALITY

The luminaire should be flexible and suit more than one activity

ENGINEERING

The luminaire should be free of discomfort glare and a low-hanging pendant

METHOD

APPROACH TO THE PROJECT

Below, I have created a process model (see figure 1), describing the process of this thesis. The process model is developed based on the approaches and methods described in detail subsequently. The process model is placed in the beginning of the project approach phrase to give an overview of how the different approaches and methods are combined and work together to create coherence and a common thread throughout the thesis. All the following methods and approaches are used in this thesis. As seen on the model the approaches are: Litterature review and case studies. The design approach is based on Bill Buxtons design approach and the transdisciplinarity is inspired by Ellen Hansen and Michael Mullins' design procedure model. The data collection methods are: Expert interviews, questionnaires and photo-vioce. Lastly, the analytical methods are the comparative analytical method and thematizing.

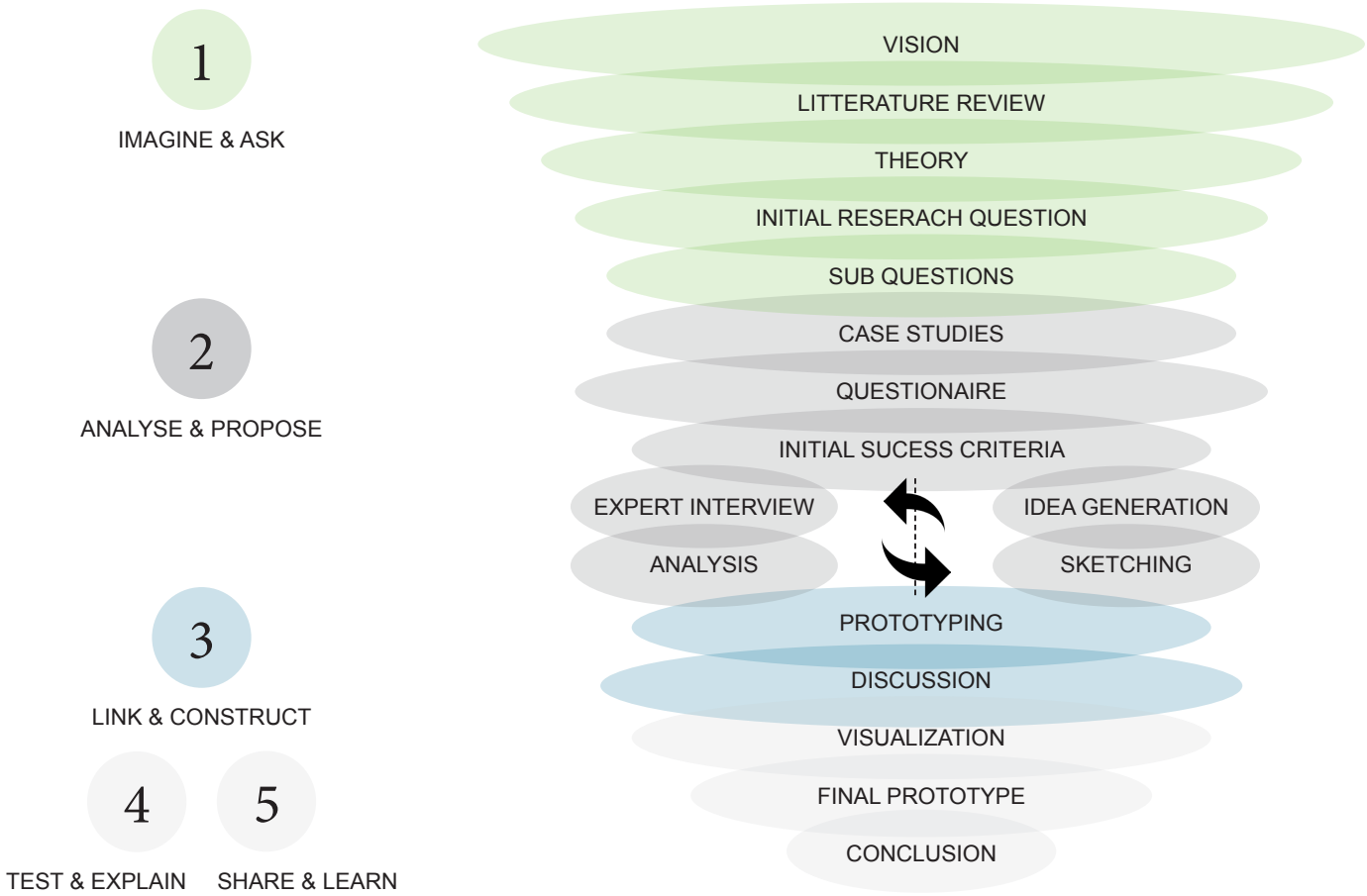


Figure 1 - Process Model

LITTERATURE REVIEW AS APPROACH

The literature review in this thesis is used as pre-analysis of the field of knowledge. The literature review gives an overview of different acknowledged theories on the topic. It creates a common ground to start the investigation from. More specifically the literature review is used in the analysis to underline or discuss the findings from the expert interviews, questionnaires and to validate the design choices. The literature review also provokes wonderings, which creates the baseline for asking the right questions/qualified questions in the empirical research methods.

The literature review in this thesis will be organised into themes related to the research question, which in a whole will create the baseline for the later analysis. The full literature review can be found in the appendix (see appendix 2). In the thesis you will find the summed version of the literature review, where focus is on the knowledge directly used later in the analysis and design process.

CASE STUDIES

The project approach 'case study' is often used to narrow down a broad field and only investigate a very specific part of a field (Petersen, Hassing, & Henriksen, 2018). The cases chosen for the case studies become examples of the bigger picture and cannot stand alone, since it is only a part of the whole truth. Therefore, it can be valuable to combine this approach with a more broad approach, such as the literature review. Some theorists state that a single case study cannot generalize (Petersen, Hassing, & Henriksen, 2018), but this has been discussed and argued against by Bent Flyvbjerg (Flyvbjerg, 2006). Flyvbjerg e.g. states: *"…That knowledge cannot be formally generalized does not mean that it cannot enter into the collective process of knowledge accumulation in a given field or in a society"* (Flyvbjerg, 2006).

Flyvbjerg argues that a single case study can be compared to an expert interview, where the human observed in the case study acts as the expert in that specific field on knowledge. In this master thesis it is not a single case study, which is evaluated and analysed, but a few cases selected from a huge field. These cases will be a representation of the common and become a valid generalisation (Flyvbjerg, 2006).

In case studies, the cases often take their starting point in the real world and not in theory. The case study approach is valuable in this thesis since the thesis investigation includes subjective opinions of e.g. aesthetics and best selling products. The case studies can in this relation help to understand and illustrate the different opinions. Furthermore, the case studies can help get in depth with the state of the art (earlier solutions), their flaws, their successes and further development opportunities.

The case studies in this thesis consist of an evaluation of seven selected cases of best selling suspension lamps for over the dining table. The case studies will also help to define the design criteria, what has been done, and how can this be improved? The analysis of the cases can be found in the 'State of the art' section. Furthermore, a selection of respondents from the questionnaires will act as case studies, analysed by using the method 'photo-voice' described in the phrase: "Argumentation for empirical research methods".

DESIGN APPROACH

Since this thesis includes a design phase, it is important to state the design approach, which the design phase will follow. The design approach is based on Bill Buxton's sketching and prototyping approach (Buxton, 2007). Bill Buxton divides the design phase into two overall phases: The sketching and the prototyping. Both phases are iterative processes, which can be described by the design funnel. The design funnel (see figure 2) illustrates, how a general design concept is developed by reducing ideas, adding ideas and reducing again until one detailed idea is developed (Buxton, 2007).

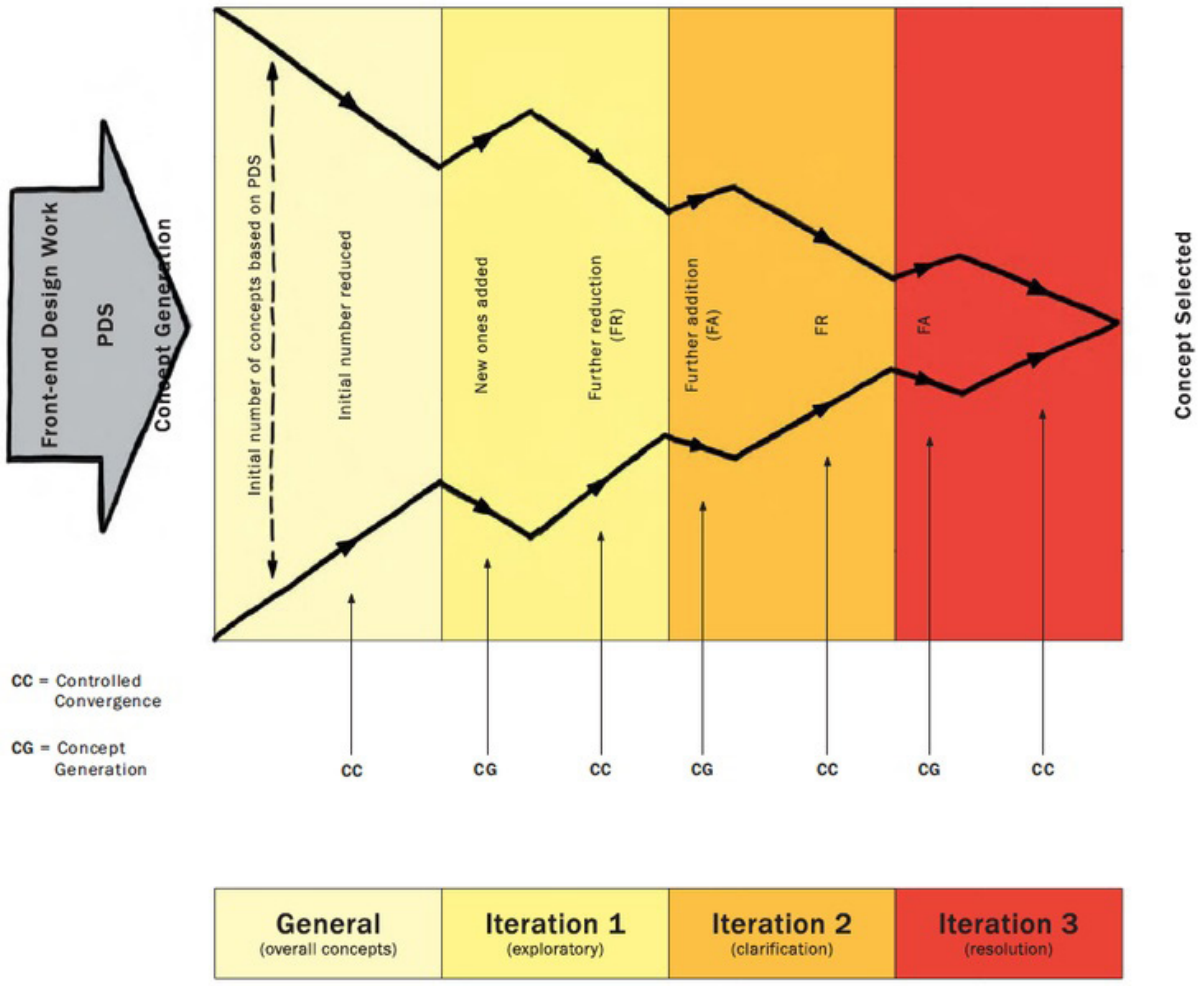


Figure 2 - Design Funnel (Buxton, 2007)

The difference between the sketch and the prototype is in short that the sketch is used to develop the design and create reflection, where the prototype illustrates the design. The sketching phase is followed up by the prototype phase. Bill Buxton's definition of a sketch and a prototype can be seen in the below figure (see figure 3). In this thesis the design process ends with the 2. generation of a prototype and four skechtes, due to time limits. In the future, further development of the design would be to consider.

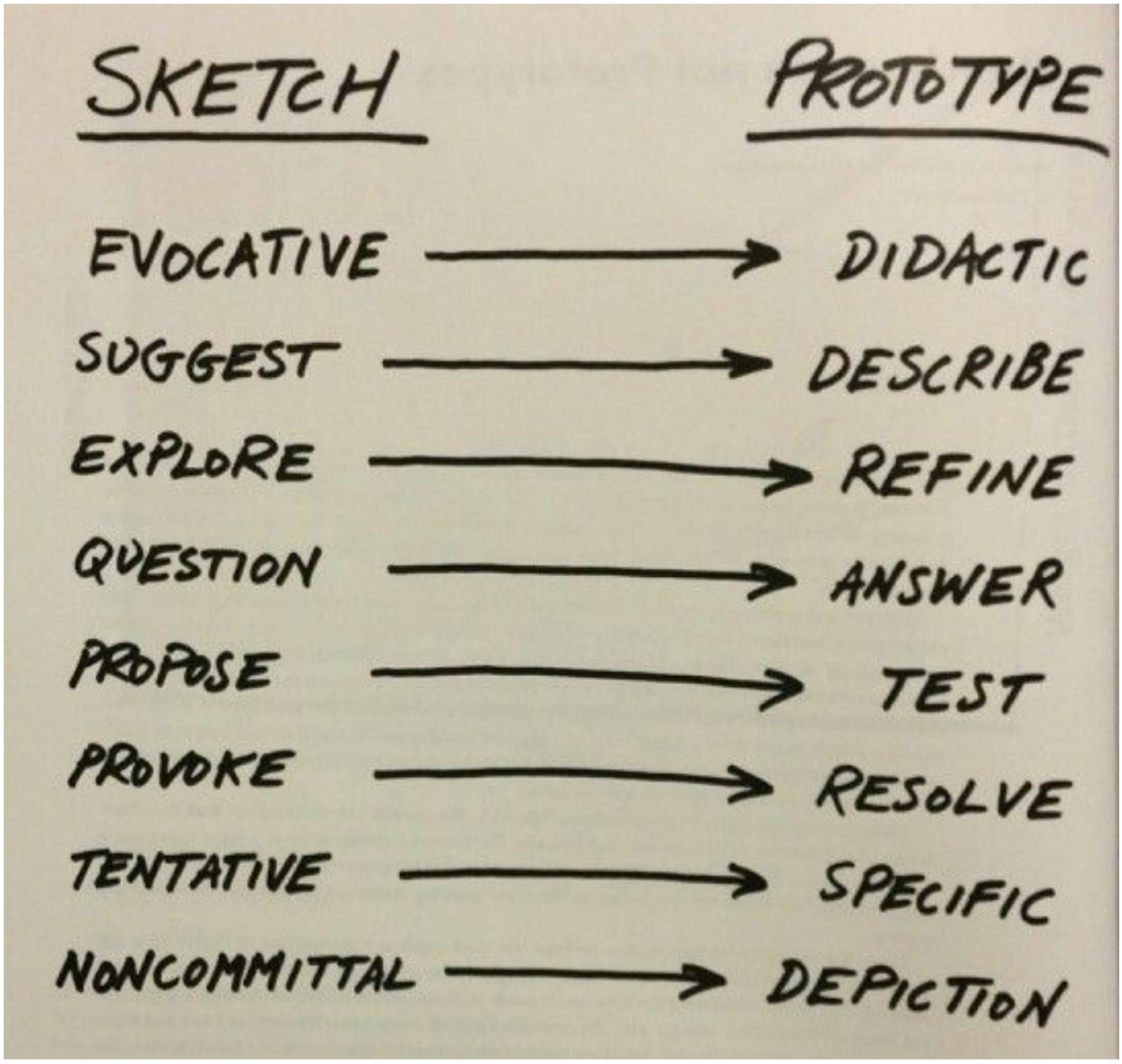


Figure 3 - Sketch vs. Prototype (Buxton, 2007)

The design development phase is organised and structured by following Ellen Kathrine Hansen and Michael Mullins' trans-disciplinary lighting design procedure model (Hansen & Mullins, 2014). In the model the lighting design development is divided into five steps: 1. IMAGINE & ASK, 2. ANALYZE & PROPOSE, 3. LINK & CONSTRUCT, 4. TEST & EXPLAIN, 5. SHARE & LEARN (Hansen & Mullins, 2014). Furthermore, the model works by combining different fields of knowledge into every step of the process (see figure 4). Setting up design criteria in the beginning of the process incorporates the trans-disciplinary approach. The design criteria cover: Architecture, engineering and functionality/media technology. By evaluating the design based on the criteria you force yourself to have the trans-disciplinary approach and a common thread through the process.

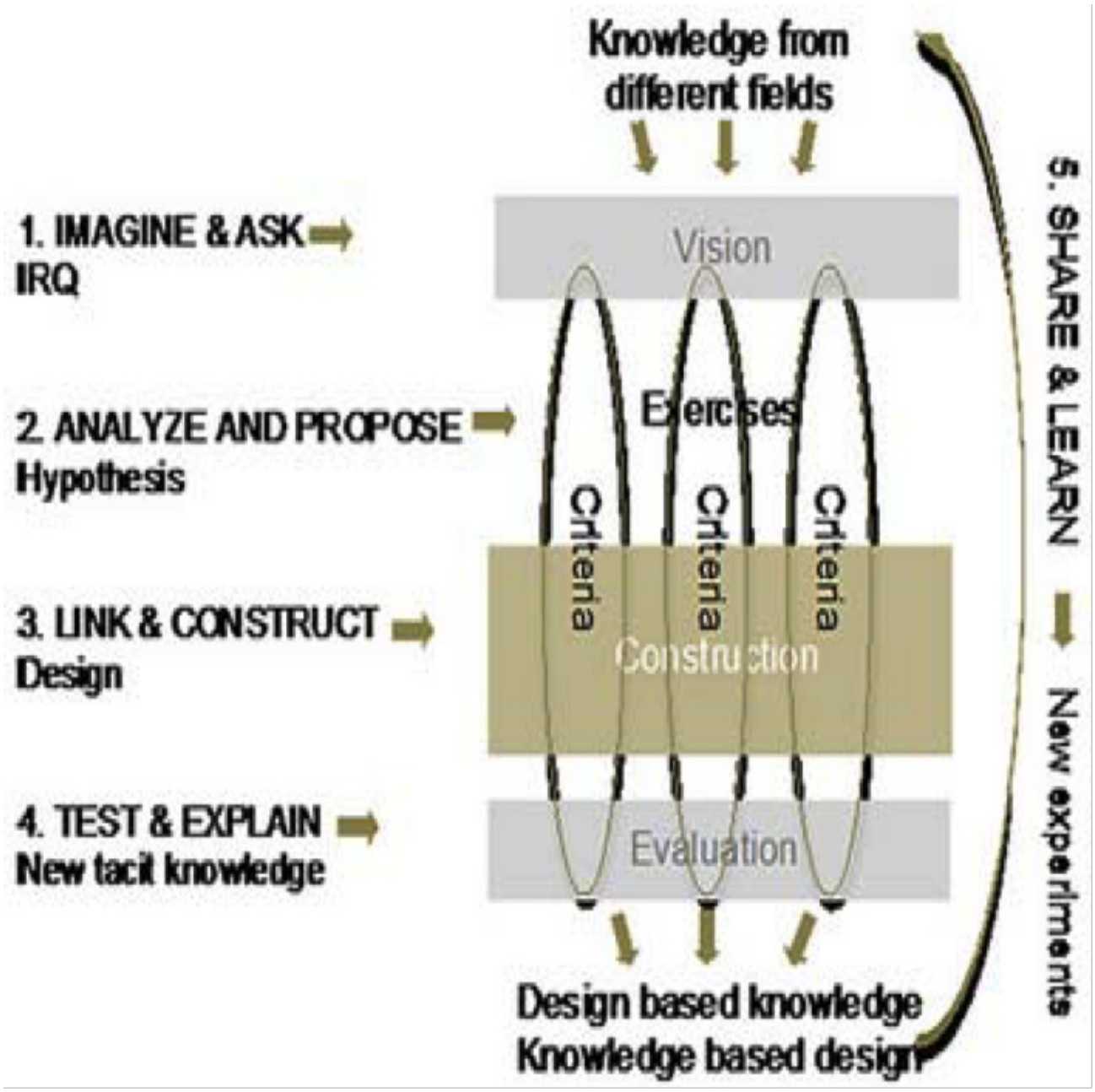


Figure 4 - Trans-disciplinary Lighting Design Procedure Model (Hansen & Mullins, 2014)

ARGUMENTATION FOR EMPIRICAL RESEARCH METHODS

EXPERT INTERVIEW

To answer the research question, the priority is to understand specific needs for lighting in the dining area. The qualitative interview is a tool to get a better understanding of the world, from a subjective point of view (Kvale & Brinkmann, Interview: Det kvalitative forskningsinterview som håndværk, 2015). There are many different types of interviews: Panel interview, group interview, job interview etc. (Kvale & Brinkmann, Interview: Det kvalitative forskningsinterview som håndværk, 2015). The expert interview is characterised by the respondents being experts in the subject you interview them about. This type of interview is valuable if you need concrete knowledge, almost facts about the subject. The type of interview conducted during this thesis is expert interviews, because the respondents have very specific knowledge and experiences in designing luminaires. Specifically the expert interviews are in this thesis also used to define the design criteria.

The structure of the two main interviews conducted is, what you refer to as a semi-structured interview. The semi-structured interview takes its starting point from an interview guide, but lets the respondent guide the conversation and not all questions are prepared beforehand. The advantage of this structure is the loose framework that creates an opportunity to dive into answers that you find interesting (Kjær & Kristiansen, 2018).

The interview guides and notes taken during the interviews can be seen in the appendix (see appendix 4, 5, 6 & 7).

During the design process several short expert interviews were also conducted. These interviews were conducted following an open dynamic structure (Kvale & Brinkmann, Interview: Det kvalitative forskningsinterview som håndværk, 2015). The open dynamic interview structure is not based on an interview guide, but is carried out more as a loose conversation about a specific topic. In this thesis the open dynamic interviews are interviews with different types of craftsmen. They are experts in the materials and craft that they work with. The purpose of these open dynamic interviews was both to gain knowledge about the different materials and their characteristics and to get competent feedback on the design idea. The open dynamic interview is very difficult to keep organised and therefore also difficult to note down and afterwards analyse (Kvale & Brinkmann, Interview: Det kvalitative forskningsinterview som håndværk, 2015). The findings from these interviews will therefore be converted directly into the design process phrase and support the choices and de-selections during the design process. The advantage of using this method is the possibility to be open-minded and take the conversation in many directions depending on the respondents' knowledge and in this case, feedback and suggestions.

PHOTO-VOICE

The method ‘Photo-voice’ is a qualitative method in the family of observations (Novak, 2010). The method is often used to give the respondent the possibility to lead the investigator, rather than vice-versa, which is e.g. the case with the expert interview. In short the method is carried out by handing over a camera to the respondent and let them take photos of specific situations, scenarios or elements (Novak, 2010). Afterwards the investigator asks the respondent to reflect on the photos taken, why they took it from that angle of view or why they chose to have that object in the centre? This encourages the respondent to tell about their thoughts and feelings of a specific place, without the investigator influencing the direction of the conversation (Novak, 2010).

In this thesis the ‘Photo-voice’ method is used to observe and understand the different scenarios, which take place at the dining area. It is used to understand the users needs. The respondents take photos in their own homes. The ‘Photo-voice’ method is chosen, because you can come closer to the private families and their routines by not inviting yourself into their homes, but instead giving them the tool to show their homes to you. The respondents are found through the questionnaires and in this process they are asked to take a picture of their dining area and send it by mail or text afterwards. The photo-voice method is not in this thesis used as a separate method, but as an extra layer on top of the questionnaires.

The photos can be found in the analysis of the questionnaires phrase.

QUESTIONNAIRE

The method ‘questionnaire’ is a quantitative method. In contrast to the expert interview and the photo-voice methods, the questionnaires can more easily include a larger number of respondents and data. The data from the questionnaires can be counted and converted into percentages to help create a full perspective of the answers. Because of the larger respondent group, the answers can also be used as more general answers. In general questionnaires are good to understand a few details about a lot of people (Kjær & Kristiansen, 2018).

In this thesis the questionnaires are used to investigate the user needs and their preferences in terms of lighting in the dining area, what type of lamp do the majority of the northern families have above their dining table, how do they use the lighting in the dining area, what are their issues and wishes? In combination with the photo-voice method the questionnaires will help to get a better understanding of the users, their behaviour and needs. Furthermore, the questionnaires will in this thesis be used to define the scenarios, which the lighting design/luminaire has to function in.

The questionnaire template and notes can be found in the appendix (see appendix 1 & 3).

ANALYTICAL METHODS

COMPARATIVE ANALYTICAL METHOD

The analysis of the case studies are comparisons, also referred to as a comparative analytical method (Petersen, Hassing, & Henriksen, 2018). With this method you are looking for similarities and differences. This analytical method can both include comparing quantitative and qualitative data. Comparisons are most often used to analyse small or very specific amounts of data, since it is an open analytical method, which with larger amounts of data can become very confusing and unorganized (Petersen, Hassing, & Henriksen, 2018). The advantages of using this method is that you can discuss the reasons behind the similarities and the differences, e.g. why one bestselling suspension lamp is more popular, than the other or why two different lamp archetypes have different light output? These types of questions and reflections often occur, when you use the comparative analytical method, which is why I have chosen this analytical method. The purpose of the case studies is to investigate, what are do's and don'ts in relation to lighting and lamp design in the dining area.

THEMATIZING

The data from all three different research methods is analysed by the same principal of analytical method. The analytical method is called thematizing and it is in the category of open coding (inductive method) (Petersen, Hassing, & Henriksen, 2018). In short the analytical method 'thematizing' is to code the data by looking for themes, repetitions and connections in the data. The data is divided into categories/themes and it is in that way the most common findings, which are enlightened (Petersen, Hassing, & Henriksen, 2018). In thematizing you try to be as open minded and objective as possible, by not looking for something specific.

Thematizing is chosen as analytical method for this thesis because the data is subjective opinions, choices or experiences, which can be difficult to compare otherwise. By looking for every connection possible and not only specifics, you can open up the possibility of finding coherence. Thematizing is in close connection with the comparative analytical approach and it can be beneficial to do overlaps.

LITERATURE REVIEW

The following literature review is a sum up of the full literature review. The full literature review can be found in the appendix (see appendix 2). The literature review is grouped into categories summing up the most important and later used knowledge within that field of knowledge. A general sum up is presented at last in this chapter.

LIGHT SOURCES – QUALITIES AND EFFECTS

Following is a review of the chosen light source for this project. In the full literature review other commonly used light sources are reviewed as well (see appendix 2).

LED (LIGHT-EMITTING DIODE)

The different LED chips and products vary quit a lot in quality, competences and cost. Also the LED technology is still being optimised and keeps getting better and better in quality. But in general it is electroluminescence, which creates the light in the LED chip. The LED chip is coated with phosphor, which makes the chip appear yellow, but this is to transform the otherwise UV-light into visible light (Tregenza & Loe, 2014). A luminaire using LED technology is build up as a light engine. The light engine is the LED chip, reflector and heat sink all together. Since it is not heat, which creates the light in the same way as the incandescent bulbs, the LED's do not emit as much excess heat and they use less power to supply the same lumen output. The efficacy is still getting better, but at the moment the efficacy is approximately 30-60 lumen/watt. This is why the LED's are considered as more energy efficient, than the halogen incandescent light bulb, which has an efficacy of 10-15 lumen/watt (Dansk Center for Lys in collaboration with Elsparefonden, 2008).

The typical lifetime of a LED is 50,000 hours, compared to the 1,000 and 2,000 hours of the incandescent light bulbs. Another quality of the LED's is that their shape and size can be altered and thereby more easily fitted into different luminaire designs. The LED chip only emits light in one direction compared to the incandescent light bulbs, therefore you must think the lighting design through and maybe modify the light, to get the wanted output, when using LED's. The downside of the new LED technology is that the colour rendering is not as good as other light sources. Often the colour rendering index is between 80-90. LED's with a CRI of more than 90 can be found (max CRI 97 for now), but costs more (Tregenza & Loe, 2014).

GLARE

When we talk about glare, we differentiate between two types of glare: Disability glare and discomfort glare (Tregenza & Loe, 2014). There are different factors, which can make glare occur. Glare depends on the size of the light source and the surrounding light (Henningsen,

1974). Too high contrast in the surroundings can create glare, both discomfort glare and disability glare (Tregenza & Loe, 2014). To avoid glare you can work with direct and indirect light, more specifically the angle of the light source (Lighting Research Center, 2002) (Bullough, Fu, & Derlofske, 2002). If the light source is not in your angle of view, then glare is avoided. This can also be worked with in terms of diffusers. A diffuser creates a bigger surface of the light source and thereby reduces the chance of glare (Henningsen, 1974). Here it is though important to note that with a diffuser you reduce the lumen output of the luminaire (Lighting Research Center, 2002).

Most references about glare discuss, how to avoid glare, but an important question to ask is, whether glare should be avoided at all times? When is it an issue and when does glare actually contribute to a more dynamic light, for example when creating play of brilliants?

LUMINAIRE ARCHETYPES

Luminaries are divided into six categories (archetypes): Recessed, ceiling-mounted, suspended, architectural, wall-mounted and plug-in (Lighting Research Center, 2018).

Suspended luminaires are the most common for the dinning area. The suspended luminaires can have all kinds of shapes and styles and both provide ambient and direct light. The suspended luminaires often intend to block the direct view of the light source (Lighting Research Center, 2018). The suspended luminaires are characterised by hanging from the ceiling. If it is above a dining table, the rule of thumb is to hang the luminaire approximately 60-65 cm. above the table (Leslie & Conway, 1996) (Fritz Hansen, 2016). Since the luminaire is hanging from the ceiling, the dimming or controlling needs to be thought in otherwise. The dimming is often mounted to the wall. The suspension lamps have traditionally mostly been providing down light and ambient light, but there is no impediment to not incorporate up light (Leslie & Conway, 1996). Also chandeliers are characterised as suspension luminaries (Leslie & Conway, 1996).

TASK LIGHTING

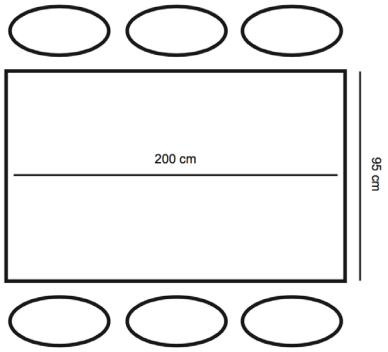
Since the dining area is not only used for eating your dinner, but also serves as a workstation, it is interesting to look into, what good office/task lighting is? Volf and Meisler have in 2016 written an article about intelligent lighting for offices. One of their findings was that cool lighting in work areas creates a good work environment. With cool light, they refer to a high colour temperature, approximately 5000 – 6000 K (Volf & Meisler, 2016).

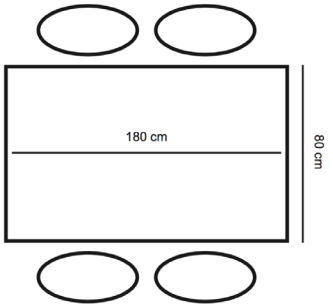
Nielsen and Bay have written an article concerning good office lighting in general. Here they state that good office lighting is not only to have appropriate light on the work task, but also to consider the surroundings, otherwise you will get listless (Nielsen & Bay, God Kontorbelysning, 2017). It is important to both consider the central vision and the peripheral vision. It is the combination, which creates the overall impression of comfort (Nielsen & Bay, God Kontorbelysning, 2017). In detail

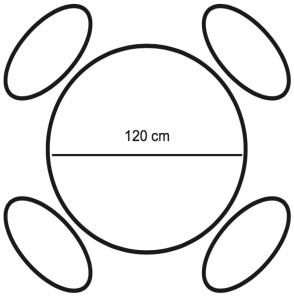
Nielsen and Bay state that good office lighting is, 300 lx for short period reading and writing, at meeting tables and at screens. 500 lx is ideal for longer periods of reading and writing. 800 lx - 1000 lx is optimal for detailed work, such as drawing. Furthermore, a colour rendering of CRI 80 is suggested. Lastly they state that the ideal lighting scenario is build of both direct, indirect, up and down light (Nielsen & Bay, God Kontorbelysning, 2017).

LIGHTING UP THE DINING AREA

First of all the two most common dining tables are either round or rectangular. The most common sizes are fitted 4-6 seats, which is approximately for the squared tables either: 180 X 80 cm. or 200 X 95 cm. The round table is most often 120 cm. in diameter. Furthermore, the dining tables are most often made of wood or laminated plastic and are either white or natural wooden coloured on the top surface (IKEA, 2018) (ILVA).







Leslie and Conway (writers about lighting at private homes) suggest providing down light, though diffused and not direct light. The danish furniture store 'Idé Nyt' has on their webpage suggested using a pendant made of a solid material, only providing down light, but with a large beam angle, so the lighting becomes spread out over the dining table (Viuf, 2015).

In a newer article (Lighting Research Center, 2018), the focus is more on minimizing glare and having the oppotunity to dimm to create the best dining area lighting. Here it is also stated that a pendant both illuminating the surroundings and the table directly would be the absolut best solution (Lighting Research Center, 2018). More detailed the webside Residential Lighting describes that the best artificial light in the evening is a warmer light source (around 2700 K) with no more than 80 lx (Lighting Research Center, 2013). Ellie Coombs (director at architectural lighting specialist Nulty) states in her article about creating the perfect dining atmosphere that the CRI value should be minimum 80 and it would be best if the CRI value is closer to 90 (Coombs, 2016). A CRI value close to 90 will ensure that food and drink are displayed to maximum impact (Coombs, 2016). In addition, to make food more appealing it is not only important that the CRI value is high, but also that the correct wavelengths are respresented in the artificial light. The colours of the food is best represented, when the similar wavelengths are also present, e.g. the colours of a red tomato is best lit up by a light source destributing red wavelengths (625 nm –

740 nm) (Philips). Wilhide (Writer on design and decoration) suggest that the the purpose of the main luminaire in the dining area is to create a space within the space – so the dining area becomes its own place in the kitchen or dining room or where it is placed in the house (Wilhide, 1999). Furthermore she describes the importance of flexibility, since the use of the dining area is becomming more and more flexible as well (Wilhide, 1999).

NORDIC DESIGN TRENDS

Anne Bay (from Danish center of light) very precisely explains, what she defines as Nordic Lighting Design. She explains that Scandinavian design often is associated with words as “minimalistic”, “robust”, “human cantered”, “simple beauty” and “sustainable” (Bay, Nordic Lighting Design Som Et Fælles Brand, 2017). She also mentions, how it is a must for Nordic lighting design to have good quality to differentiate from the cheep products around the world.

BI Design studio expresses that Nordic design is clean and simple and also mentions the specific materials, which they associate with Nordic Design: “*We wanted the building to express a clean and simple choice of natural materials, which may actually be a Nordic attitude: steel, concrete, glass, wood and copper*” (BI referred to by (Ibler, 2015)).

Both designers Marianne Tuxen and Anne Qvist agree that Nordic design is minimalistic and simple. Mariane Tuxen compares the Nordic design with Italian lighting design and states that the biggest difference here is that in Italy they use materials such as glass, and try to incorporate all kinds of quirky details into the glass, to make it look like crystals, whereas Nordic design is simple and does not try to ‘gimmick’ or add on to the materials.

Anne Qvist underlines that sustainability is a huge part of the Nordic design trend and also that we have to be more sustainable in our future designs. Anne Qvist states: “*Sustainability is a big issue. So I do think we will see local materials as very important, so maybe it will be sort of a return to fundamental basics, what can be done with what we have.*” (Anne Qvist, 2019).

SUB CONCLUSION

The literature review gives a line of direction to what the best lighting for the dinning area is. The literature review is not enough to give an adequate conclusion, but has to be discussed together with the findings of the theory, the questionnaires, the interviews and sketching/prototyping. The following is therefore the sub-conclusions found through the literature review, which will be carried forward in the rest of the project.

- LED is chosen as the light source to work with, because of its possibilities in terms of flexibility and because it is more sustainable and energy efficient, which correlates with the Nordic design trends.
- Discomfort glare and disability glare can be avoided by working with the angle of incidence and diffusion, but you should reflect on, whether glare should be avoided at all times or not?
- The luminaire has to work as a suspension lamp hanging approximatly 60-65 cm. above the table surface and both up and down light can be considered.
- If the dining area should also work as a workstation, then the best lighting solution would be cool light (5000-6000 K), with and intensity of 300-1000 lx on the table surface, with at least a CRI value of 80.
- The light output from the luminaire should both be direct and indirect lighting, creating a space within the space, by illuminating the surroundings, but focusing on the surface below.
- The beam angle should fit the largest common dining table size (200 x 95 cm. or 120 cm. in diameter), which can be round or rectangular.
- The most desired evening lighting is cosy lighting (2700 K), with an intensity of approximatly 80 lx on the surface below.
- Nordic design is often characterised as minimalistic, robust, sustainable and good quality.
- The materials, which characterises Nordic design is steel, concrete, glass, wood and copper.

THEORY

Within the field of lighting design and lighting knowledge, there are some theorists that you cannot ignore. The three theorists, who are the most important in relation to luminaire design, are Richard Kelly, Juhani Pallasmaa and the Danish designer Poul Henningsen. They have written interesting theories on, what I would categorize as ‘the shape of light’, how to describe, understand and design with light (Kelly, 1952), (Henningsen, 1974) & (Pallasmaa, 2005).

Note that ai the end of this capter, there will be a sum up.

RICHARD KELLY

Richard Kelly states three elements of light perception, which can help to understand and visualize lighting. The three elements are ‘Focal glow’, ‘Ambient luminescence’ and ‘Play of brilliants’ (Kelly, 1952). Richard Kelly states that the interplay between these three elements creates visual beauty (Kelly, 1952).

FOCAL GLOW

Focal glow can in other words be described as highlights. The light comes from one direction, one light source. It creates hard shadows and great contrast can occur with focal glow. An example of focal glow is e.g. a single star on the dark night sky or a desk lamp with directed light for reading (Kelly, 1952). The below image is a picture of Bruno Mars at one of his concerts (Maikanizam, 2018). The spotlight on him would be categorised as focal glow (see figure 5).

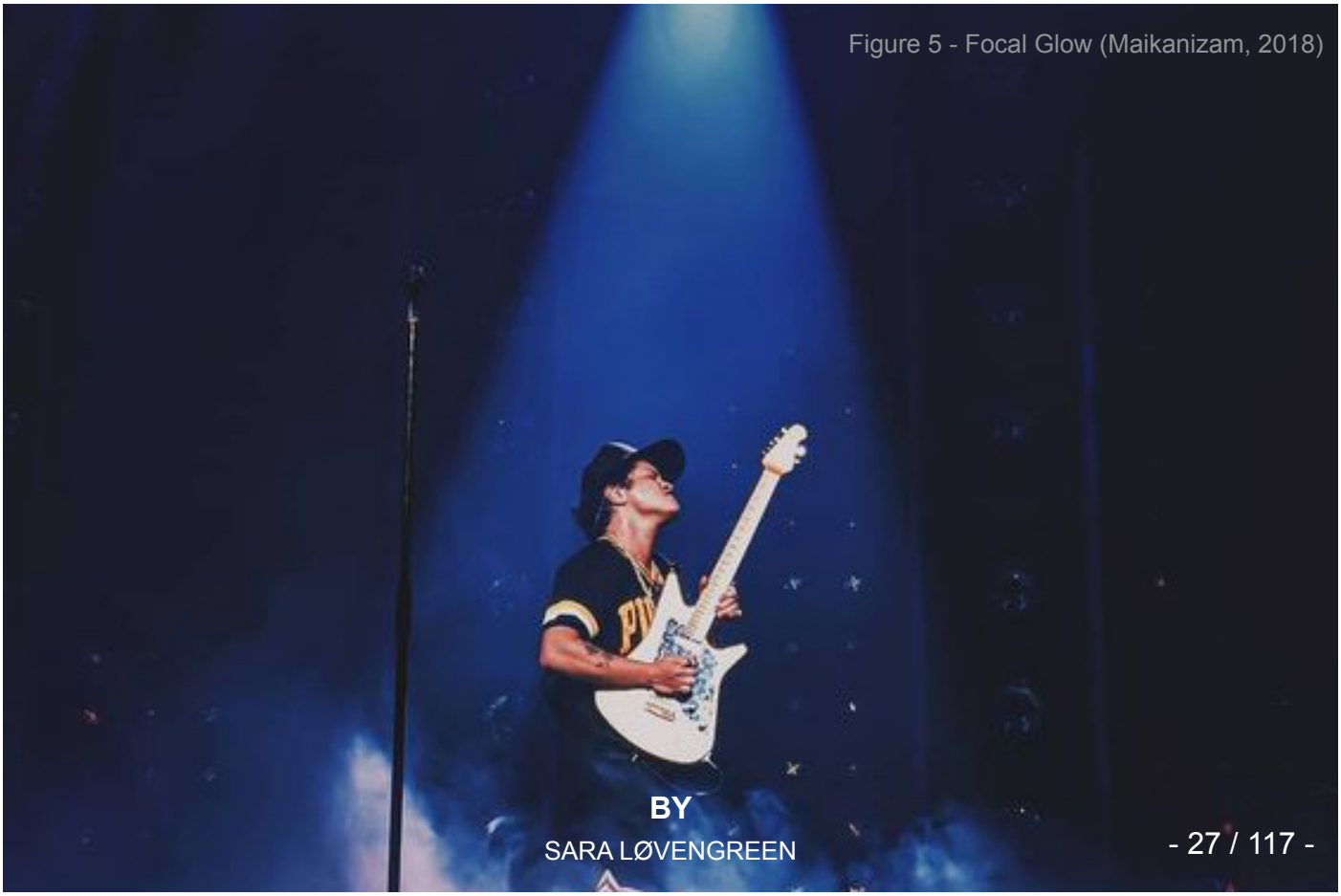


Figure 5 - Focal Glow (Maikanizam, 2018)

AMBIENT LUMINESCENCE

Ambient luminescence is diffused light, either from a single light source or several. The shadows created by ambient luminescence are soft and blurred. The level of detail in ambient luminescence is low. Ambient luminescence it is about creating an atmosphere, rather than e.g. task lighting. An example of ambient luminescence is e.g. general sky light or light from a pendant with a built in diffuser (Kelly, 1952). The below image illustrates ambient luminescence (see figure 6). It is a picture of the interior of Herning Museum of Contemporary Art. The building was designed by the well-known architect, Steven Holl (Steven Holl).

PLAY OF BRILLIANTS

Play of brilliants is most often created by more than one light source. Play of brilliants is also referred to as ‘sharp detail’. With play of brilliants there will be more than one shadow, since the light is coming from different directions. An example of play of brilliants is e.g. candles on the Christmas three or sunlight scattered through three tops (Kelly, 1952). The below image illustrates the principle of play of brilliants (see figure 7).

Figure 6 - Ambient Luminescence (Steven Holl)

Figure 7 - Play of Brilliants (Dave, 2012)

JUHANI PALLASMAA

Juhani Pallasmaa has a lot of interesting thoughts on, how the vision collaborates with the rest of the senses and how the impression of architecture is influenced by the visual circumstances (Pallasmaa, 2005). Juhani Pallasmaa explains how the eyes are organs of distance in opposition to touch, which is a sense of nearness. As he explains, when we have an emotional experience, we tend to close our eyes to feel the intimacy (Pallasmaa, 2005). The eyes and our vision take in a lot of impressions through light, which is why we need darkness and shadows, to help dim the sharpness and sort out in the impressions. The darkness and shadows help to create contour, shapes, edges and separate objects from each other and in the end create depth (Pallasmaa, 2005).

