Put the Light Where it is Needed

- a lighting design method for urban green areas
& conceptual design proposal for a physical location in Stockholm

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- A Lighting Design Method for Urban Green Areas & Conceptual Design Proposal for a Physical Location in Stockholm

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Abstract

In this thesis I have analyzed how the phenomenon level of contrast, a consequence of the relation between level of light and distribution of light, works within urban green areas. For this particular site, the too high level of contrast is a result of the high level of light distributed 1) in the direction of oncoming pedestrians and 2) in a single zone of light and 3) on a too condensed surface area and 4) in a space with irregular vertical planes (in a dark space with low reflectance values).

Being in the only lighted area surrounded by trees (vertical elements absorbing or reflecting light), with eyes adapted to its level of light, consequently makes it impossible to see beyond the path. This since our eyes always adapt to the brightest spot in our field of view, which in all directions is a spot very close to the user. And since adapting to the emitted and reflected light our eyes cannot also adapt to the darkness beyond this enclosed space.

Another perspective on this, also related to the very basics of our vision has to do with the task oriented lighting solutions. We humans have two different types of vision - central and peripheral. The central vision is approximately 2% of our field of view, it is the small spot where our gaze focus, the rest is peripheral vision. The strange thing is that modern urban lighting design have focused almost solely on task lighting and the central vision, and left the peripheral vision literally disorientated. Because, in order for the peripheral vision to help us navigate and collect spatial information, it needs variable lightning with multiple zones of light, creating differences in shade, revealing form and depth.

The main contribution of this thesis, beyond defining knowledge regarding how light acts in these specific situations, is the development of a lighting design method specifically for urban green areas from a practice based design perspective (see figure 16). And that I have started the work of creating practical knowledge and answers to the question: How can the method be used in practice?

Keywords

Lighting Design Method for Urban Green Areas; Conceptual Design Proposal; Level of Contrast; Level of Light; Distribution of Light; Perceived Safety; Aesthetic Qualities
# Table of Contents

1.0 Introduction  p. 3-4

2.0 Background  p. 4-11
   2.1 Structure of Thesis  p. 5
   2.2 Methodology  p. 5
   2.3 The Path  p. 6-11

3.0 Results  p. 12-43
   3.1 Analysis of the Path & Defining the Needs  p. 12-17
   3.2 Lighting Design Method for Urban Green Areas  p. 18-21
   3.3 Experiments I & II  p. 22-32
   3.4 Conceptual Design Proposal  p. 33-43

4.0 Discussion & Conclusions  p. 44-47
   4.1 Discussion  p. 44-46
   4.2 Conclusions  p. 46-47

5.0 Table of References  p. 48

Appendix  p. 49-51
1.0 Introduction

A walk along a path through an urban green area, could during daytime be rewarding like nothing else, but is often reduced in all its visual qualities after dark. It is often like walking in a *tunnel of light*, beside a thick wall of darkness. All the light is on you, and everywhere you look you are either dazzled by the sharp scattering light from a lamppost or gazing into a blinding veil of darkness.

You start to feel exposed; observed. Suddenly you are questioning if you even might be persecuted.

There is someone slowly coming towards you, but the person’s intention is hidden in the light. You look over your shoulder in search for someone else, but nobody seems to be here but you and the oncoming individual; and seeing beyond the path is impossible...

”It feels as if I am walking in a tunnel of light, I have the feeling of being seen or even supervised. *(man, 67)*

”Too much light at the wrong place.” *(woman, 42)*

”I am very afraid!” *(man, 11)*

Figure 1: Answers from interviews conducted on the studied path (see appendix)
In reality, when in this type of situation, you are most likely not in physical danger, but the experience of being so is still there. A lot of research, especially studies focusing on women and seniors, are showing that this type of experience is common and results in reduced ability to move outdoors. The report “The Australia we want” from 2019 showed that 50% of Australian women feel unsafe when walking alone outdoors after dark. And according to BRÅ 36% of women in Stockholm feel unsafe in their own neighborhood, and are excluding paths and ways to travel as a result of this emotional experience.

2.0 Background

There are a lot of different factors that play a part in the experience of outdoor urban spaces, such as crime rates, age, gender, social initiatives, surroundings and so on, but the most important visual factor is lighting. How a space is illuminated has been proven to be closely related to how a space also is experienced.

However, although light creates visibility and in some regards can make a space safer, by for example, presenting/creating escape routes or give the pedestrian a chance to react to a threat, it does not mean that light can make a space safe, per say. The point of this thesis is not to promote lighting design as a “crime fighting tool”, the aim & goal is rather to develop a lighting design method that enables designers to deal with the experience of urban green areas in a more nuanced way, and to present a conceptual design proposal, in regards to a site in Stockholm, using this method.

The site has been chosen because it represents the often experienced design issues and “the natural challenges” within urban green areas in general, at this geographic location. Thus, making the method applicable to other similar environments. First and foremost, in Northern Europe, but it can also have relevance in regard to spaces all across the globe, where similar issues and circumstances exist.

Initial Questions

How come it is okay to walk along paths that makes you feel unsafe?

How come only task lighting is created, are we not the same beings that in other spaces need more stimuli than just being able to perform the most basic of movements?

