FAÇADE LIGHTING AS A BRIDGE BETWEEN LANDMARK AND COMMUNITY

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Abstract:
This project investigates which lighting principles should be applied when creating a lighting solution for a landmark, such as a church. The research covers subjects such as the basic principles used when lighting a facade, how to navigate the cityscape using urban lighting, and how it interacts with the community. Lastly, staging is included, as lighting has a significant impact on the atmosphere and perception of a space. Using this research, certain spatial settings were formulated. A local church will be used, as an example case (Svogerslev Church), the existing lighting solution was analysed and used as a basis for applying the aforementioned theory. Using the theory, a set of concept designs were created, which were tested with participants from the local community. The testing indicated that the Danish people generally prefer quite dark lighting. Finally, this report proposes a new methodological process for designing lighting solutions for landmarks.

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0. TABLE OF CONTENT

0. TABLE OF CONTENT

1. INTRODUCTION

This report puts its focus on facade lighting and how it is possible to communicate the function of a landmark to its community. The report investigates which principles, in terms of lighting tools, are most relevant when setting up such a lighting solution and how this can function in urban planning, as well as in creating a bridge between a landmark and its community. The desire is to illuminate a landmark and promote its function as relating to wayfinding during the hours of darkness, whilst highlighting its symbolic function and communicating an atmosphere to the community. The research will look to the world of staging in order to gain knowledge on how one can stage an objects, such as a facade, for the benefit of its subject, the onlookers. Staging is employed when one wants to communicate an atmosphere to its audience, in this case the community.

The intent of this report is not to create a lighting solution, but rather to explore what principles are employed when creating a lighting solution and how they relate to the spatial settings, or in other words, the symbolic function, the function as a landmark, the atmosphere, and lighting pollution. These spatial settings are discussed, since they are derived from the way the different principles interact with and influence the community. However, this research will not be used to create a final lighting design, meaning that this is not a report that ends up with a lighting solution, but rather one that explores the theory behind how to create one. The report wants to investigate what criteria should be aimed for when creating a good lighting design, and where the focus of the lighting designer should lie.

The report aims to discover which principles are best employed for facade lighting. This will also be the focus of the testing chapter. In order to facilitate this exploration, a case will be used as a basis for understanding and communicating how the principles relate to the spatial settings. The case used will be a small, local church, since churches have always been identified as landmarks, even before the concept was codified.

The interest behind this project was derived from an interest in facade lighting and atmosphere, and how these concepts can influence one another. The initial question that set all this in motion was, in all simplicity:

What does it mean to light up a building?

The concept of what it “means” to light up a building can be understood in different ways. First is simply the reasoning behind lighting up the building. Secondly, what does it mean, practically, to light up a building, as in which principles are used in doing so. This sparked the interest behind the following research, which includes what principles are used in facade lighting, how a building and its lighting is viewed in the cityscape, and how one can stage a building.

2. BACKGROUND

The following research will look into the topic of facade lighting as a bridge between landmark and community, and will explore the various subjects defining this interaction. Firstly, in order to understand facade lighting and which elements are applied, the report will investigate what and how these are applied, both today and historically. Understanding facade lighting and how to apply it is very important in terms of getting to know which elements to use when applying them to a lighting solution in a methodical process. This is where Claire Van Santen gives an insight into utilising facade lighting in relation to a larger cityscape.

As for creating a bridge between landmark and community, first and foremost, one has to understand what a landmark is, and what function it serves in the cityscape. Kevin Lynch's five elements give an understanding of this. However, to include the community, one also has to understand urban planning and how pedestrians move around and experience the cityscape. Here, Jan Gehl has made a study of how cities are made for people, and how pedestrians perceive different elements in the city, which will help in understanding how a building can be seen differently at different stages in time. As part of looking into urban planning, one should look into urban lighting, since lighting is the focus of this report. This is where Kaoru Mende accounts for how lighting is used in the urban environment, and argues that applying a lot of light is not necessary in order to produce a good lighting solution, in part because having an adequate amount of light leads to less lighting pollution. The atmosphere should also be accounted for when creating a lighting solution, since there is an important relation between the subject - the community - and the object - in this case, the church - that creates an atmosphere. In his journal, Gernot Böhme explains this relationship and how to account for it. Since the point of the project is to light up an object, it is important to understand how to stage said object - the church - to better understand its symbolic function in relation to the surrounding area. This relationship is explored by Erika Fischer-Lichte. Furthermore, each person's perception is different depending on a variety of factors, including the light level. These are the topics that will be brought up in the following chapter in order to give an insight into the subject matter of this report.

2.1 The outdoor lighting scene through the ages

Public lighting can be traced back to the beginning of the sixteenth century, with candles and oil lamps. Ever since, it has gone through several large changes, arriving at what we have today (Santen, 2006). Tim Edensor addresses how the lighting scene has changed from candle light to gas lamps to electrical lighting, and what effect it has on the cities. As lighting advanced, it began to create more unnecessary lighting, which creates a blaze of light from the windows of buildings, rather than flickering candlelight. Due to the advances in artificial illumination, the amount of light in cityscapes has increased, resulting in a decrease of darkness. Another effect the advancing of artificial illumination is the fact that it reconfigures the space (Edensor, 2017). As Charles Dickens writes "The river had an awful look, the buildings on the banks were muffled in black shrouds and the reflected lights seemed to originate deep in the water, as if the spectres of suicides were holding them to show where they went down." (Edensor, 2017, p.70).

2. BACKGROUND

Artificial light can create illusions throughout a city, making it into a phantasmagorical realm, giving it a feeling of insubstantiality. John Jakle contrasts earlier nocturnal visual complexity with the intensified saturation of spaces with electric light: “Much of the romance and mystery of the urban night evaporated, street lighting, in its excess, no longer capturing and holding attention as spectacle.” (Edensor, 2017, p.71). Cityscapes have become brighter, eliminating the darkness that once was. This has had an impact on the characteristics of the cities, and will be discussed later.

2.2 Basic Principles of facade lighting

“The illumination and spotlighting of monuments, objects and other places of interest is a fixed part of the urban scene; it livens things up. Illumination also helps people to find their bearings.” (Santen, 2006).

During a previous investigation, following the concepts laid out by Santen (Hansen, 2018), a discovery was made about which elements of lighting design are important to consider when lighting up a facade for the purposes of wayfinding. The elements concluded in that report were: material and reflectance, situation, placement of luminaires, wayfinding, atmosphere, and lighting pollution (Hansen, 2018). The first of these elements will be elaborated upon in the following text, while the others will be part of a later topic. These elements, taken from the previous investigation, will be part of the foundation of the principles` that will be used further in this report to analyse lighting design and how to connect it with its surrounding.

“It is only with the benefit of light, after all, that urban spaces become accessible at night. The symbiosis of light and its surroundings plays an essential role in architecture, as well as in landscape design and urban planning.” (Brandi, 2006, p. 8). The illumination of the cityscape of the night breathes new beauty into the cities with a special aura. When lighting up a facade, there are some things that should be considered “Is there enough light in the chosen place. Is the light evenly distributed (if that is the intention)? Is any inconvenience caused to the people who use the place”. (Santen, 2006). Having these things in mind helps with conducting a qualitative and quantitative survey and helps to foster an understanding of the area.

2.2.1 Reflectance

The material and its reflectance has a huge impact on lighting up a building, and conducting a quantitative survey of the given area to understand its effects is recommended. A dark building does not reflect as much light and is, therefore, worse for visibility of the facade. This means that there is no sense in lighting up a building made of dark material, since no apparent lighting effect would be achieved by this. Therefore, It is recommended that a building have a reflectance of at least 0.2. The following table shows the reflectance values of several common materials used in the cityscape (Santen, 2006).

material	condition	reflectance
yellow brick	new	0.3–0.4
red brick	new	0.15–0.25
brick	dirty	0.05–0.1
white marble	clean	0.6–0.65
granite	clean	0.1–0.15
concrete	light	0.4–0.5
concrete	dark	0.2–0.3
concrete	dirty	0.05–0.1
plasterwork (pale yellow)	new	0.35–0.55

Table 1: Materials reflectance (Santen, 2006, p.56).

When illuminating a facade, there is a correlation between the reflectance, the illuminance, and the luminance. The illuminance required on a facade is dependent on the brightness of a surface and its reflectance, whether this is light or dark. The luminance is the reflected light coming from the facade and this is why the material of the facade and illuminance is connected to it. The relationship between the luminance, reflectance, and illuminance can be expressed quantitatively by the following formula:

$$L = \frac{E \times \rho}{\pi} \text{ or } E = \frac{\pi \times L}{\rho}$$

L = luminance (candela/ m^2)

E = illuminance (lux)

ρ = reflectance

Formula 1: The relationship between luminance, reflectance, and illuminance (Santen, 2006).

2.2.2 Situation

The illuminance required to properly light up a building is also dependent on the light level of the surrounding area. This means that a bright area (a brightly lit street) requires more lighting, whereas a dark area (dark sky) requires less illuminance. Following this logic, Santen has created a table with recommendations for the light-level (cd/m^2). The following table shows the recommended level of light (L) for different situations.

Situation	L (cd/ m^2)
Freestanding building or statue	3.2 - 6.5
Building in a street or on a square	
in a well-lit surroundings	10 - 13
in dark surroundings	6.5 - 10

Table 2: Situation and light-levels (Santen, 2006).

2.2.3 Contrast

When lighting up a landmark building, it is important that the light is brighter at the highest point of the building, in order to get the lighting to appear uniform, from the viewpoint of a person standing near the building. Furthermore, it is important to keep in mind that the contrast of the lights should not be too different, as this can give the building an unpleasant and deformed appearance. To avoid such effects, a contrast ratio of 1:10 should be applied. The reasoning behind this is that, with a certain degree of uniformity, fragmentation of the architecture can be avoided. When looking at uniformity, it is also important to look at the lenses of the light sources along with the distance of the light to the building, as these are linked together. Having a light source further away from a building allows for a better uniformity, but at the cost of the architecture becoming flatter and more dull. In addition, by having the light travel over a greater distance, there is a greater chance of creating an excess amount of light pollution (Santen, 2006). This means that when looking at the contrast, two things should be looked at; uniformity and the contrast ratio, and whether or not they are followed.

2.2.4 Colour

In the process of lighting up a building or a facade, it is not only the luminance and illuminance which are important, but also the colour of the light used, since colour can have a significant impact on the rendition of the architecture. An example of this could be, when one is trying to light up a red brick surface with a light which has poor red colour rendering, which then leads to the surface being darker and the colour of the bricks seem different. Because of this impact, it is important to know the Colour Rendering Index (CRI) of the light sources used, as this can give an insight into how well the colours are reproduced by the light. Another important aspect of the surface to consider when lighting up a facade, is the reflectance of the material, as the texture of the wall can have a great influence on the light. In summation, it is important to know the colour and structure of the target that is illuminated (Santen, 2006).

2.2.5 Placement

According to Santen, “Lighting specialists have to take various elements into account: the effect that should be achieved and what needs to be made visible; the desired level of light (which allows the number of lamps and luminaires to be determined); what sort of lamp is most suitable; where the lights can be placed.” The positioning of the luminaires has a significant influence on the lighting on the facade. They can be mounted on a pole, on the wall of a building, on top of or side of a building, or on the ground, each of these options gives different effects on the facade, as seen in Figures 1 and 2.

2. BACKGROUND

Figure 1: Light from below at Chapel, Nijmegen (Santen, 2006, p. 112).

Figure 2: Mounted light changing the lines from horizontal to vertical on Banque de Lyon (Santen, 2006, p. 56).

2.3 Cityscape

The following section will dive into the topic of wayfinding, with a focus on the effects of landmarks thereupon. Furthermore, it will elaborate upon the importance of the pedestrian in the city, and how cities are created for pedestrians, as well as the larger topic of urban planning. This will be expanded with regards to urban lighting and how it affects cities. Lastly, the issue of lighting pollution will be addressed.

2.3.1 Landmark

Kevin Lynch focuses on how the mental map of the city can be divided into five elements. These elements are important tools for developing an understanding of the cityscape. The five elements are (1) Paths: places or locations where people walk. (2) Edges: boundaries, such as fencing, walls and canals. (3) Districts: larger areas grouped as one, for example, the district of Nordhavn in Copenhagen. (4) Nodes: the places where Paths meet and traffic converges, such as intersections and plazas. (5) Landmarks: famous or easily recognisable places and objects in the cityscape the can can be used as navigational aids. All of these elements make up the main tools that people use to navigate the cityscape and avoid getting disoriented (Lynch, 1962).

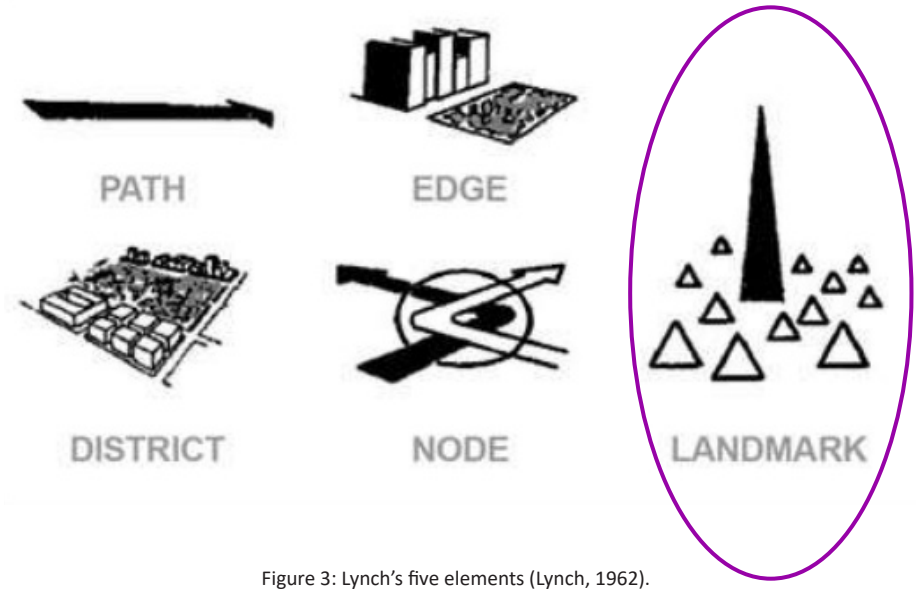

Figure 3: Lynch's five elements (Lynch, 1962).

In order to navigate and guide people through the urban environment of the city, these elements should also be represented during the dark hours. Lynch mainly focuses on working with the elements and their effects on navigation in daytime, but has very little to say about their effects during the dark hours. For wayfinding purposes, it is important to have landmarks in the cityscape, even at night. "Landmarks are used as guidance points throughout the city, without these during the hours of darkness navigation becomes difficult." (Hansen, 2018).

2.3.2 Community

According to Jan Gehl, cities are created for people, this emphasises that the city is created for the people that walk and bike through it. The growth of traffic in the cities has become overwhelming, and many cities have chosen to focus on their pedestrians. To make these cities attractive to the pedestrians, cyclists, and the inhabitants of the city in general, four wishes should be accommodated
(1) A living city: with people in the public spaces.
(2) A safe city: that invites people to roam around, even at night.
(3) A sustainable city: by making the city more eco-friendly, with a focus on the pedestrians, cyclists, and other transportation methods that do not produce high-levels of CO2.
(4) A healthy city: with healthy ways of getting through the city, for example by promoting pedestrians.

Town planning and structure influences people's behaviour. As an example, more roads means more cars and good infrastructure for cyclist means more bikes. Making room for pedestrians by making a pedestrian street, also changes the flow in the city. To achieve a high number of pedestrians in the city, it comes down to a question of invitation - making people feel welcome (Gehl, 2010). This can be helped at night with lighting, which also helps people with wayfinding in the cityscape.

Historically, people went out a lot in the city to get information about what was happening. Nowadays people more often go out for socialising. The large amount of car traffic clashes somewhat with the needs of these pedestrians. However, more and more cities, such as Copenhagen, choose to focus on the pedestrians and cyclists. The city should function as a meeting place for people. Squares are made for people to stop up and see what is happening (Gehl, 2010). This means that creating a lighting solution that promotes pedestrian interaction and socialising is preferable. Greater distances give a lot of impressions (a holistic impression of the city), whereas smaller distances give a more powerful impression (for example, the atmosphere)(Gehl, 2010). The greater distance will be addressed in the analysis as 'far', and the smaller distance will be addressed as 'close'. However, Gehl's theory will also be expanded with an in between distance, 'near', which focuses on the relation to the surrounding community.

Figure 4: Left, an active facade and right, a passive facade (Gehl, 2010, p.89).

Open and inviting facades (active) have seven times more life outside, than passive facades, as seen in Figure 4. These active facades cause pedestrians to lower their speed, turn their head, and in some instances, stop (Gehl, 2010). Although this is during daytime, the same idea must apply at night, where the lit up facade should be inviting and open.

According to Gehl, the light emitting from the shops and streets, and the life in the streets, can contribute to safety, comfort, and a friendly street environment (Gehl, 2010). This means that a good lighting solution for a facade would also achieve the same result. The cityscape's visual appearance in the hours of darkness is also beautiful and has an aesthetic quality. Lighting has a great influence on the city in terms of orientation, safety, and the city's visual aesthetic quality (Gehl, 2010).

2.3.3 Urban lighting

Kaoru Mende has, through his observations of the development of urban lighting, formulated five phases and how a theory of how they affect cities. In the first phase, lighting was used to make cities safe, because the higher light levels resulted in lower crime rates and fewer traffic accidents, and after making the cities safer, the aim of the lighting became to beautify the cities (Mende, 2010).
This leads to the second phase, in which a pleasant urban environment was the goal. The focus was primarily on creating light that was comfortable for both driver and pedestrian, since most lighting for public spaces and parks was unpleasant to be around. As an example of this philosophy of both functionality and user comfort, Mende has said that "The same light so helpful to the automobile driver is unpleasant for a couple on a leisurely stroll" (Mende, 2010). However, urban lighting is now moving towards soft, glare-free light, while still maintaining its functionality. As urban lighting progresses, there is a shift in the ideals, which Mende describes as "In contrast to the three ideals of safety, beauty, and comfort of the past, the urban lighting ideals going forward will be ecological balance and urban identity. Today we want nightscapes that help preserve the environment and conserve energy and brings out a city's uniqueness" (Mende, 2010, p. 169). This case is about facade lighting on a church, which is considered urban lighting. Therefore, only a little light is required, as the focus should be set on the beautification of the cityscape, hence the "facade" in facade lighting.

"Effect lighting and event lighting is generally short-lived. It is most typically found on lit facades, monuments or other "stages" that obviously could, and still can, attract a lot of popular attention." (Brandi, 2006, p. 5). By this, it is meant that effect and event lighting is intended to stage its subject, and thereby bring attention to the subject. Although many forms of effect and event lighting can be short lived, it is not a necessity. When compared to the lifespan of normal street lighting, it is true that the lighting on a landmark can be seen as short lived. However, modern LED technology has changed the the general lifespan of fixtures and lighting solutions. A side effect of attention-grabbing effect and event lighting, is that it helps significantly in using landmarks for wayfinding.

2. BACKGROUND

Lighting pollution is a very important topic to discuss when designing with light in the urban environment. Having a high level of light has been proved to reduce crime, however, the downside is the amount of lighting pollution that spills out. The amount of light pollution created by human settlements is visible from space (Dark-sky Association, 2018). The following terms described by the Dark-Sky Association and Tim Edensor describe different elements of lighting pollution: "(1) Light trespass - Where light invades space from a neighbouring source. (2) Light clutter - In which confusing and chaotic forms of lighting infest the nightscape, confounding orientation and legibility. (3) Overillumination - Is characterized by unnecessary lighting. (4) Skyglow - describes the expansive aura of illumination that leaches into the sky from cities." (Edensor, 2017).

2.4 Staging

The following section will describe how buildings are understood as a symbolic function, depending upon the observer. Furthermore, it will elaborate upon how an atmosphere is interpreted and created according to perceived lighting and the observer, and lastly, how people in general perceive under different lighting conditions.

2.4.1 Symbolic function

When talking about staging, one mostly thinks of it in a theatrical context. However, the spatial relation between the stage and the actor can be applied to the way one observes the symbolics of lighting on buildings. Staging is about the symbolic function of a building, rather than its practical purposes.. In order to stage something, it is important to keep the surrounding area in mind, as it helps provide a context. "Since spatial relations are established by society as a whole, by social institutions, or by individuals and/or groups of individuals, the symbolic functions fulfilled in the process can be related to the society as a whole, to the institution, or to the individuals or groups of individuals." (Fischer-Lichte, 1992). This quotation emphasises that you need a social context to be able to define a symbolic function. For instance, the space of a church can change its symbolic function, depending on the person, day, season, event, etc., but even if the symbolic function differs, the practical function of the church is the same.
As time passes, the symbolic function might change as culture evolves. This means that the church that once held a certain symbolic function for a town, might not hold the same function anymore. A church is built as a representation of faith. Nowadays, the symbolic function is more diverse and the church building holds many subjective meanings.

2.4.2 Atmosphere

As Böhme states: “Talk about atmospheres plays a part today in interior design, town planning, advertising…” (Böhme, 2013). Atmosphere has a huge influence in town planning, and this is why, when designing lighting solutions for the townscape, such as facade lighting, one should keep the resulting atmosphere in mind. “In general, it can be said that atmospheres are involved whenever something is being staged,…” (Böhme, 2013). Atmospheres are created via the manipulation of material conditions, such as the sound and light. In this case, we work with the staging and manipulation of facade lighting.

An atmosphere is a phenomenon that occurs between subject and object. The atmosphere itself is entirely subjective, the character of it is defined by the subject’s own emotional state, which helps to shape the experience. Böhme describes the act of experiencing an atmosphere as such: “…the subject experiences them as something ‘out there’, something which can come over us, into which we are drawn, which takes possession of us like an alien power.” (Böhme, 2013). A visualisation of this is shown in Figure 5, and shows the relationship between subject and object, in terms of atmosphere. It illustrates how the subject’s perception of atmosphere is based on their eyesight and their cultural background, as well as how the perception of the object can be determined by the lighting, in relation to the colour and revelation/contrast.

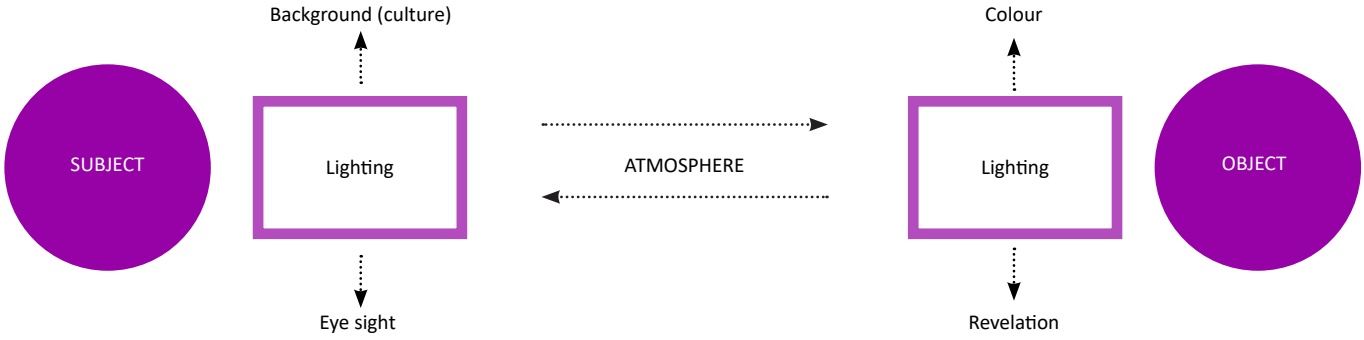

Figure 5: Connection between the person perceiving and the atmosphere perceived (Hansen, 2018).

For stages, it is a question of producing atmospheres. This, however, can seem meaningless if atmospheres are only perceived as purely subjective. “It is, after all, the purpose of the stage set to provide the atmospheric background to the action,…” (Böhme, 2013).

An atmosphere can, to some degree, change or manipulate the emotions of the subject experiencing it. “In a cheerful mood, I enter a community in mourning: its atmosphere can transform my mood to the point of tears.” (Böhme, 2013) Therefore, when designing the facade lighting, it is important to keep in mind what kind of atmosphere is projected to the observer, since having an atmosphere which induces a negative emotion could affect the opinion of the community towards the lighting.