Not all the impressions from the distance sense of vision is registered, Juhani Pallasmaa also explains how the peripheral vision is the "*essence of the lived experience*" (Pallasmaa, 2005). One of his more interesting quotes related to peripheral vision is: "*Focused vision confronts us with the world whereas peripheral vision envelops us in the flesh of the world*" (Pallasmaa, 2005). In this quote Pallasmaa describes, how the peripheral vision opens up another dimension of, how we view the world. The peripheral vision centres the viewer in the world of his or her own impressions, where the focused vision centres the object viewed (Pallasmaa, 2005).

What is really interesting about Juhani Pallasmaa's thoughts on the vision as a sense, is first of all the idea of, how you can make the user feel like being in the centre, by playing with the light. Secondly, Pallasmaa underlines, how darkness and shadows are just as important as light. Without darkness and shadows, the scene becomes dull and the viewer will be under stimulated, it will become more difficult to see (Pallasmaa, 2005). Pallasmaa is though in comparison with Richard Kelly, more a 'dreamer' or has a more philosophic approach to lighting design and architecture. His theories and thoughts cannot be directly applied on a design project, but has to be interpreted to become tangible.

POUL HENNINGSEN (PH)

Poul Henningsen has in his book "About Light"[3] described his view and understanding of correct and good lighting for the private homes. He sets up four general criteria to consider if you want to design good lighting. The four criteria are: Glare, the light's ability to create definition, clarity and shadows[4] (Henningsen, 1974).

3. Translated from the Danish title "Om Lys".
4. Translated from the Danish concepts: "Lysets Blænding", "Lysets Karakteriseringsevne", "Klarhedsrækken" and "Skyggedannelse".

GLARE

The most used method to reduce glare is to add a diffused surface to the luminaire, but another method to consider is to enlarge the light emitting area. A larger light source will also reduce glare (Henningsen, 1974). Poul Henningsen states that a large light source or light emitting area/surface is the only right solution to accommodate glare. It is suggested to use glass in combination with an incandescent light bulb to create this even and large surface of light (Henningsen, 1974).

THE LIGHT'S ABILITY TO CREATE DEFINITION

Poul Henningsen states that, when you are reading, working, cooking etc. completing tasks, where you have to focus, it is important to have the horizontal surfaces lit up evenly. While in the living room, where you want a cosy feeling, this is completely opposite. Here you would want several light sources to illuminate the room and purposely create an uneven light scene to stimulate your senses (Henningsen, 1974). He describes light as an artistic element, which indicates the intended task for a specific area (Henningsen, 1974).

CLARITY

Poul Henningsen states that there are different needs of clarity levels on the different surfaces you would find in an e.g. living room. The living room has large surfaces e.g. walls and ceilings and smaller surfaces such as tables or shelves (Henningsen, 1974). The important concept of clarity is that, the brightest surface in a room, will be the main light object and the darkest surface in a room will be a light killer. With this Poul Henningsen states that you will not notice the detail and see the object clearly, neither if it is placed in the most lit area or the least lit area (Henningsen, 1974). To create clarity you will need surfaces, which are both more and less, lit up, than the surface, which you want to be clear and eye-catching (Henningsen, 1974).

SHADOWS

A shadowless work area is not to prefer, because shadows brings the smallest details forth (Henningsen, 1974). Instead of focusing on lighting up, the focus should be on the crossing between the light and the shadow, or in other words the contrast. This crossing should according to Poul henningsen be as smooth as possible, without creating too many 'small shadows'. Poul Henningsen defines 'small shadows' as sharp shadows, created by two surfaces touching each other (Henningsen, 1974).

Poul Henningensen explains that we should use shadows to emphasize details, though without creating glare (Henningsen, 1974). And this, you can according to Poul Henningsen, do by combining direct and indirect light, and this will create, in Poul Henningsens own words, ‘Harmony’ (Henningsen, 1974).

Poul Henningsens concepts are considerably more tangible than both Kelly’s and Pallasmaa’s theories. But maybe Poul Henningsen’s concept are less relevant, since they are so literal, but from a time, where e.g. LED was not on the market yet. Poul Henningsen describes good light in the mid 70’s, where Kelly and Pallasmaa explains more general concepts, which more easily can be converted to fit a more contemporary setting. Nevertheless, the concepts of Kelly, Pallasmaa and Henningsen will be considered throughout the thesis.

SUB CONCLUSION

In short the conclusions from the different theories are the following:

- Combining the three elements of light creates visual beauty: Focal glow, ambient luminescence and play of brilliants.
- Darkness and shadows (shadow play) stimulates the eye and helps us to see edges, contours and shapes better.
- If you hide the light source, by e.g. adding a diffuser you can avoid glare.
- Evening out the light, by illuminating the surrounding surfaces will increase the visibility, but even light is not as stimulating as uneven light.
- We should smoothen out the larger areas of contrast to get comfortable light, but emphasise small details with shadow play.

STATE OF THE ART - EVALUATION OF SELECTED CASES

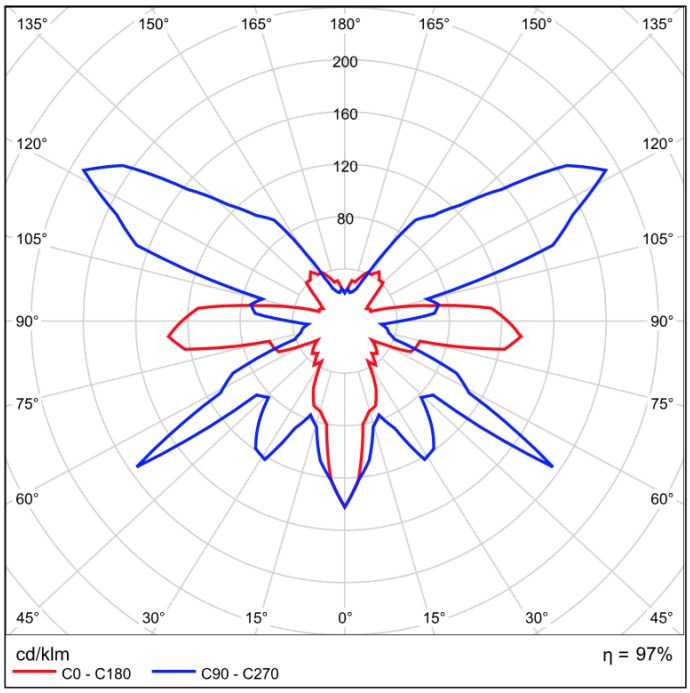
Throughout this phrase seven different examples of best selling dining table pendants will be evaluated and analysed. The seven examples are chosen for different reasons, but have one thing in common, which is that they are all recognised as bestsellers throughout time in Scandinavia (Lampemesteren, 2017), (Griffiths, 2014), (Lampemesteren), (Rasmussen, 2017) & (Lysmesteren). The seven pendants will be evaluated and analysed in relation to the knowledge gained from the literature review and the theory. I have set up six criteria based on the literature review and theory. The six criteria are overall categories, which includes all the aspects of light mentioned in the litterature review and the theory phrase. The six criteria will in this phrase act as discussion points for the evaluation. The six criteria are:

- *Richard Kelly's principals of light*
- *Glare*
- *Interplay between light and dark (shadows)*
- *Materials in relation to Nordic design trends*
- *General light output (photometrics)*
- *Functionality (how well does the light fit the activity)*

HOPE BY LUCEPLAN

Hope is a family of lamps including different archetypes, but all with the same design as starting point. The Hope family is designed by Francisco Gomez, Paz and Paolo Rizzatto and was launched by Luceplan in 2009. The Hope pendant consists of blades of polycarbonate, which creates an effect of the traditional crystal chandelier, when lit up. The family is named after the legendary Hope diamond, because of the crystal effect (Griffiths, 2014).

Figure 8 - Hope by Luceplan (Luceplan)



In terms of Richard Kelly's principals of light, the Hope lamp works with the principal 'Play of brilliants'. The intention of the light is to create an association to a sparkling diamond and the light is therefore scattered through the blades of polycarbonate. With the combination of daylight and electrical light, an effect of a prism can also occur with this lamp. The light source is shielded by the blades and is not visible to the user, but because the light is not directed one way, but scattered everywhere, there is still a chance of glare – both disability glare and discomfort glare. The interplay between light and dark does not occur within the lamp itself, but on the surfaces hit by its illuminance.

Figure 9 - Hope polar diagram (Luceplan)

The shadow play on the surrounding surfaces (both vertical and horizontal) is never the same and creates an interesting play of light, which adds to the lamps aesthetical value. In terms of materials, the polycarbonate has been a highly trendy material for furniture, but it is not very sustainable or fitting with the Nordic design culture. Since the light is not directed, but mostly indirect light, then my evaluation of the functionality, is that the Hope lamp is not suited for the dining area. Luceplan underlines this assessment through the polar diagram, where it is seen, how uneven the light is and the intensity directly downwards is not very high (see figure 9) (Luceplan).

During my job as assistant salesman at Spotlight[5], I also experienced several claims on the polycarbonate blades, because they split and get discoloured over time in direct sunlight. Even though sustainability is not a criteria for evaluation it is a huge part of the Nordic design culture, and in the Hope family this is something, which becomes an issue, if you want the best proposal for a dining table pendant.

PH 5 BY LOUIS POULSEN

The pendant PH 5 was designed by Poul Henningsen. It is one of the most iconic pendants in Scandinavia. The pendant was designed and launched first time in 1958 (Louis Poulsen). The principal of the pendant is the so-called 'three-shade-system' by Poul Henningsen. Poul Henningsen wanted to design a glare free lamps that at the same time directed the light, both directly downwards (down light), to the sides (ambient light) and upwards (up light) (Henningsen, 1974). Poul Henningsen described the light from the PH 5 as intimate and appropriate as a low hanging pendant (Henningsen, 1974).

5. https://www.spotlight.dk/om-spotlight/

Figure 10 - PH 5 by Louis Poulsen (Louis Poulsen)

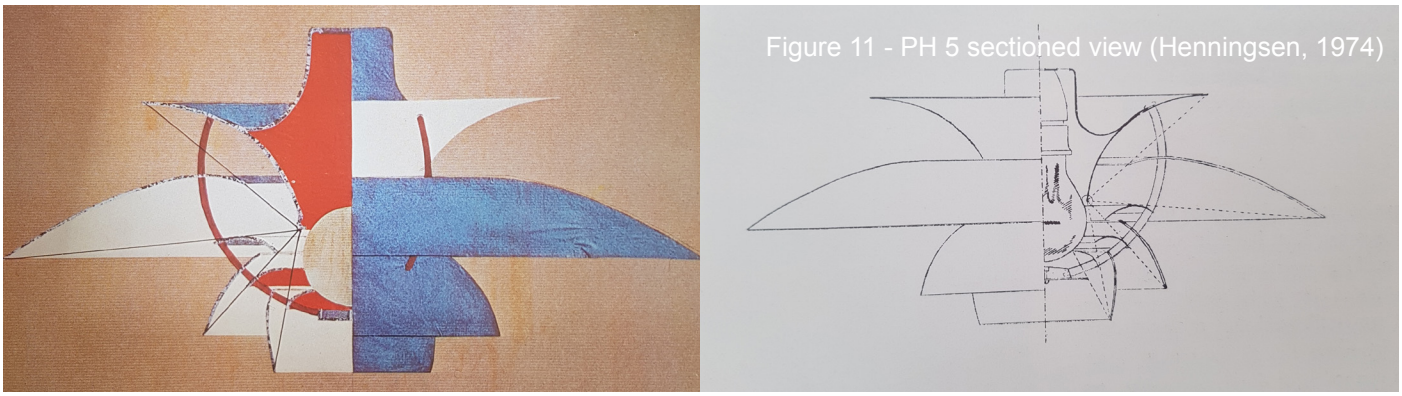


Figure 11 - PH 5 sectioned view (Henningsen, 1974)

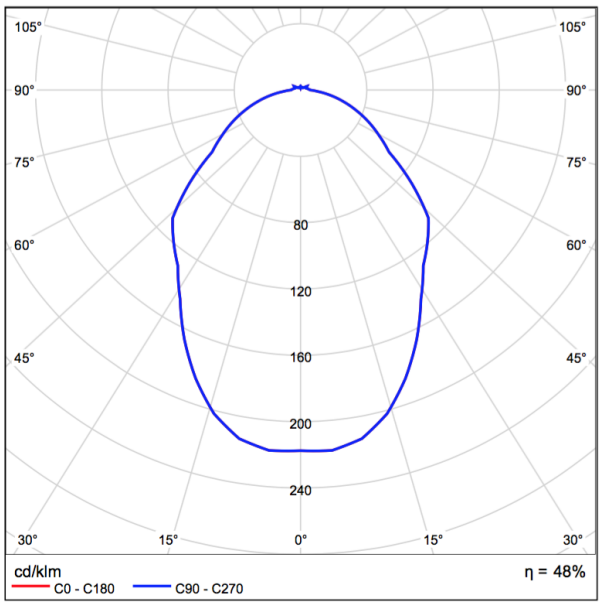


Figure 12 - PH 5 polar diagram (Louis Poulsen)

Poul Henningsen works with both focal glow and ambient luminescence is his design of the PH 5 pendant. The focal glow is the directed up – and down light, created by the shades modifying the direction of the light and the completely open top and bottom. The PH 5 is as mentioned designed to be glare free and this is accomplished by having multiple shades all modifying the direction of the light and at the same time diffusing the light directed towards the users eyes. Poul Henningsen always tried to smoothen out the shadows and remove any hard shadows, both on surrounding illuminated surfaces and on the lamp itself. His design idea for this was to use opaque glass.

Glass is often associated with Nordic design, maybe because of Poul Henningsens designs. The glass as well as the shape of the shades diffuses the light coming out of the sides, but then the openness in the top and bottom creates direct light up and down. The light from the PH 5 is therefore a combination of ambient and direct light, which was found in the literature review to be one of the best solutions for the dining area, since the light becomes flexible and suited more than one activity. As a small side note: Poul Henningsen used coloured reflectors in his design, also in the PH 5, to create a warmer light fitting the Nordic culture of warm light (Henningsen, 1974).

The discussion point for the PH 5 is its current relevance. The aesthetics of the design can be considered as contemporary, but the technology is not up to date. The design still suggests a replaceable incandescent light bulb and the suggested wattage is 60 W or more to get a high enough lumen output. Poul Henningsens design principals are interesting, but could they be further improved by considering new technology as integrated LED, O-LED and functions as warm dimming etc.?

MITO BY OCCHIO

The Mito by the German brand Occhio is a front-runner in terms of technology. It was first launched in 2017 and has only become more known since. The technology in the Mito is referred to as ‘Touch-less’. With simple hand gestures you are able to change the intensity, colour temperature and the relationship between the up and down light. Furthermore, the pendant comes in a height adjustable version (Occhio). The light in the Mito consists of two LED strips, one upwards and one downwards. The LED’s are CRI 95 and the colour temperature ranges from 2700K to 4000K (Occhio).

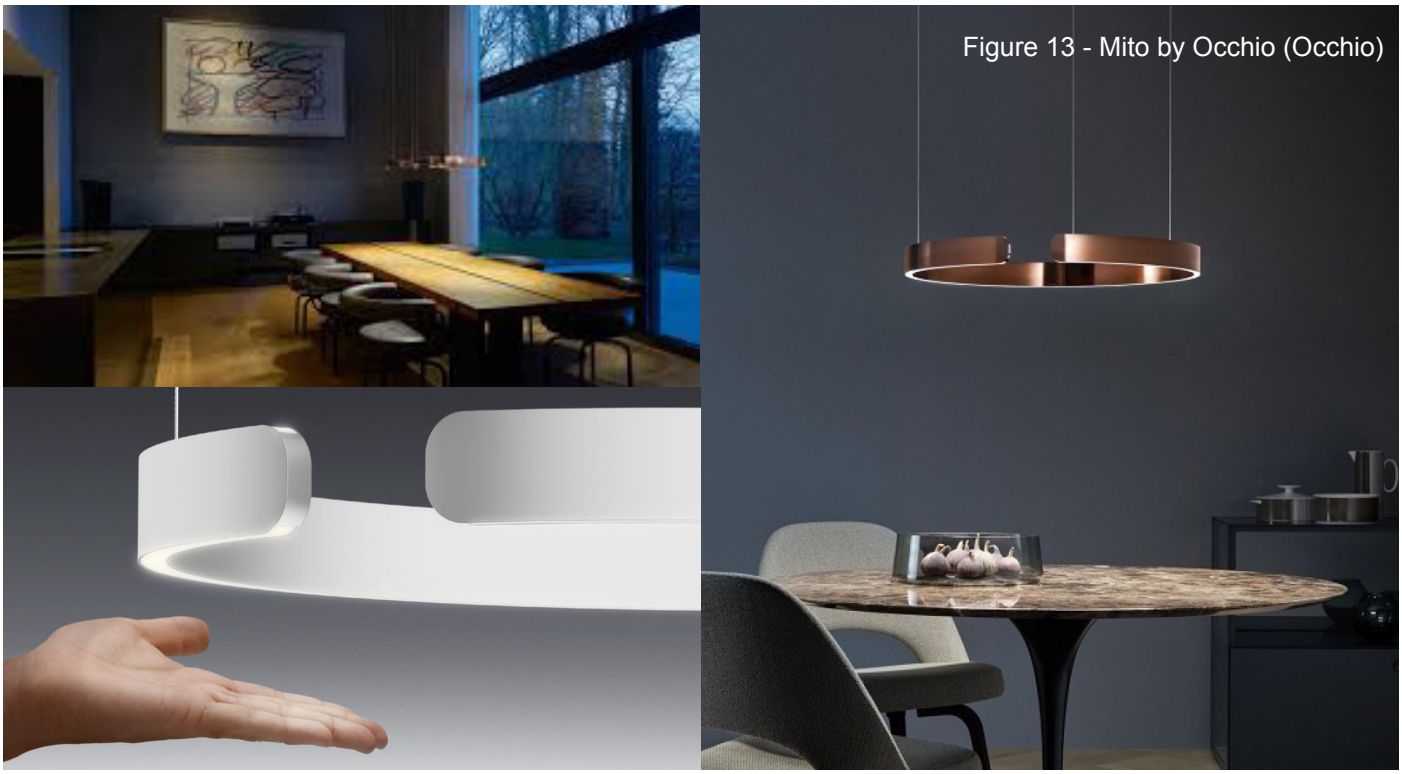


Figure 13 - Mito by Occhio (Occhio)

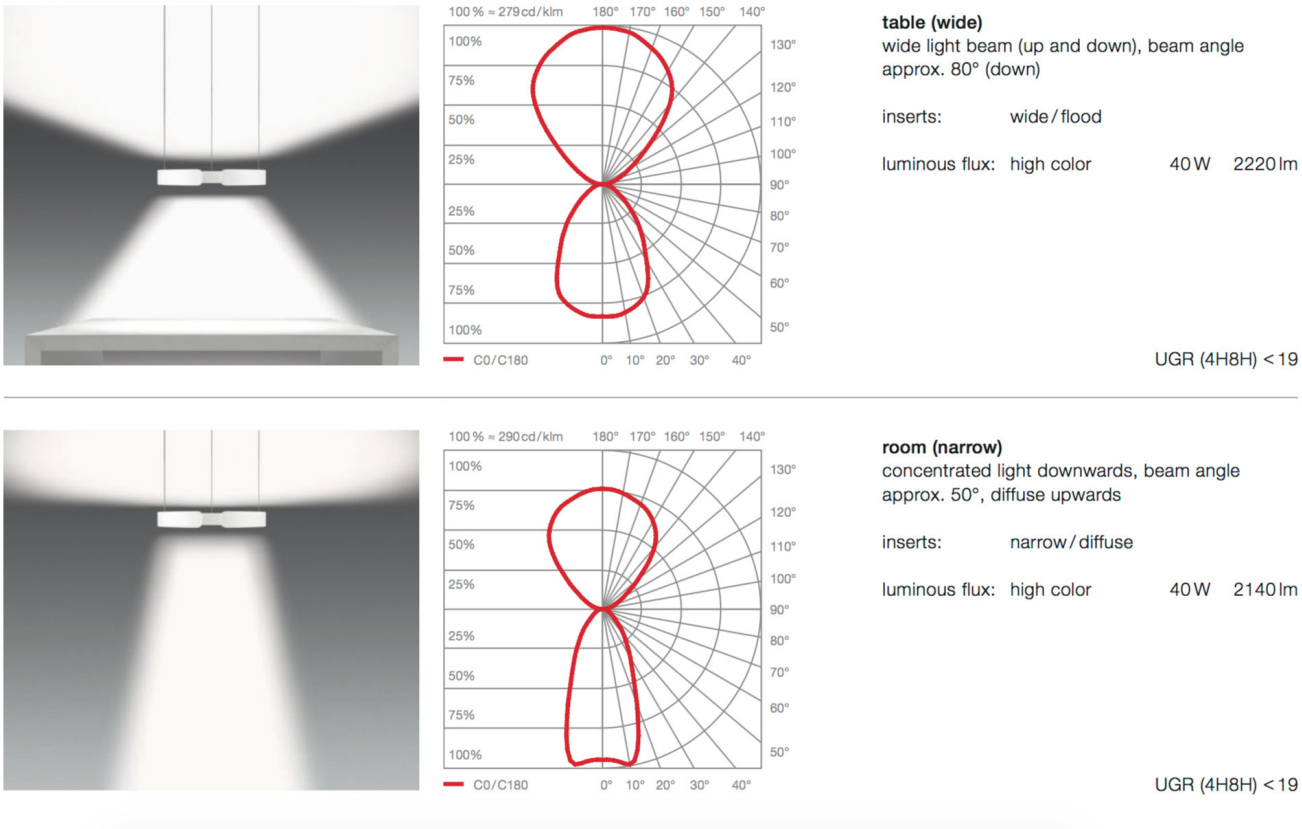


Figure 14 - Mito polar diagram (Occhio)

The light coming from the Mito is difficult to place as either focal glow or ambient luminescence, since the light is created by several small LED's, but diffused with optical silicone (Occhio). The light can also both be ambient light and direct light depending on the intensity combined with the beam angle. In my evaluation the Mito light is flexible light, working on several levels at once. As mentioned the LED's are diffused with the use of optical silicone, which smoothens out the individual hot spots in the luminaire. The light becomes almost even, but with a close look into the light source from the LED strip, you will still be able to see the hot spots. The chance of glare is therefore minimized, but still depending on the hanging height and the intensity. There is no shadow play or difference in light and dark on the Mito lamp itself, which can make the lamp seem cold aesthetically.The Mito comes in a numerous of colours. The materials differ with the colours, but in general the lamp is constructed of silicone and aluminium. Both the materials and the colour choices are in line with the newest trends of Nordic design. Also the fact that the light sources are LED's is consistent with the newest Nordic design trends. The LED's combined give a high lumen output of maximum 2220lm or 3330lm depending on the pendant size (Occhio). This is more than enough light to function as task light also, and not just ambient room light. Because of the flexibility of the light in the Mito it can function in many different scenarios. The discussion point of the Mito is the aesthetic value, since the light does not create any shadow play or play of brilliants, and this could become boring and non-stimulating.

COPPER SHADE BY TOM DIXON

The Copper Shade pendant was designed by Tom Dixon and launched in 2005 also by Tom Dixon. Copper Shade is one of Tom Dixons most iconic pendants. The pendant is coated with copper by a technique called vacuum metallisation. It is only the surface coating, which is copper, beneath is a polycarbonate sphere (Griffiths, 2014). It is though both the inner surface and outer surface, which is coated with copper, to create an effect of kaleidoscope reflections (Griffiths, 2014).

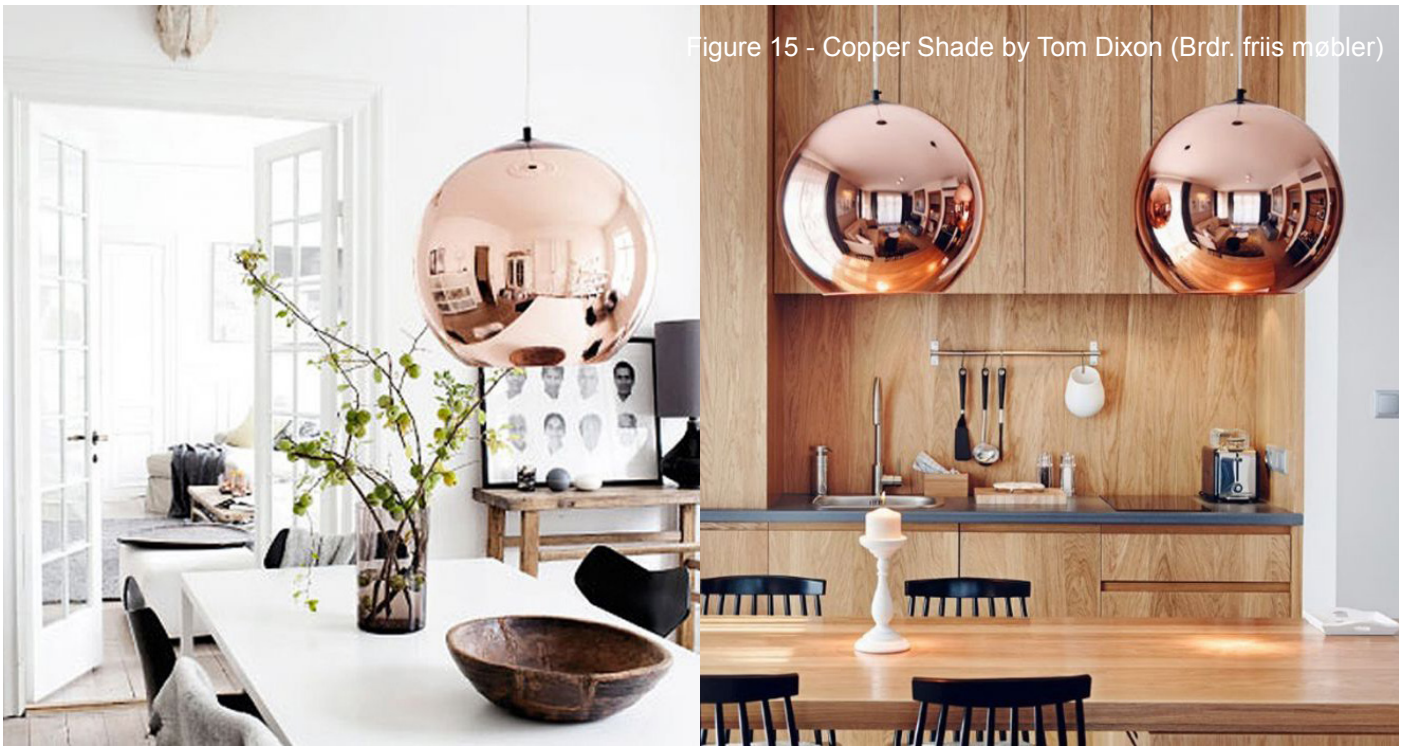


Figure 15 - Copper Shade by Tom Dixon (Brdr. friis møbler)

The Tom Dixon Copper Shade pendant is as much an art piece as a functional pendant. The light principal that the Copper Shade unfolds is the principal of focal glow. The Copper Shade pendant is a solid shade with a complete opening in the bottom. The light is direct down light, which easily can create a hot spot on the beneath horizontal surface, which is illuminated. This depends on the distance to the surface. If the pendant is hanging in the suggested height of approximately 65 cm above the dining table, then the shape of the shade will block the light to the sides and glare will not occur. But since the Copper Shade's surface is glossy, then other surrounding light sources will be reflected and therefore glare can still occur e.g. when the pendant is lit by sunlight from a nearby window. The inside surface of the shade acts like a mirror, where the light is reflected several times and this can create play of brilliants within the shade. An E27 60W light bulb is suggested for the Copper Shade (Tom Dixon). The Copper Shade does not come with a light bulb, but is designed with an E27 fitting for replaceable bulbs. Therefore, the lumen output can differ. Tom Dixon does not display the Copper Shades photometrics on their webpage or anywhere else. Instead they promote the story of the materials and the coating technique. Tom Dixon e.g. writes in the product description: "*Copper shade is an over-sized, blow moulded and perfectly*

reflective globe that kick started the recent craze for copper in interiors the world over" (Tom Dixon). The Copper Shade pendant was in 2005 a front-runner in Nordic design, mainly because of the material choice. In terms of functionality, the copper coating on the inside surface makes the pendant less suitable for detailed work activities, since the light gets a warmer glow and some light is not reflected on the surface, but 'killed' inside the shade. The warmth of the light is though highly requested in the Nordic homes, especially to create a cosy atmosphere e.g. at a dinner party.

FLOWERPOT VP1/2 BY &TRADITION

The Flowerpot pendant was originally designed in 1968 for the restaurant industry and has been a bestseller ever since (Lampemesteren, 2017). The Flowerpot pendant is a classic designed by Verner Panton (Lampemesteren). The pendant comes in two different sizes. The common is to use a few pendants if it is the small version or else one large above the dining table. The Flowerpot is designed with an outer shade and an inner shade, or in other words a 'saucer'. The inner shade shields of some of the direct down light, and reduces the chance of glare. The inner shade also hides away the light source, so it is not visible, when you are sitting at the dining table.

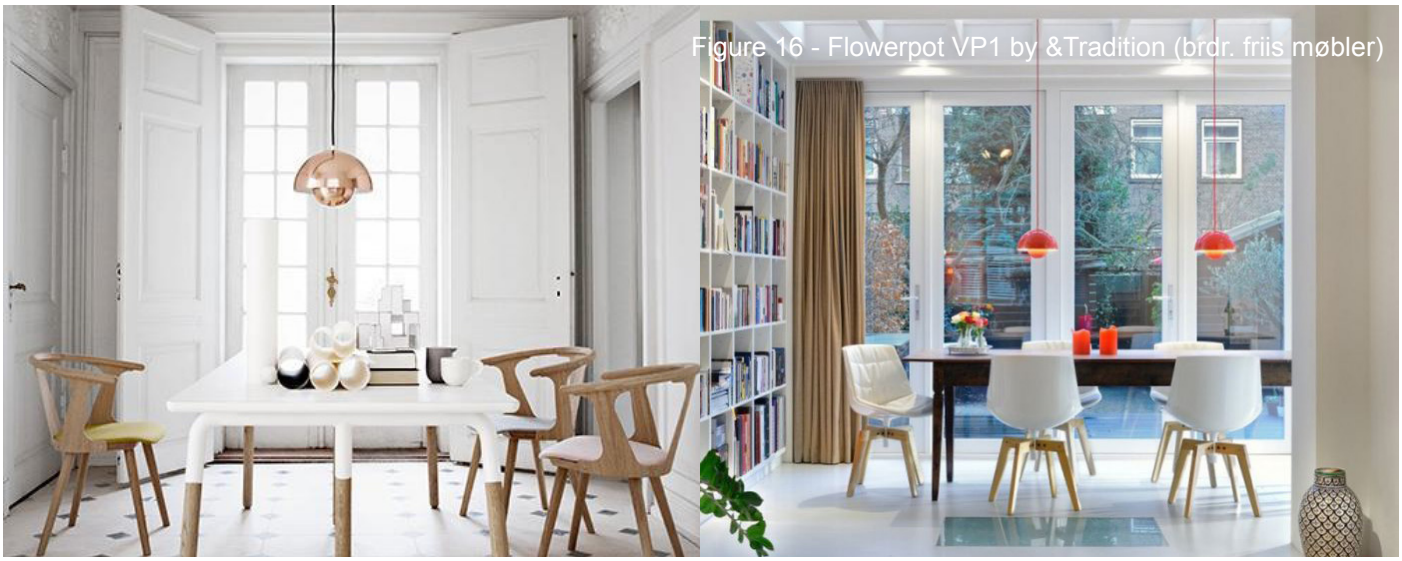


Figure 16 - Flowerpot VP1 by &Tradition (brdr. friis møbler)

Figure 17 - Flowerpot colour variants (&Tradition)

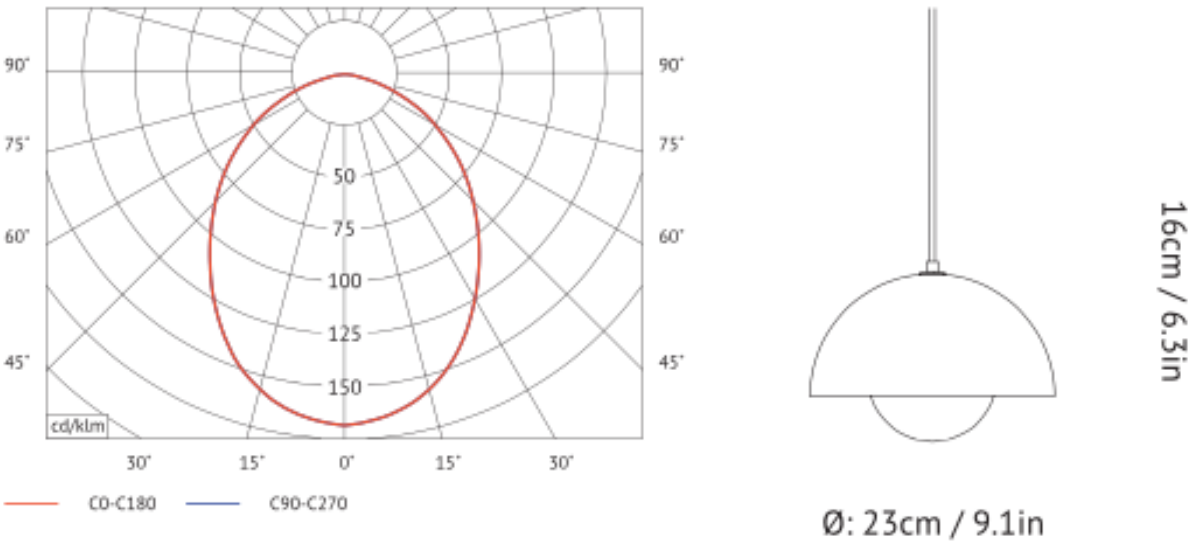


Figure 18 - Flowerpot VP1 polar diagram (&Tradition)

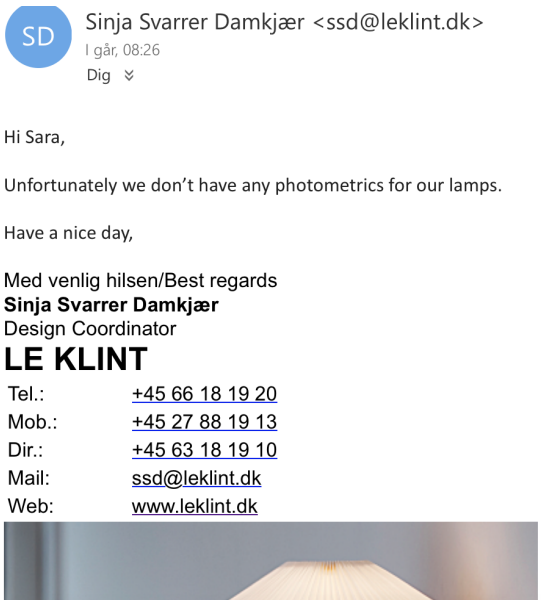
The Flowerpot pendant creates ambient luminescence, because of the inner shade, which creates indirect light instead of direct light on the below horizontal surface. The design with the shielding inner shade takes away all chance of discomfort glare from the light source, since the light source is not visible. The outer shades have changed style and colour throughout the years and some of the styles have a glossy surface. Similar to the Copper Shade by Tom Dixon, a glossy surface can create glare when lit up by other light sources. The Flowerpot also comes in a matt version, which has less chance of creating glare. The multiple different colour choices makes the Flowerpot stay timeless and can easily be fitted the new Nordic design trends.

The ambient light from the Flowerpot is a play between light and dark. Shadows are created on the inside of the outer shade and on the bottom of the inner shade, which gives the lamp a more organic feel to it. The light that hits the surrounding surfaces is ambient and there is no hard shadows created. In contrast to the Copper Shade, the Flowerpot is designed with a white inside of both the outer and the inner shade to reflect the light better. The inside is always white, no matter the colour of the shades. The light from the flowerpot is directed ambient light, as seen on the photometrics (see figure 18). Since most of the direct light is shielded off and the suggested light source is a 40W replaceable light bulb, the Flowerpot is not suited for detailed work (&Tradition).

SWIRL 1/3 BY LE KLINT

The Swirl collection is designed by the Danish designer Øivind Slaatto. The Swirl collection is designed based on mathematical principals. The mathematical principals helps to spread out the light evenly, but in every direction. The Swirl 1 and 3 are two similar pendants differing in the shape, where 1 is oval and 3 is a sphere. The whole Swirl collection is built on the same principals of light (Le Klint).

Figure 19 - Swirl 1/3 by Le Klint (Le Klint)



SD

Sinja Svarrer Damkjær <ssd@leklint.dk>
I går, 08:26
Dig

Hi Sara,

Unfortunately we don't have any photometrics for our lamps.

Have a nice day,

Med venlig hilsen/Best regards
Sinja Svarrer Damkjær
Design Coordinator
LE KLINT

Tel.:	+45 66 18 19 20
Mob.:	+45 27 88 19 13
Dir.:	+45 63 18 19 10
Mail:	ssd@leklint.dk
Web:	www.leklint.dk

Figure 20 - Mail from Le Klint (Le Klint)

The Swirl collection mostly works with one of Richard Kelly's principals of light: Ambient luminescence. The light source in the Swirl is shielded by plastic/acrylic lamellas (Le Klint). The plastic/acrylic material makes the lamellas semi-transparent and thereby lets out light through the lamellas themselves and the gaps in-between. Øivind Slaatto has a principal of always creating luminaires, which are glare free, but not by using a diffuser, but designing with mathematical principals found in nature (interview with Øivind Slaatto in (Løvengreen, 2018)). The Swirl collection is an example of this and is glare free. The interplay between light and dark is a big part of the design in the Swirl collection. The sweeping lamellas create shadows on each other and at the same time direct the light downwards. In addition to the before mentioned examples, Le Klint does not give any photometric information on the Swirl collection (Le Klint) (see figure 20). The suggested replaceable light bulb is an 800 lm light bulb with an E27 fitting (Le Klint). The light form the Swirl pendant is similar to the light from the Flowerpot; ambient directed light. Again the lack of direct down light makes it difficult to carry out detailed work on the table. The light from the Swirl collection does not suit a flexible dining area.

PS 2014 BY IKEA

The PS 2014 pendant by IKEA is inspired by science fiction and has previously won an international design competition (IKEA). The interesting design feature in the PS 2014 is its flexibility. Pulling in a cord can modify the lamp shape and the light intensity varies in accordance with the shape of the lamp (IKEA). The PS 2014 was launched in 2014 and has been one of IKEA's bestselling pendants since (IKEA).

Figure 21 - PS 2014 by IKEA (IKEA)

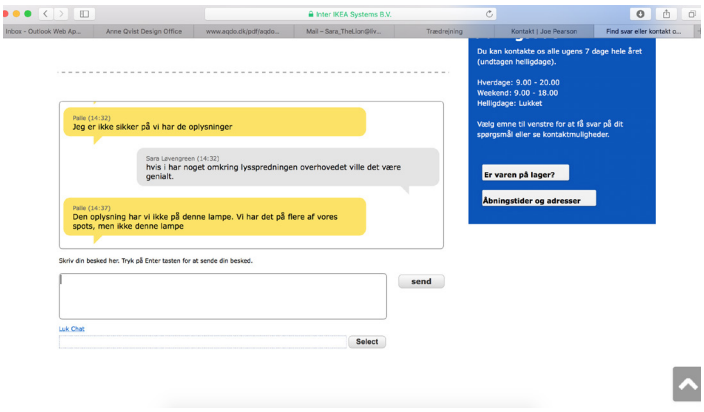


Figure 22 - Mail from IKEA (IKEA)

Because of the flexibility in the pendant it is difficult to state a specific principal of light, which is represented by the PS 2014. You could argue that the principal of light in the PS 2014 is play of brilliants, because of the many gaps that lets light out and because of the uneven illuminance of the surrounding surfaces. But there is only one light source, which could indicate that it is ambient luminescence. The light from the PS 2014 is ambient light when closed and a combination of direct light from the larger top and bottom gaps, and ambient light from the smaller gaps and reflections within the pendant itself. The interplay between light and dark is very visible in the design of the

PS 2014, both when it is closed and when it is open. And it is not only within the lamp, where there is a shadow play, also the surrounding surfaces have shadow play, because the light that gets out of the gaps is direct light and not diffused. When the pendant is opened up, there is a chance of discomfort glare, because you can see the light source through the gaps. What can be discussed in relation to the design of the PS 2014 is its design style, whether it is sustainable and fits within the Nordic design traditions. The PS 2014 is constructed of ABS Plastic, which is not sustainable and not a commonly used material in Scandinavian design (IKEA). Furthermore, the technology is a standard fitting suited for E27 replaceable light bulbs, though maximum 13W, which suggests only using retrofit LED light bulbs (IKEA). In opposition to all the other evaluated cases, the PS 2014 offers flexibility. When the pendant is open, you get direct light on the below horizontal surface, which is suited for detailed work. And when the pendant is closed, there is less chance of glare and a lower light intensity, which is suited for dining.

A COMPARISON OF THE PENDANTS

To get an overview of the different evaluated cases I have created a diagram illustrating the correlation between the cases. The diagram is arranged with the x-axes expressing the six criteria, which the pendants have been evaluated and discussed in relation to and the y-axes arranging the pendants in relation to each other, from worst to best (see figure 23 & figure 24).

