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Abstract:
Inspired by storytelling and urban scenography, this thesis seeks to explore how the perception of time can be affected by coloured light.
The research is based on literature reviews combining previous research, literature, and talks, to get a broad understanding on topics leading to the research question.
Previous studies have shown that our perception of time can be affected by blue and red light.
A curiosity towards these studies served as the point of reference to this thesis.
To test the phenomenon of time and colours, three experiments were made. Each experiment was divided respectively into the *Lab*, the *Field*, and the *Showroom* in a transdisciplinary approach trying to include different perspectives of science. The field of sciences included natural science, social science, and humanity, all using qualitative and quantitative methods.
The experiments showed that the perception of time, when exposed to blue light, was perceived as longer compared to red light. These results were shown in both the Lab study and the Field study. In the Lab study blue light was perceived as longest, while the white light was perceived as shortest. In the Field study the perception of time felt more slowly within the white light, and fastest in the red light. Even though the results showed something else, the participants in average expressed that the time perception within the blue light was perceived as being longest, and shortest for the red light
The Showroom study showed how the participants perceived the perception of time in either a coloured dynamic room, a white room, and a black room including a discussion and drawings of their experience.
Since the perception of time can vary depending on many factors, more tests need to be made, to get a more precise understanding of how light and colours can affect our perception of time.

This thesis suggest that storytelling can be the link between architectural lighting design and the time perceived within the space. Storytelling can be used as an artistic approach to design urban scenography, which in this thesis is discussed through design visualisations. This thesis suggests that coloured light and the phenomenon of time can be used to enhance the experience when designing urban spaces and creating stories told with light. By using the idea that colours can affect the perception of time, we as lighting designers dig into a new world of possibilities when designing spaces and art in a nocturnal scene.

MOMENTS OF LIGHT

How can light affect the perception of time?

Nicoline Jo Højer Hansen

Msc. Lighting Design, 2022

ABSTRACT

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TABLE OF CONTENT

PREFACE

This thesis seeks to understand how light, and colour can affect the perception of time.
The understanding of the phenomenon of time in outdoor lighting design might give new possibilities for architectural lighting designers and urban scenography.
Storytelling can be an approach when designing urban scenography which can give potentials for having the time in mind when designing outdoor spaces and memorable experiences.

STEP 1

DISCOVER

INTRODUCTION

Most people can relate to the feeling of time flies, as well as the feeling of the time moving slowly. These feelings are true, even though the measured time is the same.
Time is not just the time counted in seconds, but the perception of time can also change, when being very concentrated, passioned or by getting an experience which make you lose time and place for a moment.
Even though a clock is a worldwide measurement for time, the actual perception of time, or the phenomenon of time, is still an interesting topic that many scientists try to understand. Time can be divided into two categories to understand what kind of time scientists are focusing on.
The phenomenon of time includes: *Physical time* (time measured on an objective timescale) and *Represented time* (time in our subjective experience) (Hogendoorn 2022;129). Many might have heard of Einstein and his *theory of relativity* (1915) showing that the local time vary from two objects according to the speed and surroundings (Hildebrandt 2018). Traveling close to the speed of light will make time go more slowly compared to a not-moving object. This theory uses the speed of light as a constant to measure the time. But what if light itself can influence the perception of time?
This thesis will not focus on the physical time and the theory of relativity, but rather on the represented time, and how light and colours might influence the time perceived.

One way to forget time and place, is when exposed to an unexpected, aesthetic, or interesting experience. Storytelling is a good example of a way to forget time and place. When listening to a good story, many might have tried to create inner pictures, and vanish into a fantasy world, which sometimes even might feel as real as reality for a short moment of time. Storytelling and created experiences are based on the same idea, to either entertain, inform, inspire, or engage.
And storytelling and great experiences are a way to affect the perception of time.

Storytelling needs atmospheres to visualise the setting where the story takes place.
In theatre, which is some kind of *live storytelling*, the atmospheres are often created and based on scenography, the story, sound and light. Light is a dominant visual instrument, when creating atmosphere and to support the act, where the use of colours can change the appearance of the space immediately.
Using blue light might create a cold and clinic vibe, while red light might support love-stories or drama.

The possibilities of scenography is not only known in the theatrical context, the recent years a broad topic about *Urban Scenography*, as been discussed, trying to rethink or challenge the way we as lighting designers transform, or enhance urban spaces.

Urban scenography is not about functional architecture, but a term which describes a different approach to art in public spaces. Light can support the urban scenography by adding the atmosphere, as it does on-stage. Urban scenography is a way to tell stories, and storytelling can be a tool to understand how to tell these stories.
Can urban scenography be designed to affect the perception of time, like storytelling does – and can this be done only with light?
This thesis will investigate how light and urban scenography can be used to tell stories and investigate, if the phenomenon of time can be affected by light and colours.

Imagine if the phenomenon of time and colors can be applied in urban lighting designs to tell stories with light

STRUCTURE

A broad literature study has been made to understand the characteristics of the topics, and to collect and select relevant theories of how to design visual experiences with light. Based on the literature review the literature was narrowed down to literature considering perception of time, storytelling, created experiences, and urban scenography.

Based on the literature review and theories, the pre-analysis was made based on the 5 different categories of bus stops using observation methods. Quantitative and qualitative methods have been used to combine different observations, and to make sure that the process considered a transdisciplinary approach all time.

The research question is divided into two areas of interest, one which focus on previous research and by experiments in this study, tries to understand how light can affect perception of time. This area of interest is based on the idea that storytelling can affect the perception of time, and light can be used to enhance storytelling of spaces. The other area of interest focuses on literature and how lighting design in a theatrical context can be applied in outdoor environments as urban scenography. This area of interest will be explained and applied through design proposals and atmospheric lighting techniques, helping to understand how light can tell different stories.

The case study should help understand how this knowledge can be transferred into existing outdoor spaces.

For investigate in how light can affect the perception of time, three experiments were made. The experiments are divided into *The Lab*, *The Field*, and *The Showroom*, which refers to design research. Design research is overall a way to integrate design and research (Koskinen, Zimmerman, Binder, Redström & Wensveen 2012;23). Each part linking to each field of science. The different parts will give opportunity to test the same research question but using different methods and techniques. The overall structure is divided into overall sections called; *Discover*, *Define*, *Develop,* and *Deliver*, inspired by phases in the *Double Diamond* model. The division of the thesis should help the reader understand the approach of either divergent or convergent, guiding the reader through the process.

The background for this thesis is based on inspiration and passion in the theatre field, and a curiosity of how to merge this knowledge with urban experiences in outdoor spaces. The approach for this thesis was therefore grounded in a theatrical context.

Adolphe Appia (1954) established a hierarchy of theatrical lights existing of: the *actor,* the *space* and the *light.* Appia (1954) described the actor as the instrument for drama and action, which appears in a three-dimension space (the space), where light serves the actor and creates expressions and gives life to the stage (Appia in Journal de Genéve 1954 in Palmer 2013;148-149).

Hvass & Hansen (2020) use this hierarchy to translate it into the urban space in the nightscape (Hvass & Hansen 2020). According to Hvass & Hansen (2020) *The Scenographic Lens* is used as a tool to translate and understand potentials of the lighting design in urban spaces based on scenographic principles (Hvass & Hansen 2020). The idea is to see the urban nocturnal environment as a theatre play with the urban space as scenography, the users of the space as actors, and how the lighting design can support and interact with the behaviour and play. This thesis is inspired by this scenographic lens, with a motivation of exploring how principles of theatrical context can be applied or transferred to outdoor spaces, by using storytelling. This thesis works through a storytelling lens, linking to urban scenography and perception of time.

Figure 1 shows how different subjects are merged together, and leading to the experiments.
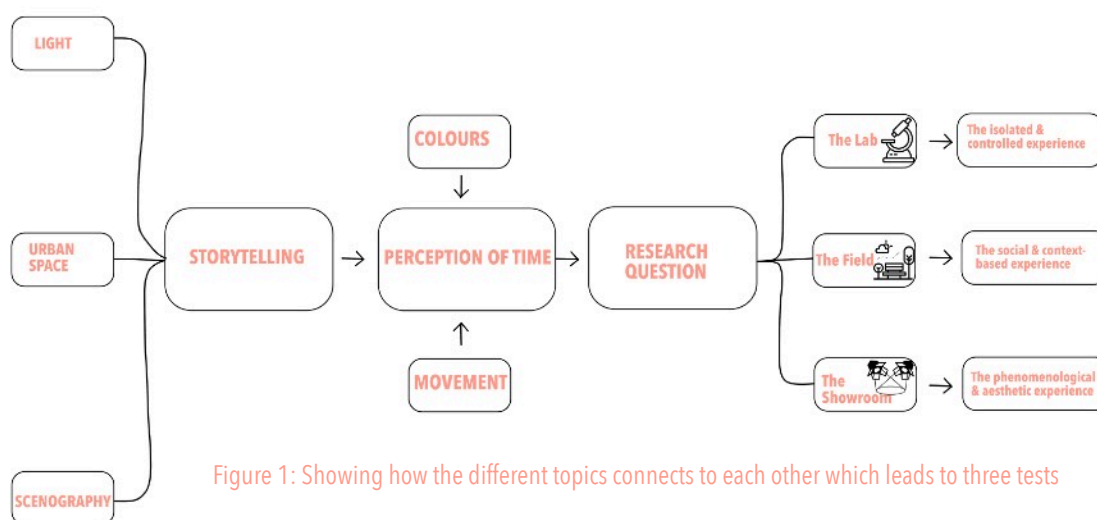

Figure 1: Showing how the different topics connects to each other which leads to three tests

THEORETICAL BACKGROUND

Based on the vision, different research topics were chosen to understand the phenomenon of time, created experiences, and storytelling.

The topics were chosen to understand the phenomenon of time, and how storytelling can be a tool to engage the listener and can affect the perception of time. By choosing created experiences, an understanding of the importance of unexpected and inspiring experiences will be defined, and how created experience has become an overall tool in the leisure industry.

The understanding of created experience together with storytelling can give an overall understand how urban scenography can affect the user. The theoretical background should be seen as an important fundamental understanding, for each topics – which later in this thesis will be merged together and defined specific for the vision and the research question.

Light and perception of time will be discussed later.

PERCEPTION OF TIME

Time itself is a well-discussed topic, with no final definition to describe the phenomenon (Navntoft 2018). Time is often understood as something that is going and something measurable. Time is something counted in seconds, but the perception of time can be very different, depending on the perceiver.

Ernst Mach (1883), an Austrian physicist, stated that; time is not something used for *measure* how things are changing, but rather an abstraction which is based on *observations* of how things are changing (Henningsen 2017). This explains time as being a concept which appears in the consciousness of human beings, formed by changes, and by this describes time, as an intersubjective reality, only existing because of a collective understanding between humans (Henningsen 2017).

The perceiver

The perception of time can vary depending on the perceiver.

According to philosopher Poul Lübcke (1981) there are two ways of perceiving time.

One way is the *objective* way, using a watch or a calendar. The other is the *subjective* way, which counts important events according to a period of time (Ebdrup 2017).

In the Western World events (instances in time) are perceived in two different ways either *ego moving* or *time moving* (Thönes & Stocker 2019;117). The Eco moving perceives events, as something we are moving forward to, e.g., "*We are approaching the weekend*" (Thönes & Stocker 2019;117). Time moving perceives the future as something moving towards us, e.g., "*The weekend is approaching*" (ibid). These two ways of perceiving time will affect how time overall is perceived but also described.

Lübcke (1981) also states that there are differences on the perception of time depending on age. He states that children experience new things all the time, why time for them can feel different comparing to adults (Navntoft 2018).

In general adults, during their life-time, already had way more experiences comparing to a child, which explains why adults will not have as many *new experiences* during a year.

Lübcke (1981) explains it as, children having approximately 100 big experiences during a year, while adults might have 10 (Navntoft 2018).

As an adult new experiences are not as urgent as when younger (Ebdrup 2017), this results in adults in average perceive the time as moving fast, and children perceive time as moving slowly.

Researchers when studied time perception uses overall 4 classes of measures: Estimation, production, reproduction, and comparison (Zakay 1990 in Foley & Matlin).

Activities affect perception of time

Events that occur during the interval being judged have a major influence on duration estimation. Ornstein (1969) suggests that a filled interval should appear to be longer, than empty intervals (in Foley & Matlin n.d.). The activities, a person fills a time period with, are influencing the time perception, depending on the amounts of cognitive effort (Foley & Matlin n.d.). Filled time intervals can appear to be shorter than unfilled intervals – if the task is a pleasant one (Foley & Matlin n.d.). The important factor, according to this, is not the complexity of particular stimuli presented, but the complexity of the task in which a person is engaged (Block 1990 in Foley & Matlin n.d.).

Time appears to pass more quickly when waiting for an unpleasant event, or if the activity is pleasant (Foley & Matlin n.d.). This is also explained by Edmonds, Cahoon, and Bridges (1981), who found that the duration of the waiting time spend for a positive experience appeared longer than the duration spend waiting for a negative experience (Foley & Matlin n.d.).

Four overall factors can influence time perception:
characteristics of the time experiencer, time-related behaviours and judgments, contents of a time period, and activities during a time period (Foley & Matlin n.d.).

Studies also show that there is a relation between perception of time and boredom. When people are feeling bored, the time seems to stand still.
In Watt (1991) findings showed how high values of boredom affected the perception of time to be passing more slowly (Watt 1991;325). Farmer & Sundberg (1986) stated that:

"[…] boredom is maintained by an environment that is perceived as static, with the actor remaining largely disconnected from the processes that comprise his or her environment" (in Watt 1991;326)

Positive experiences, which affect the routines, can affect the perception of time. Such experiences could be found in leisure activities, such as goin to theatre. If an experience is either unexpected, amazing, or engaging the time and place might be forgotten.
An experience is something *worth telling* (Madsen 2015-2016). A good experience surprises and gives something memorable to the receiver (ibid). The good experience is a balance between the *expectation-breaking* and the *expectation-affirming* (Madsen 2015-2016). Meaning that the good experience needs to surprise but at the same time represent something known and expected (ibid).

Time in a theatrical context

Time, according to the theatre practice, is described in the Danish Theatre lexicon of Gyldendal as something *ambiguous* (Andersen 2012). The theatre experience contains of two definitions of time; the *fictional time*, and the *scenic time*. Fictional time refers to a parallel time, existing in the theatre plays, differentiating from the reality off-stage.
The period of the theatre play is called the *scenic time*.
In the theatre experience the fictional time and the scenic time are often merged as one whole experience (Andersen 2012).
Depending if the theatre experience engage or bore the spectator, the subjective perception of the scenic time (the length of the theatre play) can be perceived differently (Andersen 2012).

Time in urban spaces

According to Wunderlich (2012) temporally experiences in urban spaces can give the perceiver a sense of time. This sense of time is sensory and meaningful, changed by the tempo in surroundings and the social context (Wunderlich 2012;337).
Time in urban spaces is *location-specific*, according to Wunderlich (2012) and is experienced and performed collectively – not only subjective (ibid).
The tempo in surroundings affect how an urban space is perceived but shows also how time *could* be perceived within the space. Since urban spaces include a collective perception of time, this could indicate that time in spaces can be modulated according to the desired purpose affecting more users at the time.

CREATED EXPERIENCES

The world is filled with sensations, everywhere we go colours, sounds, and odours are meeting us, some made naturally, some comes from people or is constructed (Solomon, Askegaard, & Bamossy 2019;85). Only a small number of stimuli in our environment are ever noticed (ibid). This refers to Lübcke's (1981) statement of adults perceiving time faster, than children.

The stimuli are processed subjectively and interpreted by the individual, influenced by needs and experiences (Solomon, Askegaard, & Bamossy 2019;85). The process of perception is based on exposure, attention, and interpretation (Solomon, Askegaard, & Bamossy 2019;85). Sensation is the response of our sensory receptors (eyes, ears, nose, mouth, fingers) when exposed to stimuli such as light, colour, and sound (Solomon, Askegaard, & Bamossy 2019;86). Perception is referring to the process where these stimuli are selected, organised, and interpreted (Solomon, Askegaard, & Bamossy 2019;86). Perceptual experiences can be divided into *direct experiences* and *indirect experiences* (Nielsen 2021;42). The direct experience is based on the perception of the individual and the interaction with the outside world. The direct experiences learn the perceiver to interpret what is being seen and felt making experiences logical, meaningful, or emotionally changing (Nielsen 2021;42). The indirect experiences are based on a cultural context, through history or traditions, leading to common behaviours and actions (ibid). This division define experiences as being cultural and personal.

The definition of created experiences

The word experience has different meanings:

1. An event, as it is perceived in the moment of the event, created by sensory impressions from the outside world.
2. The content of a direct participation in or observation of an event in which an evaluation of the sensory impressions takes place.
3. An accumulation of knowledge and skills arising from direct participation in incidents and actions.

<div align="right">(Jantzen et al 2012 in Madsen 2015-2016;50).</div>

Experiences, as created in the moment of events, are the focus for this thesis and how these experiences can be a way to design urban spaces.
In this case, this definition will be described as *Created Experiences*, to understand the distinguish between previous knowledge (experiences), and created sensory events (created experiences).

According to Pine & Gilmore (2009) artificial experiences doesn't exist.
Created experiences are real within the individual, whether the external stimuli are natural or simulated (Pine & Gilmore 2009;57). This means that created experiences in this context is not something unreal or artificial, but an experience which is established with a certain purpose. A created experience is impacted of the contexts which can be divided into: the *personal context* (Motivation, mood, expectations), the *sociocultural context* (people around, travelling alone or together), and the *physical context* (the physical frame/objects, sensories) (Madsen 2015-2016;42). Experiences are normally created in the perceiver itself. This happens according to surroundings, atmospheres, and other circumstances, which either the perceiver or the designer not always can control (Madsen 2015-2016;48). The designer creates a frame which the perceiver itself define (ibid).