2.4.3 Perception

Depending on the amount of available light, the human eye uses different receptors to see. There are two types of receptors in the eye; one commonly called “cones”, that perceives colour; and one commonly called “rods”, which perceive in black and white. In bright light, the eye mostly uses the cones, giving us colour vision and a sharper sight, this is called photopic vision. Under dark conditions, such as at night, the eyes rely on the rods, seeing less clearly and only in black and white, this is called scotopic vision. In between these two types of vision is what is called mesopic vision, which uses a mix of the cones and rods. Mesopic vision is used in conditions of low light, such as the twilight hours. (Admesy, 2018). The distribution of the different types of vision is shown in Figure 6.

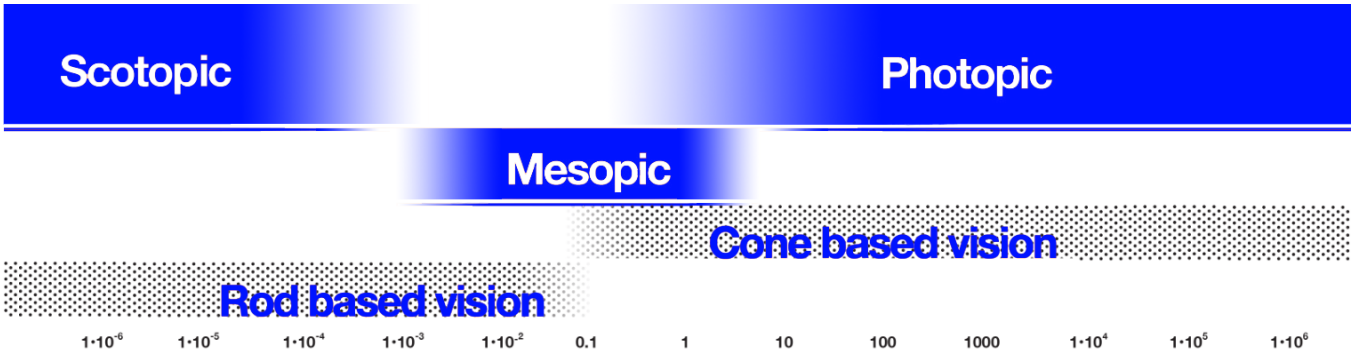

Figure 6: Visualisation of the ranges of what scotopic, mesopic, and photopic vision (Admesy, 2018).

Most facade lighting lies in the range of photopic vision, above 3 cd/m2. However, some facade lighting setups need to be in low light environments, which presents a problem, since when in mesopic vision, the eye becomes more sensitive to light on the electromagnetic spectrum around 498 nm (blue, green) (Admesy, 2018). This means that it is not possible to properly perceive the colours on the building, and some of the blue/green colour may be entirely imperceptible.

When people are walking, their field of view is horizontal, and the eyes are focused straight ahead. As shown in Figure 7, this means that the maximum downwards angle of view is 70-80 degrees, and the maximum upwards angle is 50-55 degrees (Gehl, 2010). Therefore, it is important to keep in mind when lighting up a landmark, that the light should be in this field of view, to guide the person’s perception.

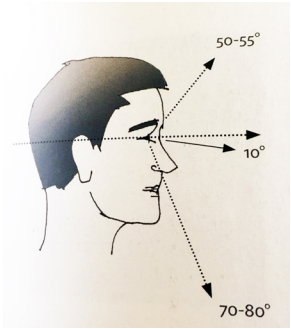

Figure 7: Field of view (Gehl, 2010, p.49).

2.5 Summery of background research

Based on the background research, a theoretical model consisting of two sets of terms was made. At the practical level, there are a set of principles for facade lighting, based heavily on Santen's theory. These principles are guidelines for the physical setup of a lighting solution, and consist of: placement, reflectance, situation, colour, and contrast.
At a more theoretical level, there are a set of elements describing the spatial settings of landmarks and lighting solutions. The spatial settings are divided into the terms: landmark, lighting pollution, atmosphere, and symbolic function. Figure 8 illustrates the division of the different terms and how they are derived from the background research.

This theoretical model is used to explain how it is possible to create a lighting design on a landmark that bridges it to its community. The spatial settings are used to create a coherent, relevant facade lighting, or a lighting design, whereas the principles are used to make sure that the lighting solution actually works in practice, giving an aesthetically pleasing facade lighting. In the end, the community will be the ones using the lighting design in their everyday lives, which is why a good lighting solution should take into account all of the aspects that are relevant to them.

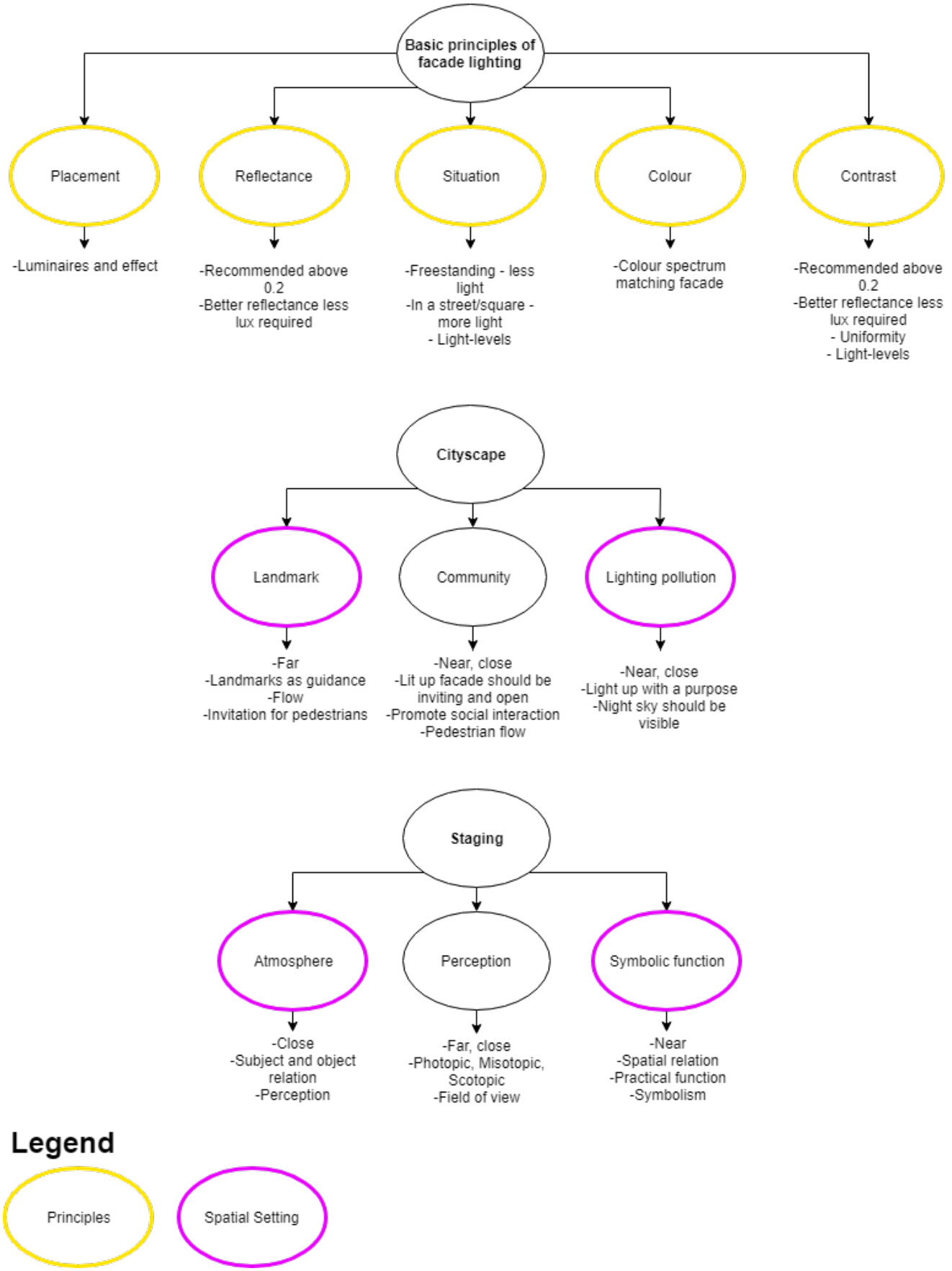

Figure 8: Illustration of the theoretical model derived from the background research.

3. Reference works

The following section will explore previous lighting solutions that have been created for various churches and monuments of power. It will look at older solutions that are still considered beautiful today. However, it will also include newer lighting solutions, to show the contrast between older technology and methods, and the newer LEDs and viewpoints.

3.1 Roskilde Cathedral

The cathedral located in Roskilde is the most iconic building of the town, both in terms of architecture and history. Parts of the church date back to somewhere around the year 1030. The towers of the cathedral stretch to the height of 75.7 metres, which makes this one of the tallest landmarks in the town (Kruse, 2003). This means that the landmark can be seen from various locations far away in the cityscape of Roskilde truly fulfilling its function as a landmark. It is location on one of the tallest hills in town and its distinct orange lighting makes the cathedral functional in terms of wayfinding. During the night, the structure is lit up and still clearly visible, and has a pleasant contrast to the surrounding area and fits with its situation as a building located in the middle of the town. The material primarily used for the structure of the cathedral is red bricks, while the roof is made of copper.

The lighting solution for the facades of the cathedral is an older solution. This is very apparent when looking at the cathedral, as it appears to have a orange glow. The current lighting solution consists of high pressure sodium luminaires, with 8 luminaires at 250W located closer to the cathedral, and 8 luminaires at 400W located further away (Appendix 1), as seen in Figure 9.

In terms of colour spectrum, the sodium luminaires are very poor, and this results in objects acquiring an orange tint, as seen in Figure 10. A further downside to using these luminaires is the colour fidelity, as well as their ability to show the architectural elements, since the nuances are blurred by the lack of certain colours. However, having the cathedral appear different at night, with this lighting, compared to during the day, may also create a contrast, which can be interpreted both as a positive thing, in terms of the atmosphere it creates, and a negative thing, in terms of the architecture. Under any circumstances, however, the current lighting solution on the cathedral is outdated, and does not display the landmark in its “true” colours. Based on this, it is arguable whether or not the symbolic function of the cathedral is truly displayed.
It is important to keep in mind that this solution is a older one, with a focus on lighting up the entire cathedral, and with the medium of sodium luminaires, which cannot be dimmed. This is very apparent when you compare it with the surrounding area, with which there seems to be a contrast and where there clear light pollution can be seen. If a new lighting solution was to be applied today, a solution with LEDs would be preferred, because of both technology, energy efficiency, and colour spectrum.

The older solution gives an understanding of facade lighting on churches and shows how the colour spectrum can influence the atmosphere and perception of a building, and furthermore, shows how extensive lighting can create a contrast and spread lighting pollution to the surrounding area.

3. REFERENCE WORKS

Figure 9: Left, the luminaires positioned close by.
Right, the ones located further away.

Figure 10: Roskilde Cathedral.

3. REFERENCE WORKS

3.1 Jyllinge Church

The church was erected in the 1130's (Jyllinge kirke, 2019). The lighting solution of the building does not seem to light up the whole church, but rather elements of the church. Namely, the tower and the entrance of the church, as seen in Figure 11.

The church is white, which means that the reflectance of its surface is high. Having such a surface is perfect for facade lighting in terms of achieving the best facade lighting with limited illuminance from the luminaires, because of the reflectance of the material. A lot of light is reflected by the white surface, which is why the surface seems very bright. Looking at the light on the surface, one can estimate that the lighting might be created by LEDs. This solution is newer than the one made for Roskilde Cathedral and is more true to the actual colours of the building. However, with only parts of the church being lit up, this solution seems to create a lot of contrast. The trees are lit up by surrounding lighting, creating a less overwhelming scene with the main lighting, as seen in Figure 12. This makes the contrast seem less invasive, and gives the impression of a more even contrast ratio of 1:10. Although only parts are lit up, these parts still display the symbolic function of the building by clearly highlighting the classic features of a church, the tower and the entry room. The atmosphere surrounding the church seems more well lit and more pleasant to be around in the dark, as compared to Roskilde Cathedral, which sets its focus on the impression on the 'far' distance.

This solutions shows how the LED technology can improve the quality of a lit up facade, while being less costly in terms of energy and creating less lighting pollution. The facade lighting is focused, as seen in Figure 12, on the church and does not spill out in the same manner as Roskilde Cathedral.The solution also shows that having a good reflectance is important in terms of luminance. It also highlights that just lighting up important elements of the church is a possibility, instead of lighting up the whole church.

3. REFERENCE WORKS

Figure 11: Lighting on Jyllinge Church (Appendix 2, 2014).

Figure 12: Lighting on Jyllinge Church and the trees (Appendix 2, 2014).

3.3 Christiansborg

Christiansborg is the seat of the Danish parliament. Although it is not a church, it is a building that demonstrates power in its architecture, like a church does. Christiansborg has constant facade lighting throughout the year, but during the Copenhagen Light Festival, this lighting solution was exchanged for a different lighting scheme with coloured lighting, that lit up the tower as seen in Figure 13. The pictures were taken during Copenhagen Light Festival 2019, that runs from the beginning of February and until the 24th. Although the focus will be on Christiansborg, it is important to mention that each lighting installation created their own stage with their own depiction and atmosphere, all of which combined into the Copenhagen Light Festival, which means that this piece is part of a larger concept.

A Spradley-inspired observation of the facade lighting was conducted during Copenhagen Light Festival, with a focus on Christiansborg (Spradley 1980), see Appendix 3 for the entire observation. The space functions as a wayfinding tool, with coloured lighting on the tower. The object lit up is only part of the tower, and this tower is visible throughout most of central Copenhagen. It functions as a beacon, or in other words a landmark, changing colours and therefore attracting the attention of the pedestrians and cars moving through the space. This serves as a good example that it is not necessary to show a building in the same colours both during the day and at night.
Coloured, dynamic lighting, and having it for a limited amount of time, can be used to draw attention to a facade in a new way. The colour can also help with showing the symbolic function of a building, such as Christiansborg and its politics, which is in constant flux. A negative thing that can be said about the coloured light is that it transforms this old piece of architecture, and takes away the feeling of age by putting it in a different context.
As seen in Figure 14, the lit up tower and the lower part of the building has a contrast. However, this contrast seems pleasant with the light being emitted from the inside the of the building. Lighting up the tower also displays power by forcing the observer to look up. The light perceived is very dependant on timing and location. The colour changes slowly, but constantly, meaning that what colour you see is dependent on when you look up. The atmosphere experienced by the viewer can be very different, depending on where they are viewing the building from, which relates to the idea of ‘far’ and ‘close’ previously mentioned in 3 Community. The atmosphere is generally very pleasant in the ‘close’ distance, as seen in Figure 13.

This solution shows that designing facades does not have to be done only with colour temperature, but can also be done with coloured lighting, depending on what symbolic function one intends to display. It also shows that there is not always a need to light up the whole building for wayfinding at night. An important thing to take from this observation is that the focus can be on the characteristic features of a building, rather than the building as a whole.

3. REFERENCE WORKS

Figure 13: The tower of Christiansborg during Copenhagen Light Festival.

Figure 14: Christiansborg during Copenhagen Light Festival.

4. ANALYSIS OF CASE

Svogerslev Church serves as our case's landmark. The following section will dive into Svogerslev Church's background, as a landmark, and its function, as a bridge between a landmark and its community. Furthermore, an analysis of the existing condition of the lighting will be presented. The analysis will be conducted based upon the findings of the background research, principles, and spatial settings derived from there, as summarised in section 2.5 Summary of background research. At a more practical level, the case will be analysed in relation to the 'wayfinding' element, specifically the aspects 'close', 'near', and 'far', as pertaining to its relation to the people around it, as well as the flow of pedestrian traffic around it. Building upon this, the analysis will look into the symbolic function of the church, in part through a questionnaire and an interview. Lastly, the analysis of the case will revolve around the lighting principles.

4.1 History of the church

Svogerslev Church is an old church, dating back to 1170. Throughout history, it has been owned by a variety people. In 1911 the church was made into a freehold.
Of the original church, only "Skibet" (the main body of the church) remains and is built of granite and limestone. Of the current church "Våbenhuset og Tårnrummet" (the entrance hall and the tower) are from around 1450 and built of brick and limestone. The small town of Svogerslev has greatly expanded since the origin of the church. As seen in Figure 15, the town has gone through a major growth during the last 60 years. It is important to keep in mind that the church was designed for a much smaller town, with fewer residents. Thus, it may not function as well in its role as a landmark for this larger community, since it is no longer visible all over town. This will be addressed in the following section 4.4 Far, near, close.

Figure 15: Left, Svogerslev 1954, and right Svogerslev today (Krak, 2018).

4.2 Observation of pedestrian flow

An observation of the pedestrian flow was conducted on a weekday between 15:45-16:15, to answer the questions: how many people in the community pass by the church, and is there a lot of foot traffic in this area? A person was located at each of the pins, as seen of Figure 16, recording cyclists and pedestrians walking by.

4. ANALYSIS OF CASE

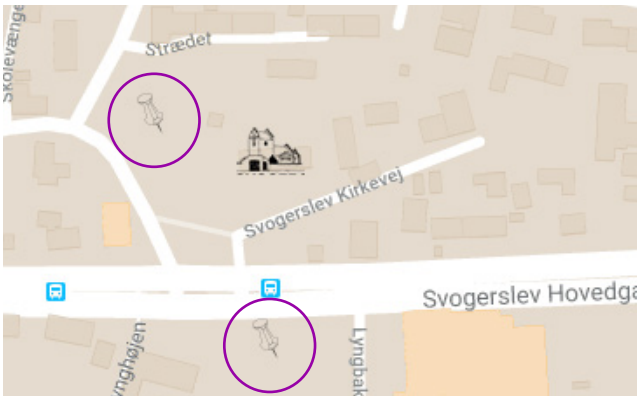

Figure 16: Observations locations (Google maps, 2019).

In the following Figure 17, it is possible to see the resulting documentation. The figure also includes the main attractions in the area, to show that the church is located in the middle of the small community and that there are plenty of reasons to be in the area. As shown in Figure 17, there is a lot of traffic flowing around the church. The pedestrian flow comes from the various attraction points and passes by the church. However, does that mean that the church fulfils its function as a landmark incorporated into the community? The church might work as a landmark for some of the bypassers, but the main function of the church today, is its symbolic function. For the people passing by the church, the important aspect is the impression that it gives them.

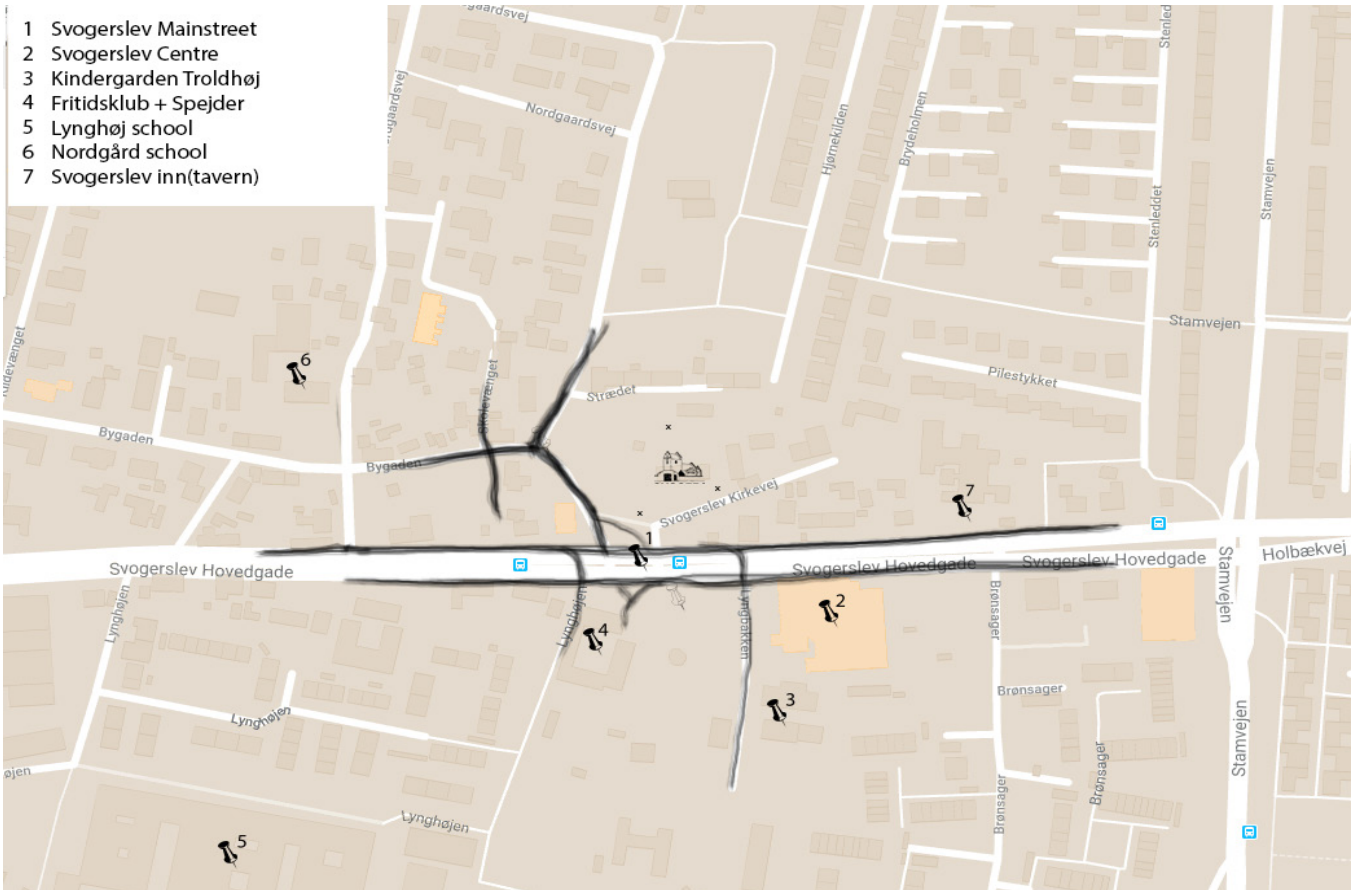

Figure 17: Pedestrian flow (Google maps).

4.3 Interview with locals

As part of the analysis, the priest of the church took part in a semi-structured interview. The interview provided some useful insight into how the church is perceived from a theological point of view. The interview was conducted in Danish and therefore, the following quotations will be presented in translation, the original answers can be found in Appendix 4.

When asked if the church was used for wayfinding, as a landmark, she answered "in a way, wayfinding, perhaps even in a sort of metaphysical sense, that we kind of have something to guide us on our way." This is an interesting statement, because it also gives a glimpse into the atmosphere that the priests experience around the church. Another statement that helps to give an idea of how the church is perceived, was what she said when asked to describe what you see when walking by the church, to which she answered "I mean, in some ways it is somewhat removed/withdrawn". This highlights a significant problem, if the church is to function as a landmark for its community, which means that it could be a good idea to make it more prominent, in order to improve its wayfinding functionality and keep the landmark visible even at night.
When asked about the lighting on Roskilde Cathedral and her own church, the prieste responded "on that point, I have thought a bit for myself, from the beginning, that to me, the cathedral has a soft lighting and that I would like something akin to that. In fact, I like what has been done for the cathedral, because I associate it with something a little warmer and dimmer." This shows that she thinks that comfortable lighting should not be too bright, but warm and soft like the solution for Roskilde Cathedral. She also highlights why lighting up the church could be favourable and what atmosphere it could create from afar in the following statement. "And when one drives around the area, I can see that it can be comforting or nice to see the churches light up around the landscape, and it would make people notice them like that. Like milestones or lighthouses".

It is possible to create an atmosphere from afar, while creating another, different atmosphere for those closer to the church. When close to the church, the atmosphere should make it seem like a special place. "Of it being a special room that one enters, and the space, the walls, and the whole" this is the atmosphere that is created inside of the church, but it should also be projected to the pedestrians passing close by outside, so that people can feel it while taking an evening walk. In this way, the atmosphere can be emitted to the community as a symbol of the city, rather than of the religion.

4. ANALYSIS OF CASE

Figure 18: Taken by a local passing by on a bike ride (Schollert, 2018).