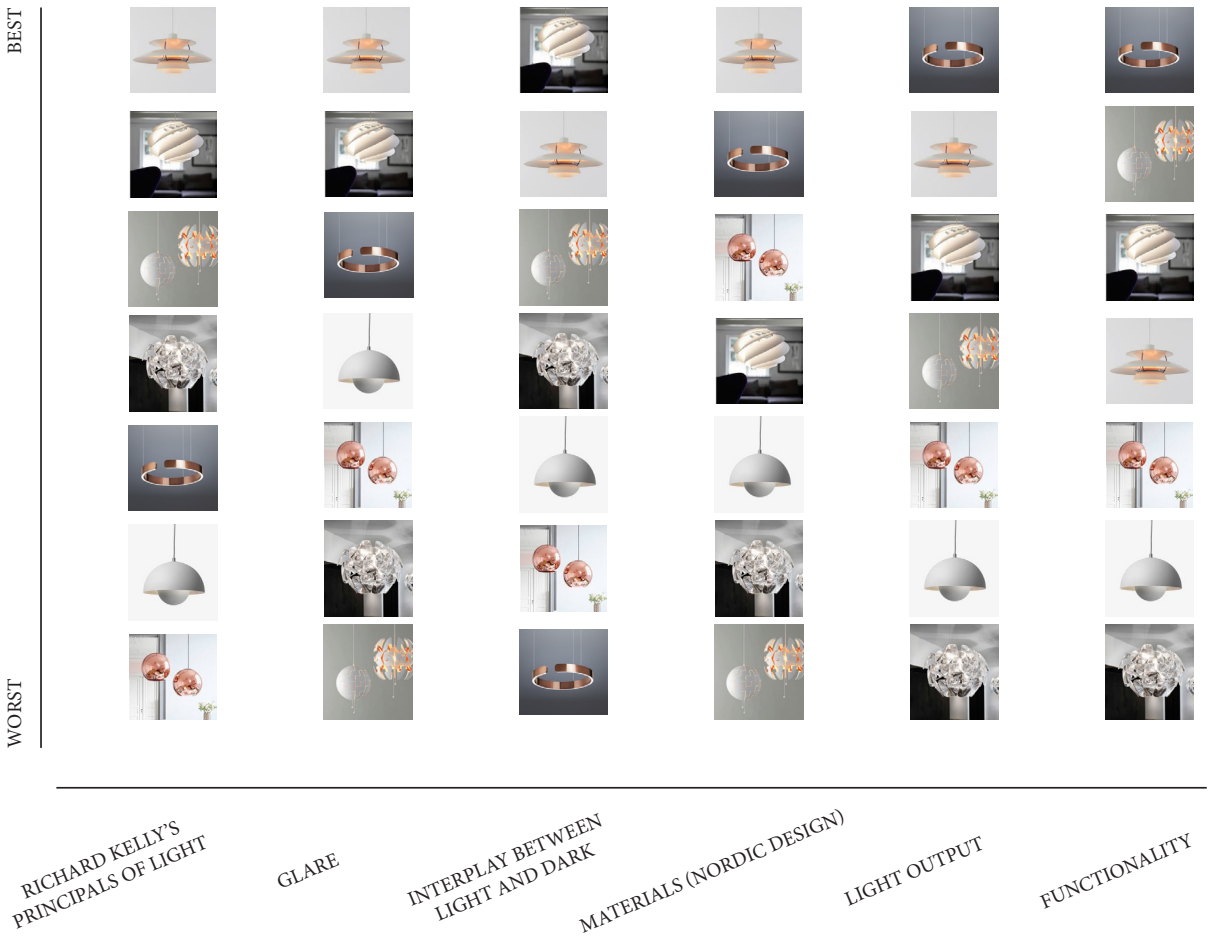


Figure 23 - Image diagram - Correlation between the cases

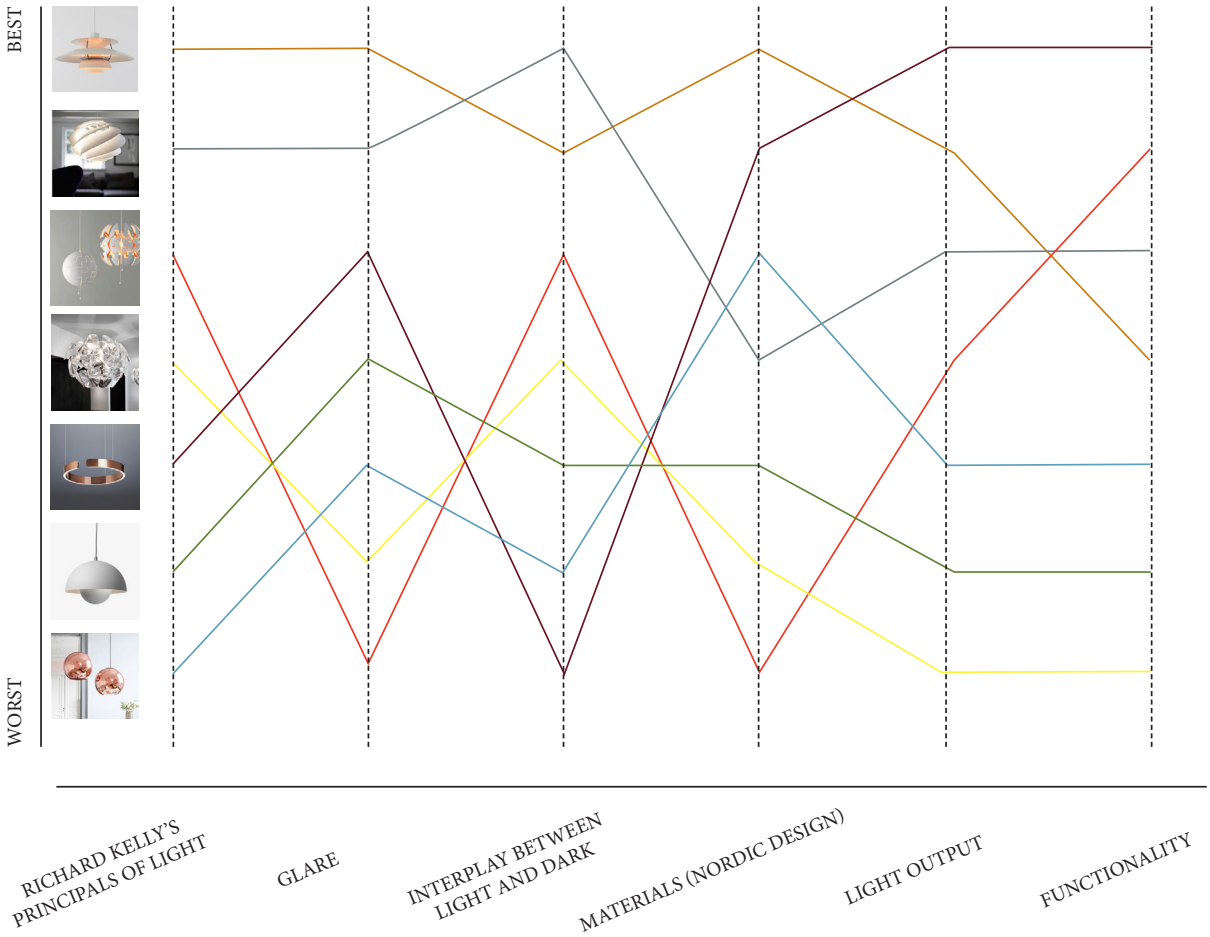


Figure 24 - Line diagram - Correlation between the cases

SUB CONCLUSION

In short the conclusions, which will be brought forward in the analysis and design process is the following:

- Polycarbonate can scatter light and create an effect of play of brilliants.
- Polycarbonate has been a highly trendy material for furniture, but it is not very sustainable or fitting with the Nordic design culture.
- Poul Henningsen worked with the 'three-shade-system' creating both, ambient light, up light and down light.
- An open top and bottom is and easy way to create directed up and down light by using the shade to modify the light.
- Opaque glass can diffuse the light.
- The technology of the PH 5 is out-dated, because it is not energy efficient, if you use the

recommended light source.

- New LED technology can give the flexibility of changing both colour temperature and intensity to suit the current activity.
- Optical silicone can be used to diffuse the light from LED chips.
- Occhio suggests a maximum lumen output of 2220 lm or 3330 lm depending on the pendant size.
- A high gloss surface can create a kaleidoscope effect.
- Most designs strive to shield off the direct view of the light source to avoid discomfort glare.
- A light coloured inner surface of the shade can help to reflect the light and create diffused ambient light.
- You can alter the shape of the pendant, but still keep the same principle of light e.g. when you design a family of luminaires.
- The nature has a lot of natural principals of light, which can be good inspiration.
- The use of semi-transparent material can create nice effects of both ambient luminescence and shadow play.

From comparing the different pendants it can also be concluded that classics as the PH 5 and the Swirl 1/3 are ranging high on almost every criteria. The classics do work in relation to most of the criteria and even very well. The place of improvements is in terms of functionality and flexibility. The old classics do not incorporate the new possibilities that we have with the LED's e.g. being able to change the intensity or the colour temperature. This is something I can try to add to my luminaire design.

ANALYSIS

The analysis phrase is divided into two analysis sections, one where the findings from the questionnaire's and the photo-voice is analysed and one where the findings from the expert interviews are analysed. As mentioned the analysis follows the method 'thematizing'.

QUESTIONNAIRES

The questionnaires were handed out personally in several places in Copenhagen and near by cities: Vanløse Kronen, Lyngby Storcenter, Frederiksberg Hallerne, Illums Bolighus and Magasin du Nord. These places were chosen, because of their large diversity in shops and people going there, to get a broad range of different respondents. Since the questionnaire concerned the choice of light in the dining area, the respondents had to be at least 18 years old and have had an influence on the choice of interior in their homes.

In total 24 respondents filled out the questionnaires. Their age ranged from 20 years old to 80 years old, with an average age of 49 years old. 10 of the respondents were males and 14 respondents were females. Since the questionnaires also concerned activities carried out at the dining area, it was important to get answers from respondents with different family constellations. This was why the questionnaires were handed out at three different days (Wednesday, Friday and Saturday) and in different time periods during the day (at 11 am - 1 pm, 12 pm – 2 pm and 5 pm – 7 pm).

The different family constellations were everything from a single adult living alone, to families with two adults, families with adults and children, and families with more than two adults.

The respondents were firstly asked to describe the main activities, which they do at the dining area. They were allowed to answer more than one activity, but only had to mention the main activities. The activities, which were mentioned were as seen on the below diagram (see figure 25).

Almost every respondent mentions the obvious activity, which is eating or having dinner. The few respondents not mentioning this activity either mentioned that they only use the dining area for more formal dinners. The more interesting part is to look at the other activities, which were heavily mentioned such as working on the computer, playing games and just having a nice relaxed time, which correlates with having friends and family over. This all requires different atmospheres and also lighting. Looking at the results from a lighting design perspective, I would argue that there is a need for three different lighting scenarios and atmospheres. Firstly, the main lighting scenario supporting having dinner, being able to see your food and drinks. Secondly, a lighting scenario supporting using the dining area as a workstation, were the computer often is in use. Lastly, a

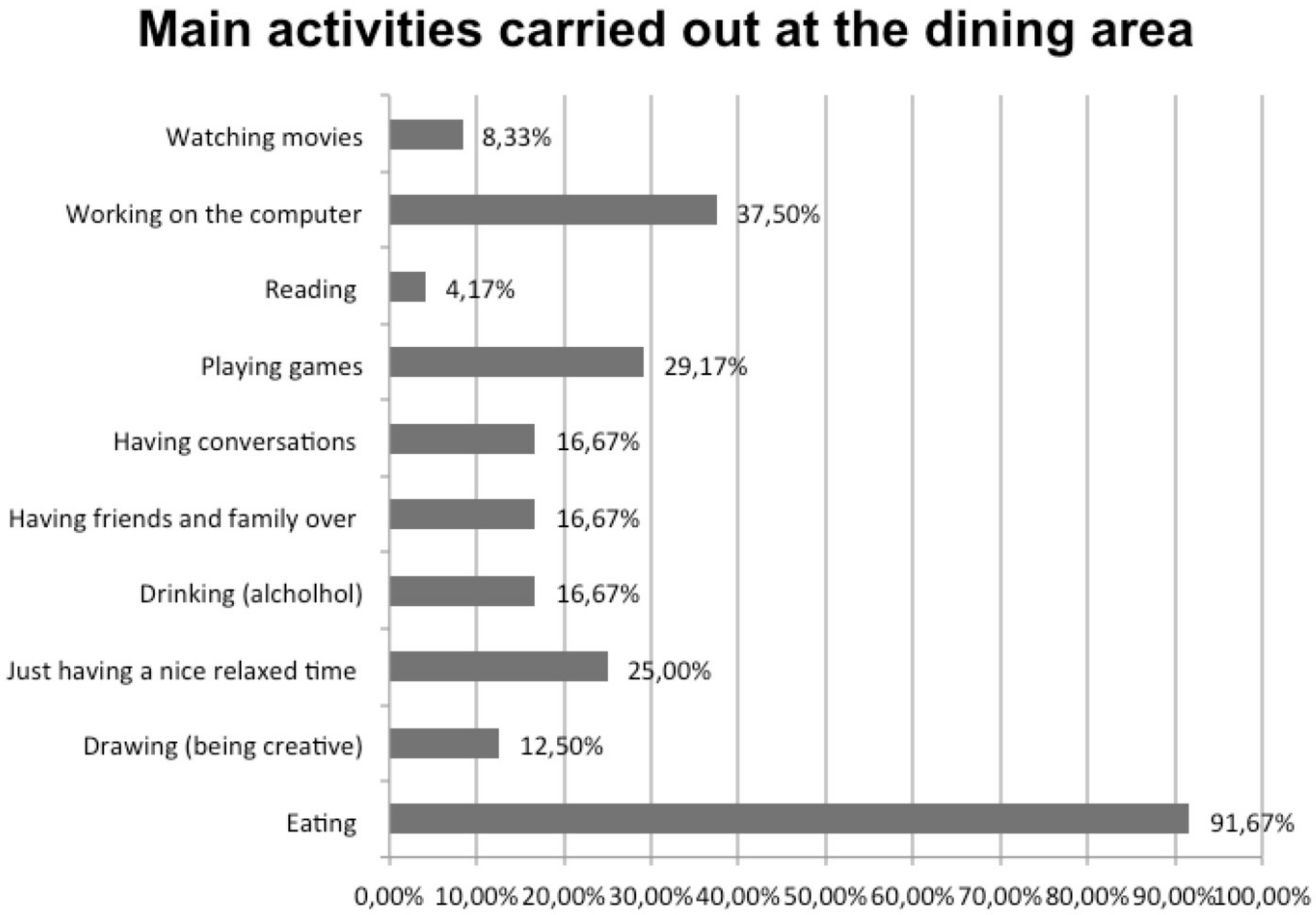


Figure 25 - Questionnaire statistics

lighting scenario creating a nice, cosy and chilled atmosphere, where you can have friends over, have intimate conversations and relax. Below I have named the three scenarios:

1. Dinnertime
2. Workstation
3. Cosiness

By withdrawing the knowledge gained from the literature review, the theory phrase and the case studies, the best-suited lighting for the different scenarios can be developed. The details for the three lighting scenarios will be further developed in the design phrase (see the phrase ‘Defining the lighting scenarios’).

Besides giving an indication of the user needs, the questionnaires also indirectly helped to get a better understanding of the current trends for choice of luminaires and lighting for the average Danish dining room. It is interesting to notice in this relation, that 90% of the respondents stated that they had considered their choice of lighting in the dining area and that it was not just random

or only chosen based on aesthetics. The lighting has been considered and reflected upon before a purchase. A selection of the respondents dining area luminaire choices is listed below and illustrations can be seen below as well (see figure 26 - 34).

26. Multi Lite by Gubi
27. GE' Pendel Krystal by Kartell
28. Safari Pendant by Christian Hvidt
29. Enigma 545 by Louis Poulsen
30. Pineapple Pendant by Dyberg-Larsen
31. Flowerpot VP1* by &Tradition
32. Coral by David Trubridge
33. P1 Caravaggio Pendel by Fritz Hansen
34. PH5* by Louis Poulsen

Figure 26

Figure 27

Figure 28

Figure 29

Figure 30

Figure 31

Figure 32

Figure 33

Figure 34

The luminaires might seem very different, but by analysing them all together, there are similarities to be found. Visually a similarity is the white colour. In terms of lighting this might be because the white surface reflects more light and the luminaire might seem to have a higher lumen output by first sight. Aesthetically the white colour fits with the Nordic minimalistic design trend. Another similarity is that most of the respondents' pendants both provide direct down light and light to the surroundings. This underlines the findings from the literature review, where it was concluded that the most suiting lighting for the dining area is a combination of direct down light and ambient light for the surroundings. This also indicates that there is a need for flexible light in the dining area. The Multi Lite by Gubi very specifically provides this flexibility and might be why more respondents have chosen this luminaire for their dining area. Lastly, it is also seen in the respondents choices that aesthetic value is sometimes more important than the functionality. Both the Coral by David Trubridge, the GE' Pendel Krystal by Kartell and the Multi Lite by Gubi have issues with discomfort glare, because of the direct sight of the light source.

In addition to the respondents' statements of choices of luminaries in their dining area, some of the respondents also sent a picture of their dining area. Analysing the pictures one main conclusion is found. The pictures illustrate, how the dining table pendants tend to become centrepieces of the dinning area (see figure 36). The pendants take a lot of visual space in the room, which is underlined by the respondents' statements. One respondent stated the following: "*We do not have a pendant above the dining table, but a Havana lamp in the corner and another small table lamp on the side table. We want a clear vision and we want to be able to see each other over the table.*" (see figure 35). Actually four of the respondents did not have a pendant to illuminate their dining table. When asked, why this was the case they all mentioned, how a pendant above the dining table can conflict with the conversations around the table, because it blocks the eye contact. Another respondent stated: "*The size of the pendant has to fit the table and the dining area.*" Again this underlines, how the luminaires in the dining area, both visually and functionally is of high importance. I think it is especially interesting, how the respondents mention that they do not want the luminaire, but the light to fill up the space. This finding will be important in the design process, where the size and shape of the luminaire has to be considered.

Figure 35 - No pendant in the dining area

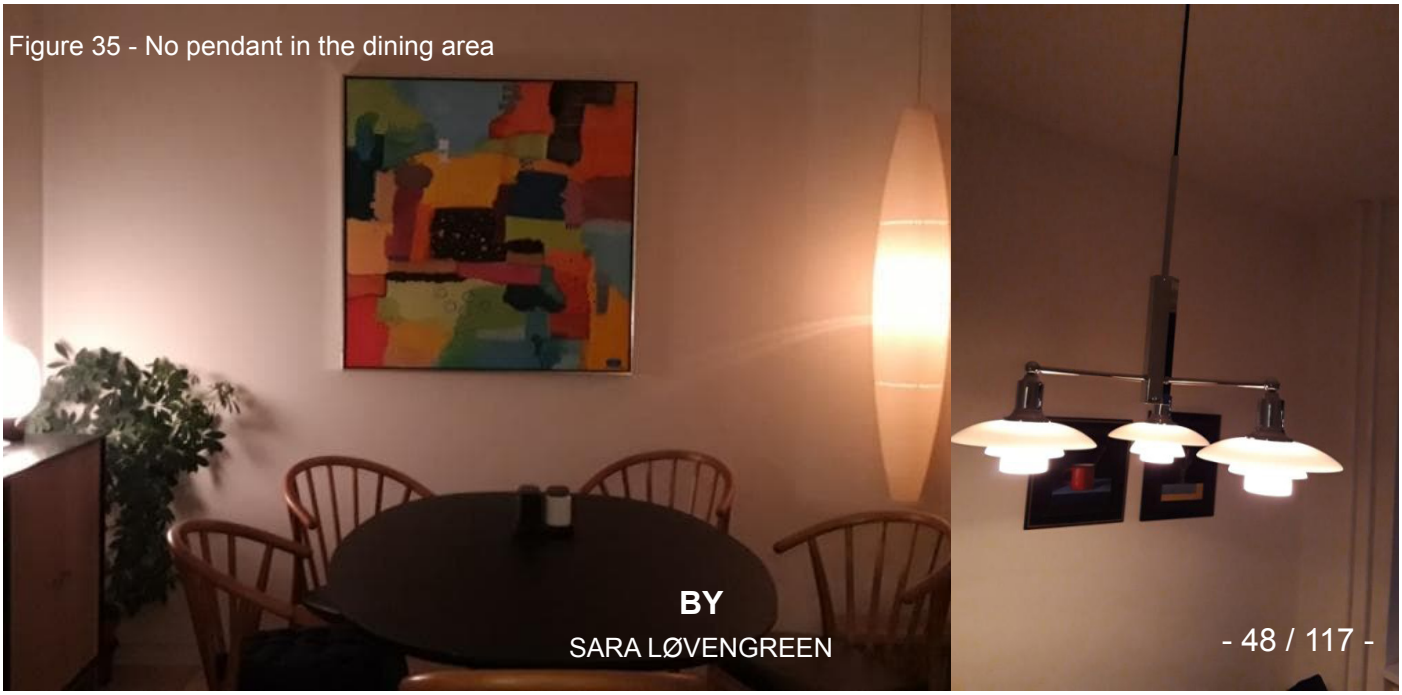


Figure 36 - Pendants centred over dining tables

Furthermore, the respondents explained their thoughts on lighting in the dining area. They explained their needs in terms of lighting. Not all respondents were very specific about those needs, but this will then be the lighting designers job to translate their vague needs into specific lighting design. The needs are though summed up in the figure on the next page (see figure 37), illustrating how many respondents mentioned the different needs.

What can be concluded from the diagram (see figure 37) is that most respondents wants what they describe as ‘good lighting’, where they are able to perform the activities they intend to at their dining table. But most of the respondents do not specify what good lighting is. A single respondent mentions ‘2700 K’ as colour temperature and more than 400 lm output on the table.

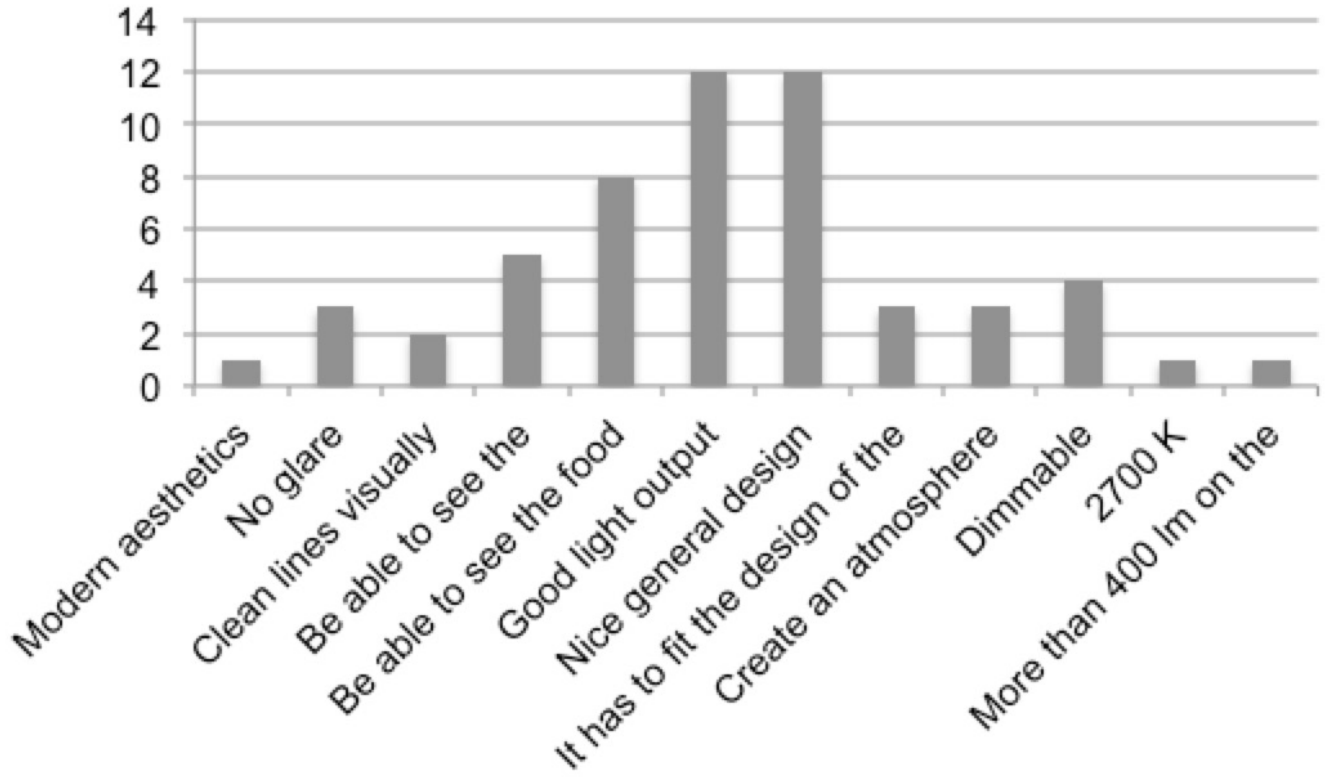


Figure 37 - Respondents' needs

Furthermore, this diagram again underlines the need for flexibility, by e.g. mentioning dimming and the wide range of different needs. The many different needs are also illustrated in the supporting statements from the respondents. The statements contradict each other and differ a lot. A respondent stated the following: "*It has to be cosy light when we are having dinner*". Another respondent in contradiction stated: "*It is important that it is not just cosy, nice light, but that you can also get enough light to work*". And a third respondent emphasised a different need: "*Light up the whole table and a bit around as well*". Summed, what can be concluded is that the users want flexibility for the lighting in the dining area, but flexibility is not the same as full autonomy. The general citizen does not have enough knowledge about lighting to know what good lighting is in the different scenarios. This leads back to the idea of creating three lighting scenarios: Dinnertime, workstation and cosiness.

EXPERT INTERVIEWS

Two expert interviews were conducted following an interview guide (see appendix 4) and the semi-structured approach. The purpose of these two interviews was to define the design criteria for this project. The design criteria are not only based on these interviews, but also take the literature review, theory and the rest of the analysis into consideration. But the interviews conclusively define the three design criteria. The interviews are analysed by the method thematizing. The thematzing takes a starting point in the research question and the three disciplines of lighting design: Architecture, functionality/media technology and engineering.

Anne Qvist is a Danish architect, interior designer and product designer. She has practiced design since she graduated from the Royal Danish Academy of Fine Artsin 1992. She has both worked in larger architect firms and as a freelance designer. Her two most successful luminaire designs are respectively the outdoor luminaire ‘Outfit’ (see figure 38) and the desk lamp designed for Lightyears ‘ AQ01’ (see figure 39).

Anne Qvist (Fritz Hansen)

Figure 38 - Outfit by Anne Qvist (Fritz Hansen)

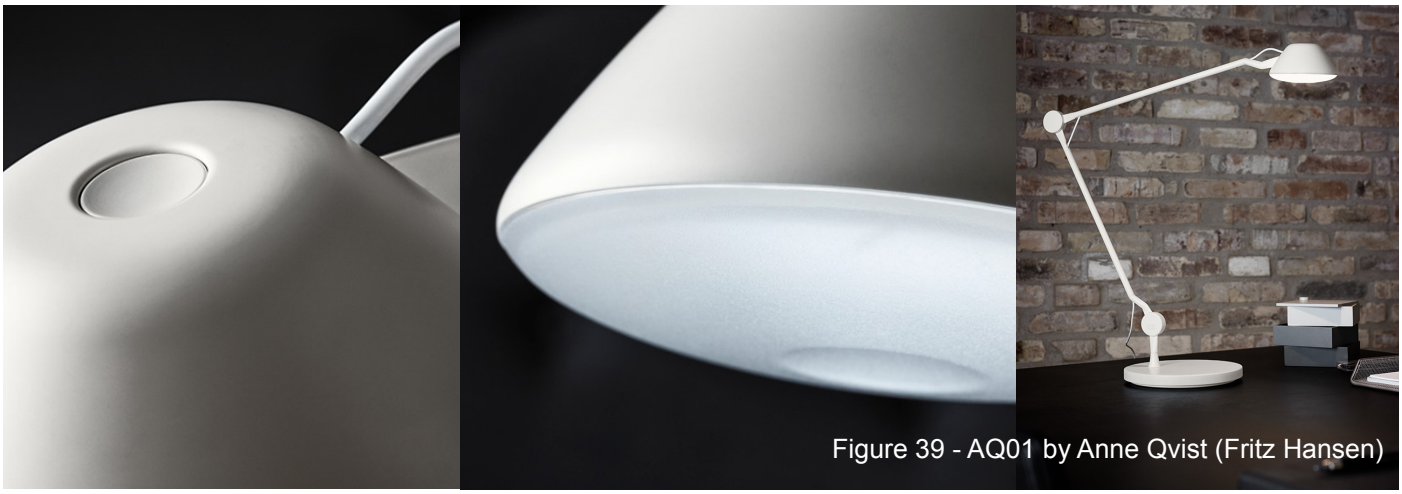


Figure 39 - AQ01 by Anne Qvist (Fritz Hansen)

Marianne Tuxen has an education in architecture from the Royal Danish Academy of Fine Arts, like Anne Qvist. Marianne Tuxen has worked with lighting design and luminaire design for more than 30 years.

During her education she worked together with the well-known Danish architect Johan Otto von Spreckelsen, and after she graduated she has worked with larger companies such as Louis Poulsen, Fagerhult and Christian Bjørn. She

Marianne Tuxen (FALHOF, 2017)

became self-employed with her own drawing office in 1988. Some of her successful designs are the bathroom luminaire ‘Safir’ designed for Louis Poulsen (see figure 40) and the newer special designed pendant for Vanløse church (see figure 41).

Figure 40 - Safir by Marianne Tuxen (FALHOF, 2017)

Figure 41 - Pendant for Vanløse church by Marianne Tuxen (FALHOF, 2017)

To refresh the mind, the research question for this thesis is:

> *What is the best lighting solution for the general citizens' dining area, in Nordic countries?*

ARCHITECTURE

In relation to architecture and aesthetics, especially Anne Qvist had strong opinions on what the upcoming trends will be and what Nordic design essentially is. In general Anne Qvist was not very pleased with the term 'New Nordic' design, since it in her opinion has been used too much. Anne Qvist stated that every design firm around the world could make Nordic design and does it. But she still stated that our Nordic design approach is noticeable and worth maintaining. According to Anne Qvist the Nordic design approach descends from the 50's and 60's, where we designed with the few essential materials we had available. This design approach has shaped our now very minimalistic style of design. Anne Qvist stated the following:

> "*I think it actually came from this modest thing, where we did not have a lot of material or have a lot of production. So we had to use what we had. […] Actually being this sort of, in many ways modest and minimalistic approach to design. Which is to me sort of the true Nordic way.*" – Anne Qvist

Marianne Tuxen also agrees that Nordic design is minimalistic or in her words 'simple'. She compares the Nordic design with Italian lighting design and states, as mentioned, that the biggest difference here is that in Italy they use materials such as glass, and try to incorporate all kinds of quirky details into the glass, make it look like crystals, whereas Nordic design is simple and does not try to 'gimmick' or add on to the materials.

Furthermore, Anne Qvist mentions sustainability as a part of the Nordic design approach and also states that this is the way we need to approach design in the future. "*Sustainability is a big issue. So I do think we will see local materials as very important, so maybe it will be sort of a return to fundamental basics, what can be done with what we have.*" (Anne Qvist, 2019). This statement is consistent with what has been concluded previously in this thesis. As concluded previously Anne Qvist mentions that a way to accommodate the sustainability issue is to use good quality materials and design long lasting solutions.

Marianne Tuxen on the other hand does not mention sustainability and in general she loves all kinds of materials, glass, concrete, cardboard, porcelain etc. She in stead focuses on, how the material works together with the light. Is the material semi-transparent and lets out a bit of diffused light, or does the material scatter the light in all directions? Marianne Tuxen also states that the focus is as much on the shadows and the darkness as on designing with light.

FUNCTIONALITY

Anne Qvist did not reflect as much on the functions of the luminaire in her designs as the aesthetics. Instead she had a few strong opinions on the subject. Her main consideration, when she designs with light is to consider the darkness and shadows as much at the light, just as Marianne Tuxen also mentions. Agreeing with e.g. Poul Henningsen, Richard Kelly and Marianne Tuxen, Anne Qvist states that light only becomes interesting, when it is accompanied with darkness. She explicitly stated that even lighting is ugly and boring.

Marianne Tuxen is very clear about, what she sees as the most important functions for a dinning area luminaire. She states: "*Most importantly the luminaire should provide direct down light on the table. Furthermore, it would be nice with a little bit of indirect light to light up the surroundings.*"[6] (Marianne Tuxen, 2019). When Marianne Tuxen designs luminaires, she starts by sketching very openly from her mind, but then when she gets an idea she likes, then she starts up the iterative process, going back and forth from designing the shape and designing the light. She states that it is a about working with how the light falls onto the shape and vice versa, how the shape influences the light. In relation to the function and the materials, she specifically mentions porcelain. With porcelain you can both get direct and indirect light. Marianne Tuxen uses this as an example of, what she thinks is both beautiful and functional light. She states:

> "*I actually think that the best lamps are the ones, which in some way illuminates themselves. […] It does not have to be more than 10% light that it gives to the surroundings, but in general the most beautiful lamps are the ones that illuminates themselves to create this indirect light as well as the direct light.*"[7] – Marianne Tuxen

Another interesting statement from Anne Qvist, in relation to most important functions of a dining area luminaire was the following: "*Of course it is nice to be able to dim the light, but that is a standard.*" (Anne Qvist, 2019). Anne Qvist here states that dimming the light has become a matter of course, but looking at the respondents answering the questionnaires, only 4 out of 24 mentioned dimming as a very important function for a dining area luminaire. This might indicate that we have become so used to having the dimming function that we forget about it. Or maybe the general citizen does not actively use the function, and therefore forget about it. Personally, I see a tendency to use the dimming function once to find the intensity you like the most and then keeping this intensity for every occasion. Getting used to the first set intensity and being satisfied with that first choice. Overall both the respondents, Anne Qvist and Mariane Tuxen sees dimming as a matter of course and especially important for the dinning area, since this creates more flexibility in the use dinning area.

6. Translated from Danish to English. See the original quote in the appendix (appendix 6).
7. Translated from Danish to English. See the original quote in the appendix (appendix 6).

In relation to the engineering criteria for a dining area luminaire, both Marianne Tuxen and Anne Qvist mostly mention LED's. Anne Qvist stated: "*LED is the thing that needs to be used. I think it is a challenge because it is still quite ugly.*" (Anne Qvist, 2019). Anne Qvist is convinced that LED's are the future, but also mentions that we have to keep developing and improving the quality of the LED's. At the moment Anne Qvist thinks that too many LED's are not good enough quality and states that poor quality LED light makes us look terrible and disrupts the possibility to combine cosy and beautiful light with functional light. She though argues that a combination of functional light and cosy beautiful light would be the perfect solution for the dining area. Furthermore, Anne Qvist mentions her thoughts on, what lighting in the dining area should do: "*It is really important that the pendant creates an intimate space between the table, the people and the pendant.*" (Anne Qvist, 2019).

Marianne Tuxen is more optimistic about the LED technology and frequently uses LED's in many shapes, sizes and types. In this relation she argues that is it very important to think about where the LED's are placed depending on the lamp shape. The LED's are not spherical as the old incandescent light bulbs, which both gives new possibilities, but also creates shadows that you have to consider. Marianne Tuxen also has a rule of thumb in relation to designing with LED's, which is that the colour temperature in Scandinavian countries should always be 2700 K for private homes and in southern countries 3000 K for private homes. Neither Anne Qvist nor Marianne Tuxen sees that the incandescent light sources are fully out-dated, but especially Marianne Tuxen looks forward to the newly developed lighting technology. Looking into the future Marianne Tuxen predicts that the O-LED technology will be very interesting, because then we would maybe be able to just make a surface, which illuminates the room.

Lastly, Anne Qvist comes with a request for the future lighting designers. She states: "*Everything is about measurements, the same with acoustics. As a designer you have to trust your senses and what is going on in the room*." (Anne Qvist, 2019).

Summed the three design criteria, for the design in this thesis, are as following:

Architecture
The luminaire should be sustainable (both sustainable design wise and environmentally)

Functionality
The luminaire should be flexible and suit more than one activity

Engineering
The luminaire should be free of discomfort glare and a low-hanging pendant

These design criteria will be used to make qualified design choices and to evaluate the final design in the discussion. An important notice point is that the design criteria are not general and cannot be converted to other luminaire design projects. The design criteria are specifically set up for this project to limit and define the success of this specific design. Anne Qvist supports this argument in the following statement: ”*…Not the same rules for all. I think that should actually change. When you work with new designs, then it is nice to set up new rules.*” (Anne Qvist, 2019).

DEFINING THE LIGHTING SCENARIOS

In the analysis phrase it was concluded that there are mainly three lighting scenarios, which are needed in the general citizens dining area in the Nordic countries. The three scenarios were named: Dinnertime, workstation and cosiness. The three scenarios will in the following paragraphs be defined definitively.

1. DINNERTIME

The dinnertime lighting scenario should facilitate eating dinner together at the dining table. Here you should first of all be able to see your food clearly. One of the most important lighting attributes is therefore the quality of the light, or in other words the CRI value. A low CRI value will make the food seem either colourless or have tones of one specific colour e.g. yellowish food. We eat with our eyes, and appetizing food is first of all, when it has the right colours. Therefore, I would argue that the CRI value is the most important lighting quality in relation to the dinnertime scenario. The CRI value should be at least 90 and preferable 97.

Furthermore, the dinnertime lighting scenario should support having conversations and as several respondents mentioned, not disturb the visibility or eye contact across the table. This is both in relation to the design of the physical luminaire and the lighting. Therefore, suggested is direct down light, which with the beam angle covers the whole table (considering the common table sizes). Direct down light is also, what Marianne Tuxen mentions as the most important lighting functionality at the dining area. Direct down light can though create discomfort glare, if the light source is visible, and this should therefore not be the case.

Since dinnertime lighting is neither focused task lighting nor comfortable cosy lighting, but a good in between, then the suited colour temperature is also in between. A colour temperature of 3000 K, would seem more fresh and clear than 2700 K, and thereby also make you feel like you can see the food more clearly. 2700 K could also be a suggestion, but to differ from the cosy lighting scenario, the colour temperature can be a bit higher, without destroying the intimate feeling. Marianne Tuxen argues that the colour temperature should not be adjustable and stay at 2700 K, while Anne Qvist is a proponent of adjustable colour temperature. Creating these three lighting scenarios supporting different activities I will argue that differing the colour temperature can improve the lighting scenarios.

Common for all three scenarios is that the most suited intensity of light is very subjective. Most people are used to the dimming function, so why take that ability away from them now? The three lighting scenarios do not have a suggested lumen output or intensity, but similar to Occhio, there is a maximum lumen output of 2220 lm, which is enough to get the suggested 500-600 lx on the table for focused tasks.

Summed the dinnertime lighting scenario is:

- CRI 90 - 97
- Direct down light
- No visual disturbance e.g. no direct sight of the light source
- 3000 K
- Flexible intensity (dimming function) max. 2220 lm

2. WORKSTATION

The workstation lighting scenario should support focused work, both on the computer, on a tablet and on paper. It is not only work that it should support, but in general detail and focused activities this can also be board games, drawing, creative work and handcrafting. To support these kinds of activities it is first of all important to have enough light, so your eyes will not get tired. So the possibility to have at least 300 lx on the table and best-case scenario 800 lx - 1000 lx on the table is therefore a necessity. Furthermore, direct light on the table and not diffused or reflected light, as main lighting, is preferred. The direct light gives a focused lighting. With direct lighting comes sharp shadows, and when using LED, there will possibly be created multiple shadows, because LED's are multiple light sources. The multiple shadows can become annoying, when e.g. drawing, and should be considered when designing the workstation lighting scenario. A way to accommodate the multiple shadows is to add a diffuser to the LED's, which will diffuse the light, but you can still have direct light on the table surface. The diffusing will though decrease the lux level on the table and the lumen output has to compensate for this.

As mentioned in the literature review it is theoretical known that a higher colour temperature (cool lighting) increases our focus and creates a good work environment. Therefore, a colour temperature of at least 4000 K would create the best work environment. Usually it is stated that a colour temperature of 5000 – 6000 K is best for work environments. But having a lighting scenario with 2700 K and one with 3000 K, then there would be a larger jump in colour temperature up to 5000 or 6000 K, and I will argue that this will be too striking to be comfortable. As Poul Henningsen and Øivind Slaattoo state, the transition has to be smooth to create beautiful lighting.

Lastly, like the dinnertime lighting scenario, good quality light is important for correct translation of colours. This relates to the colour rendering index value, which should again be at least 90 and preferably 97.

Summed the dinnertime lighting scenario is:

- CRI 90 - 97
- Direct down light
- Sharp shadows

- Diffused LED’s to accommodate multiple shadows
- 4000 K
- Possibility for at least 300 lx and preferable 800 lx - 1000 lx on the table

3. COSINESS

The cosiness lighting scenario should create a relaxed atmosphere. The cosiness lighting scenario facilitates the chilled dinner parties with friends and family, and in contrast to the two other lighting scenarios this scenario does not have to create good visibility. This is not to suggest that the quality of the light should not be high. At the cosiness lighting scenario you would still want to look good and not have strange colours or shadows on your face when having a conversation. This again suggests a CRI value of at least 90 and preferably 97.

To create this cosy atmosphere a lighting attribute as colour temperature is first to consider. As both Marianne Tuxen and some respondents stated, 2700 K is the most cosy and general for Nordic countries. Furthermore, working with the darkness can help to create an intimate space between the people, the table and the luminaire. As Richard Kelly and Anne Qivst states, beautiful light is created, when both light and darkness is present and all three types of lighting is present (here speaking of, focal glow, play of brilliants and ambient luminescence). Therefore, the cosiness lighting scenario should include all three types of lighting. This suggests both having direct and indirect lighting. The most important is that the lighting is not uniform, but organic or in other words stimulating. Lastly, the ability to dim the lighting should like in the dinnertime scenario be considered, since this can increase the feeling of intimacy.

Summed the dinnertime lighting scenario is:

- CRI 90 - 97
- Diffused up light and ambient light to the surroundings
- Shadow play
- 2700 K
- Flexible intensity (dimming function) max. 2220 lm

INITIAL LIGHTING CONCEPT AND LUMINAIRE DESIGN

The previous phrase defined the three lighting scenarios, which the lighting design should try to incorporate. The previous phrase is mostly seen from a technological and tangible perspective. Therefore, this next phrase will start with a description of, what the overall lighting in the dinning area luminaire, which I will design, should feel like aesthetically: What is the purpose of the light, what is it that it tries to accomplish? How should these three lighting scenarios be bound together and what is the concept for the lighting atmosphere?

The overall idea is to try to combine all three lighting scenarios in one lighting design concept. This lighting design concept has to be stimulating lighting, created by combining ambient luminescence, play of brilliants and focal glow. The luminaire should not be the element in focus. In stead the light should be in focus. The luminaire should blend into the surroundings. You should at first sight not be able to tell where the light comes from. It should seem as if the light just is there and embraces the room. But still the luminaire with the lighting should act as an art piece, creating a space within a space (the dining area). I have started by summing up the keywords for the design.

Keywords for the design:

- Beautiful
- Simple
- Design icon
- Nordic design approach
- Sustainable
- Stimulating
- Floating
- Honest

MOOD BOARDS

From these keywords, and previous analysis two different themed mood boards has been created. The purpose of the first mood board ‘Design aesthetics’ (see figure 42) is to illustrate and find inspiration for the art direction for the design. How is it that I imagine the design aesthetics? The mood board is illustrating the atmosphere that the lighting and luminaire should create metaphorically speaking. As seen on the mood board (see figure 42) the aesthetics and atmosphere of the lighting and luminaire should be inspired by nature and be organic and as previously mentioned stimulating. The forest is chosen as metaphor, because it has all three lighting attributes, which Richard Kelly talks about. The focal glow from the direct sun light, the play of brilliants in the scattered sun light between the trees and the ambient luminescence from the skylight. The three elements blend together in nature and are creating a whole experience, which is what I would want for the design of this project.