And how come the visual and aesthetic experience of heavily used outdoor green areas seem unimportant after dark?

Figure 3: My Initial Questions

2.1 Structure of Thesis

An overview of the thesis structure is presented in figure 4.

Chapter 1: Introducing the topic by presenting my initial reason for being interested in the experience of urban green areas.

Chapter 2: Contextualizing and expanding the experience, presenting the methods, the structure & the site/path

Chapter 3: Analysis of the path, defining the needs, developing the method, presenting experiments & the conceptual design proposal.

Chapter 4: Discussion & Conclusions

Figure 4: Structure of Thesis

2.2 Methodology

This project is sprung out of practice based artistic/design research, and is closely connected to my own artistic process.

My perspective is mainly that of the pedestrian, but the method and design proposal will also meet the needs of someone driving a vehicle (bicycle, wheelchair and so on).

As a complement to my process I have created a framework out of literature review. Mainly focusing on topics such as: perceived safety and urban lighting (of green areas). This to contextualize my ideas and incorporate other perspectives and knowledge.

The interview approach (qualitative method) I used, was posing open questions. This to get as unfiltered answers as possible in search for a wider understanding of the studied site, with a focus on the emotional experience. The interviews were conducted face to face, in late November 2019. Eleven people participated, ranging from 11-67 in age, five men and six women (see appendix).

The field studies consist of observations, evaluations, and experiments at the physical location/path. All steps are represented in photographs, photos that have been manipulated to better represent what the human eye perceives or should perceive, and not how the camera interprets.

The quantitative method used were illuminance measurements using a luxmeter at the studied site and comparing the results to measurements at a nearby connecting path (see appendix).

Development of the method - step by step

The development of the lighting design method started by identifying and defining the needs of the users; derived from research, interviews and my own observations. The needs were then translated into perspectives of lighting and aspects that a lighting design solution has to satisfy. Perspectives which then compose the final lighting design method for urban green areas. And lastly, by creating a conceptual design proposal, I started the creation of practical knowledge, sprung out of the lighting design method.
2.3 The Path

The location I have worked with is a pathway in between the suburbs Kärrtorp and Bagarmossen, in Stockholm (see figure 5). It is heavily used, from early morning and afternoon by people bicycling or walking to and from work, and during late afternoon and night by individuals of all ages going to and from a nearby sports facility and recreation area.

There are twelve lampposts along the path, four meters in height, and placed 18-20 meters apart. The light distribution of the luminaires is asymmetric, pushing the light along the path (a design solution commonly used in these environments).

To the west, at a distance varying from twenty to fifty meters, there are residential buildings. And just beyond the midpoint, there is a small trail without illumination connecting the path to a street (Vikstensvägen). There is also a swamp in between lamppost eight and nine and bedrock close to the path at the fifth lamppost (see figure 6).

As per my quantitative study, it is a heavily illuminated path, with light intensity 30 % higher than at nearby connecting paths (see appendix). Nevertheless, the interviewees regard the space as dark, unsafe and with low visibility (see appendix).

To me, the chosen path does not only represent the general design issues within urban green areas, it is also interesting since it is located so very closely to residential buildings and streets, but still experienced as a totally secluded space.

Experiencing paths with the same design issues and “natural challenges”, as this one, is a common phenomenon in Sweden, and mainly for three reasons.

Firstly, the cities here were quite often built in accordance with nature, leaving space for green areas.

Secondly, the seasonal variation in daylight hours. During the months of October to April the experience of daylight in everyday life is a non-factor. It is dark when people go to work and dark when returning home, which makes the darkness a constant presence during a period of almost 6 months. Thus, leading to reliance on artificial lighting as a substitute for daylight.

And thirdly, the type of task-oriented lighting that has been implemented since modernism struck reality like a vicious tsunami (more on that later).
Figure 5: Map (source: https://kartor.eniro.se) showing the areas surrounding the path (the area of the path is marked with a dotted circle)
Figure 6: Map of studied path with approximated placement of lampposts
Figure 7: View in two directions from the middle of the path, at every lamppost (personal photographs) 2020-04-06
Figure 8: Day-view, photo from each lamppost in south bound direction (personal photographs) 2020-04-07
Figure 9: Night-view, photo from each lamppost in south bound direction (personal photographs) 2020-04-15
3.0 Results

3.1 Analysis of the Path & Defining the Needs

With the guidance from different theoretical approaches, interviews, and own observations, I have analyzed and divided the experience into three Categories: Basic Aspects, Perceived Safety & Aesthetic Qualities (+ Reduced Energy Consumption), with inherent subcategories (see figure 10).

The Main Issue

Before entering into the realm of needs, I will first explain the main issue with current design solutions, which is:

The too high *level of contrast*, as a consequence of the relation between *level of light* and *distribution of light* (in a dark space with low reflectance values)

For this particular site, the too high *level of contrast* is a result of the high *level of light* distributed 1) in the direction of oncoming pedestrians and 2) in a single zone of light and 3) on a too condensed surface area and 4) in a space with irregular vertical planes (*in a dark space with low reflectance values*).