A questionnaire based on the same questions as the semi-structured interview was conducted, with a total of 56 participants. This was done to corroborate what the priest was saying about the church with opinion of the local community. The questionnaire was posted on the Facebook group '4000 Svogerslev' (4000 Svogerslev), which is a group for people living in the town. The questionnaire was conducted in Danish and the following quotations will be presented in translation. The questionnaire and answers can be found in Appendix 5.The first question of the questionnaire was "How many years have you lived in Svogerslev?" This was asked to insure that the participants in the questionnaire had lived in the town for more than a short while. The participants were then asked what makes Svogerslev Church unique. Here, the answers varied a lot, from its size, to the church bells, to its central location, and its general coziness. When asked what role the church plays in the community, the general response was that it functions as a central gathering point and a hub of fellowship in a variety of ways, through different events in life. These answers show the symbolic function that the community allocates to the church of Svogerslev. Their response to the facade lighting on the church was that, in general, participants enjoy the beautification that the lighting on the church provides. This is also supported by the image (Figure 18) taken by a person in the Facebook group, which received a lot of likes. The participants also gave feedback on the existing lighting on the church. There were various responses to it, but the general tendencies were that it was perceived as either "adequate" or "too much lighting". To quote a participant "Maybe dim the light a bit? It would be nice to still be able to see the church, but maybe it would be a better idea to get lighting that fits the size of the church" (Appendix 5). The last question revolved around what other churches the participants liked the lighting of. Here, the majority responded Roskilde Cathedral. This response can be attributed to the familiarity of the cathedral, since it dominates the skyline when commuting from Svogerslev.

4.4 Far, near, close

An overall analysis of the area around the church was conducted in order to analyse the church's function at three different distances:

1. Far (Wayfinding)
2. Near (Community function)
3. Close (Atmosphere)

This analysis is based on Gehl's concepts of 'far' and 'close', and combined with Spradley's grand-tour observation method (Spradley, 1980), in which the tour consists of these three different distances.
These should not necessarily be seen simply as physical distances from the building, but more accurately as conceptual divisions of the functions that a landmark serves in regard to the surrounding community. 'Far'; where the focus is on the church's function as a landmark for wayfinding. 'Near'; where one looks at the function of the church in the community, and how central a part it in the town. And lastly, 'close'; focuses on the atmosphere, and how it is created. Although each of the distances focuses on different parts of what a landmark does for the surrounding community, it is important to note that all of the aspects are present, to one degree or another, in all of the distances.The following Figures, 19 and 20, show the three distances both during the day and at night. The blue 'far' points refer to where the furthest point from which the church is visible in the given area.

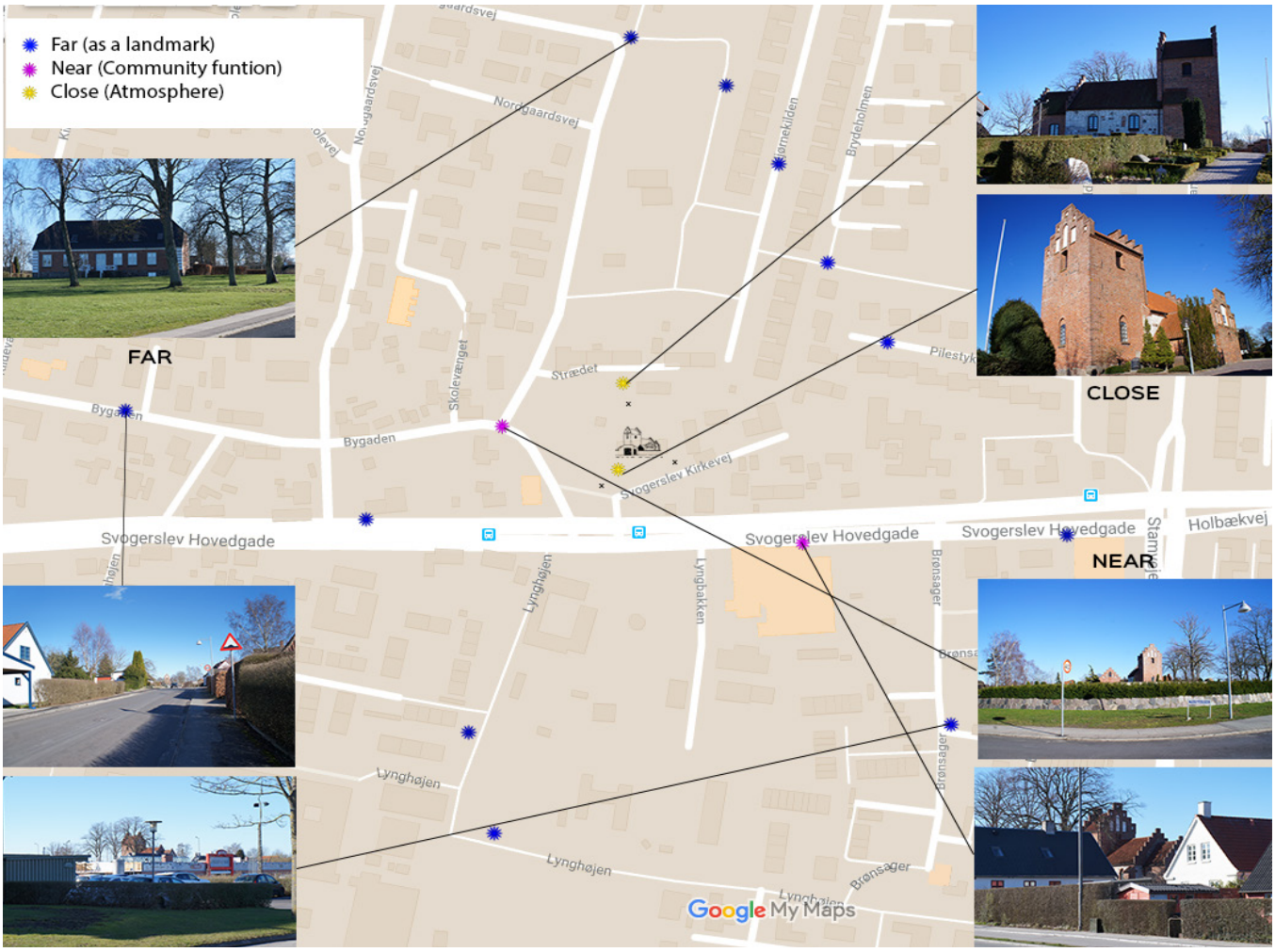

Figure 19: Pictures from 'far', 'near', and 'close' distances: Daytime.

4. ANALYSIS OF CASE

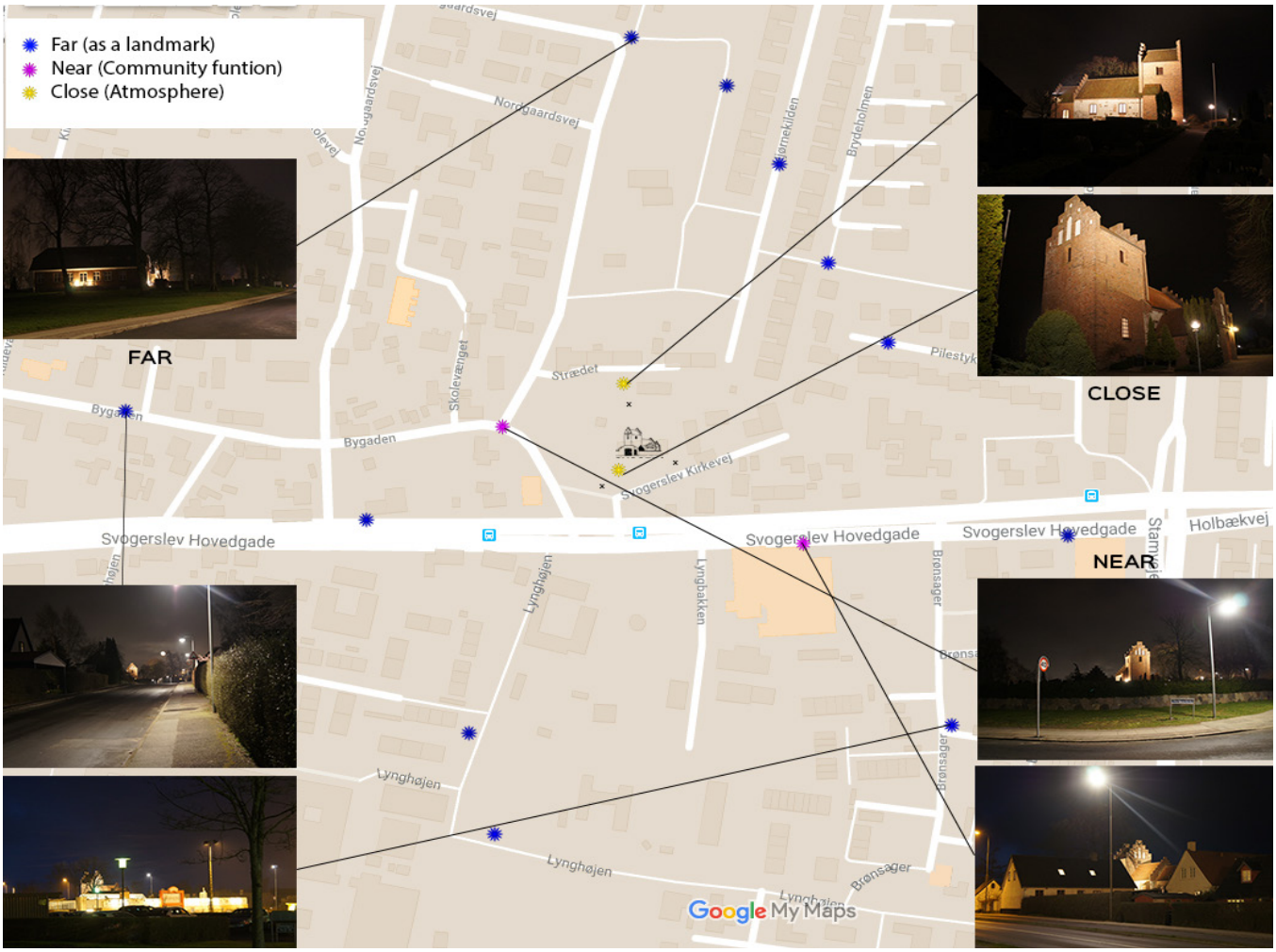

Figure 20: Pictures from 'far', 'near', and 'close' distance: Nighttime.

To summarize the observation from Figure 19 and Figure 20, this paragraph elaborates on each of the three distances, as pertaining to the specific case.

'Far': Trees are blocking the view of the church, which can be a problem if it is to fulfill the wayfinding portion of its role as a landmark. However, it does function as a landmark in certain areas of town, for example as seen from some of the main attractions in the area.

When looking at the size of the town and comparing to the visibility of the landmark for wayfinding, it is only functional in the centre of town.

'Near': The church has a big role in the community as a gathering point, due to its central location and the availability of larger rooms for gathering, which the residents also commented on in the questionnaire.

'Close': When entering church grounds, there is a huge contrast between the brightly lit white limestone walls of the church and the unlit graveyard right beside it that can be disconcerting, but despite this contrast, there is still a general feeling of safety by the church. This feeling could be because of the light being too bright, which is also reflected in the answers of some of the participants. It is important to take the surrounding space into account when designing for lighting at night, so that the solution takes into account people who are out walking late and who might want to sit and rest by the landmark for a while.

During daytime, the atmosphere of the church and its graveyard is quite pleasant. People mostly visit the church during daytime for their various reasons (grave visit, christening, Sunday mass, and weddings). However, at night, the sharp, bright light can be somewhat uncomfortable on the eyes, when contrasted with the surrounding darkness of the graveyard. This is problematic for the quality of the current lighting solution, since the place should be inviting even at night. However, there is only very limited foot traffic by the church at night, which means that the 'close' distance is not as relevant to design for in this specific case as the 'far' and 'near' distances, where the primary focus will be.
When people are walking close by the church, it is important to keep in mind that people's vision is limited to around 55 degrees upwards, as stated in 2.4.3 Perception. This means that the upper part of the church is less relevant when designing for the 'close' distance, as compared to 'far' and 'near'. Since the lighting solution is mainly meant for night time, where not a lot of people visit the church itself, it is a lot more relevant to design for the 'far', and 'near' distance in this case.

4.5 Client

When designing facade lighting for an outdoor environment, there are, in a way, two clients. The people who will pay for the lighting solution and the community, who has to view it on a daily basis. Therefore, it is important to cater to both their needs. Svogerslev Church's congregation is the primary client and, therefore, their needs should be accounted for. According to the interview with the priest (4.3 interview of locals), the reason behind lighting up the church is to create an awareness of it and to illuminate the facade in the darkest time of the year, so that it feels more festive for the celebration of the birth of Christ. As stated in Appendix 4, they (the church's congregation) have been explored what kind of lighting solution they found appropriate for their church, amongst the references were Jylling church and Roskilde Cathedral. This means that they wish to have a lighting solution lighting up the important elements of the church, such as the tower, with a warm colour temperature.

For creating a lighting design on the church, it is important to take the three distances into consideration at night, as they relate to the community. On the questionnaire, the community answered that they thought the church was pretty when lit up. This underlines that the community should find the solution visually attractive when they interact with it at the 'far' and 'near' distrances. Remembering to include the community's needs into the lighting solution will give the best result and effect. However, the church's congregation is the client, and they want the solution to create awareness of the church. This can be done by highlighting the architecture, in order to understand its symbolic function to its surrounding community. Furthermore, they wish to give a new meaning to the local building at night. This is where the function of a lighting designer comes in. Even though it is a religious building, it should embrace the community. The lighting should be appropriate for lighting up a religious Christian building, but at the same time, it should meet the needs of the people in the community, in terms of the 'far', 'near', and 'close' distances.

Figure 21: Lighting on Svogerslev Church.

4.6 Lighting analysis

The existing outdoor lighting scheme on the church lights up the church from the first Sunday of advent to the 2nd of February (Kyndelmisse). The client has chosen to turn off the light on that specific day, because Kyndelmisse is a celebration of light. The word kyndel means candela-room, light, and solemn mass. This means that, according to the congregation of the church, in the darkest time there will be lighting on Svogerslev Church. For the rest of the year they want to, as they say "preserve the dark". As stated in the church newsletter "The churches stand as lighthouses extruding upwards." (Svogerslev kirke, nr. 4 årgang 54, 2018, p.3). This is the idea behind lighting up the church, both as a religious beacon and as a landmark.

The lighting on the church can be seen in Figure 21, where it is possible to see that only three of the four sides of the church are lit up. The following sections will go into an analysis of this lighting, and furthermore, show the lighting located inside the church.

4.6.1 Indoor lighting

Figure 22: Luminaires located inside Svogerslev Church.

The indoor lighting of the church is a soft, warm lighting, as if trying to imitate candle light. This is achieved by using a low colour temperature, making it appear very orange, as seen in Figure 22. The indoor lighting is meant to create an atmosphere of safety, holiness, and coziness to convey the symbolism of the church. If the indoor light reflected the outside lighting, the facade lighting would appear like that on Roskilde Cathedral. Moreover, it would also have elements of the church lit up like the indoors, where the lighting is not designed for noticeability, but to create an atmosphere. The answers from the people in the questionnaire preferred the cathedral lighting, which could encourage the decision to apply the indoor lighting onto the facade.

4.6.2 Luminaires

Located around the church are various luminaires. Some are attached to the building, while others are standing on poles. All of them have a low colour temperature, as seen in Figure 23. The luminaires create an atmosphere around the church, and helps guide people around and across the cemetery and church. They create a gloomy, cozy feeling, since the area is not particularly brightly lit, which leads to the creation of dark areas. This is also supported in the questionnaire.

Figure 23: Luminaires located outside Svogerslev Church.

The luminaires for the facade lighting are 50W LED flood lights with a grid of 30x30, a lumen output of 6800LM, and a colour temperature of 2700K (warm white), as seen in Figure 24. They are placed on poles with a height of approximately 3.5-4 metres.

Figure 24: Facade luminaires outside Svogerslev Church.

4. ANALYSIS OF CASE

A spectrum analysis was conducted with a spectrum meter (AsenseTek alp-01) on the facade luminaires, concluding that their CRI was around 80. It was discovered that the luminaires did not emit the colour red, as seen in Figure 25.

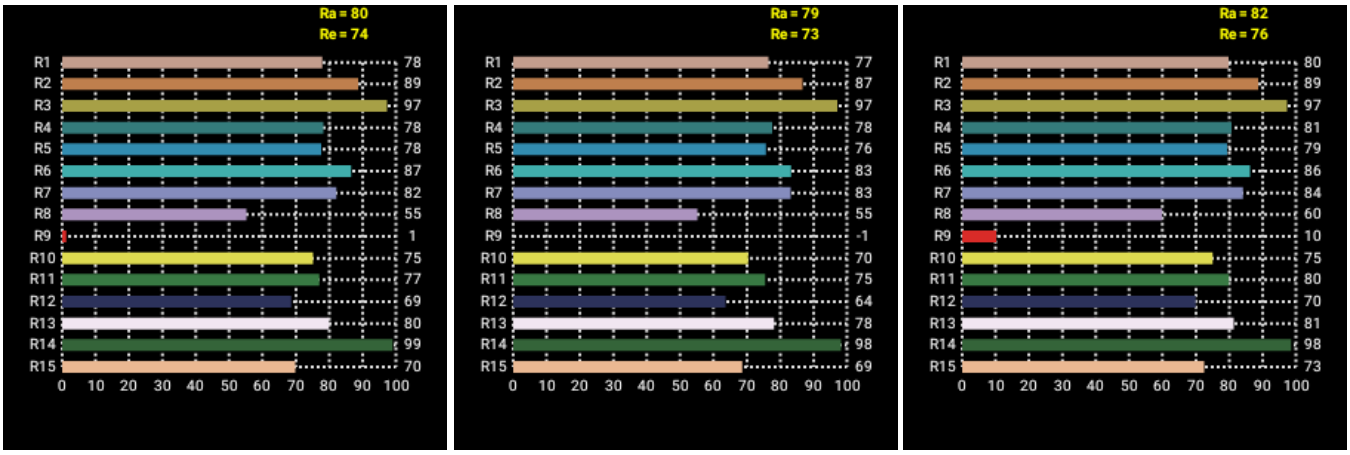

Figure 25: Colour spectrum of the facade luminaires.

A CRI around 80 is within the acceptable range for outdoor lighting. However, due to the material of the church being red bricks, the luminaires should represent the red colours, in order to fully see the correct colour of the bricks and draw out the architecture. This lack of red in the colour spectrum is not desirable and does not match up with the intentions of warm and comfortable lighting, as stated in 4.3 Interview of locals. The white elements of the building is, however, well represented with the current luminaires.

4.6.3 Lux levels

The lux levels were measured using a lux-meter (Mr.Meter LX1330B) low to the ground on both the front and back sides of the church. On the front side, there was a range of 14-22 lux and on the back there was a range of 7-20 lux. Having a higher level of lux on the front side, which faces the road and the lit up street, seems appropriate. However, having the lux levels this high at the foot of the building may not be desirable, according to the principles - the lower part of the building should receive less light than the top part. Having a high level of 22 lux may also be a little to high, since Denmark brands itself with its dark cities, and lighting so bright might interfere with this idea, as well as the goal of having the stars be visible at night, which is the goal of the darker cities. The recommended contrast ratio of 1:10 is not fulfilled with the light levels on parts of the church. This means that the contrast could be visually uncomfortable, and make the architecture seem fragmented.

4.6.4 Reflectance

As previously mentioned, the primary materials used on the church are red bricks and limestone. However, these red bricks are handmade (burned), which means that each brick has its own colour, making them vary in individual shade and hue. The reflectance of each of the different materials was measured using a lux-meter (Mr.Meter LX1330B) on the church. The results can be seen in Figure 26.

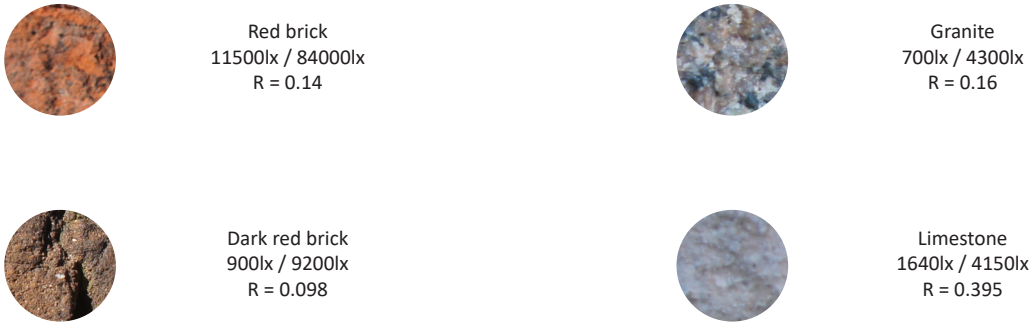

Figure 26: Reflectance of materials.

According to Table 1 from 2.2.1 Reflectance, a new red brick has a reflectance between 0.15-0.25, and clean granite has a reflectance of 0.1-0.15. Looking at Table 1 and comparing it to the results shows that the reflectance of the red brick and the dark red brick is lower than the new red bricks of Santen's table. However, this unsurprising,given the age of the church and its less than pristine condition. The bricks could perhaps be in need of a cleaning to come closer to the recommended facade reflectance of 0.2. Granite is not well suited for lighting up, since it is below Santen's recommendation of 0.2 reflectance, as seen in 2.2.1 Reflectance. The granite is, however, primarily at the foot of the church, which makes it less important to light up. However, according to the on site measurements, the granite had a reflectance of 0.16. From this we can conclude that the type of granite used for the construction of the church is on the high end of reflection, which is likely simply because of the type of granite used. Table 1 shows that white concrete generally has a reflectance of 0.40, which is quite similar to the measurements of the limestone. In the areas with limestone, there will most probably be a lot of reflective lighting. This is very apparent on the luminance map, where the areas with this material will have a markedly higher luminance than the red bricks beside it.

4.6.5 Luminance map

Three luminance maps of the church were created with a luminance meter (Luminance Meter LS-150), and HDR photos. A false-colour map was created with the luminance measurements plotted on a scale to show the luminance of the existing lighting solution. The following three Figures: 27, 28, and 29 will show the results of these measurements.

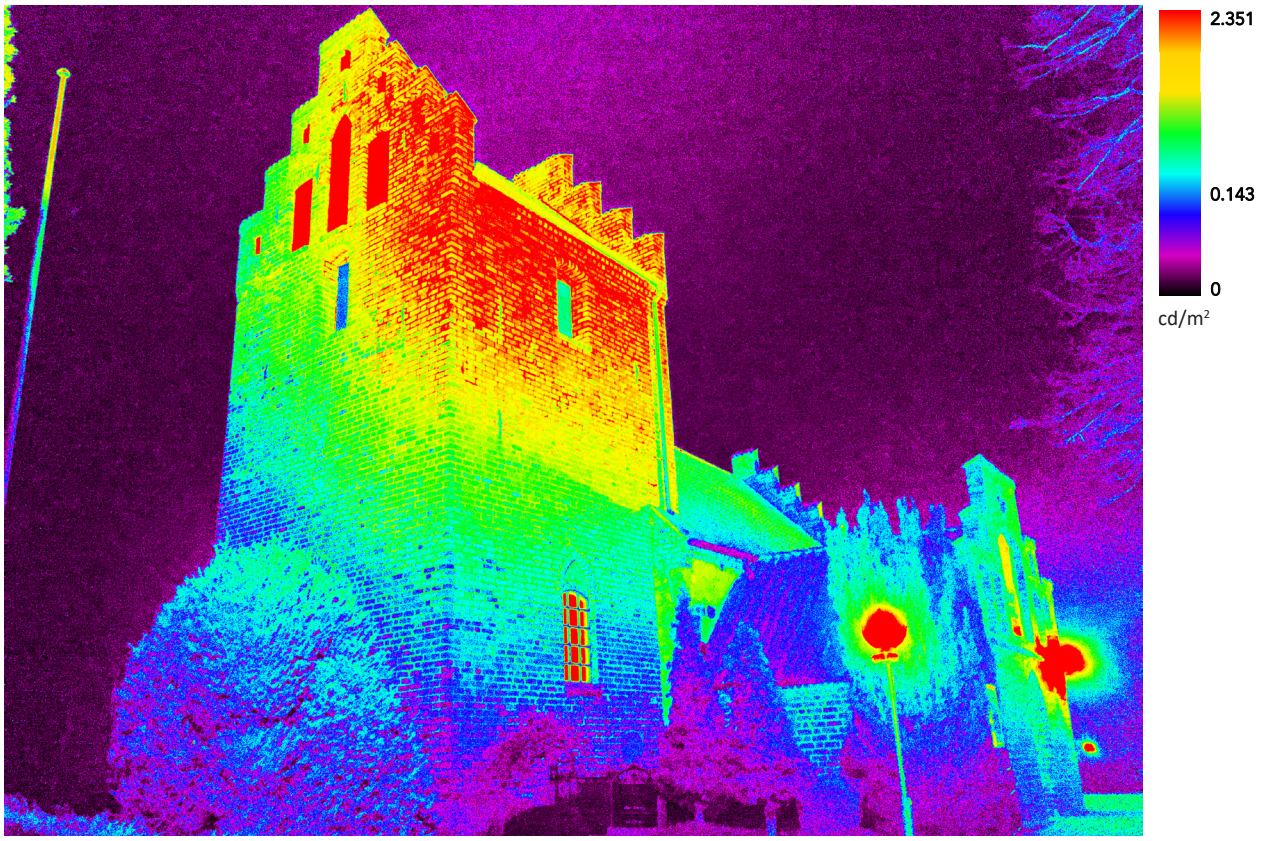

Figure 27: Luminance map A.