According to Jantzen et al (2012) created experiences are a process of either change, amaze, or transform the perceiver (Madsen 2015-2016;49). If created experiences are changing it means the experiences affect our pulse and breathing (Madsen 2015-2016;49). It's about changing the tempo and distract the perceiver from the current activity (ibid). If experiences amaze, they challenge the perceivers expectations and conceptions. When experiences transform it means that the experiences are the reason to deeper self-understanding, new expectations, and a varied perspective (Madsen 2015-2016;50).
Created experiences in this context are often seen in the leisure industry, and are associated with theatre plays, concerts, exhibitions, restaurant visits, events, and happenings. The need for created experiences is a well-discussed topic in the experience economy field. The idea of using experiences to make awareness, is based on a believe that we, as human-beings, need to feel, taste, smell objects and the phenomenological appearance of the product, event, or space.
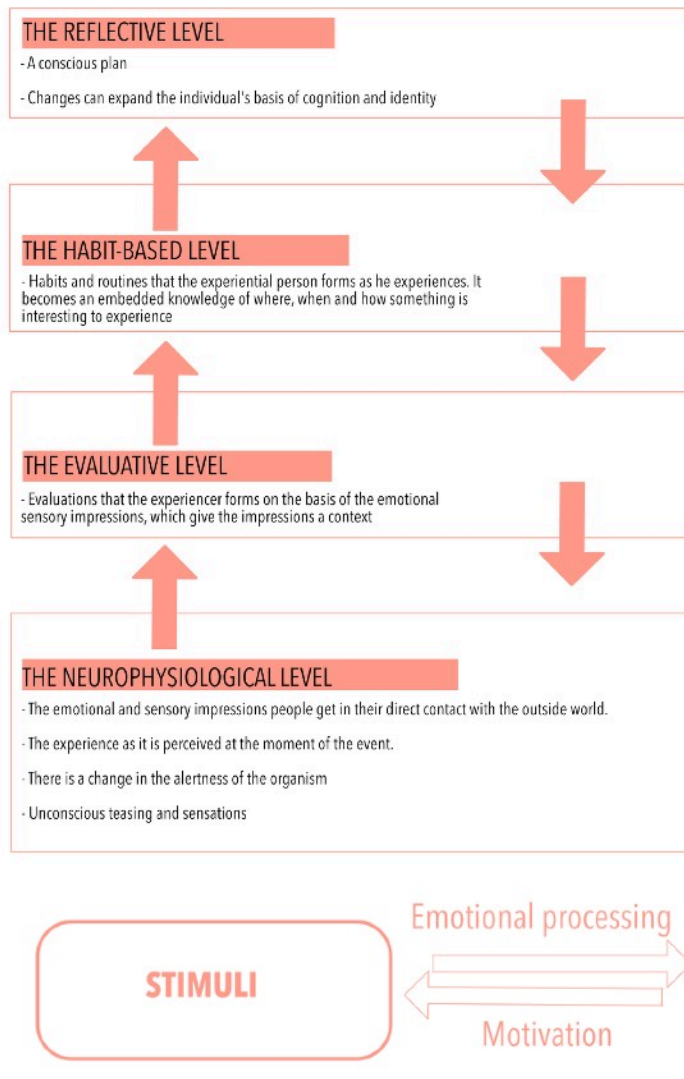
The process of experiences

THE REFLECTIVE LEVEL

- A conscious plan

- Changes can expand the individual's basis of cognition and identity

THE HABIT-BASED LEVEL

- Habits and routines that the experiential person forms as he experiences. It becomes an embedded knowledge of where, when and how something is interesting to experience

THE EVALUATIVE LEVEL

- Evaluations that the experiencer forms on the basis of the emotional sensory impressions, which give the impressions a context

THE NEUROPHYSIOLOGICAL LEVEL

- The emotional and sensory impressions people get in their direct contact with the outside world.

- The experience as it is perceived at the moment of the event.

- There is a change in the alertness of the organism

- Unconscious teasing and sensations

Figure 2: Illustration of the process of experiences

Emotional processing

STIMULI

Motivation

THE INDIVIDUAL

Figure 3: Illustration showing the relation between the individual and stimuli

The process of experiences will go through different levels according to Jantzen et al (2012). The different levels are: The *neurophysiological level*, the *evaluative level*, the *habit-based* level, and the *reflective level* (Madsen 2015-2016;57). The neurophysiological level is the basis of any experience, and at this level the individual registrate bodily sensations or stimuli (sight, hearing, balance, impulses etc.) takes place. Figure 3 shows when the individual is exposed to stimuli creating motivating effects and positive emotions, the individual will seek similar experiences again (Madsen 2015-2016;52). This refers to the neurophysiological level, which is interesting for this thesis, since small everyday experiences can trigger positive emotions and make the perceiver seek it again – this is relevant for architectural lighting designers when designing urban spaces, in a way to think light in an explorative way creating unexpected stimuli.

Created experiences & time

Good created experiences is experiences that create a present and make the receiver forget time and place for a moment of time. It's something that breaks routines but at the same time gives new inputs. The figure 2 also shows how experiences can become habit-based. A common outcome of habit-based experiences are that it might become routines, where the individual experience doesn't have the same effect on the motivation, or how we perceive the experience. New daily experiences are something that breaks routines, which according to Lübcke (1981) also will affect the perception of time. New experiences will make your life seems longer, and time moving more slowly, because there are more memorable experiences to think of.

Created experiences, such as theatre plays, cinema movies, and fun-parks, a one way to break routines and to get new input in the everyday life.

Experiences is not about only entertainment, but is about to engage and include the user (Pine & Gilmore 2009;49).

The relevance of created experiences in this context is, that if light should affect the perception of time, then the perceiver needs to be aware of the experience, and focus on the impressions – or explained in another way, the perceiver needs to experience the experience with the body within the moment. As Mason (2018) goes on to explain, moments are charismatic not because they are measurable fractions of clock time, but because they are '*multisensory glimpses, windows, apertures or revelations*' into a person's everyday world and lived experience (Mason 2018;193 in Keady, Campell, Clark, Dowlen, Elvish, Jones, Kindell, Swarbrick & Williams 2020;5).

Many different parameters might affect the present experience, and the possibilities of creating a timeless place, depends on emotional investment and mood of the receiver. If the user is not invested in the experiencing of something new to break routines, the experience will not have the same effect (TEDx Talks 2017;14:30).

According to Wunderlich (2012) can temporary experiences be a way of *representing* time in urban spaces (Wunderlich 2012;337). Wunderlich (2012) describes it as *place-rhythms*, which is a distinctive temporal experience, representing time in urban places (Wunderlich 2012;337), which is also described in the quote.

"It [place-rhythms] shares with it a particular set of sensory attributes, such as a vivid and distorted sense of time, the experience of flow, a vivid soundscape and rhythmicity. And, involves performance, is affective and offers meaning to urban spaces. The aesthetics of place-temporality can be defined close to the aesthetics of the performing arts more broadly, based on the notion of "art-form"   (Rolan Barthes 1985 in Wunderlich

STORYTELLING

Storytelling have always been used to transfer knowledge from generation to generation, which makes the human mind quite adapted to this way of presenting information and knowledge. Stories is a good way to connect to people.

People love to anticipate and as we do, we fill in the gaps on what we're seeing or hearing with our own knowledge and experience (TED 2021;6:58). Each individual has different interpretations, but storytelling can be used to guide the user through a set of activities.

The use of storytelling

In almost every search for the understanding of storytelling, topics such as digital storytelling, storytelling as a brand strategy, storytelling in literature, and performed storytelling are the ones dominating the field. Roughly speaking, this can be seen as traditional storytelling, with a narrator telling or showing a set of activities defined as the plot, and often leaves the receiver with some sort of moral or new insights.

Storytelling has a start, middle, and an end, taking place in a certain frame of time (Fludernik 2009;5).

Stories helps create continuously coherence for the perceiver which makes the existence meaningful (Madsen 2015-2016;108).

The secret of storytelling is, that it activates the way the receiver senses and makes the message makes a greater impact (Madsen 2015-2016;108).

The power of storytelling, both in branding, designing, or creating processes is that storytelling can be appealed through pathos rather than logos, which communicates to the feelings of the receiver, and might make a bigger impact (Hansen 2016;129).

Stories are according to the *narrative theory* a way for human-beings to create meaning in everyday life (ibid).

Stories help us to put single events in a meaningful whole, and helps us organise our previous experiences and make coherence of past- and future experiences (Hansen 2016;130). Storytelling is a way to create meaning, and according to Hansen (2016) is storytelling *sensemaking* (Hansen 2016;130).

The effect of storytelling

Storytelling does not only affect the way we perceive information or impressions of spaces, storytelling also affect us psychological. Storytelling affects our brain, and releases neurotransmitters and hormones such as vasopressin, oxytocin, serotonin, dopamine, and endorphins (TEDx Talks 2017;5:25). Dopamine affects focus, motivation, attention, and memory (TEDx Talks 2017;9.02) and Oxytocin makes you feel more relaxed and make you feel more empathy (TED 2021;4:48). Oxytocin is known as the *feel-good chemical*, and makes you feel more *human* (TEDx Talks 2017; 11:23), while endorphin affect creativity and makes people happier (TEDx Talks 2017;13:23).

Storytelling, in other words is a strong tool for affecting the receiver in a positive way. According to Eber (2021) show observations of the brain, how the entire brain is activated (and lights up) when listening to stories (TED 2021;3:15). According to Walter & Gioglio (2014) are visuals processed 60,000 times faster in the brain than text, and 90% of all information which is transmitted to the brain, is visuals (Walter & Gioglio 2014;16). This supports the popular approach of using storytelling as a tool to communicate. Stories leave the listener changed, and a good story keeps you in the moment by keeping your attention going (TED 2021;8:00).

Storytelling in a theatrical context

In theatre plays, the light and colours creates atmospheres to enhance the storytelling in the play. Light can tell when to be aware, when to feel sad, or when to be amazed. Light can be angled in a certain way to affect the dramatic in the play, light can highlight, and light can navigate.

Light in theatre, supports the spoken words, but operates in it's own way transforming and manipulates the space and introduces it's own language of form and space (Descottes 2011;74-75).

Light can create some sort of thematizing, since it communicates how a certain space should be seen and used, enhanced, and supported. As Pine & Gilmore (2009) states, an experience *without* some sort of thematizing, can be compared with a story without any listeners. A way to create themes is storytelling (Pine & Gilmore 2009;75).

To enhance the storytelling in experiences, the atmosphere is a key element. Atmosphere is an important element in the field of lighting design, whenever it comes to town planning, interior design or advertising. According to Böhme (2013) relates the use of light in architectural lighting design to the art at stage, and everywhere we go can be seen as something being staged (Böhme 2013;2).

Storytelling in an urban context

The atmosphere refers to the mood of the surroundings, which can affect a space drastically. If the atmosphere representing gloominess, dullness, and darkness, the space might be associated with boredom, uncomfortableness, or even scariness. On the other hand, if the atmosphere is representing bright colours, sunshine, and beautiful surroundings, the space might be associated opposite. The term atmosphere is used since the 18th century as a metaphorically for moods in the surroundings and for the emotional trace of a space (Böhme 2013;1).

Appia in La Revue (1904) says that it is not about creating an illusion of a forest, but it's about to create an illusion of a man in the atmosphere of a forest (in Palmer 2013;147). In outdoor spaces, there are already a story of the space, but not necessary a told story. In theatre, stories are created, while in urban spaces they already exist. Some places, according to Augé (1995), is called *non-places* which is a place without a story, and becomes a generic and homogeneous space, leaving no impressions of the users (Augé 1995;94). Storytelling in an urban context refers to the history of surroundings, but can also include new stories, inviting to a certain behaviour or use of the space.

METHODOLOGY

Overall, different methods have been used, trying to understand the phenomenon of time, the effect of light, and how to tell stories with light. Through literature reviews, scientific papers, observations, and tests, this thesis takes a phenomenological stance, in the understanding of the phenomenon of time and stories of urban places.

Theoretical thought & approach

This approach of this thesis is inspired by the *Double Dimond Model*, which is a process model used for problem-solving, and design development (Design Council 2022).
The process works both with *divergent* and *convergent* approaches, and is divided into 4 overall steps, defining each step in the process (figure 4).

Figure 4: The Double Diamond model
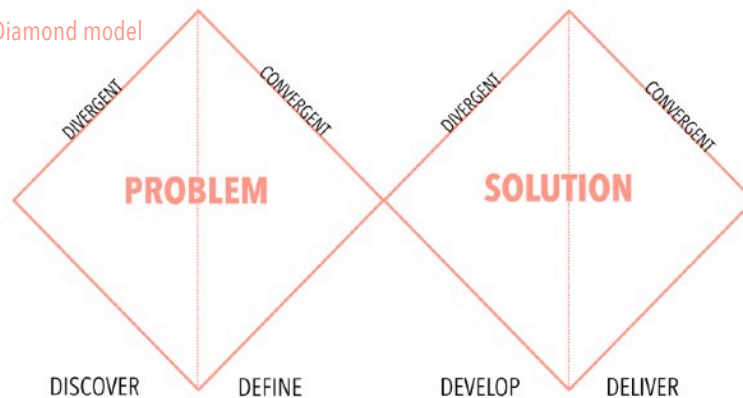
The divergent phases are about idea generation, problem-solving, and brainstorming with an open mind-set, exploring the topic. The convergent phases narrow all information from the previous phase down, reaching for one well-defined solution. This thesis is divided into the four steps in the process model (figure 4), which is merged with the *Design Experiment Model* (figure 5). The Design Experiment Model is a model that combines the three scientific fields; natural science, social science, and humanity, and divides the process into five overall steps (Hansen & Mullins 2014;619).
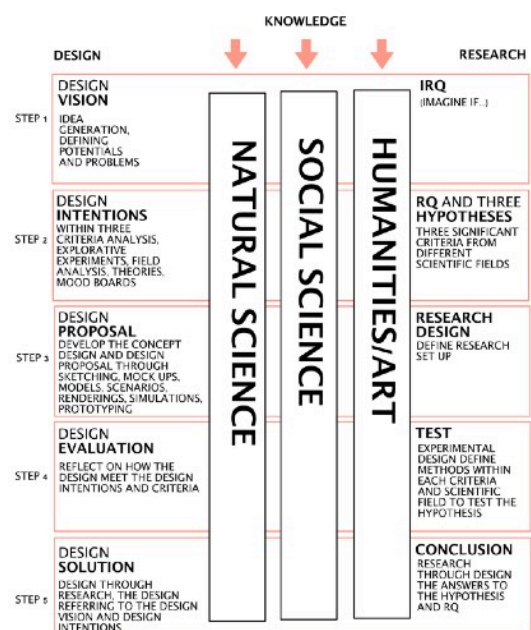
Figure 5: The Design Experiment Model

The steps of the Design Experiment Model, is then combined in the process model for this thesis, as seen in figure 6.

By including both of the models, it makes the process of this thesis easy to follow, with a frame to organise the structure.

The *Discover* phase is an open phase, where visions, ideas and literature are used to guide the process towards some sort of problem or interesting theory. The phrase was quite important for this thesis since the understanding of storytelling and time are complex concepts and needed a broad understanding. This lead to the *Define* phase where topics chosen for further investigation was chosen based on areas of interest including Urban scenography and colours affect on time. This was in the *Develop* phrase tested, through three experiments testing how colours can affect our perception of time. The knowledge from the experiments, previous studies and literature were combined in visualisation of composition and colours, in a discussion of how light can tell stories (the deliver phase).

The approach of the Double Diamond model links to the approach of PBL, which the Design Experiment model is based of. Problem-based learning (PBL) is a learning process formed by idea generation, problem analysis, problem solving, design and implementing solutions (Hansen & Mullins 2014;619). The Design Experiment model focuses on a transdisciplinary approach, in an understanding of problem solving (Meeth 1978;10).
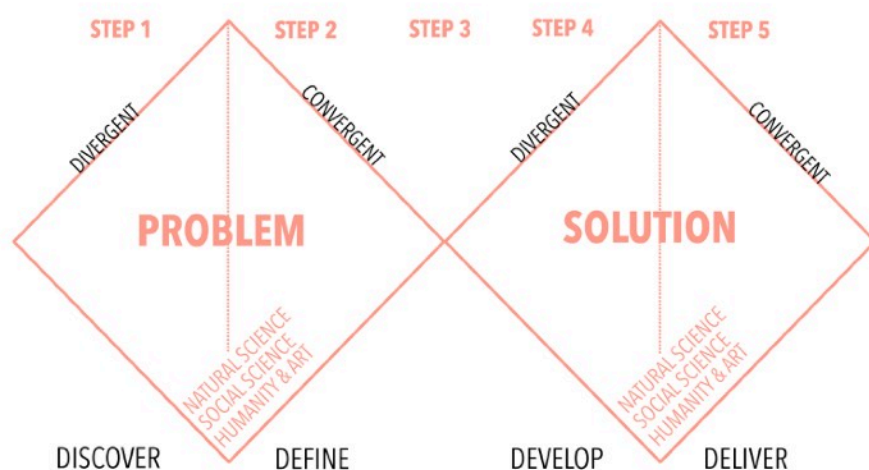

Figure 6: A combination of The Double Diamond model, and The Design Experiment Model, illustration the process.

The transdisciplinary approach combines knowledge, methods, and theories from different field of science, and make it possible to go in depth with problem-solving, and to get a deeper understanding of the topic. By using a transdisciplinary approach the gathering of literature, theories, data, and results are all time considering all fields of science, which gives a broader understanding of the research.

Research process

The research process has overall been a context led research, where the context defined what to research (Lucas 2016;11-12) (figure 7). To start with the research process was quite open, trying to understand the core of the topic, where all of the relevant material related to the topic was gathered (Lucas 2016;48). Most literature was found during a chain-search, where the sources of scientific articles were used to gain more knowledge and understanding. Reports, books, videos, and scientific articles were used as literature, to gain a broader understanding of each separate section and more insight in the research question.

Practical methods

The overall method for this thesis relates to phenomenology, which is the study of "*structures of consciousness as experienced from the first-person point of view*" (Zalta 2003). Phenomenology is about experience things, and the meaning it has in our experience. Phenomenology studies the structure of various types of experience; perception, thought, memory, imagination, desire, emotion, and volition to bodily awareness (Zalta 2003).
Phenomenological pursues familiarity and perceived emotions in experiences (Zalta 2003), why a phenomenological approach might help understanding the perception of time, while experiencing an experience.
This thesis uses the phenomenological approach by the experience of the individual.
The overall method for this thesis was deductive, since theories from scientific papers were used to frame the experiments and tests.

Experiments

Transdisciplinary approach
Prospective approach
Time estimation
Questionnaire (Multiple-choice)
Focus group
Paintings

CONTEXT

Research question

Transdisciplinary approach
Previous research
Literature

Pre-analysis

Participant observations
Trace tracking
Measurements

Findings

Design visualisations

Illustrations
Literature

Figure 7: Illustration of how different methods used through the thesis. Showing how each step is leading to the next phase.

According to this thesis both qualitative and quantitative research methods were used. Qualitative research is often used to get a deeper understanding of subjective experiences and factors, rather than absolute understanding (Lucas 2016;36). Quantitative research is measurable, related to objectivity, and tries to "*find truths build on tendencies*" (Lucas 2016;37). Qualitative methods included questionnaire, group discussion, and illustrations. The quantitative methods were time measurements, statistics, and measurements.

Also in the pre-analysis both qualitative and quantitative were used to get a deeper understanding of an existing urban space, the research question can relate to.
 The pre-analyse was based on Spradley's *Participant Observations (1980),* where his 9 dimensions were used to observe the spaces. Three out of nine of his dimensions was chosen (appendix 1). As tool for the participant observation, methods from Gehl & Svarre (2013) were used to create a simple template for each space, making sure every data needed was collected. Participant observations, impressions, and illustrations were used as the primary qualitative methods, while time measurements, lux measurements, trace tracking (movement), calculations, and counting were used as primary quantitative methods.