Which means that the user is walking in the only existing *zone of light*. Illuminated by light directed towards the eyes of the user (creating a dazzling effect/glare). The light

Categories of Needs

Basic Aspects: *Interpretation of the concept task lighting*

To See Where to Place the Feet (or steer a vehicle)
To Orientate

Perceived Safety: *Derived from Landscapes of fear and stress (Nasar & Jones) + own observations*

Prospect
Low Concealment
Facial & Intention Recognition
Access

Aesthetic Qualities: *Derived from own practice*

Visual/Aesthetic Stimuli

(+ Reduced Energy Consumption)

Figure 10: Categories of Needs
directed beyond the path is either reflected or absorbed by the surrounding trees. Meaning that almost no light is pushed beyond the first row of trees and expanding the illuminated area (which could help to balance the level of contrast).

Being in the only lighted area surrounded by trees (vertical elements absorbing or reflecting light), with eyes adapted to its level of light, consequently, makes it impossible to see beyond the path. This since our eyes always adapt to the brightest spot in our field of view, which in all directions is a spot very close to the user. And since adapting to the emitted and reflected light our eyes cannot also adapt to the darkness beyond this enclosed space.

Another perspective on this, also related to the very basics of our vision, has to do with the task-oriented lighting solutions. We humans have two different types of vision - central and peripheral. The central vision is approximately 2% of our field of view, it is the small spot where our gaze focuses, the rest is peripheral vision. The strange thing is that modern urban lighting design has focused almost solely on task lighting and the central vision and left the peripheral vision literally disoriented. Because, in order for the peripheral vision to help us navigate and collect spatial information, it needs variable lighting with multiple zones of light, creating differences in shade, revealing form and depth.

It might also be good here to mention that task lighting as a concept is not the problem, the issue is the use of it, and the lack of any other layer of lighting within these spaces.

Now, let’s decipher the experience and talk about how the main issue creates specific problems in regard to identified needs.

**Basic Aspects** - To See Where to Place the Feet & To Orientate

The Basic Aspects are simply, to be able to perform the task of moving from point A to B, by 1) seeing where to place the feet (or steer the vehicle) and 2) understanding at what direction to navigate and how the space relates to spaces beyond.

Despite the issue of the too high level of contrast, the need To See Where to Place the Feet is most often not a problem. Thus, enabling movement, and detection and avoidance of obstacles.

However, although the lampposts often form a "winding line of orientational lights" (see figure 9), which creates a feeling of continuation, this only helps to navigate towards point B. But to orientate in a wider sense, one needs to be able to see beyond the path, to pick up light from surrounding spaces. And because of the level of contrast, to orientate is just not possible. In fact, at the studied path it is hard to look anywhere but down, especially wintertime (see figure 13).

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Perceived Safety - Prospect, Low Concealment, Facial & Intention Recognition & Access

Based on Jay Appleton’s ‘prospect-refuge’ theory from 1975, city planner Jack Nasar and landscape architect Kym Jones have in their study *Landscapes of Fear and Stress* used three basic premises for Perceived Safety: *Prospect* - to see and have an unobstructed view of the environment; *Low Concealment* - that the physical environment does not provide places which may conceal someone, such as trees, shrubs, walls, and dark spots; and *Access* - the possibility to escape\(^5\).

As shown in *figure 11 & 12*, the vertical planes framing the path are almost totally concealing, making it hard to see more than just a couple of meters beyond the path. Having vertical surfaces (in this case trees) light can reflect upon is most often desirable since only reflected light is visible, but here, as mentioned, it enhances the problems and increases the amount of *concealment*. The combination of already high level of contrast, relatively high illumination on the tree trunks of the first row of trees, and the fact that little light can reach beyond these trees, ends up creating the dark areas surrounding the path (very high amount of *concealment*).

For the very same reasons, there is no chance to have an *unobstructed view of the environment* since there is no sense of space beyond the path (*prospect*). The same goes for the idea of *access*, it is impossible to spot an escape route, even though there are residential buildings at a modest distance to

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the west. These buildings could be both a calming influence and a possible way to escape. But because of the level of contrast it is hard to even spot the light transmitting through the windows at all, standing on the path (see figure 11).

It is important to also mention that figure 13 is much more representative of the space at wintertime, which is the time of year when the need for good lighting design is even more urgent, because of the given conditions winter brings. And the images in figure 11 and 12 are more representative of the brighter and lighter summer months.

In regard to Facial & Intention Recognition, the level of contrast makes it very hard to discern a face and to see what someone might carry or what the body posture can reveal. It is first when people are just a couple of meters away, one can try to interpret their intentions. The level of light and distribution of light basically turn fellow pedestrians into dark silhouettes (when on a distance), since the adaptability of our eyes cannot adapt to the level of contrast within the visual field. And creates very dark shadows in the face of someone, when at a closer distance and nearing a lamppost. Making it almost impossible to see facial features or expressions.
Wet ground plane (reflective & dark)

Totally concealing vertical planes

The plane above is totally dark

Very high level of contrast, mainly due to the level of light + the darker reflectance values and the heavy darkness of the winter.
Visual/Aesthetic Stimuli

“Functionalism has reduced light into measurable figures...(...)...reducing experience and atmosphere to zero value and neglecting the emotional well-being of the inhabitants in our build environment.”
- Carlo Volf

The aesthetic qualities and visual stimuli of urban green areas (after dark) are generally hidden beyond the light. This, again, as a result of the too high level of contrast and the task-oriented lighting design solutions. Meaning that no light is intended to illuminate the surrounding spatiality, this layer of lighting does not exist.