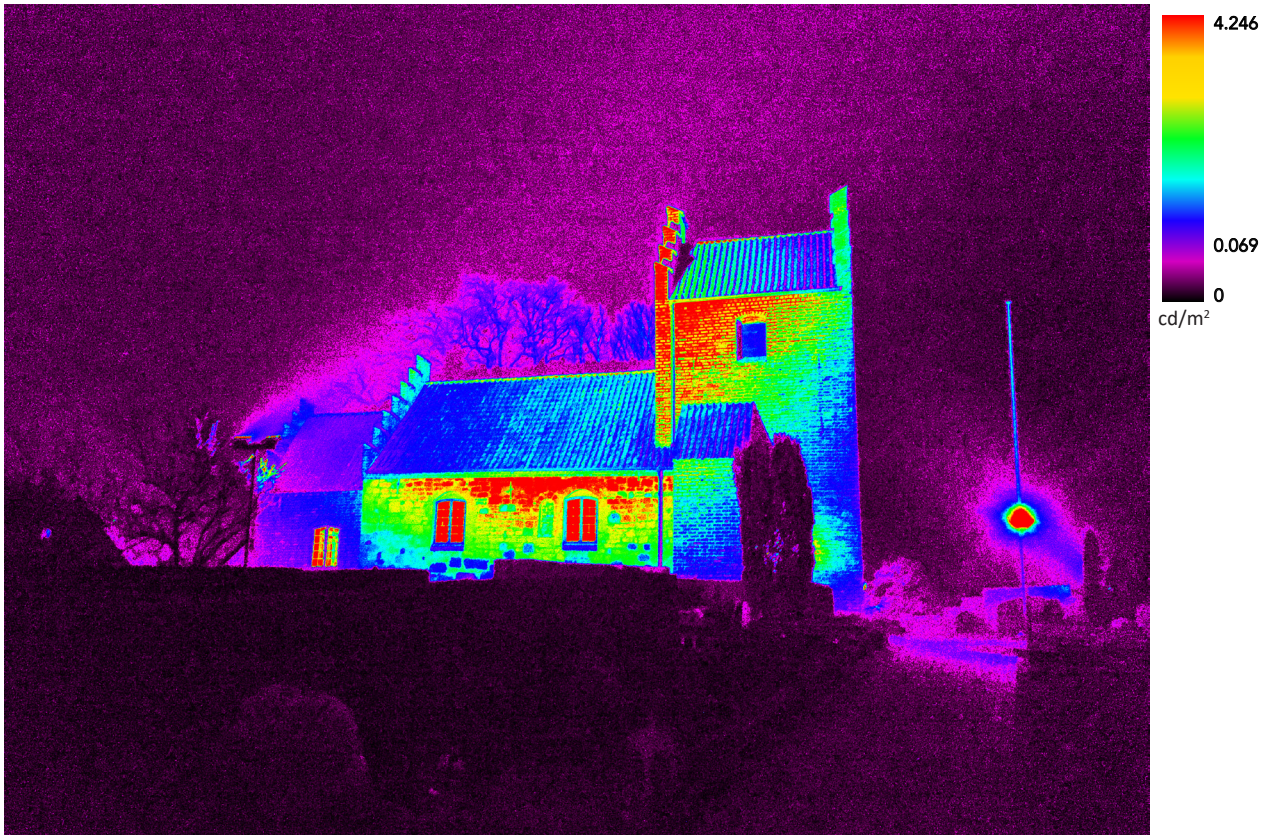

Figure 28: Luminance map B.

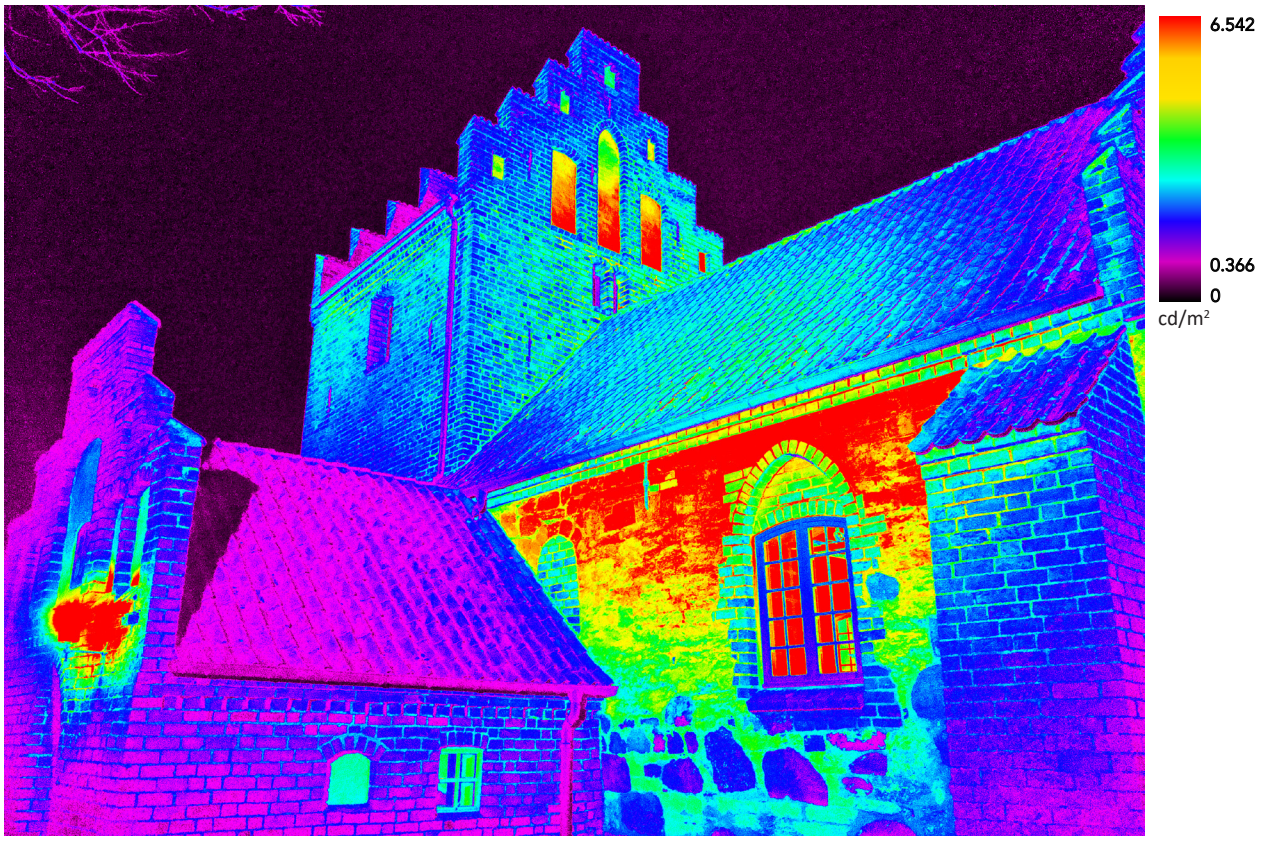

Figure 29: Luminance map C.

Based in Figure 29, it can be seen that the materials of the walls, such as the bricks, reflect quite a bit of light as compared to the roof, which reflects less. The same can be said for the limestone areas, in contrast with the bricks, as mentioned above. This means that the roof seems darker in comparison to the bricks and the bricks in comparison to the limestone. This effect is caused by the reflectance of the materials that the church is made of, and further reinforces the importance of looking at the reflectance of the involved materials when figuring out how much light is needed to properly light up the facade or building.

There is a high degree of lighting on the church that measures past the 3 cd/m^2 threshold, which means that photopic vision is in use. This means that, in theory, the colours of the church should stand out clearly. However, as previously discovered, the luminaires can not emit the full colour spectrum, and therefore, not all colours can be displayed correctly. The light level is desirable in terms of showing the texture of the material. However, for the purpose of lighting up a facade, this level can also be lower, in the mesopic area, where it is still possible to see parts of the colour spectrum.

The church building is a freestanding building surrounded by greenery and a graveyard. The greenery is lit up, as seen in Figure 28, and receives a large amount of spill light. According to Santen's table, this type of building should receive 3.2 - 6.5 cd/m^2. Looking at Figure 27, Santen's recommendation for the amount of lumens is fulfilled. However, in Denmark it is common to have dark cities, where the light-level does not match up with what Santen recommends. This is because of the desire to be able to see the night sky, and retain the cozy feeling.

4.6.6 Conclusion

Although there is lighting on the church, it is only enabled for a short period of the year. This period of time, unfortunately, does not cover the entire span of the dark months, from around the start of December until the end of February. Having the lighting solution on for this entire span of time could be conducive to communicating the identity and symbolic function of the church, both in the 'near' and 'far' sense. However, the factor of the church only being lit up for a limited amount of time creates an atmosphere of awareness of the church that is also desirable. This could be changed by either having lighting all the time, or a permanent lighting solution that changes in the aforementioned interval. The lighting solution primarily lights up the front and sides of the tower and church, which means that the back of the church is left entirely unlit. It is not necessarily important to light up this generally quite unimportant part of the church building, since the area is comparatively small and mostly insignificant, and the current solution focuses on the important parts of the church, rather than the whole. These are some of the things that, if addressed, could improve the current lighting solution.

After executing the observation of pedestrian flow, understanding the locals, and investigating the importance of the three distances, a lighting analysis was conducted based on the knowledge of the aforementioned principles, which gave an idea of what was lacking in the current lighting solution. Looking into reflectance provided an understanding of the needs of the various materials that make up the church building, with its overall low reflectance. However, the limestone walls have a high reflectance, which could possibly be utilised.
Looking into the situation showed that there is no need for as much light as the existing solution provides, since the church is a freestanding building. The trees in the area become part of the current lighting solution and its atmosphere because of all the spill light, which they reflect. Looking into the contrast gave an understanding of the positioning of the lighting on the church and how much it fractures the architecture of the building. Furthermore, having too high a contrast to the surrounding area and its attraction points may lead to an incoherent cityscape, and should therefore be addressed in a new lighting solution.
Looking at the colour of the existing luminaires shows that they are lacking red spectrum, which is suboptimal for the colour rendering of the red bricks on the church. Also, if, as stated in interviews, the locals prefer the lighting on Roskilde Cathedral, having a deficit in the red spectrum may result in not having the same type of lighting that was popular on the cathedral. Looking at the placement of the luminaires gives an idea of what kind of lighting solution was intended for the church. Having pole mounted flood luminaires bathing the church in light gives the impression that the solution is lighting up the church for the sake of lighting up the church.

After the analysis, a few questions still remain: how much lighting is needed for the identity of the church to be properly communicated throughout the three distances? Should the facade lighting be a representation of the indoor lighting and the function of the church? And lastly, does the lighting have to bathe the entire church to achieve its purpose of creating awareness and presenting itself as a landmark? - these question lead us to our research question.

5. RESEARCH QUESTION

After investigating the different principles of facade lighting, the question which stood out the most was: which of all these principles are best used in order to communicate the function, both mundane and symbolic, of a landsmark to the nearby area. From this, our research question was derived:

> *"What principles of facade lighting are best employed in lighting up a landmark like a church, to emphasise its spatial settings and importance to its community?"*

5.1 Criteria

The following criteria are based on the spatial settings from 2.5 Summary of background research along with some of the findings from 4 Analysis of case. They define what has to be taken into account when creating a good lighting solution for a landmark, in this case a church.

Each set of criteria is based on the concepts of 'far', 'near', and 'close'. For each, one or more phrases have been created, that exemplify how the concept should be taken into account when designing a lighting solution for a landmark, in order to bridge it to a community. Each phrase will then be clarified and tied to the specific case.

5. RESEARCH QUESTION

Far (Wayfinding)

The lighting solution should keep the landmark visible in the dark hours. The church should be lit up, making it visible from all the "far points" in Figure 19 & Figure 20.

The lighting solution should make the landmark distinct from the surrounding skyline or cityscape. In order to assist with navigating the cityscape, the church should be easily recognisable both at a distance and up close.

Near (Community)

The lighting design should display the identity and symbolic function of a landmark and its function. For instance the design should show the generic church architecture, and promote that it is a place for everybody, a general gathering point, as stated in section 4.3 Interview of locals.

The lighting design should avoid lighting pollution, lessening potentially uncomfortable or displeasing overillumination, which results in skyglow. In Denmark, it is a cultural norm to keep the stars visible at night, and therefore a desirable goal when lighting up such a central building.

Close (Atmosphere)

The lighting design should use enough light to support the surrounding space and its atmosphere. In this case, it would involve making the surroundings appear less dark in comparison to the church, as discussed in 4.6 Lighting analysis. This is to help ease the feeling of uneasiness and visual discomfort, as found in the analysis, and thereby creating a better atmosphere around the church (4.4 Far, near, close).

The lighting design should facilitate a comfortable space close to the landmark. The primary surrounding of Svogerslev Church is the graveyard, and not many people walk by there at night, as stated in 4.4 Far, near, close. Therefore, this criteria will not be very relevant for this case, but possibilities for fulfilling it will nonetheless be brought up in 8.3 Criteria for facade lighting.

6. DESIGN CONCEPTS

The following sections will work with different design concepts and the testing thereof, in order to get an idea of how a new lighting solution for Svogerslev Church could be made. It will discuss how they were explored on two different models, a 1:50 scale physical model and a model in the program DIALux.

6.1 Concepts

The following section will go through different lighting design concepts for the case of Svogerslev Church. It will go into how the earlier parts of this report contributed to creating the design concepts and how the criteria can be applied to them.

6.1.1 Concepts based on Reference works

The reference works were used as an inspiration for creating the different concepts. The light on Jyllinge Church does not light up the entire building, but rather focuses on providing an impression.This provided the idea of creating a concept that focuses on the architecture and atmosphere rather than illuminating the entire building. However, it is important to take into account that although Jyllinge Church and Svogerslev Church resemble each other, Jyllinge Church has a higher, more even reflectance, because of the amount of limestone surfaces.

An architectural feature that Jyllinge Church does not have, however, is the limestone panels on the tower. In comparison, these are a key feature of Svogerslev Church, that can also be found on other churches around the country.

Furthermore, a lot of people said in 4.3 Interview with locals that they preferred the lighting on Roskilde Cathedral with its warmer, more cozy colour temperature. A concept was created based on this, where the existing lighting is altered to mimic the lighting on Roskilde Cathedral.

Furthermore, a concept with coloured light was considered, since it was discovered in the lighting analysis that the red spectrum was nonexistent, and a design that promoted the bricks with red light was considered. However, based upon observations made at the Copenhagen Light Festival, it was decided that coloured lighting would work better in a solution aimed at event lighting, but would be suboptimal for an everyday lighting solution. Additionally, because of the old architecture of Svogerslev Church, coloured light may not be suitable and could be frowned upon by the community. If colour were to be applied, it would be recommendable to limit it to being used as an event lighting solution, where usage of red light could be applied to match with the red bricks.

6.1.2 Concepts based on criteria

To fulfill the criteria of Far, the higher visible points of the church should be lit up. This means that a solution should include lighting on the tower in order to fulfill the landmark's function as a wayfinding tool. This would also help display the identity of the church, and show its symbolic function. As previously stated, the tower and its architecture is commonly associated with, and perceived as, religious symbolism.

To fulfill the Near criteria, a new design should utilise the principles to communicate both the symbolic function of the church, as well as the more everyday functions, to the onlooker. This also includes that the lighting should be able to create an atmosphere that embraces the natural darkness by utilising less light, making it pleasant for passersby and reducing skyglow.

To fulfill the criteria of Close, the atmosphere should remain the same as with the existing lighting solution, while supporting the surrounding space, by making it more comfortable for pedestrians to walk across the grounds and nearby street.

6.1.3 Day and night parallel

A question emerged of whether the perceived atmosphere at night should draw a parallel to the daytime atmosphere? The answer that was reached is that, no, the lighting solution should not have to draw a parallel to the daytime, it is allowed to create an atmosphere that is unique to the night time, while keeping the symbolic function of the church clear. In the case of Svogerslev Church, it is important to acknowledge the church tower's lack of height, with regards to having the tower project the intended atmosphere in all three distances. Meanwhile, it is important to avoid lighting pollution, specifically skyglow, in order not to obscure the stars.

6.1.4 Illustrations of the concepts

The following illustrations in Figure 30 showcases the different concepts for lighting solutions on the church building.

Illustration A: Showcases an alternative version of the existing lighting. Illustration B: Makes use of the architecture of the church by lighting up the outline of it, in order to create a pleasant atmosphere, as well as making it a more unique entity in Svogerslev. Illustration C: Suggests lighting up the tower and part of the greenery to emphasize some of the dominant daytime elements at night. Illustration D: Showcases a simple lighting solution with a focus on the architectural quality of the tower by using the reflective limestone at the top of the tower.

Figure 30: Illustrations of the different concepts.

6.2 1:50 model of Svogerslev Church

In order to conduct small scale experimentation of the designs, a model of the church was created. The idea was to be able to prototype the different design concepts. Furthermore, the model helped with supplying a visual aid, as well as a tool for show and tell. The model is made in a scale of 1:50. A drawing of the model can be found in Figure 31. The drawing is based on the floor plan of the church, which can be seen in Figure 32.

In order to estimate the height of the church, the bricks were measured. As an example, to estimate the height of the tower, the bricks were counted for the entire length of the tower. This procedure was applied to obtain the various heights of the church. The church was modelled in a program called Onshape, which is a CAD program. The church was designed with the intention of laser cutting, which is why all the angles were made perpendicular. This can also be seen when comparing the floor plan, in Figure 32, to the drawing of the model in Figure 31.

6. DESIGN CONCEPTS

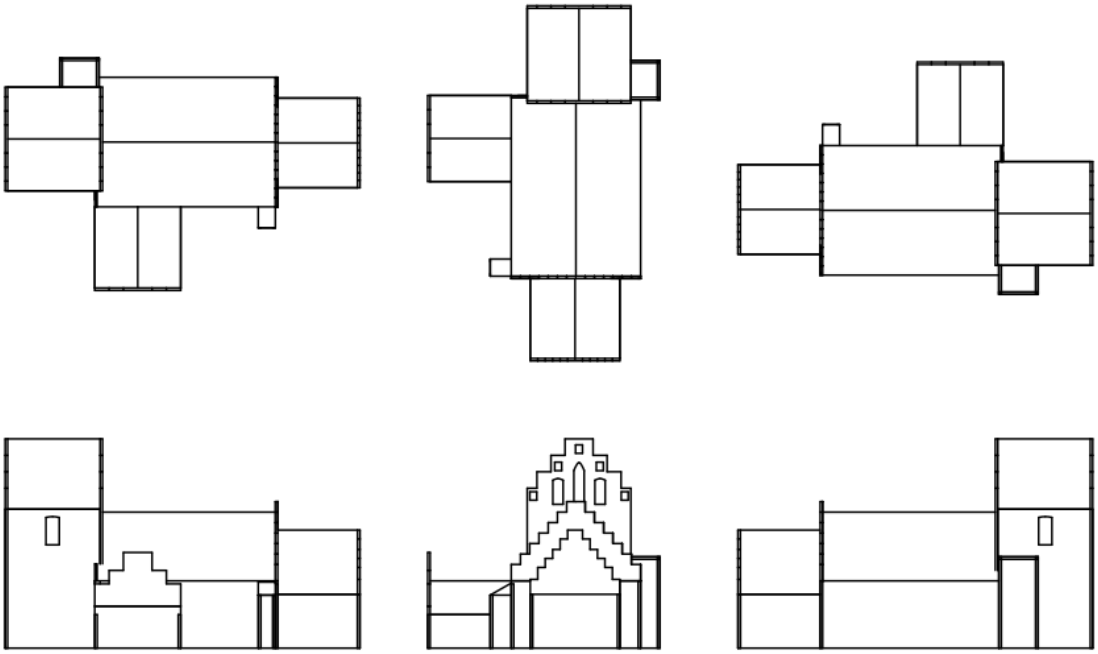

Figure 31: Drawing of the 1:50 model of the church.

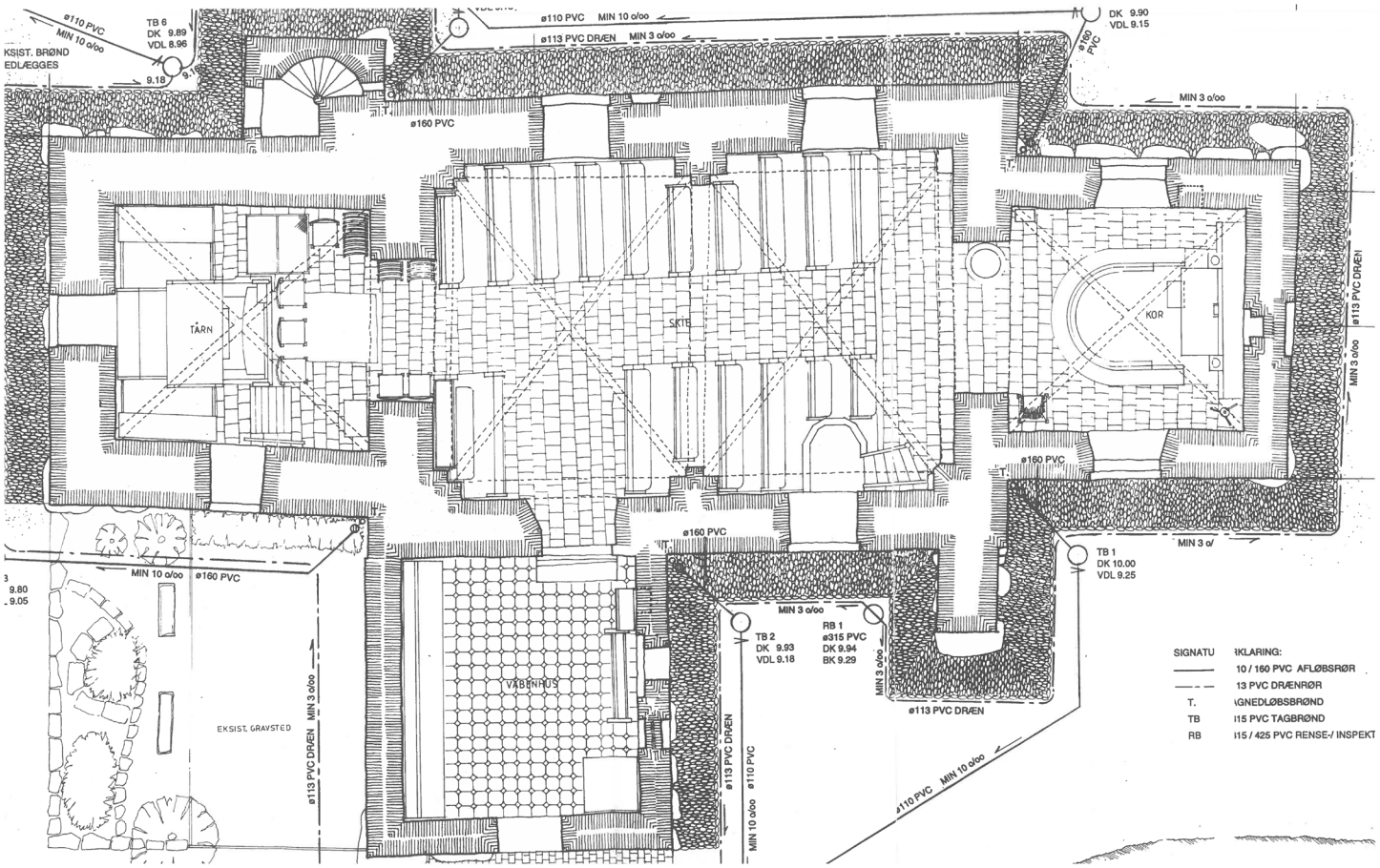

Figure 32: Floor plan of the church (Svogerslev Kirke).