Methods for testing

For understanding how light can affect the perception of time, three tests were created linking to each field of science and referring to design research. The tests were divided into; the *Lab*, the *Field*, and the *Showroom*, which gives possibilities to use different methods for the specific purpose. All tests had a prospective approach, where participants were aware that the tests were about measuring time. The *Lab study* focuses on the scientific approach, by the aim of gathering numbers representing the estimated time. Each participant was asked to point out when 45 seconds has passed, while being exposed to different colour sequences in VR-glasses. The time was notated, and the differences between the measured time and the estimated time was compared and presented in statistics. Statistics were chosen, since it's a good visual way of presenting data and makes it easy to compare amount the different sequences. The *Field study* focused on a context-based approach, testing if an outdoor context in colours, can have an influence on the perception of time. The test was therefore made in an outdoor setting.

The test was based on different time sequences, where participants were asked to guess the duration of time in each colour scenario. These results were as in the Lab study compared with the measured time, to create graphs showing their estimations. After the test, a questionnaire was fulfilled by each participants, structured by multiple choice, to make the participant reflect of their experience and how they perceive the different light scenarios. By including both qualitative and quantitative methods in the Field study, a better understanding of the results might occur. The *Showroom study* focuses on subjectivity and phenomenology, where questions, debate, and painting were tools for understand the participants experience.

Overall the three test included both qualitative and quantitative methods, depending on the specific test. Qualitative methods were used through a questionnaire in the Field study, and through a group debate and paintings in the Showroom study.

After each room in the Showroom study, the participants were asked question, when asking them to rate their experience of time. This method can exclude personal observations, or behaviour that hadn't been considered before the interview and experiment. On the other hand this way can structure the results, making sure the needed data are collected. The group debate had not a structured form, which gave the participants opportunity to go into more details based on their previous rating. Quantitative methods have been used to gather the estimated time of the test subjects and make statistics of the results.

The Lab experiment was tested on a test person before the actual experiment. This was to make sure the time duration, technical solutions, and theory was actual working, and representing the wished outcome.

All participants were found in personal networks, and the number of participants and the relationship to the them, affected the validity and was therefore not representative.

The three tests were made in a short period of time, which resulted in limitations and pitfalls, which also affected the results. The reliability was also affected, since parameters such as noise, concentration levels, and changes in light conditions might have influenced the results.

After the three test, a design proposal was made for trying to understand how the approach of storytelling can be used, when doing outdoor lighting design and urban scenography. The design proposal is based on literature, representing the theatrical context and the architectural context.

Max Keller (2006), a worldwide known lighting designer in theatre, is representing on-stage, and how composition and colours can be used to tell stories on stage. Hervé Descottes (2015), a worldwide known architectural lighting designer is overall representing off-stage, and how composition and colours are used in architectural lighting design.

Richard Kelly (2008) hierarchy of light was used to understand how to include different placements of light, and how these creates different atmospheres. These approaches are then combined and discussed in the understanding of how to tell stories with light.

STEP 2

DEFINE

OUTDOOR SPACES &
URBAN SCENOGRAPHY

Based on the theoretical research; connecting time, storytelling, and created experience - this section will focus on, how to merge these topics and translate them into an existing urban space.
This case should work as a link between the theory of urban scenography and an existing outdoor location, hopefully helping the reader to relate the knowledge into a specific space.

BUS STOPS

Urban spaces can according to Augé (1995) be divided into two groups; *places and non-places*. Places are commonly related to something the user can relate to, a place which have some historical elements, or somewhere with a characteristic identity (Augé 1995;77). Non-places, on the other hand, are spaces without identity, relations, or history, but are nameless and faceless (Oxford Reference 2022). Non-places are generic places likes bus depots, train stations, and airports (Augé 1995;94).
The definition of non-places can be considered as places without a story.

A bus stop is often a generic place, inviting to a common behaviour and common expectations no matter the location. Bus stops in Copenhagen have almost the same homogenic design with the same three spots in the ceiling of the bus shelter, for the only lighting solution – and the behaviour while being around the bus stops are almost equal. The interesting about using a non-place for this thesis, is that the space yet has no story to tell. Since the space is generic, without specific relations or history – it makes it possible to create a new story and use a generic place as a bus stops to change or transform the users. By using a non-place, it might provide unexpected experiences, which might contribute to small everyday memorable experiences. If the boundaries of a space are visible for the user, the user will feel more comfortable (Moyer 2005;19), which make the bus stop as a perfect fit, where the small generic space can be used to represent a broader understanding of the waiting experience and time perceived in outdoor settings.
To understand how storytelling can be used to enhance non-places, it's necessary to understand the behaviour within the waiting experience. Therefore, a small pre-analysis was made to understand how a generic bus stops can be transformed into urban scenography.
The pre-analysis was also made to understand the duration of waiting time and activities at bus stops. The observations were made in the field, like a *common traveller*, which according to Lucas (2016) will avoid second-hand observations or preconceptions (Lucas 2016;73). According to Spradley (1980) a participant observation is "*unseen but a way to think as an observer*" (Spradley 1980;53).
According to Jain (2017) can an observing of the space for the first time, by feeling its presence and relation to the time spent, be a way to define the user's relation to the space and its characteristics (Jain 2017;2). This perspective fits to the purpose of the pre-analysis, and the approach of the observations.
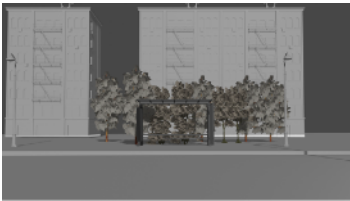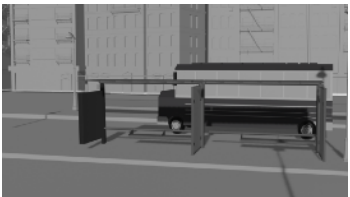
Pre-analysis

To understand the behaviour of the users in bus stops, different observations were made.
During tours around bus-lines in Copenhagen, some similarities were found in the placements of bus stops, which resulted in 5 categories of bus stops according to their location (table 1).
These categories were used to understand pattens, potentials and challenges of each category.
The route of bus 6A was chosen for observations since it included all 5 categories.
In each of the 5 bus stops observation-methods of Spradley (1980) & Gehl & Svarre (2013) were used.

Table 1: The categories of bus stops

	ILLUSTRATION	LOCATION	CHARACTERISTICS
1		Placed in front of an empty space (park, parking area etc).	• Contrasts of light • Exposed during dark hours • Open space
2		Placed in front of, or really close to residential buildings (or shops)	• Overview • Often activities in building near by • Often in busy traffic zones
3		Placed in front of, or really close to bushes, group of tress, or "Hideouts".	• Low visibility during dark hours • Close to nature • Big contrast from day to night
4		Placed in central reserves (surrounded by traffic roads)	• High traffic zone • Overview • Often more people
5		Placed in front of a train station (or in continuation of)	• Busy traffic zone • Often high activity • Often many people

Methods

Spradley (1980) suggest some categories to focus on, when during participant observations. The categories, called *The 9 Dimensions*, are a way to do observations focusing on specific factors. The dimensions should help the observer tune in on specific observations and raise the level of attention (Spradley 1980;56).

He describes it as a tool for the observer, to use himself as a research instrument (Spradley 1980;57). 4 out of the 9 dimensions were chosen to observe the bus stops (appendix 1), and included: Actor, Event, Time, and Feeling.

Actor was chosen to observe the users of the space, and *Event* was chosen based on activities in the space, and how people behave during their waiting time. *Time* was chosen based on the understanding of the time spend in the space, and the *Feeling* was chosen based on the subjective aspect, and how the waiting time can be affected based on different feelings of the users. The dimensions were chosen to get an overview of the current social situation (Spradley 1980;78).

To do the observations of Spradley – Gehl & Svarre (2013) was used as practical measurement tools, helping the observer to structure the observation (Gehl & Svarre 2013;30). Quantitative and quantitative methods were used, and all included in one template, helping to observe each space (figure 8). Pictures were taken, to get a deeper understanding of the space, and the lighting design.

Figure 8: Showing the template used for each observations in the bus stops.

Equipment

- Luxmeter
- Pen
- Template (day & night for each case)
- Camera
- Watch (time registration)

Procedure

Each place was visited twice at the same day (during daytime and dark hours), on a Monday.

Before the actual observation, two templates for each bus stop were made for observations and counting, representing daytime and dark hours (figure 8).

The observation-methods were chosen based on the idea, that all the different components, together will leave a better understanding on the use and behaviour.

Each space was observed in a time range of 15-20 mins, based on the average waiting time between the busses at 6 min.

Observations

The observations were used to get a quick overview of the level of activity, patterns of movements, and differences during daytime and dark hours (appendix 2).
Most users place themselves around the cover, either standing or leaning next to it. Other users place themselves near the bus zone, for shorten the distance when the bus arrives. Some users place themselves on the bench placed inside the bus shelter.

Often it's seen that the bench is mostly used by individuals or groups, but rarely by unfamiliar users at the same time. Only elderly people use the bench even though it's already occupied.

The overall acts contains of listening to music (wearing headphones), talking in phone or using their phone in some way. Common activities were conversations between groups or pairs, and walking around within the space, to fill in the waiting time. The actual waiting zone was defined as a big circle around the bus shelter, including the pavement, cycle paths, and areas nearby, depending on the location.
The weather was good, which affected the mood in the space and the users seemed comfortable and energised during daytime. During dark-hours the atmosphere was changed, and all bus stops on the route of 6A was quite gloomy and dull.
The behaviour also changed during dark-hours were users were more tend to travel alone, with no conversations.
People waited in average 4,4 min, with no differences compared to daytime and night.

The observations showed how users have a common behaviour in all the spaces, which supports the idea of bus stops being a non-place. The deviation in behaviour seems to depend more on the specific passenger and preferences, than the surroundings.
Although the bus stops were busier during daytime, which might indicate the bigger need for public transportation during the day. Some of the bus stops were empty, and almost all of them with few users during dark hours, and almost all places were bad lit.
The use of the bus stop during daytime and dark hours can vary of many factors, which these observations didn't focused on, but gives rise to curiosity to explore and analyse the waiting time even more.

URBAN SCENOGRAPHY

Urban lighting designers focus either on the functional light or the atmospheric light, or a combination of both. Urban lighting design has in recent years become an important tool for enhancing urban environments and outdoor spaces. Well-lit places can enhance orientation and navigation through a space, enhance the feeling of safety, and highlight areas. No light or bad lighting creates dark corner, low visibility, and can end in uncomfortableness of the users.

The understanding of scenography

McKinney (2022) states in an online talk, that scenography is about connecting bodies, human and non-human (Aberystwyth TFTS 2022, 3:30).
Urban scenography is based on an embodied experience and the connecting between body, environments, and materials (Aberystwyth TFTS 2022 4:39).
Böhme (2013) talks about characters of atmosphere, which defines how atmospheres communicates a feeling to the subjects (Böhme 2013;2). Scenography can be a tool to recall common experiences of spaces connecting to subjective feelings through atmospheres (Böhme 2017;160). Therefore, producing atmospheres is valuable not only for practices, but also in theories.
The term scenography originally refers back to the twentieth century in Eastern Europe, where the *scena*, was an impression for a visual construction of space (Jain 2017;1).
Danila Korogodsky, a scenographer from Russia, explains scenography as:
"[Scenography is about] building poetic spaces where stories can happen the most relevant way" (Howard 2009;XVIII).
Howard (2009) defines urban scenography as: *"[…] the occupation of formal and informal performing spaces – encourage spontaneous public gatherings and street theatre events"* (Howard 2009;9). This definition supports the theatrical perspective of using the urban environment as a stage. Urban scenography in this context seeks away from the traditional thinking of urban spaces as stages, but is referring to scenic architectural lighting, which creates visual landmarks or outstanding spaces. Scenography is more of a feeling or a suggestion rather than a particular message, understanding the bodied movements and interactions in the space (Aberystwyth TFTS 2022 22:00). Scenography is the visual construction of a space, and make visual poetry off the stage.

The approach of storytelling

Urban scenography can be a way to create scenic appearance of urban architecture. Light, colours, and materials can be used to transform a specific space or objects within a space. This makes urban scenography a useful way of merging theatrical lighting design with architectural lighting design. The storytelling approach, or the *lens of storytelling*, can be used to design urban scenography. By focusing on how the space can tell stories, and rethink the way the space is perceived, the approach of storytelling can help lighting designer design urban scenography including the phenomenon of time.
Storytelling by itself is more an approach to use, than a tool.
The approach of storytelling might help the lighting designer create artistic places, with all the good effects of storytelling and small everyday experiences, translated into urban scenography.

Telling stories with light, may already be a used tool in the lighting design field, since existing urban lighting designs tells a lot of stories. Illuminating a building from below, tells a story of a dramatic place, enhancing its great-fullness and power, while a building illuminated from above creates stories of a natural place, inviting and inform the visitor. Light already tells stories, with its angle, placement, colours, intensity, and quality in architectural lighting design, on purpose or not. Stories known from theatre use the same tools to create atmosphere and to support the drama.

Basic principles when designing spaces are to communicate a purpose and invite to a certain behaviour, while urban scenography can be a way to elaborate and enhance the visual structure and impression of the space (Jain 2017;3). Urban scenography is a way to manipulate the space to *be sensed* (Jain 2017;3) and can be a way to tell stories in outdoor spaces. Urban scenography can be used as a tool for architectural lighting designers to see the urban space as a stage.
Storytelling can then be used as an artistic approach to urban scenography, which gives potentials for having the perception of time in mind, when designing outdoor spaces.
The approach of storytelling could be used as an instrument to trigger emotions and influence the feeling within the space.

Stories of spaces

A space can be seen as something having a living personality with a past, present and future (Howard 2009;2), which the urban scenography can enhance. The story of a generic bus stops might be diffuse and unclear, with no personality or identity – but creates also new potentials for the lighting design.
In cities, a lot of spaces left unloved, forlorn, and forgotten exist (Howard 2009;8), which make potentials of engaging, inviting or inspire users.
A forgotten space might be a generic non-place, with no clear storytelling.

Almost everywhere we go, light is used to communicate to us. Either if it's navigation or nudging light, that engage you to follow a specific path or direction, or light as a signal or sign to tell you to be aware. The power of light is, that it communicates in a silent way.
It tells a story that is up for the individual audience to interpret.
When designing urban scenography elements from the theatrical context and the architectural context is included, communicating through elements of light and dark, colour, texture, structure, space volume, scale, pattern, rhythm, and temporality (Aberystwyth TFTS 2022 29:00). The certain space should consider the surroundings, which also indicate that the location of urban scenography should support the overall history and purpose of surroundings. City elements becomes obstacles for the moving body, influencing the route and the rhythm of the walker (Lavrinec 2013;22).
Howard (2009) argues that a theatre is not just a place you go to, but a place you go *through* (Howard 2009;8). An urban space in a city should be seen the same way.

Urban scenography can be designed according to the small- or big scale of the surroundings or the masterplan. Urban scenography considered in a masterplan level can enhance identity or coherence between spaces, creating an inspiring path through the city. Wunderlich (2008) describes the walk through the city as performing *space-time*, which is made of social everyday activities merged with natural dynamics and perceived tempo of the surroundings (Wunderlich 2008;2).
According to Lavrinec (2013) has a constellation of "*urban elements of a narrative structure*", which make a walk through the city become a speechless story, but with same results as a speech act (Lavrinec 2013;22).

Sundbo & Sørensen (2013) uses the term *in-between* spaces, which are spaces where the premises of everyday life are put on hold (Sundbo & Sørensen 2013;453), linking to non-places, where the story of the generic space is not yet told. Sundbo & Sørensen (2013) argues that these in-between spaces have potentials of transformative experiences, changing the way we perceive the space (Sundbo & Sørensen 2013;453). By paying more attention to these places and their qualities, it can link to unexpected experiences, and small memorable experiences.

When designing urban scenography, the space is manipulated to either provoke or evoke (Jain 2017;1). It is about recalling feelings and make the user or audience react (ibid).

In a quote of Pallasmaa (2005) he describes how powerful architectural experiences allows the users to experience the slow flow of time, and make the perceiver vanish into a focus on our very existence and connecting to the art (Pallasmaa 2005;52):

"A powerful architectural experience [...] focuses our attention on our very existence, and as with all art, it makes us aware of our fundamental solitude. [...] Architecture emancipates us from the embrace of the present and allows us to experience slow, healing flow of time. Buildings and cities are instruments, and museums of time. They enable us to see and understand the passing of history, and to participate in time cycles that surpass individual life"

(Pallasmaa 2005;52).

Integrating the users

Howard (2009) argues that the scenography is incomplete until the performer steps into "*the playing space, and the space is dead until the performer becomes the mobile elements of the stage picture*" (Howard 2009;XXIV-XXV).

The actors support the atmosphere and guide the spectator into a certain mood.

The actors can make the stage alive.

One main difference between urban scenography and performances in a theatrical context is the division of actors and spectators. In theatre, spectators have either active roles, co-existing in the performance, or a passive role observing the act.

In built environments this division is not as clear.

The citizens or the users of the space can also have an active- or passive role, but the role can change immediately, often also un-noticed (Lavrinec 2013;22).

Spectators of urban spaces might be observers to the space, observing for a small time period, but can penetrate to a certain extent whenever wanted and become an active role.

The users of the space, can become actors of the urban stage, interacting with the space and become deeper associated with it (Jain 2017;3).

People create spaces.

The actor or user uses their body as an instrument to engage with the space.

Urban scenography is three-dimensional, where scale and volume impact the user, not as a layout but how the space is registered at eye level (Jain 2017;2).

An outdoor space is a 360-degree experience, where the user can interact and move through the space and experience the space through all angles.

"By disturbing usual everyday rhythms and trajectories, urban art interventions establish a reflexive distance from the routine choreography of the place and propose alternative scenarios of behaviour in public space"

(Lavrinec 2013;27).