At the studied path, the aesthetic qualities are at best non-existent. Which stands in stark contrast to how this space appears during a spring or summer day. It actually looks like a scene from a nature program that could be about some ancient tribe of hipsters living in the deepest and most untouched parts of the nature reserve, and I might just have found the entrance (see figure 14).

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6 Carlo Volf (2010) Light and the Aesthetics of the Perception, p. 1

Figure 14: Photo from the path (personal photograph) 2020-05-20
3.2 Lighting Design Method for Urban Green Areas

In figure 15 the previously identified needs have been translated into perspectives of lighting.

To connect back to the previous chapter and the issues with current design/level of contrast, the logic reaction in its simplest form, is to 1) lower the level of light and 2) redistribute the light to a larger surface area beyond the first row of trees and 3) to hide all light sources.

“Findings show that sites with higher light levels are more likely to be perceived as unsafe sites – the average light level across these sites was twice what was measured across safe sites.”

Furthermore, Broms, Högman & Winells study - Energy efficient lighting strategies for urban environments - show that quite drastic reduction of level of light directly on the path, in combination with an illuminated area in a zone up to 30 meters around it, can provide solutions that score high regarding perceived safety (prospect/spatial perception).

And beyond that, the decrease in overall level of light resulted in energy reduction of around 50%.

Now, let’s immerse ourselves in the lighting design method.

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Categories of Needs & Perspectives of Lighting

Basic Aspects
To See Where to Place the Feet - Light to Move
To Orientate - Light to Orientate

Perceived Safety
Prospect - Light for Spatial Perception
Low Concealment - Light to Unveil
Facial & Intention Recognition - Light for Intention Recognition
Access - Light to Escape

Aesthetic Qualities
Visual/Aesthetic Stimuli - Light for Aesthetic Qualities

(+ Reduced Energy Consumption)

Figure 15: Categories of Needs & Perspectives of lighting

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8 Loove Broms, Lennart Högman, Anders Winell (2020) Energy efficient lighting strategies for urban environments: Feeling safe at reduced lighting levels, p. 23
**Basic Aspects - Light for Task & Light to Orientate**

The perspectives of the Basic Aspects should guide the designer to create light for the users to perform the task of moving from point A to B, reassured of existing spaces beyond.

**Light to Move**  
*Light to Move* is a perspective that should enable the user to see where to place the feet (or steer the vehicle). Basically, to illuminate the horizontal plane/the path, for the user to be able to detect and avoid obstacles.

**Light to Orientate**  
This lighting perspective should enable navigation, to know in what direction to move in order to reach point B, and to orientate in regard to the surroundings; to work with our inner map and compass. For example, enabling the detection of connecting paths, nearby streets, or residential buildings. It could be about giving the user glimpses of how spaces are connected and guide with or with the absence of light; or to work with the rhythm and flow of the path, to make users aware of oncoming changes in the structure and so on.

These two layers are superordinate for the zones of light on the path. They have an inherent task to lower the level of light in general and on the path in particular. With reduced level of light, the level of contrast decreases, which in turn results in better general visibility and ability to orientate.

The zones of light on the path should be experienced as if being in a modestly lit zone, beside zones of light with more visible direction.

**Perceived Safety - Light for Spatial Perception, Light to Unveil, Light for Facial Recognition & Light to Escape**

The lighting perspectives within this category should enable environments where the user have: an expanded sense of space, low level of concealment, the possibility to interpret fellow users’ intentions, react to a threat or escape. These layers are also superordinate for the zones of light beyond the path.

**Light for Spatial Perception**  
*Light for Spatial Perception* should enable the user to perceive the surrounding spatiality and increase the sense of space. *Light for Spatial Perception* should draw the users attention, make the gaze wonder beyond the path.

This perspective forms the basis for added zones of light in the area 2-25 meters beyond the path. These zones increase visibility, both in the sense of creating a balanced level of contrast in regard to the zones of light on the path by expanding the illuminated surface areas, but also as a result of illuminating areas previously dark.

**Light to Unveil**  
*Light to Unveil* should help to uncover the covered, unveil the frightening dark spots and areas of the surrounding space. Turn elements from something appalling and concealing into
something calming and even unveiling. *Light to Unveil* should lower the amount of concealment within the space.

In practice this layer could be just an added dimension of the *zones of light* primarily created for *Light for Spatial Perception*. It is (as all) a perspective of how to illuminate, and must not result in adding more light or fixtures. It can rather be about directing the light in a strategic way. And although, the mounting and fixation of the luminaires can be done after the light emitting artefacts have been installed, this perspective has to be planned for in advance. Which points to the importance of having this perspective in mind, when deciding the placement of the light emitting artefacts.

But of course, it could also be about adding light, for example to reduce frightening shadows of a large tree or illuminating something deeper inside the forest.