Figure 42. Design aesthetics mood board

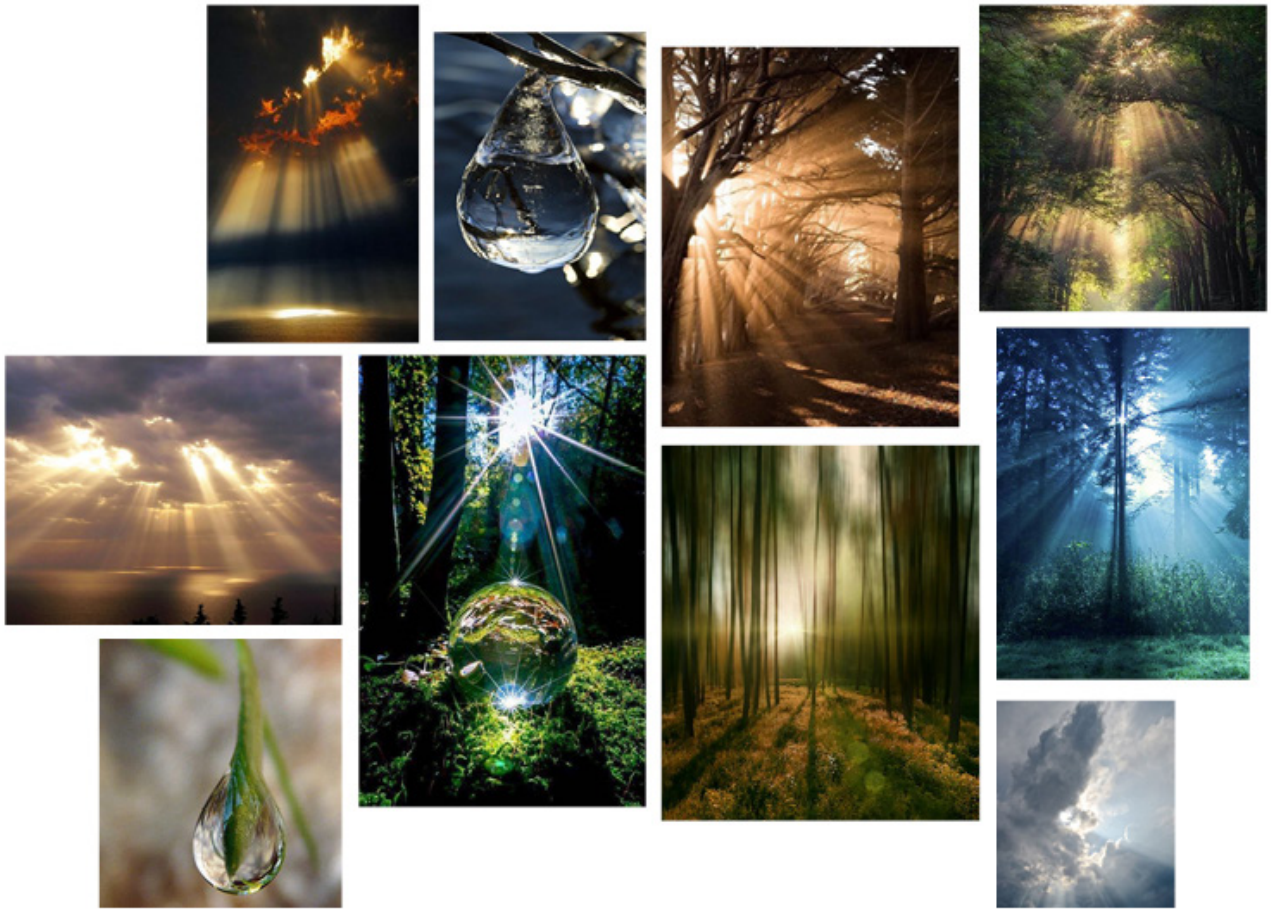
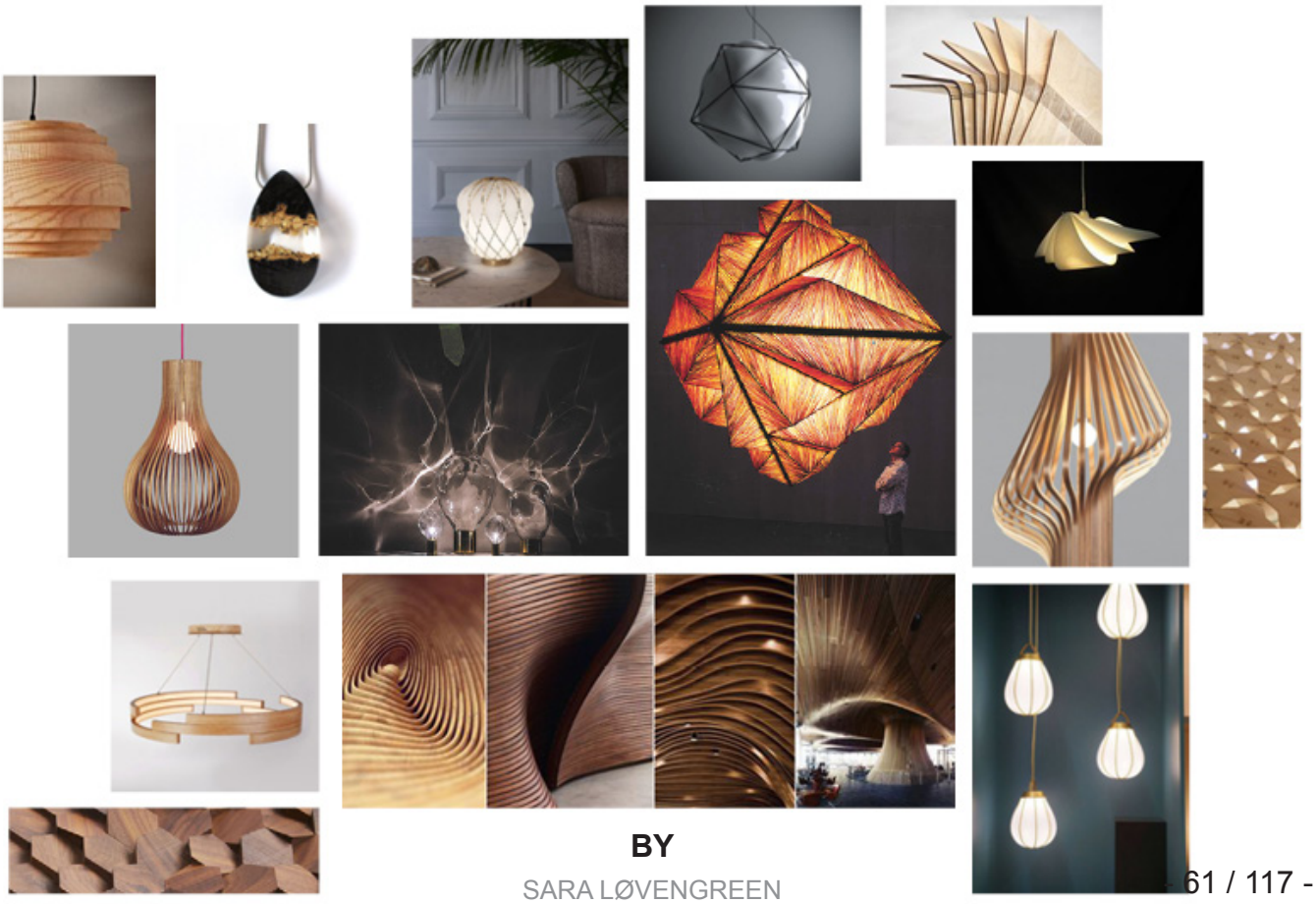
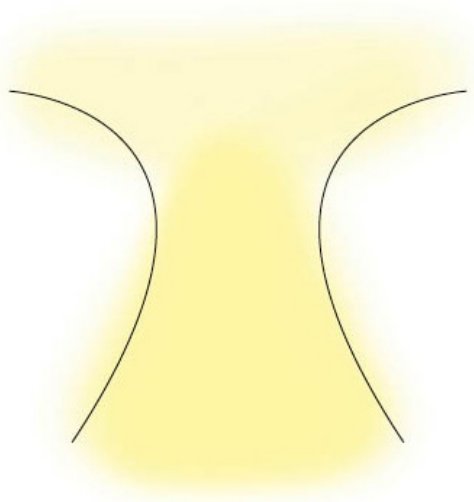


Figure 43. Design materials mood board



The second mood board ‘Design materials’ (see figure 43) intends to illustrate the Scandinavian materials and how they could be used in this design project. The second mood board is more tangible, but still works as inspiration and discussion tool. As seen on the mood board (see figure 43) especially materials such as wood, glass, porcelain and steel are interesting. These materials can be produced in Scandinavian countries and are organic sustainable materials. Furthermore, wood, glass and porcelain are interesting materials in relation to lighting, since they can be semi-transparent, fully transparent or even bend the light creating a kaleidoscope effect etc. What to be aware of with these organic materials is though that they are organic and living, which can create unforeseen challenges.

THE LIGHTING CONCEPT



The mood boards inspired the initial lighting concept. The lighting concept is as seen to the left (see figure 44). The figure illustrates, how most of the light is directed downwards in a relatively narrow beam, though with high intensity. The rest of the light is up light with a broader beam angle and lower intensity. There is almost no light directly sideways, to avoid direct light into the eyes of the people sitting around or close to the luminaire. The figure illustrates the light cone, which the design aims for. This means that the physical form of the luminaire should support and create this light cone. The luminaire should with its design and material choice shape this lighting.

Figure 44. The lighting concept

The drawings on the next page (see figure 45) are the first initial design ideas for the luminaire. The drawings for example involve an idea of a flexible material and luminaire, which can shape shift to accommodate all the three lighting scenarios. It also involves layered glass or layered materials in general to avoid direct sight of the light source and it involves and idea of reflected light creating both up and down light with just one light source. It is known as a difficult challenge to finally choose an idea to work on and develop, from these initial sketches and ideas, but as Marianne Tuxen also mentions in her interview, as a designer you have the responsibility to go with your gut feeling and afterwards try to validate, why this was the right choice or develop it into being the right choice. So the choice of idea that this project will develop further is based on designer’s preference, but also on an issue, which came up several times during the data collection for the questionnaires. The issue was that a few respondents did not own a dining area luminaire since they thought it was in the way or ‘stole’ the view during conversations and in general. Therefore, I chose to go with the idea, which is the least material and has the smallest physical volume.

Figure 45. Initial design ideas

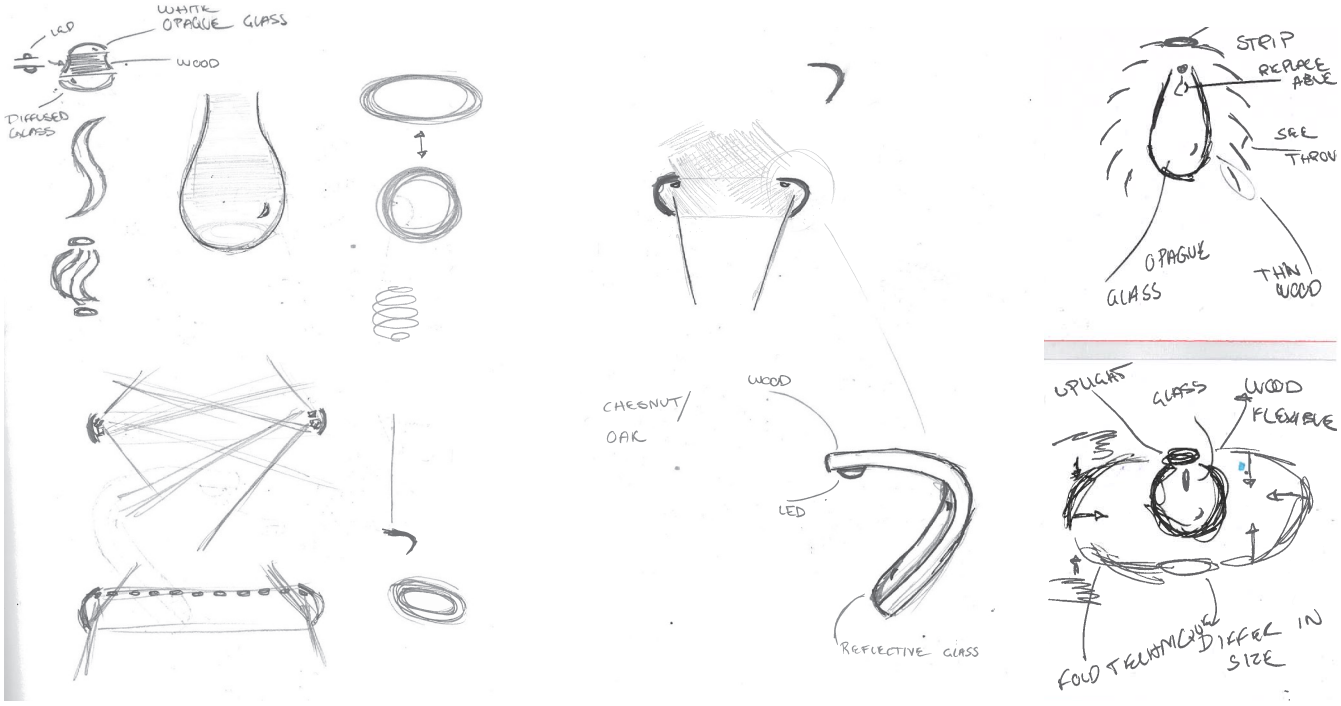
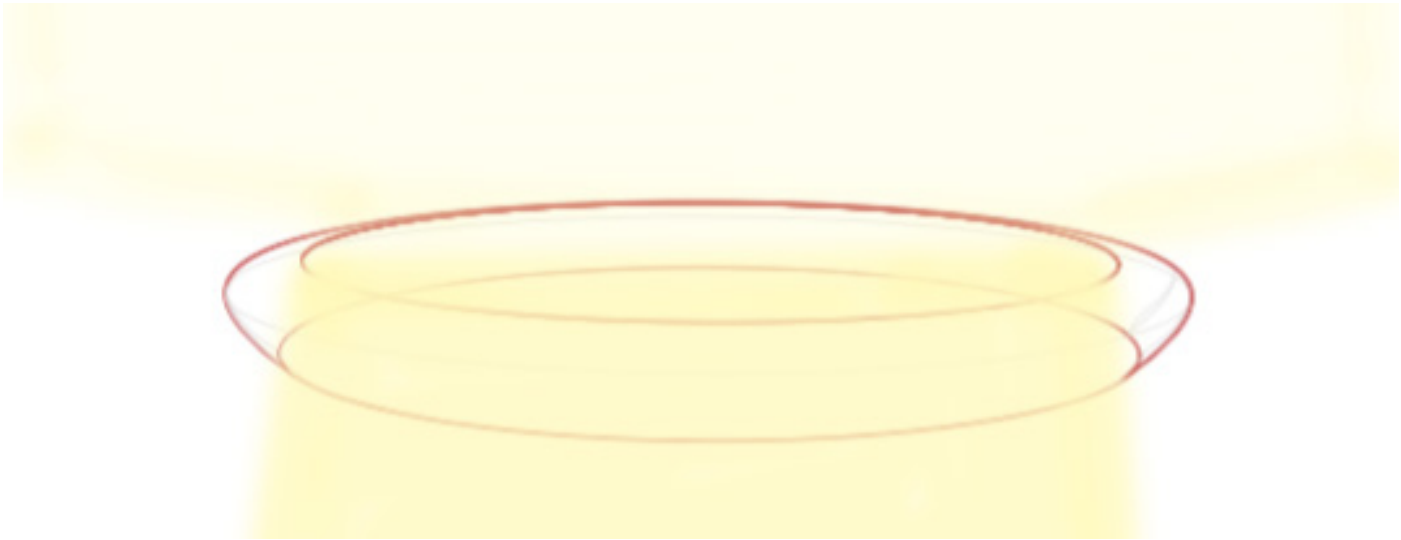


Figure 46. Overall lighting design concept



The chosen idea is a circular shaped luminaire, with a LED strip providing direct down light. The inside of the ring is reflective and side wards spill light from the LED strip is collected and reflected, which creates diffused up light. The lighting concept is illustrated in the upcoming sketches (see figure 46-48). The shape of the luminaire, more specifically the angle of the inner curve of the luminaire dictates the direction of the reflected light. And the relation between the upper and lower inner diameter of the ring dictates the beam angle of both the up light and down light. With this

concept only one light source creates both direct down light and reflected up light. The placement and the angle of the LED strip can be adjusted and developed, so the light source becomes invisible to the user and the light will thereby seem like it is coming from nothing. This lighting concept creates focal glow in the direct down light, ambient luminescence in the reflected up light, but the play of brilliants would have to be created in the shadows and reflections in the materials. Working with the materials therefore becomes a big part of this design process, since it is the play between the light and materials, which creates the stimulating and not uniform light, e.g. glass could give the effect of a sparkling diamond or semi-transparent wood could create shadow play and colour difference within the luminaire itself. The material choice is also a big part of the later discussion.

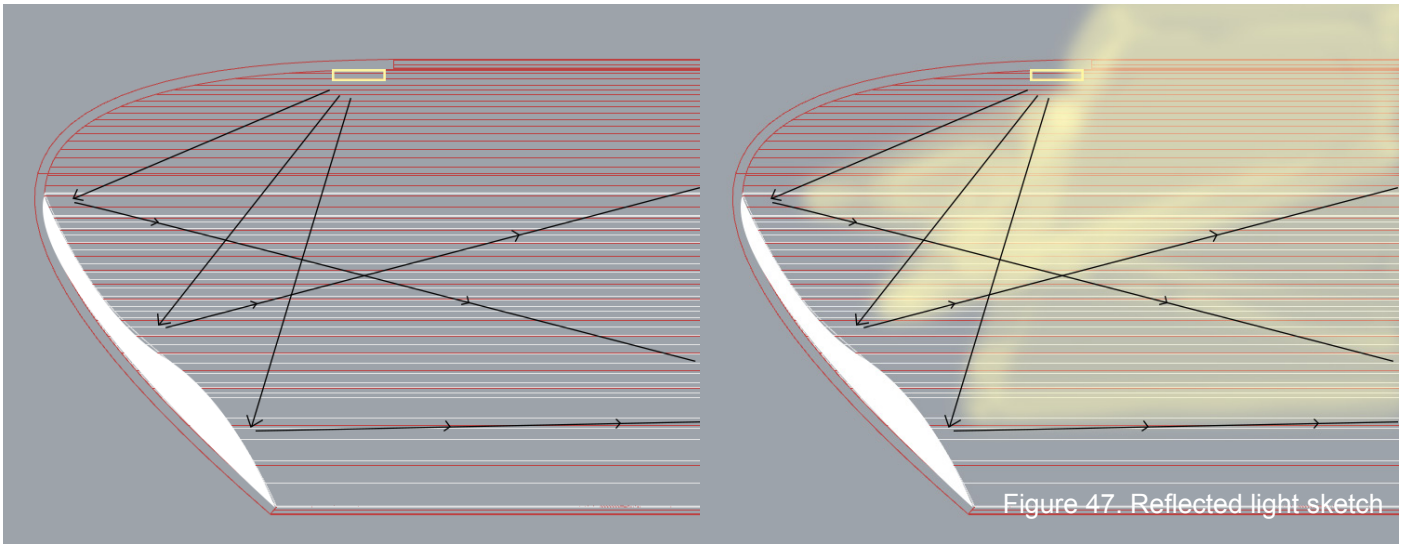


Figure 47. Reflected light sketch

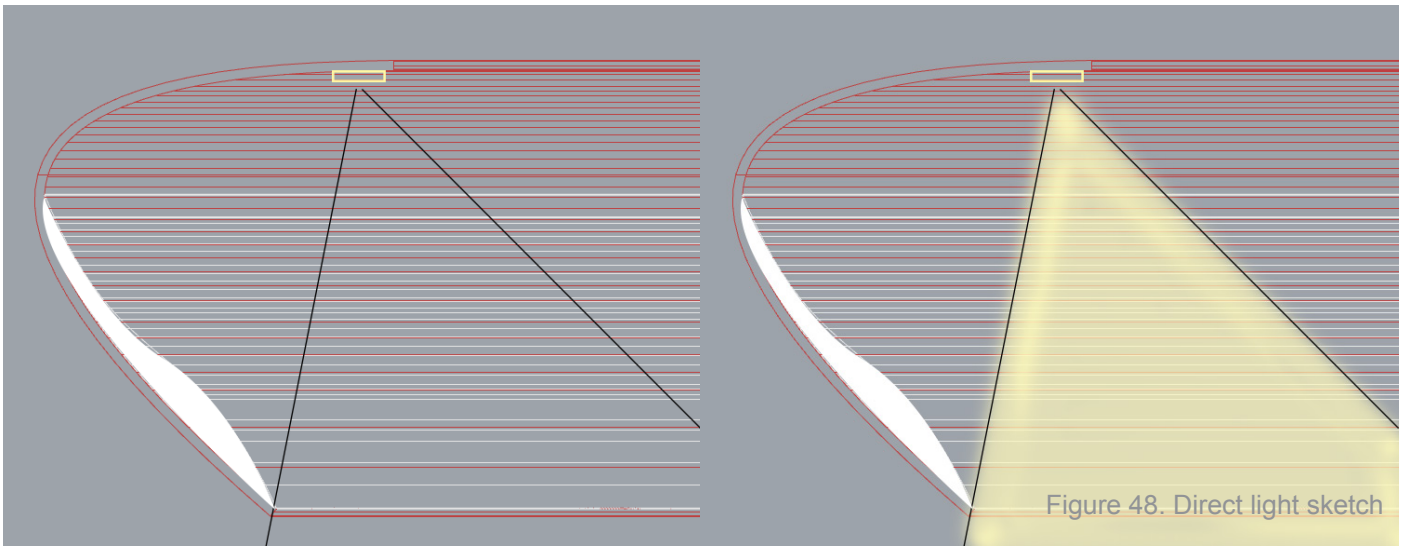


Figure 48. Direct light sketch

THE ITERATIVE PROCESS OF IDEA GENERATION, SKETCHING AND REFLECTION

The following phrase is first of all chronological structured. Furthermore, it is structured by categorising, explaining and arguing for the design choices in relation to which interview inspired the choice. This means that the interviews are presentenced in chronological order. Within the 'individual interview' phrase the reflections, iterations and decisions are discussed and argued for. To better understand the discussions and the starting point for the discussion is here a sum-up of the specific idea illustrated in visualizations, which the experts (respondents) also had presented before an interview.

Figure 49. First full view render

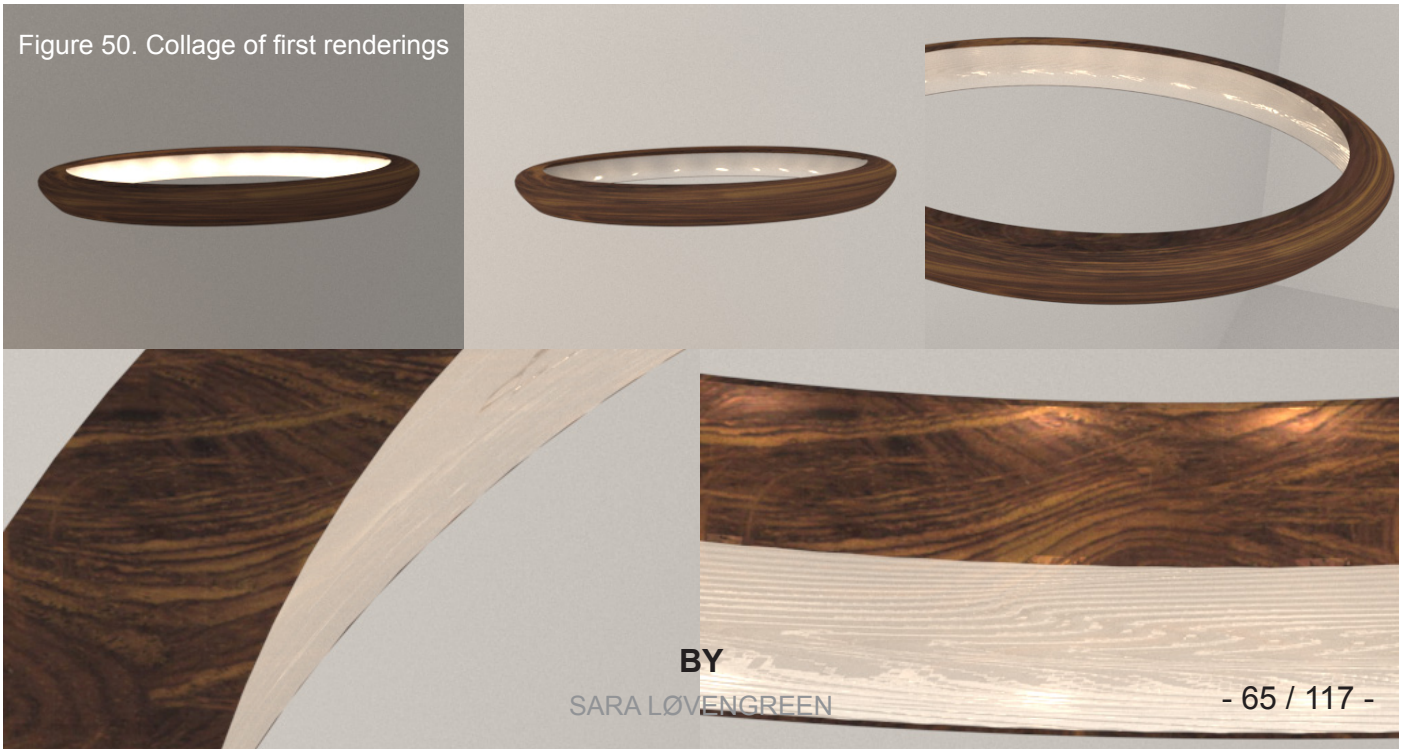


Figure 50. Collage of first renderings

The visualizations (see figure 49-50) show the luminaire both lit up and turned off. The luminaire is made of wood (in this visualization walnut wood), and has a layer of thin white glass on the inside working as a reflective surface. The suspension is initially left out, to better concentrate on the luminaire itself. Since the materials are wood and glass, the first experts to be interviewed are craftsmen with a speciality in wood or glass. Later experts in lighting design, ceramics, electronics and moulding are also interviewed.

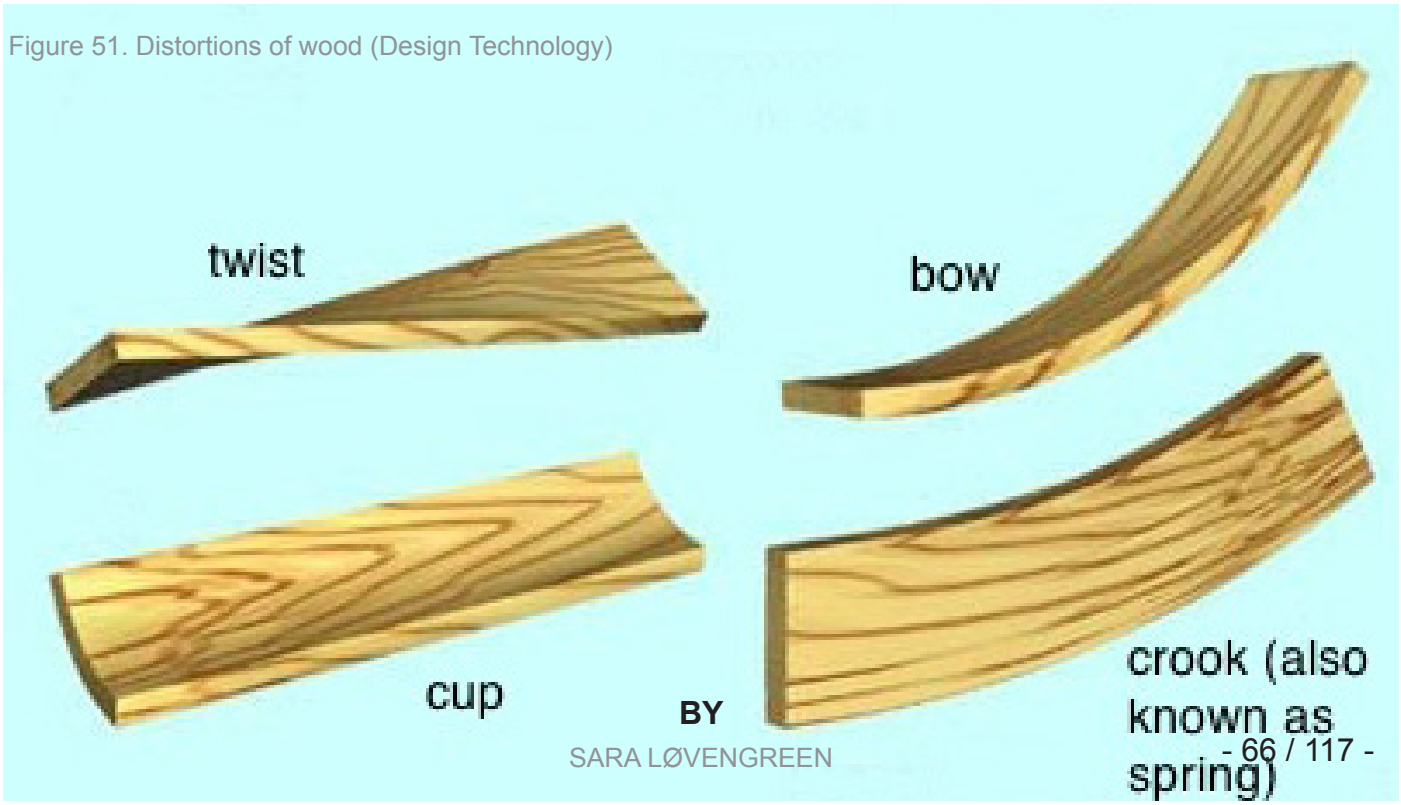
KNUD HANSEN (WOOD TURNER)

Knud Hansen started turning wood when he was 16 years old and has been in the business for more than 30 years. Now Knud Hansen has his own small workshop in the southern Fyn (Faaborg), Denmark. Knud Hansen is self-taught and is an expert in the hands on work with wood (Hansen K.). The discussion with Knud Hansen concerned wood as material and especially dimensions and possibilities in that relation.

Knud Hansen (Hansen K.)

The discussion point was that wood is an organic material, which therefore can warp and splinter or crack because of the warp (see figure 51). Wood shrinks and expands depending on the surrounding temperature and air moisture. These facts can become a complication in the luminaire design with wood, since the luminaire could end up crooked, or cracked, which is of course does not improve the quality.

Figure 51. Distortions of wood (Design Technology)



What Knud Hansen mentioned was that you could accommodate this problem, by using glued wood (see figure 52) instead of using one large piece of wood (see figure 53) to create the luminaire. The positive effects by using glued wood is that it becomes durable and lasting and you would not have to find a tree with the diameter fitting the diameter of the luminaire. The cons with using glued wood are that it aesthetically becomes less honest and less organic. Furthermore, it is more difficult to get the wood semi-transparent, when using glued wood, than with natural wood.

Figure 52. Glued wood (AD WOOD)

Figure 53. Natural wood (THE HOME DEPOT INC)

In addition Knud Hansen argued that with natural wood the size of the luminaire's diameter would be dictated by the size of the trees available. To get the luminaire in a diameter of between 40 and 50 cm. it would require a large and old tree with a diameter of at least 60 cm. This is possible and also possible in Scandinavia, but has its price. Knud Hansen himself does not have a turning lathe big enough to turn a sample in the desired size (between 40 and 50 cm. in diameter) and stated the following in that relation:

> "*I will gladly help with what I can, but I only have the equipment to turn and not hand carving or anything else, this would require special machines or tools. It can be a challenge to find dry wood in these dimensions. I can maximum turn a piece with an outer diameter of 40 cm. and maybe not even a ring as you request.*"[8] – Knud Hansen, 2019

The conclusion of the discussion with Knud Hansen is that the design is durable in wood, but the type of wood should be considered, does it matter that it can warp or is it more important that the aesthetics of the luminaire stays true to the Nordic design keywords of simplicity and honesty?

Furthermore, the discussion with Knud Hansen led to him creating two samples from send 3D drawings and sketches. Knud Hansen can as mentioned not craft the samples in the correct size, but got free rein to make the size he found durable and also in the type of wood he had disposable. The purpose of these two samples was to examine how the wood turning approach can be used and how the finish differs from one with e.g. milling. These two samples are sketches

8. Translated from Danish to English. See the original quote in the appendix (appendix 7).

and not prototypes following Buxton's before mentioned terms (Buxton, 2007). The samples are sketches because they are not a presentation of the finished design, but used as a tool to understand a material and a handicraft. The below pictures illustrate the process of turning the two samples and the final result. The larger sample is untreated maple wood and the smaller sample is Brazilian rosewood treated with heat-strengthening wax.

Figure 54. Collage of wood turning process

In regards to the design process, it was after receiving, examining and comparing the two samples (sketches) that I decided that both treated and non-treated wood and both light and dark wood sorts are interesting materials. It was also decided that natural wood aesthetically was much more appealing, than glued wood.

MARIA SPARRE-PETERSEN (PROFESSOR IN DESIGN TECHNIQUE AT KADK)

Maria Sparre-Petersen teaches design techniques at KADK and has in the past worked with materials as glass and ceramics (Det Kongelige Danske Kunstakademis Skoler for Arkitektur, Design og Konservering). What is also interesting about Maria Sparre-Petersen is her large network with other talented craftsmen. The discussion with Maria Sparre-Petersen concerned, combining materials such as glass and wood. The design proposal suggests an inside with a layer of glass, while having the main ring in wood.

Maria Sparre-Petersen (Det Kongelige Danske Kunstakademis Skoler for Arkitektur, Design og Konservering)

This combination of two different materials might not be possible at all and that was what the discussion with Maria Sparre-Petersen dealt with, is this possible and what are the possible issues with the initial design?

First of all Maria Sparre-Petersen argues that combining glass and wood, from the knowledge she had, possible. Maria Sparre-Petersen, though also mentioned the size of the luminaire as an issue, since a glass blown ring with a diameter of approximately 40 cm. would require a very skilled glassblower to perform this. In this relation Maria Sparre-Petersen mentioned Anders Raad in Denmark or else she only saw it as a possibility in countries like Sweden with bigger productions, glasshouses and factories. While examining and discussing the design Maria Sparre-Petersen interestingly questioned the design, by asking why wood at all? Why not just use opaque glass for the whole construction? This wonder of hers inspired the idea to investigate, whether the design could function better constructed of glass or another more transparent material, than wood. The opportunity with using opaque glass is that it would create ambient luminescence also through the glass and thereby to the surroundings. Furthermore, with a more transparent material there is an possibility of creating specific shadows by engraving the glass with different patterns. This is already seen in other lamp designs (see figure 55 and 56).

Figure 55. Tartan by Foscarini (Foscarini)

Figure 56. Pinecone by FontanaArte (FontanaArte)

With glass and in general more transparent materials the issue is though glare. The design was discussed with Maria Sparre-Petersen in relation to the issue of glare in general. Maria Sparre-Petersen pointed out that the relation between the upper and the lower inner circles of the design would be important, since this could in fact be the relation that determined whether the LED's would create discomfort glare or not. If the lower inner circle is small enough, then you would not be able to view the LED strip, but a small lower inner circle might also cause a smaller beam angle. This relationship between the top and the bottom of the luminaire design, the placement of the LED strip, the beam angle and the point of discomfort glare by viewing the light source is something, which Maria Sparre-Petersens mentions should be tested. Maria Sparre-Petersen agrees with Marianne Tuxen and Anne Qvist that the best way to test this would be to have a prototype/skecth in your hands and test it physically.

Overall the discussion with Maria Sparre-Petersen let to a suggested interview with Anders Raad about the technique of glassblowing. In her opinion the initial design is possible, but has to be tested physically. Furthermore, the discussion sparked the idea of investigating other materials than wood for the main construction, though not rejecting wood as an option.

ANDERS RAAD (GLASSBLOWER)

Anders Raad (Raad)

Anders Raad is an educated glass designer from the Royal Danish Design Academy in 1984. Anders has worked for Holmegaard in the past, but has had his own glasshouse in Charlottenlund since 1999 (Raad). The interview with Anders mostly concerned glass as material and its possibilities in relation to the initial design proposal. First of all Anders Raad argued against Maria Sparre-Petersen and stated that it would not be possible to blow a piece of glass to have as an inner layer of the wood. His explanation for this was that the two materials are both organic and you would never be able to blow a perfect ring, which would fit with the wood. His suggestion for the inside of the wooden ring was instead to look into water glass, which is often used for concrete surfaces to make them more water resistant. Water glass also becomes glossy and reflective, when hardened. Also he questioned, why you would use such a fragile material, if it is only to get a reflective surface and not for the aesthetics of it? This question of the design inspired to not having glass as the inside reflective surface, but look into an easier solution, which would give the same result in terms of the lighting. This could e.g. be water glass as mentioned or marine varnish or paint with a high gloss.

Regarding the idea of having the whole construction in glass, Anders Raad was much more optimistic. In his opinion this could be an option, though not something he had experience with. His concerns were about the bursting of the glass. To construct a ring and not a bubble in glass, you would have to blow a large bubble and afterwards burst off the excess material. This process is fragile and difficult, but is possible. For further production this process is much easier, since larger glasshouses use machines to blow the glass and not craftsmen. Again also the size of the luminaire would be a challenge to produce in glass by manual power, because you would have to blow very strongly with a lot of power, though still being careful to not burst the glass.

The interview with Anders Raad ended up questioning glass as material. Anders Raad as mentioned argued that a full construction of glass is possible, but also a difficult construction. And maybe glass would be more appropriate if the luminaire was created in collaboration with a larger glass factory. The discussion with Anders Raad also inspired the following consideration: Is there other more tangible materials with the same qualities in terms of transparency as glass?

TIM ELKÆR (LAB MANAGER AT AAU (V-LAB) AND 3D-DESIGNER)

Tim Elkær (Teknisk Landsforbund)

Tim Elkær is an all around craftsman with an education in 3D-design (Aalborg Universitet). His expertise lies within crafting and prototyping and in addition he has a stance regarding design, design processes and professional production. The interview and discussion with Tim Elkær mostly concerned design ethics and the most appropriate use of different materials. Tim Elkær was especially critical regarding the use of wood for this particular design. Tim Elkær argued that in his opinion using glued wood to create a ring would be a definite misuse of the qualities of wood. He argues that to cut down several trees and afterwards cut them into planks glue these together and at last drill away most of the wood, would not be to use the qualities of the material. In stead he suggested using an old huge tree trunk for each luminaire and get a wood turner to create the ring. In this relation he argues that old tree trunks often are not usable for planks, because the middle of an old tree trunk becomes to old to use, so in this case it would actually only be the outer ring of the tree trunk which is usable (see figure 57). But here you should be aware that the outer ring of an old tree trunk, which is the youngest part of the tree, and this part might be too wet or have very uneven grains. Tim Elkær strongly suggested only using this part of a tree in this process if tree should be the material at all. In my opinion the uneven grains adds an aesthetic value, since this would underline the natural and organic vibe of the luminaire design and also tell a different story about the tree, which was used, for each individual lamp. It creates uniqueness.

Figure 57. Tree trunks (Unknown, Pinterest) (Stu's Dungeon)

Tim Elkær's question about the design ethics and how to use the material most appropriately supported the previous decision of using one tree trunk for each lamp and having it hand crafted by a wood turner. Even though this might create challenges in relation to the tree warping and be more expensive than e.g. willing it from glued wood. Furthermore, Tim Elkær's critique of the material choice also underlined that investigating other Nordic materials for the main construction is important for the final design decisions.

SIA MAI (GLASS ARTIST) & ANNEMETTE KISSOW (CERAMICS ARTIST)

Annemette Kissow (KERAMIK & GLASVÆRKSTEDET)

Sia Mai (Redaktion: Helle Bjerum)

Sia Mai and Annemette work together at a small shared workshop in Copenhagen. Sia Mai is glass artist and designs smaller glass pieces such as water glasses, bowls, jugs etc. Sia Mai only designs the glass pieces, but does not blow them herself. She gets her designs blown in Sweden. Annemette is a ceramics artist and has her own medium sized oven in the workshop. She mostly uses casts to form her ceramics. She does not create the casts herself, but collaborates with former glassblower and ceramics artist Richard Saaby to create the different casts. Casting ceramic is a heavy handicraft and therefore Annemette does not do larger pieces. Also her oven has a limit in terms of size for the pieces she designs. Therefore, Annemette for the same reasons

as Sia Mai mostly designs kitchenware in all forms.

Sia Mai and Annemette were interesting to interview together, because we could have a conversation about the similarities, differences and qualities of both glass and porcelain. Firstly Sia Mai agreed with Anders Raad that a larger glasshouse would be able to construct the luminaire in glass, but additionally she also stated that the design in glass would be difficult to blow manually. Annemette and Sia Mai stated that the similarities between a production in glass and porcelain are mainly the transparency of the materials. Opaque white glass and thin porcelain would both create ambient luminescence. Annemette though argues that with porcelain the possibility to work with engraving is much easier, since you can ‘draw’ in the wet clay. Furthermore, she argued that with porcelain you can decide yourself, whether the inside and outside of the luminaire should be the same degree of diffused (see figure 58). If you do not glaze the inside, then the inside surface would still be white and reflective, but would be diffused instead of glossy and not create a mirror effect inside the luminaire (see figure 58). Glaze could also add colour to either the inside or the outside, this is not in the same way possible with glass. Coloured glass is always coated with the colour on the inside and will always be glossy on the outside, unless you sandblast the glass afterwards.

Figure 58. Collage of ceramics (KERAMIK & GLASVÆRKSTEDET)

The cons with using porcelain instead of glass is that the clay can explode in the baking, if the construction is to heavy or have air bubbles inside. Furthermore, the clay shrinks while drying up, approximately 10-20% depending on the type of clay. So you would have to add to the size to get the correct final diameter, and this process is just learning by doing. Lastly and maybe also the

biggest concern of Annemette is that this specific design proposal might collapse in clay, because the construction does not have a lot of tension. Neither Annemette nor Sia Mai had a suggestion or preference in relation to either choosing glass or porcelain, but argued that the a casting in porcelain of the initial design would be possible and have a high chance of succeeding in their opinion.

Comparing the interview with Anders Raad with the interview with Sia Mai and Annemette, my assessment is that a construction in porcelain is with the lowest risk and also gives more opportunities in relation to lighting design, since you can test different surfaces, colours and engravings in the porcelain, which is not possible with the glass.

MARIANNE TUXEN (LAMP DESIGNER AND ARCHITECT)

Marianne Tuxen is mentioned in this phrase, because after the semi-structured interview we also had an open interview/discussion about the specific design proposal. Here we mainly discussed the placement of the LED's, the LED's as light source and possible glare issues.

In terms of LED's as light source, Marianne Tuxen strongly agreed that this would be the only right solution. Marianne Tuxen though thought it would be interesting in the future to work with O-LED for a project like this, but again stated that the O-LED technology is not developed far enough to be considered for this design proposal. Marianne Tuxen also mentioned that the placement of the LED strip might become an issue, because it is not angled, but directly downwards, which might make it visible for the users. Marianne Tuxen argued that even though the LED strip would be diffused, then direct sight of the light source would cause discomfort glare. Marianne Tuxen suggested two different design iterations to solve this issue. 1. To have the LED strip placed further into the curve of the ring. The challenge with this solution is, how it would affect the beam angle and possible make the beam angle narrower. 2. To add an aluminium ring on the upper inside of the ring, where you could with the shape of the aluminium angle the LED strip just a bit, so it will not be directly visible to the user. The issue with this solution is again the beam angle, though the beam angle of the reflected light. The upside with the second solution is that adding an aluminium ring to the LED strip also solves the potential heat issue, since the aluminium would act as a heat sink. Then it is more a question of aesthetics, whether adding another material to the construction will add aesthetic value or the opposite.

Marianne Tuxen is an experienced luminaire designer and when asked, how she would make the final design decisions, she answered that she would do visualizations, 3D models and then most importantly test it out physically. Following Marianne Tuxen's advice most of the above discussed design decisions are tested physically. The test phase is unfolded in the upcoming phrase 'Test'.

Several other experts were interviewed during the design process, but these interviews and discussions are not unfolded and described in depth in the thesis. This is because these interviews

did not result in a major design decision. The interviews in stead underlined a previous decision or helped to understand a material even better. Below is a list of the remaining experts, who also contributed in the design process with their knowledge.

- Jesper Greve (Lab manager (E-Lab) at AAU)
- Tage Pedersen (Wood turner)
- Mikkel Karlshøj (Wood turner and glassblower)
- Glenn Auker (Glassblower and glass artist)
- Richard Saaby (Cast and form builder, former ceramics and glass artist)
- Hans-Henning Pedersen (Wood smith)

TEST

Overall the testing phrase is divided into two categories of tests: A sketch and a prototype test. These are two different testing approaches, which have been explained earlier in the 'design approach' phrase. Bill Buxton differentiates between sketch and a prototype. In short it is the purpose, which separates the two. The purpose of the sketch is to examine and develop, where the purpose of the prototype is to show, illustrate and do small last adjustments.