The quote of Lavrinec (2013) links to the idea of creating outstanding public spaces, referring to urban scenography and how it distinguish from common architectural design. Lavrinec (2013) uses the word *micro-scale change*, which refers to citizens taking active part in the urban scenography by leaving, losing and sharing items in the public space (Lavrinec 2013;29). Urban scenography is about creating new points of attractions on micro-level and developing alternative scenarios of use of the place (Lavrinec 2013;30).
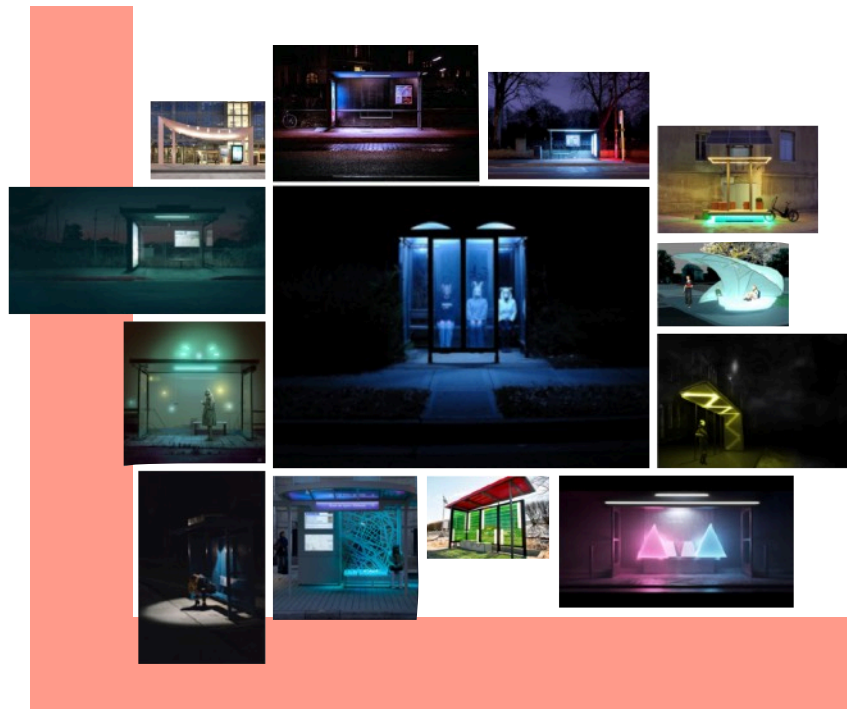
Figure 9: Moodboard showing different examples of how bus stops can appear as urban scenography.

The mood board (figure 9) shows different examples of existing or rendered bus stops appearing as urban scenography. Each bus stop tells a story, connecting the waiting experience to the surroundings and make it distinguish from the expectations of waiting time.
Light in this case is not only to inform, but for inspiring the user.

In a proceeding paper for a professional lighting design convention (PLDC) in 2019, Hvass & Hansen had discussed how scenography can help the lighting designer to get an understanding of the potentials of light in urban spaces. Hvass & Hansen (2020) describe, how to enhance the identity and social interactions of a space by analysing and designing architectural lighting scenarios (Hvass & Hansen 2020;1). Hvass & Hansen (2020) defined three potentials of light as: the *architectural potential* supporting the identity of the urban space, the *connective potential* supporting mobility, and the *social potential* supporting interaction between people (Hvass & Hansen 2020;1). These potentials of light were based on parameters defined as composition (linking to the architectural potential), Contrast (linking to connective potential) and form-shaping qualities of light (linking to the social potential) (Hvass & Hansen 2020;1). Hvass & Hansen (2020) suggest that using scenography as a framework can capture the complexity of urban spaces and consider the role of light in a different way (Hvass & Hansen 2020;2).

LIGHT &
PERCEPTION OF TIME

Light can be a tool to support scenography,
as well as urban scenography.
The use of different colours, compositions, dynamics, or
objects can transform a space immediately. The idea of using
storytelling as an approach to urban scenography linking to
the phenomenon of time, includes the investigation of how
light and colour can affect the perception of time - just like
storytelling does. Light doesn't speak direct words, but has a
silent language, inspired by the idea of *showing not telling*.
Colours can be a way to tell stories, or set atmospheres, where
colours can affect the relation, expectations, and visual
appearance of a space. The recent years scientific studies
showed how colours can affect human behaviour and
emotions. An agreement among scientist suggest that red has
an exciting effect on humans, while blue is considered
relaxing (Cook & Malloy 2014;438). The following section will
focus on previous research of how colours and light can affect
the perception of time, to get a deeper understanding how
light can tell stories. If colours can transform the way time is
perceived in a space, then the overall perception of time
within the space can be changed – and be used as an element
for designing urban scenography.

Colours & perception of time

Smets (1969) was one of the first to discover the relationship and connection between colours and the perceived time (Shibasaki & Masataka 2014;1).
Smets did an experiment by exposing subjects to a red and a blue light for 45 seconds each (Smets 1969;511). Afterwards the participants were asked to estimate the length of time in each coloured light.
The results showed that the perception of time was estimated shorter in the red light compared to blue (Smets 1969;512). Shibasaki & Masataka (2014) also researched in how colours can affect the perception of time. The results showed that the perceived duration was longer, when showed a red screen compared with a blue screen (Shibasaki & Masataka 2014;1-2). Another interesting finding was that men overestimated the duration of the red screen, while women didn't (Shibasaki & Masataka 2014;1).
The conclusion of Shibasaki & Masataka (2014) were opposite of the results by Smets (1969).

A study made by BBC Earth Lab (2019) also wanted to find the answer of how blue and red colours can affect the perception of time. They created three pots all coloured in either white light (control pot), red light, or blue light. 150 people were asked to stand in a pot illuminated in each colour, and give a sign when they think 1 min has passed (BBC Earth Lab 2019;0:41). The hypothesis was: Since the red colour might increase the sense of anxiety, the participants will perform less well, which will lead to under-estimated time estimations. Exposed to blue colour will create a sense of calmness, and will make the participants be better to judge the time, and be closer to the measured time of 1 minute. The experiments showed that colour can speed up time, but it's the colour blue who does it (BBC Earth Lab 2019;2:09). In the blue pod a minute in average lasted 11 second shorter than in the red pod (BBC Earth Lab 2019;2:16). They suggest, that a conclusion can be, that red will make us arousal and creates a fight-or-flight response slowing down time, to

In a PhD study from AAU Lighting Design Research Group, by Nielsen (2021), an investigation in how participants are able to feel the light was made, not only using the visual perception, but the bodily awareness. 26 dancers participated in the study and each dancer had to perform in a coloured illuminated space blind-folded and not, to observe if the behaviour of the participants would change (Nielsen 2021;156).

Nielsen (2021) observed how dancers moving in a totally white lit space, had controlled but faster movements (Nielsen 2021;167). In her test, participants experienced the blue scenario as calm and sensed a "*Silence*", "*dreamy*", and "*chilled out*" (Nielsen 2021;168). The participants in her study also explained how they felt coldness and were "*freezing*" exposed to the blue light (Nielsen 2021;169). In relation, out of all four lighting scenarios participants most frequently interacted with the space while being in the red spectrum of illumination, (Nielsen 2021;174). In the red scenario the participants felt more grounded, being in charged, and the feeling of power (Nielsen 2021;174).

In her study she found no significant differences between the non-blindfolded and blindfolded conditions, which might indicate that the participants were able to sense the differences of light (Nielsen 2021;178). This also indicates another parameter affecting the perception of time and how we perceive light and colours.

Visual stimuli & perception of time

Several studies also show how the perceived duration can change by using visual motions (Yamamoto & Miura 2012&2016). One study showed that the duration of fast-moving stimuli were considered to be longer, than slow-moving stimuli (Yamamoto & Miura 2012;1).

In their study Yamamoto & Miura (2012) argues that perceived duration can differ according to eye movement, emotion, attention, predictability, and various visual features (Yamamoto & Miura 2012;1). Furthermore, does studies show that the duration of moving stimuli is perceived longer, than the same duration of stationary stimuli (Yamamoto & Miura 2012;1).

Stimulus complexity also influences duration estimation. The greater the numbers of dots (Mo 1975 in Yamamoto & Miura 2016;56) or the faster the speed of rotation (Tayama, Nakamura & Aiba 1987 in Yamamoto & Miura 2012;1), the longer the time interval seems to be (Foley & Matlin n.d.).

RESEARCH QUESTION

Storytelling is a way to affect the perception of time, and as seen in previous research, so can colours. Previous studies does not agree which colour will make the perception of time feel longer, which makes room for more investigation, and makes it an interesting area to dig in to.
This research supported by tests, will try to understand how colours can affect the perception of time.

The observations of bus stop and an overall understanding of the waiting experience, leaves questions about how this knowledge can be used in urban lighting design inspired by storytelling.
As previous mentioned visual storytelling is about *showing, not telling* – why a relevant way of discussion storytelling might be by illustrating the use of light and how it can tell stories through light scenarios. This will be discussed in the *Deliver*-section.

The two areas of interest, how colours can affect the perception of time, and how light can be used to tell stories, are defined as a research question, guiding the findings and helps to define the overall structure of this study.

How can the perception of time in urban spaces be affected by coloured light, inspired by storytelling and urban scenography?

Design parameters

To answer the research questions, design parameters might help to achieve that. Based on previous research and definitions, the design parameters should link to urban scenography, storytelling with light linking to theatre, and perception of time. What all these topics have in common, as key elements, are colour and composition. Lighting design in a theatrical context uses colours and composition to support the storytelling and scenography, creating a certain atmosphere and mood. In urban scenography colours and compositions are used to distinguish from surroundings as well as consider the urban context. Perception of time can be affected by colours, as seen in previous studies, and the composition of light can illustrate time of day and create dramatic effects which can influence the waiting experience. The design parameters are shown in figure 10, and how the topics are connected.
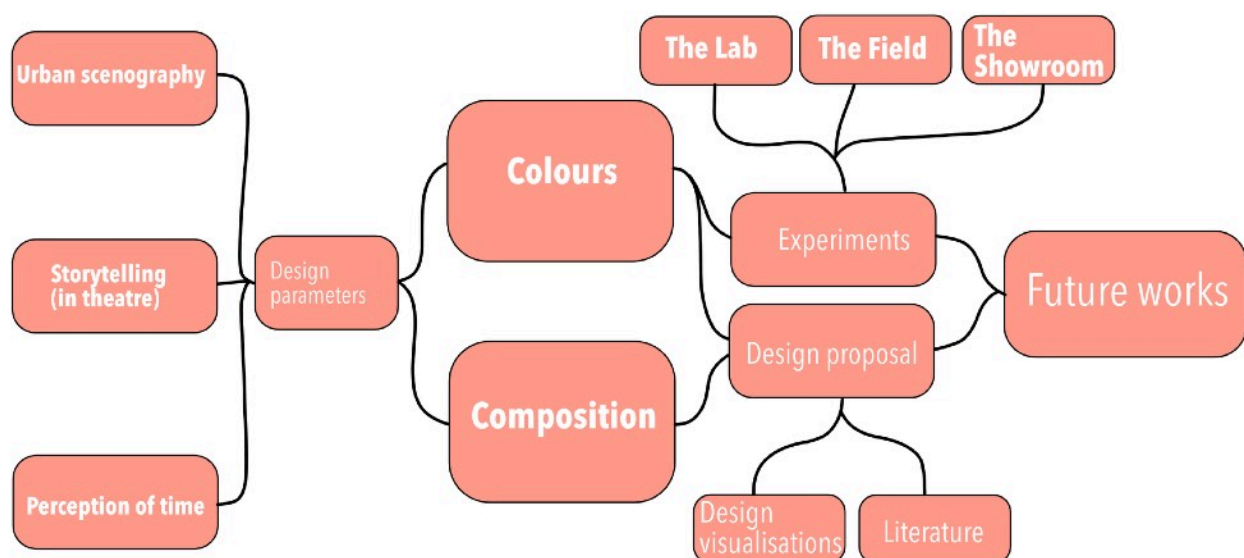

Figure 10: Illustration how the design parameters are connected to the overall thesis.

Colour as a parameter, will help to explore how colours can be a way to affect the perception of time, in a certain outdoor space. Since this design parameter is the fundament of this thesis, only experiments according to colours will be made. Composition will be discussed as well as colours, in the *Deliver* section.
A deeper discussion and experiments of how composition of light can affect the perception of time, should be for future works.

STEP 3

DEVELOP

THE EXPERIMENTS

To understand how colours can affect the perception of time, three experiments has been done.
The experiments should help understand how red and blue colours can affect, how the time is perceived.
This knowledge can be used to understand how light can tells stories which referring to a created experience affecting the perception of time.
The experiments were chosen inspired by research design, dividing the experiments into each field of science. The three tests made it possible to investigate in each field of science, and the different methods gave a deeper understanding of the findings. The lab study refers to natural science, the field study refers to social science, and the showroom refers to humanity and art.
For each of the tests, a hypothesis was made, linking to the problem statement and previous research. The methods for time estimation were also inspired by previous studies, and was based on a prospective approach, where the participants beforehand were informed that they were about to judge time duration (Avni-Babad & Ritov 2003;543). The same prospective approach was used for all experiments, trying to have some sort of connection between the three tests.
The three tests were made in a short period of time, and with few test subjects, to get a quick understanding of the effect of red and blue light.
This resulted in limitations and pitfalls, which affected the results.

THE LAB

The aim of the *Lab study* is to identity relationships designers might find interesting (Koskinen et al 2012;72). The Lab refers to bringing the object of investigation into controlled settings, and out from its natural environment (Koskinen et al 2012;75). This helps to isolate the objectives of the experimentation and gives the researcher an opportunity to focus on one thing at a time (ibid).
Constants is the keyword in natural science, which in this context is defined by equal time sequences and procedures, in an isolated environment.

Aim of the test

As already showed colours can affect the perception of time, even though people are not yet agreed, which colour has the effect of making the perception of time feel longer. In this experiment, the aim is to test if colours and movement have any effect on the perception of time. Studies show that movement can change the perception of time, and make the time feels shorter. This experiment will use knowledge from previous studies, to see if different coloured dynamic light will change the perception of time.
Dynamic light is in this case defined as moving light, in a visual sequence. White light is used as a control parameter, and the red and blue colours are chosen based on previous studies. The test will include sequences in static mode (not moving) and dynamic sequence in movement.

The hypothesis is based on the research of Yamamoto & Miura (2012) showing that the duration of fast-moving stimuli was perceived to be longer, than slow-moving stimuli (Yamamoto & Miura 2012;1) combined with the results of Shibasaki & Masataka (2014) and BBC Earth Lab (2019) showing that exposed to blue light made the perception of time feel shorter.

Hypothesis

By being exposed to the sequences with motion, the time perception will feel longer than the static ones, and the time sequence till feel shorter when exposed to blue light compared with red.

Equipment

- VR glasses (for blocking light)
- Smartphone (for VR glasses)
- Video renderings in:
    Static white
    Static red
    Static blue
    Gradient white (movement)
    Gradient red (movement)
    Gradient blue (movement)
- Blok + paper (register time)
- Stopwatch (measuring the time)

Procedure

The test subject was placed in a chair wearing VR-glasses. Each test subject should go through either sequence A, B, C, or D, with the only difference to be the order of the different colour renderings. Each sequence last 4 min, with 6 renderings in total.
The test subject was asked to guess when 45 seconds has passed, while a stopwatch was used to register the actual counted time.
This continues in all the sequences.
Each sequence contains a colour and either static or moving patterns. The colours (white, red, and blue) were either in a static mode, just showing a clear colour with no movement, or in a movement mode, where a pattern is shown moving in the chosen colour (table 2).
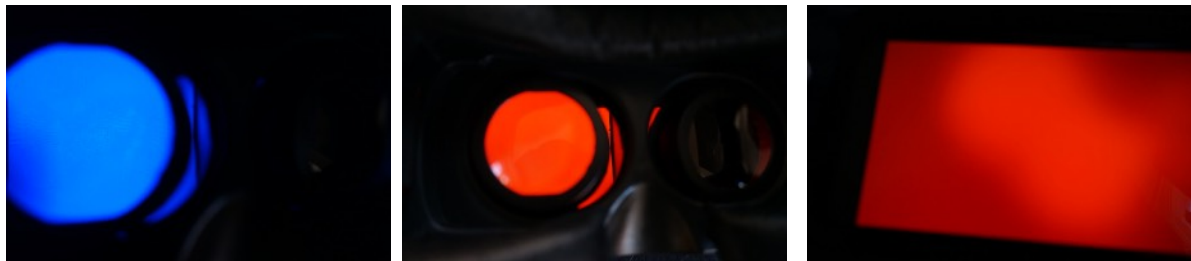
Picture 1: Showing the colour sequences in VR-glasses. A smartphone was placed inside, playing the video.

The colour renderings were made in the movie programme FinalCut (picture 2).
A clear colour was used for the static mode, and a pre-made sequence pattern was chose for the moving sequence. The colours for the moving sequences were chosen based on the same shades of the used primary colour (values). Shades of grey were chosen to symbolize a feeling of moving white colours.
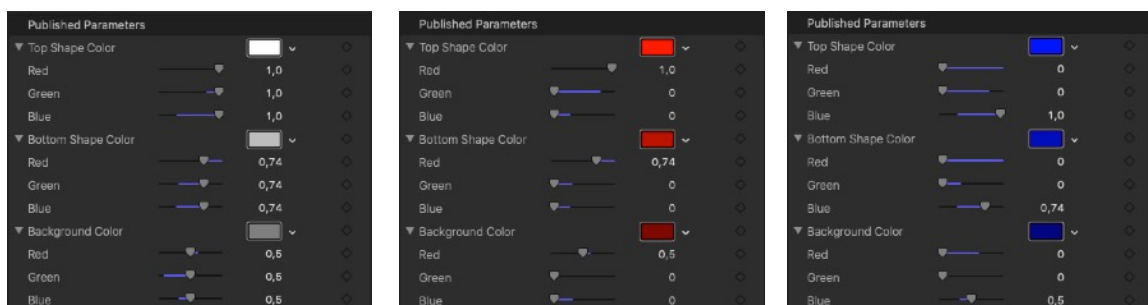
Picture 2: Showing the settings in FinalCut, when creating the sequences in movement

During the testing, the whole screen colour in the VR-glasses was either turned red (#FF0000;hue =0, saturation = 100, luminosity = 100) or blue (#0000FF; hue = 240, saturation = 100, Luminosity = 100) as coloured static stimuli. However, this study did not use a spectrophotometer to manipulate the colour of screen. Therefore, the colour might differ from the colour specified by the three dimensions (hue, saturation, and luminosity). The luminance of the screen wasn't measured either, but the intensity of the screen was equal for all the testing.

Sequences

Each test subjects were given a number, representing a certain order of the sequences. All test persons started with the colour of white, to somehow set the scene (as a control sequence).
The test was in Danish, since all participants were Danish.

Table 2: Showing the order and screen shots of each the sequence

Abbreviation	Ws	Wm	Rs	Rm	Bs	Bm
Explanation	White static	White movement	Red static	Red movement	Blue static	Blue movement

| Sequence	Order	Picture	
A	Ws, Bs, Rs, Wm, Bm, Rm	White static	
B	Ws, Rs, Bs, Wm, Rm, Bm	White movement	
		Red static	
C	Wm, Rm, Bm, Ws, Rs, Bs	Red movement	
		Blue static	
D	Wm, Bm, Rm, Ws, Bs, Rs	Blue movement	

Picture 3: Showing participants while testing

Participants

11 test subjects were tested, in the age of 23-65 years (2 males and 9 females).
The participants had no knowledge to lighting design, and with no previous knowledge about theory of colours and time.