**Light for Intention Recognition**

*Light for Intention Recognition* gives the designer the task of revealing form (body), on the path on a relative distance (approximately 15 meters). To enable the possibility to make judgements regarding the intentions of fellow pedestrians. This perspective has to do with how a person is revealed by light. To think of light as a revealer of three dimensional form, and as a phenomenon with three dimensional qualities.

The now low level of light or relative perceived brightness on the path, enables basic perception of form. To further enhance this, only reflected light is allowed on the path. If not, the level of contrast is increased and fellow pedestrians will appear as dark silhouettes. Beyond these aspects, it can also be about orchestrating light from multiple directions, by for example reflecting light. Thus, adding more incident light, which softens shadows and reveals.

**Light to Escape**

*Light to Escape* is a layer of lighting that builds on the idea of *Light to Orientate*. *Light to Escape* should guide users to other existing spaces. It should increase the amount of directions, create options and possible escape routes.

In practice it can mean that new connecting paths are created, or that light is directed in a way that it guides people towards other spaces.

**Aesthetic Qualities - Light for Aesthetic Qualities**

**Light for Aesthetic Qualities**

This perspective is intended to create or artistically bring forward aesthetic qualities of a space. The light might not be the center of attention, it might “just” reveal an element and in itself being an afterthought. *Light for Aesthetic Qualities* is what urges users to be in a space.

So, at the most basic level, it can be an added perspective of *Light for Spatial Perception*, and be about bringing a specific element forward, such as a green color of the forest, an interesting tree, bedrock or some other element.

But of course, it could also be about creating lighting installations, making the light the aesthetic quality itself. Just as long as it makes sense in regard to the space and nature.
Lighting Design Method for Urban Green Areas

Basic Aspects: to move, to orientate & enable low level of light

**Light to Move:** Light to see where to place the feet or steer the vehicle
**Light to Orientate:** Light to navigate & to note, reassured of spaces beyond

Perceived Safety: *to expand, to reveal, to assess & to connect*

**Light for Spatial Perception:** Light to increase the sense of space & draw the attention
**Light to Unveil:** Light to reduce the amount of concealment within a space
**Light for Intention Recognition:** Light to reveal intentions
**Light to Escape:** Light to guide to spaces beyond

Aesthetic Qualities: *to intrigue*

**Light for Aesthetic Qualities:** Light to create or bring forward aesthetic qualities of a space

+ Reduced Energy Consumption

**Figure 16:** The resulting lighting design method for urban green areas
3.3 Experiments I & II

Experiments I

The experiments are the first steps to create answers of how the method can be used in practice. Below in figure 17, the first set of experiments are defined.

Light for Spatial Perception:
1) Illuminate an area beyond the path from the lamppost, over the path, and out into the forest.
2) Illuminate an area beyond the path from a location closer to the area intended to be illuminated (try to avoid illuminating the first row of trees).

Light to Unveil: Experiment with angles, direction and what to illuminate (reflectance values) in order to create as low amount of concealment as possible.

Light for Intention Recognition: Illuminate a person by using reflective material (a white cardboard) 1) at the lamppost acting as a vertical surface, and 2) by reflecting up light from the ground plane in between two lampposts.

Figure 17: Design of Experiments I

Reflections & Outcomes

Light for Spatial Perception: In figure 19, one luminaire at each side, pushes back the line of darkness 15 + meters, beyond the path. The issue here is (beyond the too high level of light) that the light creates a narrow zone of light in the area intended to be illuminated (for setup of experiment see figure 20).

The different zones of light within the space must aesthetically be connected. If the zones of light are too far apart and a distinct border of darkness separates them, it makes the space look shattered and incoherent, and raises the level of concealment, which results in perceived unsafety.

Light to Unveil: When illuminating vertical objects - trees in this case - with higher reflectance values, it can easily increase the level of contrast, thus decrease visibility, and increase the level of concealment. It is preferable to illuminate lighter trees further into the forest, than near the path. And if illuminating lighter trees in the foreground, the light then has to spread to several lighter trees in the background (in z axis), a larger ground area (thus illuminating in an angle), and with lower level of light.

Luminaires directing light beyond the path have to be positioned in a way that the light is not primarily hitting the first row of trees, since the level of contrast increases if doing so. It is evident that having the light source closer to the area that is
Figure 18: Photograph from lamppost 2, existing lighting + black squares
Figure 19: Light for Spatial Perception, one luminaire at each side directing light beyond the path (viewing lamppost 3 from lamppost 2)
Figure 20: Top view illustration of current design solution + the setup of the experiment shown in figure 19
intended to be illuminated is preferable, since the light falls where it is needed and intended with much higher precision, and vice versa, to not illuminate areas not intended to be illuminated (see figure 21).

**Light for Facial Recognition:** Even though it is hard to represent in a photo, working with reflective materials on the ground, just as at a pedestrian passing on a street, is a way of increasing the amount of incident light and angles, since not being absorbed by the darker asphalt. And it definitely increases the perceived brightness and activates the space.

With that said, the experiments with a reflector below the luminaire was less successful. It is just when exactly in height with the lamppost it has any effect.

*Figure 21: Added zone of light from two different positions*
**Experiments II**

Further experiments, as a development of the first round, are presented below in figure 22.