The model was then cut on a laser cutter, using Figure 33, where red was cut, while the blue was engraved. The engraved shapes were the limestone parts of the tower. This was done so that they could be painted in white when assembling the model. In Onshape, it is possible to create joints between parts, which made for an easier assembly.

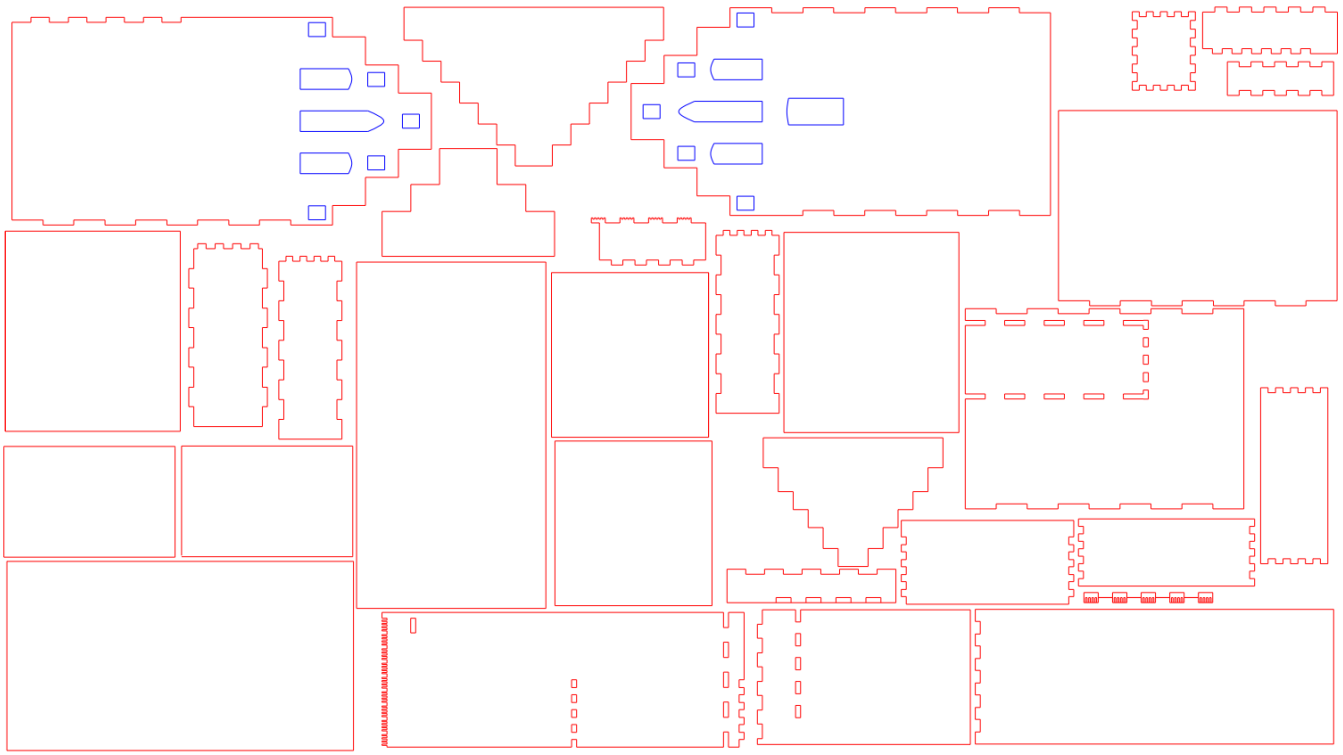

Figure 33: Guidelines for the laser cutter.

After laser cutting all the different plates, the model was assembled, using glue to ensure that it held together. This was followed by painting the limestone parts white to give them a better reflectance and to resemble the church as much as possible. The result can be seen in Figure 34.

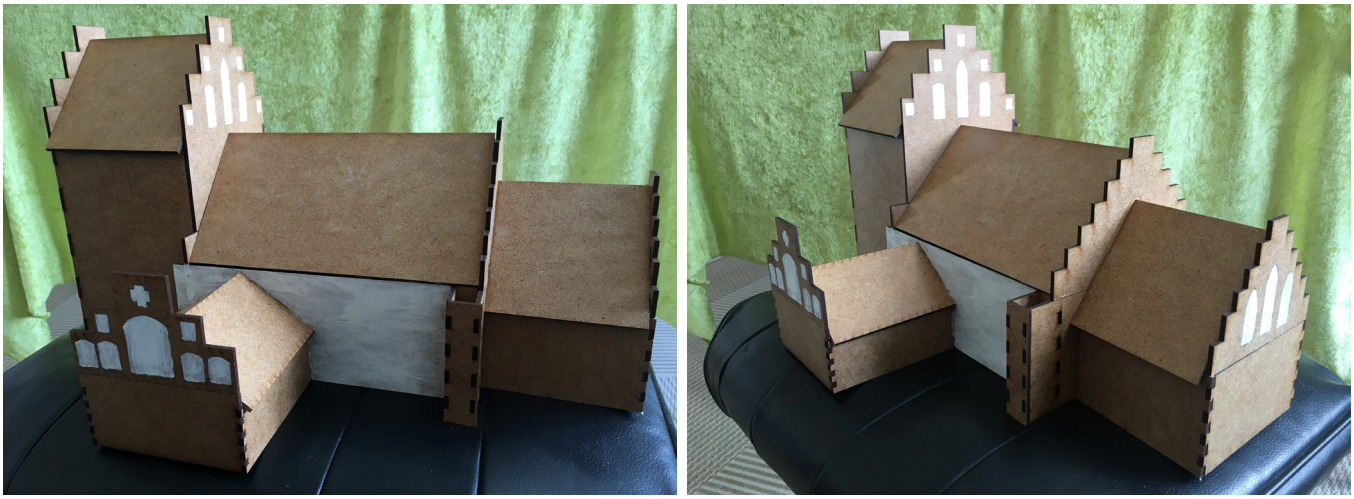

Figure 34: 1:50 model.

6.3 DIALux model of Svogerslev Church

A model was created in DIALux, in order to be able to display and measure the light properties and gain an understanding of how different luminaires will affect the lighting on the church. The model is based on the same floor plan (Figure 32) as the 1:50 church model, using the same procedure to estimate the height. Compared to the 1:50, this model was created with a lot more detail. All of these details were added to have the most accurate results in terms of reflectance of material and in order to recreate the general architecture in order to have the most realistic impression of it. To obtain the details on the church and where the various limestone arches were placed, a picture was used as a modelling reference, together with the known width of the church, as seen in Figure 35.

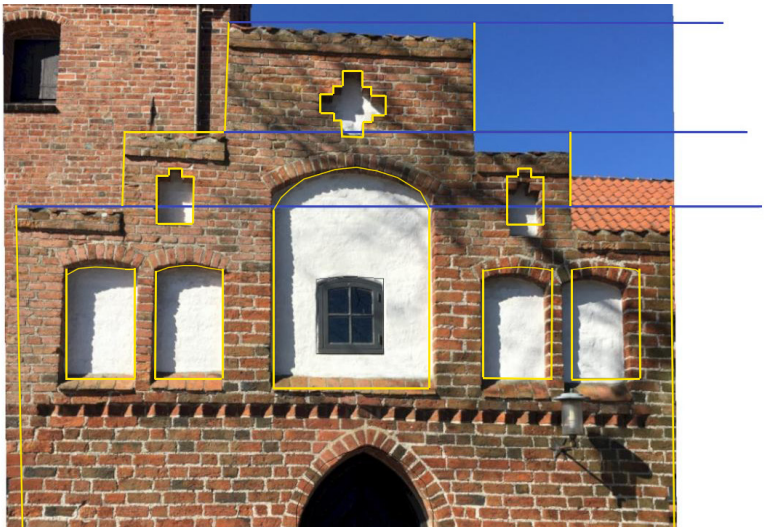

Figure 35: Reference photo used to model the church.

An estimate of the current position of the poles were also placed in the model, since these poles exist in the current lighting solution and could be the bases of new luminaires. The final model can be seen in Figure 36. At the bottom of the actual church, there are granite stones of various sizes. These have not been added to the model, since their sizes and locations varied a lot, and it was decided that it would not be important to include.

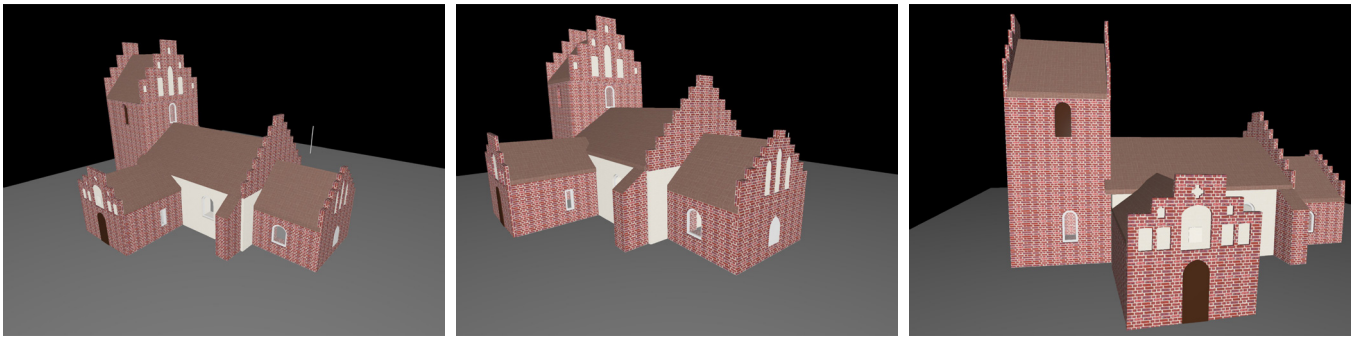

Figure 36: DIALux images of the model.

6. DESIGN CONCEPTS

The following Figure 37 shows a comparison between the pictures taken of the church and the renderings from DIALux. Though they are very similar, there are a couple of obvious differences. These stem from the measurements (floor plan) and the difficulties of modelling all the odd angles of an older building, as well as the uneven mixture of materials and the amount of different repairs and patches that have been done over time. All together, this leads to a somewhat crooked, mottled building, especially evident in the varying colours of the bricks that make up the tower, where different ages are very obvious. However, the digital model is only a representation of the church and can never accurately represent every detail, but one can strive to have as many as possible. As an example, there are other types of stone blended into the limestone walls. The same can be said about the bricks that all have different shades of red. This is almost impossible to get completely accurate.

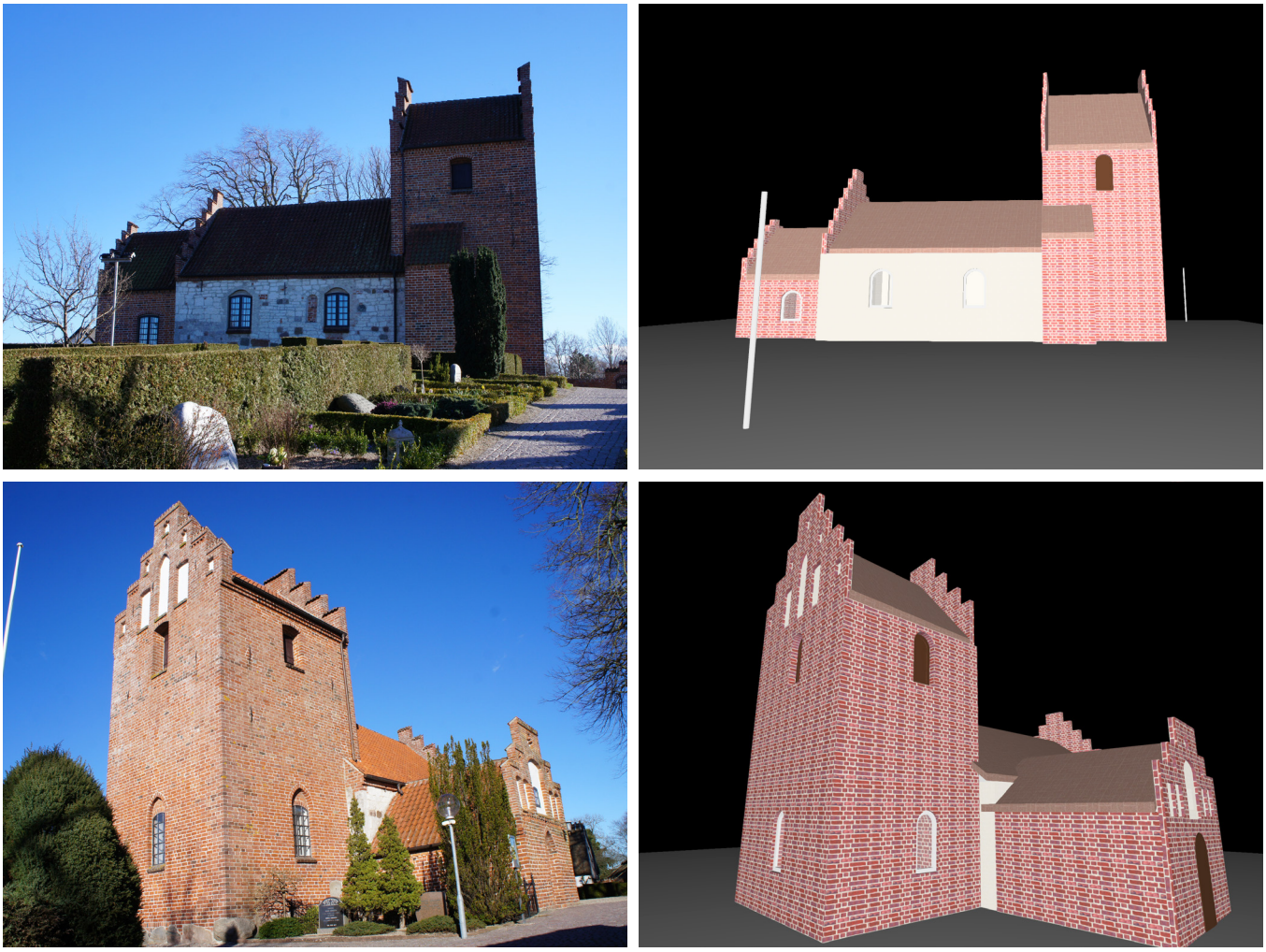

Figure 37: Reality compared to renders.

6.4 Prototyping the concept designs

The following sections will go into detail about the results of the testing on the models. Firstly, a low fidelity test was be conducted on the 1:50 model. This will be followed by an analysis of the existing lighting conditions as well as the ideas for alternative lighting solutions that emerged during conceptualisation 6.1. Concepts. Acknowledging that the reflectance of the church is not optimal, as discussed in section 4.6. Lighting analysis, The reflectance of the bricks will not be taken into account in the following designs. The following three solutions will be presented in the subsections 6.4.2 - 6.4.4.

6.4.1 Low fidelity testing of concept design

To get a better understanding of the concepts involved, a low fidelity test was performed using the physical 1:50 model, along with different light sources and positionings, to test out the different concepts. It was very clear that the existing lighting on the church would never be able to fully light up the church. However, a change of direction could make important changes in the presentation of the building, such as by focusing on the tower or the main body of the church. These experimentations can be seen Figure 38.

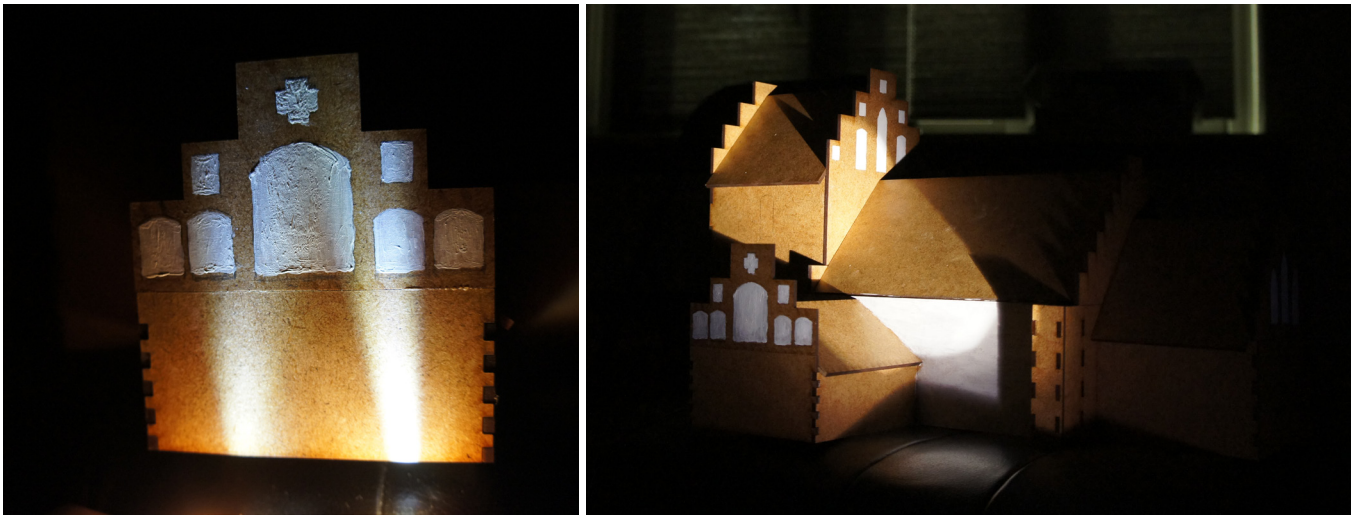

Figure 38: Experimentations with 1:50 model.

6.4.2 Concept design 1: Improving the existing solution

The first concept design was based on the existing lighting scheme, with the idea being to improve and adjust the luminaires. The first improvement would be to use luminaires that include the red colour spectrum, to produce a better colour fidelity, which would reflect the bricks in a better way. By doing this, the hope is that the architecture of the church building would seem less flat and more animated than it currently does, since the the red colour should theoretically provide a better depth to the architecture, while still keeping a CRI at 80 or above. The second would be to reduce the amount of spill light, which could be done by changing the orientation of the luminaires on the poles.

Lastly, by adjusting the illuminance of the luminaires in order to make the lighting solution able to communicate at all three distances. Letting the church building function as a landmark without the lighting becoming obnoxious, while also creating ambient lighting for the surrounding area. The result of this can be seen in Figure 39.

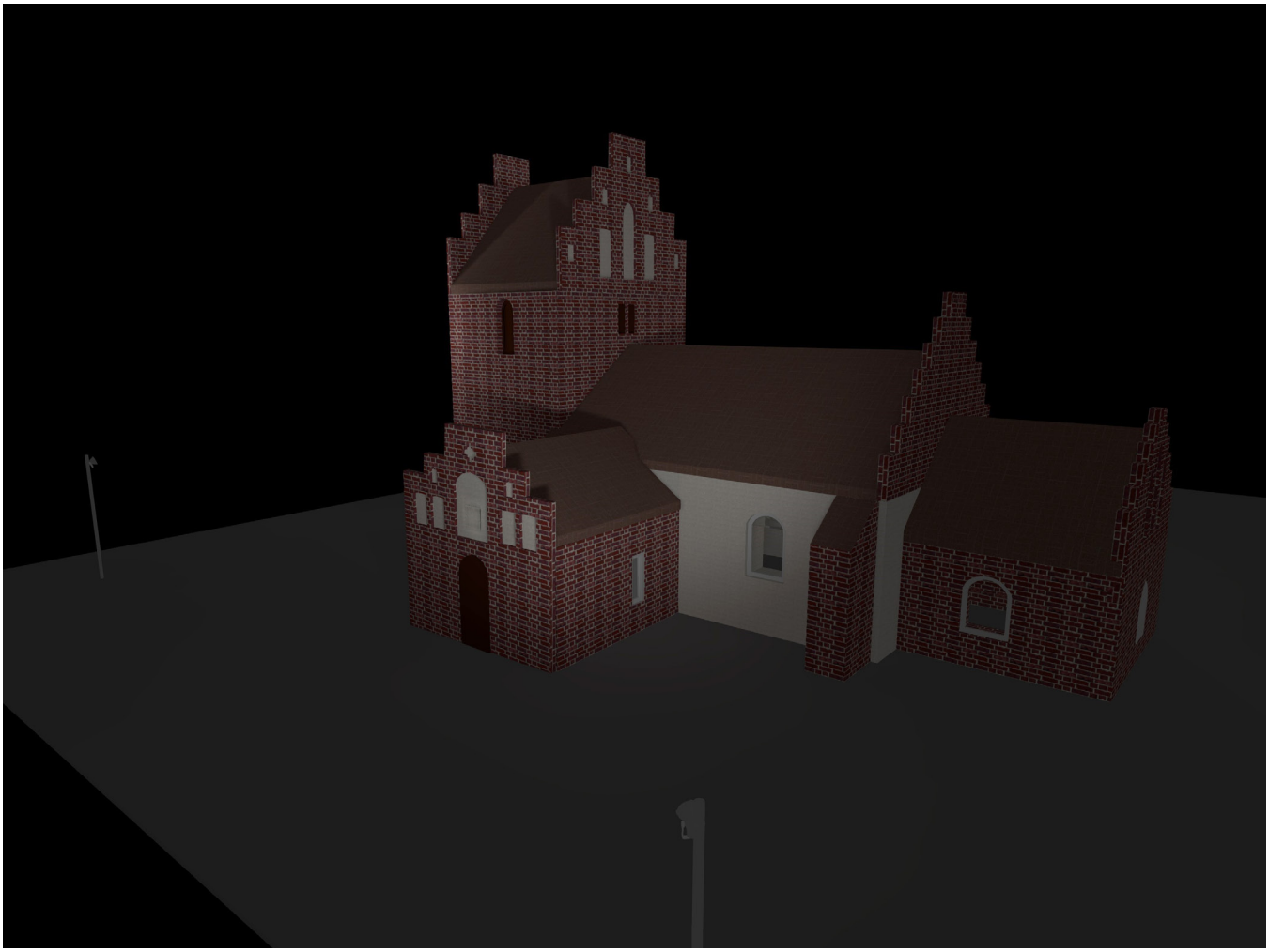

Figure 39: DIALux rendering of Concept 1.

This concept design fulfills the criteria of Far by lighting up the tower, which allows pedestrians to use the tower as a landmark for wayfinding. The theory behind Santen's elements of facade lighting have been taken into account, however, they are not necessarily applicable to the Danish norm of darker cities. Therefore, the numerical details were conformed to this norm. Thus, some of the concepts might be below the suggested values for a free standing building given in 2.2.2 Situation. As for the placement of the poles, they are not utilised to their full potential, meaning that the existing placement of the lights will never be able to light up the church evenly, as stated in 6.4 Testing of concept design. But, since one of the Near criteria is that the church should keep its symbolic function, the light does not necessarily have to light up the entire church, just enough of the architecture to communicate its identity. This is what has been done at Jyllinge Church, as mentioned in 3.2 Jyllinge Church.

6. DESIGN CONCEPTS

This design makes use of the existing solution with a slight modification, which means that the aforementioned analysis is still applicable, to a certain degree. Therefore, the analysis of the distances are the same, with a slight difference in the 'close' distance, since the lights have been dimmed in this design. This might affect the uneasiness created by the visual discomfort of the existing solution. Additionally, this dimmed and adjusted light should produce less spill light in the surrounding area. These factors make this concept an improvement on the existing solution, especially in terms of the criteria of the Close. Therefore, this design does more for the church grounds, since the luminaires used are less powerful, which should be less disruptive to the intended atmosphere experienced when close to the church.