Results
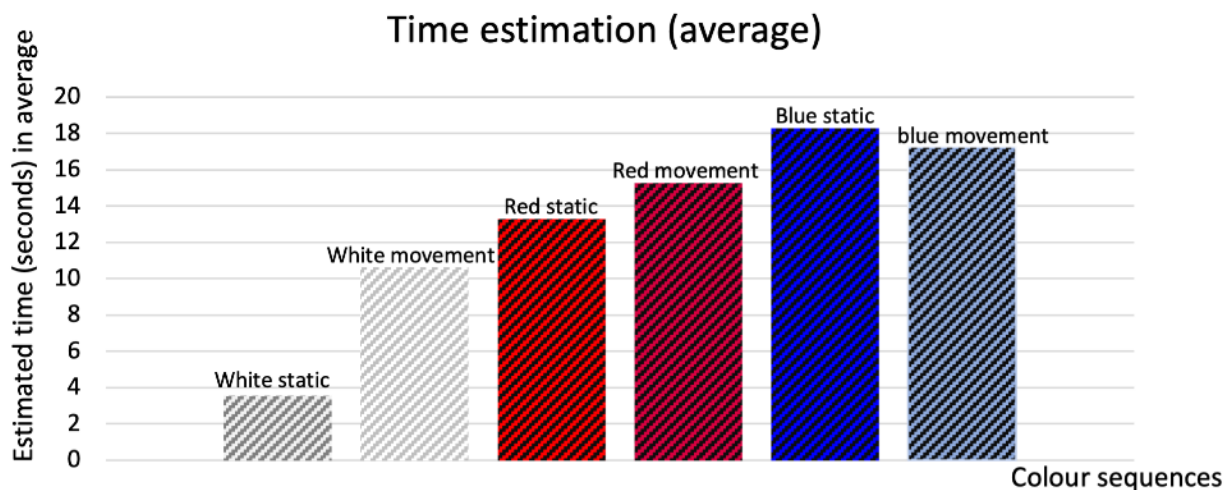
Graph 1: Showing the differences of the measured time and the estimated time for each sequence

Graph 1 shows the differences of time estimated and the time counted (se appendix 3). This means, that the estimated time for the static blue for example was estimated around 18 seconds longer, than the counted time in 45 seconds.
It shows that the blue colour was estimated longer in both the static sequence and the moving one.
The red moving sequence was estimated to be longer, than the static one which is opposite from the blue sequences. In the white sequences the one in movement was also estimated to be longest, compared to the static one.

Discussion

The results show that the blue colour was estimated longer compared to white and red. This supports the previous results from Smets (1969) but goes against the hypothesis. In this test it showed that the blue colour was estimated longer in the static sequence, but in red and white colour, the sequences in movement were estimated few seconds longer in average. The total of participants made it difficult to make any conclusions, since 11 participants are not enough for showing overall patterns. Anyway, this test shows interesting results for future tests. The test showed that in both the red and blue sequences (static and movement) 9 out of 11 overestimated the time, and only 2 out of 11 underestimated the time. The participants underestimating the time, estimated all time sequences as being shorter than the counted 45 seconds.

The differences in estimating the time in the white light were almost the same in the static sequence and the one in movement, but were estimated shorter compared to red and blue light.

This could be a result of white as being perceived more bored, than the coloured ones. This is based on test subjects' comments while perceiving blue and red colour. Some participants explained how the colours had some sort of effect on their behaviour. While perceiving the white light, no one was commenting the sequences in any of them. Participants described the red colour as affecting their pulse and alertness, while the blue sequences were described as calm, comfortable, and relaxing. The comments from the participants were not structured interviews but some participants wanted to share their experience voluntary.

It was difficult to avoid pitfalls, which might affect the results. One important issue was, that even though the test was made in a separate room, only including test subjects and tester, there were a lot of noise in the room. This might affect the results since distractions from surroundings were quite high. The mood or state of mind of the test subjects might also have a big influence on the results, as well as their expectations.

Some participants were quite concentrated and quiet, while other test subjects were distracted or had a hard time concentrate. The distracted participants had a hard time being quiet, which also influenced their time estimation. Generally, people tend to overestimate brief intervals and underestimate longer intervals (Zakay 1990 in Foley & Matlin n.d.). All sequences followed the same duration of time estimation, but how the colour can affect time might vary depending on the length of the test, which needs to be considered in future works.

The participants were not informed if it was allowed to count the time (in their head) or not. Almost all test subjects afterwards said that they counted the time, either by visualising the clock or by actual counting the seconds, but after a while they lost time counting and started mind wandering, especially in the red and blue light according to the participants own words.

After all sequences, the participants were showed their estimations for all of them. Their reaction was typically surprised, since they thought their estimations were closer to the counted time than it was. Since the test was made on a phone (placing inside the VR glasses) the settings were hard to control, and the low resolution of the videos made the experience not ideal.

Conclusion

The hypothesis stated that the sequences in motion will make the time perception feel longer. The results showed the opposite for the blue light, with the static blue estimated longest, compared to the blue sequence in movement.
In the white and red colour, the sequences in movement were estimated longer. To conclude the effect of movement on time perception, further investigations and tests need to be done.
In the hypothesis is also stated that the blue light will make the time perception feel shorter compared with red. In the results it showed that this was opposite, for both the sequences in movement and static.
The blue light was estimated to be longest, while the white light was estimated to be shortest.

THE FIELD

The *Field study* is about working with context (Koskinen et al 2012;89). Instead of bringing the objects into the lab, the Field study observes and research objectives in natural settings.

When doing field research, it allows to describe a space through exploring the social context. The approach of researchers in the field builds on theories of social interaction from psychology, sociology, and anthropology (Koskinen et al 2012;136). Architecture is constructed to serve the needs of people (Lucas 2016;15), and so must the lighting design. Social science can enhance an analysis by offering a wide range of methodologies to help understand the actual uses of the space, and the design the light to support this (Lucas 2016;15). The lab decontextualizes; the field contextualizes (Koskinen et al 2012;98). Field research focuses on context (Lucas 2016;70), and the real life is the focus.

Aim of the test

The experiment will focus on how coloured light, red and blue, can affect the perception of time in an urban context. In this test, only the colours (white, red, blue) are in focus, not the movement of light.

Based on results of the Lab study, it showed how blue light was estimated longer.

The hypothesis of the Field study tries to take the knowledge from the previous experiment, testing how it might affect in an outdoor setting.

The hypothesis is therefore inspired by the results of the Lab study and results of Smets (1969). Besides that works the hypothesis with how red colour can increase pulse rate and alertness (Cook & Malloy 2014;438) and can affect the behaviour of the user as seen in the experiment of Nielsen (2021).

According to Gustavo Avilés (2011) is movement in urban spaces not always associated with physical movement of light itself (in Laganier & van der Pol 2011;212). Movements of light in urban environments can be dynamics of contrasts, shades, darkness and light, it is not moving physically but either static (ibid). Therefore, movement from previous test was not included in this test, based on the idea that the urban setting will support with dynamics to the overall experience of the light scenarios.

Hypothesis

Red light will increase awareness, why the time will feel shorter exposed to red light compared to blue light in an outdoor setting.

Equipment

- 2 x DMX LED light (ADJ Ultra Go Par7X – battery driven)
- Light stand
- Pre-programmed colour scenarios (red, blue, white)
- Chair / bench
- Stopwatch
- Questionnaire (time estimations & questions of experience)
- Camera (take pictures of the experiment)

Location

Bench placed at Klerkegade, Copenhagen. 27th of April, 8-10 PM.

Picture 4: showing the set-up of the test, placed in an outdoor setting.

Participants

14 participants from the age of 23-65 years, including 11 females and 3 males.
The test subjects hadn't any experience in lighting design.

Procedure

Test subjects are placed on a bench (3-4 test subjects at a time) in an outdoor environment (in this case a street in Copenhagen).
The test subjects are exposed to three different light scenarios (white, red, and blue).
Each sequence lasts a certain duration of time, and the test subjects are asked to estimate how long they think, they had been exposed to the certain colour.
The time estimations are noted after each scenario by the test subject.
After all, three light scenarios, the test subjects are informed how long they actually spend in each colour (picture 5).

Picture 5: Showing the questionnaire (multiple choice) for further understanding of the participants experiences

The test subjects were afterwards asked to answer some questions about their experience (picture 5). The questions were based on the idea that red recall arousal and awareness, why the test subjects were asked to reflect on their experience, and what words they think fit best describing their experience. The words chosen was relaxed, tense, aware, and unfocused. Tense and aware were referring to arousal and awareness described in previous research about exposed to red light. Relaxed and unfocused were chosen based on representing the opposite. After choosing different words for their experience, they should answer which colour they felt as time perceived respectively fastest and slowest.

The time spend in each scenario was based on following schedule. Each group of test subjects are assigned either the number of A, B, C, or D.

Table 3: Showing time measured time for each scenario

| NUMBER	LIGHT SCENARIO	TIME
A	White	01:00 min
	Red	01:15 min
	Blue	00:45 min
B	White	01:15 min
	Red	00:45 min
	Blue	01:00 min
C	White	00:45 min
	Red	01:00 min
	Blue	01:15 min

Picture 6: Showing the LED fixture in different light scenarios

White scenario: R: 124, G: 127, B: 104 (chosen based on the perceived illuminance in the space, intensity, and colour temperature representing standard light in bus stops). Luminance = 1168 cd/m2.

Red scenario: R: 255, G: 0, B: 0.
Luminance: app. 1439 cd/m2

Blue scenario: R: 0, G: 0, B: 255. Luminance: app. 1348 cd/m2

The total amount of lux in the space wasn't measured and was constant changing since the experiment was done during transition hours.
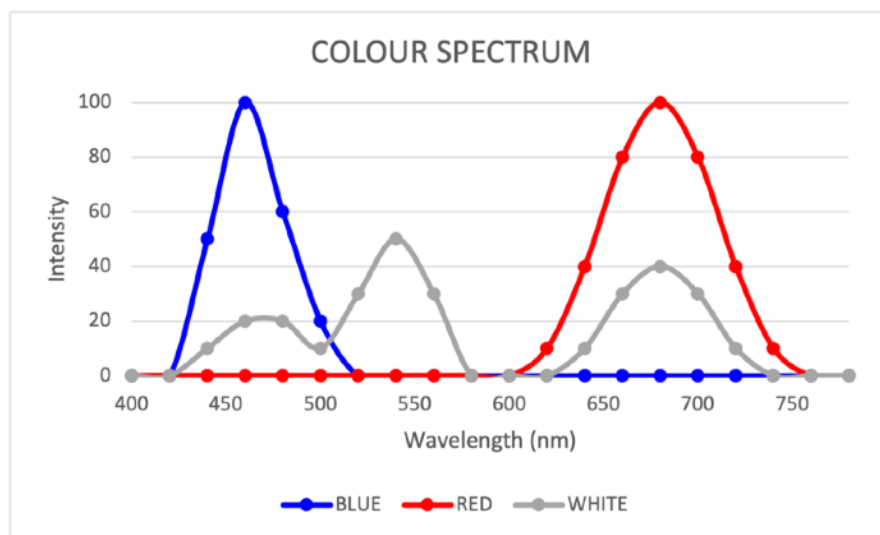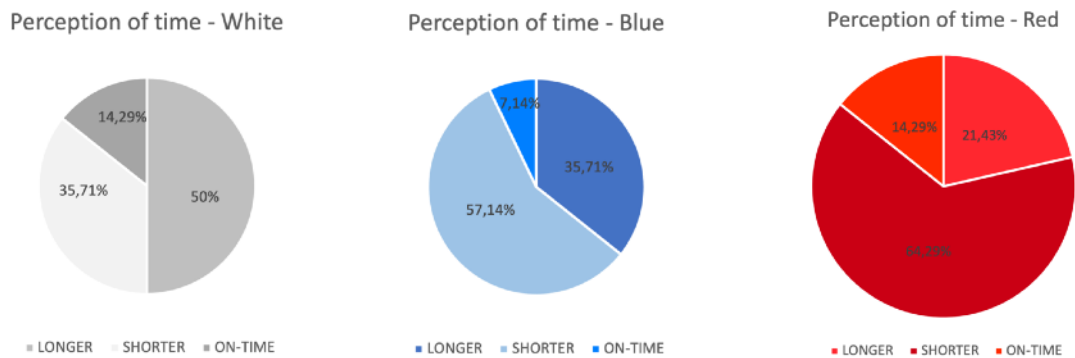

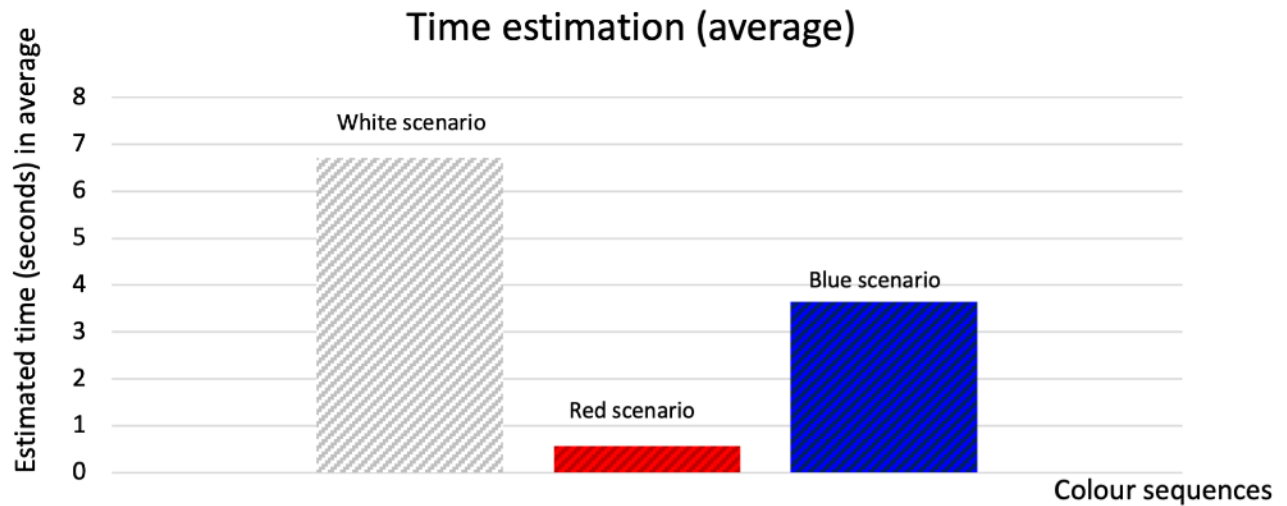Graph 2: An illustration of the colour spectrums for each colour.

In the graph (2) it shows how the intensity of the white light was not as high, as for the red and blue colour (which is also shown in the luminance level).
The values of red, green, and blue was chosen based on a scenario as close the feeling of natural white.

Perception of time - White

Perception of time - Blue

Perception of time - Red

14,29%

35,71% 50%

7,14%

35,71%

57,14%

14,29% 21,43%

64,29%

LONGER SHORTER ON-TIME

LONGER SHORTER ON-TIME

LONGER SHORTER ON-TIME

Graph 3: Showing how the differences of the measured time and the estimated time, according to each light scenario. The values show how many percentage of the participants either over-estimated, under-estimated, or was in time.

Time estimation (average)

White scenario

Blue scenario

Red scenario

Estimated time (seconds) in average

8
7
6
5
4
3
2
1
0

Colour sequences

Graph 4: Showing the differences of the measured time estimated in average, comparing each scenario

The results of the testing (5 tests in group of 3-4 participants) showed that the time estimated exposed to the red scenario in average shortest (appendix 4). 64,29% estimated the time as being shorter, than the counted time. In blue light 57,14% of the participants estimated the time as being shorter. 50% of the participants estimated the time in white light as being longer. This indicates, that in average the red light was perceived as shortest and the white light as longest.

In average the difference between counted time and perceived time was for white light 6,71 seconds. This means that the participants estimated in average 6,71 seconds longer than the measured time. For red light in average participants estimated the time as being 0,57 seconds longer than the measured time, and for blue light 3,64 seconds in average. In the questionnaire after the test, participants answered which of the scenario they felt most relaxed, tense, aware, and unfocused.

Most test subjects (11 out of 14) found the red light most relaxing, and 5 out of 14 felt the red light as unfocused as well.

9 out of 14 felt the white light as being most tense, and 7 out of 14 rated the blue light as recalling awareness. 7 test subjects chose to answer that the red light as being the one where time perception felt fastest, and 7 chose the blue light as the slowest one.

Picture 7: Showing the participants while tested

Discussion

The results show that the participants estimated the red light as being shortest, and the white light as being longest.

The test was made in April the 27th, starting around 8 PM. According to Time and Date AS[1] the sunset was at 8:39 PM, which means that the outdoor setting was not dark enough for the best perception of the different colours.

The white light was not visible before the last two tests, but for the rest, test subjects were asked to estimate the time in the current light setting, mixing the transition light and the illuminance from the DMX light. This might influence on the results and didn't give the test subjects the best light experience. On the other hand, the white light was chosen as a control colour, and the duration in the white scenario should either way represent a natural setting. The participants were anyway able to answer the questions, and expressed they felt a difference between the different light scenarios.

The white light scenario had a lower intensity than the red and blue light.

According to Hagen & Galetzka (2009) the time perception will feel shorter with low intensity than high intensity (Hagen & Galetzka 2009;137).

In this case this wasn't showed, since the white light with lower intensity was estimated to be longer than the compared scenarios. The outdoor setting was of course influenced by the level of darkness during each test but was also influenced by the surroundings. In the white scenario the participants estimated the time as being longest, which was the opposite from the test in the Lab study. In the Lab study the white scenarios were estimated to be shortest, which might indicate that both the way colours are visualised (light source or screen) and the surroundings might have an effect on the time perception. As indicated in the previous test, the time perception can be influenced by many different parameters. Since this test was made in groups, the concentration level was lower, compared to the Lab study.

It was difficult for the participants not to talk with each other, even thought they were asked to sit in silence.

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[1] https://www.timeanddate.com/sun/denmark/copenhagen?month=4

Another impact on time perception was the level of activity in the surroundings. Since the test was placed closed to a traffic road, the level of activity differs from each test. This might have an influence of the time perception since according to Ornstein (1969) will filled time intervals feel longer (in Foley & Matlin n.d.).