**Light for Aesthetic Quality (Light to Orientate):** Illuminate the bedrock at lamppost 5.

**Light for Spatial Perception (Light to Unveil):** Illuminate a larger area on each side of the path, beyond the first row of trees. Use two luminaires to create two connected zones of light (on each side).

*Figure 22: Design of Experiments II*

**Reflections & Outcomes**

**Light for Aesthetic Qualities (Light to Orientate):** It is quite striking how the bedrock just appears (see figure 23 & 24). Not only does it aesthetically enhance the space and make the surrounding spatiality visible, but it also makes it clear not to run in this direction, if in danger (Light to Orientate).

Furthermore, this type of illumination demands flexibility, the right angles and positions are not found without testing.

**Light for Spatial Perception (Light to Unveil):** In figure 25, two luminaires have been used at each side (as shown in figure 26), creating two overlapping zones of light, beyond the path. The combined zones of light are approximately 20 meters wide and 15 meters deep. This means that if placing lampposts 18-20 meters apart the zones of light from each lamppost will overlap, in between.

This is to be considered a test of how to illuminate, not how it is intended to appear or look, since the level of light is too high. Maybe it will look a bit more like in figure 27, but this has to be investigated further in a full-scale study (as all other proposals).
Figure 23: *Light for Aesthetic Quality/Light to Orientate*; existing lighting to the left, existing lighting + experiment to the right
Figure 24: Top view illustration of current design solution + the setup of the experiment shown in figure 23


Position of luminaires & direction of added zones of light
Figure 25: *Light for Spatial Perception*, two luminaires at each side directing light beyond the path (viewing lamppost 3 from lamppost 2)
Figure 26: Top view illustration of current design solution + the setup of the experiment shown in figure 25.
Figure 27: Light for Spatial Perception, lower overall level of light created in photoshop
Figure 28: Master Plan of the Conceptual Design Proposal
3.4 Conceptual Design Proposal

Zones of Light on the Path

Light to Move & Light to Orientate
Visibility and possibility to orientate is gained by both using a luminaire emitting only reflected light onto the path and decreasing the *level of light* to 1) such extent that no surface dazzles the users and 2) at least 50%. I will also suggest using LEDs with sufficient color rendering (CRI around 80), and with low CCT (below 3000K), containing less blue light, since blue light scatters in our eyes.9

To make the user aware of oncoming changes in the structure of the design (*Light to Orientate*), I have also reduced light at lamppost 1,2,3,4,1 and 8 (from north). Just one or no luminaire is directed to the west (beyond the path). By surrounding the bollards with darkness, the aim is for faster detection of the escape routes (see figure 28 or 33).

Light for Intention Recognition
Reflective zones are painted on the ground in between the lampposts (see figure 31 & 32). This to increase the amount of incident light and its directions, aiming to make fellow users more visible when in between lampposts, but maybe most importantly, to increase the perceived brightness of the space.

The pattern used in the images is just symbolic, its design must be tested in scale 1:1.

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Zones of Light beyond the Path

Light for Spatial Perception
The redesign of the lamppost was mainly a consequence of trying to efficiently illuminate areas beyond the path. First and foremost, to avoid low hanging branches, closely standing trees and so on, but also to “put the light where it is needed”, getting closer to and hitting the surface areas intended to be illuminated (and reducing light where it should not be) with higher precision. Therefore, I have created an artefact that offers flexibility in multiple ways (see figure 29 & 30).

New *zones of light*, with low *levels of light*, have been created surrounding the path. The light illuminates both the areas in between the lampposts beyond the path and out into the forest (see figures 25-28).

Light to Unveil
*Guidelines to lower the amount of concealment in the space:*
- Light should not be directed onto trees with high reflectance value closer to the path, rather further into the forest.
- Large trees should be avoided (as much as possible), since creating large concealing shadows.
- The luminaries pushing light beyond the path, must be positioned in such a way that the first line of trees can be avoided as much as possible.
- The light beyond the path must spread to a larger surface area, both to vertical and horizontal surfaces, to keep the *level of contrast* low. Thus, illuminating in an angle.
All parts attached to the vertical pole are movable in y axis (height) and rotatable, 360 degrees. The different luminaires are possible to attach at every spot along the horizontal rods, and possible to set in any angle (but the PH-like luminaire).

The PH-like luminaire illuminating the path, emit reflected light. The other luminaires emit direct light, and should therefore be mounted in a way that they don’t disturb the users field of view.

**Material:** Weathering (COR-TEN) steel

**Figure 29:** Redesign of the lamppost
Figure 30: Illustration of the *distribution of light*
Figure 31: Illustration of a pattern on the ground reflecting light (Light for Intention Recognition)
Figure 32: *Distribution of Light + Light for Intention Recognition* (pattern on the ground plane reflecting light)
Light to Escape
Firstly, the whole area has to be thinned out of vegetation (without destroying the biodiversity), especially the dead branches and trees on the ground. It is contradictory to direct people towards a space and while getting there tripping over.

New lit passages have been created, giving the users the choice to diverge from the main path onto smaller routes lit by bollards at very low levels of light. It is a way of breaking up the path in parts, aiming to lower the feeling of being in a secluded space, even more.

The low levels of light throughout the space also enable detection of surrounding elements, such as connecting paths and buildings. Elements which are possible escape routes.