TEST OF LUMINAIRE DIAMETER (SKETCH)

The test of the luminaire diameter is a small sketch test, to explore the dimensions of the initial design in a real setting. The purpose of this test is to find the aesthetically most fitting size of the diameter in relation to a real dining setting.

The starting point for this test is based on the most common pendant sizes. Often dining table pendants comes in diameter sizes between 30 – 60 cm. (Lamper.dk). Therefore, the range of diameter sizes for this test is 30 – 60 cm.

The test was carried out in two different dining settings, one with a round dining table, with a diameter of 120 cm. and one with a "rectangular" dining table in the size of 200 x 120. The test progressed by using a cut up plastic tube. The cut up plastic tube was adjustable in terms of size and could at the same time simulate a ring. The combination therefore resulted in a sketch simulating a ring, where the diameter size could be adjusted (see figure 59-60). The performance of the test is illustrated in the below images (see figure 59-60).

Figure 59. Test of luminaire diameter

Figure 60. Diameter regulation

The result of this test, of the first sketch, was that a diameter of 45 cm. would be the most fitting, since this size both accommodates a larger and a smaller dining table. Furthermore, it was found that a diameter larger than 45 cm. would be too big, but a smaller diameter between 30 and 40 could also be interesting, since this could fit the smaller dining tables even better and also gives the opportunity to have more than one pendant for the larger dining tables. Limitting the choice to one luminaire for more dining table sizes, then the diameter of 45 cm. is best suited.

TEST OF LIGHTING CONCEPT (SKETCH)

After determining the size of the initial design for the luminaire, this initial design can be tested in relation to the lighting concept. The first test of the lighting concept is a sketch test, where the purpose is to initially examine, whether the concept in theory will work or not. Specifically I will test, whether one light source, facing downwards, can be reflected in the luminaire shape created as initial design proposal, and thereby create both direct down light and reflected ambient up light. It is neither the beam angle nor the intensity, which is tested here, but only the general principle of the initial concept.

The test was carried out in the 3D modelling and visualization programme ‘3Ds Max’. Here a 3D model of the initial design of the luminaire was tested, by simulating the lighting concept. The lighting concept was simulated by placing area light sources, imitating LED’s, in the 3D model of the luminaire. Afterwards the render engine renders images illustrating, how the light would act in this luminaire. In this test the material of the luminaire is not transparent, but simulates natural wood. The test renders can be seen below (see figure 61).

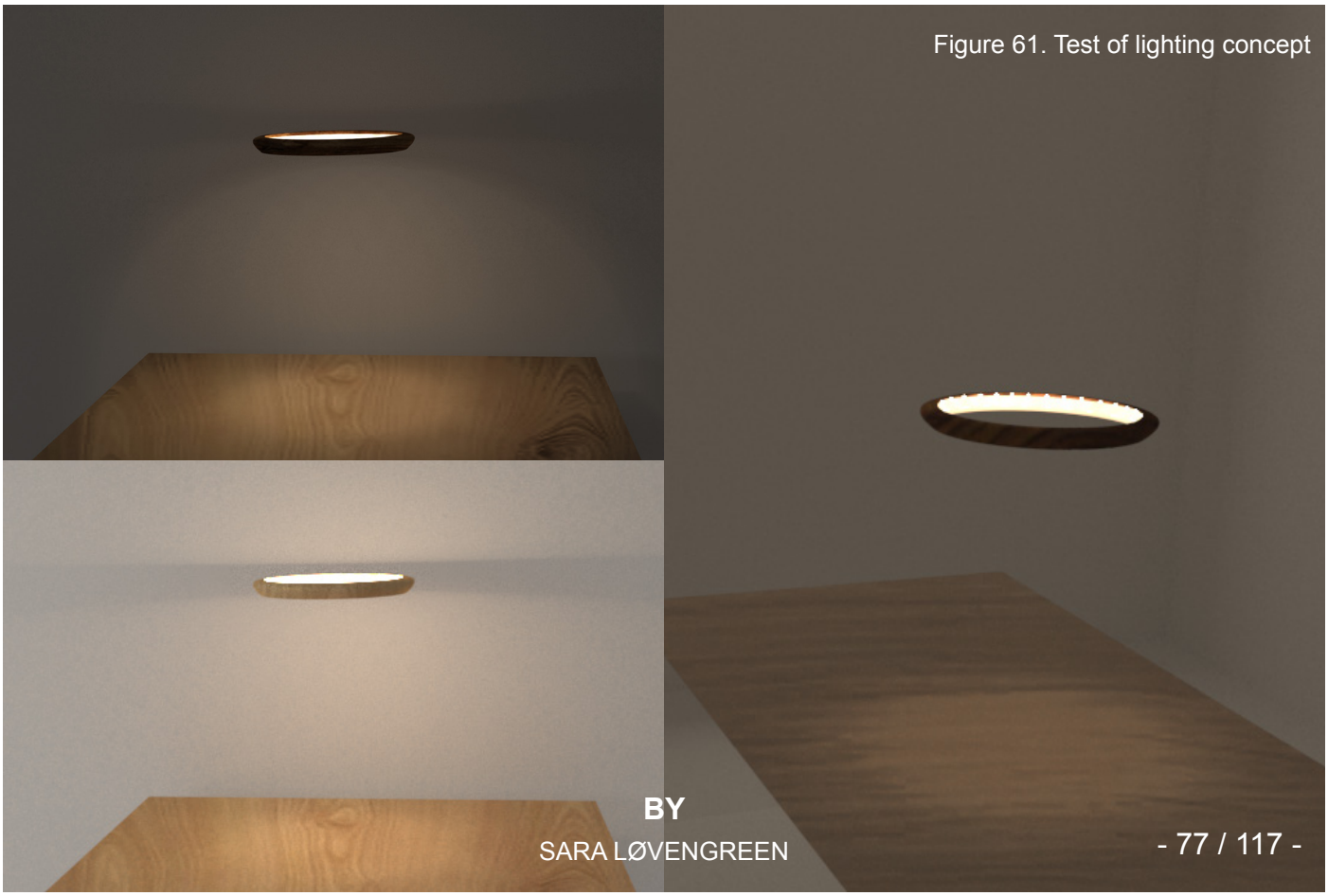


Figure 61. Test of lighting concept

What can be seen on the renders is that the overall lighting concept, of both creating up and down light with only downwards directed light sources, works. The renders show that with this lighting design, there will both be created up and down light. The relation between up and down light is not illustrated in these renders and would need further testing to study. Also the beam angle in relation to the placement of the LED's will have to be further tested.

TEST OF LUMINAIRE DIMENSIONS (SKETCH)

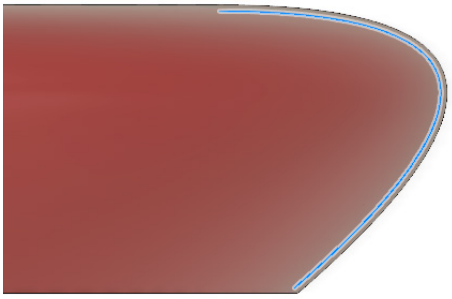
Until now the tests have been either renderings or small sketches with a material and a shape, which is not fully representing the initial design proposal. Therefore, a first physical sketch was developed using cardboard and laser cut MDF wood. The purpose of this first physical sketch was to examine the dimensions of the design proposal, in relation to the aesthetic value.

This sketch looks at, how the diameter of the luminaire fits with the height of the luminaire and how the shape looks, when it is built in a solid material (see figure 63). This sketch is also used later on in the testing phase. Here it is used as a first prototype, where LED's are added and the light is tested in the correct shape.

This sketch was created from the below 3D drawings (see figure 62). The diameter of the sketch is based on the previous test. Therefore, the diameter of this sketch is 45 cm. The height of this first sketch is 6 cm., the upper inner diameter is 33 cm. and the lower inner diameter is 35.5 cm.

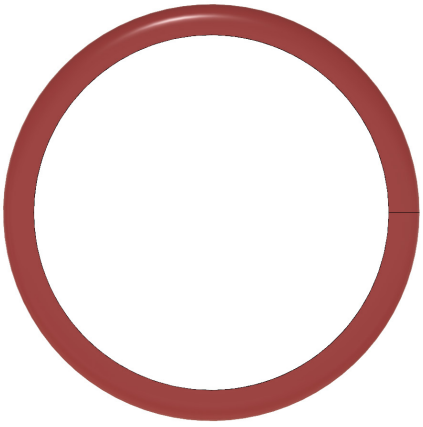
Figure 62. Initial 3D drawings

Sectioned view

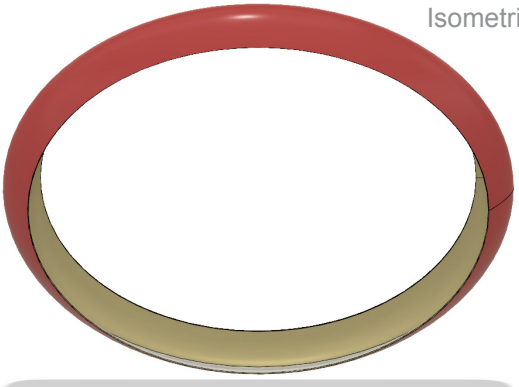


Front view

Top view



Isometric view



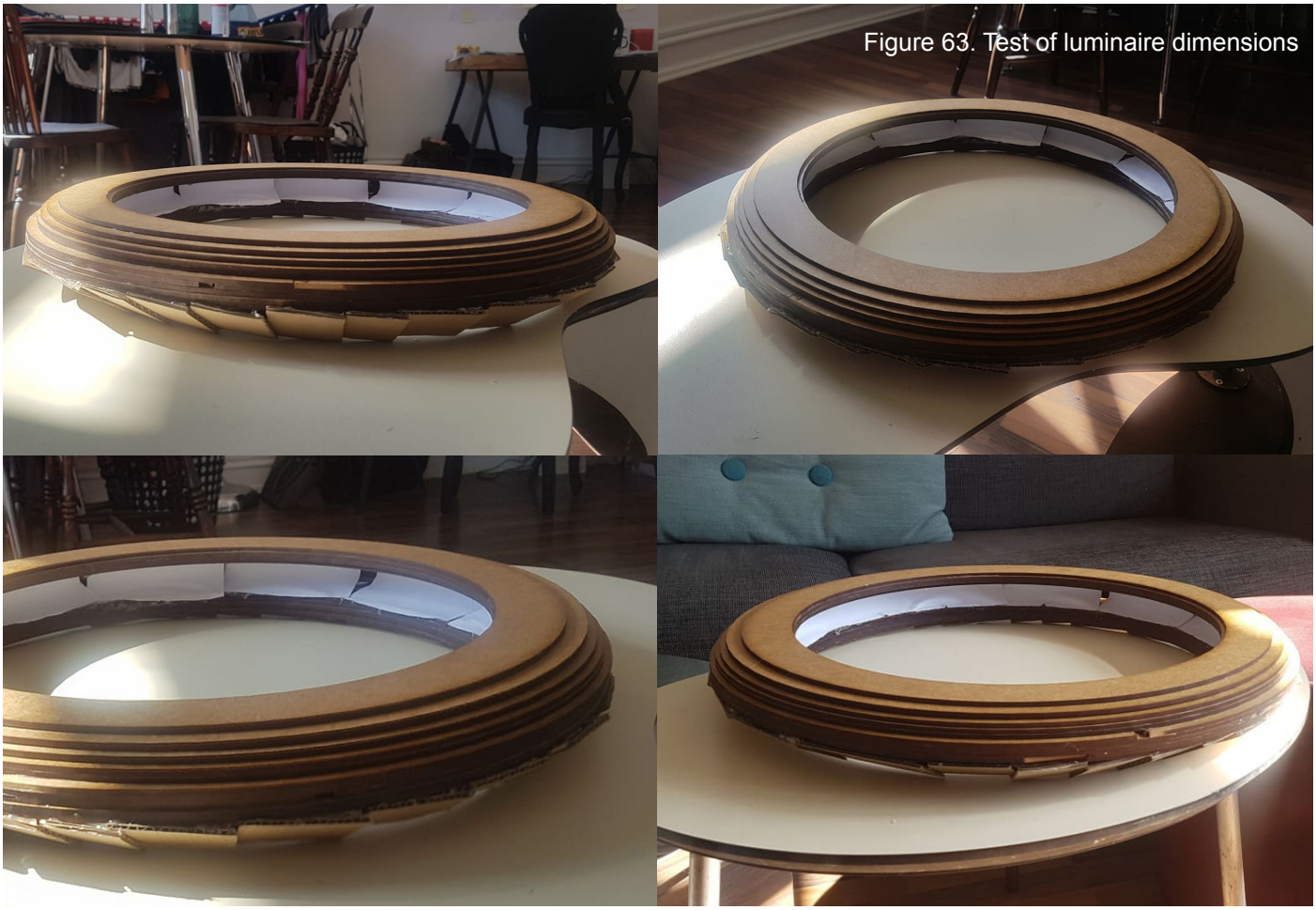


Figure 63. Test of luminaire dimensions

The conclusion of this test is that overall the shape and the dimensions are aesthetically as intended and that this full size sketch does suggest any design iterations. Though it is also noted, that the construction is visually heavy/compact in this firm material. This conclusion underlines that it is interesting to investigate other visually lighter materials for the full construction, such as porcelain.

TEST OF LIGHT IN THE FIRST PROTOTYPE (PROTOTYPE)

The first prototype is basically the first full-scale physical sketch, where light is added to it. The light source in the first prototype is a Zigzag LED strip, 4000 K produced by SOLAROX (see figure 64). It is IP20, 24V, 12 Watt and with a CRI value of 80. The lumen output is max 1070 lm.

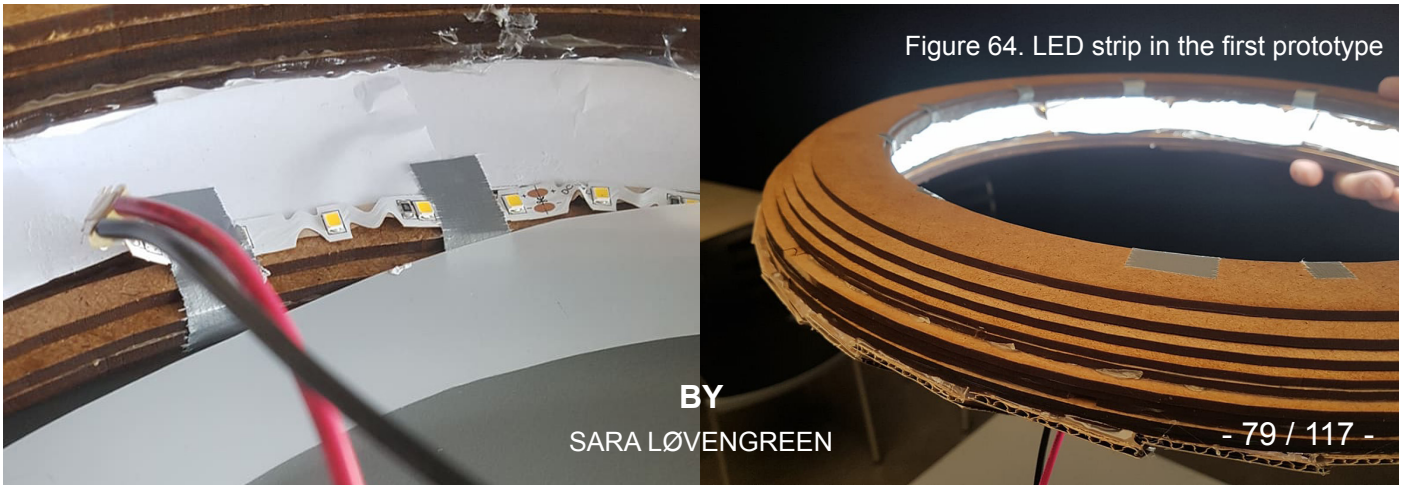


Figure 64. LED strip in the first prototype

The light was measured with a lux meter, type: Digital Lux Meter, model: LX1330B, Range: 0.1 - 200,000 lux, by Dr.Meter[9]. The luminaire was held 65 cm. and 70 cm. above a horizontal table surface (see figure 65). The room, where the test was carried out, was not fully covered and therefore not completely dark. So firstly all measuring points were taken without the prototype turned on, to measure, how many lux should be subtracted from the measures with the prototype turned on. This of course creates a source of error, which should be considered, when looking at the results.

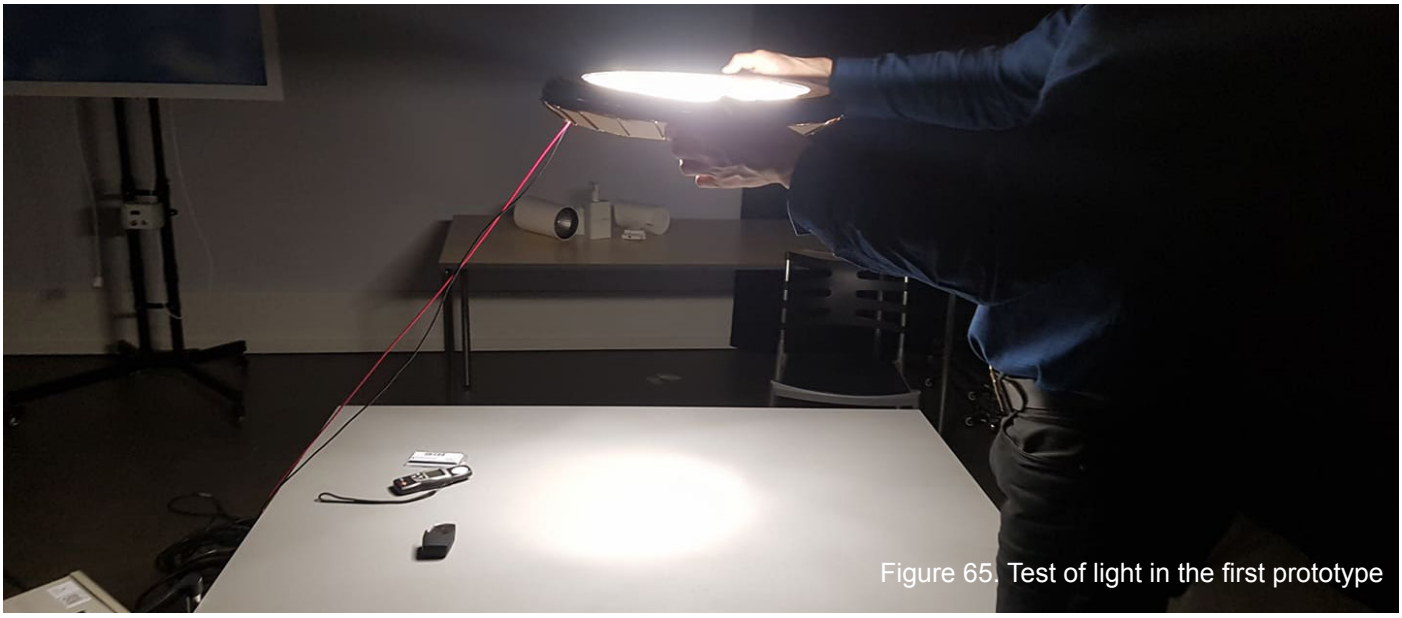


Figure 65. Test of light in the first prototype

The measuring points where as seen on the illustration below (see figure 66). One centre point directly below the luminaire, one point 50 cm. from the centre point, one point 100 cm. from the centre point and a last point 100 cm. above the luminaire, which is therefore either 165 cm. above the table surface or 170 cm. above the table surface.

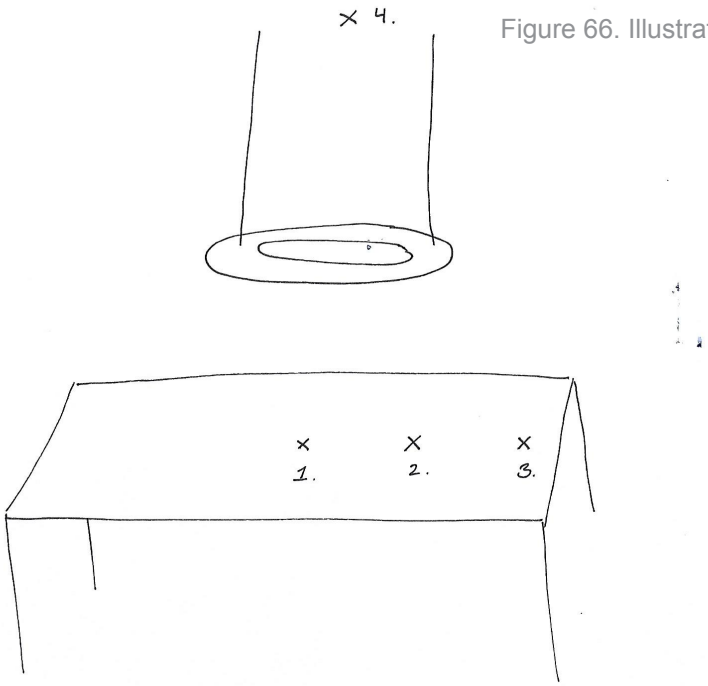


Figure 66. Illustration of measuring points

9. http://www.drmeter.com

The measuring's were as follows:

The table below is divided into two axes. The x-axes: '1,2,3,4' are the measuring points (see figure 66). The y-axes is; 'B' = before luminaire was turned on, 'V1' = when luminaire is turned on, with a suspension height of 65 cm. and 'V1**' = when the luminaire is turned on, with a suspension height of 70 cm. All the measuring's are in lux.*

	1	2	3	4
B	240	280	310	100
V1*	1500	550	410	350
V1**	1300	575	420	350

The two interesting things to look at using these measurements are the relationship between the up and down light and the uniformity on the table surface. To start with, I will subtract the before measurements from the other results to have numbers, which are comparable. The below table is the updated table with the subtracted before measurements.

	1	2	3	4
V1*	1260	270	100	250
V1**	1060	295	110	250

I will now look at the relationship between the up and down light. Here it is the measuring points 1 and 4, which are in focus. The relationship is calculated below:

V1* Relation: 1260 lx / 250 lx = 5.04

V1** Relation: 1060 lx / 250 lx = 4.24

The above calculations show that with a suspension height of 65 cm., the relation between the up and down light is approximately 1/5. This means that there is five times as much light on the table surface as ambient light 1 m. above the luminaire. With a suspension height of 70 cm., the relation between the up and down light is approximately 1/4. In other luminaires, where they also work with both up and down light, the relation is most often 1/10. Therefore, a relation of 1/5, 1 m. above the luminaire must be accepted, though it would not do any harm if less light was reflected and the relation was closer to 1/10.

The uniformity is calculated as follows:

Emin/Eaverage. (Here E is short for emittance, which is meassured in lux).

So to calculate the uniformity, the measuring points, 1,2 and 3 will be used. Firstly the average is calculated.

V1* Average: (1260 lx + 270 lx + 100 lx) / 3 = rounded 543 lx

V1** Average: (1060 lx + 295 lx + 110 lx) / 3 = rounded 488 lx

Now that we have calculated the two averages, we can calculate the uniformity on the table surface.

V1* Uniformity: 100 lx / 545 lx = rounded 0.18

V1** Uniformity: 110 lx / 488 lx = rounded 0.23

What can be concluded from the above calculations is first of all that the uniformity becomes better, when you adjust the suspension height. The extra 5 cm., from 65 cm. to 70 cm. increases uniformity with 20%. But most importantly it is seen from the calculations that this luminaire design and lighting design, at the moment creates an unwanted hot spot on the table. Following the suggestions from the EN 12464-1 standard (the lighting standard for work places) a uniformity index of at least 0.7 is requested. This hot spot effect conflicts with the design wish of a smooth transition between light and dark. This issue with the hot spot effect can though be accommodated for by e.g. adjusting the relation between the inner upper diameter and the inner lower diameter of the luminaire design. In this way the beam angle would increase and the uniformity on the table surface would in theory be better, because the hot spot is larger and fills up more of the table surface. In addition to the lux measurements, also the light in general was examined; how does the light in the luminaire look, how are the shadows on the table surface and how is the light reflected around in the room? In this relation there were three main findings:

1. There are multiple shadows on the table surface.
2. There could potentially occur discomfort glare.
3. The light is reflected as desired, but a solid material might not be the solution.

1. THERE ARE MULTIPLE SHADOWS ON THE TABLE SURFACE

During the testing it could be seen that there was multiple shadows on the table surface (see figure 67). This is because of the multiple light sources, which a LED strip is put together of. Even though the LED strip was covered by a thin 410 Opal Frost diffused paper (by LEE Filters), this was not enough to smoothen out the light and make the many LED chips in the strip become one even light source. The multiple shadows are not an issue for the ‘Dinnetime’ or the ‘Cosiness’ lighting scenarios, but it is an issue for the ‘Workstation’ lighting scenario. The multiple shadows in the ‘Workstation’ lighting scenario would make it difficult to e.g. draw, since the multiple shadows of the pencil would block the light on the drawing area and disturb the focused lighting for drawing. This issue with the multiple shadows can be accommodated for in different ways. A suggestion could be to have a smaller pixel pitch between the LED’s, so the gaps between the lights and

no light are smaller. There would in this case still be multiple shadows, but they would be closer to each other and might not be noticed as much. Another suggestion would be to increase the distance between the LED strip and the diffuser, this would smoothen out the light, but the challenge here is that it takes a lot of space to increase this distance. A third suggestion is to use another diffuser. Here it could be interesting to look into the optical silicone, which is used in the Mito by Occhio. In their construction the optical silicone is laying flat onto the LED's and the Mito does not have multiple shadows, even though you can still glimpse the separate LED's in the strip.

Figure 67. Multiple shadows

2. THERE COULD POTENTIALLY OCCOUR DISCOMFORT GLARE

Another discovery, which was uncovered during this test, was that at suspension height of 65 cm. two, taller than average people, could, when sitting down around the table, not see the light source. But by only adjusting it to 70 cm. in suspension height, then both could glimpse the light source (see figure 68). The problem with being able to see the light source is two things. First of all, it creates a possibility of discomfort glare, when the light hits the eye directly. Secondly, in terms of aesthetics and the lighting concept, it was a wish that the user should not be able to tell, where the light was coming from and it should seem as the light was just "magically" appearing. This issue can be accommodated for in different ways as well. The most intuitive way to accommodate for this issue is to adjust the placement of the LED strip. By e.g. pushing the LED strip further into the ring, then it would be less visible to the user. The challenge is though to not compromise too much with the down light, which would be the case if the LED's were moved

further into the ring. As mentioned it could also be a solution to just recommend a very specific suspension height for the pendant, but because the users, are as found in the research, both families with children and without, then the users viewing angle, because of their height, would become an issue instead. Therefore, as Marianne Tuxen also suggested, and already mentioned in the phrase discussing the interview with Marianne Tuxen, it could be a solution to adjust the angle of the LED strip. In this model the LED's are placed horizontally on the luminaire and therefore, points directly down wards, but by just adding some degrees of angle to the LED's, so they face the inside of the luminaire a bit more, then this issue is accommodated for. This hypothesis was quickly tested out during this test and the conclusion was that, just a tiny bit of angle made a huge difference. The specific angle for the LED's is though still an area to be further tested. Also this solution creates the same challenge as, with the placement adjustment. The angle of the LED's can compromise the amount of direct light on the table surface, but with LED's with a large beam angle, this can be accommodated for as well.

Figure 68. Viewing the light source

3. THE LIGHT IS REFLECTED AS DESIRED, BUT A SOLID MATERIAL MIGHT NOT BE THE SOLUTION

In general the light within the luminaire is reflected as desired. The inside of the luminaire is lit up, bright and creates this ring of floating light. Also the reflected up light is noticeable, but not too intense. The reflected up light creates ambient light to the room, but does not create a hot spot on the ceiling. Overall the light is as designed. Though one thing is questionable, the material choice. With this solid material, which simulates wood, no light at all can scatter trough the luminaire and create a play of brilliants. The solid material also creates a linear shadow on the surrounding vertical surfaces, if this luminaire is the only one providing light in the room (see figure 69). The positive with the solid materials is that it reflects the light both within the luminaire itself and up wards, creating up light as wanted. A semi-transparent material might not reflect the light in the same way, but on the other hand a semi-transparent material could create play of brilliants and an even smoother transition between light and dark. And these two last mentioned qualities of light are, including still having ambient up light and direct down light, what is stated to be the best lighting solution and beautiful light. This test therefore again underlines the importance of testing another semi-transparent material.

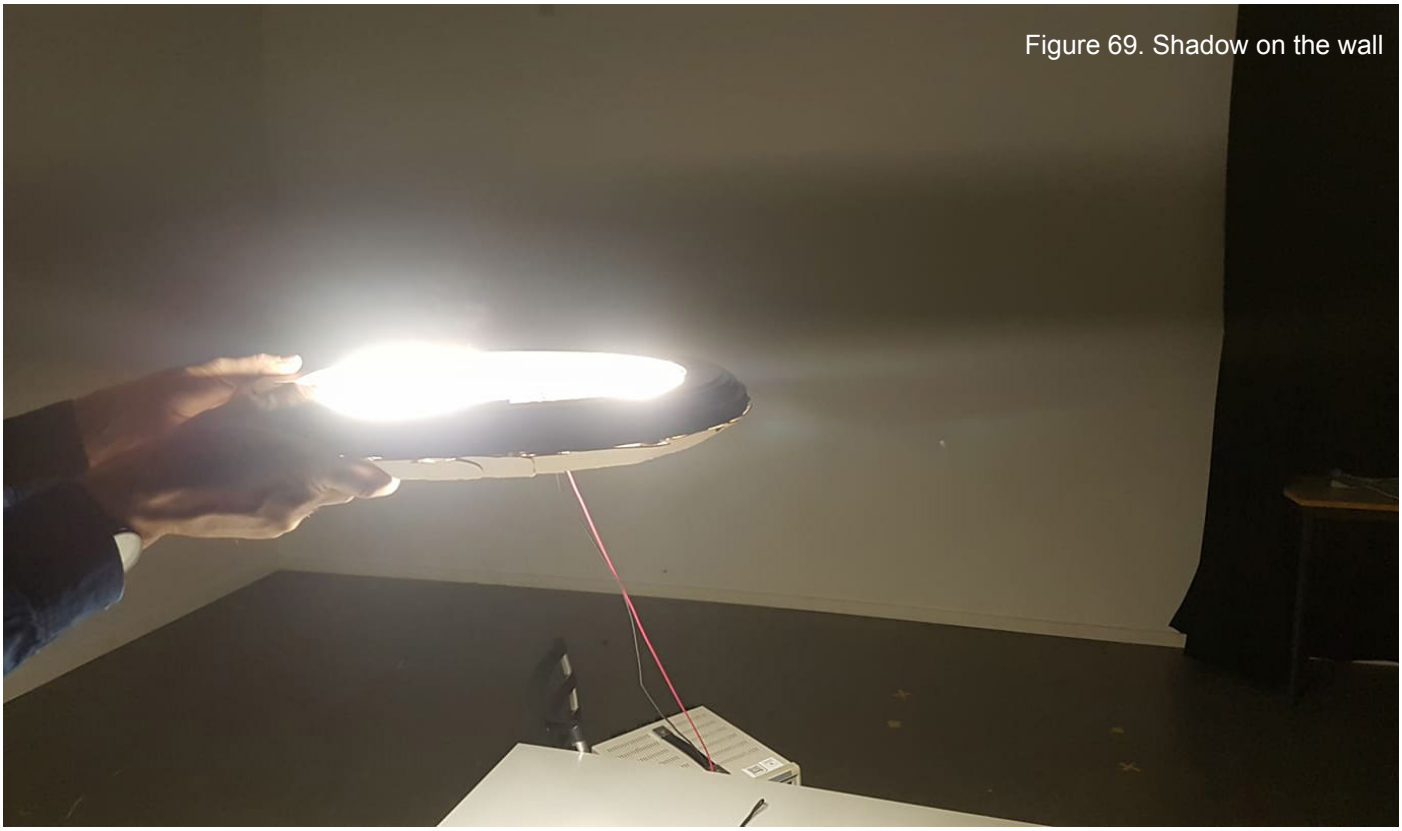


Figure 69. Shadow on the wall

SUB CONCLUSION

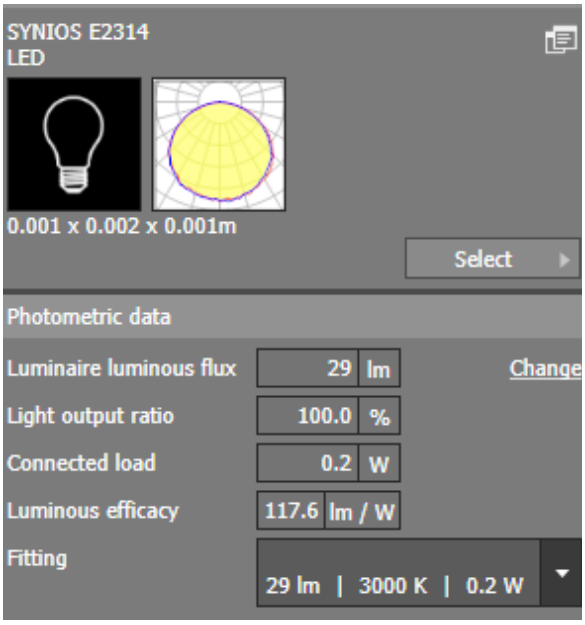
Below is a summation of the design iterations, which would have to be done to the final design based on this test.

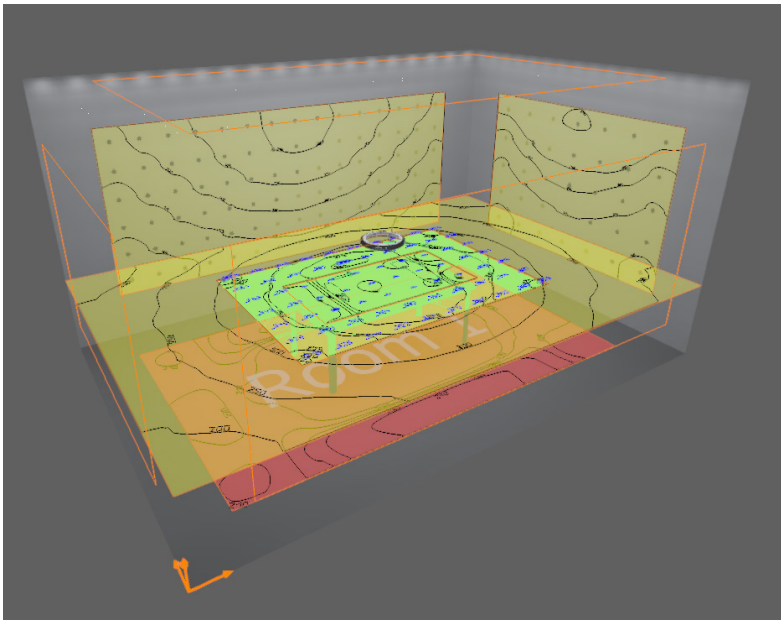
- The relationship between the upper inner diameter and the lower inner diameter has to be bigger to increase the beam angle of the down light and thereby avoid the hot spot effect.
- The height of the luminaire has to be increased to still have the same angle of incidence for the LED's onto the reflected surface. This is to ensure the reflected up light even though the LED's are angled differently.
- An optical silicone diffuser will have to be added to avoid having multiple shadows.
- The LED's will have to be angled, so they do not face directly downwards, but slightly into the ring, so the LED's are not visible for the users regardless their height and the suspension height.
- Another semi-transparent material will have to be tested before definitely deciding on the material for the full construction of the luminaire.

TEST OF LIGHT IN DIALUX (SKETCH)

Since the above test was conducted, a new 3D model has been developed. This model has been iterated in relation to the findings from the previous tests (see figure 72-76). As mentioned in the test of the lighting concept a more in depth test of the relation between the up and down light was needed. Therefore, the iterated design proposal of the luminaire is tested using the calculation and visualization software ‘Dialux Evo’. This test was carried out by, firstly importing the iterated 3D model of the luminaire into the software program and afterwards adding light sources into the luminaire. The light sources are in this case general LED’s from Osram (see figure 70). The specifications of the LED’s in this test are not important since it is the relationship between the up and down light and not the specific intensity, which is tested. In this test the pendant is hanging approximately 65 cm. above the table, which is, as mentioned, the common suspension height for a suspension luminaire in the dining area.

Figure 70. Specifications of the light source in Dialux





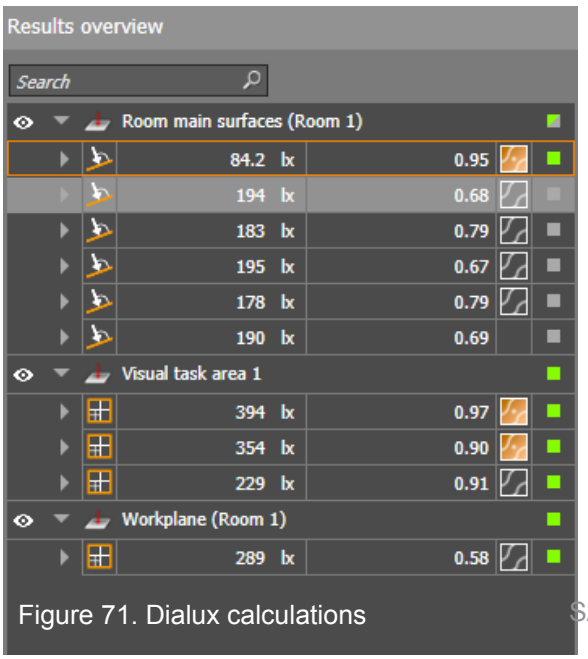
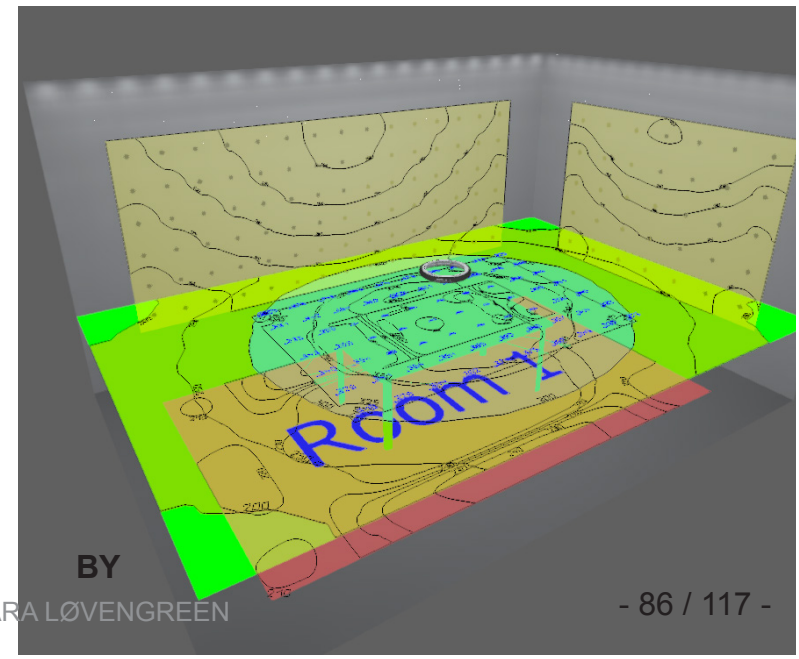


Figure 71. Dialux calculations



As you can see from the calculations illustrated on figure 71, the average lux level on the visual task area is 394 lx and the average lux level on the ceiling is 194 lx. The relationship between the up and down light can therefore be calculated as follows:

Relationship between up and down light: 394 lx /194 lx = approximately 2.03

The relationship between the up and down light is thereby 1/2, which means that the amount of the light downwards will be double the amount of light upwards. This relation is higher, than the first prototype showed in the physical test, but what should be considered here is that Dialux Evo only simulates the real world scenario, and is more 'optimal', than the real life scenario, since not all light is reflected, which is what Dialux Evo calculates that it is. In the real world the surface might not be a smooth perfect reflective surface, there might be bumps in the material etc. Therefore, I anticipate that the real physical test of the prototype 'version two' will have a lower reflectance of the up light, and that the relation will be closer to 1/5, than 1/2.

Another interesting finding from these calculations is the uniformity on the work plane, which can indicate, whether there will be a hot spot on the table or a more smooth transition.

On figure 71 it is seen that the lux level on the work plane ranges from 394 lx and down to 229 lx. This is a range of 165 lx, which is roughly 1/3 of the highest intensity on the work plane. This indicates that on the work plane there will, at the point with the least light, be three times less light as at the point with the highest amount of light. The uniformity is again calculated as follows:

Emin/Eaverage.

The average on the work plane is as seen on figure 71, 289 lx. Therefore the uniformity is in this case:

229 lx / 289 lx = 0.79

The EN 12464-1 standard (the lighting standard for work places) requires a uniformity index of at least 0.7. This calculation of the uniformity thereby indicates that there will not be a hot spot on the table, but a more or less smooth transition. Comparing it with the previous test, where the uniformity was calculated to be 0.18, a large optimization is seen. Again the fact that it is a simulated scenario vs. a real world scenario has to be taken into account. The following real world scenario test of the iterated prototype will show, whether the new design can be said to be better or not, but from only looking at these calculations, it would seem as if the new design creates less of a hot spot and a more smooth transition from light to dark.

The uncertainties and the sources of errors in this test are similar to the test in 3Ds Max. The placement of the light sources are not 100% correct in relation to the iterated design proposal and the materials reflectance's are neither fully representative for a real scenario. But this test gives a

good indication of the how the light will act in the real world.

I will from this test conclude that, as intended there will be more direct down light, than up light and the estimate is approximately a relation of 1/2. Furthermore, the new iterated design proposal does not seem to create a hot spot on the table below (the visual task area) and the estimated uniformity is 0.79, which is within the requirements of the EN 12464-1 standard. Overall this test indicates that the lighting concept works as intended and that it is optimized from the previous design proposal.

TEST OF LIGHT IN THE SECOND PROTOTYPE (PROTOTYPE)

The second prototype is an iterated version of the first design proposal. The changes can be seen in the figures below (see figure 72-76). The most important changes are as follows: The height of the luminaire is increased. The relation between the inner upper diameter and in the inner lower diameter is increased. The general finish of the prototype is improved. And the inside of the luminaire is painted white instead of using paper, which makes a more even reflective surface (see figure 76).