In the questionnaire each participant's own perception and experience was described. According to the hypothesis red light should increase arousal and awareness, and therefore affect the perception of time as being fastest. In the estimated times, red light was estimated as being the shortest. Also when the participants were asked in the questionnaire which light scenario they felt time as respectively fastest and slowest, 7 out of 14 test subjects pointed at the red light as being fastest. When asked which colour they felt respectively tense and aware, which according to previous research and the hypothesis should be the red light, the participants pointed that in white light they felt most tense, and in the blue light they felt more aware. The participants chose in average the red colour as being most relaxed.

This might indicate that either it's a question of definition or subjective factors according to the light. Participants described the red light as being warm and remind one of summer evenings. Others described the blue and white light as being cold, and two participants described the difficulties of staying concentrated since activities in the surroundings. According to Nielsen's (2021) investigating the feel of light, some similar findings were found, where participants described the blue light as giving a feeling of freezing, and red light was described as being grounded (Nielsen 2021;175).

Conclusion

The hypothesis stated that since red light increases awareness and arousal, the time will feel shorter to red light compared to blue light in an outdoor setting. The results showed that the estimated time exposed to red light was in average perceived shorter, than the blue light. The time estimated in red light was in average 0,57 seconds longer than the measured time, where it for the blue light was in average estimated 3,64 seconds longer. The statement about arousal and increased awareness didn't agree to the answers of the participants experience, but instead the red light was perceived in average as being relaxed.

The results are based on 5 tests in groups of 3-4, 14 test subjects in total, which might not lead to any conclusion, but rather results to discuss and further tests need to be done for seeing a representative overall pattern.

The Showroom study is about art and design and differentiate from natural- and social science (Koskinen et al 2012;133).

The study is about subjectivity, and it questions the way in which people see and experience, which changes through debate (Koskinen et al 2012;117). It is about using the stories of people rather than scientific research, and to get a deeper understanding of the concept (Koskinen et al 2012;118). Instead of observing patterns of the users, or statistics, the showroom focus on exposing, debating, and reinterpreting problems and issues (Koskinen et al 2012;128). The field of humanity can't be explained in one solution but works with ambiguity and conceptuality.

Aim of the test

The experiment differs from the two previous ones, since the experiment will took place in an already existing exhibition. The exhibition existed among others of three different rooms, one filled with colour and motion, one filled with white static light, and one totally black (appendix 4). The purpose of the black room tries to investigate in how absence of light can affect the perception of time, and how exposed to all white light, can affect it as well.

The aim of the experiment is to observe the effect of movement and colours compared with no movement and no colours (the dark and white room).

The aim of the experiment is to find definitive results, but to understand the experience of the participants.

This hopefully gives an insight in how colours might affect how we feel in a space, and how this can affect the perception of time.

The experiment somehow combines the knowledge and theory and creates room for an interesting debate of the feeling of time, effects of light, and bodily awareness. According to theory, the time will feel longer, when moving stimuli (Yamamoto & Miura 2012) and stimulus complexity (Mo 1975) will make the perception longer, which formed the hypothesis.

Since this study used the theory of moving stimuli as in the Lab study, this experiment will have the same consumptions, even though the results in the Lab test showed ambiguous results of moving stimuli and time.

Hypothesis

The time sequence will feel longer in the coloured room since stimulus complexity. The perception of time within the black room will feel shortest, since no visual stimuli.

Equipment

- Camera (documenting the experiment),
- Pen + paper (notes about their answers),
- Watch (to measure time)
- Paper + colours (for the painting afterwards).

Location

Current art installation
"Light&space"
at Copenhagen Contemporary[2]

Participants

7 participants in the age of 5-65 years, including 5 females and 2 males. Some younger participants were chosen for this experiment, to investigate in the differences of age and time perceived.

Picture 8: showing the participants in front of the Light&Space exhibition

[2] https://copenhagencontemporary.org/light-space/

Procedure

The participants will enter (see appendix 5)
- Coloured room: (10 min)
- White space (3 min)
- Black room (3 min)

After each room, and after the time in the previous space was revealed, the test subjects were asked to rate the experience on a rating-line from "*time passed quickly*" to "*time passes slowly*" for each room (figure 11).
The method is inspired by Joubert (1984) using magnitude estimation as a rating scale (in Foley & Matlin n.d.) The test was in Danish, since all participants were Danish.

After each room the test subjects were asked:
- Where would you place the experiment from "time passed quickly" to "time passed slowly" according to how you felt in the space? (figure 11)

TIME PASSED SLOWLY   TIME WAS "UNCHANGED"   TIME PASSED QUICKLY

Figure 11: Illustration of the rating system, where participants after each test rated and place themselves on the timeline, depending on the feeling of time passing slowly either quickly.

Picture 9: Showing when the 5 years old boy was asked about his experience

After all rooms, the participants were asked to paint their experience. The participants could decide either to paint the room which had the biggest influence on them, or all three rooms. On the back of the drawing, some keywords or a poetic description in relation to their experience was optional. While the test subjects were painting, a group discussion were made, tried to get a deeper understanding of their experiences.
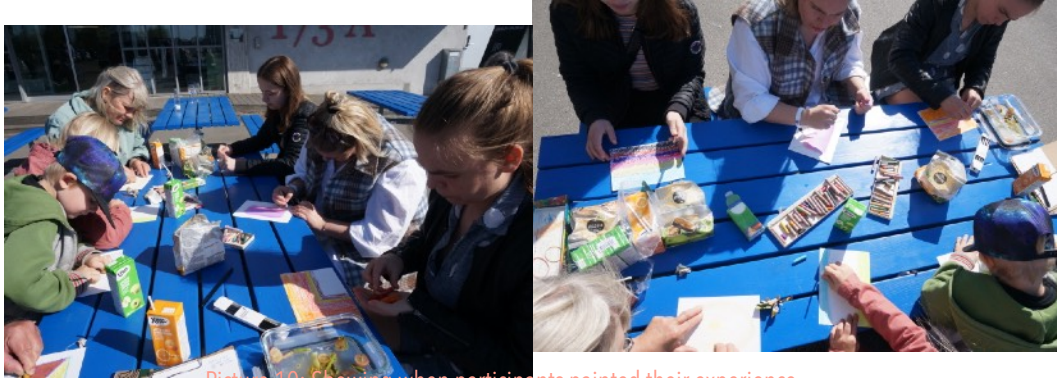
Picture 10: Showing when participants painted their experience
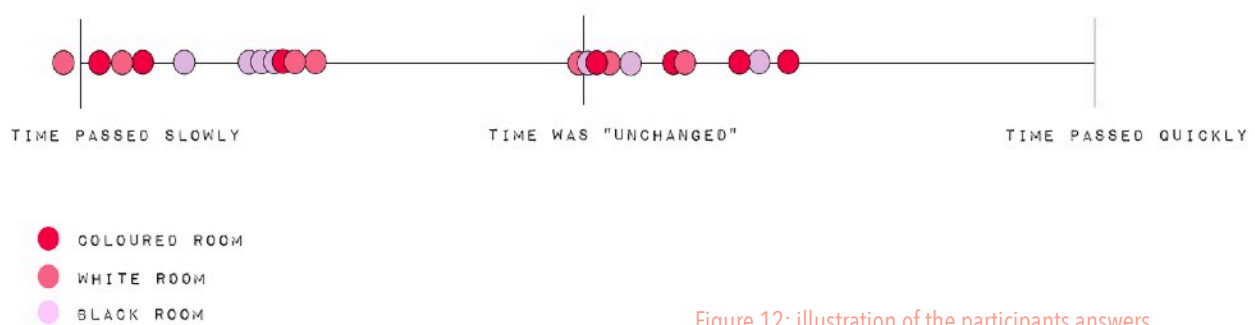
Results

Figure 12: illustration of the participants answers.

The results show that the time perception for each room was quite different depending on the individual (figure 12). In the coloured room 3 out of 7 of the participants perceived the time as passed more slowly, than the measured time. 3 participants perceived the room as passing more quickly than the measured time, and one perceived is almost as unchanged. 4 out of 7 perceived time as passing slowly in the white room, while 1 perceived is as passing more quickly. 2 perceived the time as unchanged. In the black room 4 perceived the time as passing more slowly, and 2 as more quickly, 1 perceived the time as unchanged. The eldest participants (woman, 63 and man 65) didn't vary much in their own judgements of time, but rating each room in the same area of the rating scale. The ratings by the eldest participations were not alike according to how the time was perceived. Overall the judgements were quite different, but all experiences were perceived in the same area of time, where the younger participants answers vary a lot from room to room. There were no significant differences of the time perceived and the age of the participant.
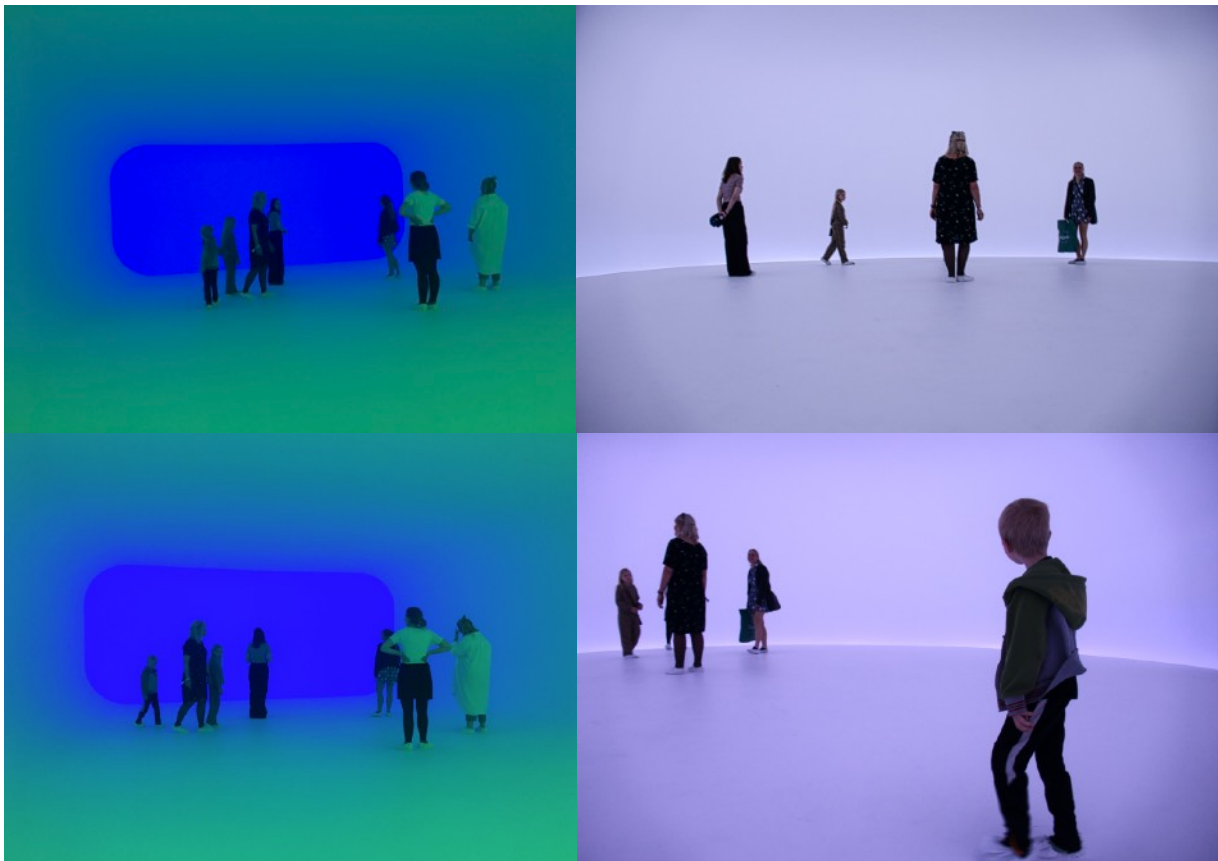
Participants, in their own words, experienced the white room as being *calm, timeless*, and most of the participant's favourite space.

The participants described the coloured room as being *intense, infinity*, and as *out of body experience*. In the coloured room, participants described it as getting the feeling of time, where the pulses of colours symbolize a development.

The dark room was described as timeless, calmness, and the feeling of being relaxed. Others described the black space as energy draining.

The words chosen for describing the spaces wasn't that different, but which room the words were describing was quite different. Overall, the participants did agree on, the coloured room as being most intense. These thoughts are also illustrated in their paintings (appendix 5).
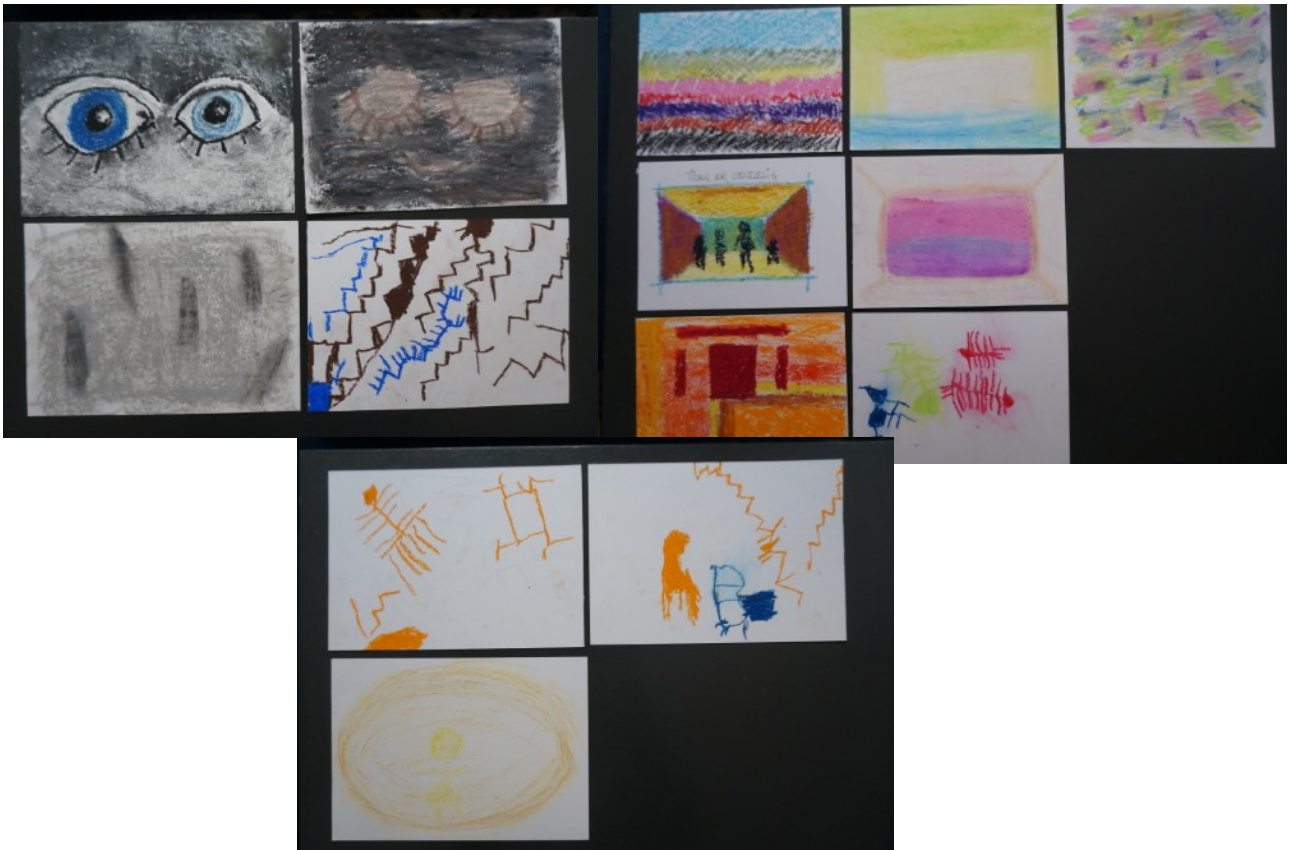
Picture 12: Showing the paintings of each room, made by the participants after the experiences

The following quotes show two descriptions from the participants.

"In the white space, it was like being inside my mum's belly. The black room was like when I'm dreaming, since it was totally dark" (Boy, 5 years old)

"I experienced being inside an egg. I wanted to lay down. I felt comfortable and a feeling of weightless, like I was flying. I wanted to stay there more; the time stopped" (Woman, 63 years old)

Discussion

The perception of time is quite subjective, which is also shown in the results.
Time perception can be affected by mood, previous experiences, age, and how the participants describe their experience. Also the understanding of time, and the question asked, might differ according to the age of the participants and subjective definitions.
The hypothesis states that the black room will be perceived as time passing more slowly, since no visual stimuli.

The results showed that both the black room, and the white room was perceived slowly, which supports the idea of no visual stimuli slows time. The black room differs from the rest, since the test subjects were more unfocused. Being in a total black room is not a common experience, which might cause why the test subjects reacted by talking and touching each other within the room.

Combing the data of perception of time, and the group discussion, showed that the white room was perceived as most slowly in average, supporting the descriptions of their experiences.
In the white room, there were no changes in stimuli, but the visibility was high.
This created a calm and relaxed experience.
The black room was also considered as slowly but not as far on the scale as the white room.
In the two spaces where time felt passing slowly, most of the participants felt calmness.
Two participants described it as a space, draining you from energy.
The coloured room was perceived as time passing more quickly compared to the other rooms, which support the descriptions of the feeling of pulsing and being quite intense.
The discussion was not recorded, only written notes.
Therefore, some statements or descriptions might be lost, also due to the translation.

Conclusion

The coloured room was perceived in average as time passed more quickly compared to the measured time. Both the black and white room were perceived more slowly, but rating the white room as being the one where time passed most slowly.

According to the hypothesis, the coloured room should feel longer, since the room offered a lot of stimulus complexity, why according to previous research (Mo 1975) show, that time will be perceived as passing slower. The results show that the coloured room was perceived more quickly compared to the others, which goes against the hypothesis.

The rating of the time perceived varied depending on the participant asked, which also makes it difficult to compare. In the hypothesis it also stated that the time perceived in the black room will feel shortest, since there are no visual stimuli (as a contrast to the coloured room).

The results showed that in average the black room was perceived more slowly, compared to the measured time, but the white room was perceived even more slowly in average.

The white room also offers few visual stimuli, since no colour and no movement.

The results only showed how the participants felt the time being in the three rooms, where no actual conclusions can be made. The aim of the test was to understand if there was any difference in the experience of rooms in different colours and absence of same and to get a discussion with the participants how the different rooms made them feel.

SUMMARY OF THE EXPERIMENTS

The three tests showed small differences in how different colours might effect on the perception of time. The experiments showed that the perception of time, when exposed to blue light, was perceived as longer compared to red light.

These results were shown in both the Lab study and the Field study (graph 5).

In the Lab study blue light was perceived as longest, while the white light was perceived as shortest.

In the Field study the perception of time felt more slowly within the white light, and fastest in the red light. Even though the results showed something else, the participants in average (7 out of 14) expressed that the time perception within the blue light was perceived as being longest, and shortest for the red light.