In order to gain better insight into this design, it was set up and measured in DIALux. More specifically, measuring was done on factors such as: spill light, illuminance, and lumen. Figures 40 and 41 show the amount of spill light projected over the top of the main building. This spill light cannot be prevented, due to the position of the existing poles.The client does not have the resources to change the position of the existing poles, because of both a lack of budget and the disruption of moving the pole set up in the graveyard. This was the main reason to base all of the design concepts on keeping the existing placement of the poles. However, if the luminaires were to be positioned differently, it would be entirely possible to lessen the lighting pollution significantly. Figure 41 shows how the light from the new luminaires could also help illuminate the graveyard by reflection, making the surrounding space appear brighter. The rest of the calculations can be found in Appendix 6.

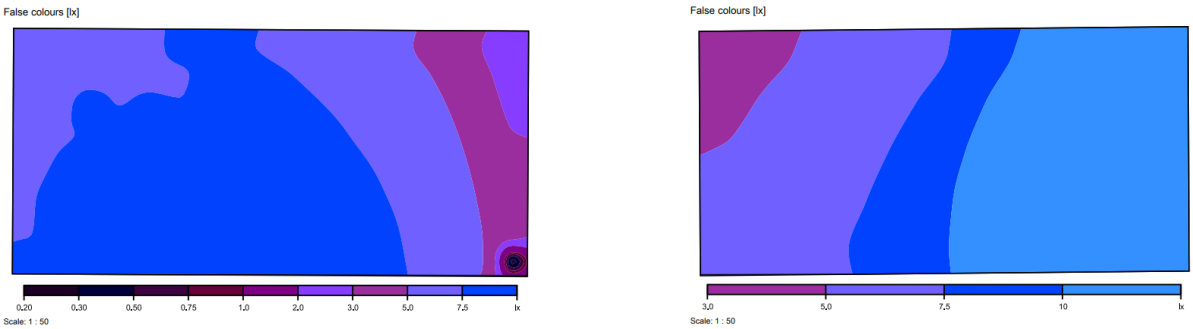

Figure 40: (1) Spil light calculation above the roof of the main building as seen from the the entrance annex side.
(2) Spill light calculation from the opposite side .

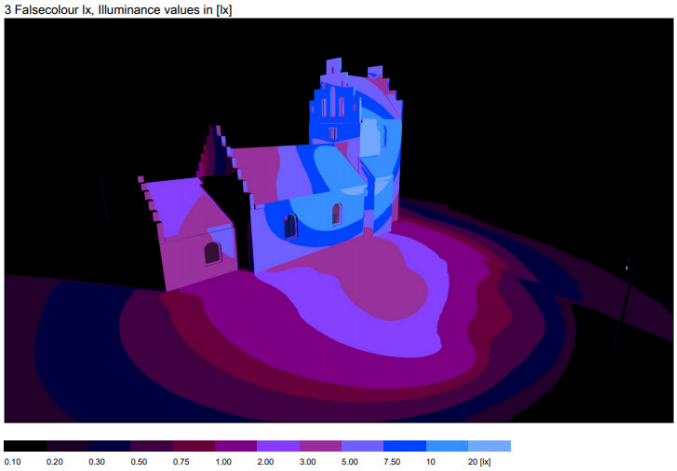

Figure 41: False coloured illuminance map of the first concept design

6.4.3 Concept design 2: Tower panels

The second concept was based on the idea that the existing scheme is only turned on for a limited period of time, but it could be beneficial to have lighting enhancing the building's effect at all three distances for the rest of the year. This lead to an idea based around lighting up the limestone panels on the church tower. This means that the thought behind this concept was to keep the existing setup, to be used between the start of December and Kyndelmisse.
The idea of using the limestone panels came from the idea of using something with a high reflectance, since the high reflectance assists in spreading the light with an even diffusion. Lighting the facade in this manner can help make the church visible, as a landmark, and creating social awareness, while keeping the traditional church atmosphere. This concept would also create a lot less light when close to the church. Two variations on this design are shown in Figure 42 and 43.

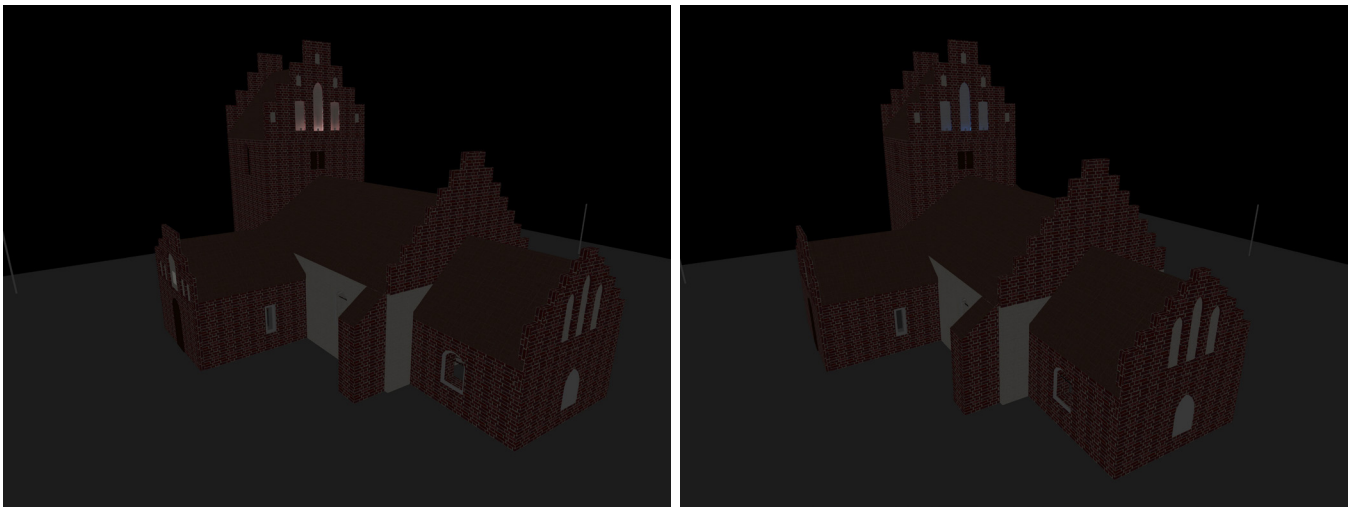

Figure 42: DIALux renders of Concept design 2A.

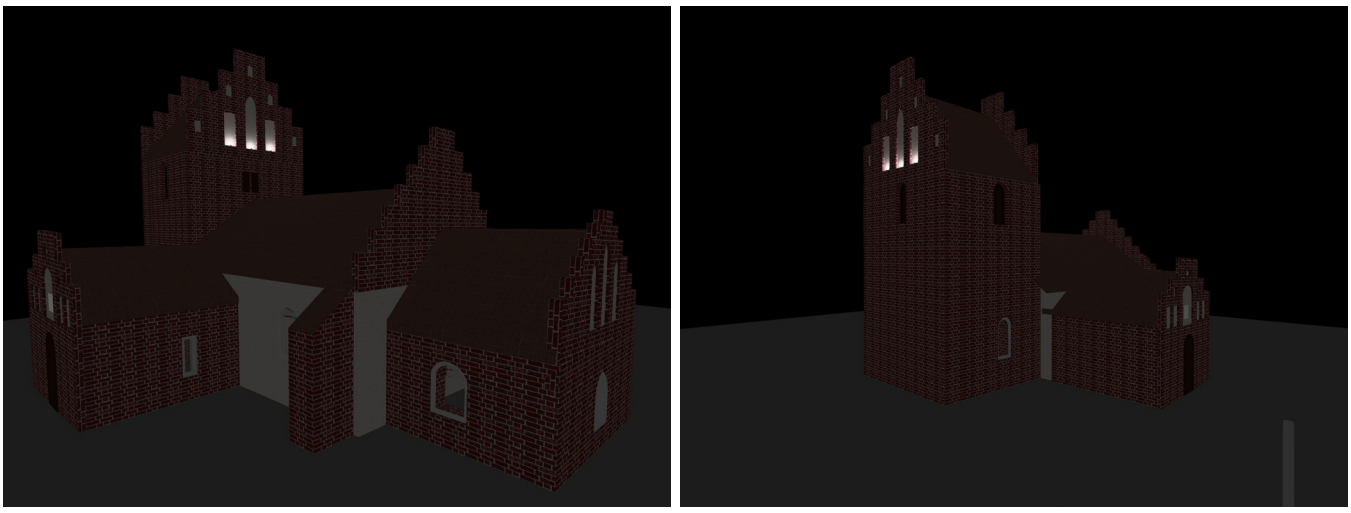

Figure 43: DIALux renders of Concept design 2B.

Concept 2A is based on having luminaires lighting up the outline of the limestone panels with primarily red, whereas 2B makes use of a wall-washer to light up the same areas. Thus, they fulfill the same criterias.

6. DESIGN CONCEPTS

These designs aims to fulfill the following criteria set out in 5.1 Criteria.
The criteria for Far are fulfilled by having the design light up the limestone parts of the tower. Since they are distinctive and in a design closely associated with churches in Denmark, it makes the church easily recognisable from a distance. Thereby, pedestrians can use it as a landmark to help guide them through the cityscape. For the Near criteria, as mentioned above, the parts of the tower that are being lit makes it easily recognisable as a church, thereby clearly communicating the symbolic function of the church to the pedestrians passing by. The luminaires are only placed in the limestone panels on the tower and might create a contrast to the rest of the church. It is therefore important not to have too much light emitting from the wall washers. The amount of spill light with this concept is quite limited, since it only lights up a small part of the tower. Lastly, when looking at the criteria for Close, the design does not really support the surrounding area, as all of the new light is mainly focused on the top of the tower. Since the light is focused on the top of the tower, it has a very limited effect on visiting pedestrians' navigation of the space. This means that this concept would not do much to support the night time atmosphere of the church grounds, but, as already discussed in 4.4 Far, near, close, the Close distance is of somewhat lesser importance in this specific case. However, the lighting should guide people's eyes upwards, and Santen recommends having more lighting on the top of a structure than at the bottom.
To understand how the lighting would function with the existing lighting scheme, a combination of the previous design and Concept 2B is shown in Figure 44.

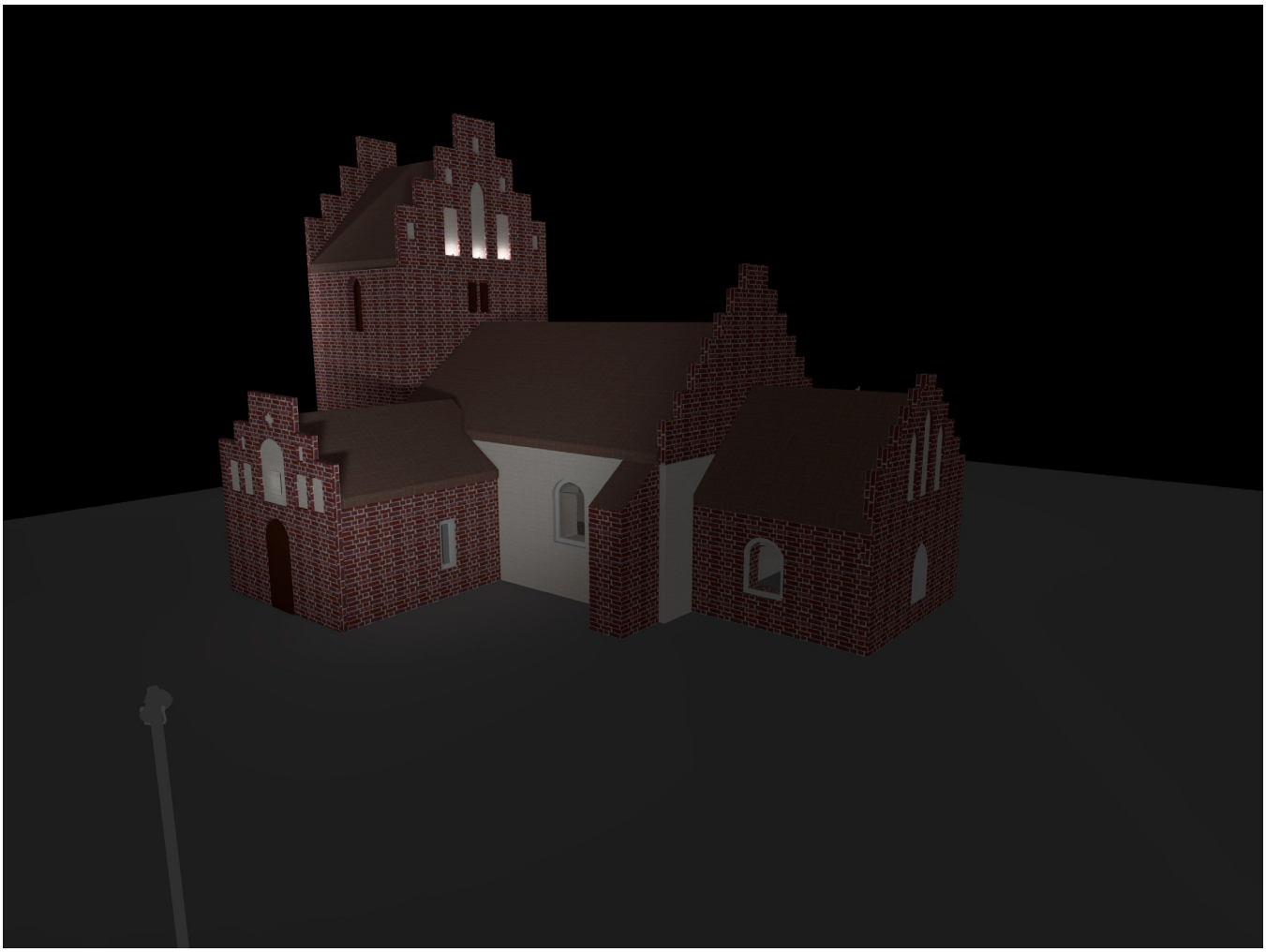

Figure 44: DIALux render of Concept design 1 combined with Concept design 2B.

6.4.4 Concept design 3: Lower wall spots

The third design was derived from the idea of having an event happening every hour like the church bells, which ring on an hourly basis, telling the time. This idea drew inspiration from the Eiffel tower in Paris, where an event with the lighting occurs every hour. In contrast to the other designs, this design would be mounted on the ground by the base of the church, lighting up the lower part of the wall. However, this design would require more maintenance, since the ground is gravel, which might cover the luminaires and disrupt the lighting. The luminaires would be lighting up the highly reflective limestone of the main building and the red bricks. This design focuses on creating a dynamic atmosphere, which can be experienced within the 'close' distance. The concept would draw its atmosphere from the association that the residents of Svogerslev have between ringing bells and the church. Additionally, since the bells do not ring throughout the night, the atmosphere and light might be able substitute for the bells, thus strengthening the connection between the church and its community. The atmosphere would primarily be created by the light on the lower part of the wall, which means that this design would function mostly in the 'close' distance. However, since the lighting is focused on the lower part of the walls, it will create a contrast between top and the bottom. Therefore, the light emitting from the ground should not be too strong.

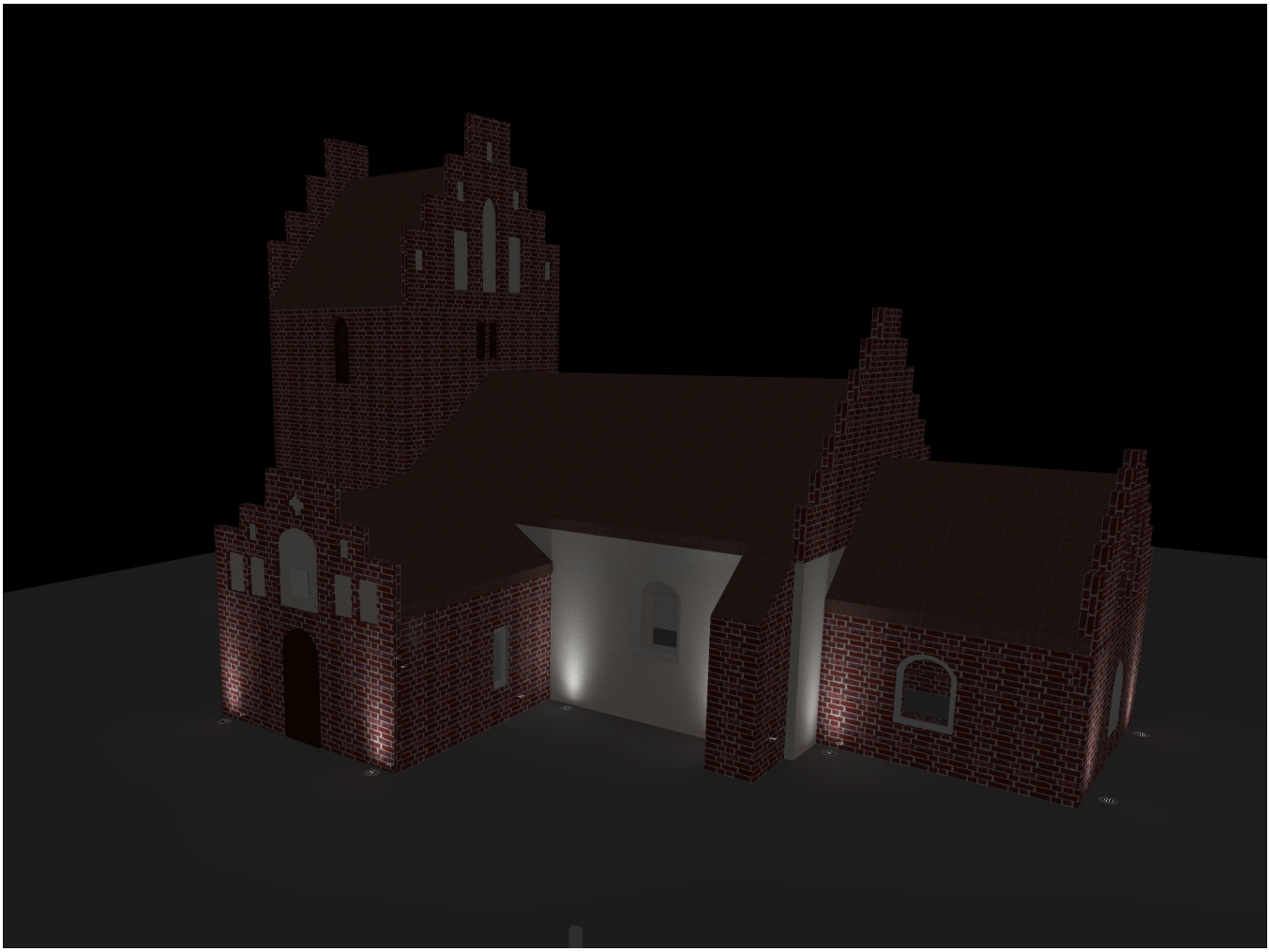

Figure 45: DIALux render of Concept design 3.

6. DESIGN CONCEPTS

When looking at the design, and whether it fulfills the different criteria of 5.1 Criteria, it does not fulfill the criteria for Far, as this design does not support wayfinding, since the luminaires are mounted in the ground. Furthermore, it does little to support the identity and symbolic function, since the church can be difficult to see from a distance. When looking at the criteria for Near, the design is producing sky glow by projecting the light into the sky. However, the spill light should not prevent people of viewing the stars in the night sky, but it might limit the amount of stars visible. While walking near the church, the symbolic function should remain the same. As pedestrians are walking by, they should be able to easily identify the church building. Lastly, the design supports the surrounding area by using ground mounted fixtures, which create less glare for people strolling through the graveyard. This means that this concept fulfills the criteria for Close.

Having poles lighting up the tower together with the new effect created by the lower wall spots would be able to fulfill the criteria for Far better, as the identity of the church is projected into the area, and can be seen from afar. But by using the pole mounted fixtures, the amount of spill light will increase as seen in Figure 46.

Figure 46: DIALux render of Concept design 3 combined with Concept design 1.

Combining the concept designs gives a better coverage of the criteria, as seen for both the combination of concept 1 and concept 2 in Figure 44, and with the combination of concept 3 and a slightly modified version of concept 1, that puts more light on the tower than on the main building, in Figure 46. Even though the concept designs are better when combined, according to the theory behind the spatial settings, it is still relevant to know which principles used in the designs the community prefers. The theory can only provide a basis for how to create a lighting solution, but it does not take into account the opinion of the community. Because of this, certain principles will be tested to see which people prefer.

6.5 Principles for testing

To get data on the public opinion on which of the lighting principles are important when lighting up a landmark, a test scenario was set up. A set of renderings, based on the concept designs in Figure 44 and 46, were put together, using various takes on the lighting principles, showing a small extent of the spatial settings for the various designs. The concept designs are in their initial stages, and therefore the focus of test is the principles. However, the test scenario only tested three of the principles, since testing all of the principles together would be too time consuming and be unimportant for this case.This specific test will be expanded upon in 8.1 Analysis of test.
The three principles investigated in the test were: the placement, the light level, and the colour temperature, as well as how important they are to the concept designs. Table 3 visualises which elements are tested.

Reflectance	**Colour**	**Placement**
Contrast	**Situation**	

Table 3: Principles marked for testing.

7.TESTING

The test was conducted in order to get an idea of which lighting principles are most important for setting up the best spatial settings for bridging a landmark to its community.
The test was conducted with participants from the community and nearby Roskilde.

7.1 Hypotheses

When conducting a test, it is important to have one or more hypotheses about the outcome, that can be falsified by the results. For this test, the following hypotheses were set up about the preferences of the community towards the lighting on the church:

Participants prefer a warmer colour temperature
Participants prefer the "low contrast" parameter
Participants dislike spots on the lower part of the wall

These hypotheses were created based on the information gathered in 2 Background research and 4 Analysis of case. According to 4.3 Interview of locals, where participants referenced the lighting on Roskilde Cathedral, and the cozy atmosphere it creates, people prefer warmer colour temperatures. This is the basis of the first hypothesis. In 2.2.2. Situation and 2.2.3 Contrast it is discussed that a lighting solution should not have too much lighting, especially if its subject is free standing and that, furthermore, the contrast ratio should not exceed more than the recommended 1:10 ratio. Based on that data, it is reasonable to expect that people will prefer the "low contrast" setups. Lastly, as explained in 3 Reference works and 4.3 Interview of locals, the placement of luminaires that people primarily attribute to churches is on poles placed at a distance. This means that having the lighting up against the walls with the spots might disrupt the atmosphere experienced by onlookers, and their perception of the space, as covered in 2.4.2 Atmosphere.

7.2 Setup

The setup for the experiment consisted of eight pictures, each with specific parameters. Image 1 through 4 all used the tower panel setup, while image 5 through 8 all used the spots on the lower wall. Image 1 had a high contrast and a high colour temperature of 4000 Kelvin. Image 2 had a low contrast and a low colour temperature of 3000 Kelvin. Image 3 had a low contrast and a low colour temperature. Image 4 had a high contrast and a low colour temperature. The parameters for images 5 to 8 mirror those of images 1 to 4, respectively, with the only difference being that the luminaires were mounted at the foot of the the church as spots on the lower wall. All the image parameters are visualised in the following Figure 47, while Figure 48 shows the images.