Figure 72. Old vs. new front view

Figure 73. Old vs. new top view

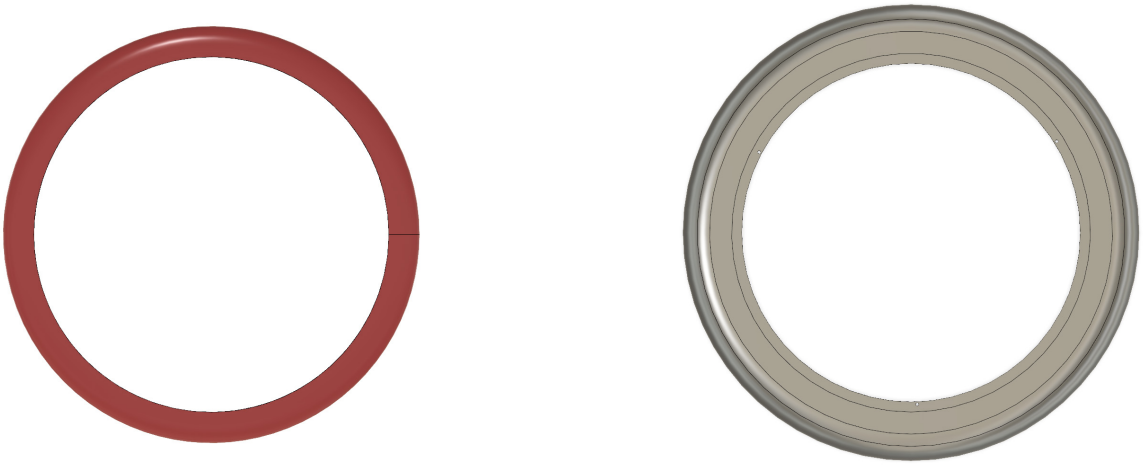


Figure 74. Old vs. new isometric view

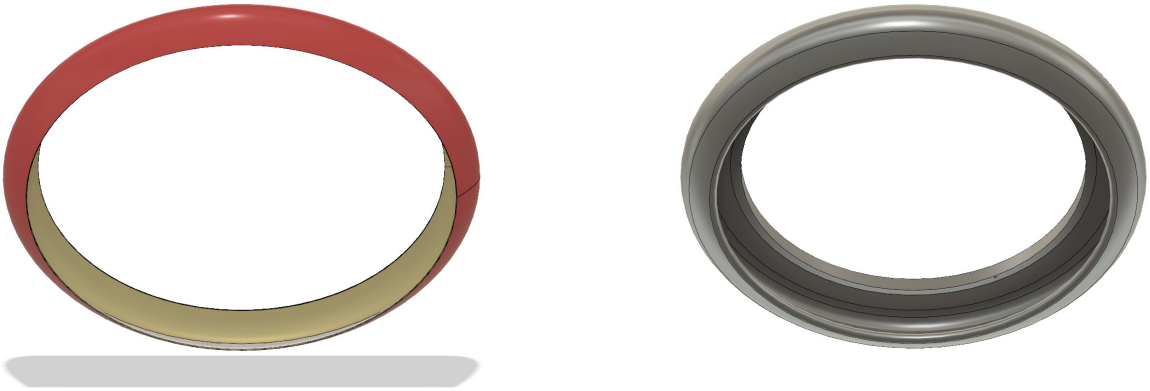


Figure 75. Old vs. new sectioned view

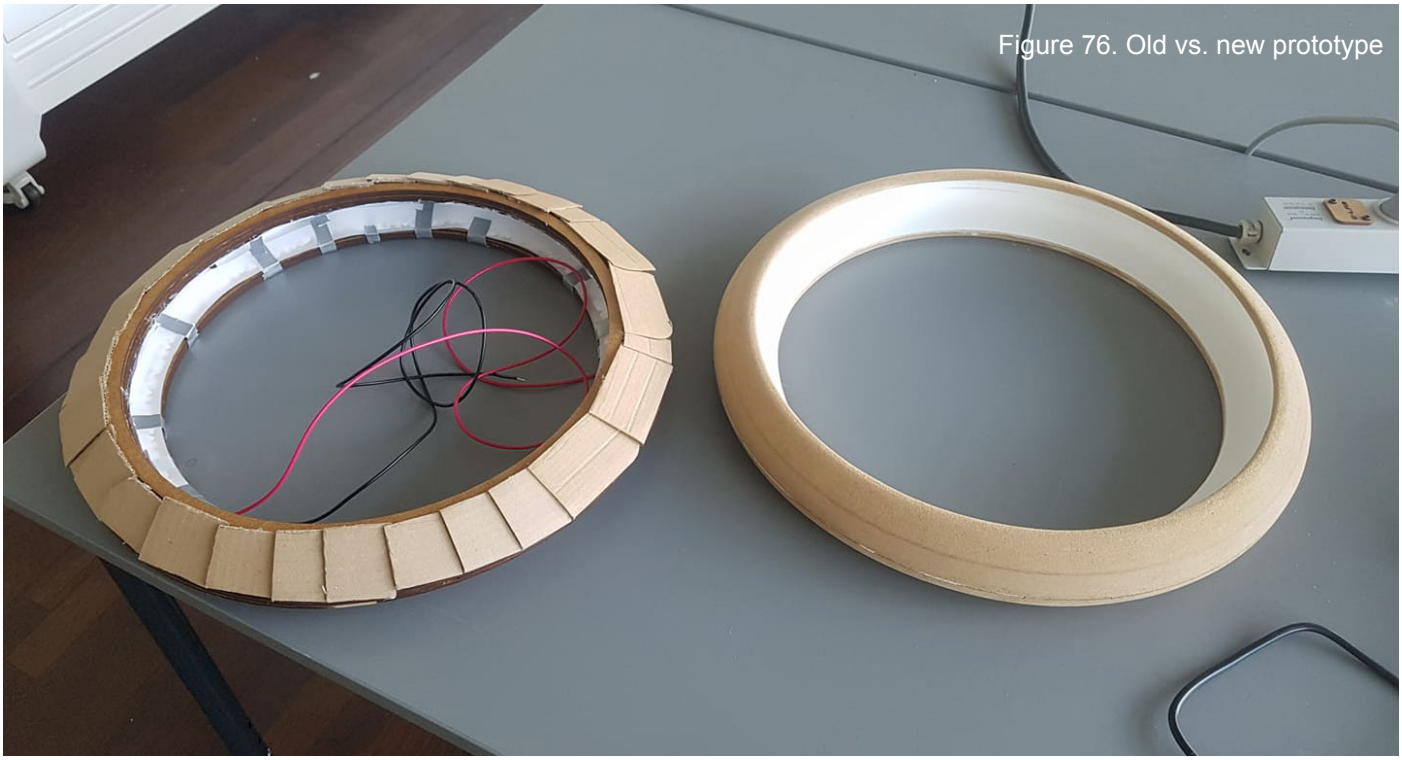


Figure 76. Old vs. new prototype

The second prototype is CNC machined and built of MDF wood. It is CNC machined in two parts, which have afterwards been glued together. The inside of the prototype is painted with 90% reflective white marine vanish (see figure 77).

Figure 77. Marine vanish inside

The light source in the second prototype is the same as in the first; a Zigzag LED strip, 4000 K produced by SOLAROX (see figure 76-77). It is IP20, 24V, 12 Watt and with a CRI value of 80. The lumen output is max. 1070 lm.

The light was again measured with a lux meter, type: Digital Lux Meter, model: LX1330B, Range: 0.1 - 200,000 lux, by Dr.Meter. The procedure of the test was exactly the same as with the first prototype. The luminaire was held 65 cm. and 70 cm. above a horizontal table surface (see figure 78). The room, where the test was carried out, was not fully covered and therefore not completely dark. So firstly all measuring points were taken without the prototype turned on, to measure, how many lux should be subtracted from the measures with the prototype turned on. This of course creates a source of error, which should be considered, when looking at the results.

Figure 78. Test of light in the second prototype

The measuring points were as seen on the previous illustration (see figure 66). One centre point directly below the luminaire, one point 50 cm. from the centre point, one point 100 cm. from the centre point and a last point 100 cm. above the luminaire, which is therefore either 165 cm. above the table surface or 170 cm. above the table surface.

The measuring's were as follows:

The table below is divided into two axes. The x-axes: '1,2,3,4' are the measuring points (see figure 66). The y-axes is; 'B' = before luminaire was turned on, 'V2*' = when luminaire is turned on, with a suspension height of 65 cm. and 'V2**' = when the luminaire is turned on, with a suspension height of 70 cm. All the measuring's are in lux.

	1	2	3	4
B	240	280	310	100
V2*	1500	1000	510	550
V2**	1600	1120	700	550

The two interesting things to look at using these measurements are again the relationship between the up and down light and the uniformity on the table surface. To start with, I will subtract the before measurements from the other results to have numbers, which are comparable. The below table is the updated table with the subtracted before measurements.

	1	2	3	4
V2*	1260	720	200	450
V2**	1360	840	390	450

I will now look at the relationship between the up and down light. Here it is the measuring points 1 and 4, which are in focus. The relationship is calculated below:

V2* Relation: 1260 lx / 450 lx = 2.8

V2** Relation: 1060 lx / 450 lx = 2.36

The above calculations show that with a suspension height of 65 cm., the relation between the up and down light is approximately 1/3. This means that there is three times as much light on the table surface as ambient light 1 m. above the luminaire. With a suspension height of 70 cm., the relation between the up and down light is approximately 1/2. Comparing these results with the previous test of the first prototype, it is seen that more light is reflected to ambient up light in the new iterated design in with the old prototype. The first prototype had a relation of 1/5, where the new here is approximately 1/3. The ambition with the new iterated design was to not get less up light, even though the angle of incidence was adjusted. And the results here show that the new angle of incidence does not influence the up light negatively.

The uniformity is again calculated as follows:

Emin/Eaverage.

So to calculate the uniformity, the measuring points, 1,2 and 3 will be used. Firstly the average is calculated.

V2* Average: (1260 lx + 720 lx + 200 lx) / 3 = rounded 727 lx

V2** Average: (1360 lx + 840 lx + 390 lx) / 3 = rounded 863 lx

Now that we have calculated the two averages, we can calculate the uniformity on the table surface.

V2* Uniformity: 200 lx / 727 lx = rounded 0.28

V2** Uniformity: 390 lx / 863 lx = rounded 0.45

What can be concluded from the above calculations is first of all that the uniformity still becomes better, when you adjust the suspension height. The extra 5 cm., from 65 cm. to 70 cm. increases uniformity with 40%, which is even more than the 20% from the first prototype. Comparing these uniformity calculations with the previous from the first prototype, it is seen that uniformity in general is better. The uniformity has increased with approximately 40-50%. But the uniformity is still not following the requirements from the EN 12464-1 standard (the lighting standard for work places), a uniformity index of at least 0.7. The clear optimization from the first to the second prototype though suggests that the iterations were correct and that a slight adjustment of the same iteration could accommodate this issue.

What is again interesting is to look at the light in the new iterated prototype and not only measure the light (see figure 79). It was in this test noticed that the hot spot effect was not as noticeable as within the test of the first prototype. This underlines the improvement of the design. The light in the second prototype seem more smoothened out, which could also be because of the higher attention to detail and finish of the second prototype. There was though still an issue with the multiple shadows and the visibility of the LED’s, but this was expected, since the iterations with optical silicone and a slight angle of the LED’s was not added to second prototype. In the future this would have to be added to a potential third prototype and similarly tested for.

To sum up the findings from this test, the iterations made from the first prototype to the second prototype had improved the lighting design significantly. Though the lighting design is still not optimal with the second prototype. The previous test in Dialux Evo indicated that the desired lighting design is possible and therefore small adjustments could accommodate for the issues found in this test. Overall the lighting design is closer to the desired and this is especially because

of the finish of the prototype, which makes the lighting more even and pleasant to look at. The material, the diffusion and the angle of incidence was not tested in this prototype, but would have to be tested in future work.

Figure 79. Evaluating the iterated prototype

TEST OF LIGHT AND MATERIALS (SKETCH)

The test of light and materials is a short and simple test, which in the future work be extended, both including more materials and also e.g. testing the translucency of the different materials. But the test conducted for this thesis had the purpose of specifically testing porcelain as material for a luminaire, because of the translucentcy and other possibilities. The test was conducted by having several sketches of the luminaire cast in porcelain, though differing in thickness, in glazing, colour and with and without engravings (see figure 80-82).

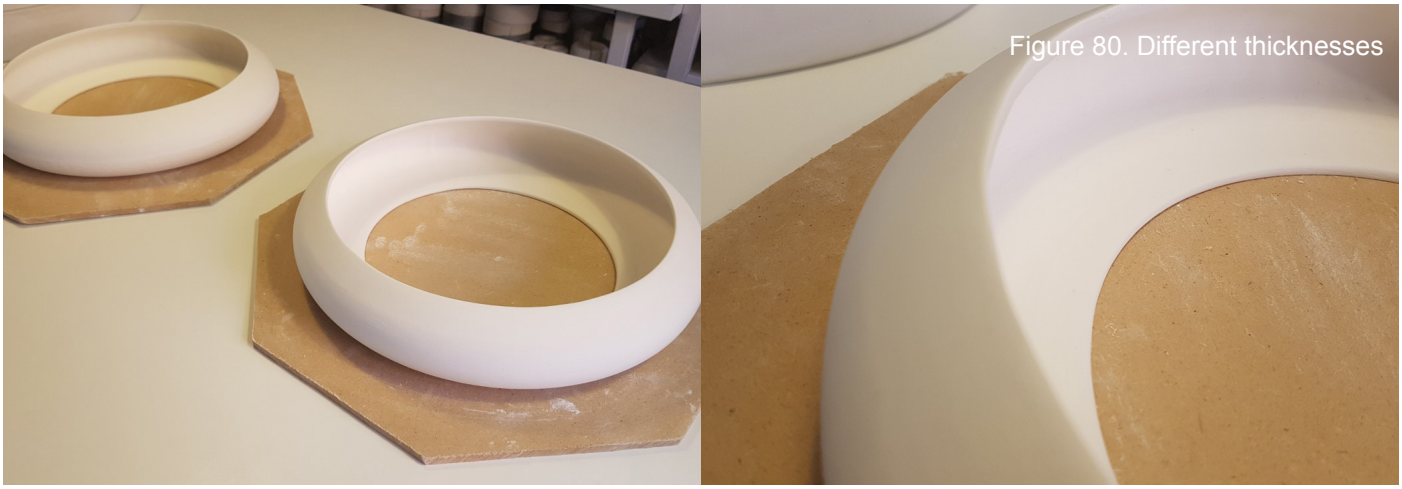


Figure 80. Different thicknesses

Figure 81. Engravings

Figure 82. Different glazings and colours

The different luminaire sketches were compared and evaluated. Firstly, they were tested without any light source included and afterwards with a light bulb held by hand in the luminaires (see figure 83). The purpose of the test was mainly to test the play of brilliants with the different translucencies and also to get a better understanding of the qualities and possibilities with the material.

Figure 83. Test of light and materials

What was found from this test was first of all that the translucency depends on two factors: The thickness of the porcelain and on the firing temperature. The thinner the porcelain is cast, the more light is scattered through. This is also seen with the engravings, where the engraved patterns are lit more up than the rest of the construction, which creates an interesting design opportunity, where you can play with different expressions in the turned off luminaire and the turned on luminaire. Engravings on the inside of the luminaire is not visible, when the luminaire is not lit up, but when the luminaire then is turned on, the pattern of the engravings come to life (see figure 83). The engravings in this test were based on the design aesthetics mood board and on the idea of keeping the design within the Nordic design language. Therefore, the engravings were heavily inspired by beech leafs (see figure 81). Beech is a very Danish tree, which is e.g. mentioned in the first stanza in the Danish national anthem:

“Der er et yndigt land,
det står med brede bøge”

Roughly translated the verse says: “There is a lovely country, it stands with wide breeches…”

The translucency of the porcelain, as mentioned, also depends on the firing temperature. The higher temperature the cast is fired at, the more translucent the finished porcelain product gets. But the cast porcelain is at the same time volnaible to high temperatures, since the clay can collapse at high firing temperatures. So it is a fine line to find the right compromise between temperature and translucency and also thickness.

Another interesting finding from this test, also regarding the translucency, was that when adding colour to the porcelain, whether it was dyed clay or glazed afterwards, it blocks all light and becomes a solid non transparent material. This means that if the material porcelain is chosen based on its quality of creating play of brilliants because of the transparency, then it can only be natural white. But coloured porcelain has a quality to it, which is in my opinion in line with the Nordic design trends, and therefore coloured porcelain also has potential. Coloured porcelain also has uniqueness to it in relation to pendants and luminaires, since it is not very common and could become the 'new' Nordic design trend. A fun little note to this is that the Danish TV station 'TV2' just sent (the 15.05.2019) an episode of their new programme, called 'the ceramics fight'[10] , where the challenge was to design luminaires in porcelain. And one competitor 'Esben' chose to work with coloured porcelain, which was acknowledged for being modern and innovative.

Summed, this test indicated that porcelain has interesting qualities in relation to lighting and that the light can be scattered through thin porcelain and create play of brilliants. The test also illustrated that the lighting concept of this luminaire has potential with several of different material styles and types. The final choice of material might not be to have only one specific material, but to suggest more materials, because they each have their own aesthetic expression and reacts differently with the light.

10. Translated from the danish title 'Keramikkampen'. http://tv.tv2.dk/keramikkamp

FINAL DESIGN

The final design is a lighting concept, designed into a suspension pendant luminaire for the dining area. The size and final physical form descends from the conclusions and design iterations made throughout this thesis. The final dimensions can be seen on the blueprint below (see figure 84). You should especially notice the diameter of the pendant, since this has been tested and iterated throughout the process and also the addition of the suspension part, which was not on the initial drawings, but was added to prevent discomfort glare and also to open up for different material possibilities. Below you can also see screenshots of the final 3D model from Rhino. The different colours on the model indicate the different materials or layers of the model: The outside body (red), the inside body (green) and the suspension part (blue) (see figure 85 - 87).

Figure 84. Blueprint of final design

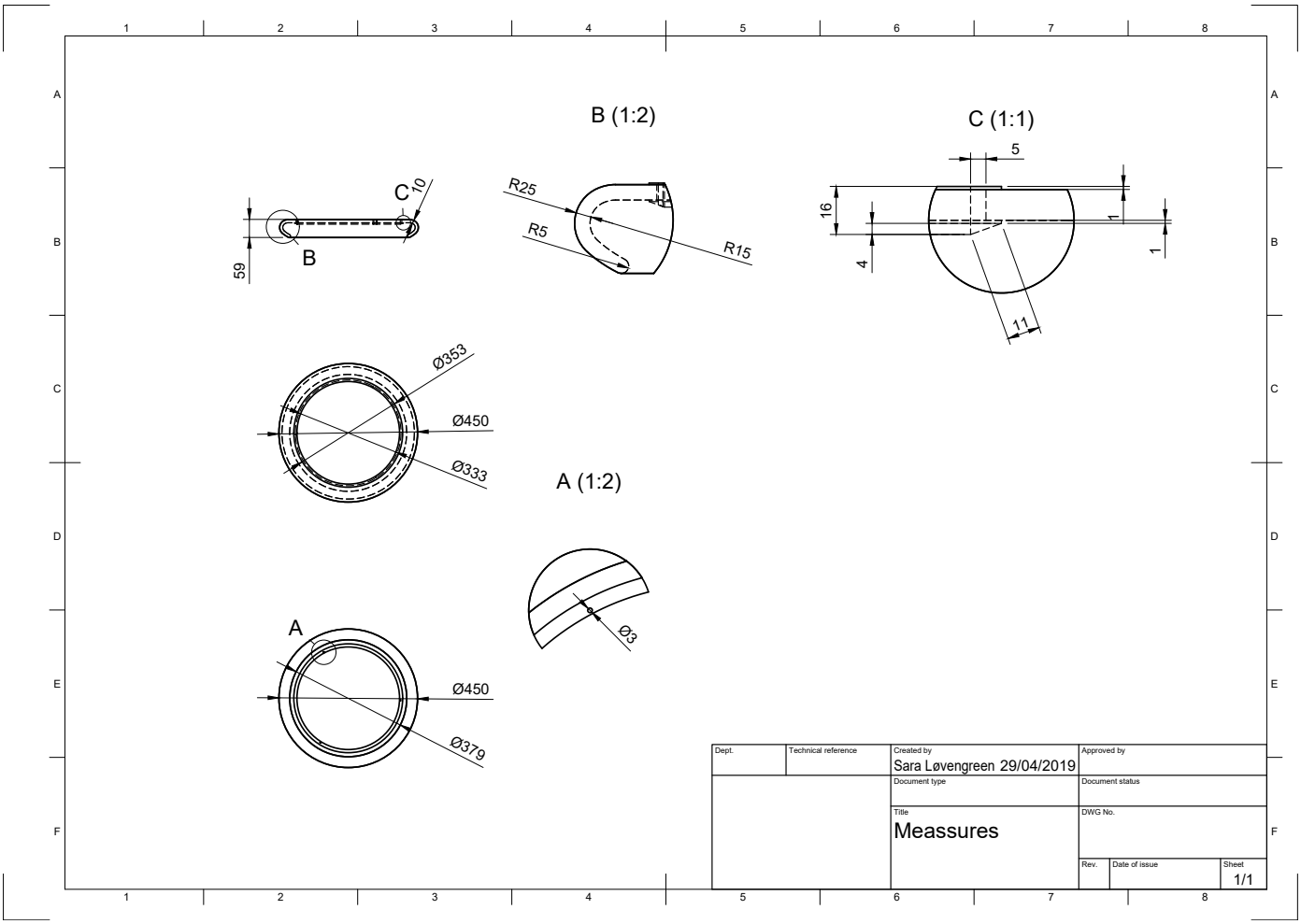


Figure 85. Final design isometric view

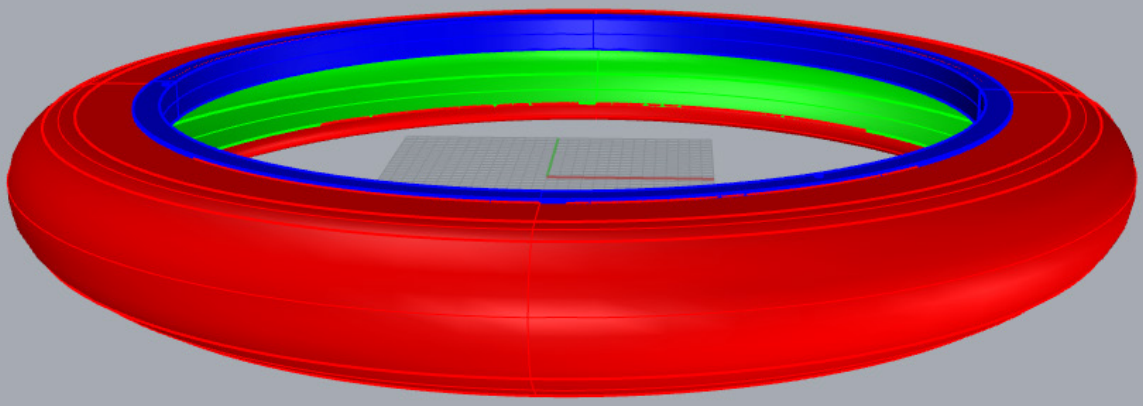


Figure 86. Final design top view

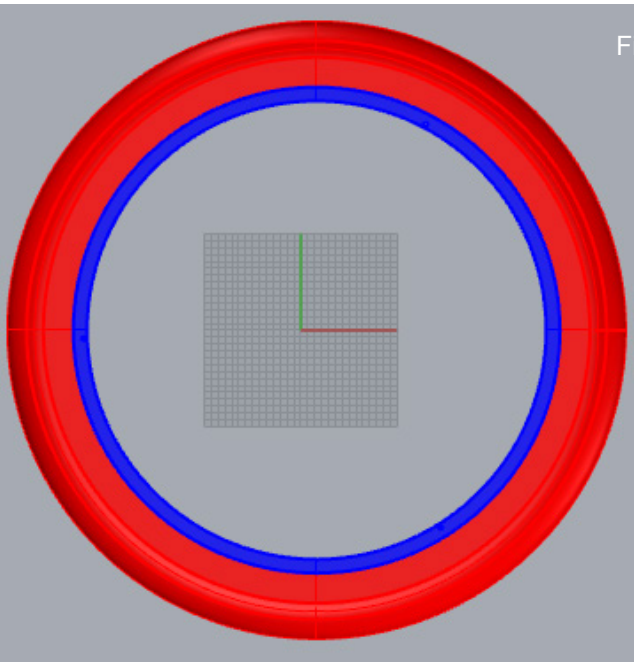
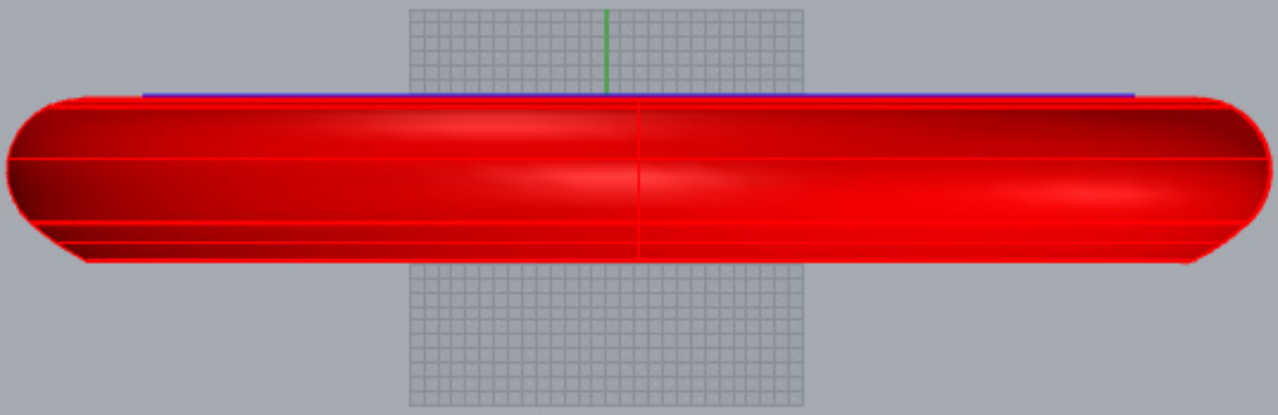


Figure 87. Final design front view



The lighting concept is overall to create aesthetically beautiful and functional well working lighting. Specifically the final design works with a combination of both ambient luminescence (from the reflected up light), play of brilliants (from the scattered light through the material), and focal glow (from direct down light). The combination of all three lighting principals is one way to create aesthetically beautiful light. But, what is beautiful is a subjective matter and therefore the final design is not a single pendant, but a lighting concept spread out in a pendant family. The pendant family is named: 'Sunna by Sara Løvengreen'. The word 'Sunna' originates from Old Norse language and the translated meaning of the word is 'Sun'. The connection to the Old Norse is supposed to sum up and create the full coherence of the final design. Since the original research explained the origin of the Nordic design, and concluded that we have to seek back to the resources in the northern countries to maintain this design language and also become more sustainable. The reasoning for choosing 'Sun'/'Sunna' is to relate the luminaire to the sun and the natural light in general, and also draw a parallel back to the idea of not knowing where the light is coming from, but just recognizing that it is there. The 'Sunna' family is visualized below, with different materials both for the luminaire body and suspension part. Each individual design in the family has its own unique name related to the material of that specific design (see figure 88-94).

Note that not all combinations are visualized nor all combinations have visualizations from every camera angle, but the visualizations shown are chosen out to illustrate the idea.

OVERVIEW OF THE SUNNA BY SARA LØVENGREEN FAMILY

- Sunna hesli/alu Ø45
- Sunna hesli/gold Ø45
- Sunna hesli/bronze Ø45
- Sunna eik/alu Ø45
- Sunna eik/gold Ø45
- Sunna eik/bronze Ø45
- Sunna kína/alu Ø45
- Sunna kína/gold Ø45
- Sunna kína/bronze Ø45

SUNNA HESLI/ALU Ø45

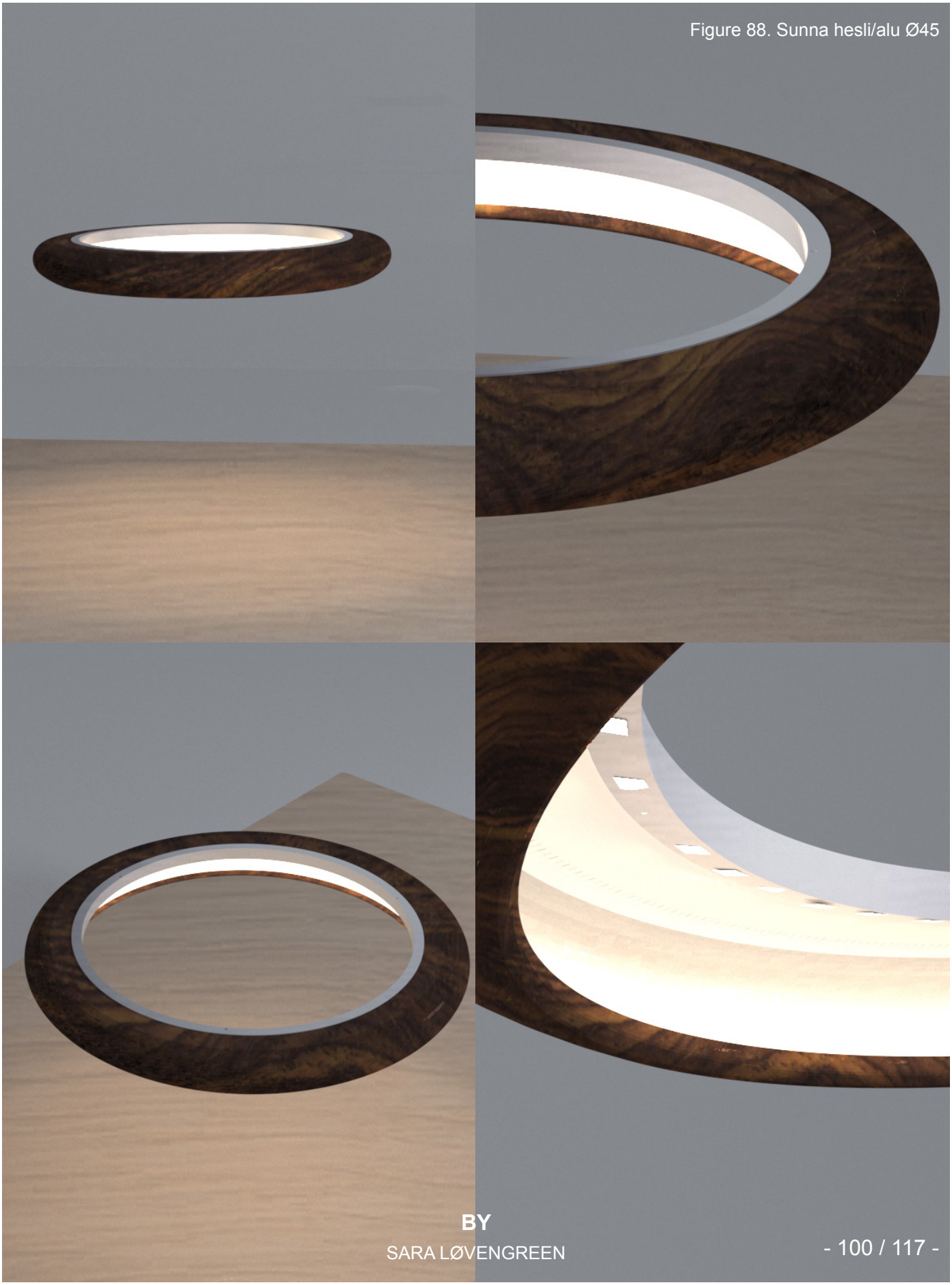


Figure 88. Sunna hesli/alu Ø45

SUNNA HESLI/GOLD Ø45

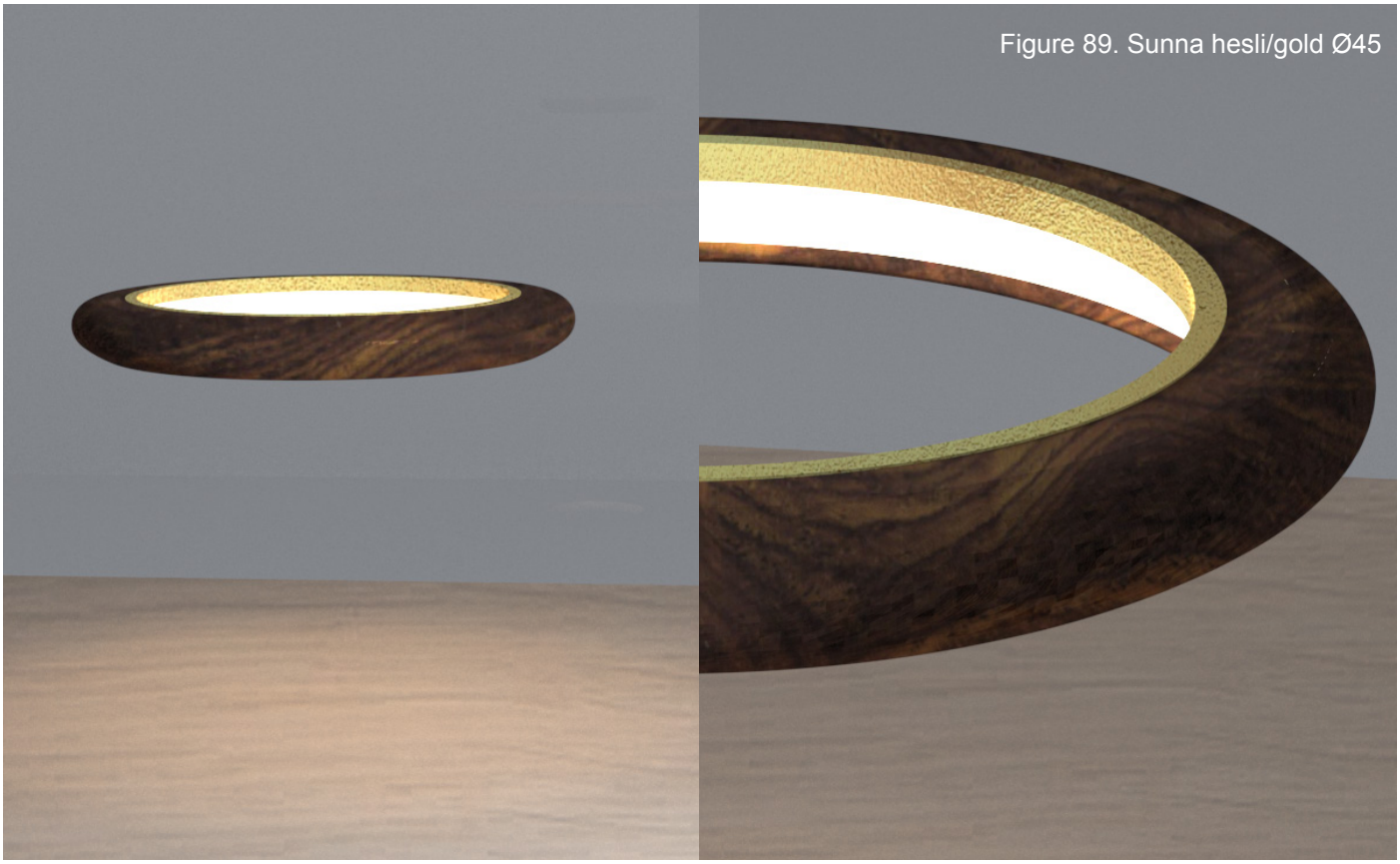


Figure 89. Sunna hesli/gold Ø45

SUNNA HESLI/BRONZE Ø45

Figure 90. Sunna hesli/bronze Ø45

SUNNA EIK/ALU Ø45

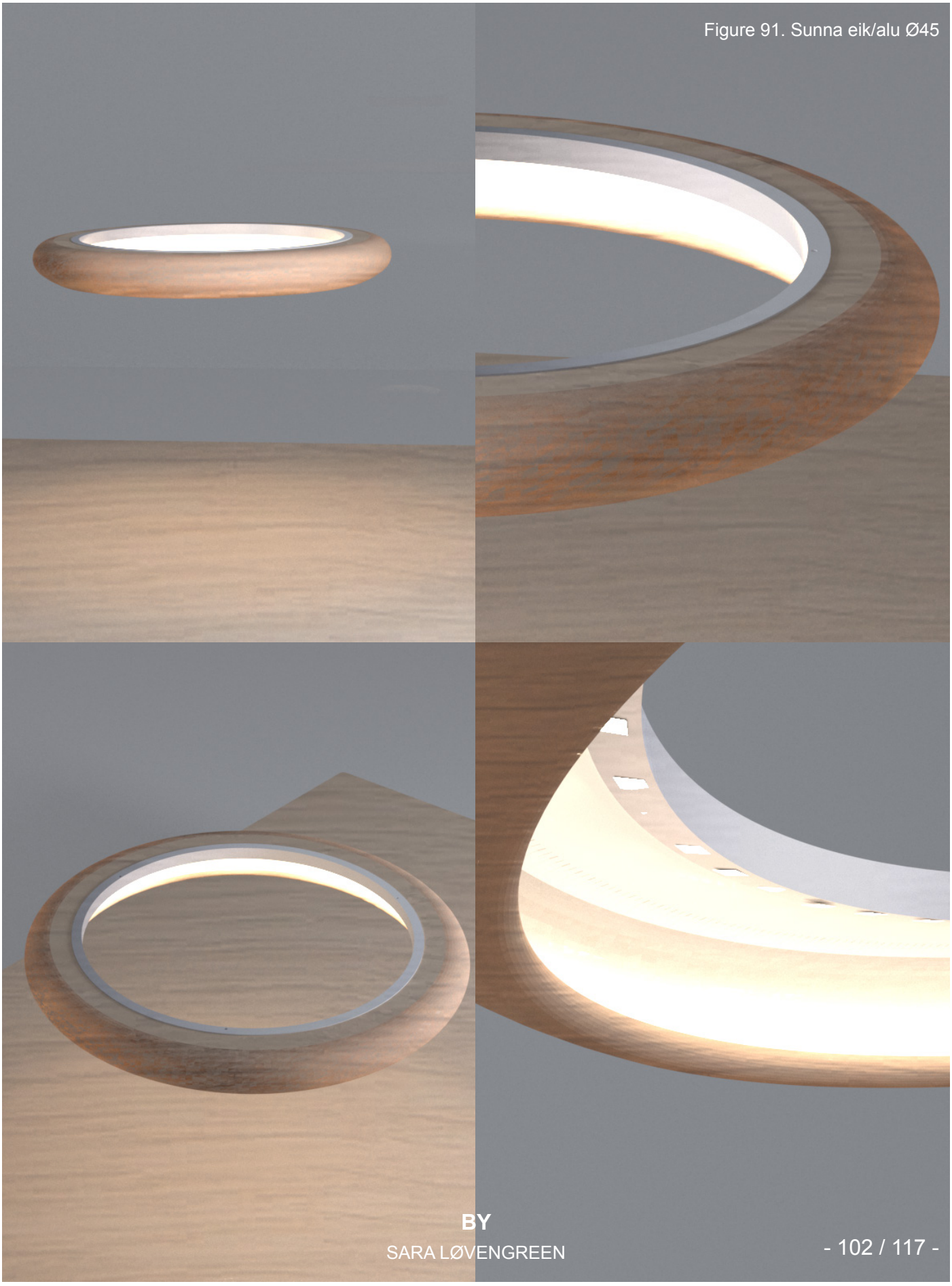


Figure 91. Sunna eik/alu Ø45

SUNNA KÍNA/ALU Ø45

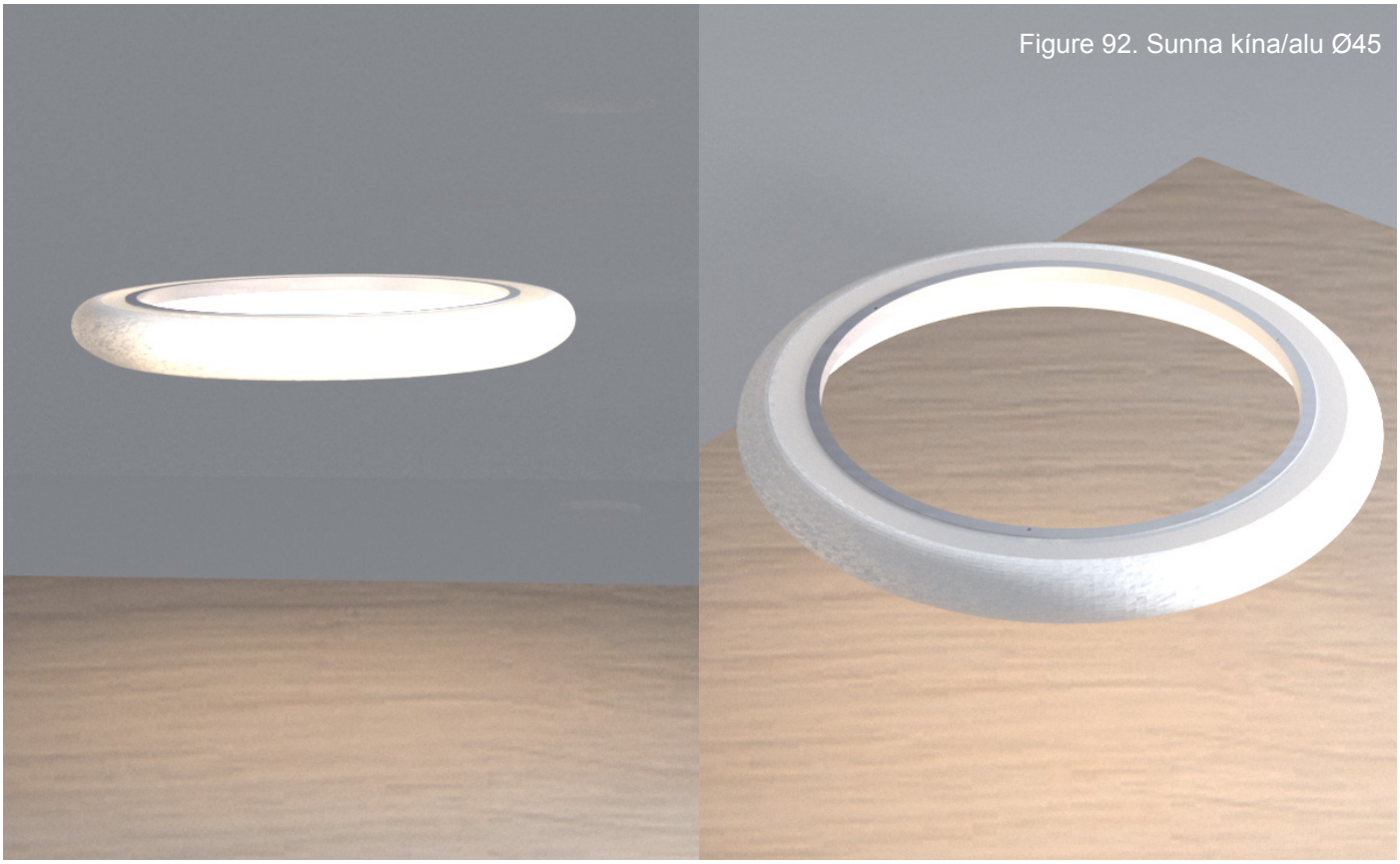


Figure 92. Sunna kína/alu Ø45

SUNNA KÍNA/GOLD Ø45 & SUNNA KÍNA/BRONZE Ø45

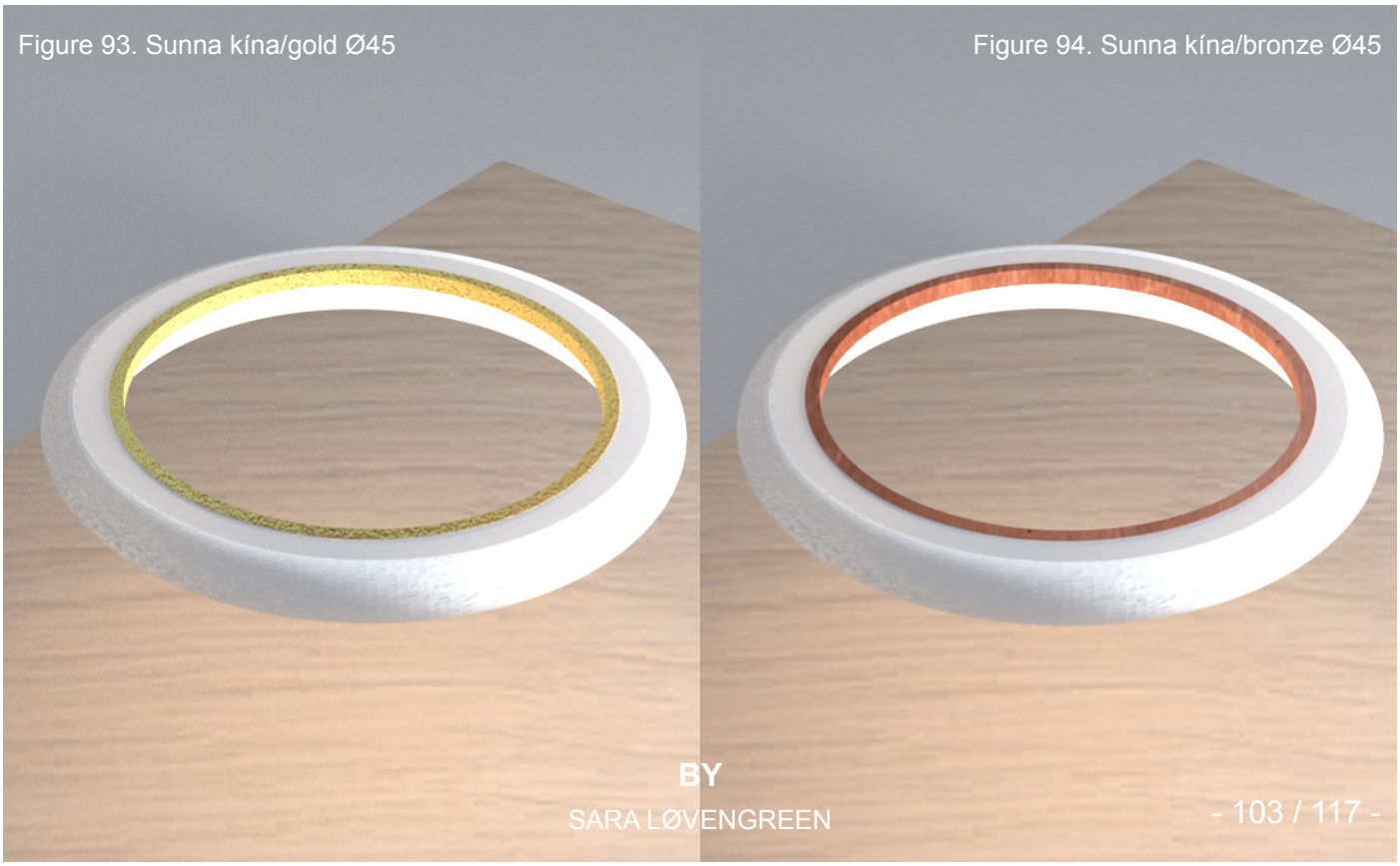


Figure 93. Sunna kína/gold Ø45

Figure 94. Sunna kína/bronze Ø45

In the ‘Sunna’ pendant family there are mainly three materials for the body of the luminaire: Walnut, oak and porcelain. Throughout the testing phase the different materials and their qualities were tested. The porcelain is more translucent compared to the wood and can thereby create play of brilliants and shadow play, which is not in the same way possible with the wood. But the walnut and the oak have a natural organic feel to it, which the porcelain does not have. The aesthetic expression differs depending on the material, but the functionality of the lighting does not differ in such extend that the use of the luminaire would differ depending on the material. Therefore, the final design is not a specific choice of material, but a series of materials, so the user can decide, which aesthetic expression is their own favourite and no matter the choice of expression by material, they still get the same functionalities and qualities of light.