This shows that the perception of time may differ a lot, not only influenced by the colour, but also other factors which it not shown in the test itself.
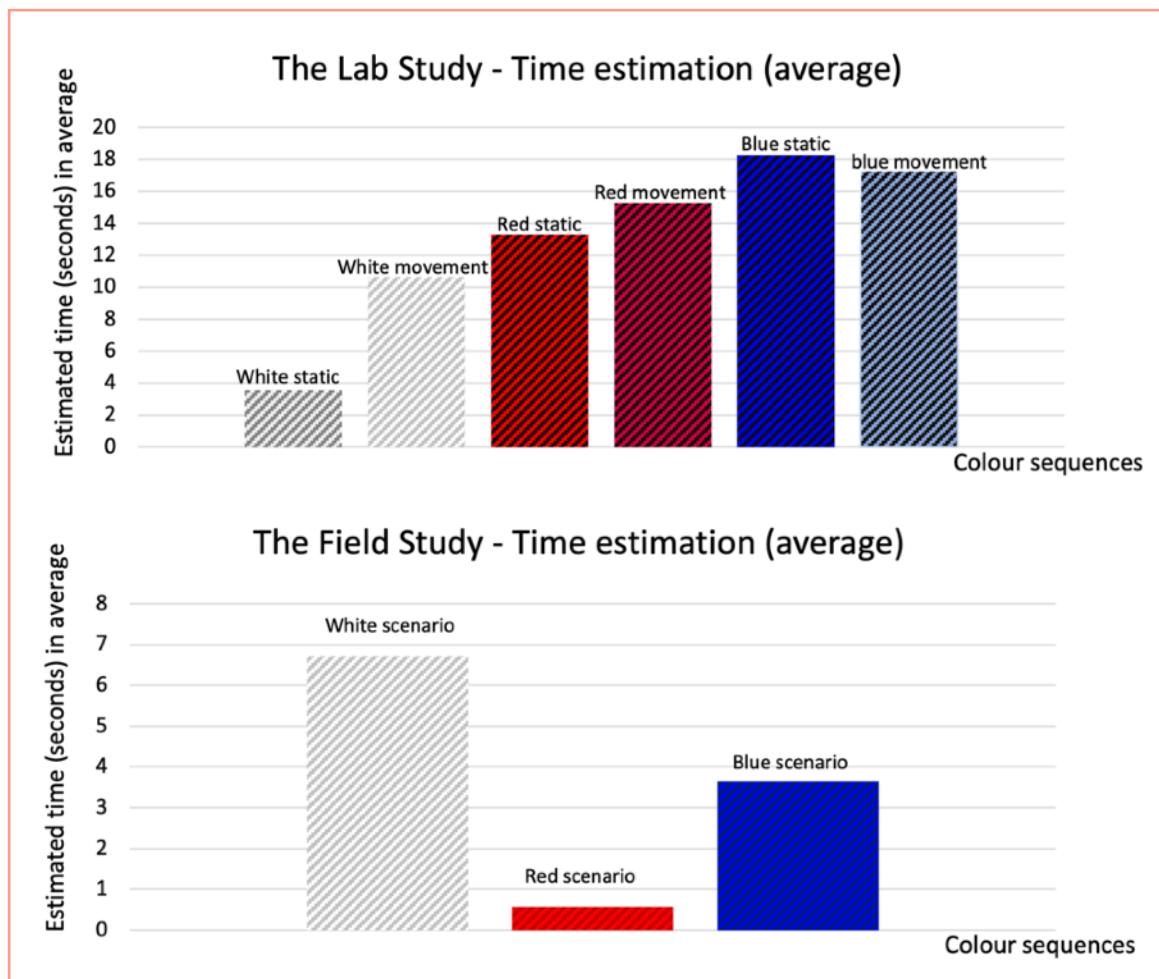
The effect of motion, on the perception of time was not possible to conclude.

The perception of time in blue light in motion, was perceived as shorter than the sequence not moving.

The results of the red and white colours in moving and static showed that sequences in motion was perceived as being longer.

The participants in the Field test described the blue colour as making them feel more *cold, aware*, and *unfocused*, but described the blue light in the Lab test as being *relaxing* and *comfortable*. This supports the described experience in the study of Nielsen (2021) where blue light made them feel *relaxed*, *silence,* and *cold* (Nielsen 2021;168-172).

This might indicate an overall pattern of the perception of blue light, creating a relaxing, fresh, and cold atmosphere. The results of the participants experiences of the colour scenarios, asked in the questionnaire of the Field study distinguish from the study of Nielsen (2021) and the few results in the Lab study.

In both the Field study and the Showroom, questions of how the participants perceived the time, was explained according to the feeling of time moving slowly or quickly compared to the measured time. The understanding of the questions, and how the participant perceive time might be a factor to be aware of. As well as definitions of words.

As seen in Thönes & Stocker (2019) people either understand time and future as ego-moving or time-moving (Thönes & Stocker 2019;117), which affecting how people are perceiving time. Parameters as this, should be considered when asked questions about time perception.

The method was on the other hand chosen based on previous studies, which affects the validity. According to Lübcke (1981) adults in average perceive the time as passing more quickly compared to children. This wasn't clear in the results, where there were no overall connection between age and the perceived time.

All these parameters affecting the perception of time, makes the phenomenon of time a difficult subject to understand. The highly interest of investigating in and understanding the phenomenon of time, might appear from the complexity of time. This complexity affects the results of smaller tests, where the tests limitations only showed an isolated example of perception of time, and overall patterns are almost impossible to conclude.

According to Shibasaki & Masataka (2014) estimated males the duration of the red screen as longer, when women didn't (Shibasaki & Masataka 2014;1). In the Lab study only two men participated, but both of them overestimated the two sequences in red.

In the Field study all 3 men underestimated the duration of time in red light. With such a few amount of participants, it can't be concluded if men overestimated the colour of red. The Showroom test showed how movements in visual stimuli can make the perception of time feel shorter, while static visual stimuli will make the perception of time feel longer. This goes against research from (Yamamoto & Miura 2012) and (Mo 1975), which showed how the perception of time will feel longer when exposed to moving stimuli and complexity.

The three tests were made in a short period of time, to get a quick understanding of the effect of red and blue light. This resulted in limitations and pitfalls, which affected the results.
These limitations of the tests also included awareness of reliability which refers to whether the results can be reproduced under the same conditions or not.
Each of the tests were challenged by reliability since each test had parameters such as noise, dynamics of light, and concentration problems which might affect the results.

Trying to increase the reliability each test was described as specific as possible, guiding to which equipment that has been used, making it easier for future studies.
The Lab study was made with video sequences showed on a smart phone, placed in VR glasses, which might vary in screen quality, light intensity, and the quality of VR-glasses.
The validity in these experiments were a result of the limitations and can't represent over patterns (Scribbr n.d).
The intern validity might be influenced by a lot of factors and variables, such as unfocused participants, impacts from surroundings, and current state of mood. This makes time perception in general, a difficult phenomenon to test, since the perception of time is impacted through a set of subjective factors (Streefkerk 2021).
This also affects the external validity, which needs further investigations for explaining an overall pattern of time perception and to include in future studies. The number of participants makes the results as not representative.
The tests should be seen as quick experiments, testing different methods and seeks to understand the phenomenon of time.

STEP 3

DELIVER

DESIGN CONCEPT

To answer the research question the use of different lighting instruments will be discussed. The aim of this section is trying to understand the effect of light, and how light can tell stories.

The paper from *PLDC* of Hvass & Hansen (2019) made visualisation to combine the findings from the literature study, the potentials and the findings from observations and interviews (Hvass & Hansen 2019;1). This section is inspired by this, including the approach of visual storytelling being *showing not telling*.

The following discussions are according to the two design parameters; composition and colours.

Visualisations can be used as a tool to gain a deeper understanding of the urban architectural design and the potentials of light in urban environments (Hvass & Hansen 2019;1). In the following section a series of visualisations focusing on composition will be made, discussing how angles and placements of light can tell different stories.

The composition of light will be followed by visualisations and discussion of how colours can tell stories and transform urban spaces.

LIGHT AS STORYTELLING

During this thesis it has been discussed what storytelling is, and how light can be a way to presents certain stories. Howard (2009) states that colour and composition are the heart of scenography (Howard 2009;64). The light supports the scenography, and by using colours and different compositions of the light, the atmosphere can completely change.

Different light angles tell different stories and guide the spectator to a certain mood. To tell stories, the designer needs to see, feel, and understand the space.

The idea of storytelling with light in this study, differs from traditional storytelling which overall is based on a certain time, a certain space, and a plot. The light is the narrator, and since light use a silent language, the plot of the story is symbolised through the behaviour of the user, making them a dynamic part of the storytelling. Lights create a certain setting, representing time and support the space, inviting the user to take part in the act or observe it as a spectator. "*We are all narrators in our own lives, in our conversations, the way we act, and interact with the surroundings*" (Fludernik 2009;1).

Since the space is changed by people using it, the visual story of the space will always be dynamic, leaving subjective impressions.

Even the surroundings are in constant change, where weather, traffic levels, or unexpected actions can have a huge impact on the overall impression of the space.

The goal of the approach is to generate more potential for engagement, conversation, and sharing (Walter & Gioglio 2014;8). Visual storytelling is not only about the drama of the space or a specific setting, but also about the atmosphere and the feelings the space leaves *within* the user.

Storytelling is a way of communicating with the surroundings, but instead of only focusing on the actual design, the lens of storytelling makes it possible to do lighting design enhancing both the current visual impression, and the phenomenological experience within the space. Storytelling can be a way to change or enhance the impression and use of a space, while creating an experience around it. Storytelling can furthermore be used as a link to the phenomenon of time, when designing urban scenography.

Light can trigger emotions, and depending on the viewer, can impact the way a space is perceived and experienced (Laganier & van der Pol 2011;392).

According to Laganier & van der Pol (2011) lighting designers can use light to tell stories, used as a communication tool similar when creating music (Laganier & van der Pol 2011;394). Telling stories with light is not only by illuminating buildings or spaces alone, but about evoking reactions in people through the lighting design (Laganier & van der Pol 2011;394).

COMPOSITION
& COLOURS

To answer the research question different examples of how light angles, placement, and colours will be discussed, trying to understand storytelling with light.

On-stage is referring to lighting design in a theatrical context, while off-stage is referring to urban spaces. The two perspectives, on-stage and off-stage, is referring to literature by Keller (2006) representing the theatrical context, and Descottes (2015) and Moyer (2008) representing the outdoor lighting design. The following section is divided into the two design parameters; composition and colours.
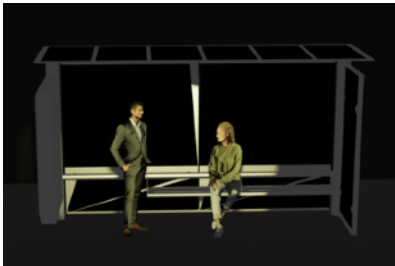
COMPOSITION

ANGLES

• FRONT LIGHT

ON-STAGE

Front light can be used to show details of an object, by highlighting or enhanced visibility of the face expressions. It is not glary for the spectator, why visibility and guiding the eye through the stage are improved. Front light creates contrasts of the highlighted and the space around, which can result in lost of depth but enhance contrasts. By using low intensity light for the front light, it can enhance the atmosphere without loosing the depth (Keller 2006;173).

OFF-STAGE

Front light can be used to improve face recognition and highlights in the space.
In front light, the space around loses contrasts, and the space can end in uniform lighting in all highlighted areas. Front light is often used to create focal points and highlights (Descottes 2015;72-73; Moyer 2008;23).

• BACK LIGHT

ON-STAGE

Backlights can create a dramatic atmosphere, and gives the scene depth. Backlight creates shadows towards the spectators, which can create silhouettes of objects and actors. Backlight is highly used when creating atmospheres (Keller 2006;173).

OFF-STAGE

Backlight can be used to create extreme contrasts. By using backlight it can decrease textures and details, while increasing shapes of objects or people (Moyer 2008;23).

• SIDELIGHT
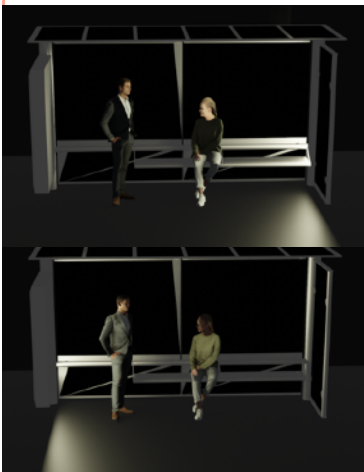
ON-STAGE

Sidelight can be used to create senses of a space, by illuminating the edges of the body and stage.
Shadows created with sidelight can make a space more dramatic and transform the perception (Keller 2006;173).

OFF-STAGE

Sidelight can be used to enhance the edges of space and to increate textures and shapes. Sidelight creates an effect similar to sunlight, which gives character to the space (Descottes 2015;72-73; Moyer 2008;23).

• UP- & DOWN LIGHT
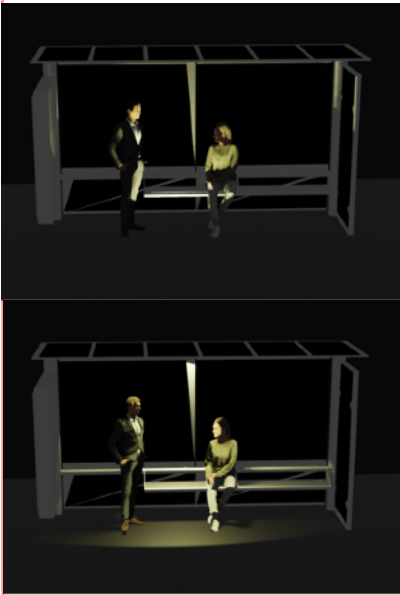
ON-STAGE

Up-light creates strange and unnatural atmospheres and shadows, but is being used to create dramatic effects. Down-light is used to highlight objects, and makes a uniform light.
A concentrated down-light can create contrasts to surroundings (Keller 2006;173).

OFF-STAGE

Indirect uplight can be used to illuminate the ceiling of a space, but is not recommended as the only light source, since it can create unnatural appearance. Downlight can be used to highlight the edges of a space, and can ground the visitor to the space (Descottes 2011;71).

Depending on angles and placement of the light sources, the impression of a space can change immediately.
The angles and placement of the light sources creates varies of impressions, atmospheres, and moods. Through the direction of light, the visual structure of a space can be highlighted, guiding the eye through the space (Descottes 2015;72-73).
Often people don't like to be too exposed, why a combination of different angles, will create a more uniform space, connecting to the surroundings.

Angles in urban planning can be used to create a certain atmosphere or impression. Often different angles are chosen based on the object to illuminate - for example, up light is quite common for illuminating trees. To tell stories with angles, it depends on the wished purpose of the space. Since the experience is a 360 degrees experience, the angles should be considered from all points of view, depending if the space should tell different stories in different point of views or not. By choosing specific angles, this can contribute to a dynamic in the space, leaving the impression differently depending on the angle and perspective of the user or spectator. The use of light and composition can dramatically transform the perception of the user, either to stand out of surroundings or blending in (Descottes 2011;71).

"[…]Perhaps one of the most intriguing aspects of stage lighting design is its ability to transform a small space and transport its viewer into a multitude of imaginary worlds over a short period of time. Here, the varied direction and distribution of light are crucial to the ongoing transformation, as margins and borders of architectural bodies seemingly appear and disappear, divide and unify, guiding a continuum or break of motion through time and space"
(Descottes 2011;73)

As seen in the quote of Descottes (2011) the composition of light is important for transforming a space, which makes possibilities for urban scenography in urban environments.

Placement of light

The hierarchy of light is a tool to create light scenes. Richard Kelly's layers of light (2008) is a way to describe the perceptions of visual designs (Kelly 2008;24). The tool can be used to understand how elements and lights interacts with each other.

The focal glow is represented as the *"follow spot on the modern stage"* (Kelly 2008;25). It draws attention and help people see (ibid). Ambient luminescence is *before-the-show* creating *"lighted dome and produces shadowless illuminations and suggest infinity"* (Kelly 2008;15). Play of brilliants is *"the ballroom of crystal chandeliers and candle flames, it stimulates the body and the spirit - It is distracting or entertaining"* (Kelly 2008;25).

The three functions and impression of light (figure 13), show how the light levels and highlights are placed and how it supports a certain atmosphere. The functional lighting refers to visibility while the ambient luminescence refers to the users and the impression of the space. The play of brilliants contributes to understand the atmosphere and '*magical*' appearance of a space. All together it describes the light of the space, or different ways to tell stories, with the play of brilliants as the mood-setting, atmospheric, and stimulating elements. The elements described by Kelly (2008) can help creating both a functional space, including the purpose of the space, but at the same time add layers of atmospheres and storytelling.
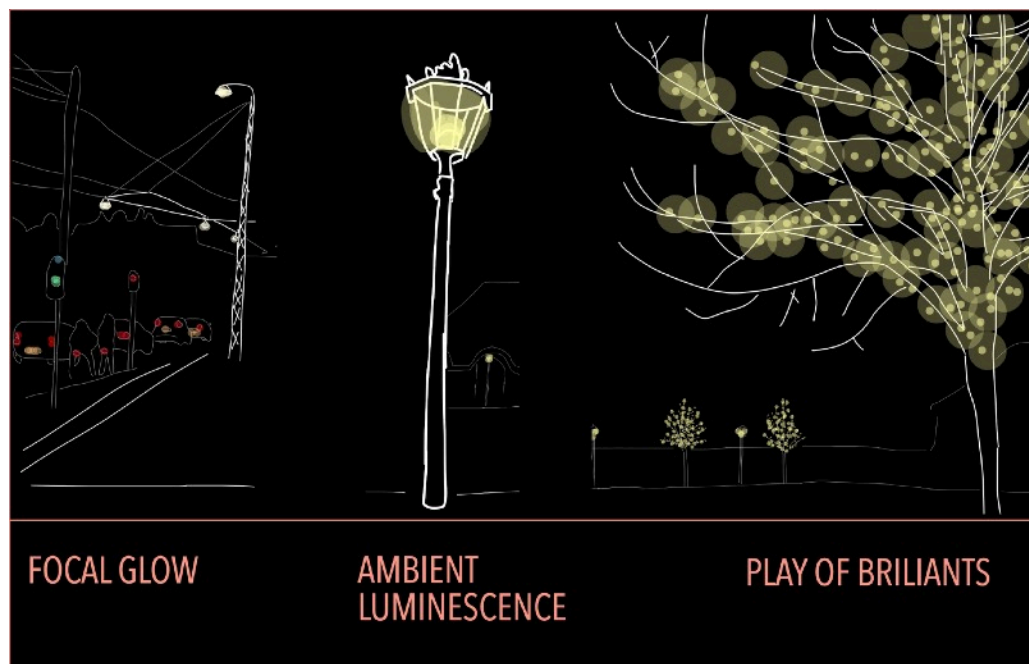
According to Descottes (2011) the relationship between intimacy and spaces can be defines as the distances to light sources (Descottes 2011;54). In private rooms, the height of the light source is placed closer to the eye level, compared to public spaces (figure 14). This leads to the perspective of how the placement of light sources tell stories about the relations to the space. To change the way a space is perceived and used, rethinking the placements and distances might be a way to tell another story.
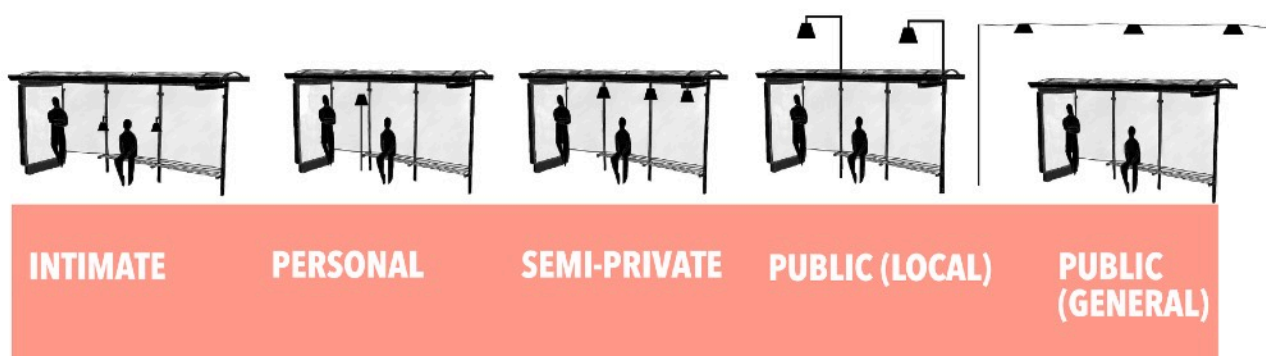
Figure 14: inspired by Descottes (2011) and the relationship between intimacy and height of light source.