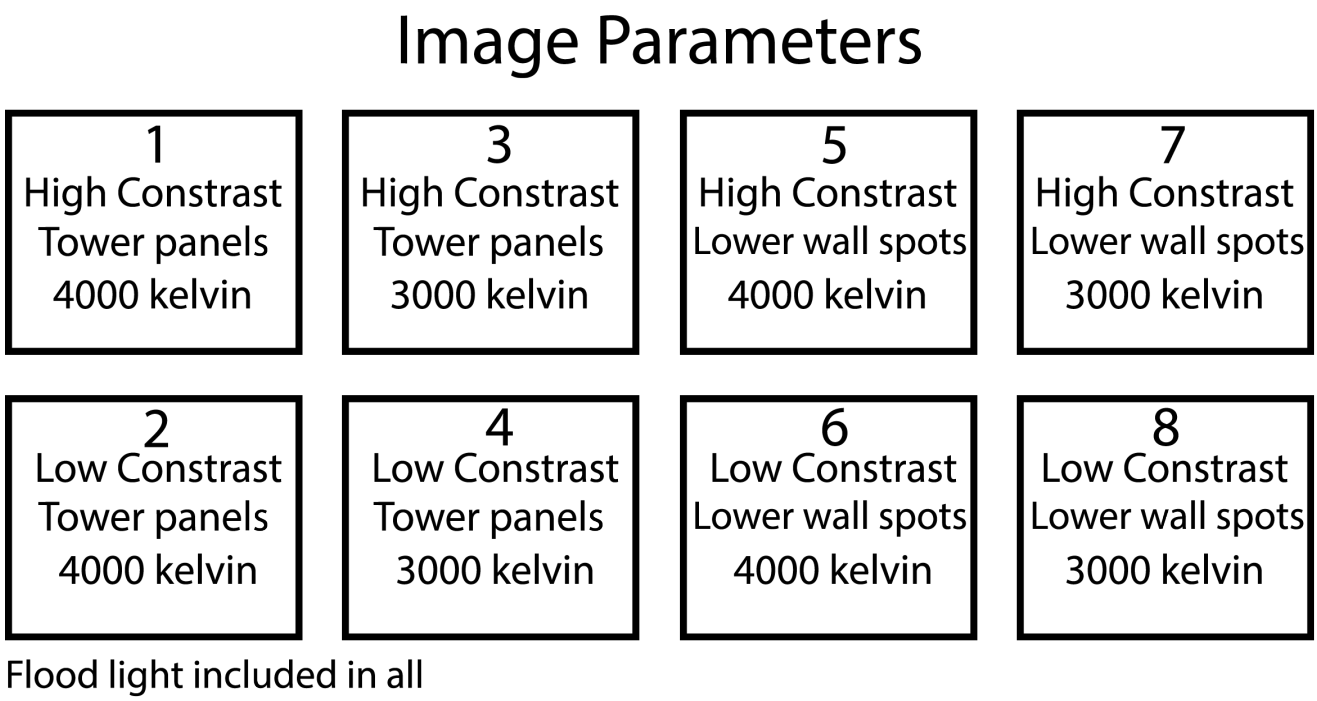

Figure 47: Image parameters.

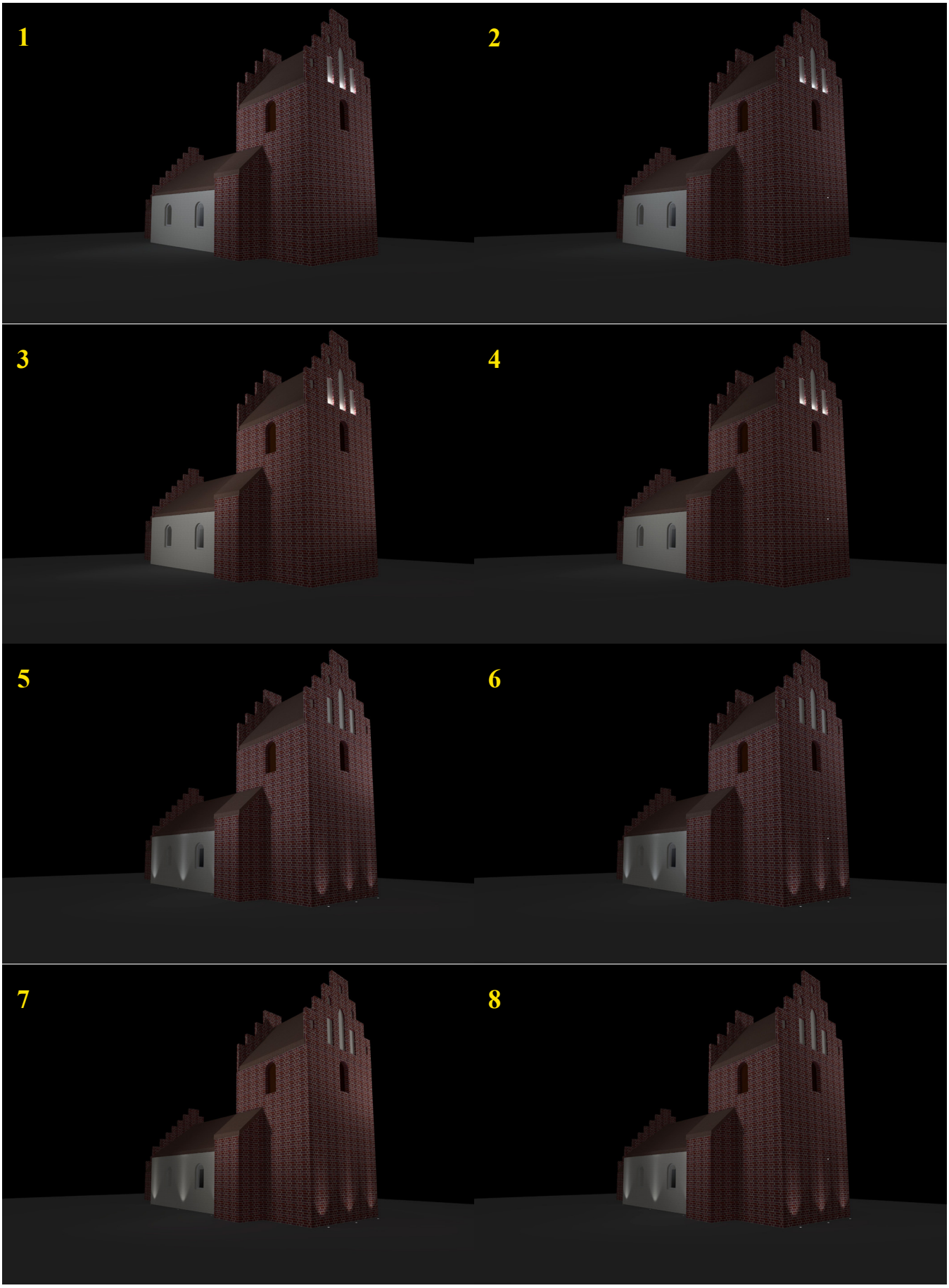

Figure 48: Renders using the image parameters.

7.3 Procedure

The experiment was set up to have a single participant or, if necessary, a small group of participants in a session. There, they were presented with a TV (Finlux 32” model nr: 37FLHYR910HU) in a dimly room and given a few minutes to adjust their eyes to the darkness. Then, the test began, as shown in Figure 49.

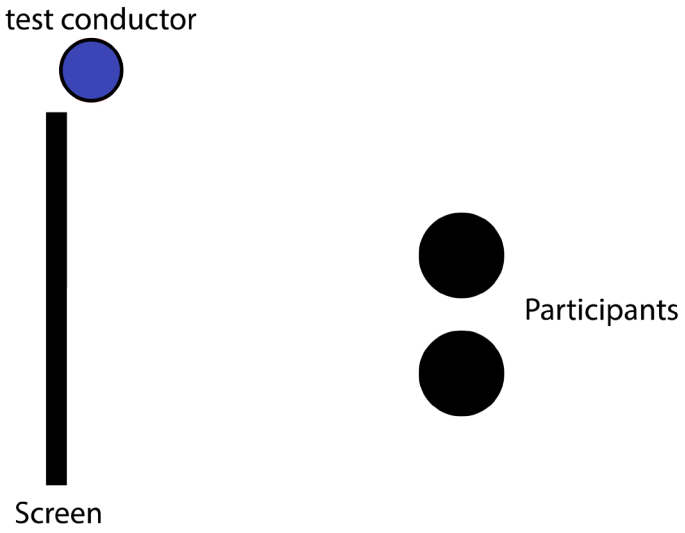

Figure 49: Experiment setup

The test consisted of the participants being presented with two out of the eight pictures side by side, set up in a randomised series containing all possible combinations. The series of pictures was randomised by a computer program for each session, as seen in Figure 50. The program can be found in Appendix 6.

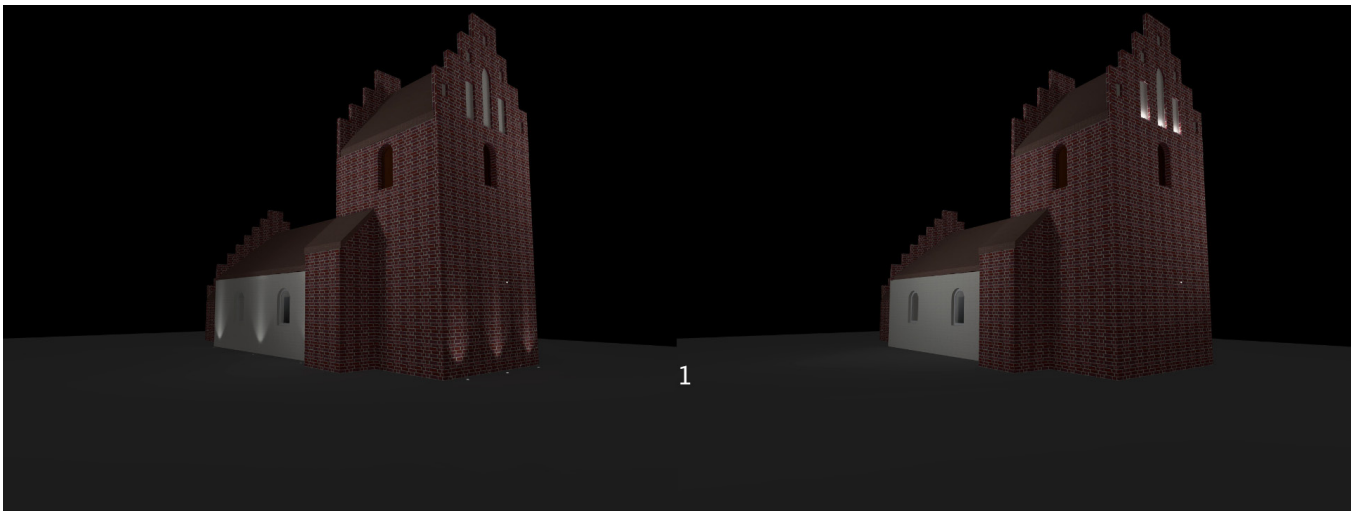

Figure 50: Example of a set shown on the screen for the participants.

To ensure a more or less comparable basis for judgment among the participants, they were presented with the scenario: “imagine that you are walking past the church on a random evening”, and asked to choose a preference based on which option they thought would give the most back to the local community. The participants were also shown the 1:50 scale model, unlit, to give them the benefit of a three dimensional view of the building they were assessing.

Each participant was given a questionnaire, with 28 lines for recording their opinion on each set of options. The answers consisted of a choice between the two images and the option of recording a short description of the reason for their choice, as shown in Table 4. The participants were given the option of explaining their answers in order to give an understanding of the perception of the spatial settings of the renders. The participants were given as much time as they wanted to look at the pictures and record their answers.

Vælg en per sæt.			Begrund hvorfor?
SET 1	A	B	
SET 2	A	B	
SET 3	A	B	

Table 4: Questionnaire sheet layout.

7.4 Results

The test was carried out between the 9th of May and the 12th of May 2019, and had 27 participants. The following section will present the results of the test. Furthermore, the results will be categorised into quantitative and qualitative data. The quantitative data will describe how many times the participants chose a specific image or parameter, while the qualitative data will outline reasons why the participants might have chosen as they did. This data will serve as a basis for falsifying the hypotheses set out before the test was conducted.

7.4.1 Quantitative

The results showed that the participants overall preferred the parameters of image 3, *High contrast 3000K Tower panels*. After that, the second most popular concept was image 4, *Low contrast 3000K Tower panels*. The image most disliked by participants was image 5, *High contrast 4000K Lower wall spots*. Table 5 shows how many times each image parameter was chosen in the test, among all participants.

High contrast 3000K Tower panels	109
Low contrast 3000K Tower panels	102
Low contrast 3000K Lower wall spots	99
High contrast 3000K Lower wall spots	97
High contrast 4000K Tower panels	95
Low contrast 4000K Lower wall spots	90
Low contrast 4000K Tower panels	84
High contrast 4000K Lower wall spots	80
Total	756

Table 5:Test results.

Table 6 shows the percentage of popularity for each of the sets of parameters. This gave a better idea of how close the different images were in popularity.

High contrast 3000K Tower panels	14.42%
Low contrast 3000K Tower panels	13.49%
Low contrast 3000K Lower wall spots	13.10%
High contrast 3000K Lower wall spots	12.83%
High contrast 4000K Tower panels	12.57%
Low contrast 4000K Lower wall spots	11.90%
Low contrast 4000K Tower panels	11.11%
High contrast 4000K Lower wall spots	10.58%

Table 6: Results in percentage.

However, the point of the test was to attempt to determine which of the lighting principles were most important to the participants. This was calculated by noting down which of the principles were prefered in each set. In cases where a set of images both contained the same use of a given principle, the choice of preference were ignored with regards to that principle. For example, if a choice was given between Low contrast 3000K Lower wall spots and High contrast 3000K Tower panels, the participant's choice would not show whether or not they had a preference between 3000K and 4000K lighting. Below, Table 7 shows a comparison between how many times the different uses of the lighting principles were chosen over its counterpart.

Principles	How many
3000K	243
4000K	189
Low	213
High	219
Tower panels	217
Lower wall spots	213

Table 7: Comparison between principles.

It is very clear that 3000K is the prefered colour temperature, since it has been chosen a third more often than 4000K, as shown in table 7. However, the two other principles, contrast and placement, are quite equal. In fact they are so close that the votes of a single participant could change the outcome.

7.4.2 Qualitative

The qualitative data consists of the free form comments of the participants, and is mostly written in Danish. Therefore, the following quotations will be presented in translation. The qualitative data will dive into what people felt and thought about the use of the principles while viewing the different images.

Much of the qualitative data supports the quantitative results in the majority of the participants preferring 3000K colour temperature. A few quotes were chosen, to show the tone of the feedback. Participants mentioned factors like: "more 'calm' on the eyes", and "it is more cozy". These comments also provide an idea of how the participants experience the atmosphere of the different scenarios.

The participants who chose the low contrast images had strong opinions about not having a lot of light on the church. Most of these participants voiced their opinion that the light was too hard or sharp.
The participants commented things like: “the lighting on A was too harsh”, “lighting too sharp on A”, “like that it is a little darker”, “I prefer soft lighting”, and “more darkness - not too lit up like in a big city”.
However, the participants who preferred low contrast lighting were slightly in the minority, while the majority of people preferred high contrast on the building. This might stem from how some people view the church as an institution. Some participants said: “The white walls should be white, in order to reinforce the purity”, “more well lit”, and “more well lit facade”. Based on these comments, there was a division of participants, with some preferring the high contrast options because they made the reflective parts of the walls seem brighter, while others preferred the low contrast solutions, finding them more visually comfortable.

Some participants found a preference to a placement and stuck with it all the way through the test, even though other factors were changing. This indicates that the placement was more important for them than the other parameters. Participants even wrote in the comments whether they liked or disliked a certain placement of luminaires. Some examples of these statements will be presented below: “Do not like lighting from below, not welcoming, looks too ‘important’”, “not a movie star”, and “hate spotlights”

A few participants voiced an opinion, and one wrote it in their comments, that the season might sway their opinion of the lighting: “Hard to say, the season might sway my choice”.

7.5 Conclusion of testing

By looking at the quantitative and qualitative data, it can be concluded that there is a slight tendency among the participants towards wanting warmer light on the church, since the majority of participants preferred to have the light at 3000K. This validates our first hypothesis, that people prefer warmer light. Generally, the participants deemed the 3000K images to be more welcoming, cause less eye strain, and seeming cosier. Denmark, being one of the nordic countries, has a cultural tendency toward preferring warm light. This fact has very likely had an effect on the popularity of the 3000K concepts in the test. This can also be seen on Roskilde Cathedral in section 3.1 Roskilde Cathedral, where the entire cathedral is bathed in warm light, as stated in the first hypothesis. This is reflected both quantitatively in the amount of votes the 3000K concepts got as compared to the 4000K concepts, and qualitatively, in the comments presented above.
As for the second hypothesis, given the very small difference between the popularity of the two options, the results of the test are inconclusive. As mentioned above, this is very likely due to the differing opinions that the participants have towards the institution.
Neither can it be claimed that the third hypothesis has been either proved or disproved. With the difference between the options being a mere four votes, the participants are split almost exactly fifty percent to each concept.

8. DISCUSSION

In this chapter the various elements which could have affected the results of the test will be discussed, and possible solutions will be mentioned. The results will also be elaborated on and theories will be put forth as to why participants might have answered one thing compared to another. The chapter will also include a discussion of how a methodological process can be derived from the criteria. This will be followed by a section about why and how the knowledge and skills of a lighting designer is important in the creation of a lighting design. Lastly, various possibilities for future research, based on this case, will be presented and discussed.

8.1 Validity and reliability

This section will investigate whether the test performed as part of researching this case was valid and reliable. This will be done by reflecting on how the test was performed and what biases might have been present. Finally, it will mention alternative test approaches that could have been used, instead of the one that was chosen.

8.1.1 Analysis of test

The test only incorporated three of the five lighting principles. This was done for logistical reasons, since adding two extra variable would have increased the the amount of possible combinations to 528. This was deemed an unfeasible amount of work to ask the test participants to do, and would have increased the time needed to conduct the test significantly. However, taking all five principles into account would probably have provided better results as to which principles are most important when lighting up a facade. The two principles that were excluded, situation and reflectance, were disregarded because they are not easily changed. The reflectance of a landmark can primarily be changed by cleaning, since dirt and other smudging reduces the reflectance of the materials involved. Testing for this would provide data on how important it is to clean and maintain the surface of the subject (material/landmark).
The situation of the building is not changed easily, especially in the case of a freestanding building. However, it would theoretically be possible to create a lighting solution that included changing the greenery and other surroundings. Doing something of that sort would change the situation of the building, and therefore its needs in terms of lighting. Unfortunately, since most of the trees surrounding the church are standing in private gardens, it would not be feasible to propose such a concept.
These two last principles might not have seemed as important to include in the testing, compared to the other three, but since they have not been tested for, that can not be concluded for certain.

The following text elaborates on possible deviations from Santen's theory in 2.2.2 Situation, and how this might have influenced the participants' choice between the low and high contrast images. Santen posits that a free standing building should reflect 3.2-6.5 cd/m^2. This value is quite high compared to the lighting on other Danish landmarks. According to Hansen, the light level on Thorvaldsens Museum - located in Copenhagen, Denmark - was measured to have a high lumen value of approximately 3 cd/m^2 (Hansen, 2018).

8. DISCUSSION

Figure 51 shows a false colour map of the luminance on the church in the high contrast renders. These renders are below the recommended luminance threshold of 3.2 cd/m^2. This means that the low contrast renders are even further below this value. What this entails is that both the high and the low contrast concepts are significantly below Santen's recommended values. The high contrast renders almost have the same lumen level as Thorvaldsens Museum, which has a comparable situation setting. Therefore, it can be said that the high contrast renders do not have a particularly high luminance at all, but rather one that is quite normal for that type of building in Denmark. It does, however, also mean that the low contrast renders have a very low luminance level. This might indicate that the Danish preference for dim lighting tends even further away from the luminance range put forth by Santen than expected. Given that the participants of the test showed just as much preference for the concept that had such low lighting means that just being able to see the church building might have been enough for the participants. It is possible to theorise that the participants did not feel that they needed a clear view of the architecture to get a sense of the spatial settings.

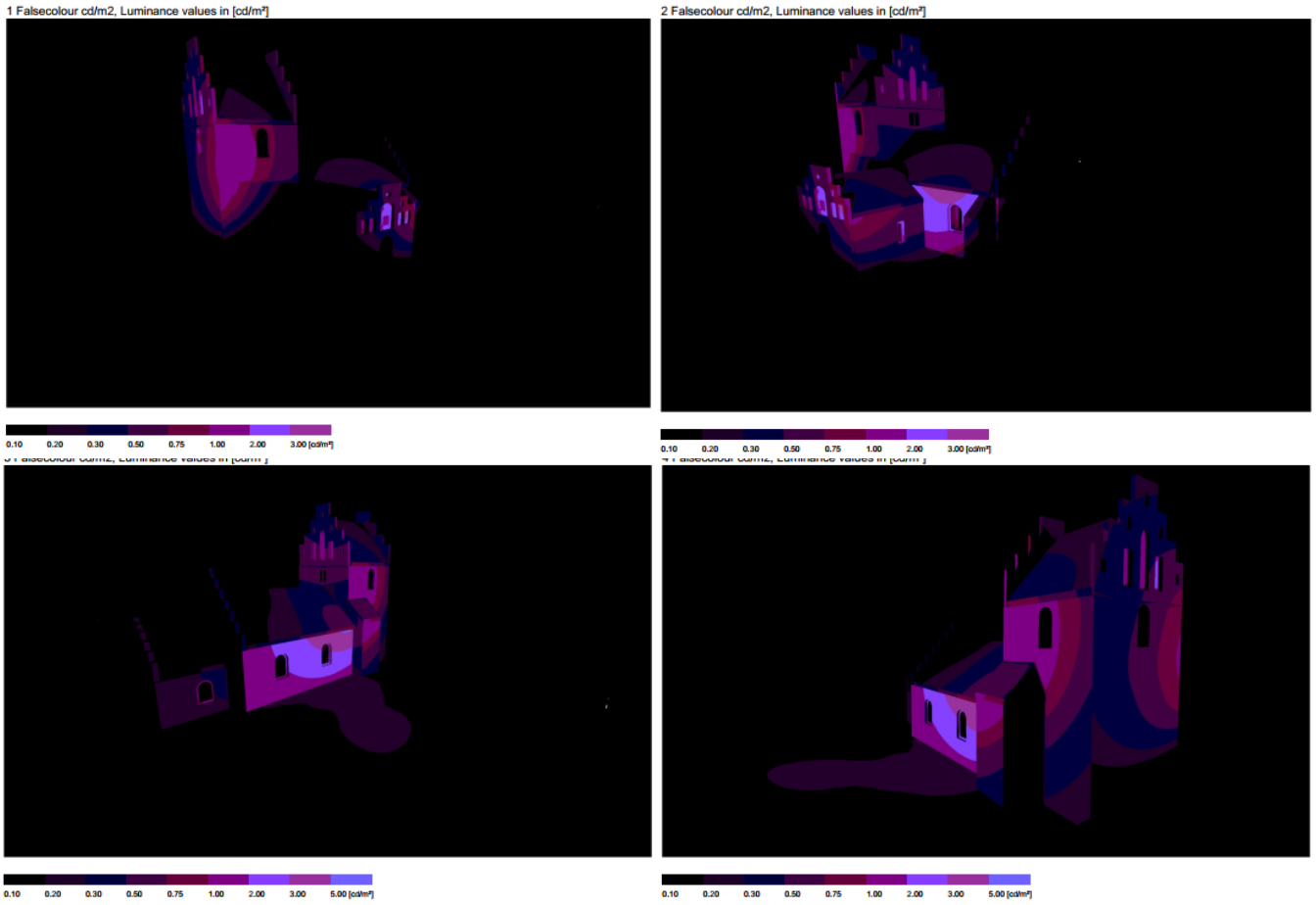

Figure 51: Renders showing the luminance.

8. DISCUSSION

As for the differences in contrast settings on the renders used in the test, the low contrast images had a contrast ratio of 1:10, while the high contrast images, in some areas, had a contrast of 1:20. This does not necessarily mean that there is as much contrast in the high contrast images as it might seem, based on the numbers alone. According to the calculations, the illuminated areas were quite uniform, which means that the contrast in these areas did not exceed the 1:10 ratio. Even though the concept may appear to have a very high contrast, the difference between the areas with 20lx and those with 0lx is not sudden, but gradual. This could mean that the high contrast renders might not have had a high enough contrast to truly have a high contrast option in the test. In order to achieve a more harsh contrast, there would have needed to be a higher illuminance on the building. On the other hand, the low contrast renders may also have had too little illuminance to provide a sufficient amount of light. It is possible that a render in between the two presented, as well as one with a clearer high contrast, might have been better for the test. As the results showed, participants were split between liking not having too much light on the church and wanting enough light on the church.