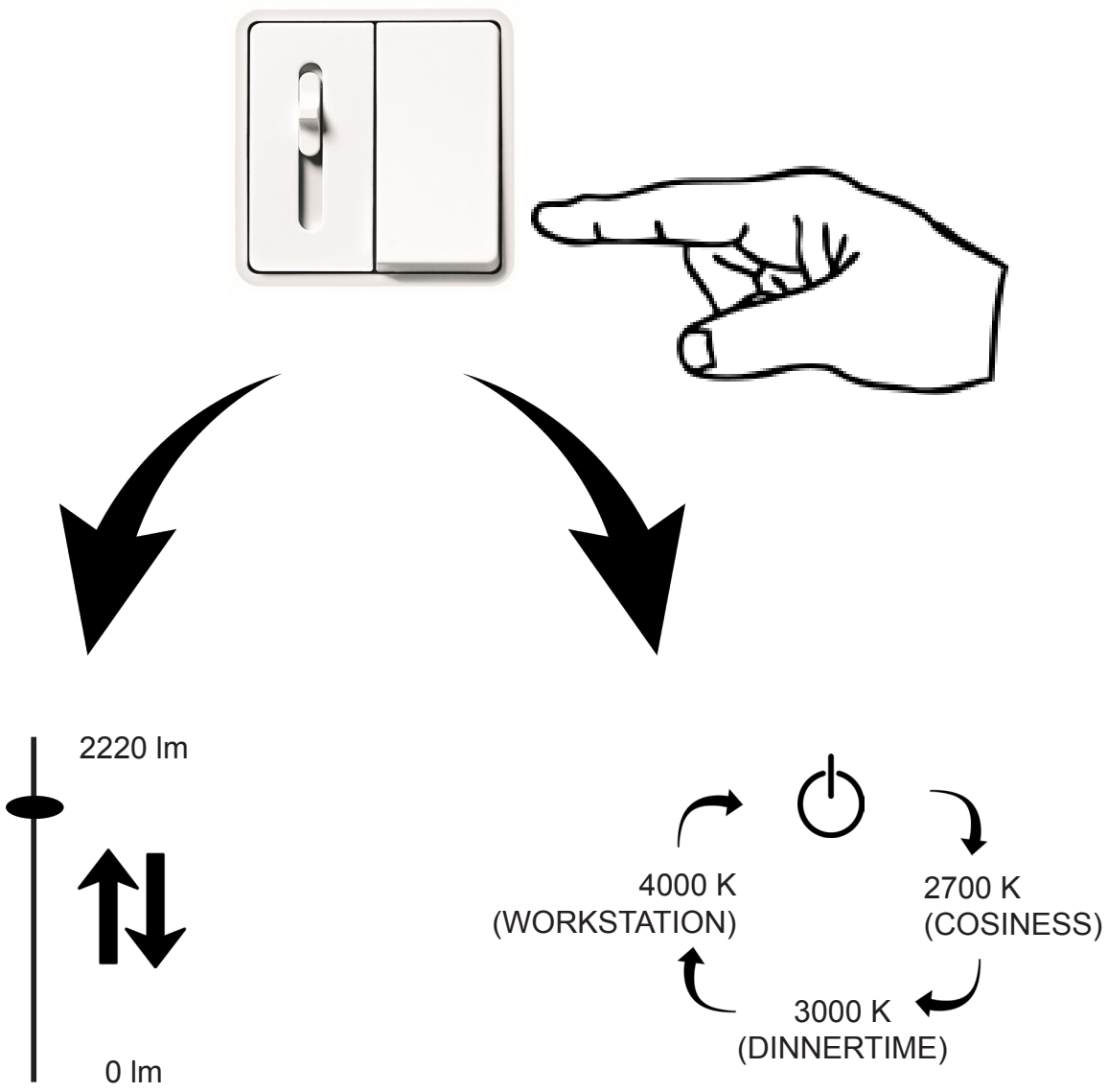
1. Dinnertime
2. Workstation
3. Cosiness

These three scenarios were defined and explain in detail in the phrase ’Defining the lighting scenarios’. But to sum up, the only thing, which actually differs between the three scenarios is the colour temperature, because the other functionalities are incorporated into the design. In the dinnertime lighting scenario the colour temperature is 3000 K. In the workstation lighting scenario the colour temperature is 4000 K and in the cosiness lighting scenario the colour temperature is 2700 K. All three scenarios have the same CRI value of 90 – 97 and the same max lumen output of 2220 lm.

In the phrase ‘Defining the lighting scenarios’, the three lighting scenarios are set up with some lighting design criteria. In the final design of the luminaire these criteria are worked in, so the form and material choice fulfils all the criteria in one design. For example the design both provides diffused up light, which was a criteria for the cosiness scenario and at the same time the design provides direct down light, which was a criteria for the workstation scenario. The design is intended to include as many of the criteria as possible in the same lighting concept and physical design. Therefore, the only thing that differs is the intensity (which is regulated separately by the user) and the colour temperature, where the user have three different settings.

The reason, why the three lighting scenarios have a name and is not just called the colour temperature (2700 K, 3000 K and 4000 K), is to help the user choose the best lighting for the intended activity. Had the scenarios been named after the colour temperature and not the activity, then the user would have to know, what colour temperature is best in the given situations. By naming the scenarios after the activity, then the user is guided to choose the optimal lighting solution. How the user would switch between the scenarios is not fully decided for the final design here, but an idea for a solution is sketched and illustrated on the next page (see figure 95-96).

Figure 95. 4 step switch and dimmer



The illustration (see figure 95) shows a power point (switch) with an incorporated dimmer on the left side. The dimmer dims smoothly from 0% to 100% intensity (0 lm – 2220 lm). The four step switch flow is illustrated on the right side of the above figure. The flow chart explains the different steps in the four step switch. First time you press the switch, you will turn on the luminaire in the cosiness setting. The second press on the switch, swicthes from the cosiness setting to the dinnertime setting, and so forth. The flow is infinite as illustrated (see figure 95).

The names of the lighting scenarios do not appear on the switch in this idea, but the steps would be explained in the instruction manual. Another idea is to develop and design a new unique wall switch, which is e.g. what Occhio does (see figure 96). But this is not in my opinion within the field of lighting design, but becomes more of product development, and therefore this has not been further developed, the importance lies within the before mentioned three lighting scenarios.

Figure 96. Special designed wall switch

Even though this phrase is called 'Final design', this is not the complete final design (full product and potential spareparts) for production. From being an intern at HAY [11], in their lighting development department, I have learned that usually a product development process takes between two to five years, before the product finally can be launched. This final design is the design as it is at this point in time. Not all design iterations have been added yet either, e.g. the finding with the engravings in the porcelain. In the two next phrases 'discussion and evaluation' and 'conclusion and future work' this final design will be evaluated and the deficiencies will be discussed. Also which future tests that could be useful to perform is mentioned. And in the 'future work' phrase new ideas, which have not been tested or fully thought through yet are also mentioned.

11. https://hay.dk/da-dk

DISCUSSION AND EVALUATION

The discussion and evaluation phrase takes its starting point in the final design. The final design is discussed and evaluated in relation to the three design criteria, which were set up in the beginning of the thesis:

Architecture
The luminaire should be sustainable (both sustainable design wise and environmentally)

Functionality
The luminaire should be flexible and suit more than one activity

Engineering
The luminaire should be free of discomfort glare and a low-hanging pendant

ARCHITECTURE DISCUSSION AND EVALUATION

Sustainability is not just an easy fix, with one solution. Sustainability can be discussed from many different points of views; are the materials good quality and long lasting, or are they recycled. Both solutions can be argued for as sustainable choices. The ‘Sunna’ luminaire family can be discussed in relation to sustainability from three different perspectives: 1. The material choices, 2. The aesthetically timeless design and 3. The quality of the luminaire in general, whether it is long-lasting or not? Usually, when you think about sustainable materials, you would think of recycled materials such as recycled plastic from the sea or waste planks from constructions sights. If it is those types of materials, which we categorize as the sustainable materials, then the ‘Sunna’ family is not a sustainable design. The ‘Sunna’ family is designed in materials, which originates in northern countries. The reason for this design decision was related to sustainability. Using Nordic materials for a design, which is assumed to be sold in the north and produced in the north is sustainable in the perspective of shipping and transport. The ‘Sunna’ family does not have to have large cargoes with materials shipped from one end of the world to the other to be produced. The production can stay within the northern countries and the CO2 pollution is therefore reduced, which makes the design more sustainable.

The material choice is in general a huge factor in relation to sustainability. The quality of the material can also make a design more sustainable. If the materials are of a long-lasting material, which does e.g. not break into pieces, if something hits it, then it could be argued for as more sustainable, since the user has the product for a longer period of time. Long-lasting materials counteracts with the buy and throw away culture. The materials in the ‘Sunna’ family can both be argued for as good, long-lasting materials and also the opposite. Treated oak and walnut woods are long-lasting materials, which do not get strongly faded by e.g. too much sunlight. But the

design solutions with the woods also suggest using a white paint on the inside to increase the reflectiveness and this white paint can fade or get a yellowish ting over time. The porcelain version is more fragile. The porcelain version does on the other hand not have to be painted or treated, other than maybe with a glazing. The colour and the reflectiveness of the porcelain version will not fade or decrease, but stay the same quality. Also porcelain compared to other clays, such as red clay, is within the profession acknowledges as a high quality material.

Overall I would argue that the ‘Sunna’ family is build of sustainable materials, because my perspective on sustainability is related to the CO2 pollution. For future work it would be interesting to do specific calculations on the CO2 pollution. This could give a better-documented conclusion of how much the CO2 pollution is reduced by keeping the production and materials local. In relation to the design I would also argue that the ‘Sunna’ family is sustainable, because of the simplicity in the design. The design can fit within every home and can also fit many different interior styles, since this design is not very ‘loud’. The ‘Sunna’ design does not scream visually, but can fade away, into the surrounding interior style. The design is intended to be timeless, to increase the sustainability of the design. Whether the design is actually timeless or could become an icon is up to the enduser, but the simplicity can though be an underlining argument.

A small note to the sustainability discussion is the choice of LED vs. the upcoming technology ‘O-LED’. LED is at the moment the most sustainable solution, but in the future O-LED might be a better solution. Using O-LED is also interesting in terms of having less material in the design. With the LED strip an optical silicone diffuser is needed, but with O-LED this might not be the occasion.

FUNCTIONALITY DISCUSSION AND EVALUATION

To begin with you could discuss the physical flexibility of the luminaire. In the idea generation process many of the initial ideas were supposed to be physically flexible. For example having a sphere, which with a slight touch could transform into a more flat egg shape. The shape shifting idea was originally thought as the solution to make the light and the luminaire fit more than one setting. It was though in the process found that it would be both easier to construct and maybe also better lighting design wise, to use the light and its qualities to create flexibility. The ‘Sunna’ family first of all has a size, which is suitable for both larger and smaller dining areas and tables. Of course the pendant is circular and the light is circular as well. This could argue against the flexibility of the design, since the ‘Sunna’ design fits a round and a squared dining table better than a rectangular or a very slim and long table. On the other hand, the testing phrase primarily concerned this issue and the final design can illuminate a rectangular table without creating a significant hot spot.

The ‘Sunna’ lighting design is thought to meet the users needs by having the three different lighting scenarios. It is these three lighting scenarios, which makes the design flexible to suit more than one activity. In this relation a discussion point is the users needs and also their understanding

of the use of the three scenarios. If the user does not understand how to use the lighting scenarios, then the design looses its flexibility. The usability has not been tested and this could again argue against the design fulfilling this design criteria. In future work it would be interesting and almost a must to test the design with the users before setting the design into production.

The starting point for the ‘Sunna’ design was the users and their needs, found through questionnaires. The quantity of the answers from the questionnaires is though not large enough to fully conclude anything, but only give a slight indication. The users have not been brought much into this thesis, but in stead the design choices have been mostly based on expert knowledge. The reason why the users have not been included more is because of their lack of knowledge on the subject. Lighting design is a field of knowledge, where you need at least the basic knowhow, before you can even discuss lighting design. This is due to the technical terms and knowledge of how the light will be affected in different situations. Lighting design is not only aesthetic design it also includes engineering knowledge and medialogy knowledge. It is therefore difficult for the general user to communicate their needs in terms of lighting, which was also seen in the answers for the questionnaires. The ‘Sunna’ design mostly takes its starting point from the experts’ knowledge and their statements of, what the users need.

Overall the ‘Sunna’ lighting design is intended to suit more than one activity, by having three lighting scenarios, but if the user does not understand the design, then the flexibility of the design falls flat.

ENGINEERING DISCUSSION AND EVALUATION

The engineering design criteria might be the design criteria, which have been the most important in my opinion to try to fulfil. This is because I have found both through previous assignments and research, but also through the research in this thesis that disability glare and also and discomfort glare is one of the main reasons, why the users say they like or dislike a luminaire. This findings was e.g. underlined in the questionnaires, where the glare issue was mentioned, and especially during the expert interviews the glare issue was also discussed.

What I have acknowledged with glare is that it is a compromise with the direct down light. If you want direct down light, the risk of creating some sort of glare will always be there. The compromise is then between, how big that risk should be and how much direct down light you want. In the ‘Sunna’ design this compromise is also something, which has been discussed and worked with. The ‘Sunna’ is not designed to be completely free of glare, since it is not an enclosed shape, where the light source is never visible to the user. The ‘Sunna’ design works with this compromise. The glare issue has been worked with in terms of the visibility of the LED’strip, meaning the angle of direction of the LED strip and also the placement of it. The LED strip is in the final design not visible to the general user, if the pendant is used as a low hanging pendant approximately hanging

60-70 cm. above the table surface. Optical silicone is also added to the final design, to lower the risk of discomfort glare. The optical silicone also helps to bend the light and thereby control the beam angle. This is important since, it creates the opportunity to angle the LED's so they are directed into the luminaire and not directly downwards, but still have direct down light on the below surface, because of the controlled large beam angle.

In the final design it is only the idea of this angled LED strip with the optical silicone, which enlarges the beam angle. This has not been tested yet and therefore it is not known, whether this design criterion is fulfilled or not. I foresee that in the future work it will be important to find the right 'prime spot', where the risk of discomfort glare is insignificant compared to the amount of direct light on the below surface.

Summed up I would argue that the 'Sunna' luminaire and lighting design fulfils the three design criteria, though knowing that future work has to be done, to tweak and optimize the design before a possible production batch. The design has the qualities, from what I have found in the analysis and in the research phrase, to become a successful design in the Nordic countries.

To draw a parrallel back to the previous analysis' and evaluations' of already existing pendants, I have created an updated version of the comparison diagram from earlier in the thesis. In this diagram I have evaluated my own design in comparison with the exsting examples. The result of my evaluation is seen on the below diagram.

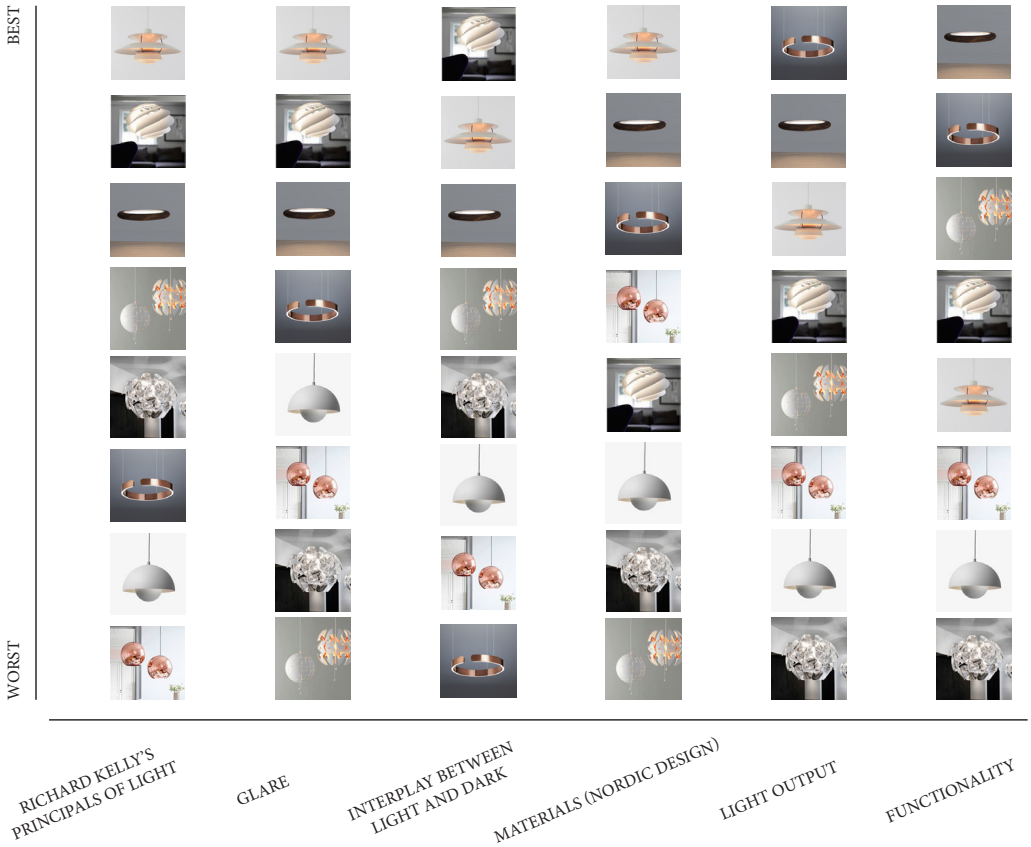


Figure 97. Updated comparison diagram

CONCLUSION AND FUTURE WORK

To sum up, the research question, which has been investigated through this thesis is the following:

What is the best lighting solution for the general citizens' dining area, in Nordic countries?

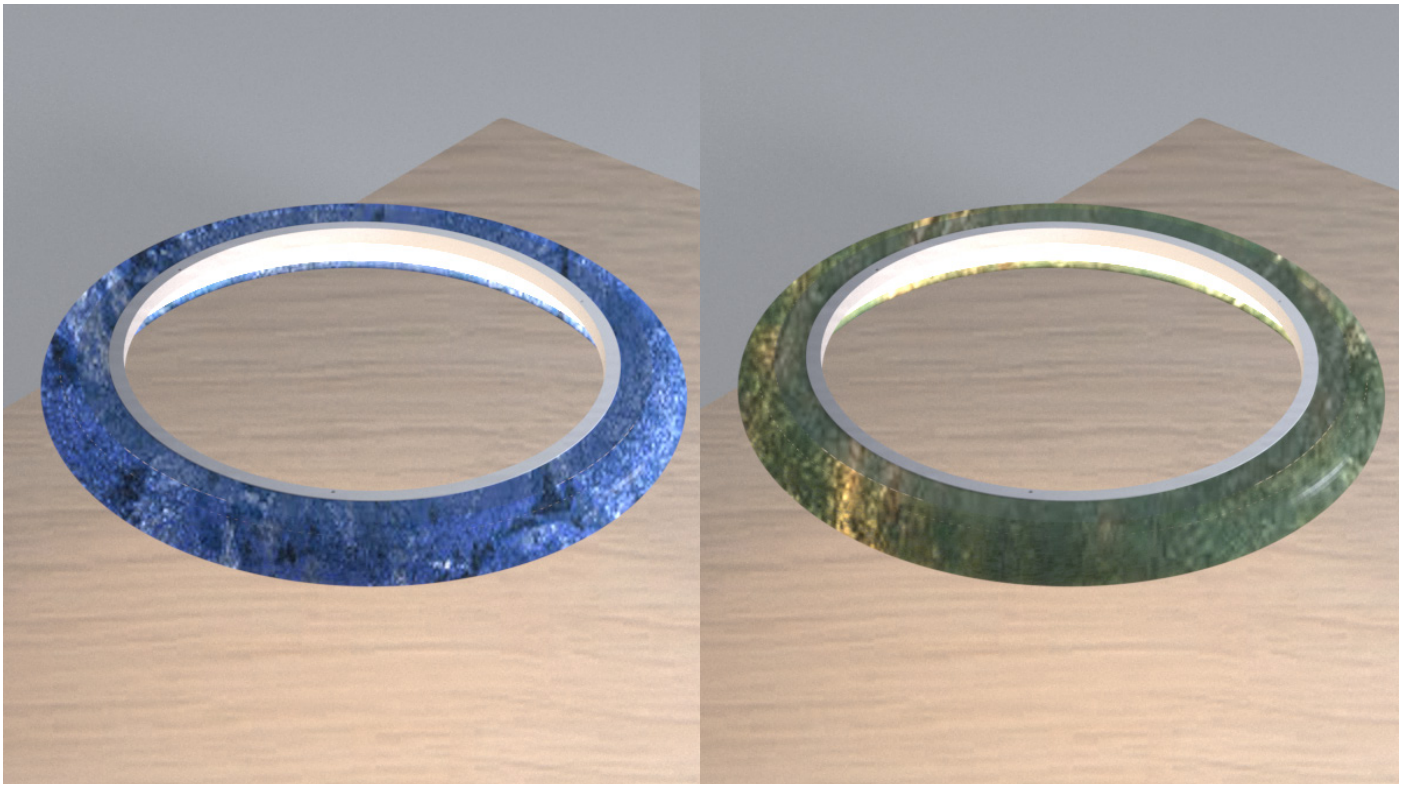
First of all, a finding that I personally found very interesting is that some of the users (general citizens) choose to not have a pendant or other luminaire in the main dining area. This conclusion was discovered during the collection of the questionnaires and has been the main inspiration for the design solution as well. One respondent specifically mentioned that she did not have a luminaire in her dining area, because she had not found a pendant yet, which did not block the view, eye contact and in general disturb the area. This respondent instead chose to have a dark dining area, and perform her activities in darkness, because no existing luminaire fulfilled her needs. This is of course not the optimal solution, but it is very interesting, because it illustrates that there is a gap in the research and an opportunity to create a design solution, which accommodates a genuine challenge.

Through research and analysis it was found that the best lighting solution for the dining area in the Nordic countries is not one specific design solution. Design wise, many different designs could in fact be the best solution, as long as both the lighting functionalities and the aesthetics are thought through. The Nordic design trends at the moment suggest that the best lighting solution is a sustainable solution, where the materials of the design originate from the Nordic countries. Furthermore, the Nordic design trends suggest working with simplicity, minimalism and natural organic aesthetics. In terms of functionality I can conclude that the best lighting solution for the dining area in the Nordic countries is to have good quality light. More specifically good lighting quality is a CRI value of 90-97, both direct and indirect lighting and a lux level of minimum 300 lx and optimally 800 – 1000 lx. What I can also conclude is that the best lighting solution is not just functionally good quality lighting, which fits the activities, it is also stimulating lighting. This is where Poul Henningsen and Richard Kelly states that stimulating beautiful lighting is created in the interplay between light and dark. Beautiful light is very subjective, but the PH 5 has been a popular pendant choice since the 1960's, which strongly indicates that Poul Henningsen knew how to create lighting, which the general citizens find beautiful. The issue with the PH 5 and the other classics is that they have not followed the technical evolution e.g. the LED technology. The PH 5 is not the best lighting solution any more, because of the evolution of technology, where many new possibilities now exists and a huge potential for optimizations. Additionally, to the technology evolution I have, through the investigation, found that the users are also learning and new needs arise in step with their progress. This leads me on to the possibilities for future work.

The user involvement is especially interesting for future work, e.g. as before mentioned to test the usability and also get an even better understanding of the users needs would benefit the

future development of the design solution. Furthermore, the testing phase in this thesis could be enlarged. Especially testing and finding the ‘prime spot’ for the angling of the LED strip would improve the design solution. As mentioned in the discussion, it is a compromise between how visible the LED’s should be and how much direct light you get on the below surface, and this has to be further tested.

Lastly, I can also conclude that the lighting design concept, which is developed in this thesis, opens up for even more design solutions, than suggested in the final design phrase. Especially the choice of materials can be investigated even more; could there be other interesting materials to work with, which reacts differently with the lighting design concept? What about materials such as marble, limestone or granite? As long as the lighting design concept is in line with, what has already been mentioned throughout this thesis, then the specific design solution can be whatever the materials’ qualities allow it to be.



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APPENDIX

APPENDIX 1 – QUESTIONNAIRE TEMPLATE

Spørgeskemaundersøgelse til kandidat speciale i lysdesign

Af Sara Therese Løvengreen

Hej,

Jeg er glad for, at du tager dig tid til at hjælpe mig, med mit projekt. Du skal igennem 12 spørgsmål og det er inklusiv de gængse, så du er hurtigt færdig med den gode gerning ;)

Navn: _____ Alder: _____ Køn: _____

Hvordan er din familie konstellation (antal):

Voksne: _____ Børn: _____

Hvilke aktiviteter foregår ved jeres spisebord?

_____

Hvilke/hvilken lampe har du over spisebordet?

_____

Hvilke kriterier har du/i valgt belysningen over jeres spisebord ud fra?

_____

Hvad er vigtigt, at en spisebordslampe skal kunne?

_____

Har du gjort dig nogle tanker omkring din spisebordsbelysning før?

Ja Nej

Hvis ja, hvilke tanker har du gjort dig?

Kan du tage et billede af jeres spisebordsbelysning, når du kommer hjem og sende det til mig på enten 26 85 18 06 eller sloven17@student.aau.dk

Må jeg kontakte dig for opfølgende spørgsmål?

Ja Nej

Hvis ja, skriv nedenstående det telefonnummer, du kan kontaktes på:

Telefonnummer: _____

Tak, for hjælpen!

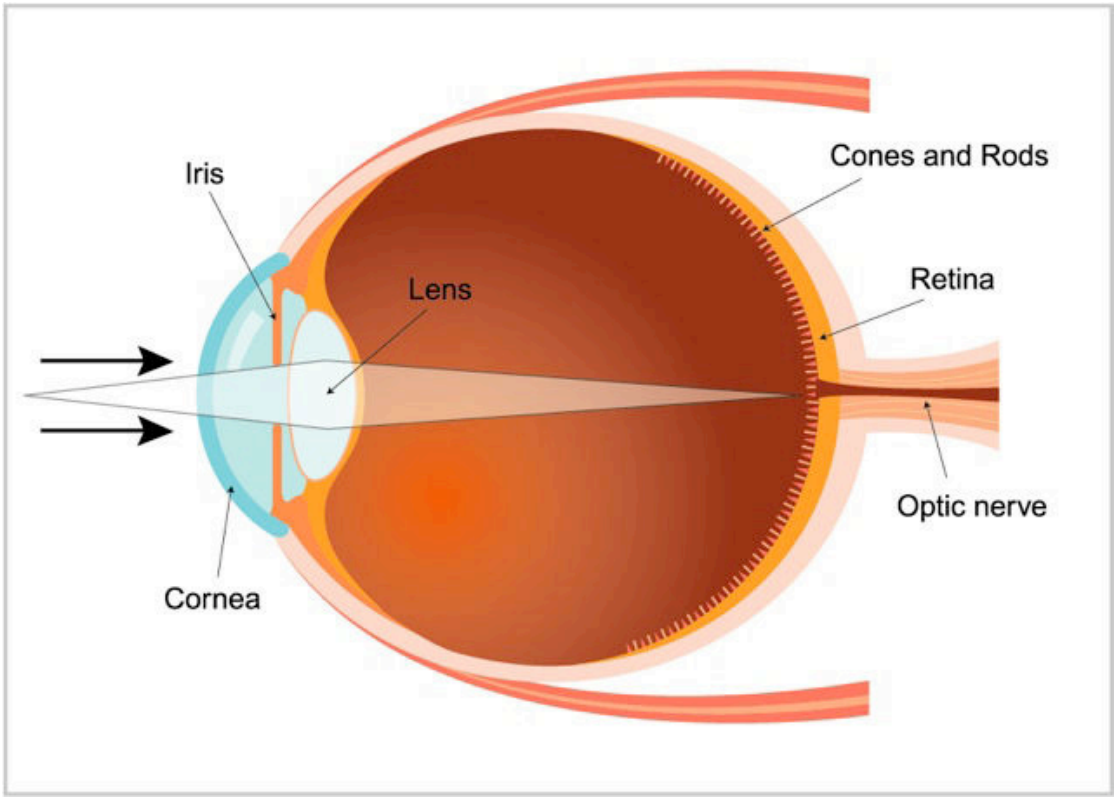
Riv dette stykke af og tag med dig hjem, så du kan huske at tage et billede og sende det til enten 26 85 18 06 eller sloven17@student.aau.dk

APPENDIX 2 – FULL LITERATURE REVIEW

The following literature review is the full review. The review is divided into four categories, each pointing out what I define as the most important theories and findings, within that field of knowledge.

LIGHT AND HEALTH – THE CIRCADIAN RHYTHM

It is commonly known that disruption of the human circadian rhythm can course several medical disorders such as depression, insomnia, cancer and general sleeping disorders (Chepesiuk, 2009). George Brainard, a professor of neurology at Jefferson Medical College, Thomas Jefferson University Philadelphia, states that exposure to light during the night can disrupt the circadian rhythm (Chepesiuk, 2009). The light photons must hit the retina for biological effects to occur. But when the light photons hit the retina at night, the melatonin production is supressed. Melatonin is the hormone produced by the pineal gland, which regulates the biological clock (Chepesiuk, 2009). This indicates that artificial light during the dark hours at night can have a negative biological effect (Touitou, Reinberg, & Touitou, 2017).



(Unknown, The Human Eye, 2019)

The circadian rhythm is in short our inner bodily clock, which tells us, when to be awake and active and when to go to sleep (Figuerio, 2013) (Lighting Research Center). It is synced with the 24-hour solar day. It is the light sensitive cells called 'pRGC' in the eye, which sends the signal to the 'SCN' and further around the body, in order to synchronise the biological processes with the solar day – Light is the strongest indication of time (Hansen & Madsen, Dialog om døgnrytmer og lys, 2018). What is important to state in this relation is though that the circadian rhythm is affected differently by light depending on age and chromotypy (Hansen & Madsen, Dialog om døgnrytmer og lys - del 2, 2018). The circadian rhythm can be disrupted or triggered by contrasts and high intensity blue light (Figuerio, 2013) (Lighting Research Center). Researchers have recently found that especially blue light is effective to stimulate the circadian rhythm, both negatively and positively (Lighting Research Center) (Touitou, Reinberg, & Touitou, 2017). Helen R. Wright and Leon C. Lack have conducted an experiment investigating different wavelengths of light in comparison to melatonin suppression (Wright & Lack, 2001). Their findings underlines that it is the blue wavelengths (short wavelengths between 400nm – 500nm), which suppresses melatonin the most. The diagram below is the findings from Wright and Lacks experiment.

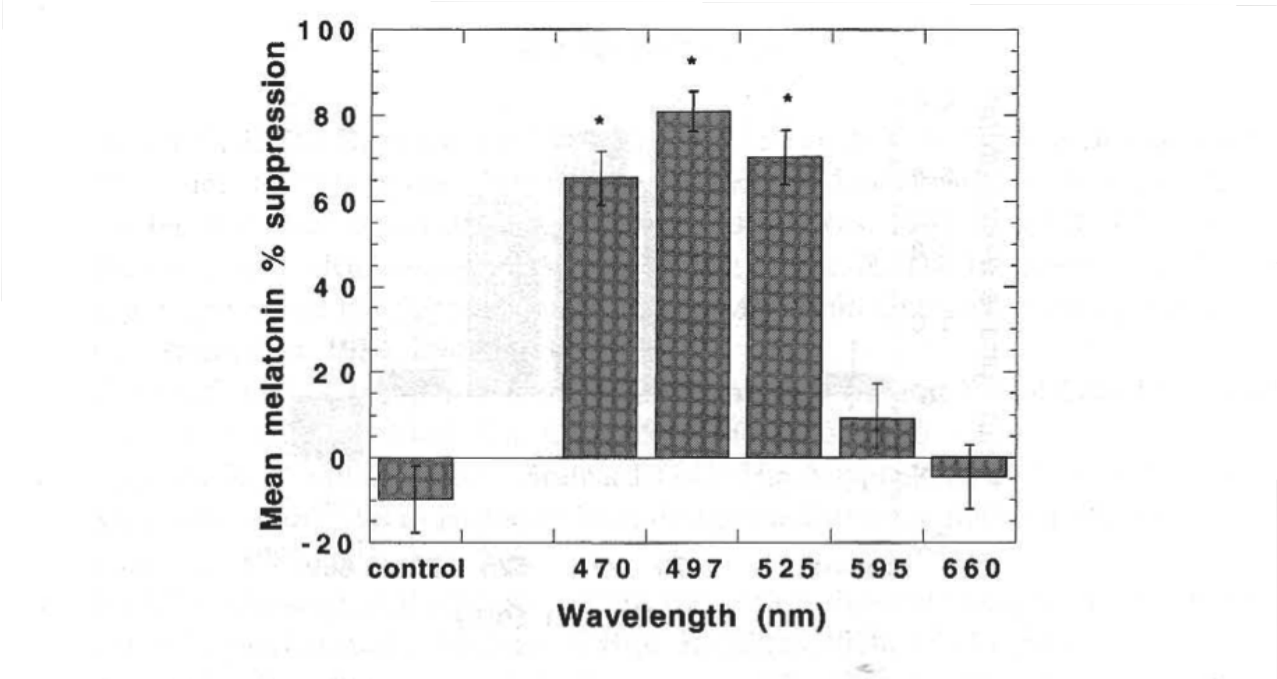


Figure 2. Mean melatonin percentage suppression and standard error bars for the no-light control condition and each light condition. *Significantly different from control, 595-nm, and 660-nm conditions.

(Wright & Lack, 2001)

It is not only too much light, which can have a negative effect – Also lack of light, especially daylight, can course depression, eating disorders and obesity (Garde, 2018). Consultant doctor at Psykiatrisk Center København, Klaus Martiny states that we, as humans, are not suited for a life in darkness, such as the Nordic winter months (Garde, 2018). Light gives us energy. It is therefore important to find the right balance between light and darkness.

Correct lighting can influence more than just our energy level. The human experience of temperature can be affected by change in colour temperature of the surrounding light environment. This hypothesis is called ‘hue-heat’ and is acknowledged by Michelle Kühl, Nanna S. Gudmandsen and Marie Rosenbeck from DTU (Danmarks Tekniske Universitet) (Kühl, Gudmandsen, & Rosenbeck, 2017). Kühl, Gudmandsen and Rosenbeck extend the investigation of colour temperature and perceived room temperature in their article ‘The Influence of Light on the Human Thermal Comfort’[12]. In the article an experiment in a controlled environment is described. From the experiment it is found that by changing the colour temperature from 6200 K to 2700 K, the perceived room temperature increases with two degrees Celsius. It is also found that a higher colour temperature is associated with better air quality and more intense light, although this was constant during the experiment. At last it was found that the change in colour temperature did not affect the test subjects’ performance (Kühl, Gudmandsen, & Rosenbeck, 2017). These findings are interesting to include in the design process, because it is here shown that colour temperature has an effect on comfort level and not necessarily on performance. This could be considered in relation to choice of light source and in the end have an influence on the energy consumption as well.

LIGHT SOURCES – QUALITIES AND EFFECTS

Even though the trend is LED light sources, LED’s are not the answer in every situation. The different light sources have different abilities and strengths. Choosing the right light source for the purpose can make the whole difference, add quality to the lighting design or make the lighting design les useful. Therefore it is important to understand the differences in the light sources and what they are good for and vice versa. Following is a review of the most common light sources for dining areas.

Standard incandescent light bulb
In the incandescent light bulbs, it is electrical current, which heats the filament and thereby creates light (Tregenza & Loe, 2014). The lifetime of a standard incandescent light bulb is typically 1,000 hours. With the low lifetime, why would you then use incandescent light sources, the answer is that the colour rendering is high. The colour rendering is usually around 97. Furthermore there is no need for a driver to incorporate dimming and flicker is minimal (Tregenza & Loe, 2014). But the fact is that the standard incandescent light bulbs are not manufactured any more, since the halogen incandescent light bulbs have taken over together with the LED’s.

Halogen Incandescent light bulb
The halogen incandescent bulb works by electrical current heating up the filament inside the bulb. It is the same technique as in the standard incandescent bulb. The difference is that the halogen gas in the halogen incandescent bulb makes the filament light up at a lower wattage. The halogen incandescent bulb therefore uses three-quarters of the energy compared to the standard incandescent light bulb (Lighting Research Center, 2011). The lifetime of a halogen incandescent

12. Translated from the danish headline: ”Lyset Indflydelse På Menneskets Termiske Komfort”.

light bulb is typically 2,000 hours. The most important quality of the halogen incandescent light bulb is that the colour rendering quality is high compared to e.g. the cheap LED's. Often the halogen incandescent light sources have a CRI value of around 97.

LED (light-emitting diode)
The different LED chips and products vary quit a lot in quality, competences and cost. Also the LED technology is still being optimised and keeps getting better and better in quality. But in general it is electroluminescence, which creates the light in the LED chip. The LED chip is coated with phosphor, which makes the chip appear yellow, but this is to transform the otherwise UV-light into visible light (Tregenza & Loe, 2014). A luminaire using LED technology is build up as a light engine. The light engine is the LED chip, reflector and heat sink all together. Since it is not heat, which creates the light in the same way as the incandescent bulbs, the LED's do not emit as much excess heat and they use less power to supply the same lumen output. The efficacy is still getting better, but at the moment the efficacy is approximately 30-60 lumen/watt. This is why the LED's are considered as more energy efficient, than the halogen incandescent light bulb, which has an efficacy of 10-15 lumen/watt (Dansk Center for Lys in collaboration with Elsparefonden, 2008).

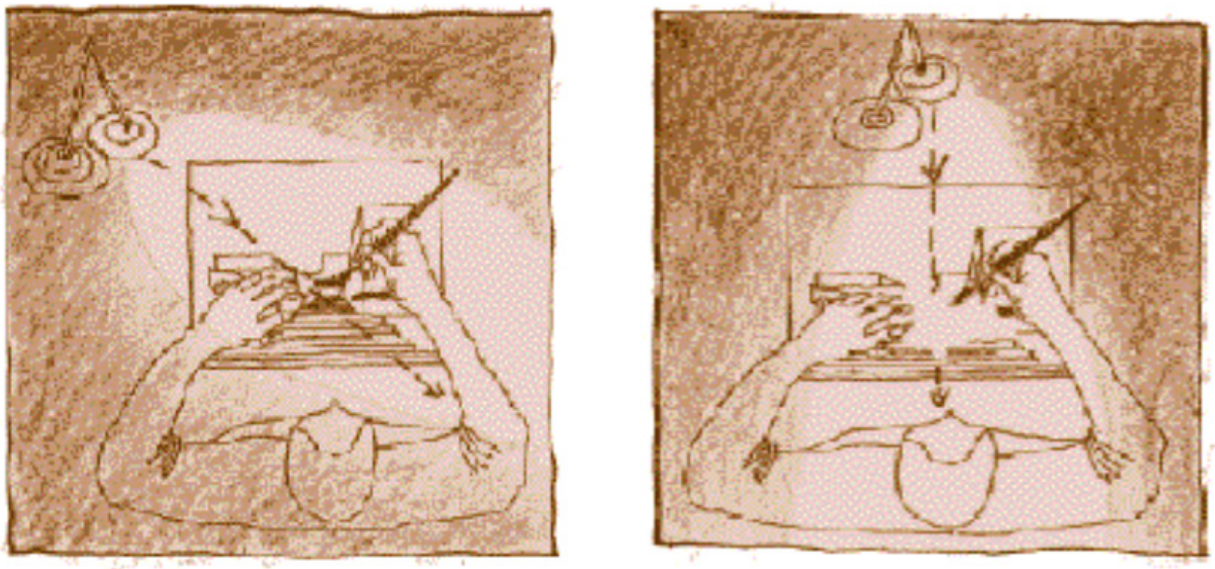
The typical lifetime of a LED is 50,000 hours, compared to the 1,000 and 2,000 hours of the incandescent light bulbs. Another quality of the LED's is that their shape and size can be altered and thereby more easily fitted into different luminaire designs. The LED chip only emits light in one direction compared to the incandescent light bulbs, therefore you must think the lighting design through and maybe modify the light, to get the wanted output, when using LED's. The downside of the new LED technology is that the colour rendering is not as good as other light sources. Often the colour rendering is between 80-90. LED's with a CRI of more than 90 can be found (max CRI 97 for now), but cost more (Tregenza & Loe, 2014).