By combining different placements of light source, layers of light can be achieved. Not only by considering the height of the light source, but also the effect of it. The choice depends on the placement of the bus stop, and its surroundings. Usually intimate and personal light is not often used in urban spaces, especially not in transportation areas.

COLOURS

Colours can affect the atmosphere and impression of the space, but also influence behaviour of the user. Colours can be used as a way of highlight or create attentions. Colours, As Cook & Mumford (1885) state, is a way to communicate to our emotions (Cook & Malloy 2014;438). It is a useful tool to create atmospheres, and state-of-minds and is often used in the stage of art.
But not only controlled colours might influence the perceiver, also uncontrolled and dynamic colours, as traffic reflections or bluish moonlight can change the overall impression of the space. Studies of how colours and light can have physical and physiological effects are broad discussed through the years.

The use of colours

As previous discussed colours are a tool for scenography to become alive and communicate a wished setting. In urban scenography colours can contribute places to be visual landmarks, or just be out-standing from surroundings. Walking through the city at night, colours appear everywhere creating a certain state of mind.
Colours can attract people, create curiosity, fantasy, and fun (Laganier & van der Pol 2011;105). Slow colour changes are often used, for making it more comfortable for the user, since it refers to natural light (ibid).

Depending on the colour, it can change the mood of the user and the appearance of the space (Laganier & van der Pol 2011;105). By using dynamic a space can become alive and breathing (Laganier & van der Pol 2011;105). The most common use of colours and light found in architectural lighting design is not hues, but differences in the colour temperatures stretching from cool white, to warm. The different colour temperatures are used to create certain atmospheres in urban spaces, to either inform, navigate, highlight, or invite. Coloured light communicates and can invite the user to the space.
According to Porter & Mikellides (2009) there is a need for built environment to engage the mind through form and colour, and the presence of colours creates aesthetic experiences (Porter & Mikellides 2009;21). Colours can create identity to a space and create visual compasses through the city (Descottes 2011;46).

The effect of colours

Colours can be provoking, distracting, and uncomfortable, why many lighting designers often choose dimmed colours or nuances of white light.

According to Peter Andres, an Australian lighting designer, the light is not the most important part of creating environments - It's all about the people using the space, creating environments where they feel comfortable without thinking why (Peter Andres in Laganier & van der Pol 2011;203).
Light can affect the way people are illuminated, and the colour, quality, and composition can change the way people look (Peter Andres in Laganier & van der Pol 2011;203). In cool light people might look ill, and healthier in warmer light (ibid). This supports the idea, that light can tell stories and by creating atmospheres, the perception of the space can change. Francesca Bettridge, an American lighting designer, agree and states that human beings are very sensitive to the balance of light. The way we perceive the users of the space, can have a positive influence and emotional reactions – it's all about how people look in the space (Francesca Bettridge in Laganier & van der Pol 2011;214).


Picture 13: showing how colours can create different moods and tell different stories

Picture 13 is showing different examples of how colours can affect the appearance of the face.

Red light creates a warm, dramatic, and intense scene. Keller (2006) describes the red colour expressing living power and energy, while blue has a peaceful and cold effect (Keller 2006;40). In the blue visualisation it shows how the blue colour creates a coolness to the scene, and make the illuminated face look cold and spacy.

The angle and intensity of the colour have a huge effect on the shadows created, which can create depth and characteristics to the scene. Picture 13 illustrates the colours and angles effect on a face, which according to the waiting experience is relevant for social interactions within the bus stop, and the appearance from a spectator view.
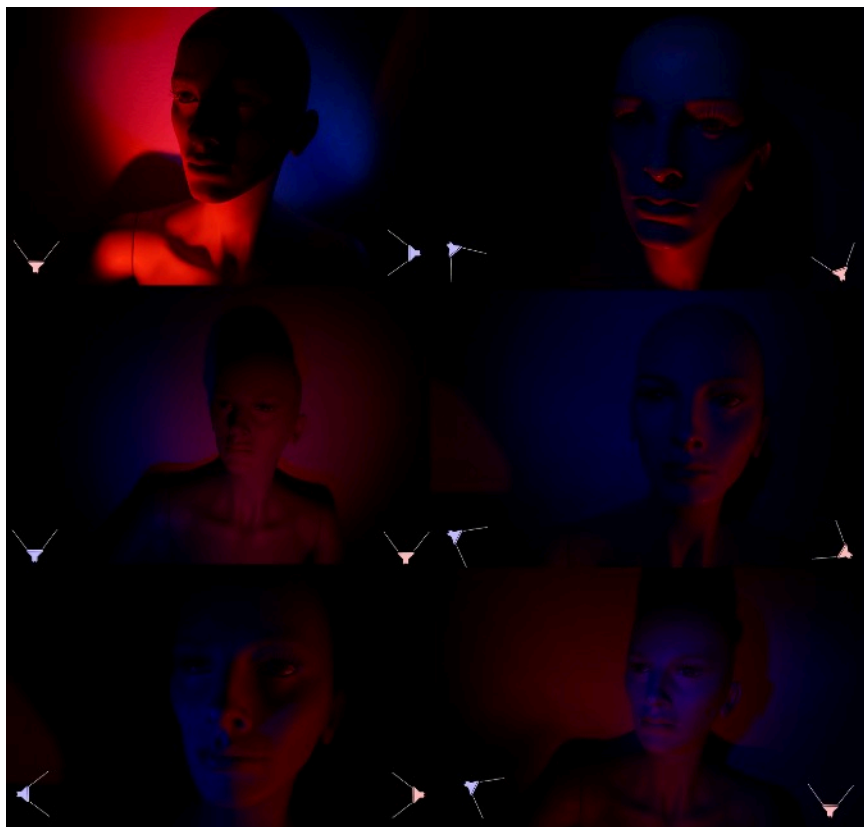
Picture 14: shows a combination of red and blue lights

Picture 14 is showing how a combination of light sources and colours can change the appearance of the face, and how the play of colours can tell other stories, depending on the aim.

Picture 15: illustration of how colours can change the appearance of the space

Picture 15 shows how colours can change the appearance of the scene, linking to the waiting experience. The picture shows how the use of blue and red light, can tell different stories of the time waited. Seen in picture 15 the blue light gives a clinic and cold vibe, while the red colour represents a warmer feeling.

Cook & Malloy (2014) explain, among others, how the use of colours can have a significant impact on moods and that cool colours (such as green or blue) can decrease the pulse rate, a calm sense, and even enhance creativity, while warm colours (red and yellow) can have the opposite effect (Cook & Malloy 2014;438).
Blue light makes a space appear cold, calm, and floating while a red room leaves the users with feelings of alertness, being awake and grounded (Nielsen 2021;38+114).

In these illustrations the colours of light within the pictures are edited, which will not give the real realistic illustration, but can be a quick way to see how colours can change the atmosphere and stories of the space.

According to this research, it showed how blue light makes the perception of time feel longer. Using the colour of blue can create a timeless, floating space, inviting to relaxation and emptiness.

Red light might make the perception of time feel faster, why using the colour of red can create a warm atmosphere, inviting to awareness and self-care.
As seen in the experiments red and blue colour might influence how we perceive a space. Linking to the tests in this thesis, different colours might be a way to affect the perception of time. Blue light can create a space where time passes slowly, inviting the user to mental breaks and relaxation. Red light can create a scene, where awareness and arousal are increased, using the red light to make the perception of time feel shorter.

DISCUSSION

As seen in the design proposal, colours and composition of the light can transform the appearance of a space and create atmospheres which can be a way to tell stories with light. But light doesn't use words, which make the idea of using storytelling in architectural lighting design a diffuse concept. On the other hand, the idea of designing urban scenography in city spaces, can impact the relations to the space, and tell stories of a visual contrast to the surroundings through light.

By using storytelling as a tool for lighting designers, the aim is to understand how to design urban spaces, leaving the users with a certain atmosphere and purpose. Storytelling should be seen as a perspective, a *lens of storytelling*, helping the lighting designer to merge the theatrical lighting design and the architectural lighting design, leading to urban scenography as the actual outcome.
Storytelling is much more than atmospheres, why thinking of how light itself can tell stories is a great challenge for the lighting designer.
The idea of light and colours can affect the perception of time, can be linked through storytelling when designing urban scenography.

Storytelling as an approach, can be used to rethink the design, where colours and composition can change the feelings of the space. The stories of light might not always be clear, leaving different impressions in the receiver, but it might either be provoking or evoking. Urban scenography can be an artistic or scenic touch to the general architectural lighting design.

The perception and preferences of urban spaces are subjective will depend on other circumstances or parameters, affecting the current mood, and therefore how we perceive the surroundings. According to Böhme (2018) is scenography a way to relate common feelings in the perceiver, why urban scenography might be able to affect the perception of space.

In the understanding of how light can affect the perception of time, three experiments were made. In the experiments, it showed how the perception of time exposed to different colours were differently among individuals but also differs according to the test methods. As seen in the tests, the results vary depending on the specific task.

There was no overall pattern in the colour of light and the perception of time. The results, anyway, showed that the experience of colours might be collective described, based on the research of this study.

The tests also created interesting findings, showing that colours might somehow affect the perception of time, but the differences of red and blue needs to be tested more. As seen in the results of previously researchers, different results of how red and blue light can affect the perception of time were discussed, which might indicate that either there are way more parameters influencing the result, or there can be a different comparing screen light with electric light. This might be shown in the PhD study of Nielsen (2021) and the feel of light. It is known that mange psychological factors can have an influence on the perception of time, why it's difficult to investigate time and colours, only as isolated factors.

The pre-analysis was made to translate the knowledge into an existing outdoor space, in this case according to the waiting experience within bus stops.

The link rise discussion of the appropriate use of urban scenography in transportation areas, which should be considered in future works. There is a potential in re-designing bus stops, making the experience even more comfortable, inspiring, or memorable.

This knowledge could be found in the observations of this thesis combined with new research.

Urban scenography might only be outstanding if it differs from surroundings, why urban scenography can't be used everywhere.

By using a non-place, in this case a bus stop, it immediately forms thoughts of the important of making non-places to places.

Maybe some non-places should be left as non-places, and instead of trying to enhance the relation to the space, maybe the space should be seen as a necessary contrast to surroundings. On the other hand, by choosing a non-place it creates possibilities for an even bigger effect on the behaviour, relations to the space, and possibilities to tell stories.

Even though mental breaks are important for well-being (Fritz, Ellis, Demsky, Lin & Guros 2013;279), this thesis will not decide rather the waiting time should be considered longer or shorter but investigate in the possibilities for changing the current experience. The aim was to understand how the use of light can affect the perception of time, and how this knowledge can be used to design urban spaces, depending on the purpose of the space.

According to Peter Andres, Australian lighting designer, the lighting design needs to be a concept in relation to the conditions of the surroundings (Peter Andres in Laganier & van der Pol 2011;151), why urban scenography falls in the space between the architectural lighting design, and the theatrical lighting design.

Since bus stops are located close to roads and traffic zones, it needs to fulfil some standards about light levels, visibility, and avoiding glare etc. This way urban scenography distinguishes from general outdoor lighting design. Outdoor lighting designers need to fulfill Standards and recommendations for street light, which consider surroundings, environment, and behaviour.

Several considerations need to be made according to restrictions, guidelines, and masterplans of outdoor lighting, which is not included in this thesis.

Outstanding lighting design, differing from surroundings, will either evoke or provoke, depending on the individual perceiving it. The effect is therefore hard to define, so the outcome of the experience might vary if its positive or negative.

According to Manav Bhargava, an Indian lighting designer, it's about giving them something to remember – even for a few moments (Manav Bhargava in Laganier & van der Pol 2011;221).

The freedom to explore a space, without be told what to perceive or what to think, is according to Roger Narboni, French lighting designer, one key element in his design. He leaves the people the freedom to think, without telling them what they should be seeing (Roger Narboni in Laganier & van der Pol 2011;339).

Storytelling can be a way to achieve that.

By using the idea that colours can affect the perception of time, it creates a lot of new possibilities in the lighting design field.

CONCLUSION

The phenomenon of time is a complex concept, which includes not only the measured time but also the subjective time.

Different elements can affect the perception of time, one way is storytelling.

Storytelling has the effect of engaging the listener and creates a parallel universes making time and space diffuse for a moment. Storytelling is more than just written or spoken words and can also be related to urban lighting design in a visual language.

This thesis seeks to understand how light can be used to tell stories, and how light can affect the perception of time. In this thesis it was discussed if storytelling can be an approach for designing urban spaces and to include the phenomenon of time.

Recent years, researchers have discussed how blue and red light can make the perception of time either go faster or slower, and how elements such as moving stimuli and complexity also might effect how we perceive time. Three experiments were made to answer this question, focusing on each field of science.

The test was inspired by design research and divided into the Lab study, the Field study, and the Showroom.

The experiments showed that the perception of time, when exposed to blue light, was perceived as longer compared to red light. These results were shown in both the Lab study and the Field study. In the Lab study blue light was perceived longest, while the white light was perceived as shortest. In the Field study the perception of time felt more slowly within the white light, and fastest in the red light.

In the questionnaire of the Field study, the participants in average expressed that the time perception within the blue light was perceived as being longest, and shortest for the red light. But their estimated times showed something else.

The white colour was used as a control group, and the time perceived within this colour varied from being perceived as the shortest in the Lab study, and the longest in the Field study.

The effect of motion, on the perception of time was not possible to conclude. The perception of time in blue light in motion, was perceived as shorter than the sequence not moving. The results of the red and white colours in moving and static showed that sequences in motion was perceived as being longer.

The Showroom study showed how the participants perceived time as passing most quickly in coloured room, and time felt passing most slowly in the white room.

The findings of the three tests showed different results which might be a result of a different subjective parameters.

The tests were made as a quick way of understanding the effect of light, and were made in a short period of time, which of course cause limitations and pitfalls. The amount of test subjects can't conclude certain overall pattern on how light can affect time perception, but the results definitely makes room for interest, and further investigation.

The discussion about how light can tell stories, relating to urban scenography, creates overall considerations when doing urban lighting design. Storytelling can be used as an approach, when designing urban scenography, including the phenomenon of time. The approach can be a way to enhance associations and invite to certain behaviours in the place. The perspective of storytelling, or *the lens of storytelling*, doesn't differ much from how good architectural lighting designers already work, but makes possibilities to transform and design urban spaces into urban scenography. With further experiments and tests, this understanding of *how colours can affect the perception of time*, might become an interesting approach when designing urban spaces.

The understanding of the phenomenon of time can give architectural lighting designers new possibilities when designing urban spaces.

FUTURE WORK

This thesis gives rise to interesting questions, but to get a better understanding of how light can affect the perception of time more investigation in this topics needs to be done. To understand how urban scenography can be used to tell stories, this study only focuses on electric light, and not natural light.

For designing urban scenography fundamentals of the light needs to be considered, such as the suns movement, the amount of daylight and reflections in the space, and how material together with electric or natural light can change a space immediately. Also the appearance of shadows, and how colours and composition of light can increase shadows which also have a huge part of the storytelling perspective.

When doing lighting design in outdoor spaces Standards and recommendation should be included, why a discussion of how to merge the artistic light with the functional light in practice would be relevant.

Others aspect of the topic, such as how different colours (beside from red and blue) can influence the perception of time. An example could be testing with amber light, as Nielsen (2021) use as one of her light scenarios in her studies, besides from blue, white, and red.

The design parameters colours and composition need to be tested further and create an even better connection to outdoor spaces. Composition is only discussed in the design proposal, why for a deeper understanding of the effect, test with this focus area needs to be made in future research.

In this study the focus was on how light can affect the perception of time, why only a pre-analysis of a bus stop was made, and not a deep understanding on the behaviour, use, and potentials. An interview of how people perceive the existing places and how they feel within the space, makes potentials for improvements, and make sure that the behaviour of the users is included in the final concept.

An actual test within a bus stop could also be relevant. This could seek to understand be a if there are any differences depending on the outdoor setting and surroundings. This could also be used to discuss how different lighting designs can create different identity, or stories of the space.

Another interesting area to focus on, is the activity while the users are being tested.

An investigation of the connection between light, boredom, and routines could give a deeper understanding why the time might feel different in each light scenario, and to understand which certain behaviour the light should invite to.

CREDITS

Figures

All figures are re-designed according to this thesis.
Some figures are inspired by literature, which is shown in the following list:

3. (Madsen 2015-2016;57)
4. (Madsen 2015-2016;52)
5. (Design Council 2022)
6. (Hansen & Mullins 2014;619)
9. Moodboard*
13. Kelly (2008)
14. (Descottes 2011;55)

*references for the moodboard are shown in Picture credit

Pictures

The following picture credits are according to the moldboard (figure 10)
Pictures which are not credited here, are either legally received from Pixabay or taken by the author in
relation to the thesis

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