In the test, there were no surroundings that could influence the situation of the church with spill light, and such a factor could have had an important effect on how participants perceived the church compared to its surroundings. On the other hand, some of the spill light from the surrounding area could help illuminate some of the darker parts of the church. That could be a positive effect. However, any spill light from outside sources could have different colour temperatures to the light of the lighting solution, interfering with its ability to communicate the identity of the building. The presence of such factors could have affected the answers of test participants.
Another thing that could have affected the choices of participants in the test, is that, often, old churches are lit up by flood lights or spotlights elevated either with poles or by placements on top of nearby buildings. Examples of such solution can be found in 3 Reference works. This means that people might be inclined to choose luminaire placements that they are used to seeing, instead of a design that makes use of alternative placements. Another factor is that wall spots mounted at the foot of a building is often seen as a more modern way to place luminaires, which may have been seen to clash with the atmosphere and symbolic function of the older building. It should be mentioned that two of the participants had lived in a town where the lighting on the town church was mounted on the ground, and they found the corresponding design concepts more appealing. It is also relevant to keep in mind that some participants might have chosen the concepts using the ground mounted wall spots in order to differ from traditional church lighting solutions.
All in all, this shows that the placement setting can have so great an influence on the choices of test participants that they will disregard the other lighting principles for a favoured luminaire placement scheme. This should not be seen as diminishing the importance of the other lighting principles, but simply an observation of the importance people sometimes place on the tactile parts of the lighting principles.

8. DISCUSSION

During the testing, some participants mentioned that they had little to no relation with churches as religious symbol. When looking at the results from these people, they had a tendency to prefer the design concepts with a higher colour temperature. The warmer colour of 3000K lighting is more associated with the Danish concept of 'hygge' than the colder 4000K lighting, and it could be theorised that the people who did not feel a connection to the symbolic function of the church, did not experience the need for the warmer lighting.

The testing was held in spring, which means that the light outside was bright and warm, compared to the winter, where it gets dark quickly. This might have influenced the results of the test, because the participants had gotten used to the bright light outside, which may have affected their opinions and their immersion in the scenario. The participants having a problem immersing themselves in the scenario could alter their experience of the atmosphere in the renders. If the test had been conducted in the winter, there is a possibility that more people might have prefered the warmer colour. Furthermore, it might also have affected the participants' perception of the atmosphere.
A bigger sample size might also have affected the results, providing a more distinct tendency in the results. Having more distinct results might have led to a more definitive conclusion.
The validity of our test may have been affected by some of the aforementioned considerations, they might have had a negative impact on the results, and the test might have yielded better results if they had been considered before performing the test. Some of these considerations were ignored due to time limitations.

8.1.2 Biases

In every testing scenario, one tries to eliminate as many biases as possible. However, this test did have some that could have had some influence on the test results, and these will be addressed in following text.

While creating the renders of the two different colour temperatures, a limitation in DIALux Evo came up. Specifically that DIALux tends to utilise white balance to make the image and lighting appear whiter/brighter. This resulted in the 3000K and the 4000K images appearing alike, and being hard to tell apart. This proved a problem when trying to display the renders of the two different colour temperatures, but was solved by setting the colour temperature directly in the program and forcing it to show the correct 4000K lighting. However, it is not possible to know whether or not this influenced the results.
Another thing that could have been added to the model would be to render more of the surrounding environment. This might have given a better feeling of the effect that the lighting would have, and given a better overall impression of the concepts, while increasing the immersion of the test participants. However, the desire was only to show the effect on the church, since the environment can change depending on the season and various other factors.

In the images, there are two noticeable "mistakes". Firstly, a window seemed to be missing from the render with the lower wall spots, as seen in Figure 52. This was pointed out by some of the participants during the test and might have influenced their opinion of these images.

However, though it may have appeared to be missing, if you look closely, it is possible to see that the window is still there, but obscured by how the shadows fall, as well as blending in with the white wall inside the church. The second mistake was an error that appeared on some of the renders, as seen in Figure 52. It appeared to the participants as a white dot on the tower, and looked out of place. Many participants mentioned this mistake, and were told to disregard it. These mistakes are significant biases that might have influenced the participants' opinion of the images.

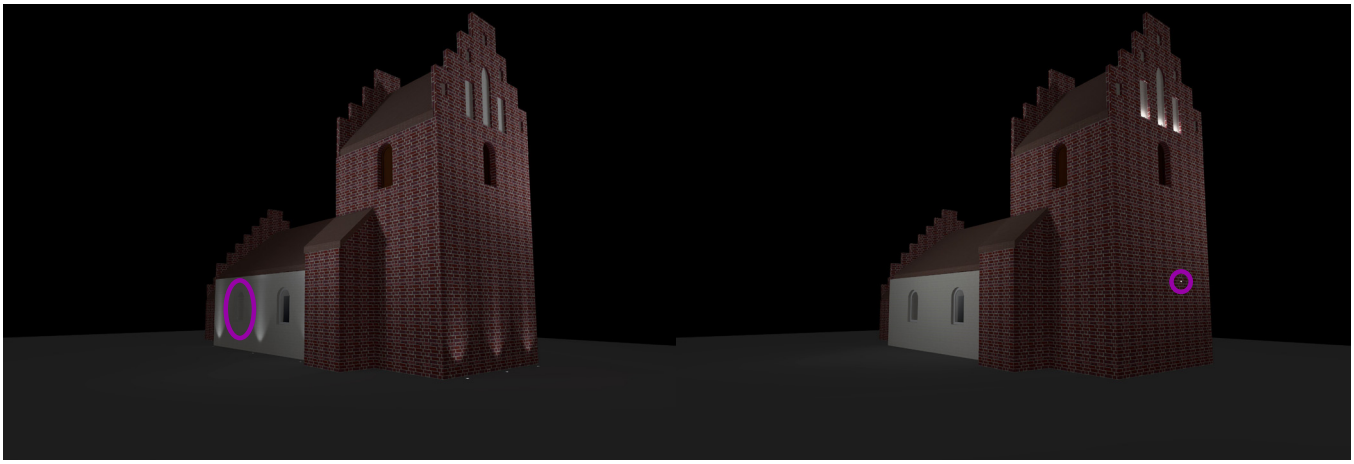

Figure 52: Render "mistakes".

Another important bias worth mentioning is that the renders are only representations of reality. However, they are not equivalent to reality. The whole context, the atmosphere, is missing. The test itself can only give an indication of which principles the participants preferred. A different approach might have given a better indication of what the test participants liked, which will also be addressed later. When choosing the angle of the images to render, the idea was to show it how a person would while standing in front of the church. However, the renders only show one angle of the church, and do not paint a full image. Again, it is only a representation of the actual church. However, a representation can give an impression of how a design concept will look, and is very useful as a tool for a lighting designer to supply their clients with an idea of the direction of a project.
Renderings are done to simulate an object from reality as accurately as possible, as discussed in section 6.3 DIALux model of Svogerslev Church. However, since renditions are done by people, they have a tendency to deviate from reality. Typically, these deviations are minor things that do not compromise the perception of the whole. Even though digital models mimic reality, onlookers typically know that the renditions are only partly representative of reality, and not a 1:1 representation.

The testing room was made as dark as possible, with the windows blocked by cardboard boxes. However, due to the natural daylight, some spill light did enter the room and might have influenced the participants' vision. It is believed that this factor might have had some influence of the decision between the 3000K and 4000K images, as well as the high and low contrast ones, but nothing can be determined for sure. The test was held in a private home, which might also have influenced the feelings and decisions of the participants. Furthermore, this might have set them at a disadvantage, by making them feel uncomfortable. If it had been held somewhere public, participants might have felt more at ease with the test conductors and might not have been influenced the same way.

8.1.3 Different test approaches

According to the research in 2.4.2 Atmosphere, one has to be physically present in order to immerse oneself and truly feeling an atmosphere. This means that looking at an image and comparing it to another does not give the full immersive experience, and therefore, other methods for presenting the different concept design could have been more effective. The most effective way would be to have the lighting and the different scenes on the church itself. In this way, a participant would be fully immersed in the environment. However, testing on site might have been seen as disrespectful to the people coming to visit their loved ones at the graveyard. Another method that does not require the use of the space would be to use VR. In this way, a participant would be able to see the space around the church. However, they would still lose the sense of smell, the feeling of the wind, etc. Both of these methods might give more accurate results in terms of judging the atmosphere, and immersing the participants more into the test.

8.2 Criteria as a basis for a methodological proces

The criteria were made to be generally applicable to other landmarks, not just Svogerslev Church. As previously stated, the first part of the criteria are general statements, whereas the second part refers specifically to the local church. The following text will go through the generalised parts of the criteria: The criteria based on the ‘far’ distance focus on the landmark, as described by Lynch, and are:
The lighting solution should keep the landmark visible in the dark hours.
The lighting solution should make the landmark distinct from the surrounding skyline or cityscape.
These criteria focus on wayfinding, which can be helpful in many cities with landmarks that are prominent in the skyline, as they help orientate people and help them with navigating the cityscape. The criteria based on the ‘near’ distance focus on the community, and are as follows:
The lighting design should display the identity and symbolic function of a landmark and its function.
The lighting design should avoid lighting pollution, lessening potentially uncomfortable or displeasing overillumination, which results in skyglow.
These criteria focus on clearly communicating the symbolic function of a landmark to its surrounding community at night. Although the symbolic function is subjective for each individual, the lighting design can still suggest a symbolic function that the individual should apply to its subject. It also addresses the importance of, when creating a lighting design, not disrupting the community with lighting pollution.
As for the criteria based on the ‘close’ distance, they are:
The lighting design should use enough light to support the surrounding space and its atmosphere.
The lighting design should facilitate a comfortable space close to the landmark.
These criteria focus mainly on the atmosphere of the space and the importance of making it comfortable to be in. The reasoning behind making these criteria so general was to shape a methodological approach for creating facade lighting for landmarks. The approach focuses on the communication of the spatial settings (landmark, lighting pollution, atmosphere, symbolic function) and bridging it to its community through the lighting principles.

8. DISCUSSION

When designing a lighting solution for a landmark, it is important to keep in mind, that the client may be the one who is paying for the design, but the community will be the ones to live with the design every day, as stated in 4.5 Client. For this reason, the community plays a larger role in the criteria, to ensure that the lighting functions for them in all aspects and is staged correctly.

8.3 The role of a lighting designer

This section will elaborate on the importance of the role of a lighting designer, with a basis in the existing lighting solution on Svogerslev Church. The congregation and the priest conducted a lot research into what kind of solution they wanted on their church, as stated in the interview in 4.3 Interview of locals. Unfortunately, the research they did and the wishes that they had were never truly fulfilled in the existing lighting solution, that they have now. Although the existing solution has a luminaire with a low, warm colour temperature of 2700K, which they wanted to have, it can not provide proper lighting on the red spectrum, which, as addressed earlier, is problematic. In this instance, the knowledge of a lighting designer on how the colour spectrum works and the science behind white light would have been very beneficial. A lighting designer could have addressed that with red bricks, the warm, white luminaire should include the red spectrum.
A follow up question to this would be: how important is having the red spectrum when paired with the low light level? With the existing solution at Svogerslev Church at night, human perception is primarily within the range of mesopic vision. This means that we can not see the entire spectrum of colours to its full extent, as mentioned in 2.4.3 Perception. Thus, the colours green and blue are less important, but having the red spectrum represented is still somewhat important. It is believed that having the red light present in the lighting solution would make a difference architecturally, and give more depth to the bricks. However, if the light-level was in the photopic level, this would be of even more importance.

The placement of the poles in the existing lighting solution is suboptimal. It provides an adequate lighting solution on the church, and resembles the references of Jyllinge Church that the congregation has looked at. However, to minimize spill light and light up the tower in a better way, a different positioning of the poles would have provided a better coverage of lighting on the church. A suggestion for a different positioning can be found in Figure 53. In this figure, one of the poles has been moved 3.5 meters in a straight line parallel to the church. This would help create less spill light, compared to the current positioning of the poles. This also created a better illumination of the church tower, as can be seen in Figure 54. Such, a minor thing makes a significant difference for the space and the architecture.

8. DISCUSSION

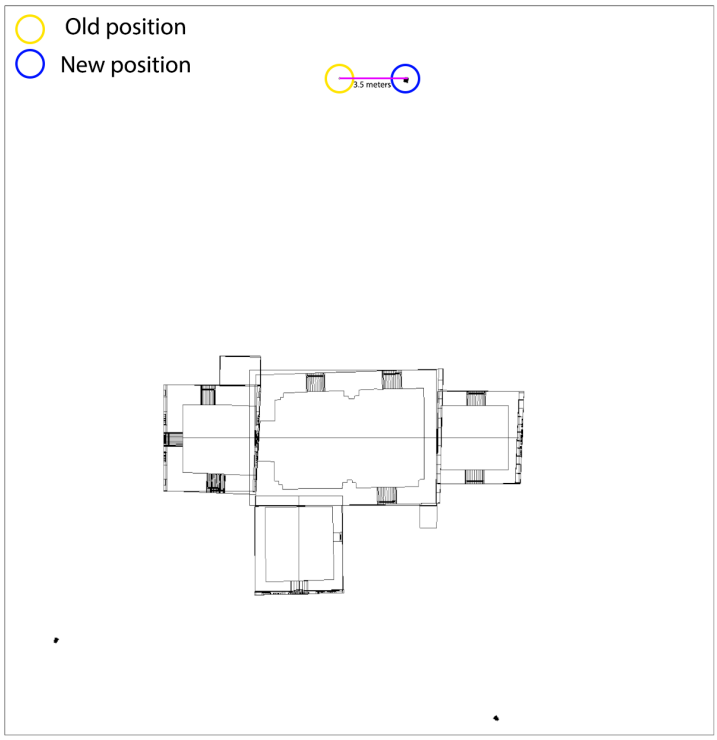

Figure 53: New position of the pole

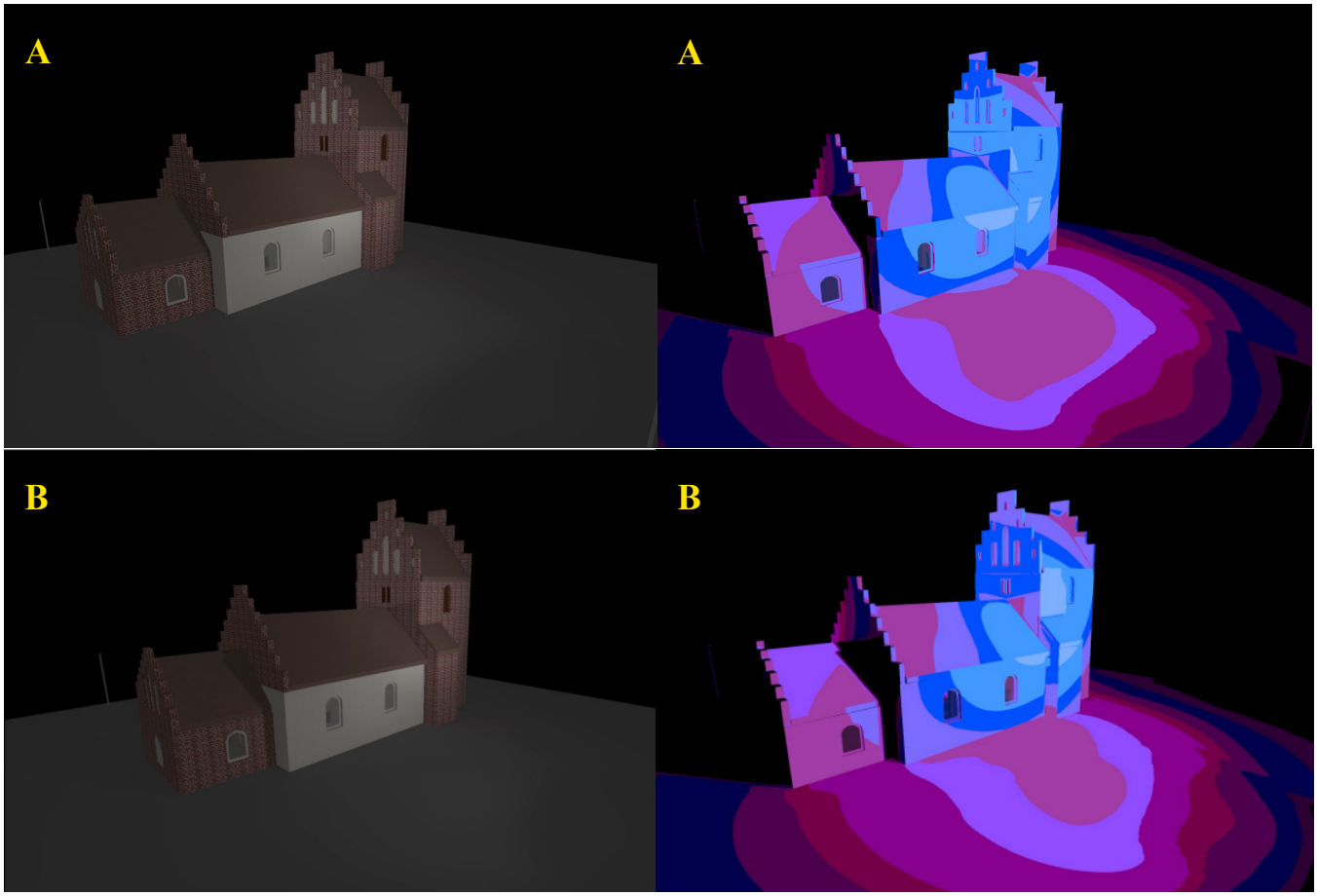

Figure 54: A, new pole placement and false colour Illuminance map. B, existing pole positions.

8. DISCUSSION

As mentioned in 4.6 Lighting analysis, the lighting is only on from the first sunday of December to Kyndelmisse, on the second of February. However, it might be relevant to have lighting on the church before December and later into February, since the days are still quite short in November and continue to be so throughout February. Throughout the shorter days, it is relevant to light up the facade, as it can then be helpful in all three of the distances. However, during the summer half of the year, it might not be too relevant to have lighting, since the sun is out longer and the evenings are brighter. Because of these bright evenings, it makes little sense to light up the church, as it would just be producing spill light, rather than contributing meaningfully to the spatial settings. Rather than lighting up the church with artificial light, it makes sense to let it be lit by daylight.
Leaving the church unlit in the summer months might not contribute as much to its function at the tree distances as artificial light, since artificial light is typically used when it is dark outside, creating a contrast similar to white on black and making the subject of the lighting appear more eye-catching. But even though daylight does not contribute as much as artificial light, it still assists with wayfinding, in that the tower is present in the skyline of the town. With the tower being visible from afar, the identity of the church can still be projected to the community, because of its prominent architecture. Furthermore, because of the bright evenings during summer, more people might be inclined to go to the graveyard, since the atmosphere is not as heavy as it is during winter.

8.4 Further research

This section focuses on what can be done further with the research presented in this report. For a start, only some of the principles were tested in this report. The remaining principles could be tested in order to figure out if certain principles are more decisive in the reception of a lighting design. As more data was gathered on the effects of the different principles, they could help to better develop design concepts, as well as making them more widely applicable as more cultural differences are documented and designs are made influenced by various locations and cultures
The report focuses mainly on facade lighting in the ‘far’ and ‘near’ distances, while neglecting the ‘close’ distance. However, it could be interesting to investigate what principles are important when creating a design for the ‘close’ distance, as it focuses mainly on the spatial relations and atmosphere around the area, and not only on the facade lighting. It would be recommendable to conduct further research into ways to implement facade lighting along with lighting inside a space and the resulting effects on the atmosphere.

It could be interesting to conduct our test on a large scale, with more participants, to see if it is possible to get a more clear answer as to which principles are best employed in lighting a landmark and afterwards apply it in similar tests on other landmarks in order to better understand how the theory applies more generally. With this type of research, it would be possible to see which principles are most important and whether it is influenced by country, city, culture, and more. This would also show what kind of differences there are from country to country, and how they deviate from the Danish norm of wanting less light and a warmer colour temperature.

8. DISCUSSION

A question that could be interesting to dive more into is: How little lighting is actually required to make a landmark stand out at the different distances; ‘far’, ‘near’, and ‘close’? Meaning what are the minimum requirements in order to function in terms of the spatial settings? As it is now, the background research in 2.2.2 Situation tells us the amount of lighting that should be on a building, as determined by whether it is a freestanding building or a building in a street or on a square, whether the building is in well-lit or in dark surroundings. It gives an idea of what the recommended levels are, but it could be interesting to see how little lighting is needed in these situations. The trick is to find the balance between having enough light and not having the architectural properties disappear into the night sky.

9. CONCLUSION

This report can conclude several things. First off, data and testing of the principles (contrast, colour, placement) indicates that people in Denmark prefer lighting with lower intensity than what is used elsewhere in the world, based on the guidelines for lighting laid out by Claire Van Santen. Even though both of the digital renders used in our test were at or below the 3.2 cd/m^2 threshold set by Santen, participants were almost equally divided between the renders with more light and those with less.
At the same time, many answers, both in the test and on the questionnaires, mentioned a desire for a cosy atmosphere around the church. This matches up very well with the theory set forth by Jan Gehl, which claims that it is important for a facade to seem open and inviting to the public. It also followed our general theory that the community would be more invested in the spatial settings than in the lighting principles, since they would mostly engage with the effects that the lighting solution would have, rather than in the technicalities of its setup. This was assumed under the same general expectation that most people who look at a painting see the depicted subject and react to how it makes them feel, as opposed to the quality of paint and the style of the brush strokes.
Together, these factors make what is almost the facade lighting equivalent of candle light or a low-burning fire. For a country like Denmark, whose culture prides itself on the concept of "hygge", it is not surprising that there seems to be a cultural inclination towards low lighting and warm colours. It is what the people associate with comfort and safety. The test also supported this tendency, with participants preferring the warmer colour on the church.
On the other hand, no matter whether the light is bright or dim, proper coverage of the intended area is crucial for a good lighting solution.

In the specific case of Svogerslev Church, which has an existing lighting solution with poles set up, there was a limit to what new installations could feasibly be suggested. This does not change the fact that some of the poles were set up in such a way that there was no way to properly light up all of the building. This meant that any design concept using only the existing poles would be somewhat flawed. However, because of the resources of the church's congregation and that the disruption to regular functions that a change would present, it was not possible. Therefore, the design concepts were made under the assumption that such a change would not be possible.
However, the test concluded that the placement of both existing and new luminaires and what that entails was what the participants considered most important. According to the theory, this is because the placement of the luminaires is the most visually obvious change to those without a deeper understanding of lighting design, and therefore has the, to them, most noticeable effect on the spatial settings of the space.

These observations, along with the rest of the background research and discussions presented in this report, gave birth to the formulation of a new theoretical model for ordering the different factors that should be considered when designing a lighting solution for a landmark in a city.
The base level of this theory is the listing of a set of principles to follow when designing a lighting solution. They are purely practical considerations and do not take into account any desired effect on the observer or other end result, only what practical needs must be taken into account. They are largely based in the theory of Santen, though it was discovered in the process of the report that her specific numbers and ranges may be conditional to culture, and therefore variable.

9. CONCLUSION

On a more theoretical level, the model seeks to take into account a set of more insubstantial parameters. The spatial settings of a given landmark include its function in wayfinding, abbreviated as the "landmark" setting; the amount of lighting pollution given off by the solution, and the effects this might have on the perception and reception of the landmark; the atmosphere experienced by the observers, as well as how it might change under conditions such as distance and familiarity; and, finally, the "symbolic function" setting, encompassing both the values that people associate with the landmark, the ties that the landmark and its space has to the surrounding buildings and spaces, and any practical functions that the landmark serves. Altogether, these settings are an attempt to define the effects that the lighting solution for a landmark has on the world around it, in order to be able to take them into account in its design.

However, it is not so simple that all of these settings are equally important for any given landmark. Therefore, the spatial settings were modified according to three "distances", a conceptualisation of the different ways in which the public interacts with a landmark, and how a lighting solution can help or hinder them. These are, respectively, the 'far' distance, which concerns itself with how the landmark can help people find their way through the cityscape; the 'near' distance, which is all about the ways that the landmark interacts with the people who live near it and pass by it on a regular basis; and the 'close' distance, which takes into account how the landmark seems to those who are right next to it at a given time, as well as what effect it has on the space it occupies.

As such, any given landmark might be more or less relevant at one or more of the distances, which then informs what spatial settings are most important for a lighting solution to support, thus informing a lighting designer in the choice of how to apply the principles.

This also means that the public will mostly interact with the spatial settings, since these are the end results of a lighting solution upon its users, while the lighting designer will focus on the principles and the distances, using their understanding of them to produce the desired spatial settings for the community.

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