Light for Aesthetic Quality
The bedrock is illuminated by luminaires directed to the east, primarily from lampposts four and five. This means having four luminaires with four different positions, to reduce unwanted shadows and illumination of surrounding greenery, and instead bring forward the intended areas with higher precision (during the experiment just two luminaries were used (see figure 23, 24 & 28)).

Illuminating the bedrock also makes it clear that escaping to the east from that position is not ideal (Light to Orientate).

Energy Consumption & Light Pollution
Using multiple luminaires enables, not only a more nuanced lighting with balanced level of contrast, but also the possibility to turn parts of the system off and on. I will use motion detectors, signaling to turn on the zones of light directed beyond the path, when someone is approaching. The sensors will trigger a gradual increase of light (for all of them simultaneously), over 3-5 seconds, from 0 to 100% (see figures 34-36). The experience of it should be that the room becomes extended, the field of view increased, when nearing. This also means that the light beyond the path is gone when nobody is there, to benefit nature and decrease the amount of light pollution.

However, the path is always illuminated, since the zone of light directed on the path is constantly turned on (although with a 50% lower intensity than normal output). Which decreases the element of sudden surprise when zones of light appear.

In regard to previously mentioned studies, using a similar design idea, I believe this could decrease the total energy consumption by approximately 40-50 % in comparison to modern LED solutions.

And lastly, as previously mentioned and as the title of the chapter says, this proposal is conceptual. Most of the solutions are based on experiments and research, but all results must be confirmed and developed in a more elaborate full-scale-study, where the proposal is built in reality.
Figure 33: Master Plan of the Conceptual Design Proposal
Figure 34: Illustration of light beyond the path being turned off (no user on or near the path)
Figure 35: Illustration of the light gradually dimming up (users are nearing)
Figure 36: Illustration of luminaires fully dimmed up (users are on the path)
4.0 Discussion & Conclusions

4.1 Discussion

Limitations

Because of the Coronavirus I have been restricted from using workshops to create material for experiments, restricted to move, restricted from interactions. It has been restrictive, to say the least.

Choice of Methods

The experiments could have been more elaborate, I wanted to do more of a full-scale-study, but because of the current situation it has been hard to work practically.

In terms of paper review, I found it very hard to find applicable research on these topics (created from a practice-based design perspective). Especially in regard to the design proposal, but as for the design method and analysis I was able to put together a helpful palette of perspectives from different fields.

The choice of interview technique was successful. Although not that extensive, I had similar results as large-scale studies, and interestingly enough, similar results as studies from different parts of the world.

Summary of Findings & Contributions

In this thesis I have analyzed how the phenomenon level of contrast, a consequence of the relation between level of light and distribution of light, works within urban green areas.

For this particular site, the too high level of contrast is a result of the high level of light distributed 1) in the direction of oncoming pedestrians and 2) in a single zone of light and 3) on a too condensed surface area and 4) in a space with irregular vertical planes (in a dark space with low reflectance values).

Being in the only lighted area surrounded by trees (vertical elements absorbing or reflecting light), with eyes adapted to its level of light, consequently, makes it impossible to see beyond the path. This since our eyes always adapt to the brightest spot in our field of view, which in all directions is a spot very close to the user. And since adapting to the emitted and reflected light our eyes cannot also adapt to the darkness beyond this enclosed space.

Another perspective on this, also related to the very basics of our vision, has to do with the task-oriented lighting solutions. We humans have two different types of vision - central and peripheral. The central vision is approximately 2% of our field of view, it is the small spot where our gaze focuses, the rest is peripheral vision. The strange thing is that modern urban lighting design has focused almost solely on task lighting and the central vision and left the peripheral vision literally disorientated. Because, for the peripheral vision to help us navigate and collect spatial information, it needs variable lightning with
multiple zones of light, creating differences in shade, revealing form and depth.

The main contribution of this thesis, beyond defining knowledge regarding how light acts in these specific situations, is the development of a lighting design method specifically for urban green areas from a practice-based design perspective (see figure 16). And that I have started the work of creating practical knowledge and answers to the question: How can the method be used in practice?

Main Discussion

I have read many reports, research papers and lighting strategies for different municipalities around Sweden, most saying that illuminating an area surrounding the path increases the perception of safety and the sense of space. But looking at the proposed or resulting solution, it can sometimes be a bit contradictory. Seeing a tree in an otherwise dark space or having luminaires directing light onto the edge of a forest and the first row of trees (which was explored during the experiments), does not really enable a sense of space, reduce the amount of concealment nor the sense of being in the illuminated space beside a dark wall. At best it pushes back the line of darkness a couple of meters at some areas or creates a warm emotional reaction in regard to a beautifully illuminated tree.

It is also interesting how some researchers, instead of defining or dealing with the very fundamentals of a phenomenon, just seem to follow trends of the markets, and add new layers to existing paradoxical ideas and solutions. Today the discussion regarding facial recognition, within the research community, seems to revolve around color temperature and light quality. But is that really what we should be focusing on, when the design of these spaces works against the basics of our vision?

Or how can the answer to perceived safety ever be more light and uniformity (which still seems to have relevance) when the answer has been proven the very opposite.