O-LED (Organic light-emitting diode)
The O-LED gives a completely different light than the standard LED's (Nielsen & Bay, OLED lever i bedste velgående, 2018). The biggest difference is that the O-LED is diffuse light and the colour rendering is high. The CRI value is often more than 90 in O-LED's. But the price follows the quality as mentioned and at the moment the price is approximately 50 USD/1000 lumens. What is also interesting with the O-LED is the physical flexibility of a O-LED panel, it can be bend, twisted and played around with even more than we can we the LED's (Nielsen & Bay, OLED lever i bedste velgående, 2018). The O-LED is build of molecules in layers between a cathode and an anode. When the current is running between those two, the molecules light up and emit different coloured light depending on the type of molecule (Lindén & Thorseth, 2019). In the future the O-LED technology can become very interesting in lighting design.

Glare
When we talk about glare, we differentiate between two types of glare: Disability glare and discomfort glare (Tregenza & Loe, 2014). Disability glare is when you are unable to perform a

specific task, because you cannot see. Discomfort glare is often when there is a very bright light source in your field of view and this becomes uncomfortable (Tregenza & Loe, 2014). Discomfort glare is often measured by subjective rating (Bullough, Fu, & Derlofske, 2002). There are different factors, which can make glare occur. Glare depends on the size of the light source and the surrounding light (Henningsen, 1974). To high contrast in the surroundings can creates glare, both discomfort glare and disability glare (Tregenza & Loe, 2014). To avoid glare you can work with direct and indirect light, more specifically the angle of the glare source (Lighting Research Center, 2002) (Bullough, Fu, & Derlofske, 2002). If the glare source is not in your angle of view, then glare is avoided. This can also be worked with in terms of diffusers. A diffuser creates a bigger surface of the light source and thereby reduces the chance of glare (Henningsen, 1974). Here it is though important to note that with a diffuser you reduce the lumen output of the luminaire (Lighting Research Center, 2002).

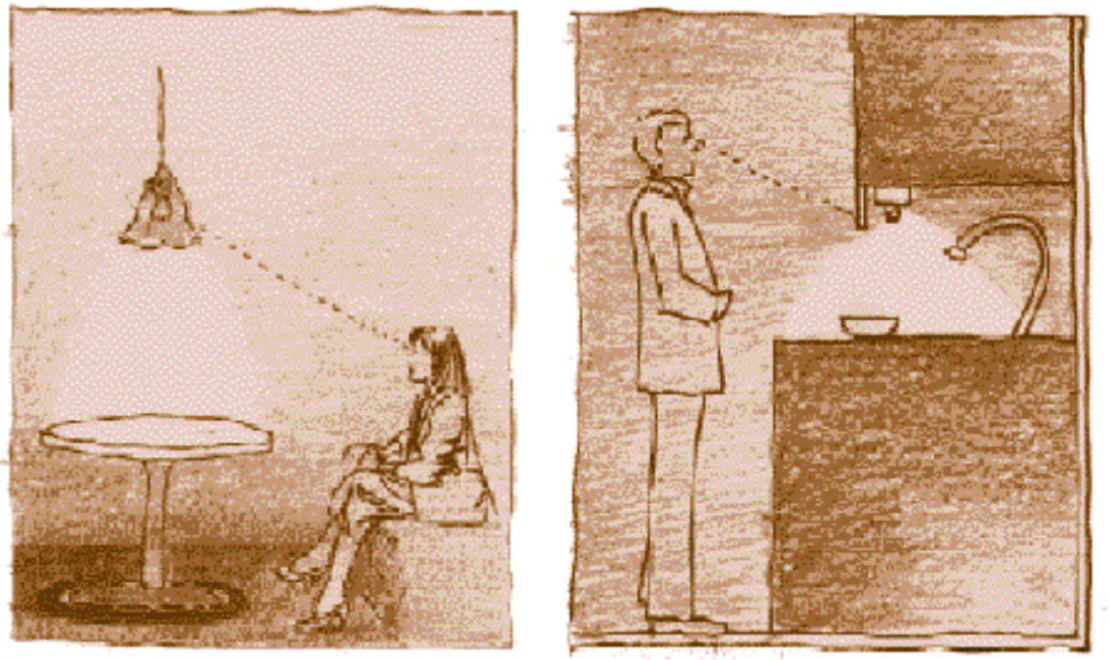
The Lighting Research Center writes an article about, how you can avoid glare, other than minimizing the contrasts. Their suggestions can be seen in the illustrations below (Lighting Research Center, 2018).



A. **B.**

Place your task light to your side (a) to avoid glare bouncing off shiny surfaces (b).

(Lighting Research Center, 2018)



A. **B.**

Block your direct view of light bulbs with a shade (a) or shielding board (b).

(Lighting Research Center, 2018)

Aim lights on the object you want to see, not on your face.

(Lighting Research Center, 2018)

LUMINAIRE ARCHETYPES

Luminaries are divided into six categories (archetypes): recessed, ceiling-mounted, suspended, architectural, wall-mounted and plug-in (Lighting Research Center, 2018). The architectural luminaries can both provide down and up light, the characteristic is that the architectural light is build into the structure. The ceiling-mounted can both be; directed light or ambient light, but is most often used to provide a room with the general lighting for that space. The plug-in luminaries are characterised by portable luminaires, often battery lamps with a charger. The recessed luminaires are close to the architectural luminaires. They provide down light or light on wall surfaces. Wall-mounted luminaires are often used as direct light for a specific task e.g. reading or cooking.

Suspended luminaires are the most common for the dinning area. The suspended luminaires can have all kinds of shapes and styles and both provide ambient and direct light. The suspended luminaires often intend to block the direct view of the light source (Lighting Research Center, 2018). The suspended luminaires are characterised by hanging from the ceiling. If it is above a dining table, the rule of thumb is to hang the luminaire approximately 60-65 cm. above the table (Leslie & Conway, 1996) (Fritz Hansen, 2016). Since the luminaire is hanging from the ceiling, the dimming or controlling needs to be thought in otherwise. The dimming is often mounted to the wall. The suspension lamps have traditionally mostly been providing down light and ambient light, but there is no impediment to also incorporate up light (Leslie & Conway, 1996). Also chandeliers are characterised as suspension luminaries (Leslie & Conway, 1996).

TASK LIGHTING

Since the dining area is not only used for eating your dinner, but also serves as a workstation, it is interesting to look into, what good office/task lighting is? Volf and Meisler have in 2016 written an article about intelligent lighting for offices. One of their findings is that cool lighting in work areas creates a good work environment. With cool light, they refer to a high colour temperature, approximately 5000 – 6000 K (Volf & Meisler, 2016). Furthermore, Volf and Meisler state that a dimmed and warm lighting atmosphere will intrigue a lower activity level and a lower noise level (Volf & Meisler, 2016). Even though they argue that cool light is better for the work area, they also state that intelligent lighting, which considers the biological clock is the best solution (Volf & Meisler, 2016).

Nielsen and Bay have written an article concerning good office lighting in general. Here they state that good office lighting is not only to have appropriate light on the work task, but also to consider the surroundings, otherwise you will get listless (Nielsen & Bay, God Kontorbelysning, 2017). It is important both to consider the central vision and the peripheral vision. It is the combination, which creates the overall impression of comfort (Nielsen & Bay, God Kontorbelysning, 2017). Nielsen

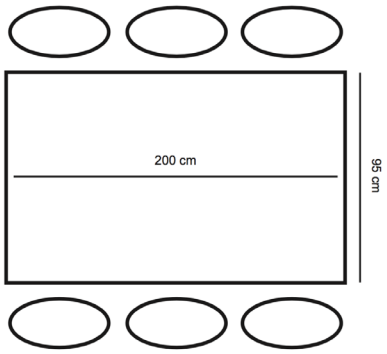
and Bay also state that it can improve your well being to be stimulated, and that lighting can be one of the factors to create variation and stimuli (Nielsen & Bay, God Kontorbelysning, 2017). Also Nielsen and Bay touch upon dynamic lighting in relation to the biological clock and, how a change in colour temperature can have a positive effect biological (Nielsen & Bay, God Kontorbelysning, 2017). In detail Nielsen and Bay state that good office lighting is, 300 lx for short period reading and writing, at meeting tables and at screens. 500 lx is ideal for longer periods of reading, writing, and more detailed work as drawing. Furthermore a colour rendering of CRI 80 is suggested. Lastly they state that the ideal lighting scenario is build of both direct, indirect, up and down light (Nielsen & Bay, God Kontorbelysning, 2017).

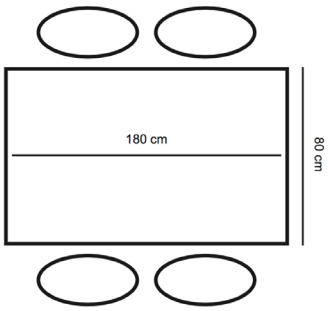
In addition to the previously mentioned article, Anne Bay has also written an article about glare in office environments (Bay, Bædning i Kontormiljøer: Hvad Hjælper?, 2017). In the article an interesting finding from Anne Bay is mentioned. The finding is that lighting up the perpendicular surfaces rather than the horizontal surfaces lets the eye rest (Bay, Bædning i Kontormiljøer: Hvad Hjælper?, 2017). Again Bay also points out that lighting up the surroundings and minimizing the contrast reduces the chance of discomfort glare. We should in offices and work areas focus more on lighting comfort, than lux and lumen (Bay, Bædning i Kontormiljøer: Hvad Hjælper?, 2017).

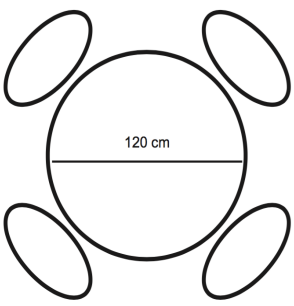
LIGHTING UP THE DINING AREA

If you search for guides for lighting in dining areas, you will get hundreds of hits. Though many of the guides mostly focus on the size and type of luminaire compared to the table. This phrase is a sum up of the guidelines concerning lighting and how to light up the dining area.

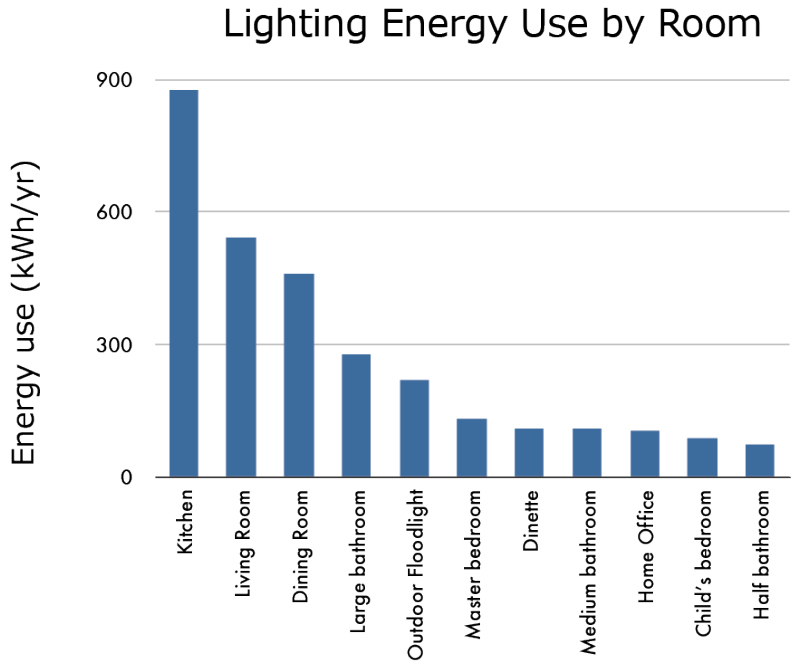
First of all the two most common dining tables are either round or rectangular. The most common sizes are fitted 4-6 seats, which is approximately for the squared tables either: 180 X 80 cm or 200 X 95 cm. The round table is most often 120 cm in diameter. Furthermore the dining tables are most often made of wood or laminated plastic and are either white or natural wooden coloured on the top surface (IKEA, 2018) (ILVA).







The dining area is especially interesting in terms of lighting, because this is the place in the private homes, where most energy is consumed by lighting. The table below illustrates the amount of energy consumed by lighting in different rooms. The dining area does not have to be in the kitchen, but the three most energy-consuming rooms are: The kitchen, living room and the dining room. The dining area is most often in one of those three rooms and therefore the dining area is in the top three of most energy consuming rooms/areas.



(Lighting Research Center, 2011)

Following Leslie and Conway's guide for lighting in the dining room, the best solution for the common sizes round table is to use a 75 watt incandescent A-lamp, suspended or ceiling-mounted. They suggest providing down light, though diffused and not direct. Another more unconvensional suggestion by Leslie and Conway is a wall washer, creating ambient light to the entide room (Leslie & Conway, 1996). The danish furniture store 'Idé Nyt' has on their webpage suggested using a pendant made of a solid material, only providing down light, but with a large beam angle, so the lighting becomes spread out over the dining table (Viuf, 2015).

In a newer article (Lighting Research Center, 2018), the focus is more on minimizing glare and having the oppotunity to dimm to create the best dining area lighting. Here it is also stated that a pendant both illuminating the surroundings and the table directly, would be the absolut best solution (Lighting Research Center, 2018). More detailed the webside Residential Lighting describes that the best artificial light in the evening is a warmer light source (around 2700 K) with no more than 50 – 80 lx (Lighting Research Center, 2013).
If we dive more into the technical suggestions for lighting in the dining area, then lighting up food should also be considered and discussed. In the article "Dining in the dark: the importance of

visual cues for food consumotion and satiety", it is in short found that dakrness in the dining area and having no visual cues of the food makes you eat more (Scheibehenne, Todd, & Wansink, 2010). Whether this is a good or bad thing is a subjective matter, but the finding is an important consideration for the design process. The Catrere states in their article about creating the perfect dining atmosphere that the CRI value should be minimum 80 and it would be best if the CRI value is closer to 90 (Coombs, 2016). A CRI value close to 90 will ensure that food and drink is displayed to maximum impact (Coombs, 2016).

In terms of aestetics and interior design, lighting in the dining area is a bit more diffucult to define. The dining area is becoming more than just for serving dinner. So what is the ideal dining lighting? Wilhide suggest that the the purpose of the main luminaire in the dining area is to create a space within the space – so the dining area becomes its own place in the kitchen or dining room or where it is placed in the house (Wilhide, 1999). Furthermore she describes the importance of flexibility, since the use of the dining area is becomming more and more flexible as well (Wilhide, 1999). The dining area should both be able to create a relaxed/intimite atmosphere, and give the oppotunity to see the food clearly, since we say that we also eat with our eyes (Wilhide, 1999). Ford suggests to meet the need for flexibility by controlling the light with a dimmer (Ford, 2009). She also mentions that both CRI and CCT is important factors for the flexibility (Ford, 2009).

NORDIC DESIGN TRENDS

Anne Bay very precisely explains, what she defines as Nordic Lighting Design. She explains that Scandinavian design often is associated with words as "minimalistic", "robust", "human cantered", "simple beauty" and "sustainable" (Bay, Nordic Lighting Design Som Et Fælles Brand, 2017). She also mentions, how it is a must for Nordic lighting design to have good quality to differentiate from the cheep products around the world. More specifically she states that Nordic lighting design is glare free and creates an atmosphere (Bay, Nordic Lighting Design Som Et Fælles Brand, 2017). Lastly she underlines, how important it also is for Nordic Lighting Design to be sustainable and not only aesthetic and functional (Bay, Nordic Lighting Design Som Et Fælles Brand, 2017).

Some of the larger Scandinavian design brands have also expressed their opinion on, what Nordic Design is. &Tradition express that Nordic design is: "Craft meets art. Function meets form. Material meets potential" (&Tradition referred to by (Gundtoft, 2015)). Gubi mentions that Nordic design is: "It is simple, but with character, and, of course, wood is essential" (Gubi referred to by (Gundtoft, 2015)). And Lastly BI Design studio expresses that Nordic design is clean a simple and also mentions the specific materials, which they associate with Nordic Design: "We wanted the building to express a clean and simple choice of natural materials, which may actually be a Nordic attitude: steel, concrete, glass, wood and copper" (BI referred to by (Ibler, 2015).

Another Scandinavian designer, who is interesting in terms of Nordic design trends is, Øivind Slaato. He has worked together with brands such as Le Klint and Louis Poulsen and has won

several prices for his designs. The article “Good lighting makes me happy”[13], Øivind Slaatto is interviewed about his view on good lighting (Gram, 2017). In the interview Øivind Slaatto states that the Nordic lighting design trend is to reduce glare and have more soft and dimmed lighting than e.g. Japan (Gram, 2017). Furthermore he states that we in the Nordic countries have a tendency to create small ‘light-islands’, to create an atmosphere in the room (Gram, 2017). Lastly he mentions that he loves the darkness and that it is the play between the light and darkness, without creating too much contrast, which interests him the most (Gram, 2017).

The Danish design magazine ‘Bo Bedre’ have often written articles about lamps, lighting and interior design. In 2018 they wrote an article focusing the new lighting trends. Here they expressed that the new trend is lamps that create emotions in the viewer, lamps with an artistic expression, almost sculptural (Holte, 2018). Furthermore they have in the beginning of 2019 written a more general article, concerning the colours, which will be trendy for interior in 2019. Bo Bedre predict that the trend colours will be Yves Klein-Blue (A deep blue) and delicate, matte colours en general (Bo Bedre, 2019).

(Bo Bedre, 2019)

Bo Bedre’s latest article about design trends is called: “Here is the most important trend in 2019 ”[14]. They here state that there is one trend, which is more important than all other trends in 2019. This trend is ‘recycling and repairing’ (Bo Bedre, 2019). This statement of the newest trends is consistent with both Anne Bay and the other above mentioned designers or companies. This indicates that sustainability is a huge trend in terms of Nordic design, also lighting design.

Taking a more technical perspective on Nordic design trends in relation to lighting, Gunver Hansen has summed the most interesting trends from the Light and Building fair 2018 (Hansen G. , 2018). One of the trends from 2018’ Light and Building fair was, according to Gunver Hansen, round luminaries. Round luminaires with both up and down light, was a clear trend. In extension to this trend were flexible LED luminaries, in other words luminaries, where the shape could be customised. Lastly a trend also mentioned in the article is to include the circadian rhythm into the lighting design (Hansen G. , 2018).

13.Translated from the Danish headline: ”Godt Lys Gør Mig Glad”
14. Translated from the Danish headline: ”Her er den vigtigste trend i 2019”

APPENDIX 3 – NOTES FROM THE QUESTIONNAIRES

Age
31, 61, 53, 20, 63, 27, 40, 31, 58, 45, 34, 38, 30, 24, 30, 61, 68, 20, 26, 53, 35, 29, 80, 76

Gender
F: 14
M: 10

Family type
2 adults, 1 child x 4
2 adults, 2 children x 2
2 adults x 6
3 adults, 1 child
1 adult x 5
1 adult, 3 children x 2
3 adults
1 adult, 1 child
4 adults
2 adults, 3 children

Activities
Eating: 22
Drawing: 3
Having a nice time: 6
Drinking: 4
Having friends over: 4
Having conversations: 4
Playing games: 7
Reading: 1
Working on the computer: 9
Watching movies: 2

We do not have a pendant above the dining table, but a Havana lamp in the corner and another small table lamp on the side table.

We want a clear vision and we want to be able to see each other over the table
An old antique lamp

None: 4
A pendant from IKEA: 3

Criteria
Modern aesthetes: 1
No glare: 3
Clean lines visually: 2
Be able to see the surroundings: 5
Be able to see the food: 8
Good light output: 12
The general design: 12
It has to fit the design of the table: 3
Create an atmosphere: 3
Dimmable: 4
2700 K: 1
More than 400 lm: 1

Reflections
Light up the whole table and a bit around as well
I want to be able to move the pendant
Should there be one or two pendants
You need to be able to see the food
I have changed from the PH5 to the Enigma 545, because I wanted a stronger light output on the table
It has to give a lot of light and look nice at the same time
The size of the pendant has to fit the table and the dining area
It was important that it was functional light, which could screen off surrounding light, while having down light
Many pendants seem out of place above the dining table
It has to be decorative and funny
I often change the lamps, so it fits the style at that moment
It has to be cosy light when we are having dinner
It is important that it is not just cosy, nice light, but that you can also get enough light to work
I do not want the lamp to take up to much space visually
I had a PH pendant, but the light was not good enough and I changed to Caravaggio
It is important with the colour rendering
We do not have enough light

APPENDIX 4 – INTERVIEW GUIDE FOR THE EXPERT INTERVIEWS

> THEME <	> ASSOCIATED RESEARCH QUESTION <	> INTERVIEW QUESTION <
Introduction to the Designer	What do other lighting design company's offer/ suggest?	- What is your educational degree? (Or job title) - How long time have you been designing luminaires? - What would you say is your most successful design? (Why?)
Nordic Design Trends	What are the current Nordic design trends (especially concerning suspension lamps)?	- How would you describe nordic lighting design? - What are the current trends in luminaire design? - What do you predict will be important factors in lighting design in the future?
Customer Needs	What are the general citizens' needs in terms of lighting in the dining area?	- What do you see as the most important features for a luminaire in the dining area? - What light is preferred in the dining area? - What tasks should the luminarie fit to/facilitate? - What does the change from traditional incandescent to LED have of influence on the light/luminaire at the dining table?
Design Critaria	What are the success criteria for a dining area luminaire?	- Can you mention three success critaia for a dining area luminaire (aestetically and functionally)? - What do you think is important, when you design a lamp for the dining area? - Do you have any 'rules', for light in the dining area? - What is the most essential function of a dining area luminaire?

APPENDIX 5 – NOTES FROM THE EXPERT INTERVIEW WITH DESIGNER ANNE QVIST

The interview was conducted over Skype the 08.03.19. The interview lasted for 30 min. and mainly followed an interview guide. Not every question was prepared beforehand, and the interview was therefore semi-structured. The following is the full transcription of the interview.

- Can you start by telling a bit about yourself, who are you?

“I studied at the school of architecture and industrial design. I graduated in 1992 and has practiced as a designer ever since. The biggest part of my carrier I have worked in architectural houses with design, and been head of design in HL Architects for ten years and eight years in Arkitema Architects. Then seven years ago I decided to start my own office and it is a one-woman business. So I work with architecture and design on a very sort of large/broad scale, I do product design, but I also do interiors. It is quit mixed. I think in Danish it is called ‘fri leg’, and it is different things, it could be furniture, and it could be interior. It is not so focused, but I have allowed myself not to be focused, because I have been focused for many many years.”

- In relation to luminaires and lamps, how much have you been doing of those kinds of products?

”Both indoor and outdoor, so there is a large range in scale. When you do outdoor it is huge products, and it is a different approach, when you do that, and then of course small lamps for indoor, that could be pendants and desk lighting, different stuff. So the whole range actually.”

- What would you say is your most successful design?

”I think I have two that I am most proud of. Successful is not about financial success, but more about, this is a nice product - this was what I really wanted to do. I have done an outdoor lamp that is called ‘Outfit’, which is an outdoor lamp you really can change. It can go from being an one-arm to being a two arm, to a three arm, and it is exhibited at the permanent collection at the Danish design museum, as a part of a fair exhibition called ‘Danish design now’, that is one I really like a lot. Then I have done a small desk lamp for Lightyears Fritz Hansen called ‘AQ01’.”

- Why do you think it is those two products, you said something about being proud of them?

”They both represent what I stand for. The outdoor lamp has been there for a long time, and I still like it, when I look at it. It is nice to come back to it and think that it is still nice, and it is the same with the desk lamp. I think it has what I wanted to do. It is quite important that you actually like the things, when you go back to them. Sometimes you think ‘ohh, well some things are not that successful’.”

- How would you describe Nordic lighting design?

”I am so sick of the words ’Nordic’ and ’New Nordic’. I think it has just been really really over used. Actually I think everybody all over the world is making Nordic design. The success is immense. And I think our success go way back to the fifties, sixties and seventies. People all over the world, designers all over the world embraced it and like it. I think it has been misused from a commercial point of view. To me it became a branding thing, instead of actually being this sort of, en many ways modest and minimalistic approach to design. Which is to me sort of the true Nordic way. I think the movement really came in the fifties. It is difficult everybody is trying to be really smart about where it came from, but I think it actually came from this modest thing, where we did not have a lot of material or have a lot of production. So we had to used what we had.”

- Does that affect the materials we try to use in the Scandinavian countries, when we design?

”Not any more, we have access to materials, from all over the world, but I do think we will see that we will be going back to using local materials, because I think we are not going to have access to the materials, because of sustainability. Sustainability is a big issue. So I do think we will see local materials as very important, so maybe it will be sort of a return to fundamental basics, what can be done with what we have.”

- So maybe something that you will predicts is that in the future also lamp design will be in materials that we can find in the Scandinavian countries?

”Yes, and recycled.”

- Do you think sustainability and recycled materials are the hottest trend right now?

”I wish it were, I am not sure it is yet. I think we are using more material, than ever. And I think the designers are to be blamed too, because we would do anything for a specific detail, a nice surface.”

- Do you try to fulfil this sustainability trend in your products? And how?

”I wish I could say ’yes, am really into it’. I think it is very complicated actually. And I think the responsibility should be with the manufactures that should be really strict with designers and anybody else, and say what you are allowed to use, ’this is what we have’. As a designer you can of course wish for it, you can encourage that it is done. I think looking at the whole circle, and then the responsibility should be with the manufactures. I like to think that the right way to design sustainable is to make good quality that will last for many years. I it just a really old fashioned way of thinking, and do not see that happening now. I think design has become very much like the fashion industry. I do not think that furniture is cheap if it only lasts for five years, then it is a very expensive piece of furniture. Good furniture should last a lifetime. For myself I would rather not have s sofa if I cannot afford the one that I want.”

- What do you think is the most important features for a luminaire to fit the dining area?

”I think that there is the aesthetics and then you have the techniques of course, and LED is the thing that needs to be used. I think it is a challenge because it is still quite ugly. It is not beautiful light and I think especially with a pendant for a dining table it has got to be beautiful. It is really important that the pendant creates an intimate space between the table, the people and the pendant. It is a space that should be created that makes people focus on whatever they are doing at the table, even if you are working. You should create a cosy space and usually you do not use pendants for work, but it is dining so a nice cosy space.”

- Can it also be something that is flexible for both dining and working, because the dining table is often more than just a place where you eat?

”That is an excellent idea and I think it is a really nice approach that products can be flexible. A pendant is a very decorative thing, something that people give a lot of money for. It would be great it you could combine it, and I think that has a lot to do with the quality of the LED.”

- How would you describe the light that you prefer at the dining table?

”An old fashioned light bulb unfortunately. It is warm, it is soft, and it makes people look good.”

- So even though you would work at your dining table you would still have warm light?

”Yes, because when I worked with interior, I have actually decided that I am going to fight this. There is so many interior project spaces where you have engineers on, and they say, ’ you got to have so much of this and then everything is fine, those 3000 lx or whatever they are’, but actually happens if you have a light that is green or blue, then it makes people look terrible. It is an even light and I think light should vary. The opposite of light is shadow and darkness and I think both should be present in the room to make light interesting. And actually when you do have a pendant, it creates focused light in one space and you will have darkness to the sites and that makes interesting spaces and makes people look more dynamic. It is really difficult, when you work with big projects, to get through with this idea, because well people are going to be more fresh and awake if you have the right amount and then you have this completely even layer of light in the room. I think that looks terrible. Everything is about measurements, the same with acoustics. As a designer you have to trust your senses and what is going on in the room. Use your senses.”

- What activities should the luminaire fit? Any specific functions?

”Of course it is nice to be able to dim the light, but that is a standard. I think the idea of dividing the space and the room, I do not think a pendant should have very much up-light, it is down-light that defines the space.”

- What about e.g. the colour temperature, should you be able to change it by yourself?

”I think designers and architects like to be dictators and tell people this is nice. Most people certainly have an idea of what they like, so of course I think it should be user controlled. I think it should be a function. I think people should take a stance. I think if you have to make a discussion it makes you think of the quality. I think about offices where you have all this even light, which is cold and blue-ish, people get used to shit and forget about quality.”

- In your designs, have you then had any criteria, like success criteria for your lamps?

”Aesthetics is a big one for me. That of course can always be discussed, but I work with that and I really care about that. And scale, it is very important to me. If you look at the AQ01 it is very detailed, down into the tiniest detail, the rounding, everything is thought of, because it is a product that is very close to you, you touch it with your hand and you look at it from a very short distance. If you take the outdoor lamp you look at it from a very long distance, you cannot really see if the weldings are rough and they are, but it is fine, because you look at it from a distance. So I think interest of detail, the right detail for the right scale. So scale and detail and aesthetics.”

- Do you have anything that you would call your aesthetic value?

”Something more than aesthetics. It is difficult, it is multidiscipline you have to take a lot of things into consideration. Like the AQ01, we have worked with that one for many years. I think that is due to many things, the company was slow and changed their crew or their staff many times, but there were just so many small details that had to work together. Compromise is a word, which is an issue. But then looking back I think we worked so hard that we did not compromise. It became what it was from the beginning.”

- In the design process, what do you think you should be aware of as a designer?

”Whom you work with and what company you work with. A good advise is to work with a company who knows how to go to market. It does not have to be big companies. It could certainly be small companies. The passion and the understanding of design are important. If the design is not appreciated then I think it is really difficult to work with them. It is really the passion for design.”

- Do you have any rules for the lamp design? Is there something that it needs to be able to do?

”Not the same rules for all. I think that should actually change. When you work with new designs, then it is nice to set up new rules. I enjoy the limited space instead of being able to do anything with any material. It is actually interesting if a company says that they want it to be e.g. only aluminium. That is just a working process for me.”

- Were there any rules for you when you designed your glass pendant?

”They had access to a glass manufacture that they thought could make some really big pieces of glass, so that was the rule: make something big in glass. I fixed it in like half an hour. It is just a shape with big glass. This one was easy.”

- What are the most essential functions for dining area luminaire lighting wise?

”If I should go buy something, then aesthetics, both on the physical lamp and on the light. Aesthetics, aesthetics, aesthetics. I think I like a lot of different things. At home I have lamps from FLOS. I am sick of PH. I think it is warn out. I think actually the light hardly comes out of the pendant. It is an icon and I think what they do with it is ’beating a dead horse’. I mean it is beautiful and what he has done is beautiful.

- Are there any materials that you see as upcoming trendy materials?

”Nothing new, I cannot really add some great idea for what is new. Hopefully it is recycled. It can be recycled anything. I do not have a good answer to that.”

APPENDIX 6 – NOTES FROM THE EXPERT INTERVIEW WITH DESIGNER MARIANNE TUXEN

The interview was conducted over Skype the 08.04.19. The interview lasted for 20 min. and mainly followed an interview guide. Not every question was prepared beforehand, and the interview was therefore semi-structured. The interview was conducted in Danish and the transcription will be in Danish as well. The quotes used in the report will be translated from Danish to English. The following is the full Danish transcription of the interview.

- Til at starte med, hvis du bare kunne fortælle lidt om dig. Hvem er du? Og hvad er din uddannelse?

”Jeg er uddannet arkitekt, med en overbygning. Dengang tog man en overbygning med design. Man havde først arkitekt afdelingen og jeg var hos Spreckelsen, som så vandt den der konkurrence i Paris, og 3. år var jeg så i Paris og arbejde på Kuben. Så tog jeg designbygning, som overbygning, som var tre måneder på design, tre måneder på møbler og tre måneder på grafik, så det vil sige, at man ved lidt om hvert. Så har jeg været på design siden.

Jeg lavede min første lampe, da jeg var på akademiet, og den vandt en konkurrence i samarbejde med Louis Poulsen. Så jeg har hele tiden lavet lamper og hele tiden lavet lys. Så blev jeg ansat hos Spreckelsen bagefter, indtil han blev syg og døde. Jeg lavede lys og hundetoiletter og med design på hans projekter. Så var jeg hos Christian Bjørn design og lavede alt fra telefoner til mejetærskere, altid noget med teknik inden i, det kan jeg godt lide. Jeg har ikke tegnet så meget glas, det har jeg også gjort. Jeg har hele tiden fået lov til at lave lys ved siden af. Så lavede jeg lys for Louis Poulsen og tegnede lamper for dem.

Jeg blev selvstændig i 1988, sagde op og egentlig haft tegnestue siden, hvor jeg har lavet alt fra grafik til lys og indretning og nu laver jeg næsten kun lys. Jeg laver designs for Carlsberg foden, speciel designs.”

- Er det ikke så meget produkt design mere?

”Jov, jeg laver også produkt design. Jeg har lige lavet nogle lamper for Fagerhult. Og lige nu sidder jeg og laver en lampe til psykiatrisk hospital. Så laver jeg jo speciel designs. Lige nu laver jeg Holmens Kirke, her har jeg lavet en lampe til orglet. I andre kirker laver jeg lysekroner. Jeg laver lysprojektet og så laver jeg speciel armaturer til. Jeg har lige lavet en ni meter lang lampe til orglet. Der er hele tiden lys i forbindelse med at jeg laver designs, lysekroner og væglamper. Det er hele tiden funktion og lys samtidigt.”

- Hvad er din indgangsvinkel til lys og lampedesign? Man får vel ikke den tekniske viden på arkitektskolen?

”Dengang gik jeg hos en der hed Sofus Sprengsen, som var sådan en der arbejdede meget med lys. Han arbejdede med lys og skygge. Man arbejder jo ligeså meget med skyggen, som man arbejder med lyset. Hele det teknisk har jeg fået ved at arbejde sammen med ingeniører. Når man har lavet lamper i over 30 år så finder man ud af, hvilken driver man skal have og hvordan den ser ud. Dengang var det for-koblingen og lyskilder. Jeg opdaterer mig hele tiden. Hver uge opdaterer jeg mig på alt nyt. Hvad der er og hvad der kommer nyt, af design hos Artemide eller andet. Jeg er med på alle messerne. Så på den måde så holder jeg mig hele tiden opdateret. Så har jeg nogen som sender ting til mig omkring lys og lyskilder. Så har jeg også undervist på arkitektskolen, men det holdt jeg op med, fordi det har jeg simpelthen ikke tid til.”

- Bliver dine designs altid produceret igennem et andet firma eller er du også selv ude og få produceret noget?

”Jeg har været ude til en fri udstillingsbygning og jeg har været ude til en bar, her har jeg været ude og bare fået trykket nogle lamper. Jeg har fået lavet dem i Kina, det koster ikke noget og der var ikke særligt man penge i budgettet. Jeg prøver altid at overholde mit budget. Jeg har faktisk aldrig overskrevet et budget og det tror jeg er en kæmpe fordel, at man prøver det. Jeg havde ingen penge til overs, så hvis jeg skulle have købt nogle lamper, så ville det have kostet for meget. Så jeg spurgte hvad det kostede i Kina bare at få trykket en metalskærm. Der er altid nogen der betaler for dem, men jeg sørger selv for produktionen og så arbejder jeg sammen med teknikkere. Så er der nogen der konstruere lampen ud fra det jeg laver. Typisk er der en ingeniør indover.”

- Hvad vil du sige, at Nordisk design er, når vi snakker om lys og lamper?

”Enkelt. Altså hvis du ser på sådan nogle som Artemide, så er det meget glas og det kan alt muligt, det kan Nordisk design ikke. Og så er der farven på lyset. Sydpå er det 3000 K og her er det 2700 K. Og så er der den der enkelthed, som styrer det design vi laver. Jeg ved ikke med teknikken, det er ingeniøren. Nogen gange har ingeniøren tænkt noget, hvor man tænker, ’hvorfor skal driveren sidde der? Den kan da ligeså godt sidde her.’. Det er meget tit, når man arbejder med teknikken, at lampedesigneren vil have det så småt som muligt og de skal bare have det bedste. Så kan man som designer sige: ’Jeg vil have en driver, der kun er 18 mm høj.’. Så går han tilbage og finder en der er 18 mm høj, så det kan passe i det design man har. Det er sådan frem og tilbage. Tit synes jeg også, at det samarbejde gør, at man selv for bearbejdet det design man oprindeligt ville afleverer, så det faktisk bliver bedre. Tit bliver det bedre af den dialog.”

- Hvad vil du sige er nutidens tendenser indenfor lysdesign og lampedesign?

”Jeg synes, at vi er ved at gå tilbage til sådan 70’er enkelthed. Der har været en masse med glas med præg og krystaller og det er vi på vej væk fra.”

- Hvordan ser du så fremtiden er?

”Jeg tror O-LED’s, når de bliver gode nok, tænk så hvad vi kan med dem. Så kan vi jo bare lave en skærm som lyser. De skal lige kunne klare den der ’dobbelt-krummethed’, det er kun enkelt krumme nu. Det ville jeg synes var rigtig sjovt at arbejde med. Fordi LED’erne har vi ligesom prøvet. Vi kan placerer dem på alle mulige måder og bruger dem fleksibelt og de bliver mindre og mindre, de kan give mere lys og har bedre farvegengivelse, men det er den samme ting, som bare bliver bedre.”

- Hvad er de vigtigste kriterier for en spisebordslampe?

”Den skal give direkte lys ned på bordet. Fordi hvis du skal spise, så vil du gerne have lys ned på bordet og spisebordet sidder du også tit og arbejder ved. Så hvis det bare er ligesom en kugle, der giver lys, så føler du ikke, at du kan se ordentligt. Det vigtigste er, at den giver lys ned på bordet. Derudover skal den også give lidt lys ud i rummet. I virkeligheden, så synes jeg, at de bedste lamper er dem, der på en eller anden måde lyser på sig selv. At du ikke bare har en metalskærm, der giver lys nedad, men hvis man på en eller anden måde kan få noget ekstra lys på skærmen, så du også ser formen, så har du både det direkte og det indirekte lys. Det behøver ikke være særlig meget, bare 10% ud i rummet. Det synes jeg som regel er de smukkeste lamper. Hvis den kan lyse på sig selv og gøre opmærksom på sig selv, så der kommer lys i rummet, så bliver det så smukt. Ellers bliver det meget direkte og sort. Hvis alt andet lys er slukket, så er der bare mørkt henover og kun reflekteret lys fra bordet lyser op.”

- Har du nogle funktionsmæssige kriterier?

”Den skal klart kunne dæmpe. Kelvingraden kommer an på, hvor du er. Er du sydpå, så vil vi helst 3000 K og nord på vil vi helst 2700 K. Men i virkeligheden, så det der hedder soft-dimming, synes jeg er ret sjovt, men det er ikke alle steder, at det fungerer. Det er jo så bare pæren du sætter i og så har du en dæmper på også.”

- Hvad har du af belysning hjemme hos dig selv?

”Der er en lampe, jeg gerne vil have, men den findes kun i 3000 K, så derfor har jeg nu bare nogle skærme, som bare er der midlertidigt. Over det andet bord har jeg en, som jeg har fået fra Louis Poulsen. Den kan jeg meget godt lide. Jeg synes den er meget godt tænkt, at lyskilden lyser på skærmene og gør i virkeligheden opmærksom på sig selv, fordi det giver lige netop lys ud i rummet og samtidigt så giver den et ret godt lys på bordet.”

- Har du nogle præferencer inden for materialevalg?

”Nej. Man skal prøve alt muligt nyt. Jeg elsker nye materialer, gitre, pap, beton, glas, alt, hvad der passer til designet. Det skal passe til konceptet og det rum man nu er i. Hvis det er et meget råt rum, så kan man jo vælge, at lave noget som er ligeså råt eller det modsatte. Ben-porcelæn synes jeg er ret flot, fordi lyset er så smukt. Hvis man arbejder med en simpelt form, så er ben-porcelæn

godt, fordi det lys, der kommer ud igennem er meget meget fint. Man skal så være opmærksom på lyskilden eller LED-båndet, da det ville give en skygge, så hvor placerer man det i lampen? Det er afhængigt af, hvordan lampen ser ud."

- Hvilke aktiviteter skal lyset kunne understøtte ved et spisebord?

"Sidde og læse og spise og hygge sig. Det skal kunne dæmpe, til hvis man har gæster eller spiller spil. Det er meget fleksibelt."

- Tror du vi er gået helt væk fra glødetrådspæren?

"Nej, det tror jeg ikke. Det tænkte jeg på et tidspunkt, men det tror jeg nu ikke. Der er også noget meget fint i, at du har en kugle, der giver lys. Det er ikke en hel kugle, når det er LED."

- Har du nogle designkriterier du arbejder ud fra i din design proces?

"Nej. Jeg prøver at arbejde på frit, som muligt i starten. Jeg skitserer fuldstændigt frit i starten. Så hvis jeg synes, at der er nogle gode ideer, så laver jeg en cirkel rundt om og ligger idéen til side. Jeg arbejder også med de grimme. Noget af det dårlige kan også føre til andet, fordi man er jo på vej et eller andet sted hen, hvor man ikke ved, hvor man er på vej hen. Det er i virkeligheden at arbejde med lyset og at arbejde med formen. Det er hele tiden den der frem og tilbage, hvor man prøver at finde en måde hvorpå lyset kan falde og så passe den til, hvis man har en idé til en form. Så snart man tænker, at man ikke kan få mere ud af den idé, så ligger man den til side og så starter man på noget helt andet. Man prøver at arbejde med 30 idéer i starten, så tager man dem frem en ad gangen og kigger på dem og vælger nogen ud og arbejder videre på dem. Jeg arbejder både i skiteseform og 3D. Så hvis jeg er gået i stå med en skitse idé, så tager jeg en anden og begynder at modellere den i 3D."

- Hvad ville du sige er dit mest succesfulde design?

"Det ved jeg ikke. Det kan jeg ikke sige rigtigt. Altså jeg er jo glad for min første lampe, fordi det var så fantastisk og her arbejdede jeg jo også meget lyset. Jeg arbejdede med det direkte lys og det indirekte lys. Det var en badeværelseslampe. Det med, at man på badeværelset skal se pæn ud. Jo tættere man kommer på spejlet, jo mere lys skal man have i hovedet, når man f.eks. skal barberer sig eller sminke sig. Men jeg har jo også lavet lamper for Hes og alt muligt."

APPENDIX 7 – NOTES FROM EXPERT INTERVIEWS WITH THE MISCELLANEOUS CRAFTSMEN

-------- Oprindelig besked --------
Fra: smedebakken37@dlgmail.dk
Dato: 16/03/2019 15.59 (GMT+01:00)
Til: 'sara Loevengreen' <sara_thelion@live.dk>
Emne: SV: Lampedesign Kandidat Speciale

Hej Sara.
Der er nogle betænkeligheder nu: Jeg kan max dreje 46 cm i udvendig diameter og muligvis slet ikke dreje en ring. Jeg ved ikke, om det så var klogest at finde en med større bænk i en fart, så det fine projekt ikke strander på tekniske besværligheder?
Det ligner valnøddetræ? Det har jeg ikke i større stykker og kan nok ikke skaffe dette.
Jeg vil gerne forsøge at lave en prototype i ø 20 i andet træ. Har vistnok noget palisander. Men det er uvist, om jeg kan lave den indvendige kant. Det skal ikke koste noget, selvfølgelig.

Det er et helt fantastisk projekt! Er det belagt med hvidt glas indvendigt? Kender du nogen, der kan forme dette i så fald?

Hvad er tidshorisonten?

Uanset om du er nødt til at finde et rigtigt drejeri eller ej, vil jeg gerne høre mere hen ad vejen og se billeder.
Mange hilsener Knud