In a way, this is why I had to leave Richard Kelly’s Three Tenets of Lighting Design behind. Which was intended to be the backbone of the method here developed. But, after starting to define needs and analyzing the path, I realized that these principles or layers of a method, does not apply to urban green areas. It does not present suitable concepts nor provide answers to the issues and needs. I am not saying that it does not have any value, but what I am saying is that it does not make sense to use when designing for urban green areas.

Take the concept of Ambient Luminescence:

“Ambient luminescence produces shadowless illumination. It minimizes form and bulk. It minimizes the importance of all things and people. It suggests freedom of space and can suggest infinity. It is usually reassuring. It quiets the nerves and is restful.”

10 Richard Kelly (1952) Lighting as an Integral Part of Architecture, College Art Journal, Vol. 12, No. 1, p. 25
There is nothing in the description of this concept that applies to urban green areas, after dark. Now, let’s say we use the concept of *ambient lighting* instead, a layer that at its most reduced definition, should make the overall space visible. But, the overall space within urban green areas is often impossible to define and delimit, and not all areas or surfaces are to be or can be lighted. So, since not directly relating to any specific need, makes it confusing to use and talk about.

Ironic enough, the only established lighting design concept I have used is *task lighting*. Which was converted into *Light to Move* and *Light to Orientate*. The rest of the layers or perspectives that form *the method*, were derived directly from needs and the experience of the space.

So why am I saying this? Because, as in the case of the researcher that runs the errands of the markets, or me if I would have forced Kelly’s principles into the realm of urban green areas, it would not have benefitted the outcome. It is, sometimes, better to start over and develop something from scratch, or at least aim to. And in the process of doing so, one might understand a subject at a deeper level and have created new answers, instead of relying on previous ones, just because they are frequently repeated and popular. Especially when something is fundamentally wrong with the current answers.

### 4.2 Conclusions

Now let’s get back to *my initial questions*: How come it seems okay to feel unsafe, why is only *task lighting* created and what about the aesthetic experience (see *figure 3*)? It is now obvious what the answer is, namely, that we don’t seem to have the necessary methods to create suitable design solutions for urban green areas.

And, maybe it is good to state that I don’t accuse Richard Kelly for this, he has nothing to do with it. The issues of today has rather to do with what our methods, norms and principles has become, since something seems to happen between the intention of the designer, the strategy of a municipality, the aim of the researcher and the outcome.

I think the lighting design community is in need of new *practice-based design methods*, which hopefully leads to new practical knowledge, new research and development of new equipment/artefacts.

New methods are important for two things. First and foremost, since there is a need for it, since the existing ones do not seem to provide the answers or guidance we need. And secondly, to not make the resulting design proposals rely on the lighting designers individual skill. By designing and using methods we, as a group, can become better creators of environments and together try to make the industry run our errands instead of us running theirs. Creating a method is basically about sharing knowledge and ways of thinking, for all lighting designers to not have to do all the same research, and
to organize us as a workforce.

**Further Development**

As mentioned before, the next step would be to build/test the design proposal in a full-scale-study as a base for further experimentation and development. All the practical results and guidelines need confirmation and development.
5.0 Table of References

Shown in the order as presented in the text.


https://kartor.eniro.se


Carlo Volf (2010) Light and the Aesthetics of the Perception, page 1


Appendix
Interviews

Answers from interviews conducted on the studied path, during the month of November 2019. The questions were posed in the same order as presented below.

1. What thoughts or feelings are evoked when moving along the pathway? (Gender, age)

- As I am in a tunnel of light; I have the feeling of being seen or even supervised. (Man, 67)
- Bad visibility. (Man, 54)
- Unsafety. (Woman, 37)
- Discomfort, after a while I almost feel observed. (Woman, 42)
- It feels deserted (Woman, 59)
- It is just dark, no harm in that (Man, 10)
- Unsettled! (Woman, 54)
- I feel unsafe! (Woman, 15)
- I am not afraid, but I can understand that someone can feel scared! (Man, 38)
- I feel safe, I always feel safe, maybe it is because of the dog. (Woman, 32)
- I am very afraid (Man, 11)

2. Why are these reactions evoked? (Gender, age)

- Being dazzled walking past every lamp post, which lasts until passing the next lamp post. It is a matter of constantly being dazzled. (Man, 67)
- The darkness (Man, 54)
- The woods, the darkness! (Woman, 37)
- Too much light at the wrong place. (Woman, 42)
- The forest, the darkness! (Woman, 59)
- No reaction (Man, 10)
- No idea, the forest, the darkness. (Woman, 54)
- Don’t know. (Woman, 15)
- Wow, what a question, don’t know. (Man, 38)
- A good question, don’t know really. (Woman, 32)
- The forest, two men suddenly came out of the forest, but they were not dangerous; luckily. (Man, 11)

3. Do you feel safe when moving along this pathway?

8 (≈ 73%) answered no; 3 (≈ 27%) answered yes.
Diagram of illuminance measurements
(17:30-18:30, 25/11-19)

The diagram shows the amount of lux hitting the ground at the middle of the path (0 m) and two (and three) meters from the middle of the path on both sides. From one lamppost to the next.

It also describes the light distribution of the luminaire at the studied path.